

Carl C. Gaither  
Alma E. Cavazos-Gaither *Editors*

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# Gaither's Dictionary of Scientific Quotations

*Second Edition*

Volume 2

# **Gaither's Dictionary of Scientific Quotations**

**Second Edition**



# Gaither's Dictionary of Scientific Quotations

**A Collection of Approximately 27,000 Quotations Pertaining to Archaeology, Architecture, Astronomy, Biology, Botany, Chemistry, Cosmology, Darwinism, Engineering, Geology, Mathematics, Medicine, Nature, Nursing, Paleontology, Philosophy, Physics, Probability, Science, Statistics, Technology, Theory, Universe, and Zoology**

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**Second Edition**



**Springer**



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# Preface to the Second Edition

*No man reads a book of science from pure inclination.*

Samuel Johnson  
*The Life of Samuel Johnson*, 1791 (p. 399)

Recently, in a library, I took a book from a shelf which, not to my surprise, I found had been opened only a few times. My wife remarked that it was a shame that this book, which had been at the library since 2002, had been so rarely used and how unfortunate it is that so many of the students of today do not take the time to read the wealth of wisdom available in libraries.

It is now three years since *Gaither's Dictionary of Scientific Quotations* was first published. The 18,000 quotations in the first edition may seem like an embarrassment of riches, but we were amazed at the wealth of language and insight still to be uncovered. This second edition has been updated with the addition of 9,000 new quotations, which increases the depth and breadth of the various thematic categories. Additionally, we have restructured and expanded the thematic categories, helping readers to find a quotation of interest more quickly.

Among the new quotations are a number that have been culled from early, difficult-to-find books and journals. Also included are a selection of quotations that are documented as "author undetermined." These and all of the other new quotations add material to the quality and depth of the collection.

Since the publication of the first edition, we received many comments asking us why a quotation was entered under a specific theme. Our answer is that all classifications are imperfect, and another subject area may have been as good a choice as ours. If the quotation is not placed where you would have placed it, we are not implying that it could not have gone elsewhere. Additionally, the themes are labeled because we thought that each label provided the best example of what type of quotations would be found there. Fortunately, there is also an author index and, in the e-book version, a more direct means of searching for a relevant quotation. We hope that you will find the perfect quotation to connect your class lecture, paper presentation, or essay to a larger context. Just browsing the entries makes for a fascinating journey through science and culture.

Killeen, TX, USA

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Alma E. Cavazos-Gaither



# Preface to the First Edition

In putting before you, the reader, this collection of 18,000 quotations seems fitting to discuss how a book such as this came about. In 1995, I told a librarian friend that I was deeply frustrated in my attempts to find quotations on statistics. I told her that although there were a few books with some quotations available, it was quite clear that each author had very different opinions of how to approach the subject. For example, both Alan Mackay and Isaac Asimov wrote books of science quotations that were organized thematically, but in them the quotations were often misstated and the documentation was sparse or nonexistent. The books were, however, the state-of-the-art for that time. Another example, Maurice B. Strauss's book *Familiar Medical Quotations*, provided good documentation but, understandably, the quantity of quotations pertaining to science as compared to medicine was limited. As I explained the failings of the extant literature, my friend looked up from her desk and quietly asked, "Well, why don't you compile one?"

I took this idea to my wife, who agreed to work with me on this task. Over a 10-year period, we wrote a series of books that contained quotations from several fields of science. These books came to be known as the Speaking Series (Institute of Physics Publishing, Bristol, UK) and were written, like the current revised and greatly expanded compendium, for a broad audience of scientists as well as lay people like ourselves who do not claim expertise in the many scientific fields.

Science is a dynamic force in virtually every sphere of life. At the beginning of the twenty-first century, few readers will need to be convinced of the enormous impact of science on art, politics, literature, commerce, education, communications, entertainment, judiciary matters, and—often intensely—on religion, and ethics. It is our opinion that the average reader of this book—whether engineer or technician, architect or artist, doctor or nurse, physicist or astronomer, poet or novelist, mathematician or statistician, teacher or student, atheist or believer—should find a great number of quotations pertaining to his or her individual interest. Furthermore, the juxtaposition of the many views may be thought provoking.

A dictionary normally consists of an alphabetical arrangement of words and their meanings. In this dictionary, instead of words we have given an alphabetical arrangement of over 2,000 *thematically* organized categories pertaining to science. Feedback from our previous books indicated that this format was preferred over an author-arranged selection of quotations. The presentation order of the quotations within each subject theme is arranged alphabetically by author. Other quotations of a particular author can be found in an author index.

Our quotation choices were largely influenced by the availability of books, magazines, journals, and newspapers; in turn, to make it as simple as possible for the reader to obtain our sources we provide our bibliographic references from what we hope are readily accessible sources. Also, for journal articles we strive to provide the actual page number where the quotation may be found, rather than just the first page of the article in which the quotation appears. Brief biographical information (birth/death date and occupation)

is given when at all possible. We were able to provide this contextual information because we were fortunate to have a publisher who did not deem the cost of including this information excessive.

The reader who needs to research a quotation in greater detail can use bibliographical information to find (1) other relevant data; (2) a fuller quote containing other interesting ideas; and (3) the context in which the quotation was used. Where we could not determine where a quotation was originally written we were obliged to use the quotation from a secondary source, and we list the reference where that has been done. Unfortunately, some very good quotations were bypassed and not included because we could not determine where they originated. As it is, about 100 of such quotations are included and have been credited, regrettably but by necessity, as “Author undetermined,” “Source undetermined,” or both. Despite unavoidable omissions, we hope that this book will provide a rich resource that allows you, the reader, to find relevant quotations or citations quickly, and will serve to inspire your search of the literature.

This dictionary, founded on the quotations from our nine previous books, contains over 7,000 additional quotations and provides by far the greatest number of scientific quotations that has appeared in any single published form to date. In addition, supporting information, such as source of the quotation and biographical information, are greatly expanded beyond any previously published effort.

Our three objectives in compiling this book were as follows: first, to show the diversity and the richness of the various sciences from a variety of literary genres; second, to demonstrate that people from virtually every settled land and continent have given science a great deal of thought from 2000 BCE and earlier to the present time; and third, to provide a resource of thought-provoking ideas useful to anyone involved in just about any aspect of science or in any of the areas noted above, which are greatly influenced by the sciences.

In our attempt to fulfill these objectives, we acted merely as collectors of quotations from many sources and from many areas of science. Here in this vast collection of quotations are the words of great philosophers and thought influencers of science, past and present. Included are better known and lesser known thinkers of the classic Greek and Roman times, religious leaders, and philosophers from the Renaissance to the present. Many times an individual has spoken or written a statement pertaining to some aspects of science that was destined to live on and have meaning beyond the immediate context in which it was made. We hope you enjoy a pleasant and stimulating journey through the forest of ideas of scientists, laymen, politicians, novelists, playwrights, and poets about the human search for and attainment of scientific knowledge.

Max Delbrück, a physicist turned biologist, said in his Noble lecture “A Physicist’s Renewed Look at Biology: Twenty Years Later” that “the books of the great scientists are gathering dust on the shelves of learned libraries.” Somewhere else we read: “...often we rake in the litter of the printing press whilst a crown of gold and rubies is offered us in vain.” Unfortunately, these “gems”—these ideas—are often lost to us before they have time to become established in the collective memory of readers. It has been our concern that much of this wit and wisdom is read once and returned to the library shelf to be heard of no more. It seemed that these ideas, hidden within obscure chapters of books, both fiction and nonfiction, or on pages between covers of long forgotten articles in journals, should once again see the light of day. Apart from the practical day-to-day use of doing so, it is valuable that a new generation see lost or forgotten quotable maxims, proverbs, aphorisms, epigrams, jokes, poetry, songs, and quotations so the young may appreciate their charm and interest.

We extend our thanks to the many publishers and authors for their kind permission to use copyrighted material from their works. For any inadvertent violation of copyright we beg forgiveness.

We would especially like to thank David Packer of Springer for his editorial guidance, and Kathleen McKenzie for her copyediting and her many valuable comments and suggestions, and for her help with fact checking.

We also wish to thank the following libraries for allowing us to use their collections:

The Perry–Castañeda Library of the University of Texas, Austin, Texas.  
The Physics-Math-Astronomy Library of the University of Texas, Austin, Texas.  
The Life Science Library of the University of Texas, Austin, Texas.  
The Engineering Library of the University of Texas, Austin, Texas.  
The Geology Library of the University of Texas, Austin, Texas.  
The Baylor University Library, Waco, Texas.  
The Mary Hardin-Baylor Library, Belton, Texas.  
The Central Texas College Library, Killeen, Texas.  
The University of South West Texas Library, Georgetown, Texas.  
The McNeese State University Library, Lake Charles, Louisiana.  
The University of Richmond Library, Richmond, Virginia.  
The Killeen Public Library, Killeen, Texas.

No claim for completeness is made, for completeness is impossible in a book of this type; nor has any attempt been made to provide balance in the quotations between the needs of the general reader and the specialist. It would have been impossible for us to document each person’s favorite scientific quotation, and thus we know that this book will suffer the fate of other literary, artistic, or musical work that attempts a broad overview: Stern critics will find fault with the omission of what they perceive as an important quotation from their respective fields. We must ask these critics to remember that our aim in compiling this book has been to save both great and not-so-great words pertaining to science and to add unmistakable value to that, which can be retrieved from the Internet, regardless of the time and effort expended by any who searches there. Within these works we found surprising and often incredible quotations pertaining to science. Just as certain views about science represented in quotes of years long past are not necessarily those of the authors, certain opinions that are stated therein concerning women, and persons of various nationalities, creeds, and races, are clearly not reasonable in an age when belief in the equality of all people—including a person’s inherent capacity to contribute to scientific thought—is a shared ideal.

Steven Skiena stated in his book, *The Algorithm Design Manual*, “It is traditional for the author to magnanimously accept the blame for whatever deficiencies remain. I don’t. Any errors, deficiencies, or problems in this book are somebody else’s fault, but I would appreciate knowing about them so as to determine who is to blame.” While we are in sympathy with this, we still believe that any errors are our responsibility and we would appreciate they be called to our attention. For our critics we are sure you will be able to suggest improvements.

Killeen, TX, USA

Carl C. Gaither  
Alma E. Cavazos-Gaither



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## A

### A PRIORI

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

It is much more high and philosophical to discover things *a priori* than *a posteriori*. And therefore the Peripatetics have not been very solicitous to gather experiments to prove their doctrines, contenting themselves with a few only, to satisfy those that are not capable of a nobler conviction. And indeed they employ experiments rather to illustrate than to demonstrate their doctrines.

*The Sceptical Chymist*

Introductory Preface (p. 20)

J.M. Dent & Sons. London, England. 1911

**Hertz, Heinrich** 1857–94

German physicist

...we cannot *a priori* demand from nature simplicity, nor can we judge what in her opinion is simple.

Translated by Daniel Evan Jones and John Thomas Walley

*The Principles of Mechanics Presented in a New Form*

Introduction (p. 23)

Macmillan & Company Ltd. London, England. 1899

**Huxley, Thomas Henry** 1825–95

English biologist

No man who has to deal daily and hourly with nature can trouble himself about *a priori* difficulties. Give me such evidence as would justify me in believing anything else, and I will believe that. Why should I not? It is not half so wonderful as the conservation of force, or the indestructibility of matter. Whoso clearly appreciates all that is implied in the falling of a stone can have no difficulty about any doctrine simply on account of its marvellousness.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XVI (p. 234)

D. Appleton & Co. New York, New York, USA. 1916

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

There is nothing physical to be learned *a priori*. We have no right whatever to ascertain a single physical truth without seeking for it physically, unless it be a necessary consequence of other truths already acquired by experiment, in which case mathematical reasoning is alone requisite.

*Lectures on Some Recent Advances in Physical Science, With a Special Lecture on Force*, (3rd edition)

Lecture I (p. 6)

Macmillan & Co Ltd. London, England. 1885

**Taylor, Bert Leston** 1866–1921

American Poet

Behold the mighty Dinosaur,  
Famous in prehistoric lore,  
Not only for his weight and strength  
But for his intellectual length.

You will observe by these remains

The creature had two sets of brains—

One in his head (the usual place),

The other at his spinal base.

Thus he could reason *a priori*

As well as a posteriori.

*A Line-o'-verse Or Two*

The Dinosaur (p. 75)

The Reilly & Britton Co. Chicago, Illinois, USA. 1911

### ABACUS

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

“Oh, now, don’t underestimate the abacus,” said Reg. “In skilled hands it’s a very sophisticated calculating device. Furthermore it requires no power, can be made with any materials you have at hand, and never goes bing in the middle of an important piece of work.”

*Dirk Gently’s Holistic Detective Agency*, (pp. 24–25)

Simon & Schuster. New York, New York, USA. 1987

### ABERRATION

**Herschel, Friedrich Wilhelm**

(Sir William)

1738–1822

English astronomer

Aberration would forever have remained a secret to us if it had not been found out by other methods than that of time-keepers.

*Astronomical Observations on the Rotation of the Planets Round Their Axes*

*Philosophical Transactions of the Royal Society of London*,

Volume 71, 1781 (p. 116)

### ABILITY

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...natural abilities are like natural plants, [they] need pruning by study ...

*Bacon’s Essays*

Of Studies (p. 472)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1875

### ABIOGENESIS

**Loeb, Jacques** 1859–1924

German-born American physiologist and biologist

Will it be possible to solve these problems? It is certain that nobody has thus far observed the transformation of

dead into living matter, and for this reason we cannot form a definite plan for the solution of this problem of transformation. But we see that plants and animals during their growth continually transform dead into living matter, and that the chemical processes in living matter do not differ in principle from those in dead matter. There is, therefore, no reason to predict that abiogenesis is impossible, and I believe that it can only help science if the younger investigators realize that experimental abiogenesis is the goal of biology.

*The Dynamics of Living Matter*

Lecture XII (p. 223)

The Columbia University Press. New York, New York, USA. 1906

## ABJURATION OF GALILEO

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

I Galileo Galilei, son of the late Vincenzo Galilei, of Florence, aged seventy years, being brought personally to judgment, and kneeling before you, Most Eminent and Most Reverend Lords Cardinals, General Inquisitors of the universal Christian republic against heretical depravity, having before my eyes the Holy Gospels, which I touch with my own hands, swear, that I have always believed, and now believe, and with the help of God will in future believe, every article which the Holy Catholic and Apostolic Church of Rome holds, teaches, and preaches. But because I had been enjoined by this Holy Office altogether to abandon the false opinion which maintains that the sun is the centre and immovable, and forbidden to hold, defend, or teach, the said false doctrine in any manner, and after it had been signified to me that the said doctrine is repugnant with the Holy Scripture, I have written and printed a book, in which I treat of the same doctrine now condemned, and adduce reasons with great force in support of the same, without giving any solution, and therefore have been judged grievously suspected of heresy; that is to say, that I held and believed that the sun is the centre of the world and immovable, and that the earth is not the centre and moveable, Willing, therefore, to remove from the minds of Your Eminences, and of every Catholic Christian, this vehement suspicion rightfully entertained towards me, with a sincere heart and unfeigned faith, I abjure, curse, and detest, the said errors and heresies, and generally every other error and sect contrary to the said Holy Church...

*Life of Galileo Galilei: With Illustrations of the Advancement of Experimental Philosophy*

Chapter XIII (pp. 188–189)

William Hyde & Co. Boston, Massachusetts, USA. 1832

## ABORTION

### Author undetermined

Why not outlaw heterosexuality instead of abortion?  
Strike at the source!

Source undetermined

**Given, William P.**

Physician

After it became legal, I tried performing them for a while. But when I'd get home I'd feel rotten. And yet I absolutely feel it's a woman's right. So now if a patient wants one I refer her to someone else, someone I know is skilled and reasonably priced. Does that make me a hypocrite?

In Louise Kapp Howe

*Moments on Maple Street*

Chapter Three (p. 21)

Macmillan & Co. New York, New York, USA. 1984

**Hachamovitch, Moshe**

American physician

By and large, legal or not, the procedure is still a pariah of our specialty.

In Louise Kapp Howe

*Moments on Maple Street*

Chapter Three (p. 21)

The Macmillan Company. New York, New York, USA. 1984

**Hippocrates** 460 BCE–377 BCE

Greek physician

...I will not give to a woman a pessary to produce abortion.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Oath (p. xiii)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kennedy, Florynce** 1916–2000

American black activist and lawyer

If men could get pregnant, abortion would be a sacrament.

The Verbal Karate of Florynce Kennedy

*Ms.*, March, 1973 (p. 2)

**Nolan, James Joseph**

No biographical data available

Physicians roasted on the spit;

Is learning the name of it?

For complications, spare no precaution;

To save a life think abortion.

On Renewed Maternal Mortality Reports

*The New England Journal of Medicine*, Volume 286, Number 17, April 27, 1972 (p. 952)

**Pope Pius XI** 1857–1939  
Bishop of Rome and Italian scholar

However we may pity the mother whose health and even life is imperiled by the performance of her natural duty, there yet remains no sufficient reason for condoning the direct murder of the innocent.

*Casti connubii*

December 31, 1930

**Reagan, Ronald W.** 1911–2004  
40th president of the USA

I've noticed that everybody that is for abortion has already been born.

Presidential campaign debate, Baltimore, Maryland, 21 September, 1980

**Tertullian** ca. 162–224  
North African theologian

It's a committing murder before hand, to destroy that which is to be born.

*Apologeticus*

IX, 197

Printed by Thomas Harper. London, England. 1655

## ABSOLUTE ZERO

**Kimball, Arthur Lalanne** 1856–1922  
American physicist

The absolute zero of temperature has to the physicist all the fascination that the North Pole has to Arctic explorers, and is probably even more difficult to attain.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
(Volume 4)

The Relations of the Science of Physics of Matter to Other Branches of Learning (p. 82)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

## ABSORPTION LINE

**Bunsen, Robert Wilhelm Eberhard** 1811–99  
German chemist

At the moment I am occupied by an investigation with Kirchhoff which does not allow us to sleep. Kirchhoff has made a totally unexpected discovery, inasmuch as he has found out the cause for the dark lines in the solar spectrum and can produce these lines artificially intensified both in the solar spectrum and in the continuous spectrum of a flame, their position being identical with that of Fraunhofer's lines. Hence the path is opened for the determination of the chemical composition of the Sun and the fixed stars.

*The Life and Experiences of Sir Henry Enfield Roscoe*

Letter from Robert Bunsen to H.E. Roscoe, November, 1859 (p. 71)

London, England. 1906

## ABSTRACTNESS

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Abstractness, sometimes hurled as a reproach at mathematics, is its chief glory and its surest title to practical usefulness.

*Mathematics* (p. 19)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

The root of these troubles seems to be the unimaginative lack of a clearly recognized objective. If the aim is merely to create new theories which many find intensely interesting and even beautiful, then the abstract method keeps on reaching its goal.

*The Development of Mathematics* (p. 248)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

'If it is not abstract it is not mathematics' might be taken as a touchstone for discriminating between mathematics and other departments of precise investigation.

*The Handmaiden of the Sciences*

Chapter 1 (p. 5)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Dickens, Charles** 1812–70  
English novelist

Men talk of nature as an abstract thing, and lose sight of what is natural while they do so.

*Nicholas Nickleby*

Chapter XLVI (p. 458)

John Sherratt & Son. Altrincham, England. 1948

**Einstein, Albert** 1879–1955  
German-born physicist

Anyone who has ever tried to present a rather abstract scientific subject in a popular manner knows the great difficulties of such an attempt.

In Lincoln Barnett

*The Universe and Dr. Einstein*

Forward (p. 1)

William Sloane Associates. New York, New York, USA. 1948

**Gell-Mann, Murray** 1929–  
American physicist

In our work we are always between Scylla and Charybdis; we may fail to abstract enough, and miss important physics, or we may abstract too much and end up with fictitious objects in our models turning into real monsters to devour us.

Quarks

*Acta Physica Austriaca*, Supplement 9, 1972 (p. 760)

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

The test of any organizing principle is its success in rendering specifics, not its status as abstract generality.

*Time's Arrow, Time's Cycle: Myth and Metaphor In The Discovery of Geological Time*  
Chapter 1 (p. 15)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

**Joubert, Joseph** 1754–1824  
French moralist

How many people become abstract in order to appear profound! Most abstract terms are shadows that conceal a void.

Translated by H.P. Collins  
*Pensées and Letters of Joseph Joubert*  
Chapter XI (p. 88)  
Books for Libraries. Freeport, New York, USA. 1972

**Kemeny, John** 1926–92  
Hungarian-born mathematician

If you have a large number of unrelated ideas, you have to get quite a distance away from them to get a view of all of them, and this is the role of abstraction. If you look at each too closely you see too many details. If you get far away things may appear simpler because you can only see the large, broad outlines; you do not get lost in petty details.

In Douglas M. Campbell and John C. Higgins (eds.)  
*Mathematics: People, Problems, Results* (Volume 3)  
Rigor Versus Intuition in Mathematics (pp. 226–227)  
Wadsworth, Inc. Belmont, California, USA. 1984

## ABSTRACTION

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Although there is a most intimate connection, and almost an identity between the ways of human power and human knowledge, yet, on account of the pernicious and inveterate habit of dwelling upon abstractions, it is by far the safest method to commence and build up the sciences from those foundations which bear a relation to the practical division, and to let them mark out and limit the theoretical.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
Second Book, Section 4 (p. 137)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bagehot, Walter** 1826–77  
English journalist

Nature does not wear her most useful lessons on her sleeve; she only yields her most productive secrets, those which yield the most wealth and the most “fruit,” to those who have gone through a long process of preliminary abstraction.

*Physics and Politics*  
Chapter 6 (p. 196)  
Ivan R. Dee, Publisher. Chicago, Illinois, USA. 1999

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Sooner or later the cold plunge into pure abstraction must be taken if one is to learn to swim in mathematics and to reason as rational, thinking human beings do.

*The Handmaiden of the Sciences*  
Chapter 1 (p. 7)  
Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Bohm, David** 1917–92  
American physicist

All is process. That is to say “there is ‘nothing’ in the universe.” Things, objects, entities, are abstractions of what is relatively constant from a process of movement and transformation. They are like the shapes that children like to see in the clouds.

In C.H. Waddington (ed.)  
*Towards a Theoretical Biology: An IUBS Symposium* (Volume 2)  
Further Remarks on Order (p. 42)  
Aldine Publishing Company. Chicago, Illinois, USA. 1968

**Boole, George** 1815–64  
English mathematician

Of the many forms of false culture, a premature converse with abstractions is perhaps the most likely to prove fatal to the growth of a masculine vigor of intellect.

*A Treatise on Differential Equations*  
Preface (p. vi)  
Chelsea Publishing Company. New York, New York, USA. 1959

**Cole, K. C.**  
Science writer

Abstractions are a way to distill the essence from an otherwise unfathomable situation.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*  
Part I, Chapter I (p. 26)  
Harcourt Brace & Co. Orlando, Florida, USA. 1999

The abstractions of science are stereotypes, as two-dimensional and as potentially misleading as everyday stereotypes. And yet they are as necessary to the process of understanding as filtering is to the process of perception.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*  
Part I, Chapter I (p. 26)  
Harcourt Brace & Co. Orlando, Florida, USA. 1999

**Devlin, Keith** 1947–  
English mathematician and writer

The increased abstraction in mathematics that took place during the early part of this century was paralleled by a similar trend in the arts. In both cases, the increased level of abstraction demands greater effort on the part of anyone who wants to understand the work.

*Mathematics: The Science of Patterns*  
Chapter 2 (p. 55)  
Scientific American Library. New York, New York, USA. 1994

**Dingle, Herbert** 1890–1978  
English astrophysicist

Abstraction is the detection of a common quality in the characteristics of a number of diverse observations: it is the method supremely exemplified in the work of Newton and Einstein... A hypothesis serves the same purpose, but in a different way. It relates apparently diverse experiences, not by directly detecting a common quality in the experiences themselves, but by inventing a fictitious substance or process or idea, in terms of which the experience can be expressed. A hypothesis, in brief, correlates observations by adding something to them, while abstraction achieves the same end by subtracting something.

*Science and Human Experience* (pp. 222–223)  
Williams & Norgate Ltd. London, England. 1931

**Einstein, Albert** 1879–1955  
German-born physicist

The theoretical scientist is compelled in an increasing degree to be guided by purely mathematical, formal considerations in his search for a theory, because the physical experience of the experimenter cannot lift him into the regions of highest abstraction.

Translated by Alan Harris  
*Essays in Science*

The Problem of Space (p. 69)  
Philosophical Library. New York, New York, USA. 1934

**Haber, Fritz** 1868–1934  
German physical chemist

The field of scientific abstraction encompasses independent kingdoms of ideas and of experiments and within these, rulers whose fame outlasts the centuries.

In Richard Willstätter  
*From My Life: The Memoirs of Richard Willstätter*  
Chapter 8 (p. 174)  
W.A. Benjamin. New York, New York, USA. 1965

**Huxley, Aldous** 1894–1963  
English writer and critic

Knowledge is power and, by a seeming paradox, it is through their knowledge of what happens in this unexperienced world of abstractions and inferences that scientists and technologists have acquired their enormous and growing power to control, direct and modify the world of manifold appearances in which human beings are privileged and condemned to live.

*Literature and Science*  
Chapter 3 (p. 9)  
Harper & Row, Publishers. New York, New York, USA. 1963

**MacLeish, Archibald** 1892–1982  
American poet and Librarian of Congress

Abstractions are wonderfully clever tools for taking things apart and for arranging things in patterns but they

are very little use in putting things together and no use at all when it comes to determining what things are *for*.

Why Do We Teach Poetry?  
*The Atlantic Monthly*, Volume 197, Number 3, March, 1956 (p. 51)

...abstractions have a limiting, a dehumanizing, a dehydrating effect on the relation to things of the man who must live with them. The result is that we are more and more left, in our scientific society, without the means of knowledge of ourselves as we truly are or of our experience as it actually is.

Why Do We Teach Poetry?  
*The Atlantic Monthly*, Volume 197, Number 3, March, 1956 (p. 51)

**Smithson, Robert**

Abstraction is everybody's zero but nobody's nought.

In Nancy Holt  
*The Writing of Robert Smithson*  
Some Void Thoughts on Museums (p. 58)  
New York University Press. New York, New York, USA. 1979

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

The power of using abstractions is the essence of intellect, and with every increase in abstraction the intellectual triumphs of science are enhanced.

*The Scientific Outlook*  
Chapter III (p. 87)  
George Allen & Unwin Ltd. London, England. 1931

**Sullivan, John William Navin** 1886–1937  
Irish mathematician

Science, indeed, tells us a very great deal less about the universe than we have been accustomed to suppose, and there is no reason to believe that all we can ever know must be couched in terms of its thin and largely arbitrary abstractions.

*Beethoven, His Spiritual Development*  
Art and Reality (pp. 21–22)  
Alfred A. Knopf. New York, New York, USA. 1964

**von Raumer, Friedrich** 1781–1873  
German historian

Abstractions are like clouds, which assume a hundred different forms, and which men may run after forever without catching anything real.

Translated by Sarah Austin and H.E. Lloyd  
*England in 1835*  
Letter V (p. 35)  
Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1836

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

You know of course that a mathematical line, a line of thickness nil, has no real existence. They taught you that? Neither has a mathematical plane. These things are mere abstractions.



In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today* 1971  
*The Time Machine*, Chapter One (p. 449)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

It is this union of passionate interest in the detailed facts with equal devotion to abstract generalisation which forms the novelty in our present society. . . . This balance of mind has now become part of the tradition which infects cultivated thought. It is the salt which keeps life sweet.

*Science and the Modern World*  
 Chapter I (p. 4)  
 The Macmillan Company. New York, New York, USA. 1929

...the utmost abstractions are the true weapons with which to control our thought of concrete fact.

*Science and the Modern World*  
 Chapter II (p. 32)  
 The Macmillan Company. New York, New York, USA. 1929

...to be an abstraction does not mean that an entity is nothing. It merely means that its existence is only one factor of a more concrete element of nature.

*The Concept of Nature*  
 Chapter VIII (p. 171)  
 At the University Press. Cambridge, England. 1920

**Wilder, Raymond L.** 1896–1982  
 American mathematician

There is nothing mysterious, as some have tried to maintain, about the applicability of mathematics. What we get by abstraction from something can be returned!

*Introduction to the Foundations of Mathematics*  
 Chapter XII (p. 275)  
 John Wiley & Sons, Inc. New York, New York, USA. 1952

**Young, John Zachary** 1907–97  
 English zoologist

It is of our very nature to see the universe as a place that we can talk about. In particular, you will remember, the brain tends to compute by organizing all of its input into certain general patterns. It is natural for us, therefore, to try to make these grand abstractions, to seek for one formula, one model, one God, around which we can organize all our communication and the whole business of living.

*Doubt and Certainty in Science: A Biologist's Reflections on the Brain*  
 Eighth Lecture (p. 163)  
 Oxford University Press, Inc. Oxford, England. 1960

## ABSTRUSE

**Bailey, Liberty Hyde** 1858–1954  
 American horticulturist and botanist

Every person is interested in the evident things, few in the abstruse and recondite.

*Botany: An Elementary Text for Schools*, (4th edition)  
 Paragraphs for the Teacher (p. vi)  
 The Macmillan Co. New York, New York, USA. 1901

**Mackenzie, Henry** 1745–1831  
 Scottish novelist

...in knowledge and philosophy be careful to distinguish that the purpose of research should ever be fixed on making simple what is abstruse, not abstruse what is simple ...

*The Man of the World*  
 Chapter I (pp. 31–32)  
 Printed by Robert Tullis. London, England. 1802

## ABSURD

**Gogol, Nikolai** 1809–52  
 Ukrainian-born Russian humorist, dramatist, and novelist

What is utterly absurd happens in the world.

In Leonard J. Kent (ed.)  
 Translated by Constance Garnett  
*The Collected Tales and Plays of Nikolai Gogol*  
*The Nose*  
 Chapter III (p. 495)  
 Octagon Books. New York, New York, USA. 1978

**Iyer, S. Sandaram**  
 No biographical data available

A thing may appear *absurd* and be true when it is above common sense but a thing contrary to the laws of mathematics is really and absolutely absurd, and whoso believes in such an absurdity is a fool.

*Thoughts on the Metaphysics of Theosophy*  
 Synthetic Recapulation (p. 92)  
 The Calcutta Central Press. Calcutta, India. 1883

## ABYSS

**Nietzsche, Friedrich Wilhelm** 1844–1900  
 German philosopher

If you gaze long into an abyss, the abyss will gaze back into you.

*Beyond Good and Evil*  
 Aphorism 146  
 The Modern Library. New York, New York, USA. 1917

## ACADEMIC MIND

**Fisher, Sir Ronald Aylmer** 1890–1962  
 English statistician and geneticist

The academic mind, as we know, is sometimes capable of assuming an aggressive attitude. The official mind, on the contrary, is and has to be, expert in the art of self-defense.

Presidential address, First Indian Statistical Congress, 1938

## ACADEMIC POLITICIAN

**Cornford, Francis M.** 1874–1943

English academic

My heart is full of pity for you, O young academic politician. If you *will* be a politician you have a painful path to follow, even though it be a short one, before you nestle down into a modest incompetence.

*Microcosmographia Academica*

Warning

Bowes &amp; Bowes, Publishers. Cambridge, England. 1908

I like you the better for your illusions; but it cannot be denied that they prevent you from being effective, and if you do not become effective before you cease to want anything to be done—why, what will be the good of you?

*Microcosmographia Academica*

Warning

Bowes &amp; Bowes, Publishers. Cambridge, England. 1908

The *Young Man in a Hurry* is a narrow-minded and ridiculously youthful prig, who is inexperienced enough to imagine that something might be done before very long, and even to suggest definite things. His most dangerous defect being want of experience, everything should be done to prevent him from taking any part in affairs. He may be known by his propensity to organise societies for the purpose of making silk purses out of sows' ears. This tendency is not so dangerous as it might seem; for it may be observed that the sows, after taking their washing with a grunt or two, trundle back unharmed to the wallow; and the purse-market is quoted as firm. The Young Man in a Hurry is afflicted with a conscience, which is apt to break out, like measles, in patches. To listen to him, you would think that he united the virtues of a Brutus to the passion for lost causes of a Cato; he has not learnt that most of his causes are lost by letting the Cato out of the bag, instead of tying him up firmly and sitting on him, as experienced people do.

*Microcosmographia Academica*

Parties

Bowes &amp; Bowes, Publishers. Cambridge, England. 1908

## ACCELERATOR

**Kaku, Michio** 1947–

Japanese-American theoretical physicist

There are 60 sub-atomic particles they've discovered that can explain the thousands of other sub-atomic particles, and the model is too ugly. This is my analogy: it's like taking Scotch tape and taping a giraffe to a mule to a whale to a tiger and saying this is the ultimate theory of particles.... We have so many particles that Oppenheimer once said you could give a Nobel Prize to the physicist that did not discover a particle that year. We were drowning in sub-atomic particles.

Now we realize that this whole zoo of sub-atomic particles, thousands of them coming out of our accelerators, can be explained by little vibrating strings.

In Nina L. Diamond

*Voices of Truth*

Part Three, Chapter Eleven (p. 334)

Lotus Press. Twin Lakes, Wisconsin, USA. 2000

**Lederman, Leon** 1922–

American high-energy physicist

The accelerator laboratory became a service center with a variety of products. By the late 1980s, Fermilab's sales force advertised to potential customers that the following hot and cold running beams were available: protons, neutrons, pions, kaons, muons, neutrinos, antiprotons, hyperons, polarized protons (all spinning in the same direction), tagged photons (we know their energy), and if you don't see it, ask!

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 6 (p. 251)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

## ACCIDENT

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

ACCIDENT, *n.* An inevitable occurrence due to the action of immutable natural laws.

*The Collected Works of Ambrose Bierce*

The Devil's Dictionary (p. 17)

The Neale Publishing Co. New York, New York, USA. 1911

**Davy, Sir Humphry** 1778–1829

English chemist

...it requires a certain degree of knowledge and scientific combination to understand and seize upon the facts which have originated in accident.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (pp. 233–234)

J. Murray. London, England. 1830

**Gore, George** 1826–1909

English electrochemist

We are too apt to attribute to accident or occult influence that which we cannot understand.

*The Art of Scientific Discovery*

Part II, Chapter XXVI (p. 223)

Longmans, Green &amp; Co. London, England. 1878

**Gregg, Alan** 1890–1957

American medical educator and philosopher

One wonders whether the rare ability to be completely attentive to, and to profit by, nature's slightest deviation from the conduct expected of her is not the secret of the best research minds and one that explains why some men turn to most remarkably good advantage seemingly

trivial accidents. Behind such attention lies an unremitting sensitivity...

*The Furtherance of Medical Research*

Chapter III (p. 98)

Yale University Press. New Haven, Connecticut, USA. 1941

**Gribbin, John** 1946–

English science writer and astronomer

Our form of life depends, in delicate and subtle ways, on several apparent “coincidences” in the fundamental laws of nature which make the Universe tick. Without those coincidences, we would not be here to puzzle over the problem of their existence.... What does this mean? One possibility is that the Universe we know is a highly improbable accident, “just one of those things”.

*Genesis: The Origins of Man and the Universe*

Chapter 9 (p. 307)

Delacorte Press. New York, New York, USA. 1981

**Lessing, Gotthold Ephraim** 1729–81

German philosopher, dramatist, and critic

Nothing under the sun is coincidence.

*Emilia Galotti*

Act V, Scene 3

Frederick Ungar Publications Company. New York, New York, USA.

1962

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

What hope is there then of human improvement? According to the Neo-Darwinists, to the Mechanists, no hope whatever, because improvement can come only through some senseless accident which must, on the statistical average of accidents, be presently wiped out by some other equally senseless accident.

*Back to Methuselah*

Preface (p. xvi)

Constable & Company Ltd. London, England. 1921

**Whewell, William** 1794–1866

English philosopher and historian

The common love of the marvelous, and the vulgar desire to bring down the greatest achievements of genius to our own level, may lead men to ascribe such results to any casual circumstances which accompany them; but no one who fairly considers the real nature of great discoveries, and the intellectual processes which they involve, can seriously hold the opinion of their being the effect of accident.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2)

Book XI, Chapter II (p. 24)

John W. Parker. London, England. 1847

## ACCOMPLISHMENT

**Berthelot, Marcellin (or Marcelin)**

**Pierre Eugène** 1827–1907

French chemist and politician

What we are is due but in small measure to our own labor and to our personal individuality, for we owe it almost entirely to our ancestors – ancestors by blood and ancestors of our character. If any of us add anything to the common good in the realm of science, of art, or of morality, it is because a long line of generations has lived, toiled, thought, and suffered before us.

In Camille Matignon

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Marcellin Berthelot (p. 684)

Government Printing Office. Washington, D.C. 1908

**Einstein, Albert** 1879–1955

German-born physicist

I refuse...to make money out of my science. My laurel is not for sale like so many bales of cotton.

What Life Means to Einstein: An Interview by George Sylvester Viereck

*The Saturday Evening Post*, October 26, 1929 (p. 17)

## ACCURACY

### Author undetermined

Accuracy and knowledge of detail are the great aims of modern scientific men. There may be much that is indefinite, but, when accuracy comes, every opposing speculation and supposed law or fact falls as hopelessly before it as that celebrated road to the skies which was felled to the earth by a well-aimed blow from Jack’s hatchet.

Accuracy

*The Chemical News and Industrial News*, Volume XIX, Number 474,

January 1, 1869 (p. 3)

**Babbage, Charles** 1792–1871

English mathematician

No person will deny that the highest degree of attainable accuracy is an object to be desired, and it is generally found that the last advances towards precision require a greater devotion of time, labour, and expense, than those which precede them.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter V (p. 167)

Printed for B. Fellowes. London, England. 1830

The extreme accuracy required in some of our modern inquiries has, in some respects, had an unfortunate influence, by favouring the opinion, that no experiments are valuable, unless the measures are most minute, and the accordance amongst them most perfect.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter V (pp. 167–168)

Printed for B. Fellowes. London, England. 1830

**Bogart, Humphrey** 1899–1957

American film actor

Fred C. Dobbs don't say nothin' he don't mean.

*The Treasure of the Sierra Madre*

Film (1948)

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“How is bread made?”

“I know *that!*” Alice cried eagerly. “You take some flour—”

“Where do you pick the flour?” the White Queen asked.

“In a garden or in the hedges?”

“Well, it isn't *picked* at all,” Alice explained: “it's ground—”

“How many acres of ground?” said the White Queen.

“You mustn't leave out so many things.”

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*, Chapter IX (p. 254)

The Modern Library. New York, New York, USA. 1936

**Darwin, Charles Robert** 1809–82

English naturalist

...I value praise for accurate observation far higher than for any other quality...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Hooker, December 11, 1860 (p. 148)

D. Appleton & Company. New York, New York, USA. 1896

...good heavens, how difficult accuracy is!

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Gray, June 3, 1874 (p. 457)

D. Appleton & Company. New York, New York, USA. 1896

Accuracy is the soul of Natural History. It is hard to become accurate; he who modifies a hair's breadth will never be accurate.... Absolute accuracy is the hardest merit to attain, and the highest merit.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

Darwin to Scott, July 2, 1863? (p. 323)

D. Appleton & Company. New York, New York, USA. 1903

## Editor

Accuracy and knowledge of detail are the great aims of modern scientific men. There may be much that is indefinite, but, when accuracy comes, every opposing speculation and supposed law or fact falls as hopelessly before it as that celebrated road to the skies which was felled to the earth by a well-aimed blow from Jack's hatchet.

Accuracy

*Chemical News and Journal of Industrial Science*, Volume XIX, Number 574, January 1, 1869 (p. 1)

**Fresenius, C. R.** 1818–97

German chemist

Knowledge and ability must be combined with ambition as well as with a sense of honesty and a severe conscience. Every analyst occasionally has doubts about the accuracy of his results, and also there are times when he knows his results to be incorrect. Sometimes a few drops of the solution were spilt, or some other slight mistake made. In those cases it requires a strong conscience to repeat the analysis and not to make a rough estimate of the loss or apply a correction. Anyone not having sufficient will-power to do this is unsuited to analysis no matter how great his technical ability or knowledge. A chemist who would not take an oath guaranteeing the authenticity, as well as the accuracy of his work, should never publish his results, for if he were to do so then the result would be detrimental, not only to himself, but to the whole of science.

In Ferenc Szabadváry

*History of Analytical Chemistry*

Chapter VII (p. 176)

Gordon & Breach Science. Langhorne, Pennsylvania, USA. 1992

**Gombrich, Ernst Hans** 1909–2001

English art historian and scholar

Everyone is acquainted with dogs and horses, since they are seen daily. To reproduce their likeness is very difficult. On the other hand, since demons and spiritual beings have no definite form, and no one has ever seen them, they are easy to execute.

*Art and Illusion*

Part II, Chapter VIII (p. 269)

Pantheon Books. New York, New York, USA. 1960

**Helps, Arthur** 1813–75

English writer

I do not know that there is anything, except it be humility, which is so valuable as an incident of education as accuracy. And accuracy can be taught. Direct lies told to the world are as dust in the balance when weighed against the falsehoods of inaccuracy.

*Brevia: Short Essays and Aphorisms*

Short Essays and Aphorisms (p. 105)

Robert Brothers. Boston, Massachusetts, USA. 1871

**Hume, David** 1711–76

Scottish philosopher and historian

Accuracy is, in every case, advantageous to beauty, and just reasoning to delicate sentiment. In vain would we exalt one by depreciating the other.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section I (p. 453)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Thomas Henry** 1825–95  
English biologist

Accuracy is the foundation of everything else...

*Collected Essays* (Volume 3)

*Science and Education*

Section I, Address on Behalf of the National Association for the Promotion of Technical Education (p. 432)

Macmillan & Company Ltd. London, England. 1904

**Jevons, William Stanley** 1835–82

English economist and logician

Numerical precision is the soul of science....

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book III, Chapter XIII (p. 273)

Macmillan & Company. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

He who has not made the experiment, or who is not accustomed to require rigorous accuracy from himself, will scarcely believe how much a few hours take from certainty of knowledge, and distinctness of imagery; how the succession of objects will be broken, how separate parts will be confused, and how many particular features and discriminations will be compressed and conglobated into one gross and general idea.

*A Journey to the Western Islands of Scotland* (pp. 239–240)

Printed by Thomas Walker. Dublin, Ireland. 1775

**Kolthoff, I. M.** 1894–1993

American chemist

**Sandell, E. B.**

American chemist

Anyone who has acquired sufficient skill to make an exact analysis satisfactorily can adapt himself to the performance of a less accurate one – but the reverse is not true.

*Textbook of Quantitative Inorganic Analysis* (3rd edition)

Introduction (p. 4)

The Macmillan Company. New York, New York, USA. 1952

**Miller, George Abram** 1863–1951

American mathematician

Mathematical accuracy should not be confused with mathematical minutiae.

*Historical Introduction to Mathematical Literature*

Preface (p. v)

The Macmillan Co. New York, New York, USA. 1916

**Mitchell, Maria** 1818–89

American astronomer and educator

The training of a girl fits her for delicate work. The touch of her fingers upon the delicate screws of an astronomical instrument might become wonderfully accurate in results; a woman's eyes are trained to nicety of color.

The eye that directs a needle in the delicate meshes of embroidery will equally well bisect a star with the spider web of the micrometer. Routine observations, too, dull as they are, are less dull than the endless repetition of the same pattern in crochet-work.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter XI (pp. 237–238)

Lee & Shepard. Boston, Massachusetts, USA. 1896

## ACCURATELY

**Ritchie, Arthur David** 1891–1967

Scottish philosopher and science history writer

It is really just as bad technique to make a measurement more accurately than is necessary as it is to make it not accurately enough.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter V (p. 113)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

## ACHIEVEMENT

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

In these days of conflict between ancient and modern studies, there must surely be something to be said for a study which did not begin with Pythagoras, and will not end with Einstein, but is the oldest and the youngest of all.

*A Mathematician's Apology*

Section 6 (p. 76)

Cambridge University Press. Cambridge, England. 1967

## ACID

### Author undetermined

Add acid to watum

Just as you oughta.

Source undetermined

**Huheey, James E.**

American chemist

In a very real sense, we can make an acid be anything we wish – the differences between the various acid-base concepts are not concerned with which is 'right' but which is most convenient to use in a particular situation.

*Inorganic Chemistry: Principles of Structure and Reactivity*

Chapter 6 (p. 207)

Harper & Row, Publishers. New York, New York, USA. 1972

**Lavoisier, Antoine Laurent** 1743–94

French chemist

The acids, for example, are compounded of two substances, of the order of those which we consider as



simple; the one constitutes acidity, and is common to all acids, and, from this substance, the name of the class or the genus ought to be taken; the other is peculiar to each acid, and distinguishes it from the rest, and from this substance is to be taken the name of the species. But, in the greatest number of acids, the two constituent elements, the acidifying principle, and that which it acidifies, may exist in different proportions, constituting all the possible points of equilibrium or of saturation. This is the case in the sulphuric and the sulphurous acids; and these two states of the same acid we have marked by varying the termination of the specific name.

Translated by Robert Kerr

*Elements of Chemistry* (Volume 1) (5th edition)

Preface (p. xxxi)

Printed for W. Creech. Edinburgh, Scotland. 1802

## ACETIC

**Laurent, Auguste** 1807–53

French chemist

From this time everything was copulated. Acetic, formic, butyric, margaric, &c., acids, alkaloids, ethers, amides, anilides, all became copulated bodies. So that to make acetanilide, for example, they no longer employed acetic acid and aniline, but they re-copulated a copulated oxalic acid with a copulated ammonia. I am inventing nothing – altering nothing. Is it my fault if, when writing history, I appear to be composing a romance?

Translated by William Odling

*Chemical Method, Notation, Classification, & Nomenclature*

Metamorphoses (p. 204)

Printed for the Cavendish Society. 1855

## AMINO

**Cloud, Preston Ercelle** 1912–91

American biogeologist, paleontologist, and humanist

One amino acid does not a protein make – let alone a being.

*Oasis in Space: Earth History from the Beginning*

Chapter Ten (p. 231)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

## CARBOLIC

**Lister, Joseph** 1827–1912

English surgeon

Bearing in mind that it is from the vitality of the atmospheric particles that all the mischief arises, it appears that all that is requisite is to dress the wound with some material capable of killing these septic germs, provided that any substance can be found reliable for this purpose, yet not too potent as a caustic.

‘On a New Method of Treating Compound Fracture, Abscesses, etc: With Observations on the Conditions of Suppuration’, Part 1  
*The Lancet*, March 16, 1867 (p. 327)

In the course of the year 1864 I was much struck with an account of the remarkable effects produced by carbolic acid upon the sewage of the town of Carlisle, the admixture of a very small proportion not only preventing all odour from the lands irrigated with the refuse material, but, as it was stated, destroying the entozoa which usually infest cattle fed upon such pastures.

‘On a New Method of Treating Compound Fracture, Abscesses, etc: With Observations on the Conditions of Suppuration’, Part 1  
*The Lancet*, March 16, 1867 (p. 327)

## FORMIC

### Coroner Putnam (Fictional character)

Well, Old Man Johnson could’ve died in anyone of five ways. His neck and back were broken, his chest was crushed, his skull was fractured...and here’s one for Sherlock Holmes. There was enough formic acid in him to kill twenty men.

*Them*

Film (1954)

## HYDROCHLORIC

**Webster, Jean** 1876–1916

American writer

I must go to the laboratory and look into a little matter of acids and salts and alkalis. I’ve burned a hole as big as a plate in the front of my chemistry apron, with hydrochloric acid. If the theory worked, I ought to be able to neutralize that hole with good strong ammonia, oughtn’t I?

*Daddy-Long-Legs*

February 4th (p. 130)

The Century Co. New York, New York, USA. 1913

## MURIATIC

**Marcet, Mrs. (Jane Haldimand)** 1769–1858

English expository author in chemistry, botany, religion, and economics

MRS. B: ... There is... a beautiful green salt too curious to be omitted; it is produced by the combination of cobalt with muriatic acid, which has the singular property of forming what is called sympathetic ink. Characters written with this solution are invisible when cold, but when a gentle heat is applied, they assume a fine bluish green colour.

*Conversations on Chemistry In Which the Elements of that Science Are Familiarly Explained and Illustrated by Experiments* (Volume 1)

Conversation X (p. 159)

Oliver D. Cooke

Hartford, Connecticut, USA. 1822

## SULPHURIC

**von Liebig, Justus** 1803–73  
German organic chemist

It is no exaggeration to say, we may judge, with great accuracy, of the chemical prosperity of a country from the amount of sulphuric acid it consumes. In this point of view there is no manufacture worthy of greater attention on the part of the government.

*Familiar Letters on Chemistry and Its Relation to Commerce, Physiology, and Agriculture*  
Letter III (p. 30)  
Taylor & Walton. London, England. 1843

**Willans, Geoffrey** 1911–58  
English author and journalist

**Searle, Ronald** 1920–  
English artist and cartoonist

A good way in a science lesson is to wait until some old fashioned poison like sulphuric acid, etc. turns up. As per usual science master, who not forward-looking, sa: No boy is to touch the contents of the tube.

Make up tube which look the same and place alongside acid. Master begins lesson drone drone drone. Suddenly you spring to feet with grate cry: ‘Sir Sir I can’t stand it any longer!’

Drink coloured water and collapse to be carried out as if dead. n.b.. if you make a mistake with this one you are still carried out as if dead and you *are*.

*Down With Skool!*  
How to Avoid Science (p. 62)  
Vanguard Press. New York, New York, USA. 1954

## URIC

**Wöhler, Friedrich** 1800–82  
German chemist

No other substance in organic chemistry attracts the attention of the physiologist and chemist to a higher degree than uric acid.

In Rolf Huisgen  
Adolf von Baeyer’s Scientific Achievements – A Legacy  
*Angewandte Chemie International Edition in English*, Volume 25,  
Number 4, April, 1986 (p. 302)

## ACKNOWLEDGEMENT

**Forsyth, Richard**  
No biographical data available

Many people, other than the authors, contribute to the making of a book, from the first person who had the bright idea of alphabetic writing through the inventor of movable type to the lumberjacks who felled the trees that were

pulped for its printing. It is not customary to acknowledge the trees themselves, though their commitment is total.

*Machine Learning*  
Acknowledgements (p. 12)  
Chapman & Hall, Ltd. 1989

## ACOUSTIC

**Payne, Roger** 1935–  
American biologist and environmentalist

...you cannot assess an acoustic phenomenon visually any more than you can judge a visual phenomenon acoustically – if you decide that the brightest rainbows accompany the loudest thunder you will sometimes be right of course, but only by chance. Most of the time you will be wrong.

*Among Whales*  
Chapter 5 (p. 175)  
Charles Scribner’s Sons. New York, New York, USA. 1995

## ACTION AT A DISTANCE

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact; as it must do, if gravitation, in the sense of Epicurus be essential or inherent in it. That gravity should be innate, inherent, and essential to matter, so that one body may act on another, at a distance, through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is, to me, so great an absurdity, that I believe no man who, in philosophical matters, has a competent faculty of thinking can ever fall into it.

In John Playfair  
*The Works of John Playfair* (Volume 2)  
Section IV (p. 431)  
Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

## ACTIVITY

**Pauli, Wolfgang** 1900–58  
Austrian-born physicist

Contrary to the strict division of the activity of the human spirit into separate departments – a division prevailing since the nineteenth century – I consider the ambition of overcoming opposites, including also a synthesis embracing both rational understanding and the mystical experience of unity, to be the mythos, spoken and unspoken, of our present day and age.

In Ken Wilbur (ed.)  
*Quantum Questions* (p. 175)  
Shambhala Publications, Inc. Boston, Massachusetts, USA. 2001

**ACTUARY****Author undetermined**

An insurance company is like an automobile going down the road at high speed. The managing director has his hands on the wheel, the marketing director has his foot on the accelerator. The finance director is heaving with all his might on the hand-brake and the actuary is in the back screaming directions from a map he has just made by looking out the rear window.

Source undetermined

Actuaries are funny people. Even when they are wrong, they are right. I told an actuary to go to the back of the queue. He immediately came back and said that he couldn't – there was already someone there.

Source undetermined

Someone once asked an accountant, a mathematician, an engineer, a statistician and an actuary how much 2 plus 2 was. The accountant said '4'. The mathematician said 'It all depends on your number base.' The engineer took out his slide-rule and said 'approximately 3.99'. The statistician consulted his tables and said, 'I am 95% confident that it lies between 3.95 and 4.05.' The actuary said, 'What do you want it to add up to?'

Source undetermined

**Karpinski, Lewis Charles**

Mathematician

Analytical and graphical treatment of statistics is employed by the economist, the philanthropist, the business expert, the actuary, and even the physician, with the most surprising valuable results...

In Charles Hughes Johnston (Ed.)

*High School Education*

Chapter 6 (p. 134)

Charles Scribner's Sons. New York, New York USA. 1912

**ADAPTABILITY****Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Adaptability is an asset for biological survival, but paradoxically, the greatest threat to the quality of human life is that the human species is so immensely adaptable that it can survive even under the most objectionable conditions.

*Reason Awake*

Chapter 5 (pp. 167–168)

Columbia University Press. New York, New York, USA. 1970

Almost universally, man tries to eliminate the unpleasant effects of environmental forces instead of making the greater effort required to cope with them through his own adaptive physiological resources.

*Man, Medicine, and Environment* (p. 85)

Frederick A. Praeger. New York, New York, USA. 1968

One of the unique characteristics of man is that he does not live only in the present; at his best, he has a deep sense of continuity with the past and is concerned with the future... . Adaptability must incorporate the needs of day-to-day existence subject to limitations and requirements created by the desire to preserve the past and modified by anticipations for the future.

*Man, Medicine, and Environment* (pp. 87–88)

Frederick A. Praeger. New York, New York, USA. 1968

**ADAPTATION****Geddes, Patrick** 1854–1932

Scottish biologist and botanist

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Every creature is a bundle of adaptations. Indeed, as Weismann says of the whale, "When we take away the adaptations, what have we left?"

*Evolution*

Chapter III (p. 97)

Henry Holt & Co. New York, New York, USA. 1911

**ADDRESS****Brinton, William**

English physician

There are many here before whom I would far rather be listening than speaking; many whose presence dignifies our inaugural meeting, but whose knowledge is not likely to be increased by anything I can say.

Introductory Lecture

*The London Lancet*, Volume 2, Number 6, December, 1857 (p. 433)

**Cayley, Arthur** 1821–95

English mathematician

...I think it is more respectful to you that I should speak to you upon and do my best to interest you in the subject which has occupied me, and in which I am myself most interested. And in another point of view, I think it is right that the Address of a President should be on his own subject, and that different subjects should be thus brought in turn before the meetings. So much the worse, it may be, for a particular meeting; but the meeting is the individual, which on evolution principles must be sacrificed for the development of the race.

*The Collected Mathematical Papers of Arthur Cayley* (Volume 11)

Presidential Address to the British Association, Southport, September, 1883 (p. 430)

At the University Press. Cambridge, England. 1896

**Faraday, Michael** 1791–1867

English physicist and chemist

...I shall here claim, as I always have done on these occasions, the right of addressing myself to the younger



members of the audience, – and for this purpose, therefore, unfitted as it may seem for an elderly infirm man to do so, I will return to second childhood and become, as it were, young again amongst the young.

In William Crookes

*A Course of Six Lectures on the Various Forces of Matter and Their Relations to Each Other*

Lecture 1 (p. 2)

Richard Griffin & Co. London, England. 1860

**Haldane, J. S. (John Scott)** 1860–1936

Scottish physiologist

In deciding to address you on the relation of physiology to physics and chemistry, I am aware that I have selected a subject which has already been treated from this Chair by more than one distinguished predecessor. My excuse for returning to it again is that not only does it possess deep scientific interest for us all, but a great deal remains to be said about it.

*The New Physiology and Other Addresses*

Chapter I (p. 1)

Chas. Griffin & Co., Ltd. London, England. 1919

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

I must not and do not doubt, that many...of those whom I now address, have, from time to time, been stirred by such visitations, and been conscious of such aspirings; and that you need not me to inform you, that astronomy, though a science, and an eminent one, is yet more than a science – that it is a chain woven of feeling as well as thought – an influence pervading not the mind only, but the soul of man.

*Life of Sir William Rowan Hamilton*

Introductory Lecture on astronomy (p. 641)

Hodges, Figgis & Co. Dublin, Ireland. 1882

**Hawkins, J. C.**

No biographical data available

It is taken quite as a matter of course that the yearly crop of flowers and fruit will reflect the condition, favorable or unfavorable, of the season. If the crop be poor quality only, we can sort out and save the best, but if it be also very scanty in quantity it may be a real misfortune. If the president's address is of poor quality, we never complain of its shortness. The less in quantity, the better we are pleased.

President's Annual Address

*The Minnesota Horticulturist*, Volume 27, Number 8, August, 1899 (p. 281)

**Hobson, Ernest William** 1856–1933

English mathematician

I propose to address to you a few remarks, necessarily fragmentary and incomplete, upon the scope and tendencies of modern mathematics.

Address of the President

*Science*, Volume 23, Number 821, September 23, 1910 (p. 386)

**Maschke, Heinrich**

German mathematician

The different branches of algebra and analysis which have been investigated are so numerous that it would be quite impossible to give an approximately exhaustive representation even only of the most important problems, within the limits of the time allowed to me. I, therefore, have confined myself to the minimum admissible number, namely *one*.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

On Present Problems of Algebra and Analysis (p. 518)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1905

**Maxwell, James Clerk** 1831–79

Scottish physicist

It is not the special but the universal interest of molecular science which encourages me to address you. It is not because we happen to be chemists or physicists or specialists of kind that we are attracted toward this centre of all material existence, but because we all belong to a race endowed with faculties which urge us on to search deep and ever deeper into the nature of things.

The Theory of Molecules

*The Popular Science Monthly*, Volume 4, January, 1874 (p. 278)

**Phillips, John** 1800–1874

English Geologist

English Geologist...when, on other occasions, we meet in quiet colleges and academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it labour is dignified and science fertilised, and the condition of human, society exalted!

Presidential Address, Delivered September 6, 1865

*The Chemical News and Journal of Physical Science*, Volume 11 (p. 115)

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

There is something inherently comforting about a panel of experts. One knows that the partial and inadequate and slanted and personal views that he expresses will be corrected by the less partial, less personal views of everyone else on the panel; it is not unlike the experience of the professor who always is glad that he has to meet his class again because he can correct the mistakes that he made the last time.

*The Open Mind*

The Scientist in Society (p. 119)

Simon & Schuster. New York, New York, USA. 1955

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

To many the frost of custom has made even these imposing annual ceremonies cold and lifeless. To you, at least of

those present, they should have the solemnity of an ordinance – called as you are this day to a high dignity and to so weighty an office and charge. You have chosen your Genius, have passed beneath the Throne of Necessity, and with the voices of the fatal sisters still in your ears, will soon enter the plain of Forgetfulness and drink of the waters of its river. Ere you are driven all manner of ways, like the souls in the tale of Er the Pamphylian, it is my duty to say a few words of encouragement and to bid you, in the name of the Faculty, God-speed on your journey.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

*Aequanimitas* (p. 3)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1904

### **Remsen, Ira** 1846–1927

American chemist and university president

At the weekly services of many of our churches it is customary to begin with the reading of a verse or two from the Scriptures for the purpose, I suppose, of putting the congregations in the proper state of mind for the exercises which are to follow. It seems to me we may profit by this example, and accordingly I ask your attention to Article I. of the Constitution of the American Association for the Advancement of Science, which reads thus: “The objects of the association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider use.”

Scientific Investigation and Progress

*Science*, N.S. Volume 19, Number 4, January 1, 1904, (p. 1)

### **Stokes, Sir George** 1819–1903

English mathematician and physicist

In the address with which the business of the meeting is opened, it is usual for your President to give some account of the most recent progress of science. The task is by no means an easy one. Few, indeed, are familiar with science in all its branches; and even to one who was, the selection of topics and the mode of treating them would still present difficulties. I shall not attempt to give an account of the recent progress of science in general, but shall select from those branches with which I am more familiar some examples of recent progress which may, I hope, prove to be of pretty general interest. And even in this I feel that I shall have to crave your indulgence, for it is hard to be intelligible to some without being wearisome to others.

British Association, Meeting at Exeter

*Journal of Botany, British and Foreign*, Volume 7, 1869 (p. 284)

### **Sylvester, James Joseph** 1814–97

English mathematician

It is not without a feeling of surprise and trepidation at my own temerity that I find myself in the position of

one about to address this numerous and distinguished assembly.

*Report of the Thirty-ninth Meeting of the British Association for the Advancement of Science*

Mathematics and Physics (p. 1)

John Murray. London, England. 1870

## ADHESIVE

### **Armour, Richard** 1906–89

American poet

Removing adhesive is hazardous work:

Little by little?

Or one sudden jerk?

Whichever it is, you may doubt you will win—

Removing adhesive, but leaving the skin.

*The Medical Muse*

Stuck with It

McGraw-Hill Book Company, Inc. New York, New York, USA. 1963

## ADSORPTION

### **Matthews, Albert**

No biographical data available

Adsorption...is a physico-chemical term meaning the concentration of substances at phase-boundaries in heterogeneous systems. Dressing can be called a process of adsorption. Every morning when we dress, clothing which has been distributed throughout our environment – dispersed in the surrounding phase – concentrates itself at the surface of our bodies. At night the process is reversed. We might go on to express these events by a curve or isotherm, showing how the quantity adsorbed is a function of the amount in the room, how it usually proceeds to an equilibrium, how it is greater at low than at high temperatures, that it is reversible and not accompanied by chemical change in the clothes, that it is specific in that certain clothes are adsorbed with greater avidity than others, that certain adsorbents (people) adsorb with greater avidity than others, or more so, and finally we could prove that the clothing moved into the surface film in virtue of the second law of thermodynamics and in consonance with the principle of Willard Gibbs.

In Joseph Needham

*The Sceptical Biologist*

The Sceptical Biologist, IV (p. 33)

W.W. Norton & Company, Inc. New York, New York, USA. 1930

## ADVENTURE

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Adventure is essential, namely, the search for new perfection.

*Adventures of Ideas*

Part IV, Chapter 17 (p. 257)

Cambridge University Press. Cambridge, England. 1959

## ADVERSARY

**Bernard, Claude** 1813–78

French physiologist

You need not hesitate to say aloud that my adversary is wrong and that he is an imbecile.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin

*The Cahier Rouge of Claude Bernard* (p. 92)

Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

## AESTHETIC

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

In science as in the arts, sound aesthetic judgments are usually arrived at only in retrospect. A really new art form or scientific idea is almost certain at first to appear ugly. The obviously beautiful, in both science and the arts, is more often than not an extension of the familiar. It is sometimes only with the passage of time that a really new idea begins to seem beautiful.

In Jeremy Bernstein

*Experiencing Science*

Part 1, Two Faces of Physics, Chapter I, Kepler: Harmony of the World (p. 3)

Basic Books, Inc., Publishers. New York, New York, USA. 1978

**Bragg, Sir William Lawrence** 1890–1971

Australian-born English physicist

When one has sought long for the clue to a secret of nature, and is rewarded by grasping some part of the answer, it comes as a blinding flash of revelation: it comes as something new, more simple and at the same time more aesthetically satisfying than anything one would have created in one's own mind. This conviction is of something revealed, and not something imagined.

In C.A. Coulson

*Science and Christian Belief*

Christian Belief (p. 99)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1955

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

...aesthetics never do anything but what they are told.

*Lunacy and Letters*

The Love of Lead (p. 160)

Sneed & Ward, Inc. New York, New York, USA. 1958

**Dewey, John** 1859–1952

American philosopher and educator

For only when an organism shares in the ordered relations of its environment does it secure the stability essential to

living. And when the participation comes after a phase of disruption and conflict, it bears within itself the germs of a consummation akin to the aesthetic.

*Art as Experience*

Chapter I (p. 15)

Milton, Balch & Company. New York, New York, USA. 1934

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

Whenever there is no objective confirmation, our attitude toward certain theories depends, in the last resort, on aesthetic considerations, disturbing as this may seem.

*The Road to Reason*

Chapter I (fn 4, p. 30)

Longmans, Green & Company. New York, New York, USA. 1949

**Flannery, Maura C.** 1947–

Biologist

...although to the non-scientist the aesthetic of biology would mean simply the beauties of nature, to the biologist it means much more. For example, the surface beauty of a leaf is nothing compared to the beauty of its cellular structure and of the process of photosynthesis. Learning about these things just increases appreciation. This is contrary to the idea held by many non-scientists that analysis destroys beauty. This latter view is based on a lack of understanding and knowledge of the processes of science. This is why many of the biologist's beauties are not appreciated by most non-scientists.

*Biology Is Beautiful*

*Perspectives in Biology and Medicine*, Volume 35, Number 3, Spring, 1992 (p. 430)

The aesthetic is intrinsic to biology. Biologists are drawn to the field by its aesthetic qualities and continually nurtured by them. This is true in all the sciences, but the aesthetics of biology is a little richer, or at least slightly different.

*Biology Is Beautiful*

*Perspectives in Biology and Medicine*, Volume 35, Number 3, Spring, 1992 (p. 433)

**King, Jerry P.**

American mathematician

...one's intellectual and aesthetic life cannot be complete unless it includes an appreciation of the power and the beauty of mathematics. Simply put, aesthetic and intellectual fulfillment requires that you know about mathematics.

*The Art of Mathematics*

Introduction (p. 3)

Plenum Press. New York, New York, USA. 1992

**Kline, Morris** 1908–92

American mathematics professor and writer

Much research for new proofs of theorems already correctly established is undertaken simply because

the existing proofs have no aesthetic appeal. There are mathematical demonstrations that are merely convincing; to use a phrase of the famous mathematical physicist, Lord Rayleigh, they ‘command assent’. There are other proofs which woo and charm the intellect. They evoke delight and an overpowering desire to say, “Amen, Amen.” An elegantly executed proof is a poem in all but the form in which it is written.

*Mathematics in Western Culture*

Chapter XXVIII (p. 470)

Oxford University Press, Inc. New York, New York, USA. 1953

**Kuhn, Thomas S.** 1922–96

American historian of science

...the importance of aesthetic considerations can sometimes be decisive. Though they often attract only a few scientists to a new theory, it is upon those few that its ultimate triumph may depend. If they had not quickly taken it up for highly individual reasons, the new candidate for paradigm might never have been sufficiently developed to attract the allegiance of the scientific community as a whole.

*The Structure of Scientific Revolutions*

Chapter XII (p. 156)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Penrose, Roger** 1931–

English mathematical physicist

Aesthetic qualities are important in science, and necessary, I think, for great science.

In John Hogan

Quantum Consciousness

*Scientific American*, Volume 261, Number 5, November, 1989 (p. 32)

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

And it is because simplicity, because grandeur, is beautiful, that we preferably seek simple facts, sublime facts, that we delight now to follow the majestic course of the stars, not to examine with the microscope that prodigious littleness which is also a grandeur, now to seek in geologic time the traces of a past which attracts because it is far away.

*The Foundations of Science*

*Science and Method*, Book I

Chapter I (p. 367)

The Science Press. New York, New York, USA. 1913

**Steen, Lynn Arthur**

American mathematician

...despite an objectivity about mathematical results that has no parallel in the world of art, the motivation and standards of creative mathematics are more like those of art than of science. Aesthetic judgments transcend both logic and applicability in the ranking of mathematical theorems: beauty and elegance have more to do with the

value of a mathematical idea than does either strict truth or possible utility.

*Mathematics Today: Twelve Informal Essays*

Mathematics Today (p. 10)

Springer-Verlag. New York, New York, USA. 1978

**Sullivan, John William Navin** 1886–1937

Irish mathematician

Since the primary object of the scientific theory is to express the harmonies which are found to exist in nature, we see at once that these theories must have an aesthetic value. The measure of the success of a scientific theory is, in fact, a measure of its aesthetic value, since it is a measure of the extent to which it has introduced harmony in what was before chaos.

The Justification of the Scientific Method

*The Athenaeum*, Number 4644, 2 May, 1919 (p. 275)

**Thomson, Sir George Paget** 1892–1975

English physicist

One can always make a theory, many theories, to account for known facts, occasionally even to predict new ones.

The test is aesthetic.

*The Inspiration of Science*

Chapter II (p. 17)

Oxford University Press, Inc. London, England. 1961

**AFFINITY**

**Brewster, David** 1781–1868

Scottish scientist, inventor, and writer

It is often some hidden relation, some deep-seated affinity, which is required to complete, or rather to constitute, a great discovery; and this relation is often discovered among the wildest conceptions and fancies after they have been sobered down by the application of experiment and observation.

In Margaret Maria Gordon

*The Home Life of Sir David Brewster* (3rd edition)

Chapter VIII (p. 72)

David Douglas. Edinburgh, Scotland 1881

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

How great has been the progress of natural science since serious attention began to be given to affinities, and especially since their true underlying principles have been determined!

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter II (p. 29)

The University of Chicago Press. Chicago, Illinois, USA. 1984

We must then be guided everywhere by natural affinities in composing the groups which result by dividing each kingdom into classes, each class into orders, each

order into sections or families, each family into genera, and each genus into different species if there is occasion for it.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter II (p. 33)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Whewell, William** 1794–1866

English philosopher and historian

Attractions take place between bodies, Affinities between the particles of a body. The former may be compared to the alliances of states, the latter to the ties of family.

*The Philosophy of the Inductive Sciences Founded upon Their History*

(Volume 2)

Aphorisms

Aphorisms Concerning Ideas, LXXV (p. 458)

John W. Parker. London, England. 1847

**AGE**

**Curtis, George William** 1824–92

American writer

...age... is a matter of feeling, not of years.

*Prue & I.*

Titbottom's Spectacles (p. 143)

Harper & Brothers Publishers. New York, New York, USA. 1894

**Davy, Sir Humphry** 1778–1829

English chemist

Ah! Could I recover anything like that freshness of mind, which I possessed at twenty-five, and which, like the dew of the dawning morning, covered all objects and nourished all things that grew, and in which they were more beautiful ever than in mid-day sunshine – what would I not give! – All that I have gained in an active and not unprofitable life. How well I remember that delightful season, when, full of power, I sought for power in others; and power was sympathy, and sympathy power – when the dead and the unknown, the great of other ages and distant places, were made, by the force of the imagination, my love; when every flower had the bloom and odor of the rose; and every spray or plant seemed either the poet's laurel, or the civic oak – which appeared to offer themselves as wreaths to adorn my throbbing brow.

*Memoirs in the Life of Sir Humphry Davy* (Volume 2)

Chapter VI (p. 304)

In John Davy

Longman, Rees, Orme, Brown, Green & Longman.. London, England. 1836

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

Age is, of course, a fever chill

That every physicist must fear.

He's better dead than living still

When once he's past his thirtieth year.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 5 (p. 168)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Einstein, Albert** 1879–1955

German-born physicist

A person who has not made his great contribution to science before the age of thirty will never do so.

In S. Brodetsky

Newton: Scientist and Man

*Nature*, Volume 150, Number 3816, December 19, 1942 (p. 699)

**AGING**

**Albutt, Thomas Clifford** 1836–1935

English physician

The stealthy foot of time carries us from youth to age so imperceptibly that we are hardly aware of the change; insensibly we shorten our arms, husband our strength, and are willing to think our prowess undiminished.

Sir William Osler

*British Medical Journal*, Volume 1, 1920 (p. 64)

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

To know how to grow old is the master-work of wisdom, and one of the most difficult chapters in the great art of living.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

September 21, 1874 (p. 279)

A.L. Burt Company, Publishers. New York, New York, USA. 189?

**Berthelot, Marcellin (or Marcelin) Pierre**

**Eugène** 1827–1907

French chemist and politician

To my age first of all. Your sympathy makes it shine like the last burst of light from a lamp on the point of being extinguished in eternal night! The respect that humanity pays to the aged is the expression of the binding force that unites the present generations with those that have preceded us, and with those that are to follow.

In Camille Matignon

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Marcellin Berthelot (p. 684)

Government Printing Office. Washington, D.C. 1908

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

About the best thing that extreme old age kan do for us iz tew make death a relief.

*Everybody's Friend: or Josh Billing's Encyclopedia and Proverbial Philosophy of Wit and Humor* (p. 242)

American Publishing Company. Hartford, Connecticut, USA. 1874



**Brody, Elaine M.**

Social worker, researcher, and gerontologist

The aging person's functioning, impaired though it may be, cannot be preserved or improved if he is assigned the role of full-time professional patient. His person and dress, the room in which he lives, the opportunity for privacy, the rhythm of his daily life...should convey the fact that the institution is his home, and should permit expression of his personal life style.

Long-term care for the Elderly: Optimisms, Options, and Opportunities  
*Journal of the American Geriatric Society*, Volume 19, 1971

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

We all know the troubles of old age. The bones creak; the eyes get dim, one forgets names.... The spark does not ignite; adrenalin has lost its potency. But there is something to be said on the other side. It is pleasant to rise in the morning, look out at the snow, and remark "I'm not going to the office today...." The beauty of nature has lost none of its charm; the beauty of women none of its benediction. There is...a possibility of growing old gracefully, and with content in one's heart.

Letter

*Bulletin New York Academy of Medicine*, Volume 47, 1971 (pp. 1274–1275)

**Davy, Sir Humphry** 1778–1829

English chemist

The advance in years bring indifference, and at the same time strength and steadiness. The young sapling is moved by every breeze; shoots forth its leaves vigorously when favoured by dew and sunshine; but is often severely injured, if not destroyed, by frost. In the mature tree, as the heartwood is covered by many coatings of sapwood, it becomes compressed and harder; but though it loses its vitality, it contributes to the strength of the vegetable.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter IV (p. 214)

Smith, Elder & Company. London, England. 1839–1849

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

The young ones have always a claim to the old to help them forward.

*Middlemarch*

Book VI, Chapter LVI (p. 549)

Clarendon Press. Oxford, England. 1986

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Men born in the same year watch each other, especially as the sands of life begin to run low, as we imagine so many damaged hour-glasses to keep an eye on each

other. Women, of course, never know who are their contemporaries.

*Our Hundred Days in Europe*

Chapter II (p. 44)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Habits are the crutches of old age; by the aid of these we manage to hobble along after the mental joints are stiff and the muscles rheumatic...when every act of self-determination costs an effort and a pang.

*Over the Teacups*

Chapter II (pp. 37–38)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

Women find it easier than men to grow old in a becoming way.... With old men it is too often different. They do not belong so much indoors as women do. They have no pretty little manual occupations.... [He] smokes his pipe, but does not know what to do with his fingers.

*Over the Teacups*

Chapter XII (p. 293)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Isaacs, Bernard**

English geriatric physician

The 'Geriatric Giants' – immobility, incontinence, instability and intellectual deterioration.

*The Challenge of Geriatric Medicine* (p. 1)

Oxford University Press, Inc. New York, New York, USA. 1992

**Priestley, Joseph** 1733–1804

English theologian and scientist

It may be my fate to be a kind of comet, or flaming meteor in science, in the regions of which (like enough to a meteor) I made my appearance very lately, and very unexpectedly; and therefore, like a meteor, it may be my destiny to move very swiftly, burn away with great heat and violence and become as suddenly extinct.

*Philosophical Empiricism*

Section V (p. 67)

Printed for J. Johnson. London, England. 1775

**Ramsay, Sir William** 1852–1916

English chemist

The minds of most men, like their bodies, grow stiff with age and unreceptive of new impressions...

*Essays Biographical and Chemical*

The Great London Chemists

Lord Kelvin (p. 100)

Archibald Constable & Company Ltd. London, England. 1908

**Yudowitch, K. L.**

No biographical data available

The knowledge that so many important discoveries in physics have been made by young men comes as a surprise to most students – and a pleasant surprise. Students never fail to look with new interest upon work done by a man at very nearly their own age. Physics is revitalized

in the minds of the students by the knowledge that it is a field for young men – men like themselves.

Young Men in Physics

*American Journal of Physics*, Volume 15, Number 2, March–April, 1947 (p. 191)

## AGNOSTICISM

### Wainwright, Samuel

No biographical data available

“God created man”? No such thing! The monads developed him. “The heavens declare the glory of God”? Far from it: “they declare only the glory of the astronomer!” “We have now no need of the hypothesis of God.”

These utterances, and such as these, startling alike to reverence and to faith, are the merest common places of modern agnosticism.

*Scientific Sophisms: A Review of Current Theories Concerning Atoms, Apes and Men*

Chapter I (p. 25)

Funk & Wagnalls. New York, New York, USA. 1883

Agnosticism made candid confession of its ignorance. Gnosticism parades its pretensions to knowledge. The former did not know: the latter is quite sure.

*Scientific Sophisms: A Review of Current Theories Concerning Atoms, Apes and Men*

Chapter I (p. 26)

Funk & Wagnalls. New York, New York, USA. 1883

## AGRICULTURE

### Taylor, Sir Edward

The rudest savage, skilled as he is in the habits of the food-plants he gathers, must know well enough that if seeds or roots are put in a proper place in the ground they will grow.

*Anthropology*

Chapter IX (p. 214)

Macmillan & Co. London, England. 1881

### von Liebig, Justus 1803–73

German organic chemist

Chemistry...is the foundation of agriculture, and we cannot hope to give a scientific form and basis to this important art without a knowledge of the constituents of the soil, and of the substances which constitute the food of plants.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter I (p. 21)

Walton & Maberly. London, England. 1859

### Warner, Charles Dudley 1829–1900

American editor and author

To own a bit of ground, to scratch it with a hoe, to plant seeds, and watch their renewal of life – this is the

commonest delight of the race, the most satisfactory thing a man can do.

*My Summer in a Garden*

Preliminary (p. 13)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1897

## AILMENT

### Author undetermined

An imaginary ailment is worse than a disease.

Source undetermined

### Heller, Joseph 1923–99

American writer

Yossarian had so many ailments to be afraid of that he was sometimes tempted to turn himself in to the hospital for good and spend the rest of his life stretched out there inside an oxygen tent with a battery of specialists and nurses seated at one side of his bed twenty-four hours a day waiting for something to go wrong....

*Catch-22*

Chapter Seventeen (pp. 177–178)

Dell Publishing Company, Inc. New York, New York, USA. 1985

## AIR

### Adams, George 1750–95

English instrument maker

Air is a fluid into which you are plunged the moment you are born, and without which you would in a moment be deprived of life.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture I (p. 7)

Printed by R. Hindmarsh. London, England. 1794

### Boyle, Robert 1627–91

English natural philosopher and theological writer

The generality of men are so accustomed to judge of things by their senses that, because the air is invisible, they ascribe but little to it, and think it but one remove from nothing.

In Sir W. Ramsay

*The Gases of the Atmosphere*

Chapter I (p. 10)

Macmillan & Company Ltd. London, England. 1905

### Cohen, J. B.

No biographical data available

As regards the air we breathe, we stand much in the same relation as Mohammed to the mountain. As we cannot bring pure air to the town, we go and seek it in the country or by the sea; that is, those of us who can afford it.

*Annual Report of the Board of Regents of the Smithsonian Institution*

The Air of Towns, Lecture 1 (p. 350)

U.S. Government Printing Office. Washington, D.C. 1896

**Muir, John** 1838–1914  
American naturalist

The air was perfectly delicious, sweet enough for the breath of angels. Every draught of it gave a separate and distinct piece of pleasure. I do not believe that Adam and Eve tasted better in their balmiest nook.

*Letters to a Friend* (p. 38)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1915

**Neruda, Pablo (Nefalí Ricardo Reyes**

**Basoalto)** 1904–73  
Chilean writer and politician

There is something from every living being in the atmosphere: close inspection of the air would disclose beggars, lawyers bandits, mailmen, seamstresses and a little of each occupation, a humbled remnant wants to perform its own work within us.

*Selected poems*

Nocturnal Collections

Houghton Mifflin Co. Boston, Massachusetts, USA. 1990

**Ramsay, Sir William** 1852–1916

English chemist

To tell the story of the development of men's ideas regarding the nature of atmospheric air is in great part to write a history of chemistry and physics.

*The Gases of the Atmosphere*

Chapter I (p. 1)

Macmillan & Company Ltd. London, England. 1905

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...this most excellent canopy, the air, look you, this brave o'erhanging firmament, this majestical roof fretted with golden fire ...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*

Act II, Scene ii, l. 301–303

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sherman, Joe**

No biographical data available

Once air was simply marvelous, filled with demons who lurked in shadows, with sylphs who lived in thunderstorms and caressed the back of your neck as warm summer breezes, with angels speaking Enochian, with particles from distant planets trying to invade your body – all watched over by celestial ether, the big air made splendid by the light of God.

*GASP!*

Chapter 4 (p. 99)

Shoemaker & Hoard. Washington, D.C. 2004

## ALCHEMY

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

As long as the alchemist merely sought [the] philosopher's stone and aimed at finding the art of making gold, all [his] endeavors were fruitless; it was only when people restricted themselves to seemingly less valuable questions that they created chemistry. Thus natural science appears completely to lose from sight the large and general questions; but all the more splendid is the success when, groping in the thicket of special questions, we suddenly find a small opening that allows a hitherto undreamt of outlook on the whole.

In Brian McGuinness (ed.)

Translated by Paul Foulkes

*Theoretical Physics and Philosophical Problems. Selected Writings*

The Second Law of Thermodynamics (pp. 13–14)

Reidel Publishing Company, Boston, Massachusetts, USA. 1974

**Gibbon, Edward** 1737–94

English historian

Philosophy, with the aid of experience, has at length banished the study of alchemy; and the present age, however desirous of riches, is content to seek them by the humbler means of commerce and industry.

*The History of the Decline and Fall of the Roman Empire* (Volume 1)

Chapter XIII (p. 375)

John Murray. London, England.. 1846

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

“...I have not crawled so long on my belly with my nails dug in the earth through all the innumerable windings of that dark mine, without perceiving in the far distance – at the end of the dim passage – a light, a flame, a something; the reflection, no doubt, from that dazzling central laboratory in which the patient and the wise have come upon God.”

“And finally,” interrupted Tourangeau, “what do you hold for true and certain?”

Translated by Jessie Haynes

*Notre Dame de Paris*

Book V, Chapter I (pp. 168–169)

P.F. Collier & Son. New York, New York, USA. 1902

**Kircher, Athanasius** 1602–80

German Jesuit archaeologist

...alchemy is a science, not yet known but which may become known.

In Bernard Jaffe

*Crucibles: The Story of Chemistry*

Chapter XVI (p. 331)

Dover Publications. New York, New York, USA. 1976



**Luciano, Giano**

No biographical data available

[Alchemy]...the key to all good things, the Art of Arts, the science of sciences.

*The New Pearl of Great Price...*

The Third Distinction (pp. 138–139)

Arno Press. New York, New York, USA. 1974

**Luther, Martin** 1483–1546

Leader of the Protestant Reformation

The science of alchymy I like very well, and indeed, 'tis the philosophy of the ancients. I like it not only for the profits it brings in melting metals, in decocting, preparing, extracting and distilling herbs, roots; I like it also for the sake of the allegory and secret signification, which is exceedingly fine, touching the resurrection of the dead at the last day.

Translated by William Hazlitt

*The Table-Talk of Martin Luther*

DCCCV (p. 326)

David Bogue. London, England. 1898

**Mersenne, Marin** 1588–1648

French theologian and mathematician

We can take pride in the fact that there is no science as certain as ours [alchemy] because it teaches by experience which is the mother, the source and the universal cause of all knowledge: and it is for the lack of this that Aristotle and the other philosophers have wondrously failed in their philosophy...

In Allen G. Debus

*The French Paracelsians*

Chapter 3 (p. 72)

Cambridge University Press. Cambridge, England. 1991

**Milton, John** 1608–74

English poet

...if by fire

Of sooty coal th' empiric alchymist

Can turn, or holds it possible to turn,

Metals of drossiest ore to perfect gold.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book V, l. 439

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Norton, Thomas** 1532–84

English alchemist

Maistryefull merveyulous and Archimastrye

Is the tincture of holy Alkimy;

A wonderful Science, secrete Philosophie,

A singular grace and gifte of th' Almightye:

Which never was found by labour of Mann,

But it by Teaching, or by Revalacion begann.

*The Ordinall of Alchemy*

Capitulum I, l. 181–186

Oxford University Press, Inc., London, England. 1975

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541

Swiss alchemist and mystic

The great virtues that lie hidden in nature would never have been revealed if alchemy had not uncovered them and made them visible. Take a tree, for example; a man sees it in the winter, but he does not know what it is, he does not know what it conceals within itself, until summer comes and discloses the buds, the flowers, the fruit.... Similarly the virtues in things remain concealed to man, unless the alchemist disclose them, as the summer reveals the nature of the tree.

In Jolande Jacobi (ed.)

*Paracelsus: Selected Writings*

Chapter III (p. 218)

Pantheon Books. New York, New York, USA. 1951

**Pratchett, Terry** 1948–

English author

The Explosion removed the windows, the door and most of the chimney.

It was the sort of thing you expected in the Street of Alchemists. The neighbors preferred explosions, which were at least identifiable and soon over. They were better than the smells, which crept up upon you.

*Moving Pictures* (p. 15)

Corgi Books. London, England. 1991

Most alchemists were nervous, in any case; it came from not knowing what the crucible of bubbling stuff they were experimenting with was going to do next.

*Moving Pictures* (p. 20)

Corgi Books. London, England. 1991

**Proverb, Spanish**

It is approved alchemy to have an income and spend nothing.

In Robert Christy

*Proverbs, Maxims and Phrases of All Ages* (p. 21)

G.P. Putnam's Sons. New York, New York, USA. 1888

**Sagan, Carl** 1934–96

American astronomer and author

The ash of stellar alchemy was now emerging into consciousness. At an ever-accelerating pace, it invented writing, cities, art and science, and sent spaceships to the planets and the stars. These are some of the things that hydrogen atoms do, given fifteen billion years of cosmic evolution.

*Cosmos*

Chapter XII (p. 338)

Random House, Inc. New York, New York, USA. 1980

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

You are an alchemist; make gold of that.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume Two)  
 Timon of Athens  
 Act V, Scene i, l. 117  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Smith, Horace

No biographical data available

Agriculture is the noblest of all alchemy, for it turns earth, and even manure, into gold ...

*The Tin Trumpet; Or Heads and Tales, for the Wise and Waggish Alchymist* (p. 28)

### Temple, Sir William 1628–99

English statesman and essayist

I have always looked upon alchemy in natural philosophy, to be like enthusiasm in divinity and to have troubled the world much to the same purpose.

*The Works of Sir William Temple Bart* (Volume 3) (p. 357)  
 Printed for J. Clarke. London, England. 1757

## ALGEBRA

### Adams, Douglas 1952–2001

English author, comic radio dramatist, and musician

You also get dramatic advances when you spot that you can leave out part of the problem. Algebra, for instance (and hence the whole of computer programming), derives from the realisation that you can leave out all the messy, intractable numbers.

*The Salmon of Doubt*  
 The Universe (p. 116)  
 Harmony Books. New York, New York, USA. 2002

### Arbuthnot, John 1667–1735

Scottish mathematician and physician

To understand the theory of chance thoroughly, requires a great knowledge of numbers, and a pretty competent one of Algebra.

*An Essay on the Usefulness of Mathematical Learning*  
 25 November, 1700

### Author undetermined

The human mind has never invented a labor-saving machine equal to algebra.

Two Works of Algebra  
*The Nation*, Volume 33, Number 847, September 22, 1881 (p. 237)

Does it lie 'mid Algebra's stern array,  
 Where the Law of Symmetry points the way,  
 And the path leads up through ascending powers  
 To the hilltop won after weary hours.

The Happy Land  
*The Mathematical Gazette*, Volume VIII, Number 117, May, 1915 (p. 99)

Algebra begins with the unknown and ends with the unknowable.

Source unknown

When you long for the good old days of your youth, just think of algebra.

Source undetermined

A young man, to impress his girl friend: "I'm taking four courses at the university – German, French, Russian and Algebra."

His girl friend replied: "Gee, you're a genius! Now, darling, do tell me 'I love you' in Algebra."

Source unknown

### Barrie, Sir James M. 1860–1937

Scottish journalist, writer, and dramatist

PHOEBE: Algebra! It – it is not a very ladylike study Isabella.

*The Plays of J.M. Barrie*  
 Quality Street, Act II (p. 113)  
 Charles Scribner's Sons. New York, New York, USA. 1948

MISS SUSAN: What is algebra exactly; is it those three-cornered things?

PHOEBE: It is  $x$  minus  $y$  equals  $z$  plus  $y$  and things like that. And all the time you are saying they are equal, you feel in your heart, why should they be?

*The Plays of J.M. Barrie*  
 Quality Street, Act II (p. 115)  
 Charles Scribner's Sons. New York, New York, USA. 1948

### Birkhoff, Garrett 1911–96

American mathematician

### MacLane, Saunders 1909–2005

American mathematician

Modern algebra has exposed for the first time the full variety and richness of possible mathematical systems.

*A Survey of Modern Algebra*  
 Chapter I (p. 1)  
 The Macmillan Co. New York, New York, USA. 1965

### Birkhoff, George David 1884–1944

American mathematician

Algebra tends to the study of the explicit structure of postulationally defined systems closed with respect to one or more rational operations.

Some Recent Advances in Algebra  
*The American Mathematical Monthly*, Volume 46, January, 1939 (p. 18)

### Black, Max 1908–88

Anglo-American philosopher

...perhaps every science must start with metaphor and end with algebra; and perhaps without the metaphor there would be no algebra.

*Models and Metaphors: Studies in Language and Philosophy* (p. 242)  
 Cornell University Press. Ithaca, New York, USA. 1962

### Boole, Mary Everest 1832–1916

English mathematical psychologist

The method of solving problems by honest confession of one's ignorance is called Algebra.

*Philosophy & Fun of Algebra*  
Chapter 1 (p. 14)  
C.W. Daniel Ltd. London, England.

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

The operations of symbolic arithmetic seem to me to afford men one of the clearest exercises of reason that I ever yet met with, nothing being there to be performed without strict and watchful ratiocination, and the whole method and progress of that appearing at once upon the paper, when the operation is finished, and affording the analyst a lasting and, as it were, visible ratiocination.

*The Works of the Honourable Robert Boyle* (Volume 3) (p. 426)  
Printed for J. & F. Rivington. London, England. 1772

**Brahmagupta** 598–670  
Indian mathematician

As the sun eclipses the stars by his brilliancy, so the man of knowledge will eclipse the fame of others in assemblies of the people if he proposes algebraic problems, and still more if he solves them.

In Florian Cajori  
*A History of Elementary Mathematics*  
The Hindus (p. 100)  
The Macmillan Company. New York, New York, USA. 1924

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

In mathematics he was greater  
Than Tycho Brahe or Erra Pater;  
For he, by geometric scale,  
Could take the size of pots of ale;  
Resolve by sines and tangents straight  
If bread or butter wanted weight;  
And wisely tell you what hour o' th' day  
The clock does strike, by algebra.

*The Poetical Works of Samuel Butler* (Volume 1)  
Hudibras, Part I, Canto I, l. 125  
Bell & Daldy. London, England. 1835

**Cajori, Florian** 1859–1930  
Swiss-born American educator and mathematician

...he best review of arithmetic consists in the study of algebra ...

*The Teaching and History of Mathematics In The United States*  
Chapter III (p. 110)  
Government Printing Office. Washington, D.C. 1890

**Carlyle, Thomas** 1795–1881  
English historian and essayist

...unless my Algebra deceive me, Unity itself divided by Zero will give Infinity.

*Sartor Resartus*  
Ginn & Co. Boston, Massachusetts, USA. 1897

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

Let U = the University, G = Greek, and P = Professor, then GP = Greek Professor...

*The Complete Works of Lewis Carroll*  
*The New Method of Evaluation* (p. 1124)  
The Modern Library. New York, New York, USA. 1926

**Clifford, William Kingdon** 1845–79  
English philosopher and mathematician

We may always depend upon it that algebra, which cannot be translated into good English and sound common sense, is bad algebra.

*The Common Sense of the Exact Sciences*  
Chapter 1, Section 7 (p. 20)  
B.J. Holdsworth. London, England. 1823

**Cochran, William G.** 1909–80  
Scottish-born American statistician

**Cox, Gertrude M.** 1900–78  
American statistician

...polynomials are notoriously untrustworthy when extrapolated.

*Experimental Designs* (2nd edition)  
Chapter 8A (p. 336)  
John Wiley & Sons, Inc. New York, New York, USA. 1992

**Comte, Auguste** 1798–1857  
French philosopher

[Algebra] has for its object the resolution of equations; taking this expression in its full logical meaning, which signifies the transformation of implicit functions into equivalent explicit ones. In the same way arithmetic may be defined as destined to the determination of the values of functions.... We will briefly say that Algebra is the Calculus of functions, and Arithmetic is the Calculus of Values.

*Philosophy of Mathematics* (p. 55)  
New York, New York, USA. 1851

**Date, J. C. B.**  
No biographical data available

To Algebra God is inclined –  
The world is a thought in His Mind.

It seems so erratic,  
Because it's quadratic,  
And the roots are not easy to find.

In E.O. Parrott (ed.)  
*The Penguin Book of Limericks*  
Theory and Practice  
Penguin Books, Ltd. London, England. 1983

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

Nothing proves more clearly that the mind seeks truth, and nothing reflects more glory upon it, than the delight

it takes, sometimes in spite of itself, in the driest and thorniest researches of algebra.

*Histoire du renouvellement de l'Academie des Sciences*

Preface

Chez Pierre de Coup. Amsterdam. 1720

**de Morgan, Augustus** 1806–71

English mathematician and logician

The first thing to be attended to in reading any algebraical treatise, is the gaining a perfect understanding of the different processes there exhibited, and of their connection with one another. This cannot be attained by a mere reading of the book, however great the attention which may be given. It is impossible, in a mathematical work, to fill up every process in the manner in which it must be filled up in the mind of the student before he can be said to have completely mastered it. Many results must be given of which the details are suppressed, such are the additions, multiplications, extractions of the square root, etc., with which the investigations abound. These must not be taken on trust by the student, but must be worked by his own pen, which must never be out of his hand, while engaged in any algebraical process.

*On the Study and Difficulties of Mathematics*

Chapter XII (pp. 175–176)

The Open Court Publishing Company. La Salle, Illinois, USA. 1943

The science of algebra, independently of any of its uses, has all the advantages which belong to mathematics in general as an object of study, and which it is not necessary to enumerate. Viewed either as a science of quantity, or as a language of symbols, it may be made of the greatest service to those who are sufficiently acquainted with arithmetic, and who have sufficient power of comprehension to enter fairly upon its difficulties.

*Elements of Algebra*

Preface

Taylor & Walton. London, England. 1837

Algebra, as an art, can be of no use to anyone in the business of life; certainly not as taught in the schools. I appeal to every man who has been through the school routine whether this be not the case. Taught as an art it is of little use in the higher mathematics, as those are made to feel who attempt to study the differential calculus without knowing more of the principles than is contained in books of rules.

*Elements of Algebra*

Preface

Taylor & Walton. London, England. 1837

Imagine a person with a gift of ridicule, and knowledge enough, trying his hand on the junction of the assertions which he will find in various books of algebra. First, that a negative quantity has no logarithm; secondly, that a negative quantity has no square root; thirdly, that the first non-existent is to the second as the circumference of a circle to its diameter.

In David Eugene Smith (ed.)

*A Budget of Paradoxes* (Volume 1) (2nd edition)

On Theological Paradoxers (pp. 319–320)

The Open Court Publishing Co. Chicago, Illinois, USA. 1915

I think the time may come when double algebra will be the beginner's tool; and quaternions will be where double algebra is no. The Lord only knows what will come above the quaternions.

*Graves' Life of Hamilton* (Volume 3) (p. 493)

New York, New York, USA. 1882–1889

**Einstein, Jacob**

German electrical engineer

Algebra is a merry science.

In Ronald W. Clark

*Einstein: The Life and Times*

Part One, Chapter 1 (p. 12)

The World Publishing Company. New York, New York, USA. 1971

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

Of algebra I had no knowledge whatever. I had heard the name; and the syllables represented to my poor brain the whole whirling legion of the abstruse.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 278)

Dodd, Mead & Co. New York, New York, USA. 1915

An heroic method of learning to swim is to leap boldly into the sea. Let us hurl ourselves head first into the algebraical gulf; and perhaps the imminent danger of drowning will call forth efforts capable of bringing me to land. I know nothing of what he wants. It makes no difference: let's go ahead and plunge into the mystery. I shall learn by teaching.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 279)

Dodd, Mead & Co. New York, New York, USA. 1915

Algebra, the poem of order, has magnificent flights. I look upon its formulae, its strophes as superb, without feeling at all astonished when others do not agree.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 302)

Dodd, Mead & Co. New York, New York, USA. 1915

**Fitzhugh, Percy Keese** 1876–1950

American writer

I hate algebra, too. My father says it's good to know algebra, even if you don't want to be especially good friends with it. I'll let it alone if it'll let me alone – that's what I told him.

*Roy Blakeley's Silver Fox Patrol*

Chapter XXXII (p. 179)

Gossett & Dunlap. New York, New York, USA. 1920

**Hamilton, Sir William Rowan** 1805–65  
Irish mathematician

The Study of Algebra may be pursued in three very different schools, the Practical, the Philological, or the Theoretical, according as Algebra itself is accounted an Instrument, or a Language, or a Contemplation; according as ease of operation, or symmetry of expression, or clearness of thought, (the *agere*, the *fari*, or the *sapere*,) is eminently prized and sought for.... The felt imperfections of Algebra are of three answering kinds... The Philological Algebraist complains of imperfection, when his Language presents him with an Anomaly; when he finds an Exception disturb the simplicity of his Notation, or the symmetrical structure of his Syntax; when a Formula must be written with precaution, and a Symbolism is not universal.

Theory of Conjugate Functions, or Algebraic Couples; with a Preliminary and Elementary Essay on Algebra as the Science of Pure Time  
*The Transactions of the Royal Irish Academy*, Volume XVII, 1837 (p. 293)

...the subject matter of algebraic science is the abstract notion of time; divested of, or not yet clothed with, any actual knowledge which we may possess of the real Events of History, or any conception which we may frame of Cause and Effect in Nature; but involving, what indeed it cannot be divested of, the thought of possible Succession, or of pure, ideal Progression.

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 633)  
Hodges, Figgis & Company. Dublin, Ireland 1882–1889

...instead of seeking to attain consistency and uniformity of system, as some modern writers have attempted, by banishing this thought of time from the higher Algebra, I seek to attain the same object, by systematically introducing it into the lower or earlier parts of the science.

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 634)  
Hodges, Figgis & Company. Dublin, Ireland 1882–1889

### **Herstein, I. N.**

No biographical data available

In mathematics itself abstract algebra plays a dual role: that of a unifying link between disparate parts of mathematics and that of a research subject with a highly active life of its own.... A subject that was once regarded as esoteric has become considered as fairly down-to-earth for a large cross section of scholars.

*Abstract Algebra* (p. vii)

The Macmillan Company. New York, New York, USA. 1986

*Topics in Algebra*

Chapter 3 (p. 113)

Xerox College Publishing. Waltham, Massachusetts, USA, 1964

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The child who is beginning to learn algebra never takes kindly to  $x$ ,  $y$  and  $z$ ; he is only satisfied when he is told

that they are: numbers of apples or pears or something such.

*Physics and Philosophy*

Chapter I (p. 9)

Dover Publications. New York, New York, USA. 1981

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

...I would advise you Sir, to study algebra, if you are not an adept already in it...

*Johnsonian Miscellanies* (Volume 1)

Anecdotes (p. 301)

At the Clarendon Press. Oxford, England. 1847

**Khayyam, Omar** 1048–1122  
Persian mathematician, astronomer, and poet

Whoever thinks algebra is a trick in obtaining unknowns has thought it in vain. No attention should be paid to the fact that algebra and geometry are different in appearance. Algebras are geometric facts which are proved.

Quoted by J.J. Winter and W. Arafat

The Algebra of "Umar Khayyam,"

*Journal of the Royal Asiatic Society of Bengal*, Volume 41, 1950

By the help of God and with His precious assistance I say that algebra is a scientific art. The objects with which it deals are absolute numbers and (geometrical) magnitudes which, though themselves unknown, are related to things which are known, whereby the determination of the unknown quantities is possible. Such a thing is either a quantity or a unique relation, which is only determined by careful examination.... What one searches for in the algebraic art are the relations which lead from the known to the unknown, to discover which is the object of algebra as stated above.

In Daoud Suleiman Kasir

*The Algebra of Omar Khayyam* (p. 47)

Teachers College, Columbia University. New York, New York, USA. 1931

**Lagrange, Joseph Louis** 1736–1813  
Italian/French mathematician and astronomer

As long as algebra and geometry traveled separate paths their advance was slow and their applications limited. But when these two sciences joined company, they drew from each other fresh vitality, and thenceforward marched on at a rapid pace toward perfection. It is to Descartes that we owe the application of algebra to geometry – an application which has furnished the key to the greatest discoveries in all branches of mathematics.

Quoted in William Betz

*Proceedings of the Tenth Annual Conference*

Graphic Methods in Elementary Algebra (p. 103)

New York State Science Teachers Association. Bulletin 375, June, 1906

**Langer, Susanne Katherina Knauth** 1895–1985  
American philosopher

Behind these symbols lie the boldest, purest, coolest abstractions mankind has ever made. No schoolman



speculating on essences and attributes ever approached anything like the abstractness of algebra.

*Philosophy in a New Key*

Chapter I (p. 18)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Lebowitz, Fran** 1951–

American comedian

Stand firm in your refusal to remain conscious during algebra. In real life, I assure you, there is no such thing as algebra.

*Social Studies*

Tips for Teens (p. 36)

Random House, Inc. New York, New York, USA. 1981

**Lipsky, Eleazar** 1911–1993

American lawyer, novelist, and playwright

Liberty and Justice for All. This principle can be represented as follows:

$$L + J = 1$$

Where L = Liberty; J = Justice; and 1 = All.

It is evident that as J increases in value, L will decrease. In simple terms, the more Justice, the less Liberty. This is almost a truism... The formula was modified to

$$J/L = 1$$

or:

$$J = 1(L)$$

From which it follows, the more Justice, the more Liberty.

Snitkin's Law

*The Magazine of Fantasy and Science Fiction*, February, 1959 (p. 61)

**Locke, John** 1632–1704

English philosopher and political theorist

They that are ignorant of Algebra cannot imagine the wonders in [relations between abstract ideas] this kind are to be done by it: and what further improvements and helps advantageous to other parts of knowledge the sagacious mind of man may yet find out, it is not easy to determine. This at least I believe, that the *ideas of quantity* are not those alone that are capable of demonstration and knowledge; and that other, and perhaps more useful, parts of contemplation, would afford us certainty, if vices, passions, and domineering interest did not oppose and menace such endeavors.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book IV, Chapter III, Section 18 (p. 317)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Algebra is a way to bring us to certainty in mathematics; but must it be presently condemned as an ill way, because there are some questions in mathematics, which a man cannot come to certainty in by the way of Algebra?

*The Works of John Locke*

A Letter to the Right Rev. Edward Lord Bishop of Worcester (p. 40)

Printed for Thomas Tegg. London, England. 1823

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The object of all arithmetical operations is to save direct enumeration, by utilizing the results of our old operations of counting. Our endeavor is, having done a sum once, to preserve the answer for future use.... Such, too, is the purpose of algebra, which, substituting relations for values, symbolizes and definitely fixes all numerical operations which follow the same rule.

*The Science of Mechanics* (5th edition)

Chapter IV, Part IV, Section 5 (p. 585)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maclaurin, Colin** 1838–1916

Scottish mathematician

Algebra is a general Method of Computation by certain signs and symbols which have been contrived for the Purpose, and found convenient.

*A Treatise of Algebra* (6th edition)

Part I, Chapter I (p. 1)

Printed for F. Windgrave. London, England. 1796

**Morley, Christopher** 1890–1957

American writer

Marriage is the square of a plus b

In other words

$$a^2 + b^2 + 2ab$$

Where 2ab (of course)

Are twins.

*Translations from the Chinese*

(a + b)<sup>2</sup>

George H. Doran Company. New York, New York, USA. 1922

**Moser, Leo** 1921–1970

Austrian-born mathematician

A quadratic function, ambitious,

Said, "It's not only wrong, but it vicious.

It's surely no sin

To have max. and min.;

To limit me so is malicious."

In E.O. Parrott (ed.)

*The Penguin Book of Limericks*

Theory and Practice

Penguin Books, Ltd. London, England. 1983

**Pastan, Linda** 1932–

American poet

I used to solve equations easily. If train A left Sioux Falls at nine o'clock, traveling at a fixed rate, I knew when it would meet train B. Now I wonder if the trains will crash; or else I picture naked limbs through Pullman windows, each a small vignette of longing.

In Ernest Robson and Jet Wimp

*Against Infinity*

Algebra (p. 50)

Primary Press, Parker Ford, Pennsylvania, USA. 1979

**Poe, Edgar Allan** 1809–49  
American short story writer

To speak algebraically – Mr. M. is execrable, but Mr. C. is x plus 1-ecrable.

*The Works of the Late Edgar Allan Poe* (Volume 3)  
*James Russell Lowell* (p. 279)  
Redfield. New York, New York, USA. 1857

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

In the beginning of algebra, even the most intelligent child finds, as a rule, very great difficulty. The use of letters is a mystery, which seems to have no purpose except mystification. It is almost impossible, at first, not to think that every letter stands for some particular number, if only the teacher would reveal what number it stands for.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 63)

Longmans, Green & Co. London, England. 1919

...how little, as a rule, is the teacher of algebra able to explain the chasm which divides it from arithmetic, and how little is the learner assisted in his groping efforts at comprehension!

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 63)

Longmans, Green & Co. London, England. 1919

...in algebra the mind is first taught to consider general truths, truths which are not asserted to hold only of this or that particular thing, but of anyone of a whole group of things. It is in the power of understanding and discovering such truths that the mastery of the intellect over the whole world of things actual and possible resides; and ability to deal with the general as such is one of the gifts that a mathematical education should bestow.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 63)

Longmans, Green & Co. London, England. 1919

**Smullyan, Raymond** 1919–  
American mathematician and logician

I am a firm believer that in studying mathematics one should never forget one's common sense. Many years ago, I was teaching an elementary algebra course. On one exam, I had a standard-type question that involved finding the ages of the mother, father, and child. After the students read the question, I said, "On this problem, I'll give you one hint." All eyes eagerly turned to me. I continued, "If the child should turn out to be older than either of the parents, then you've done something wrong."

*5000 B.C. and Other Philosophical Fantasies*

Chapter 3 (p. 21)

St. Martin's Press. New York, New York, USA. 1983

**Sterne, Laurence** 1713–68  
English novelist and humorist

Algebra is the metaphysics of arithmetic.

*The Works of Laurence Sterne: With a Life of the Author*  
*The Koran* (p. 346)  
William Durell & Co. New York, New York, USA. 1814

**Sylvester, James Joseph** 1814–97  
English mathematician

Music the Algebra of sense, Algebra the Music of the reason; Music the dream, Algebra the waking life – the soul of each the same!

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Address to the Mathematical and Physical (p. 659, fn)

At the University Press. Cambridge, England. 1908

**Trumbull, John** 1756–1843  
American painter

What though in algebra, his station  
Was negative in each equation.

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter II (p. 62)

Government Printing Office. Washington, D.C. 1890

**Verne, Jules** 1828–1905  
French novelist

...your x's and zeros, and algebraic formulae, are rattling in my head like nails in a bag.

*Works of Jules Verne*

*A Tour of The Moon*

Chapter IV (p. 271)

F. Tyler Daniels. New York, New York, USA. 1911

**Vico, Giovanni Battista** 1668–1744  
Italian philosopher, rhetorician, historian, and jurist.

The practice of giving to young men the elements of the science of magnitude on the algebraic method, chills all that is lively and vigorous in the youthful mind, clouds the imagination, debilitates the memory, dulls the ingenuity, and enervates the intellect ...

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 306)

Harper & Brothers Publishers. New York, New York, USA. 1861

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

The whole process of algebraical calculation is a purely logical operation; it can yield no relation between the quantities submitted to it that is not already contained in the equations which give occasion for its being applied.

Translated by Edmund Atkinson

*Popular Lectures on Scientific Subjects* 2nd Series

Lecture II (p. 34)

Longmans, Green & Co. London, England. 1903

**Weil, Simone** 1909–43  
French philosopher and mystic

Money, mechanization, algebra. The three monsters of contemporary civilization.

*Gravity and Grace*

Algebra (p. 139)

Routledge & Kegan Paul. London, England. 1952

...algebra is the intellectual instrument which has been created for rendering clear the quantitative aspects of the world.

*The Organization of Thought*

Chapter I (pp. 14–15)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**Weyl, Hermann** 1885–1995

German mathematician

Important though the general concepts and propositions may be with which the modern industrious passion for axiomatizing and generalizing has presented us, in algebra perhaps more than anywhere else, nevertheless I am convinced that the special problems in all their complexity constitute the stock and core of mathematics, and that to master their difficulties requires on the whole the harder labor.

*The Classical Groups: Their Invariants and Representations*

Preface to the First Edition (p. vii)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...the laws of algebra, though suggested by arithmetic, do not depend on it. They depend entirely on the conventions by which it is stated that certain modes of grouping the symbols are to be considered as identical. This assigns certain properties to the marks which form the symbols of algebra. The laws regulating the manipulation of algebraic symbols are identical with those of arithmetic. It follows that no algebraic theorem can ever contradict any results which would be arrived at by arithmetic; for the reasoning in both cases merely applies the same general laws to different classes of things. If an algebraic theorem can be interpreted in arithmetic, the corresponding arithmetical theorem is therefore true.

*A Treatise on Universal Algebra*

Book I, Chapter I (p. 11)

At the University Press. Cambridge, England. 1898

...algebra is the intellectual instrument which has been created for rendering clear the quantitative aspects of the world.

*The Organization of Thought*

Chapter I (pp. 14–15)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## ALGEBRA BOOK

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

...O mysterious tome, whose Arab name breathes a strange mustiness of occult lore and claims kindred with

the sciences of almagest and alchemy. What will you show me? Let us turn the leaves at random. Before fixing one's eyes on a definite point in the landscape, it is well to take a summary view of the whole. Page follows swiftly upon page, telling me nothing.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (pp. 282–283)

Dodd, Mead & Co. New York, New York, USA. 1915

## ALGEBRA PRAYER

### Author undetermined

Our Professor,  
which doth have tenure,  
Feared be thy name.  
Thy sets partition,  
Thy maps commute,  
In groups as in vector spaces.  
Give us this day our daily notation,  
And forgive us our obtuseness,  
As we forgive tutors who cannot help us.  
Lead us not into Lye rings,  
But deliver us from eigenvalues,  
For thine is the logic, the notation, and the accent,  
That confuses us forever.

Amen

Source undetermined

Algebra Prayer

## ALGEBRAIC TOPOLOGY

**Lefschetz, Solomon** 1884–1972

American mathematician

...it was my lot to plant the harpoon of algebraic topology into the body of the whale of algebraic geometry.

*A Page of Mathematical Autobiography*

*Bulletin of the American Mathematical Society*, Volume 74, Number 5, 1968 (p. 854)

## ALGEBRAIST

**Sylvester, James Joseph** 1814–97

English mathematician

...Algebraists (who are wont to regard each other as the flower and salt of the earth) are a set of mere calculating-machines endowed with organs of locomotion, or, at best, a sort of poor visionary dumb creatures only capable of communicating by signs and symbols with the outer world ...

*The Laws of Verse*

Inaugural Presidential Address (p. 104)

Longmans, Green & Co. London, England. 1870



## ALGORITHM

**Banks, Iain M.** 1954–  
Scottish writer

Elegance is an algorithm.

*The Algebraist*

Orbit. London, England. 2004

**Joseph, George Gheverghese**

Indian-born historian of mathematics

A “good” algorithm should have three properties:

- (a) it should be clear and simple, laying out step by step the procedures to be followed,
- (b) it should emphasize the general character of its applications by pointing out its appropriateness, not to a single problem but to a group of similar problems, and
- (c) it should show clearly the answer obtained after the prescribed set of operations is completed.

*The Crest of the Peacock: Non-European Roots of Mathematics*

Chapter 5 (p. 127)

Penguin. London, England. 1991

**Kauffman, Stuart A.** 1939–

American theoretical biologist

Algorithms are a set of procedures to generate the answer to a problem. An example is the algorithm to find the solution to a quadratic equation, which most of us were taught while learning algebra. Not only was I taught the algorithm, but our entire class was invited to tattoo it on our stomachs so that we could solve quadratic equations by rote.

*At Home in the Universe: The Search for Laws of Complexity*

Chapter 1 (p. 21)

Oxford University Press, Inc. New York, New York, USA. 1995

**Stoppard, Tom** 1937–

Czech-born English playwright

Nature manipulates the  $x$  and turns it into  $y$ . Then  $y$  goldfish is your starting population for the following year.... Your value for  $y$  becomes your next value for  $x$ . The question is what is being done to  $x$ ? What is the manipulation? Whatever it is, it can be written down as mathematics. It’s called an algorithm.

*Arcadia*

Act I, Scene Four (p. 45)

Faber & Faber Ltd. London, England. 1993

## ALIENS

**Joyce, James** 1882–1941

Expatriate Irish writer and poet

[Bloom] had conjectured as a working hypothesis which could not be proved impossible that a more adaptable and differently anatomically constructed race of beings might subsist otherwise under Martian, Mercurial, Veneral, Jovian,

Saturnian, Neptunian or Uranian sufficient and equivalent conditions, though an apogean humanity of beings created in varying forms with finite differences resulting similar to the whole and to one another would probably there as here remain inalterably and inalienably attached to vanities, to vanities of vanities and all that is vanity.

*Ulysses* (p. 684)

Random House, Inc. New York, New York, USA. 1946

**Koch, Howard** 1902–1995

American screen writer

Good heavens, something’s wriggling out of the shadow like a grey snake. Now it’s another one, and another. They look like tentacles to me. There, I can see the thing’s body. It’s large as a bear and glistens like wet leather. But that face. It – it’s indescribable. I can hardly force myself to keep looking at it. The eyes are black and gleam like a serpent’s. The mouth is V-shaped with saliva dripping from its rimless lips that seem to quiver and pulsate.

In Isabel S. Gordon and Sophie Sorkin (eds.)

*The Armchair Science Reader*

Part I, Man among the Stars, Invasion from Mars (p. 9)

Simon & Schuster. New York, New York, USA. 1959

## Scottie (Fictional character)

I bring you a warning...Tell the world ...tell this to everyone, wherever they are ...watch the skies ...watch everywhere ...keep looking ...watch the skies!

*The Thing*

Film (1951)

**Taylor, Rod** 1930–

Australian-born actor

You know, if this is Venus, or some other strange planet, we’re liable to run into some high-domed characters with green blood in their veins who’ll blast at us with their atomic death ray guns, and there we’ll be with these – these poor old-fashioned shootin’ irons.

*World Without End*

Film (1956)

## ALTERNATIVE

**Hoyle, Fred** 1915–2001

English astronomer

Here is an example of what seems to be general practice in astronomy: when two alternatives are available, choose the more trivial. It was so with the discovery of pulsars – white dwarfs, everybody said they were, until confrontations with fact showed otherwise. And it is so today throughout cosmology. Astronomers seem to live in terror that someday they will discover something important.

*Home is Where the Wind Blows: Chapters from a Cosmologist’s Life*

Chapter 19 (p. 269)

University Science Books. Mill Valley, California, USA. 1994

**ALTERNATIVE LIFE**

**Jeffers, Robinson** 1887–1962  
American poet

They are animals, as we are. There are many other chemistries of animal life

Besides the slow oxidation of carbohydrates and amino-acids.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

Animals (p. 364)

Stanford University Press. Stanford, California, USA. 1988

**AMATEUR**

**Sharp, Katharine Dooris** 1846–1935  
Irish botanist

There is this advantage in being an amateur: one may break into verse if so inclined. A technologist or professor is not supposed to have any such inclinations.

*Summer in a Bog*

The Woman Botanist (p. 91)

Stewart & Kidd Co. Cincinnati, Ohio, USA 1913

**AMBITION**

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

I have not chosen a career which will lead me to a great fortune, but that is not my principal ambition.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter I (p. 1)

Cambridge University Press. Cambridge, England. 1978

**AMNION**

**Cowen, Richard** 1940–  
American paleontologist

...the most fundamental innovation is the evolution of another internal fluid-filled sac, the amnion, in which the embryo floats. Amniotic fluid has roughly the same composition as seawater, so that in a very real sense, the amnion is the continuation of the original fish or amphibian eggs together with its microenvironment, just as a space suit contains an astronaut and a fluid that mimics the Earth's atmosphere. All of the rest of the amniote egg is add-on technology that is also required for life in an alien environment, and in that sense it corresponds to the rest of the space station with its food storage, fuel supply, gas exchangers, and sanitary disposal systems.

*History of Life*

Chapter Eight (p. 166)

Blackwell Scientific Publications. Boston, Massachusetts, USA. 1990

**AMPUTATION**

**Middleton, Thomas** 1580–1627  
English Jacobean playwright

I'll imitate the pities of old Surgeons  
To this lost limb, who, ere they show their art,  
Cast one asleep, then cut the disease'd part.

*Women Beware Women*

Act IV, Scene I (p. 128)

Manchester University Press. Manchester, England. 1975

**Webster, John** 1580?–1625?  
English playwright

I had a limb corrupted to an ulcer,  
But I have cut it off; and now I'll go  
Weeping to heaven on crutches.

*The White Devil*

Act IV, Scene II, l. 117–119

A. & C. Black. London, England; 1996

**ANALOGY**

**Anderson, Christopher**

No biographical data available

...analogy has much in store for man; because, though it is not infallible, it is that powerful engine or telescope of the mind, by which it is marvelously assisted in the discovery of both physical and moral truth. The great expectations which are entertained, they would found upon the extraordinary discoveries which have been made in physics, under the guidance of analogy: that powerful engine, they say, in the mind of a Newton, having discovered to us the laws of other worlds; and in that of Columbus, having put us in full possession of our own.

*Book for Parents*

Preface (p. vii)

Perkins, Marvin & Co. Boston, Massachusetts, USA. 1834

**Arendt, Hannah** 1906–75  
German-Jewish political theorist

Analogies, metaphors, and emblems are the threads by which the mind holds on to the world even when, absent-mindedly, it has lost direct contact with it, and they guarantee the unity of human experience. Moreover, in the thinking process itself they serve as models to give us our bearings lest we stagger blindly among experiences that our bodily senses with their relative certainty of knowledge cannot guide us through. The simple fact that our mind is able to find such analogies, that the world of appearances reminds us of things non-apparent, may be seen as a kind of 'proof' that mind and body, thinking and sense experience, the invisible and the visible, belong together, are 'made' for each other, as it were.

*The Life of the Mind: Thinking*

Chapter II (p. 109)

Harcourt Brace Jovanovich. New York, New York, USA. 1981

**Banach, Stefan** 1892–1945  
Polish mathematician

Good mathematicians see analogies between theorems or theories, the very best ones see analogies between analogies.

In S.M. Ulam

*Adventures of a Mathematician*

Chapter 10 (p. 203)

Charles Scribner's Sons. New York, New York, USA. 1976

**Bernstein, Jeremy** 1929–  
American physicist, educator, and writer

It is probably no exaggeration to say that all of theoretical physics proceeds by analogy.

*Elementary Particles and Their Currents*

Philosophical Preface (p. vii)

W. H. Freeman. San Francisco, California, USA. 1968

**Binford, Lewis R.** 1930–  
American archaeologist

Analogy serves to provoke certain types of questions which can, on investigation, lead to the recognition of more comprehensive ranges of order in the archaeological data.

Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning

*American Antiquity*, Volume 32, Number 1, January, 1967 (p. 10)

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

The question about the role of analogy in scientific research is clearly an essential feature of any work in natural science, even if it is not always obvious. It is often possible to employ a mathematical or geometrical model which handles the problems in question in such a way that the account acquires almost a purely logical character. In general, however, and particularly in some new fields of investigation, one must remember the obvious or likely inadequacy of pictures: as long as the analogies show through strongly one can be content if their usefulness-or rather fruitfulness-in the area in which they are being used is beyond doubt. Such a state of affairs holds not least from the standpoint of the present atomic theory. Here we find ourselves in the peculiar situation that we have obtained certain information about the structure of the atom which may surely be regarded as just as certain as anyone of the facts in natural science. On the other hand, we meet with problems of such a profound kind that they seem to defy solution: it is my personal opinion that these difficulties are of such a nature that they hardly allow us to hope that we shall be able, within the world of the atom, to carry through a description in space and time that corresponds to our ordinary sensory images.

In Niels Bohr Scientific Correspondence

Letter to Hoffding, 22 September, 1922 Microfiche 3

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

...how awkward is the human mind in divining the nature of things, when forsaken by the analogy of what we see and touch directly?

Certain Questions of the Theory of Gasses

*Nature*, Volume 51, Number 1322, February 28, 1895 (p. 414)

**Butler, Joseph** 1692–1752  
English bishop and exponent of natural theology

It is then but an exceeding little way, and in but a very few respects, that we can trace up the natural course of things before us, to general laws. And it is only from analogy, that we conclude the whole of it to be capable of being reduced into them: only from our seeing, that part is so. It is from our finding, that the course of nature, in some respects and so far, goes on by general laws, that we conclude this of the rest.

*The Analogy of Religion*

Part II, Chapter IV (p. 224)

Printed for C. & J. Rivington. London, England. 1824

**Campbell, Norman R.** 1880–1949  
English physicist and philosopher

...analogies are not "aids" to the establishment of theories; they are an utterly essential part of theories, without which theories would be completely valueless and unworthy of the name. It is often suggested that the analogy leads to the formulation of the theory, but that once the theory is formulated the analogy has served its purpose and may be removed or forgotten. Such a suggestion is absolutely false and perniciously misleading.

*Physics: The Elements*

Chapter VI (p. 129)

At the University Press. Cambridge, England. 1920

To regard analogy as an aid to the invention of theories is as absurd as to regard melody as an aid to the composition of sonatas.

*Physics: The Elements*

Chapter VI (p. 130)

At the University Press. Cambridge, England. 1920

**Chang, Kwang-Chih**  
Chinese-born anthropologist and archaeologist

As to analogy, archaeology as a whole is analogy, for to claim any knowledge other than the objects themselves is to assume knowledge of patterns in culture and history and to apply these patterns to the facts.

*Rethinking Archaeology*

Chapter 6 (p. 109)

Random House, Inc. New York, New York, USA. 1967

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

When a science approaches the frontiers of its knowledge, it seeks refuge in allegory or in analogy.

*Essays on Nucleic Acids*

Chapter 8 (p. 119)

Elsevier Publishing Company. Amsterdam. 1963

**Cohen, Morris Raphael** 1880–1947

American philosopher

...the number of available analogies is a determining factor in the growth and progress of science.

*The Meaning of Human History*

Chapter 8 (p. 249)

The Open Court Publishing Company. LaSalle, Illinois, USA. 1947

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

Analogy although it is not infallible, is yet that telescope of the mind by which it is marvelously assisted in the discovery of both physical and moral truth.

*Lacon: or, Many Things in Few Words*

Analogy in Physics and Morals (pp. 9–10)

William Tegg. London, England. 1866

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

An analogy is not a reason...

*Engineers and Ivory Towers*

For Man's Use of God's Gifts (p. 109)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Davy, Sir Humphry** 1778–1829

English chemist

The substitution of analogy for fact is the bane of chemical philosophy; the legitimate use of analogy is to connect facts together and to guide to new experiments.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 14 (p. 200)

Longmans. London, England. 1967

By observation, facts are distinctly and minutely impressed in the mind; by analogy, similar facts are connected ; by experiment, new facts are discovered ; and, in the progression of knowledge, observation, guided by analogy, leads to experiment, and *analogy*, confirmed by *experiment*, becomes *scientific truth*.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 214)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

In the early stages of discovery, the imagination is often dazzled by the brilliancy of the new facts, and trusts to weak or remote analogies.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 218)

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

...science is nothing but the finding of analogy, identity, in the most remote parts.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

The American Scholar (p. 56)

The Library of America. New York, New York, USA. 1983

**Hamerton, Philip Gilbert** 1834–94

English artist and art critic

It is always a mistake to push analogies too far ...

*Landscape*

Chapter XVIII (p. 160)

Roberts Brothers. Boston, Massachusetts, USA. 1885

**Hartley, David** 1705–57

English physician and psychologist

Animals are also analogous to Vegetables in many things, and Vegetables to Minerals: So that there seems to be a perpetual Thread of Analogy continued from the most perfect Animal to the most imperfect Mineral, even till we come to elementary Bodies themselves.

*Observations on Man* (Volume 1)

Chapter III, Section 1, Proposition 82 (p. 294)

Woodstock Books. Poole, England. 1998

**Heinlein, Robert A.** 1907–88

American science fiction writer

Analogy is even slipperier than logic.

*Stranger in a Strange Land*

Part III, Chapter XXIV (p. 318)

G.P. Putnam's Sons. New York, New York, USA. 1961

**Hesse, Mary B.** 1924–

English science historian

...one of the main functions of an analogy or model is to suggest extensions of the theory by considering extensions of the analogy, since more is known about the analogy than is known about the subject matter of the theory itself.... A collection of observable concepts in a purely formal hypothesis suggesting no analogy with anything would consequently not suggest either any directions for its own development.

Operational Definition and Analogy in Physical Theories

*British Journal for the Philosophy of Science*, Volume II, Number 8, February, 1952 (p. 291)

**Hodnett, Edward** 1901–84

English illustration historian

Analogy suggests rather than proves.

*The Art of Problem Solving*

Part III, Chapter 18 (p. 143)

Harper & Brothers. New York, New York, USA. 1955

**Huxley, Thomas Henry** 1825–95  
English biologist

...if evidence that a thing may be, were equivalent to proof that it is, analogy might justify the construction of a naturalistic theology and demonology not less wonderful than the current supernatural; just as it might justify the peopling of Mars, or of Jupiter, with living forms to which terrestrial biology offers no parallel.

*Collected Essays*

Prologue (p. 40)

D. Appleton & Co. New York, New York, USA. 1900

**Johnson-Laird, P. N.** 1936–  
English-born psychologist

A scientific problem can be illuminated by the discovery of a profound analogy, and a mundane problem can be solved in a similar way.

*The Computer and the Mind*

Chapter 14 (p. 266)

Harvard University Press. Cambridge, Massachusetts, USA. 1988

**Latham, Peter Mere** 1789–1875  
English physician

It is safest and best to fill up the gaps of our knowledge from analogy.

In William B. Bean

*Aphorisms from Latham* (p. 37)

Prairie Press. Iowa City, Iowa, USA. 1962

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

The way to determine the secret workings of Nature is from analogous cases where one has caught her in act.

In J.P. Stern

*Lichtenberg: A Doctrine of Scattered Occasions*

Further Excerpts from Lichtenberg's Notebooks (p. 293)

Indiana University Press. Bloomington, Indiana, USA. 1959

**Maxwell, James Clerk** 1831–79  
Scottish physicist

In order to obtain physical ideas without adopting a physical theory we must make ourselves familiar with the existence of physical analogies. By a physical analogy I mean that partial similarity between the laws of one science and those of another which makes each of them illustrate the other. Thus all the mathematical sciences are founded on relations between physical laws and laws of numbers, so that the aim of exact science is to reduce the problems of nature to the determination of quantities by operations with numbers.

*Transactions of the Cambridge Philosophical Society* (Volume 10)

On Faraday's Lines of Force (p. 28)

At the University Press. Cambridge, England. 1864

**Melville, Herman** 1819–91  
American novelist, essayist, and poet

O Nature, and O soul of man! how far beyond all utterance are your linked analogies! not the smallest atom stirs or lives on matter, but has its cunning duplicate in mind.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 70 (p. 231)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Analogy is not identity.

*Geology Versus Astronomy: Or 'the Conditions and the Periods;' being a View of the Modifying Effects of Geologic Discovery on the Old Astronomic Inferences respecting the Plurality of Inhabited Worlds*

Chapter I (p. 8)

Glasgow, Scotland. 1857

**Newman, Francis William** 1805–97  
English scholar

...analogy is like a hound, always on the scent, and on the alert for every indication of game.

*Lectures on Logic*

Section IV (p. 93)

J.H. Parker. Oxford, England. 1838

It is frequently analogy which guides the experienced to what are called *good guesses*.

*Lectures on Logic*

Section IV (p. 93)

J.H. Parker. Oxford, England. 1838

On the whole, Analogy is to be regarded as a step towards satisfactory proof, much in advance of first presumptions, if skillfully applied; though if the excessive vagueness of the word like be not checked, arguments from analogy may be of the wildest and silliest kind.

*Lectures on Logic*

Section IV (p. 96)

J.H. Parker. Oxford, England. 1838

**Olson, Harry F.** 1901–82  
American acoustical engineer

Analogies are useful for analysis in unexplored fields. By means of analogies an unfamiliar system may be compared with one that is better known. The relations and actions are more easily visualized, the mathematics more readily applied, and the analytical solutions more readily obtained in the familiar system.

In John N. Shive and Robert L. Weber

*Similarities in Physics*

Chapter 3 (p. 24)

John Wiley & Sons, Inc. New York, New York, USA. 1982



**Parsons, James**

No biographical data available

The Chain of my Arguments, thro' this little Work, shall be carried on Link by Link, in Search of the Mystery of Propagation by *Analogy*.

*Philosophical Observations on the Analogy Between the Propagation of Animals*

Chapter II (pp. 67–68)

Printed for C. Davis. London, England. 1752

**Pasteur, Louis** 1822–95

French chemist

The arguments...by which you support my theories, are most ingenious, but not founded on demonstrated facts; analogy is no proof.

In R. Vallery-Radot

*Life of Pasteur*

Chapter VIII (p. 223)

Garden City Publishing Company. Garden City, New York, USA. 1926

**Pepper, Stephen** 1891–1972

American philosopher

A man desiring to understand the world looks about for a clue to its comprehension. He pitches upon some area of commonsense fact and tries to understand other areas in terms of this one. The original area becomes his basic analogy or root metaphor.

*World Hypotheses: A Study in Evidence*

Chapter V (p. 91)

University of California Press. Berkeley, California, USA. 1948

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

Analogy may aid, but cannot assure us.

*Nature and Culture*

Chapter 1 (p. 7)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**Silver, Brian L.**

Israeli professor of physical chemistry

Professors have a weakness for analogies. So here's one: A gas, any gas, is similar to a crowd of flies. The analogy is dangerous, but we can learn from the dangers. First of all, flies can see; they don't normally bump into each other. Molecules are 'blind'; in a gas they are continually blundering into each other. Every collision changes the speed and direction of both molecules involved, so that a molecule in a gas resembles a flying dodgem car, continually getting jolted. Another difference between flies and molecules is that the molecules in our box are presumed to fly in straight lines unless they hit something. Flies practice their aeronautical skills. An improved fly analogy is a crowd of straight-flying, blind, deaf flies, but this is still misleading. Flies get tired. They often relax, and in the end they die and lie on the floor with their legs up. Molecules don't do this; the molecules in an oxygen cylinder never stop moving – until the end of

time, as they say at MGM. Again improving our analogy, we liken the molecules in a gas to a collection of straight-flying, blind, deaf, radarless, tireless, immortal flies. We're getting there, but the problem, as we will soon see, is that flies have a sense of smell and molecules don't. First, however, let's look at the speeds of molecules.

*The Ascent of Science*

Part I, Chapter I (p. 6)

Solomon Press Book. New York, New York, USA. 1998

**Simmons, Charles** 1798–1856

American clergy and litterateur

Those who reason forever by analogies, reason never by logic, and are slaves to imagination.

*A Laconic Manual and Brief Remarker* (p. 36)

Charles Simmons. North Wrentham, Massachusetts, USA. 1852

Analogies, like two balls, often touch in but one place.

*A Laconic Manual and Brief Remarker* (p. 36)

Charles Simmons. North Wrentham, Massachusetts, USA. 1852

**Strindberg, August** 1849–1912

Swedish dramatist and novelist

Two times two – is two!, Yes! I shall prove it by means of analogy, the highest form of proof. Follow carefully. One times one is one, therefore two times two is two. What applies to one applies to the other.

Translated by Evert Sprinchorn

*Selected Plays*

A Dream Play (p. 696)

University of Minnesota Press. Minneapolis, Minnesota, USA. 1986

**Sylvester, James Joseph** 1814–97

English mathematician

Induction and analogy are the special characteristics of modern mathematics, in which theorems have given place to theories and no truth is regarded otherwise than as a link in an infinite chain. "*Omne exit in infinitum*" is their favorite motto and accepted axiom.

A Plea for the Mathematician

*Nature*, Volume 1, Thursday, January 6, 1870 (p. 261, fn)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

All perception of truth is the detection of an analogy...

*The Journal of Henry D. Thoreau* (Volume 2)

September 5, 1851 (p. 463)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

To communicate knowledge by means of analogy appears to me a process equally useful and pleasant. The analogous case is not there to force itself on the attention or prove anything; it offers a comparison with some other cases, but it is not in union with it.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

523 (p. 185)

The Macmillan Co. New York, New York, USA. 1906

Analogy has two errors to fear – the one when it contents itself with being serviceable to wit, in which case it floats away in futile sport; the other, when it shrouds itself in tropes and similes: this last is the less dangerous of the two.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 158)

William Blackwood & Sons. Edinburgh, Scotland. 1883

**Westbroek, Peter** 1937–

Geologist

We have known since the days of Kant that scientific arguments must never be founded on analogies, but the authors are dead serious about these poetic digressions.

The Oceans Inside Us

*The London Times Higher Education Supplement*, November 3, 1995

## ANALYSIS

**Allen, Roy George Douglas** 1906–83

English economist and mathematician

Not even the most subtle and skilled analysis can overcome completely the unreliability of basic data.

*Statistics for Economists*

Chapter I (p. 14)

Hutchinson's University Library. London, England. 1951

## Author undetermined

Finally, the sublime Quadrature himself and all his engineers and hosts, went forth and enveloped the equation with some sort of powerful analysis; but a chemist might as well try to decompose a bank-safe with buttermilk; they were all glad to get back to day-light again considerably shattered.

The Symbol of Darkness

*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 217)

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The technical analysis of any large collection of data is a task for a highly trained and expensive man who knows the mathematical theory of statistics inside and out. Otherwise the outcome is likely to be a collection of drawings – quartered pies, cute little battleships, and tapering rows of sturdy soldiers in diversified uniforms – interesting enough in the colored Sunday supplement, but hardly the sort of thing from which to draw reliable inferences.

*Mathematics: Queen and Servant of Science*

Choice and Chance (p. 383)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Boehm, George A. W.** 1922–93

American editor and mathematician

The backbone of mathematics, pure as well as applied, is a conglomeration of techniques known as “analysis.”

*Annual Report of the Board of Regents of the Smithsonian Institution, 1959*

New Uses of the Abstract (p. 317)

Government Printing Office. Washington, D.C. 1960

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

Our only way of avoiding the extremes of materialism and mysticism is the never ending endeavor to balance analysis and synthesis.

In Loyd S. Swenson, Jr.

*Genesis of Relativity: Einstein in Context*

Preface (p. xvi)

Burt Franklin & Company, Inc. New York, New York, USA. 1979

**Bridgman, Percy Williams** 1882–1961

American physicist

The act of understanding is at the heart of all scientific activity; without it any ostensibly scientific activity is as sterile as that of a high school student substituting numbers into a formula. For this reason, science, when I push the analysis back as far as I can, must be private.

*Reflections of a Physicist*

Chapter 4 (p. 72)

Philosophical Library. New York, New York, USA. 1955

**Brown, Alexander Crum** 1838–1922

Scottish organic chemist

Analysis is to the chemist what astronomical methods for determining longitudes and latitudes are to the geographical explorer. Without it many interesting and useful discoveries may be made, but it is only when complete and accurate analyses are made of all the new substances produced in the course of a research that the research becomes fully available to other explorers. If Liebig had contributed nothing to organic chemistry but his method of analysis, he would still have been in a perfectly true sense the founder of modern organic chemistry.

*The Encyclopaedia Britannica*

Liebig, Justus (p. 566)

1888

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

He was in Logick, a great Critick,

Profoundly skill'd in Analytick;

He could distinguish and divide

A hair 'twixt south and south-west side.

*The Poetical Works of Samuel Butler* (Volume 1)

Hudibras, Part I, Canto I, l. 65

Bell & Daldy. London, England. 1835

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

I have seen too much not to know that the impression of a woman may be more valuable than the conclusion of an analytical reasoner...

*The Complete Sherlock Holmes*  
*The Man with the Twisted Lip*

Doubleday & Company, Inc. Garden City, New York, USA. 1930

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The simplicity of nature is not that which may easily be read, but is inexhaustible. The last analysis can no wise be made.

*Essays*

Essay IV (p. 112)

James Munroe & Co. Boston, Massachusetts, USA. 1841

**Fischer, Emil Hermann** 1852–1919  
German chemist

You are urgently warned against allowing yourself to be influenced in any way by theories or by other preconceived notions in the observation of phenomena, the performance of analyses and other determinations.

Quoted in Joseph Stewart Fruton

*Contrasts in Scientific Style*

Chapter V (p. 172)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1990

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

The analysis of phenomena, philosophically speaking, is principally useful, as it enables us to recognize, and mark for special investigation, those which appear to us simple; to set methodically about determining their laws, and thus to facilitate the work of raising up general axioms, or forms of words, which shall include the whole of them, which shall, as it were, transplant them out of the eternal into the intellectual world, render them creatures of pure thought, and enable us to reason them out a priori.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part II, Chapter II, Section 88 (p. 97)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Keynes, John Maynard** 1883–1946  
British economist

But to argue, without analysis of the instances, from the mere fact that a given event has a frequency of 10 percent in the thousand instances under observation, or even in a million instances, that...it is likely to have a frequency near to 1/10 in a further set of observations, is...hardly an argument at all.

*Treatise on Probability*

Chapter XXXIII (p. 407)

Macmillan & Company Ltd. London, England. 1921

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

An intelligence that, at a given instant, could comprehend all the forces by which nature is animated and the respective situation of the beings that make it up, if moreover it were vast enough to submit these data to analysis, would encompass in the same formula the movements of the greatest bodies of the universe and those of the lightest atoms. For such an intelligence nothing would be uncertain, and the future, like the past, would be open to its eyes.

*A Philosophical Essay on Probabilities* (p. 2)

Dover Publications, Inc. New York, New York, USA. 1951

But the language of analysis, most perfect of all, being in itself a powerful instrument of discoveries, its notations, especially when they are necessary and happily conceived, are so many germs of new calculi.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter V (p. 48)

John Wiley & Sons. New York, New York, USA. 1902

Analysis confirms what simple common sense teaches us, namely, the correctness of judgments is as much more probable as the judges are more numerous and more enlightened.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter XIII (p. 132)

John Wiley & Sons. New York, New York, USA. 1902

**Marlowe, Christopher** 1564–93  
English poet

Sweet Analytics, 'tis thou has ravish'd me...

*Christopher Marlowe's Doctor Faustus*

Act I, Scene i

Broadview Press. Peterborough, Ontario, Canada. 1991

**Maurice, F.**  
Swiss mathematician

I regard as quite useless the reading of large treatises of pure analysis: too large a number of methods pass at once before the eyes. It is in the works of applications that one must study them; one judges their ability there and one appraises the manner of making use of them.

In I. Grattan-Guinness

*Convolutions in French Mathematics, 1800–1840*

Chapter 3 (p. 126)

Birkhäuser Verla. Boston, Massachusetts, USA. 1990

**Mill, John Stuart** 1806–73  
English political philosopher and economist

...the habit of analysis has a tendency to wear away the feelings.

*Autobiography*

V (p. 116)

Oxford University Press, Inc. London, England. 1969



**Ostwald, Carl Wilhelm Wolfgang** 1853–1932  
Latvian-born German chemist

I myself have no cause for complaint whatsoever about lack of recognition of the scientific work which I have been so happy to perform in the field of general chemistry; yet the purely intellectual achievement of conceiving catalytic phenomena as accelerations of possible processes which are in progress, whereby the whole vast field of catalysis was first opened to exact study, lay at the time so far outside general scientific thought that where the broader masses of scientists are concerned it is today still at the incubation stage, notwithstanding the passing of some twenty years. I presume that subsequently this advance will become so naturally part and parcel of the overall context of scientific thought that, compared with before, the gap will cease to be apparent at all and I shall be deprived of that measure of personal glory to which I am justly entitled by virtue of this advance in theory. Yet this will not upset me any further since in the meantime I have come to regard such matters as object studies in the reactions of the collective psyche.

*Nobel Lectures, Chemistry 1901–1921*

On Catalysis

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Poe, Edgar Allan** 1809–49  
American short story writer

The mathematicians, I grant you, have done their best to promulgate the popular error to which you allude, and which is none the less an error for its promulgation as truth. With an art worthy a better cause, for example, they have insinuated the term ‘analysis’ into application to algebra. The French, are the originators of this particular deception; but if a term is of any importance – if words derive any value from applicability – then ‘analysis’ conveys ‘algebra’ about as much as, in Latin, ‘ambitus’ implies ‘ambition,’ ‘religio’ ‘religion,’ or ‘homines honesti’ a set of *honourable* men.

*Tales of Mystery and Imagination*

The Purloined Letter (p. 192)

Henry Frowde. London, England. 1902

The mental features discoursed of as the analytical, are, in themselves, but little capable of analysis.

*Mystery Tales of Edgar Allan Poe*

*Murders In the Rue Morgue* (p. 1)

A.L. Burt Co. New York, New York, USA. 1907

**Rudner, Richard** 1922–79  
American philosopher of science

The very excellence of analysis...tends to weaken and undermines whatever is the result of prejudice; that it enables us mentally to separate ideas which have only casually clung together...

In E.D. Klemke, Robert Hollinger, and A. David Kline

*Introductory Reading in the Philosophy of Science*

The Scientist Qua Scientist Makes Value Judgments (p. 234)

Prometheus Books. Buffalo, New York, USA. 1980

**Silberling, N. J.**  
Geologist

The following discussion is based largely on speculation, preconception, supposition, and other subjective thinking processes fundamental to megathinking and therefore it must be considered as a preliminary statement or working hypothesis to be tested by further field work and other lines of objective endeavor.

*The Pick and Hammer Club*, May 2, 1958 (p. 19)

**Stoppard, Tom** 1937–  
Czech-born English playwright

I can put two and two together, you know. Putting two and two together is my subject. I do not leap to hasty conclusions. I do not deal in suspicion and wild surmise. I examine the data; I look for logical inferences.

*Jumpers*

Act One (p. 17)

Grove Press, Inc. New York, New York, USA. 1972

**Tukey, John W.** 1915–2000  
American statistician

If data analysis is to be well done, much of it must be a matter of judgment, and “theory” whether statistical or non-statistical, will have to guide, not command.

*The Future of Data Analysis*

*Annals of Mathematical Statistics*, Volume 33, Number 1, March, 1962 (p. 10)

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

It requires a very unusual mind to undertake the analysis of the obvious.

*Science in the Modern World*

Chapter I (p. 4)

The Macmillan Company. New York, New York, USA. 1925

**Woodward, Calvin Milton** 1837–1915  
American educator

The secret of a lucid analysis is, like that of untangling a snarl of yarn, viz: to *get hold of the right end of the thread*.

*Rational and Applied Mechanics*

Preface (p. vii)

Nixon-Jones Printing Co. St. Louis, Missouri, USA. 1912

## ANALYSIS OF VARIANCE

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

There is, then, in this analysis of variance no indication of any other than innate and heritable factors at work.

*The Causes of Human Variability*

(The coining of the phrase “analysis of variance.”)

*Eugenics Review*, Volume 10, 1918

However, perhaps the main point is that you are under no obligation to analyse variance into its parts if it does not come apart easily, and its unwillingness to do so naturally indicates that one's line of approach is not very fruitful.

*Natural Selection, Heredity, and Eugenics*

Letter to L. Hogben, 25 February, 1933 (p. 218)

Clarendon Press. Oxford, England. 1983

The analysis of variance is not a mathematical theorem, but rather a convenient method of arranging the arithmetic.

Supplement, Discussion to "Statistics in Agricultural Research," by J. Wishart,

*Journal of the Royal Statistical Society*, Volume 1, 1934

## ANALYST

### Buck, R. C.

No biographical data available

The intermarriage of traditional analysis with its neighbors has not come about as a rational decision of its practitioners. At first sight, the change seemed to have been largely a matter of semantics; one adopted the terminology of algebra and topology solely as a convenience to describe briefly certain situations which arose frequently. But it soon became evident that the adoption of another viewpoint, another observation platform, gave a clearer vision; the introduction of techniques borrowed from other fields enabled the analyst to achieve both striking economies in proof, and vivid insights into classical phenomena.

*Studies in Modern Analysis* (p. 2)

Prentice-Hall. Englewood, New Jersey, USA. 1962

### Keeney, Ralph

Professor of systems management

### Raiffa, Howard

Bayesian decision theorist

...be wary of analysts that try to quantify the unquantifiable.

*Decisions with Multiple Objectives: Preferences with Value Trade-Offs* (p. 12)

John Wiley & Sons, Inc. New York, New York, USA. 1976

## ANALYTICAL ENGINE

### Babbage, Charles

1792–1871

English mathematician

We may say most aptly that the Analytical Engine weaves algebraical patterns just as the Jacquard-loom weaves flowers and leaves.

In Richard Taylor (ed.)

*Scientific Memoirs* Volume 3

Sketch of the Analytical Engine, Translator's Notes (p. 696)

Printed by Richard & John E. Taylor. London, England. 1843

## ANAPHYLAXIS

### Richet, Charles

1850–1935

French physiologist

Phylaxis, a word seldom used, stands in the Greek for protection. Anaphylaxis will thus stand for the opposite. Anaphylaxis, from its Greek etymological source, therefore means that state of an organism in which it is rendered hypersensitive, instead of being protected.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1913

Anaphylaxis (p. 473)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## ANATOMIST

### Hutchinson, Henry Neville

No biographical data available

Every bone has its meaning, and every skeleton can be made (in the hands of competent anatomists) to tell its story.

*Creatures of Other Days*

Chapter II (p. 23)

Chapman & Hall. London, England. 1894

### Richardson, Samuel

1689–1761

English novelist

And I believe that anatomists allow that women have more watery heads than men.

*The Works of Samuel Richardson* (Volume VII)

*The History of Clarissa Harlowe*, Volume IV, Letter XXVII (p. 130)

H. Sotheran. London, England. 1883–1884

## ANATOMY

### Agassiz, Jean Louis Rodolphe

1807–73

Swiss-born American naturalist, geologist, and teacher

It requires as much practical knowledge, in dealing with facts of anatomy, to trace the relations of one family with another, as it does in mathematics to deal with intricate problems.

*The Structure of Animal Life*

Lecture I (p. 8)

Sampson Low, Son & Marston. London, England. 1866

### Author undetermined

Be assured, gentlemen, there is very little left for us now to find out in descriptive anatomy. The history of anatomy is like that of a harvest-field. First come the reapers; and they have only to stretch out their hands, to gather in a glorious harvest. These are the early anatomists, such as Vesalius, Fallopius, Fabricius, Malpighi, and our own immortal Harvey. After them come the gleaners, who still find ears enough to set up a few stooks. Such were

Valsailva, Albinus, Vicq d'Azyr, the two Monros and the Hunters. And last of all come the geese, who, poor things, are glad to pick up in the stubble a grain or two here and there, with which they go home, cackling with satisfaction. Gentlemen, we are the geese.

*Monthly Journal of Medical Science*, Volume 15, July, 1852 (pp. 63–64)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

In the inquiry which is made by anatomy, I find much deficiency: for they inquire of the parts, and their substances, figures, and collocations; but they inquire not of the diversities of the parts, the secrecies of the passages, and the seats or nestling of the humors, nor much of foot-steps and impressions of diseases.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 5 (p. 52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bourne, Gilbert Charles** 1861–1933

British naturalist

Comparative anatomy, then, is the science which treats of the architecture of animals, and we shall see that just as there are several styles of architecture, Classical, Byzantine, Gothic, etc., each with its subdivisions, as Gothic into Pointed, Perpendicular, Decorated, etc., so there are several styles of animal architecture, and in each style there is infinite variety, though the general plan, the “motive,” is the same.

*An Introduction to the Study of the Comparative Anatomy of Animals* (Volume 1)

Introduction (p. 10)

George Bell & Sons. London, England. 1900

**Brinton, William**

English physician

To say that a physician or surgeon ignorant of Anatomy is like a man professing to mend watches without ever having opened one, or like a traveler wandering through an unknown country ...

Introductory Lecture

*The London Lancet*, Volume 2, Number 6, December, 1857 (p. 435)

**Burton, Robert** 1577–1640

English clergyman and scholar

[Diseases] crucify the soul of man, attenuate our bodies, dry them, wither them, shrivel them up like old apples, make them as so many anatomies.

*The Anatomy of Melancholy* (Volume 1)

Part I, Sect. II, Memb. III, subsec. 10 (p. 323)

AMS Press, Inc. New York, New York, USA. 1973

**Corner, George W.** 1889–1981

Anatomist

...microscopical anatomy is like mathematics in books on astronomy or physics – something to be avoided if

possible. Yet physiology without cell structure means less than Einstein without calculus.

*The Hormones in Human Reproduction*

Chapter II (p. 52)

Princeton University Press. Princeton, New Jersey, USA. 1947

**Dagi, Teodoro Forcht**

Physician

Ask any doctor off the street

To speak of his most prized feat:

No doubt he'd answer honestly,

And say “to pass anatomy.”

*Anatomy of the Brain and Spinal Medulla: A Manual for Students*

*The New England Journal of Medicine*, Volume 286, Number 18, May 4, 1972 (p. 1010)

**de Vigevano, Guido** fl. 1330s

High Medieval physician and engineer

Since it is prohibited by the Church to perform anatomies on the human body, and since it is impossible to know the medical art completely, unless one has knowledge of anatomy...I shall demonstrate patently and openly the anatomy of the human body, through properly executed illustrations.

Quoted in E.L. Wickersheimer

“Anatomie” de Guido de Vigevano, Médecin de la Reine Jeanne de Bourgogne

*Archiv für geschichte de medizin*, Volume 7, 1914

**Dickinson, Emily** 1830–86

American lyric poet

A science – so the Savants say,

“Comparative Anatomy” –

By which a single bone –

Is made a secret to unfold

Of some rare tenant of the mold,

Else perished in the stone –

*The Complete Poems of Emily Dickinson*

No. 100 (p. 49)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Fernel, Jean** 1497–1558

French physician

Anatomy is to physiology as geography is to history; it describes the theater of events.

*De naturali parte medicinae libri septem*

Chapter I

Apud Simonem Colinæum. 1542

**Flexner, Abraham** 1866–1959

American educator

Anatomy and physiology form but the vestibule of medical education. They teach the normal structure of the body, the normal function of the parts, fluids, organs, and the conditions under which they operate. The next step carries the student in medias res; he begins pharmacology – the experimental study of the response of the body to medication.

*Medical Education in the United States and Canada*

Chapter IV (p. 63)

The Carnegie Foundation. New York, New York, USA. 1910

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

Anatomy has its uses, even in a midnight scuffle.

*The Uttermost Farthing*

Chapter III

C.A. Pearson. London, England. 1920

**Freer, J. W.**

American physician

A physician or surgeon ignorant of anatomy, is like a man professing to mend watches without ever having opened one; or like a traveler wandering in a foreign land, ignorant of its geography, and without chart or compass; or a General at the head of an army, marching and fighting in a country he has never seen – with slender knowledge acquired through danger, clouded by suspicion, and obscured by willful falsehood.

Introductory Address

*The Chicago Medical Journal*, Volume 23, Number 11, November, 1866 (pp. 494–495)

**Galen** 130–200

Roman physician and philosopher of Greek origin

Make it rather your serious endeavor not only to acquire accurate book knowledge of each bone but also to examine assiduously with your own eyes the human bones themselves

Translated by Charles Joseph Singer

*Galen on Anatomical Procedures* (p. 3) 1956

**Halle, John** 1529–1568

English physician

But chieflye the anatomye

Ye oughte to understande:

If ye will cure well anye thinge,

That ye doe take in hande.

In Mary Lou McDonough

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*

Anatomy (p. 11)

C.C. Thomas. Springfield, Illinois, USA. 1945

**Harvey, William** 1578–1657

English physician

...I profess to learn and to teach anatomy, not from books but from dissections; not from the positions of philosophers but from the fabric of nature...

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Dedication (p. 268)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

What geology has done for our knowledge of the earth, has been done for our knowledge of the body by that method of study to which is given the name of General Anatomy.

*Medical Essays*

Border Lines in Medical Science (p. 222)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Hyman, Libbie Henrietta** 1888–1969

American invertebrate zoologist

The whole aim of comparative anatomy is to discover what structures are homologous ...

*A Laboratory Manual for Comparative Vertebrate Anatomy*

Chapter I (p. 3)

The University of Chicago Press. Chicago, Illinois, USA. 1922

**Lee, Sidney L.**

No biographical data available

I must no less commend the study of anatomy, which whosoever considers, I believe will never be an atheist; the frame of man's body, and coherence of his parts, being so strange and paradoxical, that I hold it to be the greatest miracle of nature.

*The Autobiography of Edward, Lord Herbert of Cherbury*

Life of Lord Herbert (p. 59)

John C. Nimo. London, England. 1886

**Maugham, W. Somerset** 1874–1965

English novelist and playwright

You will have to learn many tedious things...which you will forget the moment you have passed your final examination, but in anatomy it is better to have learned and lost than never to have learned at all.

*Of Human Bondage*

Chapter LIV (p. 239)

Doubleday & Company, Inc. Garden City, New York, USA. 1936

**Melanchthon, Philipp** 1497–1560

German reformer and designer of educational systems

It is shameful for man to rest in ignorance of the structure of his own body, especially when the knowledge of it mainly conduces to his welfare, and directs his application of his own powers.

Attributed

**Muller, Herbert Joseph** 1905–80

American historian and educator

To say...that a man is made up of certain chemical elements is a satisfactory description only for those who intend to use him as a fertilizer.

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*

Chapter V (p. 107)

G. Braziller. New York, New York, USA. 1943

**Nye, Bill** 1850–96  
American journalist

The word anatomy is derived from two Greek spatters and three pollywogs, which, when translated, signify “up through” and “to cut,” so that anatomy actually, when translated from the original wappy-jawed Greek, means to cut up through. That is no doubt the reason why the medical student proceeds to cut up through the entire course.

*Remarks*

Anatomy (p. 27)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

Human anatomy is either general, specific, topographical or surgical. These terms do not imply the dissection and anatomy of generals, specialists, topographers and surgeons, as they might seem to imply, but really mean something else. I would explain here what they actually do mean if I had more room and knew enough to do it.

*Remarks*

Anatomy (p. 28)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Anatomy may be likened to a harvest-field. First come the reapers, who, entering upon untrodden ground, cut down great store of corn from all sides of them. These are the early anatomists of modern Europe, such as Vesalius, Fallopius, Malpighi, and Harvey. Then come the gleaners, who gather up ears enough from the bare ridges to make a few loaves of bread. Such were the anatomists of last century – Valsalva, Cotunnus, Haller, Winslow, Vicq d’Azyr, Camper, Hunter, and the two Monroes. Last of all come the geese, who still contrive to pick up a few grains scattered here and there among the stubble, and waddle home in the evening, poor things, cackling with joy because of their success. Gentlemen, we are the geese.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (pp. 84–85)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Pouchet, Félix Archimède** 1800–72  
French biologist

The torch of anatomy has shed a flood of light upon the organization of the inferior animals, and the microscope, by allowing us to pry into the most inaccessible nooks of it, has unfolded before our eyes a horizon as vast as it was unexpected.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book III, Chapter I (p. 99)

Blackie & Son. London, England. 1870

**Reid, Thomas** 1710–96  
Scottish philosopher

If a thousand of the greatest wits that ever the world produced were, without any previous knowledge in anatomy, to sit down and contrive how, and by what internal organs, the various functions of the human body are carried on, how the blood is made to circulate and the limbs to move, they would not, in a thousand years, hit upon anything like the truth.

*The Works of Thomas Reid*

Essays on the Intellectual Powers of Man, Essay I, Chapter III (p. 235)

Maclachlan & Stewart. Edinburgh, Scotland. 1863

**Stapp, Paul** 1910–99  
American Air Force colonel

The human body comes in only two shapes and three colors. I don’t expect there will be any changes, so what we learn about it now will serve us for a long time to come.

*The Fastest Man on Earth*

*Time*, Volume LXVI, Number 11, September 12, 1955 (p. 88)

## ANESTHESIA

**Armour, Richard** 1906–89  
American poet

Behold the patient uncomplaining,  
Not asking whether losing, gaining,  
Not offering unsought advice,  
But really being very nice.

...

Behold the patient quite relaxed,  
With nerves, this once, not overtaxed,  
Serene, almost unrecognized,  
Not fighting back – anesthetized.

*The Medical Muse*

Behold the Patient

McGraw-Hill Book Company, Inc. New York, New York, USA. 1963

**du Bartas, Guillaume de Salluste** 1544–90  
French poet

Even as a Surgeon, minding off-to-cut  
Some cure-less Limb; before in cure he put  
His violent Engines on the vicious member,  
Bringeth his Patient in a sense-less slumber,  
And grief-less then (guided by Life and Art),  
To save the whole; saws off th’ infested part...

*Du Bartas: His Divine Weekes and Workes*

First Week, Sixth Day (p. 57)

Printed by Robert Young. London, England. 1641

**Helmuth, William Tod** 1833–1902  
American physician

For thus we read (although the analgesia  
Of Richardson was then entirely unknown)



Adam profoundly slept with anaesthesia,  
And from his thorax was removed a bone.

This was the first recorded operation,  
(No doctor here dare tell me that I fib!)

And surgery, thus early in creation,  
Can claim complete excision of a rib!

*Scratches of a Surgeon*

Surgery vs. Medicine (p. 66)

W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

...three natural anesthetics – sleep, fainting, death...

*Medical Essays*

The Medical Profession in Massachusetts (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Kraus, Karl** 1874–1936

Austrian essayist and poet

Anesthesia: wounds without pain.

In Harry Zohn (ed.)

*Half-Truths & One-and-a-Half Truths*

Lord, Forgive Them (p. 112)

The University of Chicago Press. Chicago, Illinois, USA. 1990

**Massinger, Philip** 1583–1640

English dramatic poet

1 October We have given her, sir,  
A sleepy potion, that will hold her long,  
That she may be less sensible of the torment  
The searching of the wound will put her to.

*The Plays of Philip Massinger* (Volume 1)

*The Duke of Milan*, Act V, Scene II (p. 337)

G. & W. Nicol. London, England. 1805

### The Bible (King James Version)

And the LORD God caused a deep sleep to fall upon  
Adam and he slept: and he took one of his ribs, and  
closed up the flesh instead thereof;

Genesis 2:21

## ANESTHETIST

**Cvikota, Raymond J.**

No biographical data available

Anesthetist's cone: Ether bonnet.

*Quote, the Weekly Digest*, October 27, 1968 (p. 337)

**Trotter, Wilfred** 1872–1939

Surgeon and sociologist

Mr. Anesthetist, if the patient can keep awake, surely you  
can.

Very Special Article

*The Lancet*, Volume 2, 1965 (p. 1340)

## ANGLE

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

After all, are you sure that it is impossible to trisect  
the angle by Euclid? I have not to lament a single hour  
thrown away on the attempt, but fancy that it is rather a  
tact, a feeling, than a proof, which makes us think that  
the thing cannot be done. No doubt we are influenced  
by the cubic form of the algebraic equation. But would  
Gauss's inscription of the regular polygon of seventeen  
sides have seemed, a century ago, much less an impos-  
sible thing, by line and circle?

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 3)

From Sir W. E. Hamilton to A. de Morgan (p. 433)

Hodges, Figgis & Co. Dublin, Ireland. 1889

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

For I doubt not, but if it had been a thing contrary to any  
man's right of dominion, or to the interest of men that  
have dominion, "the three angles of a triangle, should  
be equal to two angles of a square;" that doctrine should  
have been, if not disputed, yet by the burning of all books  
of geometry, suppressed, as far as he whom it concerned  
was able.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth,*

*Ecclesiastical and Civil* (2nd edition)

Of Manners (p. 55)

George Routledge & Sons. London, England. 1886

**Miller, Hugh** 1802–56

Scottish geologist and theologian

The natural boundaries of the geographer are rarely  
described by right lines.

*The Old Red Sandstone*

Chapter VI (p. 95)

John B. Alden, Publisher. New York, New York, USA. 1892

Whenever these [right angles] occur, however, the geolo-  
gist may look for something remarkable.

*The Old Red Sandstone*

Chapter VI (p. 95)

John B. Alden, Publisher. New York, New York, USA. 1892

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

If you look for curves, you will see curves; if you look for  
angles, you will see angles.

*Modern Painters*

Part V, Chapter XVIII (p. 303)

John Wiley & Sons. New York, New York, USA. 1890

## ANIMAL

### Abbey, Edward 1927–89

American environmentalist and nature writer

We have never entered into an animal's mind and we cannot know what it is like, or even if it exists. The risk of attributing too much is no greater than the risk of attributing too little.

In Joseph Wood Krutch  
*The Great Chain of Life*

Prologue (p. x)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1957

In all of nature, there is no sound more pleasing than that of a hungry animal at its feed. Unless you are the food.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 86)

St. Martin's Press. New York, New York, USA. 1989

### Ackerman, Diane 1948–

American writer

One of the things I like best about animals in the wild is that they're always off on some errand. They have appointments to keep. It's only we humans who wonder what we're here for.

*The Moon by Whale Light, and Other Adventures among Bats and Crocodilians, Penguins and Whales*

Chapter 1 (pp. 41–2)

Random House, Inc. New York, New York, USA. 1991

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born U.S. naturalist, geologist, and teacher

Animals are worthy of our regard, not merely when considered as to the variety and elegance of their forms, or their adaptation to the supply of our wants; but the Animal Kingdom, as a whole, has a still higher signification. It is the exhibition of the divine thought, as carried out in one department of that grand whole which we call Nature; and considered as such, it teaches us most important lessons.

*Principles of Zoology*

Chapter First (p. 25)

Gould, Kendall & Lincoln. Boston, Massachusetts, USA. 1848

The divisions of animals according to branch, class, order, family, genus, and species, by which we express the results of our investigations into the relations of the animal kingdom, and which constitute the primary question respecting any system of Zoology, seem to me to deserve the consideration of all thoughtful minds. Are those divisions artificial or natural?

*An Essay on Classification*

Chapter I (p. 8)

Longman, Brown, Green, Longmans & Roberts. London, England. 1859

It is a fact, which seems to be entirely overlooked by those who assume an extensive influence of physical causes upon the very existence of organized beings, that the most diversified types of animals and plants are everywhere found under identical circumstances.

*An Essay on Classification*

Chapter I (p. 15)

Longman, Brown, Green, Longmans & Roberts. London, England. 1859

Is there an investigator, who having once recognized such a similarity between certain faculties of Man and those of the higher animals, can feel prepared, in the present stage of our knowledge, to trace the limit where this community of nature ceases?

*An Essay on Classification* (p. 89)

Longman, Brown, Green, Longmans & Roberts. London, England. 1859

### Allee, Warder C. 1885–1955

American zoologist

The subsocial and social life of animals shows two major tendencies: one toward aggressiveness, which is best developed in man and his fellow vertebrates; the other unconscious, and in higher animals, toward conscious cooperation. With various associates I have long experimented upon both tendencies. Of these, the drive toward cooperation... is the more elusive and the more important.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain Their Various Fields to the Layman*

Biology (p. 243)

Simon & Schuster. New York, New York, USA. 1955

### Andrews, Ted

Writer and mystic

Every animal is a gateway to the phenomenal world of the human spirit. What most fail to realize is that what they think of animals reflects the way they think of themselves.

*Animal-Speak: The Spiritual and Magical Powers of Creatures Great and Small*

Introduction (p. x)

Llewellyn Worldwide, LTD. Woodbury, Minnesota, USA. 1993

### Author undetermined

*Cet animal est tres mechant;*

*Quand on l'attaque il se defend.*

This animal is very malicious;  
when attacked it defends itself.

La Menagerie (a song)

### Beston, Henry 1888–1968

American writer

For the animal shall not be measured by man. In a world older and more complete than ours they move finished and complete, gifted with extensions of the senses we have lost or never attained, living by voices we shall never hear. They are brethren, they are not underlings; they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendor and travail of the earth.

*The Outermost House*

Chapter II (p. 25)

Rinehart & Co. New York, New York, USA. 1928

We need another and a wiser and perhaps a more mystical concept of animals.... We patronize them for their incompleteness, for their tragic fate of having taken form so far below ourselves. And therein we err, and greatly err. For the animal shall not be measured by man. In a world older and more complete than ours they move finished and complete, gifted extensions of the senses we have lost or never attained, living by voices we shall never hear. They are not brethren, they are not underlings, they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendor and travail of the Earth.

*The Outermost House*

Chapter II (p. 25)

Rinehart & Company, New York, New York, USA. 1928

**Borges, Jorge Luis** 1899–1986

Argentine writer

...to a certain Chinese encyclopedia entitled Celestial Emporium of Benevolent Knowledge...it is written that animals are divided into (a) those that belong to the Emperor, (b) embalmed ones, (c) those that are trained, (d) suckling pigs, (e) mermaids, (f) fabulous ones, (g) stray dogs, (h) those that are included in this classification, (i) those that tremble as if they were mad, (j) innumerable ones, (k) those drawn with a very fine camel's hair brush, (l) others, (m) those that have just broken a flower vase, (n) those that resemble flies from a distance.

*Other Inquisitions*

The Analytical Language of John Wilkins (p. 103)

University of Texas Press, Austin, Texas, USA. 1964

**Bradbury, Ray** 1920–

American writer

The animal does not question life. It lives. Its very reason for living is life; it enjoys and relishes life.

*The Martian Chronicles* (p. 91)

HarperCollins Publishers, Inc. New York, New York, USA. 1997

**Brophy, Brigid** 1929–95

English novelist and essayist

I don't hold animals superior or even equal to humans. The whole case for behaving decently to animals rests on the fact that we are the superior species. We are the species uniquely capable of imagination, rationality, and moral choice – and that is precisely why we are under an obligation to recognize and respect the rights of animals.

*Don't Never Forget: Collected Views and Reviews*

The Rights of Animals (p. 21)

Holt, Rinehart & Winston, New York, New York, USA. 1966

**Bruchac, Joseph**

Native-American writer

Let my words

be bright with animals,

images the flash of a gull's wings.

If we pretend  
that we are at the center,  
that moles and kingfishers,  
eels and coyotes  
are at the edge of grace,  
then we circle, dead moons  
almost a cold sun.

This morning I ask only  
the blessing of the crayfish,  
the beatitude of the birds;  
to wear the skin of the bear  
in my songs;  
to work like a man with my hands.

*Near the Mountains*

Prayer

White Pine Press, Fredonia, New York, USA. 1987

**Brusca, Gary** –2000

American fisheries biologist

The range of morphological diversity among crustaceans far exceeds that of even the insects. In fact, because of their diversity of form and number, it is often said that crustaceans are the “insects of the sea.” We prefer to think of insects as the “crustaceans of the land.”

*Invertebrates Evolution*

Chapter Sixteen (p. 514)

Sinauer Associates, Inc. Sunderland, Maine, USA. 2003

**Pallister, William Hales** 1877–1946

Canadian physician

With eight thousand CRUSTACEAN species, we list  
All the lobsters and crabs, many others beside;  
On the beaches and tide-strips their races subsist  
On the wreck of the sea and the wrack of the tide;  
In his jointed shell, hungry and seeking each goes,  
If one loses a claw, soon another one grows.

*Poems of Science*

Beginnings

Playford Press, New York, New York, USA. 1931

**Burroughs, John** 1837–1921

American naturalist and essayist

In summer and winter, in storm and cold, in all seasons  
and in all places, by night as by day, without organiza-  
tion, or power of reason, or supervision, or leaders, or  
defenders, or government, or schools, or churches, there  
they [animals] go, well and happy, equal to all, or nearly  
all, emergencies, and making fewer mistakes than we  
human beings do.

*Under The Apple Tree*

Dame Nature and Her Children (p. 82)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Canetti, Elias** 1905–94

Bulgarian playwright and novelist

Whenever you observe an animal closely, you feel as if a  
human being sitting inside were making fun of you.



Translated by Joachim Neugroschel

*The Human Province*

1942 (p. 7)

Seabury Press. New York, New York, USA. 1978

**Chapman, George** 1559–1634

English poet and dramatist

I will neither yield to the song of the siren nor the voice of the hyena, the tears of the crocodile nor the howling o' the Wolf.

*The Works of George Chapman*

*Eastward Ho!* (p. 482)

Chatto & Windus. London, England. 1874

**Cobbe, Frances Power** 1822–1904

Irish writer

The radical mistake in all our writing and painting of animals from very early ages has been the semi-serious effort to *see human nature* in the brute and bird, and to describe it as, in fact, a Man in fur or in feathers. The process, though at first sight similar to the true method, is in reality the very converse of it, and beginning at the wrong end, diverges wider from the truth at every step. The more elaborate the story or the picture so constructed, and the more wire-drawn the parallel, the further it inevitably departs from the veracity of nature. Not by starting with the resolution to find human character in animals, but by studying them carefully and dispassionately till we come down to the ground of common feeling where they and we are alike, and where Nature is neither Human nor bestial, can we hope to obtain a real knowledge of them.

*False Beasts and True, Essays*

Animals in Fable and Art (p. 5)

Oxford University Press. Oxford, England. 1878

**Compton-Burnett, Ivy** 1884–1969

English writer

A leopard does not change his spots, or change his feeling that spots are rather a credit.

*More Women than Men*

Chapter 4 (p. 54)

Victor Gollancz LTD. London, England. 1974

**Dickens, Charles** 1812–70

English novelist

...judiciously show a cat milk, if you wish her to thirst for it. Judiciously show a dog his natural prey, if you wish him to bring it down one day.

*A Tale of Two Cities*

Book 2, Chapter XV (p. 160)

Dodd, Mead & Company. New York, New York, USA. 1925

**Diderot, Dennis** 1713–84

French encyclopedist and philosopher of materialism

The animal is a system of different organic molecules, which, impelled by dim sensations similar to those of

obtuse and vague touch – sensations which have been imparted to them by Him who created matter in general – have combined, until each has found the position most suitable to its form and to its repose.

In Henry Fairfield Osborn

*From the Greeks to Darwin: An Outline of the Development of the Evolution Idea* (p. 116)

The Macmillan Co. New York, New York, USA. 1905

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

There is a terrible innocence in the benumbed world of the lower animals, reducing life there to a universal chomp.

*Pilgrim at Tinker Creek*

Chapter 10, I (p. 168)

Harper's Magazine Press. New York, New York, USA. 1974

**Ehrlich, Gretel** 1946–

American writer

Animals give us their constant, unjaded faces and we burden them with our bodies and civilized ordeals.

*The Solace of Open Spaces*

Friends, Foes, and Working Animals (p. 62)

Basic Books, Inc., Publishers. New York, New York, USA. 1982

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Animals are molded by natural forces they do not comprehend. To their minds there is no past and no future. There is only the everlasting present of a single generation – its trails in the forest, its hidden pathways in the air and in the sea.

*The Star Thrower*

The Long Loneliness (p. 37)

Times Books. New York, New York, USA. 1978

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Animals are such agreeable friends – they ask no questions, they pass no criticism.

*Scenes of Clerical Life*

Mr. Gilfil's Love Story, Chapter VII (p. 116)

Oxford University Press, Inc. Oxford, England. 1985

**Elton, Charles Sutherland** 1839–1900

English lawyer and writer

It is usual to speak of an animal as living in a certain physical and chemical environment, but it should always be remembered that strictly speaking we cannot say exactly where the animal ends and the environment begins ...

*Animal Ecology*

Chapter IV (p. 34)

University of Chicago Press. Chicago, Illinois, USA. 2001

All cold-blooded animals and a large number of warm-blooded ones spend an unexpectedly large proportion of

their time doing nothing at all, or at any rate nothing in particular

*Animal Ecology*

Chapter V (pp. 55–56)

University of Chicago Press. Chicago, Illinois, USA. 2001

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Nature is always consistent, though she feigns to contravene her own laws. She keeps her laws, and seems to transcend them. She arms and equips an animal to find its place and living in the earth, and at the same time she arms and equips another animal to destroy it.

*Essays & Lectures*

*Essays* (Second Series)

Nature (p. 547)

The Library of America. New York, New York, USA. 1983

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

You rip up the animal and I study it alive; you turn it into an object of horror and pity, whereas I cause it to be loved; you labour in a torture-chamber and dissecting-room, I make my observations under the blue sky to the song of the Cicadas, you subject cell and protoplasm to chemical tests, I study instinct in its loftiest manifestations; you pry into death, I pry into life.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter I (p. 14)

Dodd, Mead & Co. New York, New York, USA. 1915

Making ample allowance for anatomy, a precious aid, what do we know of animals? Next to nothing. Instead of inflating cabbalistic bladders with this nothing, let us collect well-observed facts, however humble. From a sheaf of such facts a clear, calm light may shine forth one day, a light far preferable to the fireworks of theories which dazzle us for a moment only to leave us in blacker darkness.

Translated by Alexander Teixeira de Mattos

*The Life of the Weevil*

Chapter ii (p. 39)

Hodder & Stoughton. London, England. nd

**Feynman, Richard P.** 1918–88

American theoretical physicist

The universality of the deep chemistry of living things is indeed a fantastic and beautiful thing. And all the time we human beings have been too proud to even recognize our kinship with the animals.

*The Meaning of It All*

Chapter I (p. 11)

Perseus Books. Reading, Massachusetts, USA. 1998

**Gardner, John** 1933–82

American writer and scholar

Always be kind to animals,  
Morning, noon, and night;

For animals have feelings too,  
And furthermore, they bite.

*A Child's Bestiary*

Introduction

Alfred A. Knopf. New York, New York, USA. 1977

**Grahame, Kenneth** 1859–1932

English writer

Animals arrived, liked the look of the place, took up their quarters, settled down, spread, and flourished. They didn't bother themselves about the past – they never do; they're too busy.

*The Wind in the Willows* (pp. 88–89)

Charles Scribner's Sons. New York, New York, USA. 1908

**Hodgkin, Alan L.** 1914–98

English physiologist and biophysicist

...the zoologist is delighted by the differences between animals, whereas the physiologist would like all animals to work in fundamentally the same way.

*Chance & Design: Reminiscences of Science in Peace and War*

Part I, Chapter 6 (p. 66)

Press Syndicate of the University of Cambridge. Cambridge, England.

1992

**Hornaday, William Temple** 1854–1937

American naturalist

He who attempts to study any small group of animal forms without first gaining a bird's-eye view of the surrounding territory, and becoming familiar with the zoological grand divisions that lie around him, loses much.

In Francis Rolt-Wheeler (ed.)

*The Science-history of the Universe*

Introduction (p. xii)

The Current Literature Publishing Co. New York, New York, USA. 1909

He who knows the wild animals of the world always travels among friends, and in every land he finds a welcome.

In Francis Rolt-Wheeler (ed.)

*The Science-history of the Universe*

Introduction (p. xv)

The Current Literature Publishing Co. New York, New York, USA. 1909

To assume that every wild beast and bird is a sacred creature, peacefully dwelling in an earthly paradise, is a mistake. They have their wisdom and their folly, their joys and their sorrows, their trials and tribulations.

*The Minds and Manners of Wild Animals: A Book of Personal Observations*

Man and the Wild Animals (p. 1)

Charles Scribner's Sons. New York, New York, USA. 1922

On one side of the heights above the River of Life stand the men of this little world, the fully developed, the underdone, and the unbaked, in one struggling, seething mass. On the other side, and on a level but one step lower down, stands the vanguard of the long procession of "Lower" Animals, led by the chimpanzee, the orang

and the gorilla. The natural bridge that almost spans the chasm lacks only the keystone of the arch.

*The Minds and Manners of Wild Animals: A Book of Personal Observations*

Part IV, Chapter XXV (p. 252)

Charles Scribner's Sons. New York, New York, USA. 1922

An Animal is a living creature belonging to the animal kingdom; but the word is commonly, though incorrectly, used to designate mammals alone.

In William H. Carr

*The Stir of Nature*

Chapter Fourteen (p. 181)

Oxford University Press, Inc. New York, New York, USA. 1930

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

In our conviction, if souls were viable we should distinctly see the strange fact that every individual of the human species corresponds to some one of the species of animal creation; and we might easily recognize the truth, which has as yet scarce occurred to the thinker, that from the oyster to the eagle, from the hog to the tiger, all animals are in man, and that each one of them is in a man. Sometimes even several of them at a time.

*Les Misérables*

Volume I, Book V, Chapter 5 (p. 167)

The Heritage Press. New York, New York, USA. 1938

...from the oyster to the eagle, from the swine to the tiger all animals are in man, and that each of them is in a man; sometimes even, several of them at a time. Animals are nothing but the forms of our virtues and vices, wandering before our eyes, the visible phantoms of our souls.

*Les Misérables*

Fantine, Section 5 (p. 100)

Carlton Publishers. New York, New York, USA. 1884

### **Huxley, Thomas Henry** 1825–95

English biologist

Not only does every animal live at the expense of some other animal or plant, but the very plants are at war.... The individuals of a species are like the crew of a foundered ship, and none but good swimmers have a chance of reaching the land.

*Collected Essays* (Volume 2)

*Darwiniana*

The Darwin Hypothesis (p. 18)

Macmillan & Company Ltd. London, England. 1904

...the animal world is on about the same level as a gladiator's show. The creatures are fairly well treated, and set to fight – whereby the strongest, the swiftest, and the cunningest live to fight another day. The spectator has no need to turn his thumbs down, as no quarter is given.

*Collected Essays* (Volume 9)

The Struggle for Existence in Human Society (pp. 199–200)

Macmillan & Company Ltd. London, England. 1904

### **Jaeger, Benedict** 1789–?

Austrian born American entomologist

The utmost expansion of the human intellect can comprehend only a small part of the wondrous nature, life, and character of the animated masses around him.

*The Life of North American Insects*

ORDER I (p. 19)

Harper & Brothers Publishers. New York, New York, USA. 1859

### **James, Will** 1892–1942

Canadian illustrator

To my way of thinking there's something, wrong, or missing, with any person who hasn't got a soft spot in their heart for an animal of some kind. With most folks the dog stands highest as man's friend, then comes the horse, with others the cat is liked best as a pet, or a monkey is fussed over; but whatever kind of animal it is a person likes, it's all hunky-dory so long as there's a place in the heart for one or a few of them.

*Smoky, The Cow Horse*

Preface (p. v)

Charles Scribner's Sons

New York, New York, USA. 1926

### **Jennings, Elizabeth** 1926–2001

English poet

I hate a word like “pets”: it sounds so much Like something with no living of its own.

*Collected Poems: 1953–1985*

*My Animals*

Carcanet Press. New York, New York, USA. 1986

### **Jerome, Jerome K.** 1859–1927

English author

Let your boat of life be light, packed with only what you need – a homely home and simple pleasures, one or two friends, worth the name, someone to love and someone to love you, a cat, a dog, and a pipe or two, enough to eat and enough to wear, and a little more than enough to drink; for thirst is a dangerous thing.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 3 (p. 25)

Time Incorporated. New York, New York, USA. 1964

### **Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

...the most important reason why there are so many gaps in the available life histories of even the commoner animals is less the perversity of professors than the fact that there are an awful lot of these common creatures and that actually to follow their lives from day to day is a very difficult time-consuming task.

*The Desert Year*

The Contemplative Toad (p. 109)

W. Sloane Associates. New York, New York, USA. 1952

**La Fontaine, Jean de** 1621–95  
French fabulist

...for animals I choose  
To proffer lessons that we all might use.

Translated by Norman R. Shapiro  
*The Complete Fable of Jean de La Fontaine*  
For Monseigneur le Dauphin  
University of Illinois Press. Champaign, Illinois, USA. 2007

**Leclerc, Georges-Louis, Comte de Buffon** 1707–88  
French naturalist

As we can judge only in proportion as we compare, and as all our knowledge turns upon the relations by which one object differs from another, if there existed no brute animals, the nature of the human beings would be still more incomprehensible.

*Natural History* Volume 5  
Chapter I (p. 1)  
Printed for H.D. Symonds. London, England. 1811

An animal has two modes of existence; that of motion, or awake, and that of rest, or asleep; and which, while life lasts, succeed each other alternately. In the former, all the springs of the machine are in action; in the latter, there is only a part of them so, and this part acts as well while the animal is asleep as while it is awake, and, is therefore, absolutely necessary since the animal cannot exist, without it.

*Natural History* Volume 5  
Chapter I (p. 3)  
Printed for H.D. Symonds. London, England. 1811

**Erskine, Thomas (First Baron Erskine)** 1750–1823  
English lawyer and politician

In the large animals, you see  
And own a wise economy –

...  
Without their aids, Man's boundless sway  
You feel would languish and decay.  
The Farmer's Vision  
*The London Literary Gazette*, Number 113, March 20, 1819

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

When we consider how much we owe to the Dog, Man's faithful friend, to the noble Horse, the patient Ox, the Cow, the Sheep, and our other domestic animals, we cannot be too grateful to them: and if we cannot, like some ancient nations, actually worship them, we have perhaps fallen into the other extreme, underrate the sacredness of animal life, and treat them too much like mere machines.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter II (p. 41)  
Macmillan & Company Ltd. London, England. 1903

...if Man would but treat other animals with kindness, so that they might approach us without fear, and we might have the constant pleasure of watching their winning ways. Their origin and history, structure and habits, senses and intelligence, offer an endless field of interest and wonder.

*The Pleasures of Life*  
Chapter VII (p. 151)  
The Macmillan Co. New York, New York, USA. 1891

**MacNeice, Louis** 1907–63  
British and Irish poet and playwright

Many people take to animals to escape from human beings – but often, it turns out, because they find the animals so human. Others, of whom I am one, find animals a delightful change just because they are not human and never can be.

*Selected Prose of Louis MacNeice*  
Wild and Domestic (p. 49)  
Oxford University Press. Oxford, England. 1990

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist

**Sagan, Dorion** 1959–  
American science writer

Human religion and mythology have always been full of fantastic combinations of creatures – the mermaids, sphinxes, centaurs, devils, vampires, werewolves, and seraphs that combine animal parts to make imaginary beings. Truth being stranger than fiction, biology has refined the intuitively pleasing idea with its discovery of the overwhelming statistical probability of the reality of combined beings.

*Microcosmos*  
Chapter 7 (p. 120)  
Summit Books. New York, New York, USA. 1986

No animal has ever really completely left the watery microcosm. The blastula and embryo still develop in the primeval wetness and buoyancy of the womb.... No matter how high and dry the mountain top, no matter how secluded and modern the retreat, we sweat and cry what is basically seawater.

*Microcosmos*  
Chapter 11 (pp. 183, 184)  
Summit Books. New York, New York, USA. 1986

**Montgomery, James** 1771–1854  
Scottish poet and journalist

The slow-worm crawl'd, the light chameleon climb'd  
And changed his colour as his place he changed;  
The nimble lizard ran from bough to bough,  
Glancing through light, in shadow disappearing;  
The scorpion, many-eyed,  
with sting of fire,

Bred there, the legion-fiend of creeping things.

*The Poetical Works of James Montgomery, With Notes, etc.*

Pelican Island (p. 199)

Frederick Warne and Co. London, England. 1893

**Muir, John** 1838–1914

American naturalist

Of the many advantages of farm life for boys one of the greatest is the gaining a real knowledge of animals as fellow-mortals, learning to respect them and love them, and even to win some of their love. Thus godlike sympathy grows and thrives and spreads far beyond the teachings of churches and schools, where too often the mean, blinding, loveless doctrine is taught that animals have neither mind nor soul, have no rights that we are bound to respect, and were made only for man, to be petted, spoiled, slaughtered or enslaved.

*My Boyhood and Youth*

Chapter III (p. 89)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

Most wild animals get into the world and out of it without being noticed. Nevertheless we at last sadly learn that they are all subject to the vicissitudes of fortune like ourselves.

*My Boyhood and Youth*

Chapter III (p. 109)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

**Oken, Lorenz** 1779–1851

German naturalist

Animal is blossom without a stem.

In H.R. Hays

*Birds, Beasts, and Men: A Humanist History of Zoology*

Chapter 17 (p. 212)

G.P. Putnam's Sons. New York, New York, USA. 1972

**Owen, Richard** 1804–92

English biologist, comparative anatomist, and paleontologist

In the endeavor to complete the Natural History of any class of animals, the mind seeks to penetrate the mystery of its origin, and by tracing its mutations in time past, to comprehend more clearly its actual condition, and gain an insight into its probable destiny in time to come.

*A History of British Fossil Mammals, and Birds*

Introduction (p. xiii)

John van Voorst. London, England. 1846

**Pratchett, Terry** 1948–

English author

[For animals] the whole panoply of the universe has been neatly expressed to them as things to (a) mate with, (b) eat, (c) run away from, and (d) rocks.

*Equal Rites* (p. 78)

Gollancz. London, England. 1986

**Purcell, Rosamond**

American photographer

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Animals in nature, contrary to the suspicions of cynics or the hopes of idealists, are neither intrinsically vicious nor altruistic. Competition and cooperation are both nature's ways.

*Illuminations: A Bestiary*

Viper (p. 101)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Sanborn, Kate** 1839–1923

American writer

...if Darwin's theory should be true, it will not degrade man; it will simply raise the whole animal world into dignity, leaving man as far in advance as he is at present.

*Studies of Animal Nature*

*Atlantic Monthly*, February, 1877 (p. 135)

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Nature teaches beasts to know their friends.

*Great Books of the Western World* (Volume 27)

*Coriolanus*

Act ii, scene 1

Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Spencer, Herbert** 1829–1903

English social philosopher

...the behavior of men to the lower animals and their behavior to each other, bear a constant relationship...

*Social Statics*

Chapter XXX (p. 451)

D. Appleton & Co. New York, New York, USA. 1865

**Stoker, Bram** 1847–1912

English writer

Then a dog began to howl somewhere in a farmhouse far down the road, a long, agonized wailing, as if from fear. The sound was taken up by another dog, and then another and another, till, borne on the wind which now sighed softly through the Pass, a wild howling began, which seemed to come from all over the country, as far as the imagination could grasp it through the gloom of the night.

*Dracula*

Chapter I (p. 11)

Ameron House. Mattituck, New York, USA. nd

I have always thought that a wild animal never looks so well as when some obstacle of pronounced durability is between us. A personal experience has intensified rather than diminished that idea.

*Dracula*

Chapter XI (p. 148)

Ameron House. Mattituck, New York, USA. nd

**Twain, Mark (Samuel Langhorne Clemens)**1835–1910  
American author and humorist

Of all the animals, man is the only one that is cruel. He is the only one that inflicts pain for the pleasure of doing it.

*Collected Tales, Sketches, Speeches, and Essays 1891–1910*  
Man's Place in the Animal World (p. 210)  
The Library of America. New York, New York, USA. 1992

**Wheeler, William Morton**1865–1937  
American entomologist

Why animals and plants are as they are we shall never know; of how they came to be what they are, our knowledge will always be extremely fragmentary; but that organisms are as they are, that apart from members of our own species they are our only companions in an infinite and unsympathetic waste of electrons, planets, nebulae and stars, is a perennial joy and consolation.

In Joseph Wood Krutch  
The Thought of Turtles  
*The Nation*, Volume 166, Number 24, June 12, 1948

**Whitman, Walt**1819–92  
American poet, journalist, and essayist

I think I could turn and live with animals, they are so placid and self-contained,

I stand and look at them long and long:

They do not sweat and whine about their condition,  
They do not lie awake in the dark and weep about their sins,

They do not make me sick discussing their duty to God.

*Leaves of Grass*  
Song of Myself. 32

**Wordsworth, William**1770–1850  
English poet

The cattle are grazing,  
Their heads never raising:

There are forty feeding like one!

*The Complete Poetical Works of William Wordsworth*  
The Cock Is Crowing  
Crowell. New York, New York, USA. 1888

...scattered herds, that in the meadow graze,  
Some amid lingering shade, some touched by the sun's rays.

*Complete Poetical Works*  
Guilt and Sorrow  
Verse lx  
Troutman & Hayes. Philadelphia, Pennsylvania, USA. 1852

**von Goethe, Johann Wolfgang**1749–1832  
German poet, novelist, playwright, and natural philosopher

...every creature sundered from its natural surroundings, and brought into strange company, makes an unpleasant impression on us, which disappears only by habit

In John Stuart Blackie (ed.)  
*The Wisdom of Goethe*  
Nature – Natural History (p. 183)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

**ANIMAL: AMPHIBIAN****Smith, Langdon**1858–1908  
American poet

We were amphibians, scaled and tailed  
And drab as a dead man's hand;  
We coiled at ease 'neath the dripping trees  
Or trailed through the mud and sand.  
Croaking and blind, with our three clawed feet  
Writing a language dumb,  
With never a spark in the empty dark  
To hint at a life to come.

In David L. George (ed.)  
*The Family Book of Best Loved Poems*  
Evolution  
Hanover House. Garden City, New Jersey, USA. 1952

**FROG****Author undetermined**

What a wonderful bird the frog are –  
When he stand he sit almost;  
When he hop, he fly almost.  
He ain't got no sense hardly;  
He ain't got no tail hardly either.  
When he sit, he sit on what he ain't got almost.  
Source undetermined

**Carr, Archie**1909–87  
American zoologist

I like the look of frogs, and their outlook, and especially the way they get together in wet places on warm nights and sing about sex.

*The Windward Road: Adventures of a Naturalist on Remote Caribbean Shores*  
The Paradox Frog (p. 90)  
Alfred A. Knopf. New York, New York, USA. 1956

**Holmes, Oliver Wendell**1809–94  
American physician, poet, and humorist

Nature has organized one of her creatures so admirably for the purposes of the physiologist that Mr. Bergh himself would hardly deny that there was a meaning in it. One cannot help thinking what a festival of science the Plague of Frogs must have been to the Brown-Se'guards of the time of Moses. That luckless animal, which has storks and mice and snakes and anglers and boys as its natural enemies, displays some of its nerves so beautifully and



liberally on the most superficial anatomical inspection, that it becomes in consequence of this indiscreet exposure a foredoomed and necessary victim of experiment.

*The Writings of Oliver Wendell Holmes*

*Pages from an Old Volume of Life*

Chapter VI (p. 195)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1891

**Muir, John** 1838–1914

American naturalist

Frogs abound in all the bogs, marshes, pools, and lakes, however cold and high and isolated. How did they manage to get up these high mountains? Surely not by jumping. Long and dry excursions through weary miles of boulders and brush would be trying to frogs. Most likely their stringy spawn is carried on the feet of ducks, cranes, and other water birds. Anyhow, they are most thoroughly distributed, and flourish famously. What a cheery, hearty set they are, and how bravely their krink and tronk concerts enliven the rocky wilderness!

*Our National Parks*

Chapter VI (p. 211)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Ovid** BCE–17 AD

Roman poet

Ev'n slime begets the frog's loquacious race:  
Short of their feet at first, in little space  
With arms, and legs endu'd, long leaps they take  
Rais'd on their hinder parts, and swim the lake,  
And waves repel: for Nature gives their kind,  
To that intent, a length of legs behind.

*Ovid*

*Metamorphoses*, Book the Fifteenth (p. 163)

Harper & Brothers Publishers. New York, New York, USA. 1836

**Wedl, Carl** 1815–91

Austrian pathologist

For researches of this kind [circulation of the blood], the Frog – that arch-martyr to science – affords the most convenient subject.

Translated by George Busk

*Rudiments of Pathological Histology*

Chapter II (p. 15)

Printed for the Sydenham Society. London, England. 1855

## POLLYWOG

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

The pollywogg iz created bi the sides ov the road, out ov thick water, and spends hiz infancy in pollywogging.

*Josh Billings' Wit and Humor*

The Pollywogg (p. 89)

George Routledge & Sons. London, England. 1874

## SALAMANDER

**Addison, Joseph** 1672–1719

English essayist, poet, and statesman

In short, the artist did his part to admiration, and was so encompassed with fire and smoke, that one would have thought nothing but a salamander could have been safe in such a situation.

*The Guardian*

Volume 2, Number 103, July 9, 1715 (p. 97)

John Sharpe. London, England. 1804

**Glanvill, Joseph** 1636–80

English clergyman and philosopher

According to this *Hypothesis* [that there is a sphere of fire under the concave of the moon], the whole *Lunar* world is a *Torrid Zone*; and on a better account, then *Aristotle* thought ours was, may be supposed *inhabitable*, except they are *Salamanders* which dwell in those *fiery Regions*.

*Scep sis Scientifica*

Chapter XX (p. 151)

Kegan Paul, Trench & Co. London, England. 1885

## TADPOLE

**Pallister, William Hales** 1877–1946

Canadian physician

Three large glass bowls,  
In each some half grown tadpoles,  
All hatched from the same spawn,  
Breathing with gills like fishes  
In their small transparent dishes,  
Waving their long tails,  
Important to themselves as whales,  
Some of them to be experimented on...

*Poems of Science*

The Nature of Things, Tadpoles (p. 6)

Playford Press. New York, New York, USA. 1931

## TOAD

**Fawcett, Edgar** 1847–1904

American poet

Blue dusk, that brings the dewy hours,  
Brings thee, of graceless form in smooth,  
Dark stumbler at the roots of flowers,  
Flaccid, inert, uncouth.

In John Burroughs (ed.)

*Songs of Nature*

A Toad

Doubleday, Page & Company. Garden City, New York, USA. 1912

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

I met a toad  
the other day by the name

of warty bliggens  
 he was sitting under  
 a toadstool  
 feeling contented  
 he explained that when the cosmos  
 was created  
 that toadstool was especially  
 planned for his personal  
 shelter from the sun and rain  
 thought out and prepared  
 for him

*the lives and time of archy & mehitabel*  
 warty bliggens, the toad (p. 38)

Doubleday Doran & Co. Garden City, New York, USA. 1934

**McArthur, Peter** 1866–1924  
 Canadian poet

Probably no creature in all nature has been so villainously libeled as the toad. The greatest of poets speak of “the toad, ugly and venomous,” and in fairy lore they are regarded as poisonous. So deeply rooted are these erroneous beliefs that no amount of scientific education seems able to eradicate them. The children are taught in school that the toad is not only harmless, but useful as an insect destroyer, and yet little girls will shriek at a toad just like their mothers.

*The Best of Peter McArthur*  
 Toads (p. 177)

Vancouver, Clarke, Irwin. Toronto, Ontario, Canada. 1967

**Milne, A. A. (Alan Alexander)** 1882–1956  
 English poet, children’s writer, and playwright

(Weasels, Stoats, and Ferrets, together:) Toad! Toad!  
 Down with Toad!  
 Down with the popular, successful Toad!

*Toad of Toad Hall*  
 Act 1, Number 7 (p. 18)

Charles Scribner’s Sons. New York, New York, USA. 1929

**Montgomery, James** 1771–1854  
 Scottish poet and journalist

Loathsome, unsightly, swollen to obscene bulk,  
 Lurk’d the dark toad beneath the infected turf ...

*The Poetical Works of James Montgomery*  
 The Pelican Island

Little, Brown & Co. Boston, Massachusetts, USA. 1860

## ANIMAL: ANTHROPODA

### BARNACLE

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

The little Barnacles which crust the rocks at low tide, and which to live there at all must be able to resist the surf,

have the building of their shells constructed strictly with reference to this necessity. It is a structure all hollowed and chambered on the plan which engineers have so lately discovered as an arrangement of material by which the power of resisting strain or pressure is multiplied in an extraordinary degree. That shell is as pure a bit of mechanics as the bridge, both being structures in which the same arrangement is adapted to the same end.

*The Reign of Law* (4th American edition)

Chapter 2 (pp. 99–100)

George Routledge & Sons. New York, New York, USA. 1873

### CENTIPEDE

**Blanshard, Brand** 1892–1987  
 American philosopher

The centipede was happy quite  
 Until the toad for fun  
 Said: “Pray which leg comes after which?”  
 This wrought his mind to such a pitch,  
 He lay distracted in the ditch  
 Considering how to run.

*The Nature of Thought* (Volume 1)

Chapter VI, fn 1 (p. 232)

George Allen & Unwin Ltd. London, England. 1939

**Burroughs, William S.** 1914–97  
 American novelist, essayist, and social critic

Now what sort of man or woman or monster would stroke a centipede on his underbelly? “And here is my good big centipede!” If such a man exists, I say kill him without more ado. He is a traitor to the human race.

*The Western Lands*

Chapter 4 (p. 86)

Viking Penguin. New York, New York, USA. 1987

**Marquis, Don** 1878–1937  
 American newspaperman, poet, and playwright

the centipede adown the street  
 goes braggartly with scores of feet  
 a gaudy insect but not neat

*the lives and time of archy & mehitabel*

archy at the zoo (p. 130)

Doubleday Doran & Co. Garden City, New York, USA. 1934

### CRAB

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
 American writer and humorist

Natur is fond ov a joke.

She must have felt full ov fun, when she made a soft shell crab. The strongest emotion the crab haz iz tew bite. They aint afrade tew bite a sawlog, or a black bear. They are



born in the water, but they kan live out doors on the land  
az long az they kan find ennything tew bite.

*Josh Billings' Wit and Humor*

The Crab (p. 85)

George Routledge & Sons. London, England. 1874

**James, William** 1842–1910

American philosopher and psychologist

Probably a crab would be filled with a sense of personal outrage if it could hear us class it without ado or apology as a crustacean, and thus dispose of it. “I’m no such thing,” it would say, “I am MYSELF, MYSELF.”

*The Varieties of Religious Experience*

Lecture I (p. 10)

The Modern Library. New York, New York, USA. 196?

## CRAWFISH

**Flaubert, Gustave** 1821–90

French novelist

Crayfish. Female of the lobster. Walks backward. Always call reactionaries “crayfish.”

*Dictionary of Accepted Ideas*

Animal Life (pp. 139–140)

M. Reinhardt. London, England. 1954

## LOBSTER

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

‘Tis the voice of the Lobster: I heard him declare  
“You have baked me too brown, I must sugar my hair.”

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter X (p. 111)

The Modern Library. New York, New York, USA. 1936

## MILLIPEDE

**Garstang, Walter** 1868–1949

English embryologist and amateur poet

The hatching of a Millipede brings curious things to light:

The embryo within its shell is curled up snug and tight  
Enclosed inside an inner skin with a thorn upon its neck,  
Whose task it is to pierce the shell, as chicks their prisons peck.

What is this extra covering that thus comes into view?

An heirloom from antiquity here blended with the new?

Another “Nauplius-coat” around another embryo,

The same that Peracarids on their cradled babes bestow?

*Larval Forms, and Other Zoological Verses*

The Millipede’s Egg-Tooth, Stanza 1 (p. 51)

The University of Chicago Press. Chicago, Illinois, USA. 1985

## MITE

### Author undetermined

The cheese-mites asked how the cheese got there,  
And warmly debated the matter;

The orthodox said it came from the air,

And the heretics said from the platter.

In Arnold Silcock

*Verses and Worse*

Four More Brief Beliefs (p. 60)

Faber & Faber Ltd. London, England. 1952

**Duck, Stephen** 1705–56

English poet

Dear Madam, did you never gaze

Thro’ optic glass on rotten cheese?

There, Madam, did you ne’er perceive

A crowd of dwarfish creatures live?

The little things, elate with Pride,

Strut to and fro, from side to side:

In tiny pomp and partly vein,

Lords of their pleasing orb they reign;

And fill’d with harden’d Curds and Cream,

Think the Whole Dairy made for *them*.

In T.E. Hughes

*Mites, or the Acari* (p. vii)

University of London. London, England. 1959

**Frost, Robert** 1874–1963

American poet

A speck that would have been beneath my sight

On any but a paper sheet so white

Set off across what I had written there.

And I had idly poised my pen in air

To stop it with a period of ink

When something strange about it made me think.

This was no dust speck by my breathing blown,

But unmistakably a living mite

With inclinations it could call its own.

*Complete Poems of Robert Frost*

A Considerable Speck

Henry Holt & Company. New York, New York, USA. 1949

**Hooke, Robert** 1635–1703

English physicist

The least of Reptiles I have hitherto met with, is a Mite.

*Micrographia*

Observation, LV (p. 213)

Printed by Jo. Martyn & Ja. Allestry. London, England. 1665

## SCORPION

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The Scorpion is as black as soot,

He dearly loves to bite;  
He is a most unpleasant brute  
To find in bed, at night.

*Complete Verse*

The Scorpion (p. 243)

Gerald Duckworth. London, England. 1970

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The Scorpion is an uncommunicative insect, occult in his manners and unpleasant to deal with.... He has at all times struck the popular imagination, even to the point of being numbered among the signs of the zodiac.

Fear made the gods, said Lucretius. Deified by terror, the Scorpion is glorified in the sky by a constellation and in the almanac by the symbol for the month of October. Let us try to make him speak.

Translated by Alexander Teixeira de Mattos

*The Life and Love of the Insect*

The Languedocian Scorpion (p. 223)

Adam & Charles Black. London, England. 1911

## SPIDER

**Allen, Grant** 1848–99

Canadian-born writer

In selecting a garden spider of my acquaintance...I do not desire to hold her up to the young, the gay, the giddy, and the thoughtless as a pattern for imitation. She does not point a moral with the ant. On the contrary, she must rank with Semiramis and the famous queen who dwelt in the Tour de Nesle as a shining example of abandoned and shameless wickedness.

*Flashlights on Nature*

Chapter III (pp. 47–48)

Doubleday, Page & Co. New York, New York, USA. 1905

**Bunyan, John** 1628–88

English Christian writer and preacher

SINNER: What black, what ugly, crawling thing art thou?

SPIDER: I am a spider –

*The Complete works of John Bunyan*

*The Sinner and the Spider*

Bradley, Garretson & Co. Philadelphia, Pennsylvania, USA. 1872

**Dickinson, Emily** 1830–86

American lyric poet

The spider as an artist  
Has never been employed  
Though his surpassing merit  
Is freely certified.  
By every broom and Bridget  
Throughout a Christian land.  
Neglected son of genius,  
I take thee by the hand.

*The Complete Poems of Emily Dickinson*

No. 1275 (p. 557)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The Spider has a bad name: to most of us, she represents an odious, noxious animal, which everyone hastens to crush under foot. Against this summary verdict the observer sets the beast's industry, its talent as a weaver, its wiliness in the chase, its tragic nuptials and other characteristics of great interest.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Chapter I (p. 39)

Dodd, Mead & Company. New York, New York, USA. 1913

There are no masters nor apprentices in their [spiders] guild; all know their craft from the moment that the first thread is laid.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Chapter X (p. 248)

Dodd, Mead & Co. Boston, Massachusetts, USA. 1917

**Florian, Douglas** 1950–

American author and illustrator

O Daddy

Daddy O

How'd you get

Those legs to grow

So very long

And lean in size?

From spiderobic

Exercise?

*Insectlopedia: Poems and Paintings*

The Daddy Longlegs

Harcourt Brace. San Diego, California, USA. 1998

**Lugosi, Bela** 1882–1956

Hungarian film star

The spider spinning his web for the unwary fly. The blood is the life...

*Dracula*

Film (1931)

**Martin, Charles-Noël** 1923–

French physicist

Spiders act as if they had the brains of first-class mathematicians. For them, space has properties which makes its structure quite unique.

Translated by A.J. Pomerans

*The Role of Perception in Science*

Chapter 5 (p. 114)

Hutchinson of London. London, England. 1963

**Pallister, William Hales** 1877–1946

Canadian physician

Of the SPIDERS and SCORPIONS, five thousand kinds:  
These are scattered abroad, on the sea and the shore,

Quite unpleasant to think of, but still it reminds  
To be glad there are not many thousand kinds more.  
These are eight-legged beauties, with schemes of their own,  
And the safest precaution is: Leave them alone!

*Poems of Science*

Beginnings, Animal Life (p. 140)

Playford Press. New York, New York, USA. 1931

### Smith, Bertha Wilcox

No biographical data available

Throughout the night he spun a thread  
With which he wove medallioned lace  
That stretched between two milkweed pods  
Beside a dusty, traveled place;  
The pattern was a scalloped round –  
Each radius exactly drawn  
With trellised filaments between,  
And over all bright diamonds shone;  
In meshed and tenuous design  
It was a fragile, wayside sonnet –  
The maker, heedless of acclaim,  
Had left no signature upon it.

*Nature Magazine*, Volume 50, Number 5, May, 1957 (p. 234)

### Taylor, Ann 1782–1866

English poet and children's author

“O look at that great ugly Spider,” said Ann,  
And screaming, she knocked it away with her fan;  
“‘Tis a great ugly creature, as ever can be,  
I wish that it would not come crawling on me.”

*Original Poems for Infant Minds*

The Spider, Stanza I

Robert Carter. New York, New York, USA. 1856

### Topsell, Edward 1572–1625?

English divine and writer

To begin therefore to make an enumeration of their pray-  
ses, I will declare unto yo, the rich vertues and external  
goods of the body, fortune and minde. And first to begin  
with the good gifts of their bodies. If you will weigh and  
consider the matter and substance of a Spiders body, you  
shall finde it to be light, partaking much of fire and ayr,  
(being two of the most noble and effectual elements in  
operation) and having but little earthy dragginesse and  
drossy refuse.

*The History of Four-Footed Beasts*

The History of Serpents

Of the Spider (p. 778)

G. Sawbridge. London, England. 1658

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Some of these spiders could straddle over a common  
saucer with their hairy, muscular legs, and when their  
feelings were hurt, or their dignity offended, they were

the wickedest-looking desperadoes the animal world can  
furnish. If their glass prison-houses were touched ever so  
lightly they were up and spoiling for a fight in a minute.  
Starchy? – proud? Indeed, they would take up a straw  
and pick their teeth like a member of Congress.

*Roughing It* (Volume 1)

Chapter XXI (p. 176)

Harper & Brothers Publishers. New York, New York, USA. 1899

### White, Terence Hanbury 1906–64

English author

A spider is an air worm, as it is provided with nourish-  
ment from the air, which a long thread catches down to  
its small body.

*The Book of Beasts: Being a Translation From a Latin Bestiary of the  
Twelfth Century* (p. 191)

G.P. Putnam's Sons. New York, New York, USA. 1954

## TICK

### Florian, Douglas 1950–

American author and illustrator

Not gigan-tic.

Not roman-tic.

Not artis-tic.

Not majes-tic.

Not magne-tic.

Nor aesthe-tic.

Ticks are strictly parasi-tic.

*Insectlopedia: Poems and Paintings*

The Ticks

Harcourt Brace. San Diego, California, USA. 1998

### Pliny (C. Plinius Secundus) 23–79

Roman savant and author

...ticks, the foulest and nastiest creatures that be ...

Translated by Philmon Holland and Paul Turner

*Selections from The History of the World, Commonly Called The Natu-  
ral History of C. Plinius Secundus* (p. 317)

Southern Illinois University Press. 1962

## WOODLOUSE

### Garstang, Walter 1868–1949

English embryologist and amateur poet

MacBride was in his garden settling pedigrees,  
When came a baby Woodlouse and climbed upon his  
knees,

And said: “Sir, if our six legs have such an ancient air,  
Shall we be less ancestral when we've grown our moth-  
er's pair?”

*Larval Forms, and Other Zoological Verses*

Isopod Phylogeny, Stanza 3 (p. 50)

The University of Chicago Press. Chicago, Illinois, USA. 1985

**ANIMAL: BIRD**

**Atkinson, Brooks** 1894–1984  
American drama critic

Nothing wholly admirable ever happens in this country except the migration of birds.

*Once Around the Sun*

March 23 (p. 80)

Harcourt, Brace & Company. New York, New York, USA. 1951

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

There are no such indefatigable entomologists as birds.

*Star Papers*

The Value of Birds, XIII (p. 194)

J.B. Ford & Co. New York, New York, USA. 1873

They [birds] eat what they like, wipe their mouths on a limb, return thanks in a song, and wing away to a quiet nook to doze or meditate ...

*Star Papers*

The Value of Birds, XIII (p. 195)

J.B. Ford & Co. New York, New York, USA. 1873

We charge every man with positive dishonesty who drives birds from his garden in fruit-time. The fruit is theirs as well as yours. They took care of it as much as you did. If they had not eaten egg, worm, and bug, your fruit would have been pierced and ruined. They only come for wages. No honest man will cheat a bird of his spring and summer's work.

*Star Papers*

The Value of Birds, XIII (p. 196)

J.B. Ford & Co. New York, New York, USA. 1873

**Beston, Henry** 1888–1968  
American writer

On flocks of birds flying up before him as he walks the beach: "Standing on the beach, I watch the lovely sight of the group instantly turned into a constellation of birds, into a fugitive Pleiades whose living stars keep their chance positions."

*The Outermost House*

Chapter II (p. 23)

Rinehart & Company. New York, New York, USA. 1928

**Bogart, Humphrey** 1899–1957  
American film actor

Let's talk about the black bird.

*The Maltese Falcon*

Film (1941)

**Burroughs, John** 1837–1921  
American naturalist and essayist

It might almost be said that the birds are all birds of the poets and of no one else, because it is only the poetical temperament that fully responds to them.

*Birds and Poets With Other Papers*

Birds And Poets (p. 9)

David Douglas Edinburgh, Scotland. 1884

The very idea of a bird is a symbol and a suggestion to the poet. A bird seems to be at the top of the scale, so vehement and intense is his life – large brained, large lunged, hot, ecstatic, his frame charged with buoyancy and his heart with song. The beautiful vagabonds, endowed with every grace, masters of all climes, and knowing no bounds – how many human aspirations are realised in their free, holiday-lives – and how many suggestions to the poet in their flight and song!

*Birds and Poets With Other Papers*

Birds And Poets (p. 10)

David Douglas Edinburgh, Scotland. 1884

**Chapman, Frank M.** 1864–1945  
American ornithologist

...birds will appeal most strongly to us through their songs. When your ears are attuned to the music of birds, your world will be transformed. Birds' songs are the most eloquent of Natures' voices....

*Bird-Life*

Chapter I (p. 11)

D. Appleton & Company. New York, New York, USA. 1903

**Cornwall, Barry (Bryan Waller Procter)** 1787–1874  
English author

Come, all ye feathery people of mid-air,  
Who sleep 'midst rocks, or on the mountain summits  
Lie down with the wild winds; and ye who build  
Your homes amidst green leaves by grottoes cool;  
And ye who on the flat sands hoard your eggs  
For suns to ripen, come!

*The Poetical Works of Milman, Bowles, Wilson, and Barry Cornwall*

An Invocation to Birds

A. & W. Galignani. Paris, France. 1829

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

A bird is an instrument working according to a mathematical law, which instrument it is within the capacity of man to reproduce, with all its movements.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Flying Machine (p. 493)

George Braziller. New York, New York, USA. 1958

**Darwin, Charles Robert** 1809–82  
English naturalist

We behold the face of nature bright with gladness, we often see the superabundance of food; we do not see or we forget, that the birds which are idly singing round us mostly live on insects or seeds, and are thus constantly destroying life; or we forget how largely these songsters, or their eggs, or their nestlings, are destroyed by birds

and beasts of prey; we do not always bear in mind, that, though food may be now superabundant, it is not so at all seasons of each recurring year.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter III (p. 32)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Dewar, Douglas** 1875–1957

British civil servant

Only those who have come under the sway of the charm of birds can appreciate to what an extent the “*joie de vivre*” is enhanced by an acquaintance with them. Interest in the feathered hosts, when once aroused in a man, will never flag or wane.

*Annual Report of the Board of Regents of the Smithsonian Institution (1908)*

The Birds of India (p. 623)

Government Printing Office. Washington, D.C. 1909

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The bird is not in its ounces and inches, but in its relations to Nature; and the skin or skeleton you show me, is no more a heron, than a heap of ashes or a bottle of gases into which his body has been reduced, is Dante or Washington.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Beauty (p. 1099)

The Library of America. New York, New York, USA. 1983

Hast thou named all the birds without a gun?

*Collected Poems and Translations*

Forbearance

Library of America. New York, New York, USA. 1994

### **Fish, Henry C.**

No biographical data available

A concert will be given on Tuesday, May twentieth, at half-past four A.M. Robin, Oriole, Thrush, and many other exquisite and justly celebrated musicians, will be among the performers.

Price of admission, ‘early rising.’

Sermon XVIII

*The National Preacher*, Volume IV, 1861 (p. 271)

### **Guinzelli, Guido** 1230–1276

Italian poet

Many strange birds are on the air abroad,

Nor are all of one flights of one force,

But each after his kind dissimilar.

In Robert Edwards (ed.)

*The Poetry of Guido Guinzelli*

Of Moderation and Tolerance

Garland Publications. New York, New York, USA. 1987

### **Headley, F. W.**

No biographical data available

...a bird seems to have more life in him than any other living creature.

In Douglas Dewar

*Annual Report of the Board of Regents of the Smithsonian Institution (1908)*

The Birds of India (p. 624)

Government Printing Office. Washington, D.C. 1909

### **Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Birds in general are stupid, in the sense of being little able to meet unforeseen emergencies; but their lives are often emotional, and their emotions are richly and finely expressed.

*Essays of a Biologist*

An Essay on Bird-Mind (p. 111)

Alfred P. Knopf. New York, New York, USA. 1929

### **Jefferies, Richard**

The birds of spring come as imperceptibly as the leaves. One by one the buds open on hawthorn and willow, till all at once the hedges appear green, and Bo the birds steal quietly into the hushes and trees, till by-and-by a chorus fills the wood, and each warm shower is welcomed with varied song.

Birds of Spring

*Chamber's Journal of Popular Literature, Science and Arts*, Volume 1, Number 9, March 1, 1884 (p. 129)

### **Klee, Paul** 1879–1940

Swiss painter

The birds are to be envied:

They avoid

Thinking about the trees and the roots.

Agile, self contented, all day long they swing

And sing, perched on ultimate end.

*The Inward Vision: Watercolors, Drawings, Writings*

Cover Page

N.H. Abrams. New York, New York, USA. 1958

### **Lawrence, D. H. (David Herbert)** 1885–1930

English writer

I never saw a wild thing

Sorry for itself.

A small bird will drop frozen dead

From a bough

Without ever having felt sorry for itself.

*The Complete Poems of D.H. Lawrence*

Self Pity

The Viking Press. New York, New York, USA. 1973

### **Longfellow, Henry Wadsworth** 1807–82

American poet

You call them thieves and pillagers; but know,

They are the winged wardens of yours farms,

Who from the cornfields drive the insidious foe,  
And from your harvests keep a hundred harms...

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 4)

The Poet's Tale

Birds of Killingworth, Stanza 19

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Lucas, Frederic Augustus** 1852–1929

American naturalist and zoologist

For, though so different in outward appearance, birds and reptiles are structurally quite closely allied, and the creeping snake and the bird on which it preys are relatives, although any intimate relationship between them is of the serpent's making, and is strongly objected to by the bird.

*Animals of the Past: an Account of Some of the Creatures of the Ancient World* (6th edition)

Chapter VII (p. 82)

American Museum Of Natural History New York, New York, USA. 1922

**Lynd, Robert** 1879–1949

Anglo-Irish essayist

There is nothing in which the birds differ more from man than the way in which they can build and yet leave a landscape as it was before.

*The Blue Lion*

The Nuthatch (p. 29)

Books for Libraries Press. Freeport, New York, USA. 1968

**Mansfield, Katherine** 1888–1923

English author

It is astonishing how violently a big branch shakes when a silly little bird has left it. I expect the bird knows it and feels immensely arrogant.

In J. Middleton Murry (ed.)

*Journal of Katherine Mansfield*

1917, August 21, Alors, je pars (p. 70)

Alfred A. Knopf. New York, New York, USA. 1946

**Maxwell-Lefroy, Harold** 1877–1925

English entomologist

Birds are the fluctuating check on insect life, the safety valve as it were; they congregate where they find insects, regardless of their species or habits, and constantly consume the superfluous and the superabundant insect life.

*Indian Insect Pests*

Part II, Chapter V (p. 67)

Office of the Superintendent of Government Printing. Calcutta, India. 1906

**McArthur, Peter** 1866–1924

Canadian poet

The robins, killdeere, red-winged blackbirds and grackles come back with the warm wave. This means that the great university of nature is about to open for its spring and summer terms.

*The Best of Peter McArthur*

Nature's University (pp. 169–170)

Vancouver, Clarke, Irwin. Toronto, Ontario, Canada. 1967

**Newton, Alfred** 1829–1907

English zoologist and ornithologist

Birds have no need to lurk hidden in dens, or to slink from place to place under the shelter of the inequalities of the ground or of the vegetation which clothes it, as is the case with some many animals of similar size.

In Thomas Spencer Baynes (ed.)

*The Encyclopaedia Britannica* (Volume 18) (9th edition)

Ornithology (p. 2)

Henry G. Allen & Co. New York, New York, USA. 1888

**Pallister, William Hales** 1877–1946

Canadian physician

Of the birds, thirteen thousands of species are named; This is the first life with warm blood! We could not know all

And quite truly one need not feel greatly ashamed

If some few of the rare names are hard to recall,

But the birds are so lovely, I wish that I knew

All about all of them, and I'm sure so do you.

*Poems of Science*

Beginnings, Animal Life (p. 141)

Playford Press. New York, New York, USA. 1931

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

... we have no natural history of birds written yet. It cannot be written but by a scholar and a gentleman; and no English gentleman in recent times has ever thought of birds except as flying targets, or flavoured dishes.

*Love's Meinie*

Lecture I, 3 (p. 7)

John Wiley & Son. New York, New York, USA. 1873

In general, the scientific natural history of a bird consists of four articles – first, the name and estate of the gentleman whose gamekeeper shot the last that was seen in England; secondly, two or three stories of doubtful origin, printed in every book on the subject of birds for the last fifty years; thirdly, an account of the feathers, from the comb to the rump, with enumeration of the colours which are never more to be seen on the living bird by English eyes; and, lastly, a discussion of the reasons why none of the twelve names which former naturalists have given to the bird are of any further use, and why the present author has given it a thirteenth, which is to be universally, and to the end of time, accepted.

*Love's Meinie*

Lecture I, 4 (p. 8)

John Wiley & Son. New York, New York, USA. 1873

...it [a bird] rests upon the air, subdues it, surpasses it, out races it – *is* the air, conscious of itself, conquering itself, ruling itself.

*The Queen of the Air*

Chapter II, 65 (p. 70)

George Allen. London, England. 1903



...into the throat of the bird is given the voice of the air. All that in the wind itself is weak, wild, useless in sweetness, is knit together in its song. As we may imagine the wild form of the cloud closed into the perfect form of the bird's wings, so the wild voice of the cloud into its ordered and commanded voice; unwearied, rippling through the clear heaven in its gladness, interpreting all intense passion through the soft spring nights, bursting into acclaim and rapture of choir at daybreak, or lisping and twittering among the boughs and hedges through heat of day, like little winds that only make the cowslip bells shake, and ruffle the petals of the wild rose.

*The Queen of the Air*

Chapter II, 65 (p. 70)

George Allen. London, England. 1903

It [a bird] is little more than a drift of the air brought into form by plumes ...

*The Queen of the Air*

Chapter II, 65 (p. 70)

George Allen. London, England. 1903

### Urquhart, Alexander

No biographical data available

In their natural healthy state birds are, almost without exception, dainty creatures, but daintiness does not always or often characterize their actions. Indeed, one who walks abroad in winter days, and watches the feathered people, is struck above all things by their absolute superiority to that characteristic human trait squeamishness. They have no objection to dirt, even when it is rank and smells high, and they approach putrescence with the serenity of an analytical chemist.

*Odd Hours With Nature*

The Unsqueamish Bird (p. 28)

Fisher Unwin. London, England. 1913

### Valéry, Paul 1871–1945

French poet and critic

If a bird could say exactly what he sings, why he sings it, and *what*, within himself, is singing, he would not sing.

Translated by Stuart Gilbert

*The Collected Works of Paul Valéry* (Volume 14)

*Analects*

Odds and Ends (p. 18)

Princeton University Press. Princeton, New Jersey, USA. 1979

### White, Gilbert 1720–93

English naturalist and cleric

The language of birds is very ancient, and, like other ancient modes of speech, very elliptical: little is said, but much is meant and understood.

*The Natural History of Selborne*

Letter XLIII (p. 198)

Robert M. McBride & Company. New York, New York, USA. 1925

### Whitman, Walt 1819–92

American poet, journalist, and essayist

You must not know too much, or be too precise or scientific about birds and trees and flowers and watercraft; a certain free margin, and even vagueness – perhaps ignorance, credulity – helps your enjoyment of these things.

*Specimen Days*

Birds – And a Caution (p. 112)

D.R. Godine. Boston, Massachusetts, USA. 1971

## ADJUANT

### Dewar, Douglas 1875–1957

British civil servant

If the hornbill be the clown of the forest, the adjuant is the buffoon of the open plain.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1908)

The Birds of India (p. 619)

Government Printing Office. Washington, D.C. 1909

### Kipling, Lockwood 1837–1911

English illustrator, museum curator, and father of Rudyard Kipling

For grotesque devilry of dancing the Indian adjutant beats creation. Don Quixote or Malcollo was not half so solemn or dancing, and yet there is an abandonment and lightness of step, a wild lift in each solemn prance which are almost demoniacal. If it were possible for the most angular, tall, and demure of elderly maiden ladies to take a great deal too much champagne and then to give a lesson in ballet dancing, with occasional pauses of acute sobriety, perhaps some faint idea might be conveyed of the peculiar quality of the adjutant's movements.

In Douglas Dewar

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1908

The Birds of India (p. 619)

Government Printing Office. Washington, D.C. 1909

## ALBATROSS

### Coleridge, Samuel Taylor 1772–1834

English lyrical poet, critic, and philosopher

And a good south wind sprung up behind,  
The Albatross did follow,  
And every day, for food or play,  
Came to the mariner's hollo!

“God save thee, ancient Mariner!

From the fiends that plague thus thee! –

Why look'st thou so?” –

With my crossbow

I shot the Albatross.

*The Rime of the Ancient Mariner and Other Poems*

Rime of the Ancient Mariner, Part I

pt. I, Stanza 18, l. 71–74, 76–80

Little Leather Library Corporation. New York, New York, USA. 1915

**Leland, Charles G.** 1824–1903  
American writer

Great albatross! – the meanest birds  
Spring up and flit away,  
While thou must toil to gain a flight,  
And spread those pinions grey...  
*The Music-Lesson of Confucius*  
Perseverando, Stanza 3  
J.R. Osgood & Company. Boston, Massachusetts, USA. 1872

**Lysaght, Sidney Roysse** 1860–1941  
Irish writer

An albatross wheeling in circles,  
Sails with a wing to the clouds and a wing to the touch  
of the billow ...  
*Poems*  
Storm  
Macmillan & Co. London, England. 1928

## AUK

**Fowles, John** 1926–2005  
English novelist

There seemed many great auks till the last one was killed.  
*Poems*  
Protect the Word (p. 48)  
Ecco Press. New York, New York, USA. 1973

## BALD EAGLE

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

I wish the Bald Eagle had not been chosen as the representative of our country. He is a bird of bad moral character; he does not get his living honestly...  
*Ornithological Biography* (Volume 1)  
White-Headed Eagle (p. 168)  
Adam Black. Edinburgh, Scotland. 1831

## BIRD OF PARADISE

**Colum, Padraic** 1881–1972  
Irish poet and writer

With sapphire for her crown,  
And with the Libyan wine  
For lustre of her eyes;  
With azure for her feet  
(It is her henna stain);  
Then iris for her vest,  
Rose, ebony, and flame,  
She lives a thing enthralled,  
In forests that are old,  
As old as is the Moon.  
*Collected Poems*  
Bird of Paradise  
Devin-Adair. New York, New York, USA. 1953

**Moore, Thomas** 1779–1852  
Irish poet

Those golden birds that, in the spice-time, drop  
About the gardens, drunk with that sweet food  
Whose scent hath lur'd them o'er the summer flood  
And those that under Araby's soft sun  
Build their high nests of budding cinnamon.  
*The Poetical Works of Thomas Moore*  
Lalla Rookh, The Veiled Prophet of Khorassan (p. 48)  
Lee & Shepard. Boston, Massachusetts, USA. 1873

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

Nature seems to have taken every precaution that these, her choicest treasures, may not lose value by being too easily obtained. First we find an open, harbourless, inhospitable coast, exposed to the full swell of the Pacific Ocean; next, a rugged and mountainous country, covered with dense forests, offering in its swamps and precipices and serrated ridges an almost impassable barrier to the central regions; and lastly, a race of the most savage and ruthless character, in the very lowest stage of civilization. In such a country and among such a people are found these wonderful productions of nature. In those trackless wilds do they display that exquisite beauty and that marvelous development of plumage, calculated to excite admiration and astonishment among the most civilized and most intellectual races of man...  
*Proceedings of the Zoological Society of London 1862* (p. 160)

## BLACKBIRD

**Moir, David Macbeth** 1798–1851  
Scottish physician and writer

The birds have ceased their songs,  
All save the blackbird, that from yon tall ash,  
'Mid Pinkie's greenery, from his mellow throat,  
In adoration of the setting sun,  
Chants forth his evening hymn.  
*The Poetical Works of David Macbeth Moir*  
An Evening Sketch  
W. Blackwood & Sons. Edinburgh, Scotland. 1860

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

The blackbird is a perfect gentleman, in deportment and attire, and is not noisy, I believe, except when holding religious services and political conventions in a tree...  
*Following the Equator* (Volume 2)  
Chapter II (p. 32)  
Harper & Brothers Publishers. New York, New York, USA. 1899



**BLUE JAY**

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

Reader, look at the plate in which are represented three individuals of this beautiful species – rogues though they be, and thieves, as I would call them, were it fit for me to pass judgment on their actions. See how each is enjoying the fruits of his knavery, sucking the egg which he has pilfered from the nest of some innocent dove or harmless partridge! Who could imagine that a form so graceful, arrayed by nature in a garb so resplendent, should harbour so much mischief...

*Ornithological Biography* (Volume 2)

The Blue Jay (p. 11)

Adam Black. Edinburgh, Scotland. 1834

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910  
American author and humorist

Now there is more to a bluejay than any other animal. He has got more different kinds of feeling. Whatever a bluejay feels he can put into language, and not mere commonplace language, but straight out and out book talk, and there is such a command of language. You never saw a bluejay get stuck for a word. He is a vocabularized geyser. Now you must call a jay a bird, and so he is in a measure, because he wears feathers and don't belong to any church, but otherwise he is just as human nature made him. A bluejay hasn't any more principle than an ex-congressman, and he will steal, deceive and betray four times out of five; and as for the sacredness of an obligation, you cannot scare him in the detail of principle. He talks the best grammar of all the animals. You may say a cat talks good grammar. Well, a cat does; but you let a cat get excited, you let a cat get at pulling fur with another cat on a shed nights and you will hear grammar. A bluejay is human; he has got all a man's faculties and a man's weakness. He likes especially scandal; he knows when he is an ass as well as you do.

*A Tramp Abroad*

Chapter II

Penguin Books. New York, New York, USA. 1997

**BLUEBIRD**

**Burroughs, John** 1837–1921  
American naturalist and essayist

Nature made the bluebird she wished to propitiate both the sky and the earth, so she gave him the color of the one on his back and the hue of the other on his breast, and ordained that his appearance in spring should denote that the strife and war between these two elements was at an end.

*The Writings of John Burroughs*

Chapter VII (p. 205)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1904

**Longfellow, Henry Wadsworth** 1807–82  
American poet

In the thickets and the meadows

Piped the bluebird, the Owaisa...

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)

*Hiawatha*, Part XXI

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

A man's interest in a single bluebird is worth more than a complete but dry list of the fauna and flora of a town.

*The Writings of Henry David Thoreau* (Volume 6)

Letter to Daniel Ricketson, November 22, 1856 (p. 341)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

**BOBOLINK**

**Cranch, Christopher Pearse** 1813–92

American Unitarian minister, poet, and author

One day in the bluest of summer weather,

Sketching under a whispering oak,

I heard five bobolinks laughing together,

Over some ornithological joke.

*Collected Poems of Christopher Pearse Cranch*

Bird Language, Stanza I

Scholars' Facsimiles & Reprints, Gainesville, Florida, USA. 1971

**BUZZARD**

**Faulkner, William** 1897–1962

American novelist, film screenwriter, and poet

[If I were reincarnated] I'd want to come back a buzzard. Nothing hates him or envies him or wants him or needs him. He is never bothered or in danger, and he can eat anything

In Joseph Blotner

*Faulkner: A Biography*

October 1955–February 1957 (p. 619)

First Vintage Books. New York, New York, USA. 1991

**CANARY**

**Mulock, Dinah Maria (Mrs. Craik)** 1826–87

English author

Sing away, ay, sing away,

Merry little bird,

Always gayest of the gay,

Though a woodland roundelay

You ne'er sung nor heard;

Though your life from youth to age  
Passes in a narrow cage.

*Miss Mulock's Poems*

The Canary in His Cage

Houghton, Osgood. Boston, Massachusetts, USA. 1880

**Nash, Ogden** 1902–71

American writer of humorous poetry

The song of canaries

Never varies,

And when they're molting

They're pretty revolting.

*Verses from 1929 On*

The Canary

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## CANYON WREN

**Moore, Kathleen Dean**

American philosophy professor and writer

The song of the canyon wren is the sound of falling water. Its bright tones fall off the canyon rim from ledge to ledge a step at a time. Sliding down a pour-off bouncing off a sandstone shelf, then dropping to the next layer of stone and down again – a falling scale, eight tones, a liquid octave of birdsong in the hand, sun-cut canyon.

*Holdfast: At Home in the Natural World*

The Song of the Canyon Wren (p. 75)

The Globe Pequot Press

Guilford, Connecticut, USA. 1999

## CONDOR

**Brower, David** 1912–2000

American environmentalist

A condor is about 5 percent feathers, blood, and bone, and about 95 percent place. Place designs the condor, as it does the Arctic tern and the monarch butterfly.

*Let the Mountains Talk, Let the Rivers Run*

Chapter 18 (p. 146)

HarperCollins Publishers, Inc. New York, New York, USA. 1995

## CROW

**Baynes, Ernest Harold** 1868–1925

American naturalist and writer

Few birds are more intelligent than the Crow. That he has a language, by which he can readily communicate with his fellows, and which can be translated in English, is now well known to ornithologists.

In William H. Carr

*The Stir of Nature*

Chapter Eleven (p. 142)

Oxford University Press, Inc. New York, New York, USA. 1930

**Dewar, Douglas** 1875–1957

British civil servant

...the splendid crow – splendid in sagacity, resource, adaptiveness, boldness, cunning, and depravity – a veritable Machiavelli among birds.

*Annual Report of the Board of Regents of the Smithsonian Institution (1908)*

The Birds of India (p. 618)

Government Printing Office. Washington, D.C. 1909

**Gay, John** 1685–1732

English poet and dramatist

To shoot at crows is powder flung away.

*The Poetical Works of John Gay (Volume 1)*

Epistle to the Right Honourable Paul Methuen, Esq., l. 96

Lawrence & Bullen. London, England. 1893

**Longfellow, Henry Wadsworth** 1807–82

American poet

Even the blackest of them all, the crow,  
Renders good service as your man-at-arms,

Crushing the beetle in his coat of mail,

And crying havoc on the slug and snail.

*The Complete Writings of Henry Wadsworth Longfellow (Volume 4)*

The Poet's Tale

Birds of Killingworth, Stanza 19

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Kipling, John Lockwood** 1837–1911

English art teacher, illustrator, and museum curator

In a land [India] where the pitris or spirits of the dead are believed to be flitting round continually, seeking rest, and inhabiting the bodies of animals and birds, it is easy to imagine the bold and familiar crow haunting houses,

*Beast and Man in India*

Chapter 2 (p. 29)

Macmillan & Co Ltd. London, England. 1904

**Seton, Ernest Thompson** 1860–1946

Scoto-Canadian (and naturalized US citizen) author

Crows know the value of organization, and are as well drilled as soldiers – very much better than some soldiers, in fact, for crows are always on duty, always at war, and always dependent on each other for life and safety.

*Wild Animals I Have Known*

The Story of A Crow (p. 29)

McClelland & Stewart. Toronto, Ontario, Canada. 1977

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

In the course of his evolutionary promotion, his sublime march toward ultimate perfection, he has been a gambler, a low comedian, a dissolute priest, a fussy woman, a blackguard, a scoffer, a liar, a thief, a spy, an informer, a trading politician, a swindler, a professional hypocrite, a patriot for cash, a reformer, a lecturer, a lawyer,

a conspirator, a rebel, a royalist, a democrat, a practicer and propagator of irreverence, a meddler, an intruder, a busybody, an infidel, and a wallower in sin for the mere love of it. The strange result, the incredible result, of this patient accumulation of all damnable traits is, that he does not know what care is, he does not know what sorrow is, he does not know what remorse is, his life is one long thundering ecstasy of happiness, and he will go to his death untroubled, knowing that he will soon turn up again as an author or something, and be even more intol-erably capable and comfortable than ever he was before.

*Following the Equator* (Volume 2)

Chapter II (p. 31)

Harper & Brothers Publishers. New York, New York, USA. 1899

## CUCKOO

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...the cuckoo builds not for himself...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume Two)

*Anthony and Cleopatra*

Act II, Scene vi, l. 28

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## DODO

**Cuppy, Will** 1884–1929

American humorist and critic

The Dodo never had a chance. He seems to have been invented for the sole purpose of becoming extinct and that was all he was good for.

*How to Become Extinct*

The Dodo (p. 102)

Dover Publications. New York, New York, USA. 1964

## DOVE

**Barrett-Browning, Elizabeth** 1806–61

English poet

And there my little doves did sit  
With feathers softly brown,  
And glittering eyes that showed their right  
To general Nature's deep delight.

*The Complete Poetical Works of Elizabeth Barrett Browning*

My Doves, Stanza 2

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The dove and very blessed spirit of peace...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*Second Part of King Henry the Fourth*

Act IV, Scene i, l. 46

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## DUCK

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

...even the skeptical mind must be prepared to accept the unacceptable when there is no alternative. If it looks like a duck, and quacks like a duck, we have at least to consider the possibility that we have a small aquatic bird of the family *Anatidae* on our hands.

*Dirk Gently's Holistic Detective Agency*

Chapter 30 (p. 269)

Simon & Schuster. New York, New York, USA. 1988

**Nash, Ogden** 1902–71

American writer of humorous poetry

Behold the duck.

It does not cluck.

A cluck it lacks.

It quacks.

It is specially fond

Of a puddle or pond.

When it dines or sups,

It bottoms ups.

*Verses from 1929 On*

The Duck

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## EAGLE

**Tennyson, Alfred (Lord)** 1809–92

English poet

He clasps the crag with crooked hands,

Close to the sun in lonely lands;

Ring'd with the azure world, he stands.

The wrinkled sea beneath him crawls;

He watches from his mountain walls,

And like a thunderbolt he falls.

*Alfred Tennyson's Poetical Works*

The Eagle

Oxford University Press, Inc. London, England. 1953

## EMU

**Cuppy, Will** 1884–1929

American humorist and critic

His kick is less severe than that of the Ostrich, which easily breaks a man's leg. The Emu's kick seldom breaks more than the fibula, the smaller bone of the leg, leaving the tibia in first-class condition.

*How to Attract the Wombat*

The Emu (fn 4, p. 183)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Prelutsky, Jack** 1940–

American poet

Do not approach an emu,

the bird does not esteem you.  
 It wields a quick and wicked kick  
 That's guaranteed to cream you.  
*A Pizza the Size of the Sun: Poems*  
 Do Not Approach an Emu  
 Greenwillow Books. New York, New York, USA. 1996

## FALCON

**Lowell, James Russell** 1819–91  
 American poet

I know a falcon swift and peerless  
 As e'er was cradled in the pine:  
 No bird had ever eye so fearless,  
 Or wing so strong as this of mine.  
*The Poetical Works of James Russell Lowell*  
 The Falcon  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

My falcon now is sharp and passing empty;  
 And till she stoop, she must not be full-gorged,  
 for then she never looks upon her lure.  
 In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*The Taming of the Shrew*  
 Act IV, Scene i, l. 193–195  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FLAMINGO

**Dinesen, Isak** 1885–1962  
 Danish writer

The Flamingos are the most delicately colored of all the  
 African birds, pink and red like a flying twig of an Ole-  
 ander bush.  
*Out of Africa and Shadows on the Grass*  
 Chapter 4 (p. 274)  
 Vintage International Edition. New York, New York, USA. 1989

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
 Scottish zoologist and classical scholar

[A] flock of flamingos, wearing on rosy breast and crim-  
 son wings a garment of invisibility, fades away into the  
 sky at dawn or sunset like a cloud incarnadine.  
*On Growth and Form* (Volume 2)  
 Chapter XVI (pp. 959–960)  
 At the University Press. Cambridge, England. 1951

## GOLDFINCH

**Cowper, William** 1731–1800  
 English poet

Two goldfinches, whose sprightly song

Had been their mutual solace long,  
 Lived happy prisoners there.  
*The Poetical Works of William Cowper*  
 Faithful Bird  
 John W. Lovell Company. New York, New York, USA. No date

**Dryden, John** 1631–1700  
 English poet, dramatist, and literary critic

A goldfinch there I saw, with gawdy pride  
 Of painted plumes, that hopped from side to side,  
 Still pecking as she pass'd; and still she drew  
 The sweets from every flower, and suck'd the dew:  
 Sufficed at length, she warbled in her throat,  
 And turned her voice to many a merry note...  
*The Poetical Works of Dryden*  
 Tales from Chaucer: The Flower and the Leaf, l. 106–111  
 The Riverside Press. Cambridge, Massachusetts, USA. 1949

## GOOSE

**Nash, Ogden** 1902–71  
 American writer of humorous poetry

Be careful not to cross the gander,  
 A bird composed of beak and dander,  
 His heart is filled with prideful hate  
 Of all the world except his mate.  
 And if the neighbors do not err  
 He's overfond of beating her.  
 Is she happy? What's the use  
 Of trying to psychoanalyze a goose?  
*Verses from 1929 On*  
 The Gander  
 Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

As wild geese that the creeping fowler eye,  
 Or russet-pated choughs, many in sort,  
 Rising and cawing at the gun's report,  
 Sever themselves, and madly sweep the sky.  
 In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*A Midsummer-Night's Dream*  
 Act III, Scene ii, l. 20–23  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Young, Roland** 1887–1953  
 English actor

The plural of goose is geese,  
 But the plural of moose ain't meese,  
 And the plural of noose ain't neese,  
 But the plural of goose – is geese.  
*Not for Children*  
 The Goose  
 Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**GRACKLE****Nash, Ogden** 1902–71

American writer of humorous poetry

The grackle's voice is less than mellow,  
 His heart is black, his eye is yellow,  
 He bullies more attractive birds  
 With hoodlum deeds and vulgar words,  
 And should a human interfere,  
 Attacks that human in the rear.  
 I cannot help but deem the grackle  
 An ornithological debacle.

*Verses from 1929 On*

The Grackle

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1959

**HAWK****Shakespeare, William** 1564–1616

English poet, playwright, and actor

When I bestride him, I soar, I am a hawk...

*In Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)*The Life of King Henry the Fifth*

Act III, Scene vii, l. 14

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tennyson, Alfred (Lord)** 1809–92

English poet

The wild hawk stood with the down on his beak,  
 And stared with his foot on the prey.

*Alfred Tennyson's Poetical Works*

The Poet's Song, l. 11–12

Oxford University Press, Inc. London, England. 1953

**HERON****Paulsen, Gary** 1939–

American writer

Sometimes the heron isn't there even when he's there.

All tall lines and long lines, he stands in the reeds and  
 grass along the side of the bay and does not curve until  
 he looks down for a frog or minnow, he freezes and holds  
 the stillness for such a long time that even when you're  
 looking at him, looking right at him and you know he  
 is there all gray-metal-shine and beautiful he disappears  
 and isn't there even when he

*The Island*

Heron (p. 51)

Orchard Books. New York, New York, USA. 1988

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Two blue herons with their long and slender limbs  
 relieved against the sky were seen travelling high over

our heads – The lofty and silent flight of these birds  
 wending their way at evening surely not to alight in any  
 marsh on the earth's surface, but perchance on the other  
 side of our atmosphere, was a symbol for the ages to  
 study – whether impressed upon the sky –  
 or sculptured amid the hieroglyphics of Egypt.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2)

(p. 46)

Princeton University Press. Princeton, New Jersey, USA. 1984

**HORNBILL****Dewar, Douglas** 1875–1957

British civil servant and ornithologist

Hornbills are the clowns of the forest.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

The Birds of India (p. 619)

Government Printing Office. Washington, D.C. 1909

**HUMMING BIRD****Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

Where is the person who, on seeing this lovely little  
 creature moving on humming winglets through the air,  
 suspended as if by magic in it, flitting from one flower  
 to another, with motions as graceful as they are light and  
 airy, pursuing its course over our extensive continent,  
 and yielding new delights wherever it is seen – where  
 is the person, I ask of you, kind reader, who on observ-  
 ing this glittering fragment of the rainbow, would not  
 pause, admire, and instantly turn his mind with reverence  
 toward the Almighty Creator...

*Ornithological Biography* (Volume 1)

The Ruby-Throated Humming Bird (p. 248)

Adam Black. Edinburgh, Scotland. 1831

**Guiterman, Arthur** 1871–1943

American writer

A morsel of rainbow forgot by a shower ...

*The Laughing Muse*

The Humming-bird

Harper &amp; Brothers Publishers. New York, New York, USA. 1915

**Hudson, William Henry**

Argentinean/English ornithologist, naturalist, and author

Have you ever observed a humming-bird moving about  
 in an aerial dance among the flowers – a living pris-  
 matic gem that changes its colour with every change of  
 position...

*Green Mansions: a Romance of the Tropical Forest* (p. 108)

Alfred A. Knopf. New York, New York, USA. 1916

**Pallister, William Hales** 1877–1946  
Canadian physician

A flashing, dashing, rainbow-streak,  
The whirl or wondrous wings;  
We hold our breath, we must not speak,  
Such shy, such splendid things!

*Poems of Science*

De Ipsa Natura, Humming-Birds (p. 222)  
Playford Press. New York, New York, USA. 1931

**Riley, James Whitcomb** 1849–1916  
American poet

And the humming-bird that hung  
Like a jewel up among  
The tilted honeysuckle-horns,  
They mesmerized and swung  
In the palpitating air,  
Drowsed with odors strange and rare,  
And, with whispered laughter, slipped away,  
And left him hanging there.

*The Complete Works of James Whitcomb Riley* (Volume 4)

The South Wind and the Sun, Stanza 8  
P.F. Collier & Son, Company. New York, New York, USA. 1916

**St. John de Crevecoeur, Hector**

No biographical data available

When it [the hummingbird] feeds, it appears as if immovable though continually on the wing; and sometimes, from what motives I know not, it will tear and lacerate flowers into a hundred pieces: for, strange to tell, they are the most irascible of the feathered tribe. Where do passions find room in so diminutive a body? They often fight with the fury of lions, until one of the combatants falls a sacrifice and dies.

*Letters from an American Farmer*

Letter X (p. 179)  
Thomas Davies. London, England. 1963

**Tabb, John Banister** 1845–1909  
American poet

A flash of harmless lightning,  
A mist of rainbow dyes,  
The burnished sunbeams brightening,  
From flower to flower he flies...

*The Poetry of Father Tabb*

Birds, The Humming-Bird  
Dodd, Mead. New York, New York, USA. 1928

**JAY**

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

What is the jay more precious than the lark,  
Because his feathers are more beautiful.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Taming of the Shrew*

Act IV, Scene iii, l. 177–178

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**LARK**

**Barrett-Browning, Elizabeth** 1806–61  
English poet

The music soars within the little lark,  
And the lark soars.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book III, l. 155–156

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Cather, Willa** 1873–1947  
American novelist

...there are only two or three human stories, and they go on repeating themselves as fiercely as if they had never happened before; like the larks in this country, that have been singing the same five notes over for thousands of years.

*O Pioneers!*

Part II, Chapter IV (p. 119)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Muir, John** 1838–1914  
American naturalist

The larks come in large flocks from the hills and mountains in the fall, and are slaughtered as ruthlessly as the robins. Fortunately, most of our song birds keep back in leafy hidings, and are comparatively inaccessible.

*Our National Parks*

Chapter VII (p. 238)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

A balmy day. Sunshine and lark song in glorious measure. A petition is being circulated in favor of preservation of larks from the ruthless slaughter of gunners. Larks are as characteristic of California weather as sunbeams. As well shoot the sun out of the sky.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter VIII, Section 1, February 1 (p. 336)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

**Rossetti, Christina Georgina** 1830–94  
English poet

The sunrise wakes the lark to sing.

*The Complete Poems of Christina Rossetti* (Volume 1)

Poems Added in 1875, Bird Raptures (p. 210)

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1979



## LINNET

**Wordsworth, William** 1770–1850  
English poet

Hail to thee, far above the rest  
In joy of voice and pinion!  
Thou, linnet! in thy green array,  
Presiding spirit here to-day,  
Dost lead the revels of the May;  
And this is thy dominion.

*The Complete Poetical Works of William Wordsworth*  
The Green Linnet, Stanza II,  
Crowell. New York, New York, USA. 1888

## LOON

**Burroughs, John** 1837–1921  
American naturalist and essayist

Some birds represent the majesty of Nature, like the eagles ; others its ferocity, like the hawks ; others its cunning, like the crow; others its sweetness and melody, like the song-birds. The loon represents its wildness and solitariness.

*Birds and Poets With Other Papers*  
Touches of Nature (p. 83)  
David Douglas Edinburgh, Scotland. 1884

**Lawrence, Jerome** 1915–2004  
American writer and lyricist

**Lee, Robert Edwin** 1918–94  
American writer and lyricist

Henry: Anytime you hear a man called “loony,” just remember that’s a great compliment to the man and a great disrespect to the loon. A loon doesn’t wage war, his government is perfect, being nonexistent. He is the world’s best fisherman and completely in control of his senses, thank you.

*The Night Thoreau Spent in Jail*  
Act One (p. 18–19)  
Samuel French, Inc. London, England. 2000

## LOUISIANA WATER THRUSH

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

Much and justly as the song of the Nightingale is admired, I am inclined, after having often listened to it, to pronounce it in no degree superior to that of the Louisiana Water Thrush. The notes of the latter bird are as powerful and mellow, and at times as varied.

*Ornithological Biography* (Volume 1)  
The Louisiana Water Thrush (p. 99)  
Adam Black. Edinburgh, Scotland. 1831

## MAGPIE

**Browning, Robert** 1812–89  
English poet

...and the pie with the long tongue  
That pricks deep into oak warts for a worm,  
And says a plain word when she finds her prize,  
But will not eat the ants...

In Horace E. Scudder (ed.)  
*The Complete Poetical Works of Browning*  
*Dramatis Personae*  
Caliban Upon Setebos (p. 392)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1895

**Hinkson, Katharine Tynan** 1861–1931  
Irish-born writer and poet

I love the sweet linnet, the lark, and the thrush,  
And the gold-throated blackbird with a song in each bush ;  
The finch and the robin, I love everyone,  
But not the pied magpie that’s walking alone.

*Cuckoo Songs*  
Magpie  
Copeland & Day. Boston, Massachusetts, USA. 1894

## MALLARD

**Audubon, John James** 1785–1851  
American ornithologist, naturalist, hunter, and painter

Look at that Mallard as he floats on the lake; see his elevated head glittering with emerald-green, his amber eyes glancing in the light! Even at this distance, he has marked you, and suspects that you bear no good will towards him, for he sees that you have a gun, and he has many a time been frightened by its report, or that of some other. The wary bird draws his feet under his body, springs upon them, opens his wings, and with loud quacks bids you farewell.

*The Birds of America* Volume 6  
Mallard (p. 237)  
J.J. Audubon  
New York, New York, USA. 1843

## MARTLET

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the martlet  
Builds in the weather on the outward wall,  
Even in the force and road of causality.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Merchant of Venice*  
Act II, Scene ix, l. 28–30  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**MOCKING BIRD**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Then from the neighboring thicket the mocking-bird,  
wildest of singers,  
Swinging aloft on a willow spray that hung o'er the water,  
Shook from his little throat such floods of delirious  
music,  
That the whole air and the woods and the waves seemed  
silent to listen.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)  
Evangeline  
Part II, Stanza II (pp. 75–76)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**MOUNTAIN QUAIL**

**Muir, John** 1838–1914  
American naturalist

...like every true mountaineer, he is quick to follow the  
spring back into the highest mountains.

*Our National Parks*  
Chapter VII (p. 220)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**NIGHTINGALE**

**Burton, Robert** 1577–1640  
English scholar

...a nightingale, dies for shame, if another bird sing bet-  
ter, he languisheth and pineth away in the anguish of his  
spirit.

In Arthur Richard Shilleto (ed.)  
*The Anatomy of Melancholy* Volume 1  
Part I, Section II, Mem. III, Subs. VII (p. 305)  
George Bell & Sons. London, England. 1896

**Sappho** 630 BCE–570 BCE  
Greek lyric poet

The nightingale is the harbinger of Spring and her voice  
is desire.

*Poems and Fragments*  
Fragment 114  
University of Michigan Press. Ann Arbor, Michigan, USA. 1965

**OSTRICH**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The ostrich roams the great Sahara.  
Its mouth is wide, its neck is narra.  
It has such long and lofty legs,  
I'm glad it sits to lay its eggs.

*Verses from 1929 On*  
The Ostrich  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**OWL**

**Borland, Hal** 1900–78  
American writer

The owl, that bird of onomatopoeic name, is a repeti-  
tious question wrapped in feathery insulation especially  
for Winter delivery.

*Sundial of the Seasons: A Selection of Outdoor Editorials from the New  
York Times*  
Questions, December 27 (p. 271)  
Lippincott. Philadelphia, Pennsylvania, USA. 1964

**Sackville-West, Victoria** 1862–1936  
English poet

...I met a baby owl in a wood, when it fell over dead,  
apparently from sheer temper, because I dared to  
approach it. It defied me first, then died. I have never for-  
gotten the horror and shame I experienced when that soft  
fluffy thing (towards which I had nothing but the most  
humanitarian motives) fell dead from rage at my feet.

*Country Notes*  
Owls (p. 124)  
Harper & Brothers Publishers. New York, New York, USA. 1940

**Shakespeare, William 1564–1616**

English poet, playwright, and actor

The clamorous owl that nightly hoots and wonders  
At our quaint spirits.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*A Midsummer-Night's Dream*  
Act II, Scene ii, l. 6–7  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**PARROT****Mr. Praline (Fictional character)**

'E's not pinin'! 'E's passed on! This parrot is no more!  
He has ceased to be! 'E's expired and gone to meet 'is  
maker! 'E's a stiff! Bereft of life, 'E rests in peace! If you  
hadn't nailed 'im to the perch 'e'd be pushing up the dai-  
sies! 'Is metabolic processes are now 'istory! 'E's off the  
twig! 'E's kicked the bucket, 'e's shuffled off 'is mortal  
coil, run down the curtain and joined the bleedin' choir  
invisible!! THIS IS AN EX-PARROT!!

*Monty Python's Flying Circus*  
Dead Parrot Sketch Series I, Show

**Prelutsky, Jack** 1940–  
American poet

The parrots, garbed in gaudy dress,  
with almost nothing to express,



delight in spouting empty words...  
they are extremely verbal birds.

*A Pizza the Size of the Sun: Poems*

The Parrots

Greenwillow Books. New York, New York, USA. 1996

## PARTRIDGE

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

When a brood ov yung patridges fust begin tew toddle  
about with the old bird, they look like a lot ov last year's  
chestnut burs on legs.

*Josh Billings' Wit and Humor*

The Partridge (p. 107)

George Routledge & Sons. London, England. 1874

**Spenser, Edmund** 1552–99

English poet

Like as a fearful partridge, that is fled  
From the sharpe hauke which her attacked neare,  
And falls to ground to seeke for succor theare,  
Whereas the hungry spaniells she does spye,  
With greedy jaws her ready for to teare.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book III, Canto VIII, Stanza 33

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

## PASSENGER PIGEON

**Abbott, Roy L.** 1886–1968

American professor of biology

We human beings are seemingly so indifferent to the death of one of our own kind that for us to give thought to the death of a bird appears strange indeed. Yet thousands of people took serious and melancholy notice of the death of a certain bird back in 1914 .... Its death marked the close of what was perhaps Nature's greatest dynasty of birds. Its history is one of thoughtless destruction and ruthless persecution without parallel.

The Passing of the Passenger Pigeon

*Natural History*, Volume 53, Number 2, February, 1944 (p. 86)

### Report of the Senate Select Committee

The passenger pigeon needs no protection. Wonderfully prolific, having the vast forests of the North as its breeding grounds, traveling hundreds of miles in search of food, it is here to-day and elsewhere to-morrow, and no ordinary destruction can lessen them, or be missed from the myriads that are yearly produced.

*Fifteenth Annual Report of the Ohio State Board of Agriculture* (p. 387)

Richard Nevins, State Printer. Columbus, Ohio, USA. 1861

## Wisconsin Society of Ornithology

We have erected a monument to commemorate the funeral of a species. It symbolizes our sorrow. We grieve because no living man will see again the onrushing phalanx of victorious birds, sweeping a path for spring across the March skies, chasing defeated winter from all the woods and prairies of Wisconsin.

In Aldo Leopold

*A Sand County Almanac, with Essays on Conservation from Round River*

Part II, Wisconsin (p. 116)

Sierra Club. San Francisco, California, USA. 1970

## PEACOCK

**Leland, Charles G.** 1824–1903

American author

To Paradise, the Arabs say,  
Satan could never find the way  
Until the peacock led him in.

*The Music-Lesson of Confucius*

The Peacock, Stanza 2

J.R. Osgood & Company. Boston, Massachusetts, USA. 1872

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Remember that the most beautiful things in the world are the most useless; peacocks and lilies for instance ...

*The Stones of Venice* (Volume 1)

Chapter II (p. 44)

Smith, Elder & Co. London, England. 1873

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Why, he stalks up and down like a peacock – a stride and a stand...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Troilus and Cressida*

Act III, Scene iii, l. 251–252

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## PELICAN

**Merritt, Dixon Lanier** 1879–1954

American poet and humorist

A wonderful bird is the pelican!

His bill will hold more than his belican.

He can take in his beak

Food enough for a week

But I'm darned if I see how the helican.

*The Pelican*

Apocryphal – No source found

**Montgomery, James** 1771–1854  
Scottish poet and journalist

Bird of the wilderness, what is thy name? –  
The pelican! – go, take the trump of fame,  
And if thou give the honour due to me,  
The world may talk a little more of thee.

*Poetical Works of James Montgomery* (Volume 2)

Birds

Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

## PENGUIN

**Ackerman, Diane** 1948–  
American writer

The short, potbellied, penguins, whose necks wobbled  
with baby fat, huddled together like Russian business-  
men in fur coats.

*The Moon by Whale Light* (p. 182)

First Vintage Books. New York, New York, USA. 1992

**Cherry-Garrard, Apsley** 1886–1959  
English explorer of Antarctica

They are extraordinarily like children, these little people  
of the Antarctic world, either like children, or like old  
men, full of their own importance and late for dinner, in  
their black tail-coats and white shirt-fronts – and rather  
portly withal.

*The Worst Journey in the World*

Chapter 3 (p. 64)

Carroll & Graf. New York, New York, USA. 1997

**Herford, Oliver** 1863–1935  
American writer and illustrator

The Pen-guin sits up-on the shore  
And loves the lit-tle fish to bore;  
He has one en-er-vat-ing joke  
That would a very Saint provoke:  
“The Pen-guin’s might-i-er than the Sword-fish”  
He tell this dai-ly to the bored fish,  
Un-til they are so weak, they float  
With-out re-sis-tance down his throat.

*A Child’s Primer of Natural History*

A Penguin

Charles Scribner’s Sons. New York, New York, USA. 1899

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

the patagonian  
penguin  
is a most  
peculiar  
bird  
he lives on  
pussy  
willows

and his tongue  
is always furred

*the lives and time of archy & mehitabel*

some natural history (p. 144)

Doubleday Doran & Co. Garden City, New York, USA. 1934

## Racovitz, M.

No biographical data available

Imagine a little old man, standing erect, provided with  
two broad paddles instead of arms, with a head small  
in comparison with the plump, stout body; imagine this  
creature with his back covered with a dark coat spotted  
with blue, tapering behind to a pointed tail that drags  
on the ground, and adorned in front with a glossy white  
breastplate. Have this creature walk on his two feet, and  
give him at the same time a droll little waddle and a con-  
tinual movement of the head; you have before you some-  
thing irresistibly attractive and comical.

In L. Gain

*Annual Report of the Board of Regents of the Smithsonian Institution*  
(1912) (p. 476)

Government Printing Office. Washington, D.C. 1913

**Young, Roland** 1887–1953  
English actor

The little penguins look alike  
Even as Ike resembles Mike.  
They are so gentle and so nice  
God keeps these little birds on ice.

*Not for Children*

The Penguin

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## PHEASANT

**Pope, Alexander** 1688–1744  
English poet

See! from the brake the whirring pheasant springs,  
And mounts exalting on triumphant wings:  
Short is his joy; he feels the fiery wound,  
Flutters in blood, and panting beats the ground.

*The Complete Poetical Works*

Windsor Forest, l. 111–114

Houghton Mifflin Company. New York, New York, USA. 1903

## PIGEON

**Willis, Nathaniel Parker** 1806–67  
American author

On the cross-beam under the Old South bell  
The nest of a pigeon is builded well.  
In summer and winter that bird is there,  
Out and in with the morning air.

*Poems of Nathaniel Parker Willis*

The Belfry Pigeon

Hurst & Company. New York, New York, USA. 1882

**PURPLE FINCH**

**Peterson, Roger Tory** 1908–96  
American naturalist

...a Sparrow dipped in raspberry juice.

*Field Guide to the Birds*

(Eastern) Purple Finch (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1947

**QUAIL**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

The song-birds leave us at the summer's close,  
Only the empty nests are left behind,  
And pipings of the quail among the sheaves.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 3)

The Harvest Moon

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**RAVEN**

**Poe, Edgar Allan** 1809–49  
American short story writer and poet

And the raven, never flitting, still is sitting, still is sitting  
On the pallid bust of Pallas just above my chamber door;

And his eyes have all the seeming of a demon's that is dreaming,

And the lamplight o'er him streaming throws his shadow  
on the floor;

And my soul from out that shadow that lies floating on  
the floor

Shall be lifted – nevermore!

*The Raven and Other Poems*

The Raven, Stanza 18

Columbia University Press. New York, New York, USA. 1942

**REDSTART**

**Jefferies, Richard**  
No biographical data available

A brightly coloured bird, the redstart, appears suddenly  
in spring, like a flower that has bloomed before the bud  
was noticed.

*Birds of Spring*

*Chamber's Journal of Popular Literature, Science and Arts*, Volume 1,  
Number 9, March 1, 1884 (p. 131)

**ROBIN**

**Blake, William** 1757–1827  
English poet, painter, and engraver

A Robin Red breast in a Cage  
Puts all Heaven in a Rage.

*The Complete Poetry and Prose of William Blake*

Auguries of Innocence, l. 5–6

University of California Press. Berkeley, California, USA. 1982

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

If you think of it, you will find one of the robin's very chief ingratiatory faculties is his dainty and delicate movement – his footing it feately here and there. Whatever prettiness there may be in his red breast, at his brightest he can always be outshone by a brickbat. But if he is rationally proud of anything about him, I should think a robin must be proud of his legs. Hundreds of birds have longer and more imposing ones – but for real neatness, finish, and precision of action, commend me to his fine little ankles, and fine little feet ...

*Love's Meinie*

Lecture I, 24 (p. 24)

John Wiley & Son. New York, New York, USA. 1873

**ROOK**

**Tennyson, Alfred (Lord)** 1809–92  
English poet

The building rook'll caw from the windy tall elm-tree...

*Alfred Tennyson's Poetical Works*

The May Queen, New Year's Eve, Stanza 5

Oxford University Press, Inc. London, England. 1953

**RUKH****The Arabian Nights**

And... behold the sun became concealed from us, and the day grew dark, and there came over us a cloud by which the sky was obscured. So we raised our heads to see what had intervened between us and the sun, and saw that the wings of the rukh were what veiled from us the sun's light, so that the sky was darkened.

Translated by Edward William Lane

*The Arabian Nights*

The Story of Sinbad the Sailor and Sinbad the Porter

The Fifth Voyage (p. 484)

Oxford University Press. Oxford, England. 1915

**SANDPIPER**

**Thaxter, Celia** 1835–94  
American poet

Across the narrow beach we flit,  
One little sandpiper and I;  
And fast I gather, bit by bit,  
The scattered driftwood, bleached and dry.  
The wild waves reach their hands for it,  
The wild wind raves, the tide runs high,

As up and down the beach we flit,  
One little sandpiper and I.

*The Poems of Celia Thaxter*

The Sandpiper

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

## SEAGULL

**Bach, Richard** 1936–

American writer

They...found Jonathan gliding peacefully and alone  
through his beloved sky. The two gulls which appeared  
at his wings were pure as starlight...most lovely of all  
was the skill with which they flew, their wingtips moving  
a precise and constant inch from his own.

*Jonathan Livingston Seagull*

Part I (p. 46)

The Macmillan Co. New York, New York, USA. 1970

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

And being fed by us you used us so  
As that ungentle gull, the cuckoo's bird,  
Useth the sparrow.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The First Part of King Henry the Fourth*

Act V, Scene i, l. 59–61

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## SEA-MEW

**Barrett-Browning, Elizabeth** 1806–61

English poet

How joyously the young sea-mew  
Lay dreaming on the waters blue,  
Whereon our little bark had thrown  
A little shade, the only one,  
But shadows ever man pursue.

*The Complete Poetical Works of Elizabeth Barrett Browning*

The Sea-Mew, Stanza I

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Garstang, Walter** 1868–1949

English embryologist and amateur poet

Bold Sea-mew – you whose soaring flight  
Inspires my envious Muse –  
Pray, with this compliment polite  
My liberty excuse.

*Larval Forms, and Other Zoological Verses*

To a Herring Gull, Stanza 1 (p. 72)

The University of Chicago Press. Chicago, Illinois, USA. 1985

## SEDGE-BIRD

**Clare, John** 1793–1864

English poet

Fixed in a white-thorn bush, its summer guest,  
So low, e'en grass o'er-topped its tallest twig,  
A sedge-bird built its little benty nest,  
Close by the meadow pool and wooden brig.

*The Rural Muse*

Poems, The Sedge-Bird's Nest

Whittaker & Company. London, England. 1835

## SNIPE

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

The snipe haz a long bill (about the length of a doktor's)  
and git a living bi thrusting it down into the fat earth, and  
then pumping the juices out with their tounge.

*Josh Billings' Wit and Humor*

The Snipe (p. 107)

George Routledge & Sons. London, England. 1874

## SPARROW

**Longfellow, Henry Wadsworth** 1807–82

American poet

The sparrows chirped as if they still were proud  
Their race in Holy Writ should mentioned be.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 4)

The Poet's Tale

The Birds of Killingworth, Stanza 12

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The hedge-sparrow fed the cuckoo so long,  
That it had its head bit off by its young.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*King Lear*

Act I, Scene iv, l. 235–236

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

I once had a sparrow alight upon my shoulder for a  
moment, while I was hoeing in a village garden, and I felt  
that I was more distinguished by that circumstance than I  
should have been by any epaulet I could have worn

*Walden*

Winter Animals (p. 426)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1847

## SWALLOW

**Barrie, Sir James M.** 1860–1937

Scottish journalist, writer, and dramatist

“Do you know,” Peter asked “why swallows build in the  
eaves of houses? It is to listen to the stories.”

*Peter Pan*

Chapter 3 (pp. 40, 42)

Charles Scribner's Sons. New York, New York, USA. 1954

**Jefferies, Richard** 1848–87

English naturalist and author

The beautiful swallows, be tender to them, for they symbol  
all that is best in nature and all that is best in our hearts.

In J. Baden Jefferies (ed.)

*Field and Hedgerow*

Swallow-Time (p. 101 )

Longmans, Green &amp; Co. London, England. 1897

**Tennyson, Alfred (Lord)** 1809–92

English poet

...nature's licensed vagabond, the swallow...

*Alfred Tennyson's Poetical Works*

Queen Mary

Act V, Scene I

Oxford University Press, Inc. London, England. 1953

**Thomson, James** 1700–48

Scottish poet

The swallow is come!

The swallow is come!

O, fair are the seasons, and light

Are the days that she brings,

With her dusky wings,

And her bosom snowy white.

*The Seasons*

Spring, l. 651

Printed by W.W. Woodward. Philadelphia, Pennsylvania, USA. 1797

**SWAN****Beston, Henry** 1888–1968

American writer

...I chanced to look up a moment at the southern sky,  
and there for the first and still the only time in my life,  
I saw a flight of swans. The birds were passing along the  
coast well out to sea; they were flying almost cloud high  
and traveling very fast, and their course was as direct  
as an arrow's from a bow. Glorious white birds in the  
blue October Heights over the solemn unrest of ocean –  
their passing was more than music, and from their wings  
descended the old loveliness of earth which both affirms  
and heals.

*The Outermost House*

Chapter II (p. 37)

Rinehart &amp; Company. New York, New York, USA. 1928

**Thomson, James** 1700–48

Scottish poet

The stately-sailing swan

Gives out his snowy plumage to the gale;

And, arching proud his neck, with oary feet

Bears forward fierce, and guards his osier isle,

Protective of his young.

*The Seasons*

Spring, l. 775

Printed by W.W. Woodward. Philadelphia, Pennsylvania, USA. 1797

**THROSTLE****Wordsworth, William** 1770–1850

English poet

And hark! how blithe the throstle sings!

He, too, is not mean preacher:

Come forth into the light of things,

Let Nature be your teacher.

*The Complete Poetical Works of William Wordsworth*

The Tables Turned, Stanza IV

Crowell. New York, New York, USA. 1888

**THRUSH****Hardy, Thomas** 1840–1928

English poet and regional novelist

At once a voice arose among

The bleak twigs overhead

In a full-hearted evensong

Of joy illimited;

An aged thrush, frail, gaunt, and small,

In blast-beruffled plume,

Had chosen thus to fling his soul

Upon the growing gloom.

*Collected Poems of Thomas Hardy*

The Darkling Thrush, Verse 3 (p. 137)

The Macmillan Company. New York, New York, USA. 1964

**Tennyson, Alfred (Lord)** 1809–92

English poet

When rosy plumelets tuft the larch,

And rarely pipes the mounted thrush...

*Alfred Tennyson's Poetical Works*

In Memoriam, Verse XCI

Oxford University Press, Inc. London, England. 1953

**TIDULA****Moore, Thomas** 1779–1852

Irish poet

The puny bird that dares with teasing hum Within the  
crocodile's stretched jaws to come!

*Lalla Rookh: An Oriental Romance*

The Veiled Prophet of Khorassan (p. 53)

Oakley, Mason, &amp; Co. New York, New York, USA. 1871

**Spenser, Edmund** 1552–99

English poet

Beside the fruitful shore of muddy Nile, Upon a sunny  
bank outstretched lay In monstrous length a mighty  
crocodile, That, crammed with guiltless blood, greedy  
prey Of wretched people traveling that way, Thought all  
things less than his disdainful pride, Soon came a little  
bird called tidula, The least of thousands which on earth

abide, That forced this hideous beast to open wide The  
grisly gates of his devouring hell, And let him feed as  
nature doth provide Upon his jaws that with black venom  
swell. Why then should greatest things the least disdain,  
That so small so mighty can constrain?

*The Poetical Works of Edmund Spenser* Volume 5  
Vision of the World's Vanity  
William P. Nimmo. Edinburgh, Scotland. 1868

## TOUCAN

**Nash, Ogden** 1902–71

American writer of humorous poetry

The toucan's profile is prognathous,  
Its person is a thing of bathos.  
If even I can tell a toucan  
I'm reasonably sure that you can.

*Verses from 1929 On*  
The Toucan  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Wood, Robert William** 1868–1955

American physicist

Very few can  
Tell the Toucan  
From the Pecan –  
Here's a new plan:  
To take the Toucan from the Tree,  
Requires im-mense a-gil-i-tee,  
While anyone can pick with ease  
The Pecans from the Pecan trees.  
It's such an easy thing to do,  
That even the Toucan he can too.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*  
The Pecan. The Toucan (p. 11)  
Dover Publications, Inc. New York, New York, USA. 1959

## TURKEY

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

The great size and beauty of the Wild Turkey, its value as  
a delicate and highly prized article of food, and the cir-  
cumstance of its being the origin of the domestic race now  
generally dispersed over both continents, render it one of  
the most interesting of the birds indigenous to the USA.

*Ornithological Biography* (Volume 1)  
The Wild Turkey (p. 1)  
Adam Black. Edinburgh, Scotland. 1813

**Breathed, Guy Berkeley** 1957–

American cartoonist

Dear Lord, I've been asked, nay commanded, to thank Thee  
for the Christmas turkey before us... a turkey which was no  
doubt a lively, intelligent bird... a social being... capable of

actual affection... nuzzling its young with almost human-  
like compassion. Anyway, it's dead and we're gonna eat it.  
Please give our respects to its family....

*Bloom County Babylon* (p. 47)  
Little, Brown & Co. Boston, Massachusetts, USA. 1986

**Dickens, Charles** 1812–70

English novelist

It was a Turkey! He could never have stood upon his  
legs, that bird. He would have snapped 'em short off in a  
minute, like sticks of sealing-wax.

*The Works of Charles Dickens*  
*A Christmas Carol*  
A Christmas Carol (p. 73)  
P.F. Collier & Son. New York, New York, USA. 1911

**Nash, Ogden** 1902–71

American writer of humorous poetry

There is nothing more perky  
Than a masculine turkey.  
When he struts he struts  
With no ifs or buts.  
When his face is apoplectic  
His harem grows hectic,  
And when he gobbles  
Their universe wobbles.

*Verses from 1929 On*  
The Turkey  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

## VULTURE

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The Vulture eats between his meals,  
And that's the reason why  
He very, very rarely feels  
As well as you and I.

*Complete Verse*  
The Vulture (p. 244)  
Gerald Duckworth. London, England. 1970

**Dewar, Douglas** 1875–1957

British civil servant

At the other extreme [of beauty] stands the superlative  
of the avian hideousness, the ugliest bird in the world –  
*Neophron ginginianus*, the scavenger vulture. The bill,  
the naked face, and the legs of this creature are a sickly  
yellow. Its plumage is dirty white, with the exception of  
the ends of the wing feathers, which are a shabby black.  
Its shape is displeasing to the eye; its gait is an ungainly  
waddle. Nevertheless, such is the magic of wings, even  
this fowl looks almost beautiful as it sails, on outstretched  
pinions, high in the heavens.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1908)  
The Birds of India (p. 618)  
Government Printing Office. Washington, D.C. 1909



**Montgomery, James** 1771–1854  
Scottish poet and journalist

Abdominal harpies, spare the dead.  
– We only clear the field which man has spread;  
On which should Heaven its hottest vengeance rain?  
You slay the living, we but strip the dead.

*Poetical Works of James Montgomery* (Volume 2)

Birds

Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910  
American author and humorist

A vulture on board; bald, red, queer-shaped head, featherless red places here and there on his body, intense great black eyes set in featherless rims of inflamed flesh; dissipated look; a business-like style, a selfish, conscienceless, murderous aspect – the very look of a professional assassin, and yet a bird which does no murder. What was the use of getting him up in that tragic style for so innocent a trade as his? For this one isn't the sort that wars upon the living, his diet is offal – and the more out of date it is the better he likes it. Nature should give him a suit of rusty black; then he would be all right, for he would look like an undertaker and would harmonize with his business; whereas the way he is now he is horribly out of true.

*Following the Equator* (Volume 2)

Chapter I (p. 15)

Harper & Brothers Publishers. New York, New York, USA. 1899

## WARBLER

**Halle, Louis J.** 1910–98  
American diplomat and writer

When I see men able to pass by such a shining and miraculous thing as this Cape May warbler, the very distillate of life, and then marvel at the internal-combustion engine, I think we had better make ourselves ready for another Flood.

*Spring in Washington*

Chapter II (p. 74)

William Sloane Associates, Inc.. New York, New York, USA. 1947

## WHITE-THROAT

**Clare, John** 1793–1864  
English poet

The happy white-throat on the swinging bough,  
Rocked by the impulse of the gadding wind  
That ushers in the showers of April, now  
Carols right joyously; and now reclined

Crouching, she clings close to her moving seat,  
To keep her hold.

*The Rural Muse*

Poems, The Happy Bird

Whittaker & Company. London, England. 1835

## WHOOPING CRANE

**Allen, Robert Porter** 1905–63  
American author and conservationist

When you sit crouched in a blind and watch an adult (whooping crane) stride close by you, his head high and proud, his bearing arrogant and imposing, you feel the presence of a strength and of a stubborn will to survive...

*The Whooping Crane*

Preface (p. iv)

National Audubon Society. New York, New York, USA. 1952

For the whooping crane there is no freedom but that of unbounded wilderness, no life except its own. Without meekness, without a sign of humility, it has refused to accept our idea of what the world should be like.

*The Whooping Crane*

Part I, Distribution (p. 14)

National Audubon Society. New York, New York, USA. 1952

## WOODPECKER

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

I have always imagined, that in the plumage of the beautiful Ivory-Billed Woodpecker, there is something very closely allied to the style of colouring of the great Vandyke. The broad extent of its dark glossy body and tail, the large and well-defined white markings of its wings, neck, and bill, relieved by the rich carmine of the pendent crest of the male, and the brilliant yellow of its eye, have never failed to remind me of some of the boldest and noblest productions of that inimitable artist's pencil.

*Ornithological Biography* (Volume 1)

The Ivory-Billed Woodpecker (p. 341)

Adam Black. Edinburgh, Scotland. 1831

It would be difficult for me to say where I have not met with that hardy inhabitant of the forest, the Pileated Woodpecker. Even now, when several species of our birds are becoming rare, either to gratify the palate of the epicure or to adorn the cabinet of the naturalist; it is to be found everywhere in the wild woods, although scarce and shy in the peopled districts.

*Ornithological Biography* (Volume 2)

The Pileated Woodpecker (p. 74)

Adam Black. Edinburgh, Scotland. 1834

**Wyatt-Simple, Sue**

No biographical data available

Though he may be a chisler  
As someone has said  
I admire the woodpecker –  
He uses his head!

Boredom

*The Nature Magazine*, Volume 39, Number 2, February, 1946 (p. 92)

**WREN****Wordsworth, William** 1770–1850

English poet

Among the dwellings framed by birds  
In fields or forests with nice care,  
Is none that with the little wren's  
In snugness may compare.

*The Complete Poetical Works of William Wordsworth*

A Wren's Nest, Stanza I

Crowell. New York, New York, USA. 1888

**ANIMAL: CEPHALOPOD****GIANT SQUID****Bullen, Frank Thomas** 1857–1915

author and novelist

The imagination can hardly picture a more terrible object than one of these huge monsters brooding in the ocean depths, the gloom of his surroundings increased by the inky fluid (sepia) which he secretes in copious quantities, every cup-shaped disc, of the hundreds with which the restless tentacles are furnished, ready at the slightest touch to grip whatever is near, not only by suction, but by the great claws set all round within its circle. And in the centre of this net-work of living traps is the chasm-like mouth, with its enormous parrot-beak, ready to rend piecemeal whatever is held by the tentaculae. The very thought of it makes one's flesh crawl.

*The Cruise of the Cachalot*

Chapter XII (p. 101)

Penguin Books. Harmondsworth. Middlesex, England. 1945

**Melville, Herman** 1819–91

American novelist

...we now gazed at the most wondrous phenomenon which the secret seas have hitherto revealed to mankind. A vast pulpy mass, furlongs in length and breadth, of a glancing cream-colour, lay floating on the water, innumerable long arms radiating from its centre, and curling and twisting like a nest of anacondas, as if blindly to clutch at any hapless object within reach. No perceptible

face or front did it have; no conceivable token of either sensation or Instinct; but undulated there on the billows, an unearthly, formless, chance-like apparition of life.

*Moby Dick*

Chapter LIX (pp. 263–264)

L.C. Page & Co. Boston, Massachusetts, USA. 1892

**Verne, Jules** 1828–1903

French novelist

Before my eyes was a horrible monster, worthy to figure in the legends of the marvelous. It was an immense cuttle-fish, being eight yards long. It swam cross-ways in the direction of the *Nautilus* with great speed, watching us with its enormous staring green eyes. Its eight arms, or rather feet, fixed to its head, that had given the name of cephalod to these animals, were twice as long as its body, and were twisted like the Furies' hair.

*20,000 Leagues under the Sea*

Chapter XVIII (p. 314)

Butler Brothers. New York, New York, USA. 1887

**NAUTILUS****Montgomery, James** 1771–1854

Scottish poet and journalist

Light as a flake of foam upon the wind,  
Keel upward, from the deep emerged a shell, Shaped like  
the moon ere half her horn is filled. Fraught with young  
life it righted as it rose,

And moved at will along the yielding water.

The native pilot of this little bark

Put out a tier of oars on either side,

Spread to the wafting breeze a two-fold sail,

And mounted up and glided down the billow

In happy freedom, pleased to feel the air,

And wander in the luxury of light.

*The Poetical Works of James Montgomery*

The Pelican Island (p. 103)

Longman, Brown, Green & Longmans. London, England. 1850

**Wood, Robert William** 1868–1955

American physicist

The Argo-naut or Nautilus,

With habits quite adventurous,

A com-bin-a-tion of a snail,

A jelly-fish and a paper sail.

The parts of him that did not jell,

Are packed securely in his shell.

It is not strange that when I sought

To find his double, I found Naught.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*

Naught. Nautilus (p. 49)

Dover Publications, Inc. New York, New York, USA. 1959



## OCTOPUS

**Cuppy, Will** 1884–1929  
American humorist and critic

Octopuses do not develop their minds. They get by and that's all they care.

*How to Attract the Wombat*

The Octopus (fn 2, p. 119)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Hugo, Victor** 1802–85  
French writer, lyric poet, and dramatist

No grasp is like the sudden strain of the cephaloptera. It is with the sucking apparatus that it attacks. The victim is oppressed by a vacuum drawing at numberless points: it is not a clawing or a biting, but an indescribable scarification. A tearing of the flesh is terrible, but less terrible than a sucking of the blood. Claws are harmless compared with the horrible action of these natural air-cups. The talons of the wild beast enter into your flesh; but with the cephaloptera it is you who enters into the creature.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Fourth, Chapter II

Chapter II (p. 472)

The Heritage Press. New York, New York, USA. 1961

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

the octopus's secret wish  
is not to be a formal fish  
he dreams that some time he may grow  
another set of legs or so  
and be a Broadway music show

*the lives and time of archy & mehitabel*

archy at the zoo (p. 130)

Doubleday Doran & Co. Garden City, New York, USA. 1934

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Tell me, O Octopus, I begs,  
Is those things arms, or is they legs?  
I marvel at thee, Octopus;  
If I were thou. I'd call me Us.

*Verses from 1929 On*

The Octopus

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## SQUID

**Chun, Carl** 1852–1914  
German marine biologist

Among all the marvels of coloration which the animals of the deep sea exhibited to us nothing be even distantly compared with the hues of these [internal] organs [of the *Thaumatomolpus diadema*]. One would think that the

body was adorned with a diadem of brilliant gems.

Quoted in Sir Alister Hardy

*Great Waters*

Chapter 9 (p. 220)

Harper & Row Publishers. New York, New York, USA. 1967

## ANIMAL: CHORDATA

## OIKOPLEURA

**Garstang, Walter** 1868–1949  
English embryologist and amateur poet

Now although Oikopleura sits by himself  
In the midst of his house on a jelly-built shelf,  
He's firmly attached in front by his snout,  
and never lets go till his house wears out.

*Larval Forms, and Other Zoological Verses*

Oikopleura, Jelly-Builder

The University of Chicago Press. Chicago, Illinois, USA. 1985

## ANIMAL: CNIDARIA

## CORAL

**Agassiz, Jean Louis Rodolphe** 1807–83  
Swiss-born American naturalist, geologist, and teacher

Hence the extraordinary assemblage of all classes of animals upon the reef, where, besides those particular kinds of corals which contribute largely to its formation, we find upon it, or on the foundation from which it rises, a great variety of other corals, which, though too insignificant in size to take a conspicuous part in building up these extensive accumulations of organic lime-rock, add none the less their small share in the work, contributing especially to fill up the vacant spaces left by the more rapid and durable growth of the larger kinds. They are to the giants of the reef what the more slender parts are to the lords of the forest, adding the elegance and delicacy of slighter forms to the strength, power, and durability of their loftier companions.

*Annual Report of the Superintendent of the Coast Survey, Showing the Progress of that Work During the Year Ending November, 1851*

Extracts from the report of Professor Agassiz to the Superintendent of the Coast Survey, on the examination of the Florida reefs, keys, and coast (p. 151)

Printed by Robert Armstrong, Washington. 1852

**Crabbe, George** 1754–1832  
English poet

Involved in sea-wrack, here you find a race,  
Which science, doubting, knows not where to place;  
On shell or stone is dropp'd the embryo-seed,  
And quickly vegetates a vital breed.

*Poems* (Volume 1)

The Borough, Letter IX, l. 90–94

AMS Press. New York, New York, USA. 1979

**Maury, Matthew Fontaine** 1806–73

American astronomer, astrophysicist, historian, and oceanographer

The coral groves of the ocean floor are decorated like the gardens of the land, the flower-like polyps answering to our pinks, daisies, violets and lilies. They strew the bottom, which is of the whitest and purest sand; or hang like leaves and flowers, or cling like mosses and lichens to the branching coral, and lend rare enchantment to the scene. Fishes of many colors, with exquisite grace of movement, dart among the branches

*Physical Geography*

Part II, Section IV (pp. 41–42)

University Publishing Co. New York, New York, USA. 1894

**Montgomery, James** 1771–1854

Scottish poet and journalist

And nameless tribes, half-plant, half-animal,  
Rooted and slumbering through a dream of life.

*The Pelican Island, and Other Poems*

The Pelican Island (p. 10)

Longman, Rees, Orm, Brown &amp; Green. London, England. 1828

**Moore, Thomas** 1779–1852

Irish poet

The crimson blossoms of the coral-tree  
In the warm isles of India's sunny sea

*The Complete Poetical Works of Thomas Moore*

Flowers, Stanza I

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Nicols, Thomas** fl. 1652

Writer on gemstones

There is a bud of maritime beauty, and the delight of children, the best of nature's buds, as somewhat furthering the springtide of their growth. The coral is a plant of nature's setting in the sea, which, through being covered with the waters of the sea, it bee green and soft, yet so soon as it is elevated above the waves and discovered in the region of the aire it altereth its colour and changeth its nature: its firmness and solidnesse of a stone, beautiful and lasting; by the operation of the aire encompassing its sometimes soft and flaccid substance.

*Arcula Gemmea*

London, England. 1653

**Palmer, James Croxall** 1811–83

US naval surgeon

We wandered where the dreamy palm Murmured above  
the sleeping wave; And through the waters clear and  
calm, Looked down into the coral cave, Whose echoes  
never had been stirred, By breath of man, or song of  
bird.

*Thulia: A Tale of the Antarctic*

The Bridal Rose (p. 56)

Samuel Coleman. New York, New York, USA. 1843

**JELLYFISH****Allen, Grant** 1848–99

American naturalist

A jellyfish swam in a tropical sea,  
And he said, "This world it consists of me:  
There's nothing above and nothing below  
That a jellyfish ever can possibly know  
(Since we've got no sight, or hearing, or smell),  
Beyond what our single sense can tell."

*Poems of Evolution*

The First Idealist

Haldeman-Julius, Girard, Kansas, USA. 1924

**Kendall, May (Emma Goldworth)** 1861–1931

English writer

Her beauty, passive in despair,  
Through sand and seaweed shone,  
The fairest jelly-fish I e'er  
Had set mine eyes upon.

It would have made a stone abuse  
The callousness of fate,  
This creature of prismatic hues,  
Stranded and desolate!

*Dreams to Sell*

The Philanthropist and the Jelly-Fish

Longmans, Green Publishers. New York, New York, USA. 1887

**Schweitzer, Albert** 1875–1965

Alsatian-German theologian and philosopher

Every evening the glimmer of the sea, as the ship ploughs  
her way through it, is wonderful: the foam is phosphores-  
cent, and little jelly-fishes spring up through it like glow-  
ing balls of metal.

Translated by C.T. Campion

*On the Edge of the Primeval Forest*

Chapter II (p. 21)

The Macmillan Company. New York, New York, USA. 1931

**Whiteman, Lily**

No biographical data available

...these creatures [jellyfish] – boneless, brainless, blood-  
less, and successfully oceangoing for 650 million years ...

The Blobs of Summer

*OnEarth Magazine* Summer 2002**SEA ANEMONE****Austin, Alfred** 1835–1913

English poet

What are these! Shells flung far and wide  
By winter's snow fast-ebbing tide  
In language called, for him who sees  
But grossly, wood-anemones.

*At the Gate of the Convent, etc.**A Defence of English Spring*

**Damon, William E.**

No biographical data available

...those charming sea-flowers, the anemones, many of which rival in beauty the choicest treasures of the garden or conservatory. But added to their loveliness of form and color is the superior attraction of their vitality; for these sea-flowers are living animals, breathing, eating, digesting, and capable of changing their forms at will. Would not a pink be more curious if it could walk? A rose awaken greater interest if it could reach after its necessary nourishment, and take care of its own buds? Well, this is what the flowers of the sea do.

*Ocean Wonders:**Companion for the Seaside:*

Chapter II (p. 7)

D. Appleton &amp; Co. New York, New York, USA. 1879

**Morris, Sir Lewis** 1833–1907

Welsh poet

To-day the many-hued anemone,  
Waving, expands within the rock-pools green,  
And swift transparent creatures of the sea  
Dart through the feathery sea-fronds, scarcely seen.

*Harvest Tide*

Lydstep Caverns

Stanza 5

**ANIMAL: DINOSAUR****Alexander, R. McNeill** 1934–

Biomechanics researcher

Physics and engineering are as useful in the study of living animals and of the human body as in the study of dinosaurs and other extinct animals. Physics is the basic science of matter and energy, and engineering is physics applied to structures and machines. They and chemistry are the sciences that biologists need to explain the structure and mechanism of living things.

*Dynamics of Dinosaurs and Other Extinct Giants*

Chapter XIII (p. 164)

Columbia University Press. New York, New York, USA. 1989

**Angelou, Maya**

American poet

Hosts to species long since departed,  
Marked the mastodon,  
The dinosaur, who left dried tokens of their sojourn here  
on our planet floor,  
Any broad alarm of their hastening doom  
Is lost in the form of dust and ages.

*On the Pulse of Morning*

A Rock, a River, a Tree

Random House, Inc. New York, New York, USA. 1993

**Bakker, Robert T.** 1945–

American paleontologist

If we measure success by longevity, then dinosaurs must rank as the number one success story in the history of the land life. Not only did dinosaurs exercise an airtight monopoly as large land animals, they kept their commanding position for an extraordinary span of time – 130 million years. Our own human species is no more than a hundred thousand years old. And our own zoological class, the Mammalia, the clan of warm-blooded furry creatures, has ruled the land ecosystem for only seventy million years. True, the dinosaurs are extinct, but we ought to be careful in judging them inferior to our kind. Who can say that the human system will last another thousand years, let alone a hundred million? Who can predict that our Class Mammalia will rule for another hundred thousand millennia?

*The Dinosaur Heresies*

Part 1 The Conquering Cold-Bloods: A Conundrum.

Chapter 1 Brontosaurus in the Great Hall at Yale (p. 16)

William Morrow &amp; Company, Inc. New York, New York, USA. 1986

**Burroughs, Edgar Rice** 1875–1950

American writer

Bradley was in the lead when he came suddenly upon a grotesque creature of Titanic proportions. Crouching among the trees, which here commenced to thin out slightly, Bradley saw what appeared to be an enormous dragon.... From frightful jaws to the tip of its long tail it was fully forty feet in length. Its body was covered with plates of thick skin which bore a striking resemblance to armor-plate. The creature saw Bradley almost at the same instant that he saw it and reared up on its enormous hind legs until its head towered a full twenty-five feet above the ground. From the cavernous jaws issued a hissing sound of a volume equal to the escaping steam from the safety-valve of half a dozen locomotives, and then the creature came for the man.

*Out of Time's Abyss* (p. 20)

First World Library. Fairfield Iowa, USA. 2004

Now when we are attacked by large flying reptiles we run beneath spreading trees; when land carnivora threaten us, we climb into trees, and we have learned not to fire at any of the dinosaurs unless we can keep out of their reach for at least two minutes after hitting them in the brain or spine, or five minutes after puncturing their hearts – it takes them so long to die.

*The Land That Time Forgot*

Chapter 6 (p. 60)

Nelson Doubleday. Garden City, New York, USA. nd

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There were, as I say, five of them, two being adults and the three young ones. In size they were enormous. Even

the babies were as big as elephants, while the two large ones were far beyond all creatures I have ever seen. They had slate-coloured skin, which was scaled like a lizard's and shimmered where the sun shone upon it. All five were sitting up, balancing themselves upon their broad, powerful tails and their huge three-toed hind-feet, while with their small five-fingered front-feet they pulled down the branches upon which they browsed. I do not know what I can bring their appearance home to you better than by saying that they looked like monstrous kangaroos, twenty feet in length, and with skins like black crocodiles.

*The Lost World*

Chapter X (p. 168)

The Colonial Press. Clinton, Massachusetts, USA. 1959

Anyone of the larger carnivorous dinosaurs would meet the case. Among them are to be found all the most terrible types of animal life that have ever cursed the earth or blessed a museum.

*The Lost World*

Chapter XI (p. 187)

The Colonial Press. Clinton, Massachusetts, USA. 1959

I passed close to the pterodactyl swamp, and as I did so, with a dry, crisp, leathery rattle of wings, one of these great creatures – it was twenty feet at least from tip to tip – rose up from somewhere near me and soared into the air. As it passed across the face of the moon the light shone clearly through the membranous wings, and it looked like a flying skeleton against the white, tropical radiance.

*The Lost World*

Chapter XII (p. 206)

The Colonial Press, Clinton, Massachusetts, USA. 1959

**Esar, Evan** 1899–1995

American humorist

[Dinosaur] A colossal fossil.

*Esar's Comic Dictionary*

Dinosaur

Doubleday. Garden City, New York, USA. 1983

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The prehistoric animal is first and foremost an atrocious machine for grabbing, with a stomach for digesting.

Translated by Alexander Teixeira de Mattos

*The Life of the Weevil*

Chapter i (p. 16)

Hodder & Stoughton. London, England. nd

**Hornaday, William Temple** 1854–1937

American naturalist

It is quite beyond the power of words to convey adequate conceptions of the reptilian giants that formed the group of dinosaurs. The Brontosaurus, the Diplodocus, the Triceratops, the Stegosaurus and the Tyrannosaurus all must be seen in order that the wonders of them may be appreciated.

In Francis Rolt-Wheeler

*The Science-history of the Universe*

Introduction (p. xiv)

The Current Literature Publishing Co. New York, New York, USA. 1909

**Johnston, Eric**

No biographical data available

The dinosaur's eloquent lesson is that if some bigness is good, an overabundance of bigness is not necessarily better.

*Quote, the Weekly Digest*, February 23, 1958

**Kurten, Bjorn** 1924–88

Vertebrate paleontologist

Dinosaurs, more than any other creatures of the past have a popular image. Museum visitors flock to the dinosaur exhibits, whether to get factual information about them, to try to visualize what life was like when these monsters existed in the flesh, or just to wonder at their odd and outlandish shapes.

*The Age of Dinosaurs*

Chapter 1 Theories and Discoveries (p. 7)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Kyte, Frank** 1949–

American geologist and geochemist

You will never convince some paleontologist that an impact killed the dinosaurs unless you find a dinosaur skeleton with a crushed skull and a ring of iridium round the hole.

Quoted in Stefi Weisburd

*Extinction Wars*

*Science News*, February 1, 1986 (p. 77)

**Owen, Sir Richard** 1804–92

English zoologist and comparative anatomist

[Owen's text uses Greek letters here], fearfully great; [Greek letters are also used here], a lizard.

Report on British Fossil Reptiles, Part I

*Report of the British Association for the Advancement of Science*, April, 1842 (fn, p. 102)

The combination of such characters, some, as the sacral bones, altogether peculiar among reptiles, others borrowed, as it were, from groups now distinct from each other, and all manifested by creatures far surpassing in size the largest of existing reptiles, will, it is presumed, be deemed sufficient ground for establishing a distinct tribe or suborder of Saurian Reptiles, for which I would propose the name of Dinosauria.

Report on British Fossil Reptiles, Part II

*Report of the British Association for the Advancement of Science*, April, 1842 (fn, p. 103)

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Why the dinosaurs died out is not known, but it is supposed to be because they had minute brains and devoted

themselves to the growth of weapons of offense in the shape of numerous horns. However that may be, it was not through their line that life developed.

*Mortals and Others* (Volume 2)  
Men versus Insects (p. 53)

**Shelley, Percy Bysshe** 1792–1822  
English poet

...the might Of earth-convulsing behemoth, which once  
Were monarch beasts, and on the slimy shores,  
And weed-overgrown continents of earth,  
Increased and multiplied like summer worms  
On an abandoned corpse, till the blue globe  
Wrapt deluge round it like a cloke, and they  
Yelled, gasped, and were abolished; or some God  
Whose throne was in a comet, past, and cried,  
Be not! And like my words they were no more.

*Poems*

The Spirits of the Earth and the Moon  
Macmillan & Co Ltd. London, England. 1902

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

As for the dinosaur – But Noah’s conscience was easy; it was not named in his cargo list and he and the boys were not aware that there was such a creature. He said he could not blame himself for not knowing about the dinosaur, because it was an American animal, and America had not then been discovered.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*  
Adam’s Soliloquy (p. 636)

The Library of America. New York, New York, USA. 1992

**Updike, John** 1932–

American novelist, short story writer, and poet

A post-heroic herbivore, I come to breakfast liking for  
A bite. Behind the box of Brex  
I find Tyrannosaurus rex.

*Midpoint and Other Poems*

On the Inclusion of Miniature Dinosaurs in Breakfast Cereal Boxes  
Stanza 1

Fawcett Publications, Inc. Greenwich, Connecticut, USA. 1970

**Wilford, John Noble** 1933–

American science writer

...we have...searched under the junipers for some dinosaur bones and come face to face with ourselves.

*The Riddle of the Dinosaur*

Chapter 18 (p. 272)

Alfred A. Knopf. New York, New York, USA. 1986

**Wise, William**

No biographical data available

Oh, Dinosaurs, Dinosaurs,  
What do you eat?

Sir, I dine on green leaves,  
And he dines on red meat!

*Dinosaurs Forever*

Dinosaur Dinners

Dial Books for Young Readers. New York, New York, USA. 2000

## ALLOSAURUS

**Prelutsky, Jack** 1940–

Poet

Allosaurus likes to bite,  
its teeth were sharp as sabers,  
it frequently, with great delight,  
made mincemeat of its neighbors.

*Tyrannosaurus Was a Beast*

Allosaurus

Greenwillow Books. New York, New York, USA. 1988

## ANKYLOSAURUS

**Prelutsky, Jack** 1940–

Poet

Clankity clankity clankity clank!  
Ankylosaurus was built like a tank,  
its hide was a fortress as sturdy as steel,  
it tended to be an inedible meal.

*Tyrannosaurus Was a Beast*

Ankylosaurus

Greenwillow Books. New York, New York, USA. 1988

## ARCHAEOPTERYX

**Moore, John N.**

No biographical data available

No one has produced yet a single fossil with half-way wings or a fossil of an animal showing a transition between the cold-blooded scaled reptile and the warm-blooded feathered bird... And not even the fossil Archaeopteryx can qualify as a transitional form, because it apparently had a bird-like skull, perching feet, and fully developed wings with feathers.

*Should Evolution Be Taught?* (p. 17)

Creation-Life. San Diego, California, USA. 1974

**Pallister, William Hales** 1877–1946

Canadian physician

Examine well this ancient bird,  
The Archaeopteryx,  
Dismissing all you may have heard,  
And then his status fix.

*Poems of Science*

Archaeopteryx (p. 217)

Playford Press. New York, New York, USA. 1931

**Pringle, John R.**

No biographical data available

One day an Archaeopteryx  
Sat brooding on her nest of sticks,  
“Can it be true what I have heard,  
That I’m a reptile, not a bird?”

Identity Crisis

*Perspectives in Biology and Medicine*, Volume 18, Number 3, Spring  
1975 (p. 33)

**BRACHIOSAURUS****Prelutsky, Jack** 1940–

Poet

Brachiosaurus had little to do  
but stand with its head in the treetops and chew,  
it nibbled the leaves that were tender and green,  
it was a perpetual eating machine.

*Tyrannosaurus Was a Beast*

Brachiosaurus

Greenwillow Books. New York, New York, USA. 1988

**BRONTOSAURUS****Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

[Adam speaking] When the mighty brontosaurus came  
striding into camp, she regarded it as an acquisition,  
I considered it a calamity; that is a good sample of the  
lack of harmony that prevails in our views of things....  
She believed it could be tamed by kind treatment and  
would be a good pet; I said a pet twenty-one feet high  
and eighty-four feet long would be no proper thing to  
have about the place...

*Eve's Diary*

Friday (p. 73)

Harper &amp; Brothers Publishers. New York, New York, USA. 1906

**CARCHARODON****Fabre, Jean-Henri** 1823–1915

French entomologist and author

Palaeontology calls him *Carcharodon meglodon*. Our  
modern Shark, the terror of the seas, gives an approxi-  
mate idea of him, in so far as a dwarf can give an idea  
of a giant.

Translated by Alexander Teixeira de Mattos

*The Life of the Weevil*

Chapter i (p. 7)

Hodder &amp; Stoughton. London, England. nd

**ICHTHYOSAURUS****Blackie, John Stuart** 1809–95

Scottish scholar

Behold a strange monster our wonder engages,  
If dolphin or lizard your wit may defy,  
Some thirty feet long on the shore of Lyme-Regis  
With a saw for a jaw, and a big-staring eye.

A fish or a lizard? An ichthyosaurus,  
With big goggle-eyes, and a very small brain,  
And paddles like mill-wheels in clattering chorus  
Smiting tremendous the dread sounding main!

*Lays and Legends of Ancient Greece: With Other Poems*

A Song of Geology (p. 23)

Sutherland &amp; Knox. Edinburgh, Scotland. 1857

**Buckland, Francis Trevelyan** 1826–80

English surgeon, zoologist, popular author, and natural historian

“You will at once perceive,” continued PROFESSOR  
ICHTHYOSAURUS, “that the skull [indicating a human  
skull] before us belonged to some of the lower order of  
animals; the teeth are very insignificant, the power of the  
jaws trifling, and altogether it seems wonderful how the  
creature could have procured food.”

*Curiosities of Natural History*

Frontispiece

R. Bentley &amp; Son. London, England. 1890–1891

**IGUANODON****Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“Iguanodons,” said Summerlee. “You’ll find their foot-  
marks all over the Hastings sands, in Kent, and in Sus-  
sex. The South of England was alive with them when  
there was plenty of good lush green-stuff to keep them  
going. Conditions have changed, and the beasts died.  
Here it seems that the conditions have not changed, and  
the beasts have lived.”

*The Lost World*

Chapter X (p. 172)

The Colonial Press, Clinton, Massachusetts, USA. 1959

**Inscription**

He discovered the Iguanodon

Castle Palace

Gideon Mantell’s House at Lewes, Sussex

**LEPTOPTERYGIUS****Prelutsky, Jack** 1940–

Poet

Leptopterygius, big as a city bus,  
was an insatiable ichthyosaur,



anything captured by Leptopterygius  
Never was seen in the sea anymore.

*Tyrannosaurus Was a Beast*

Leptopterygius

Greenwillow Books. New York, New York, USA. 1988

## PTERODACTAL

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There is a chill in the air after dark, and we had all drawn close to the blaze. The night was moonless, but there were some stars, and one could see for a little distance across the plain. Well, suddenly out of the darkness, out of the night, there swooped something with a swish like an aeroplane. The whole group of us were covered for an instant by a canopy of leathery wings, and I had a momentary vision of a long, snake-like neck, a fierce, red, greedy eye, and a great snapping beak, filled, to my amazement, with little, gleaming teeth.

*The Lost World*

Chapter IX (pp. 144–145)

The Colonial Press. Clinton, Massachusetts, USA. 1959

**Kingsley, Charles** 1819–75

English clergyman and author

People call them Pterodactyls: but that is only because they are ashamed to call them flying dragons, after denying so long that flying dragons exist.

*The Water-Babies*

Chapter II (p. 61)

Dodd, Mead & Company. New York, New York, USA. 1910

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

The less said about the pterodactyl the better. It was a spectacle, that beast! a mixture of buzzard and alligator, a sarcasm, an affront to all animated nature, a butt for the ribald jests of an unfeeling world. After some ages Nature perceived that to put feathers on a reptile does not ennoble it, does not make it a bird, but only a sham, a joke, a grotesque curiosity, a monster; also that there was no useful thing for the pterodactyl to do, and nothing likely to turn up in the future that could furnish it employment. And so she abolished it.

In John S. Tuckey (ed.)

*Mark Twain's Fables of Man*

Flies and Russians

University of California Press. Berkeley, California, USA. 1972

Now I'll bet there isn't a man here who can spell "pterodactyl," not even the prisoner at the bar. I'd like to hear him try once – but not in public, for it's too near Sunday, when all extravagant histrionic entertainments are barred. I'd like to hear him try in private, and when he got through trying to spell "pterodactyl" you wouldn't know

whether it was a fish or a beast or a bird, and whether it flew on its legs or walked with its wings. The chances are that he would give it tusks and make it lay eggs.

*Mark Twain's Speeches?*

The Alphabet and Simplified Spelling (p. 201)

Harper & Brothers Publishers. New York, New York, USA. 1910

## STEGOSAURUS

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

For a moment I wondered where I could have seen that ungainly shape, that arched back with triangular fringes along it, that strange bird-like head held close to the ground. Then it came back to me. It was the stegosaurus – the very creature which Maple White had preserved in his sketch-book, and which had been the first object which arrested the attention of Challenger! There he was – perhaps the very specimen which the American artist had encountered. The ground shook beneath his tremendous weight, and his gulplings of water resounded through the still night. For five minutes he was so close to my rock that by stretching out my hand I could have touched the hideous waving hackles upon his back. Then he lumbered away and was lost among the boulders.

*The Lost World*

Chapter XII (p. 211)

The Colonial Press, Clinton, Massachusetts, USA. 1959

## TYRANNOSAURUS REX

**Bradbury, Ray** 1922–2003

American fantasy, horror, science fiction, and mystery writer

Out of the mist, one hundred yards away, came Tyrannosaurus rex.... It came on great oiled, resilient, striding legs. It towered thirty feet above half of the trees, a great evil god, folding its delicate watchmaker's claws close to its oily reptilian chest. Each lower leg was a piston, a thousand pounds of white bone, sunk in thick ropes of muscle, sheathed over in a gleam of pebbled skin like the mail of a terrible warrior.

*Dinosaur Tales*

A Sound of Thunder (p. 68)

Bantam Books. Toronto, Ontario, Canada 1983

**Carpenter, Kenneth**

Paleontologist

Tyrannosaurus was truly the Schwarzenegger of dinosaurs.

*Times*, 3 July 1990

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Tyrannosaurs, enormous bipedal caricatures of men, would stalk mindlessly across the sites of future cities and go their way down into the dark of geologic time.

*The Immense Journey*

How Flowers Changed the World (p. 64)

Vintage Books. New York, New York, USA. 1957

**Wise, William**

No biographical data available

What colors were the Dinosaurs?  
 The fact is, no one knows.  
 We're only sure that each had skin  
 That stretched from head to toes....  
 But one thing I am certain of –  
 I truly cannot think  
 That huge Tyrannosaurus Rex  
 Could ever have been pink!

*Dinosaurs Forever*

Dinosaur Colors

Dial Books for Young Readers. New York, New York, USA. 2000

**ANIMAL: ECHINODERMATA****Cuppy, Will** 1884–1929

American humorist and critic

For anyone who has ever considered the bizarre panoply that composes the Echinodermata, it is difficult to lose sight of the fact that echinoderms are strange. Their ontogenetic twists and turns of symmetry, absence of certain familiar organ systems, and presence of some less familiar systems might tempt one to imagine an extraterrestrial origin for the Echinodermata. The very strangeness of the Echinodermata is partly responsible for the dedication that specialists in the group feel. We revel in their weirdness.

In C.R.C. Paul and A.B. Smith (eds.)

Evolutionary Dissent: A Review of "Echinoderm Phylogeny and Evolutionary Biology

*Paleobiology*, Volume 15, 1989**ANIMAL: EUGLENA VIRIDIS****Pallister, William Hales** 1877–1946

Canadian physician

A plant when there is sunshine; an animal at night.  
 The living proof of theories, biologists' delight,  
 Created by environment and matching it so well,  
 You are both plant and animal. Which one the time can tell.

*Poems of Science*

Euglena Viridis

Playford Press. New York, New York, USA. 1931

**ANIMAL: FISH****Bradley, Jr., John Hodgdon** 1898–1962

American geologist

No one knows whence nor how the first fish came. The earth is silent on the matter.

*Parade of the Living*

Part I, Chapter V (p. 52)

Coward-McCann, Inc. New York, New York, USA. 1930

**Charlie Chan (Fictional character)**

Fish in sea like flea on dog – always present, but difficult to catch.

*Charlie Chan at the Olympics*

Film (1937)

**Cuppy, Will** 1884–1929

American humorist and critic

As a rule fish in their native element do not remain stationary for any length of time, especially when something is chasing them.

*How to Attract the Wombat*

The Squid (fn 5, p. 122)

Rinehart &amp; Company, Inc. New York, New York, USA. 1949

Fish are very easy to understand because only about thirteen thousand kinds or species have been discovered up to now.

*How to Become Extinct*

Fish and Democracy (p. 1)

Dover Publications. New York, New York, USA. 1964

**Hemingway, Ernest** 1899–1961

American novelist, short-story writer and journalist

He is a great fish and I must convince him, he thought. I must never let him learn his strength nor what he could do if he made his run...but thank God, they are not as intelligent as we who kill them; although they are more noble and more able.

*The Old Man and the Sea* (p. 61)

Charles Scribner's Sons. New York, New York, USA. 1952

**Hunt, Leigh** 1784–1859

English author, poet, and editor

You strange, astonish'd-looking, angle-faced,  
 Dreary-mouth'd, gaping wretches of the sea,  
 Gulping salt-water everlastingly,  
 Cold-blooded, though with red your blood be graced,  
 And mute, through dwellers in the roaring waste;  
 And you, all shapes beside, that fishy be –  
 Some round, some flat, some long, all devilry,  
 Legless, unloving, infamously chaste:

*The Poetical Works of Leigh Hunt*

The Fish, the Man, and the Spirit (p. 250)

Oxford University Press, Inc. London, England. 1923

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

This is beyond me, this fish,  
 His God stands outside my God.

*The Collected Poems of D.H. Lawrence*

Fish

Martin Secker. London, England. 1928

**MacLeish, Archibald** 1892–1982

American poet and Librarian of Congress

Plunge beneath the ledge of coral  
 Where the silt of sunlight drifts



Like dust that settles toward a floor –  
 As slow as that: feel the lifting  
 Surge that rustles white above  
 But here is only movement deep  
 As breathing: watch the reef fish hover  
 Dancing in their silver sleep  
 Around their stone, enchanted tree...

*The Collected Poems of Archibald MacLeish*

The Reef Fisher

Houghton Mifflin Company. Boston, Massachusetts, USA. 1952

### Maisey, John

American paleontologist

The term “fish” is of value on restaurant menus, to anglers and aquarists, to stratigraphers and in theological discussions of biblical symbolism. Many systematists use it advisedly and with caution. Fishes are gnathostomes that lack tetrapod characters; they have no unique derived characteristics. We can conceptualize fishes with relative ease because of the great evolutionary gaps between them and their closest living relatives, but that does not mean they comprise a natural group. The only way to make the fishes monophyletic would be to include tetrapods, and to regard the latter merely as a kind of fish. Even then, the term “fish” would be a redundant colloquial equivalent of “gnathostome” (or “craniate,” depending upon how far down the phylogenetic ladder one wished to go).

In D.R. Prothero and R.M. Shoch (eds.)

*Major Features of Vertebrate Evolution*

Short Courses in Paleontology 7

University of Tennessee Press. Knoxville, Tennessee, USA. 1994

### Pallister, William Hales 1877–1946

Canadian physician

Fifteen thousands of species of FISHES are known,  
 And some kinds are enormous and others minute;  
 They are widespread, wherever their tribes can be grown  
 And all seeking the foods which their habits will suit;  
 Some migrating in millions that their spawn may be sown,  
 Some in depths of the ocean, but rarely alone.

*Poems of Science*

Beginnings, Animal Life (p. 140)

Playford Press. New York, New York, USA. 1931

### Paulsen, Gary 1939–

American writer

Part of our problem is that we run around naming things without asking them if they want to be named. Then after we name them, they don't know they're named anyway. A tree doesn't know it's a tree; a fish doesn't know it's a fish; and if the fish did know, it would probably be upset by it. Who wants to be called a fish?

*The Island*

Chapter 1 (p. 5)

Orchard Books. New York, New York, USA. 1988

### Peacock, Thomas Love 1785–1866

English writer

Premising that this is a remarkably fine slice of salmon, there is much to be said about fish: but not in the way of misnomers. Their names are single and simple. Perch, sole, cod, eel, carp, char, skate, trench, trout, brills, bream, pike, and many others, plain monosyllables: salmon, dory, turbot, gudgeon, lobster, whitebait, grayling, haddock, mullet, herring, oyster, sturgeon, flounder, turtle, plain disyllables: only two trisyllables worth naming: anchovy and mackerel; unless anyone should be disposed to stand up for halibut, which, for my part, I have excommunicated.

*Gryll Grange*

Chapter 1 (p. 12)

Penguin Books. Harmondsworth, England. 1949

### Shakespeare, William 1564–1616

English poet, playwright, and actor

Third FISHERMAN: Master, I marvel how the fishes live in the sea.

First FISHERMAN: Why, as men do a-land: the great ones eat up the little ones.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Pericles, Prince of Tyre

Act II, Scene i, l. 30–32

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Smith, John 1580–1631

English soldier, sailor, and author

Of fish we were best acquainted with sturgeon, grampus, porpoise, seals [and] stingrays whose tails are very dangerous. Brit, mullets, white salmon, trout, sole, plaice, herring, conyfish, rockfish, eels, lampreys, catfish, shad, perch of three sorts, crabs, shrimps, crayfish, oysters, cockles, and mussels. But the most strange fish is a small one, so like the picture of St. George his dragon as possibl[y] can be, except his legs and wings; and the toadfish, which will swell till it be like to burst, when it cometh into the air.

*The True Travels, Adventures and Observations of Captain John Smith* (Volume 1)

Of Such Things Which are Naturally In Virginia, And How They Use Them (p. 125)

William W. Gray. Richmond, Virginia, USA. 1819

### Swift, Jonathan 1667–1745

Irish-born English writer

They say Fish should swim thrice.... First it should swim in the Sea; (do you mind me?) then it should swim in Butter; and at last Sirrah, it should swim in good Claret.

*Polite Conversation*

Dialogue II (p. 125)

Andre Deutsch. London, England. 1963

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Who hears the fish when they cry?  
*The Writings of Henry David Thoreau* (Volume 1)  
*A Week on the Concord and Merrimack Rivers*  
Saturday (p. 45)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Walton, Izaak** 1593–1683  
English writer

If I should begin but to name the several sorts of strange fish... that run into the sea, I might beget wonder in you, or unbelief, or both; and yet I will venture to tell you....  
*The Complete Angler*  
Chapter XIX  
T.N. Foulis. London, England. 1913

## BARRACUDA

**Gardner, John** 1933–82  
American writer and scholar

Slowly, slowly, he cruises,  
And slowly, slowly, he chooses  
Which kind of fish he prefers to take this morning;  
Then without warning  
The Barracuda opens his jaws, teeth flashing,  
And with a horrible, horrible grinding and gnashing,  
Devours a hundred poor creatures and feels no remorse.  
“But,” (as he says with an evil grin) “it’s actually not my fault, you see: I’ve nothing to do with the tragedy; I open my mouth for a yawn and – ah me – They all swim in.”  
*A Child’s Bestiary*  
The Barracuda  
Alfred A. Knopf. New York, New York, USA. 1977

## CARP

**Cuppy, Will** 1884–1929  
American humorist and critic

The Carp is dull and cluggish and greenish or brownish.  
You wouldn’t want him around.  
*How to Become Extinct*  
The Carp (p. 6)  
Dover Publications. New York, New York, USA. 1964

## CODFISH

### Author undetermined

The codfish lays a thousand eggs  
The homely hen lays one. The codfish never cackles  
To tell you what she’s done.  
And so we scorn the codfish

While the humble hen we prize  
Which only goes to show you  
That it pays to advertise.  
In Mark Kurlansky  
*Cod: A Biography of the Fish that Changed the World* (p. 29)  
Walker & Company. New York, New York, USA. 1997

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

The codfish iz a child ov the oshun. This ackounts for their being so salt.  
*Josh Billings’ Wit and Humor*  
The Cat, and the Kangaroo (p. 88)  
George Routledge & Sons. London, England. 1874

I hav noticed that the codfish alwus haz a stiff upper lip, but I think this iz more owing tew the bone that iz in him than it iz tew his blood.  
*Josh Billings’ Wit and Humor*  
The Cat, and the Kangaroo (p. 89)  
George Routledge & Sons. London, England. 1874

## COELACANTH

**Smith, James Leonard Brierley** 1897–1968  
South African ichthyologist

Coelacanth – yes, God! Although I had come prepared, that first sight hit me like a white-hot blast and made me feel shaky and queer, my body tingled. I stood as if stricken to stone. Yes, there was not a shadow of doubt, scale by scale, bone by bone, fin by fin, it was a true Coelacanth. It could have been one of those creatures of 200 million years ago come alive again. I forgot everything else and just looked and looked, and then almost fearfully went close up and touched and stroked.  
*Old Fourlegs: The Story of the Coelacanth*  
Longman, Green Publishers. London, England. 1956

## FLYING FISH

**Bullen, Frank Thomas** 1857–1915  
Author and novelist

There are few prettier sights to be seen at sea than is visible when, on a fairly calm night, with the smooth water highly phosphorescent, a school of Flying-fish are disturbed. Like a galaxy of meteors they may be seen streaming along very swiftly just beneath the surface, each leaving behind it a broadening track of light, until, as if at one impulse, the whole company suddenly leave the water, the points of their multitudinous exit gleaming in tiny showers of diamond spray.  
*Denizens of the Deep*  
Chapter XVII (pp. 224–225)  
Fleming H. Revell Co. New York, New York, USA. 1904

**GOLDFISH**

**Cuppy, Will** 1884–1929  
American humorist and critic

Goldfish come of a very old family, but it seems to do them no good. They have little place to go.... They have been cultivated so long that they are now useless. Goldfish have most uninteresting habits.

*How to Become Extinct*

The Goldfish (p. 8)

Dover Publications. New York, New York, USA. 1964

**GUPPY**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Whales have calves,  
Cats have kittens,  
Bears have cubs,  
Bats have bittens.  
Swans have cygnets,  
Seals have puppies,  
But guppies just have little guppies.

*Verses from 1929 On*

The Guppy

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**HERRING**

**Cuppy, Will** 1884–1929  
American humorist and critic

Some fishes become extinct, but Herrings go on forever. Herrings spawn at all times and places and nothing will induce them to change their ways. They have no fish control. Herrings congregate in schools, where they learn nothing at all. They move in vast numbers in May and October. Herrings subsist upon Copepods and Copepods subsist upon Diatoms and Diatoms just float around and reproduce. Young Herrings or Sperling or Whitebait are rather cute. They have serrated abdomens. The skull of the Common or Coney Island Herring is triangular, but he would be just the same anyway. (The nervous system of the Herring is fairly simple. When the Herring runs into something the stimulus is flashed to the forebrain, with or without results.)

*How to Become Extinct*

The Herring (p. 13)

Dover Publications. New York, New York, USA. 1964

**KIPPER**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

For half a century, man and nipper,  
I've doted on a tasty kipper,  
But since I am no Jack the Ripper  
I wish the kipper had a zipper.

*Everyone but Thee and Me*

The Kipper (p. 63)

Little, Brown & Company. Boston, Massachusetts, USA. 1962

**MACKEREL**

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

The mackrel iz a game fish. They ought tew be well educated, for they are always in schools.

*Josh Billings' Wit and Humor*

The Mackerel (p. 89)

George Routledge & Sons. London, England. 1874

**PICKEREL**

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The pickerel...the swiftest, wariest, and most ravenous of fishes.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimack Rivers*

Saturday (p. 36)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**SALMON**

**Cuppy, Will** 1884–1929  
American humorist and critic

Salmon have strange ideas. They are afraid of parsley and slices of lemon.

*How to Become Extinct*

The Salmon (p. 29)

Dover Publications. New York, New York, USA. 1964

**McGregor, James**

No biographical data available

Oh! For the thrill of a Highland stream,  
With the bending rod of a fisherman's dream,  
The screaming reel and flying line,  
Where the far-flung pearl-drops wetly shine –  
The sudden leap, then the silent strife,  
While the salmon grimly fights for life;  
As a worthy foe, or a regal dish,  
We respect this gallant fighting fish.

In Arnold Silcock

*Verses and Worse*

Ode to a Salmon (p. 21)

Faber & Faber Ltd. London, England. 1952

## SCULPIN

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Now the Sculpin (*Cottus virginianus*) is a little water beast which pretends to consider itself a fish, and, under that pretext, hangs about the piles on which West Boston Bridge is built, swallowing the bait and hook intended for flounders. On being drawn from the water, it exposes an immense head, a diminutive bony carcass, and a surface so full of spines, ridges, ruffles and frills that the naturalist have not been able to count them without quarreling about their number.

*The Professor at the Breakfast Table*

Chapter I (p. 2)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

## SEA HORSE

**Kraus, Jack**

No biographical data available

SEA HORSE: Philly of flounder.

*Quote, the Weekly Digest*, October 23, 1966 (p. 17)

## SEA SQUIRT

**Dennett, Daniel Clement** 1942–  
American philosopher

The juvenile sea squirt wanders through the sea searching for a suitable rock or hunk of coral to cling to and make its home for life. For this task, it has a rudimentary nervous system. When it finds its spot and takes root, it doesn't need its brain anymore so it eats it! (It's rather like getting tenure.)

*Consciousness Explained*

Chapter 7 (p. 177)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

## SHARK

**Benchley, Peter** 1940–2006  
American writer

Sharks have everything a scientist dreams of. They're beautiful – God, how beautiful they are! They're like an impossibly perfect set of machinery. They're as graceful as any bird. They're as mysterious as any animal on earth.... The more I learned about them, the more I knew I didn't know...

*Jaws*

Part II, Chapter 6 (p. 121)

Doubleday & Company, Inc. Garden City New York, USA. 1974

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

"You see," he went on after a pause, "it's as well to be provided for *everything*. That's the reason the horse has anklets around his feet."

"But what are they for?" Alice asked in a tone of great curiosity.

"To guard against the bite of sharks," the Knight replied.

*Alice's Adventures in Wonderland & Through the Looking-Glass*

Chapter 8 (p. 105)

The Macmillan Company. New York, New York, USA. 1966

**Cromie, William J.** 1930–  
American journalist and writer

Sharks are infamous for their ravenous appetites and catholic diet.

*The Living World of the Sea*

Chapter 8 (p. 138)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1966

**Melville, Herman** 1819–91  
American novelist, essayist, and poet

Though amid all the smoking horror and diabolism of a sea-fight, sharks will be seen longingly gazing up to the ship's decks, like hungry dogs round a table where red meat is being carved, ready to bolt down every killed man that is tossed to them...

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 64 (p. 217)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nash, Ogden** 1902–71  
American writer of humorous poetry

How many Scientists have written

The shark is gentle as a kitten!

Yet this I know about the shark:

His bite is worser than his bark.

*Verses from 1929 On*

The Shark

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Schweitzer, Albert** 1875–1965  
Alsatian-German theologian and philosopher

"A shark! A shark!" I rushed out of the writing room and was shown a black triangle sticking out of the water some fifty meters from the ship, and moving in our direction. It was the fin of the dread monster.

Translated by C.T. Campion

*On the Edge of the Primeval Forest*

Chapter II (pp. 17–18)

The Macmillan Company. New York, New York, USA. 1931

**Verne, Jules** 1828–1903  
French novelist

...If you were invited to hunt the bear in the mountains of Switzerland, what would you say? "Very well! tomorrow we will go and hunt the bear." If you were asked to hunt the lion in the plains of Atlas, or the tiger in the

Indian jungles, what would you sayf “ Ha ! ha I it seems we are going to hunt the tiger or the lion ! ” But when you are invited to hunt the shark in its natural element, you would perhaps reflect before accepting the invitation.

*20,000 Leagues Under the Sea*

Part II, Chapter II (p. 153)

Geo. M. Smith & Co. Boston, Massachusetts, USA. 1873

## SMELT

**Nash, Ogden** 1902–71

American writer of humorous poetry

Oh, why does man pursue the smelt?  
It has no valuable pelt,  
It boasts of no escutcheon royal,  
It yields not ivory or oil,  
Its life is dull, its death is tame,  
A fish as humble as its name.  
Yet – take this salmon somewhere else,  
And bring me half a dozen smelts.

*Verses from 1929 On*

The Smelt

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## STURGEON

**Longfellow, Henry Wadsworth** 1807–82

American poet

On the white sand of the bottom  
Lay the monster Mishe-Nahma,  
Lay the sturgeon, King of Fishes;  
Through his gills he breathed the water,  
With his fins he fanned and winnowed,  
With his tail he swept the sand-floor.  
There he lay in all his armor;  
On each side a shield to guard him,  
Plates of bone upon his forehead,  
Down his sides and back and shoulders  
Plates of bone with spines projecting!

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)

*Hiawatha*, Part VIII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

## WHITING

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“Will you walk a little faster?” said a whiting to a snail,  
“There’s a porpoise close behind us, and he’s treading  
on my tail.”

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter X (p. 107)

The Modern Library. New York, New York, USA. 1936

## X-RAY FISH

**Sierra, Judy** 1945–

Children’s author, poet, and folklorist

Xenia the X-ray fish  
Swims serenely in a dish.  
We like to sit and watch her dinner  
When it is already in her.  
*There’s A Zoo in Room 22*  
Xenia the X-ray Fish  
Harcourt. Orlando, Florida, USA. 2000

## ANIMAL: INSECT

### Acheta Domestica

House Cricket

Insects are by far the most numerous race of animals. Wherever air and light are, there they are to be found. Where other living beings would perish with hunger, there they survive. There is no place so barren as not to afford sustenance to them. Their name is legion.

Episodes of Insect Life

*The Living Age*, Volume 30, 1851 (p. 153)

The proboscis of the elephant fills every spectator of the well-regulated mind with wonder at the work of the Great Artificer’ but we do not design to notice the equally admirable proboscis of the fly, or that of the gnat, at once an awl and a pump, unless, indeed, we are made to feel those irritating instruments, when we crush the insect without bestowing a thought on the intricate and perfect mechanism of the apparatus which has annoyed us.

Episodes of Insect Life

*The Living Age*, Volume 30, 1851 (p. 153)

Without a knowledge of the habits of insects, vain is the attempt at deliverance from their overwhelming ravages.

Episodes of Insect Life

*The Living Age*, Volume 30, 1851 (p. 153)

**Ackerman, Diane** 1948–

American writer

Although it may be a little odd to think of it as a form of armor, smell plays many crucial roles in an insect’s life. It’s similar to a telephone wire over which different kinds of messages can flow: threat, invitation, courtship; the whereabouts of food; a call to arms; a password; a death knell; the trail home.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Insect Love (p. 150)

Vintage Books. New York, New York, USA. 1997

**Allee, Warder C.** 1885–1955

American zoologist

The mortal enemies of man are not his fellows of another continent or race; they are the aspects of the physical

world which limit or challenge his control, the disease germs that attack him and his domesticated plants and animals, and the insects that carry many of these germs as well as working notable direct injury. This is not... the age of man, however great his superiority in size and intelligence; it is literally the age of insects.

*The Social Life of Insects*

Chapter 7

W.W. Norton & Company, Inc. New York, New York, USA. 1938

**Bailey, Liberty Hyde** 1858–1954

American horticulturist and botanist

What wader, be he boy or water-fowl, has not watched the water-insects? How they dart hither and thither, some skimming the surface, others sturdily rowing about in the clear shallows! The sunlight fastens, for an instant, their grotesque reflections on the smooth bottom, then away – the shadow is lost, except for the picture it left in the memory of the onlooker.

*Cornell Nature-study Leaflets*

Leaflet XI (p. 135)

J.B. Lyon Co. Albany, New York, USA. 1904

**Barbauld, Anna Laetitia** 1743–1825

English writer, essayist, and poet

What atom forms of insect life appear!  
And who can follow Nature's pencil here?  
Their wings with azure, green and purple gloss'd,  
Studded with color eyes, with gems embossed,  
Inlaid with pearl, and marked with various stains  
Of lovely crimson, through their dusky veins.

In Lucy Aikin (ed.)

*The Works of Anna Laetitia Barbauld* (Volume 1)

To Mrs. P\*\*\*\*\*

David Reed. Boston, Massachusetts, USA. 1826

**Bouvier, E. L.**

No biographical data available

Insects are creatures which seem to defy the imagination with the strangeness of their form and their extraordinary habits. In the "War of the Worlds," Wells the novelist surprises us with his belligerent Tripods which descend as conquerors upon our planet, where they terrify and exterminate poor humanity. This fiction appears bizarre, but it falls far short of what Nature herself shows us in the world of the articulates!

Translated by L.O. Howard

*The Psychic Life of Insects*

Introduction (p. xi)

The Century Co. New York, New York, USA. 1922

**Brues, Charles Thomas** 1879–1955

American entomologist

Another, and far more extensive series, of unbidden guests, is made up of numerous other animals and plants, some originally associated with the human species, and others attracted to it as the result of changes wrought by

civilization.... A quite considerable part of this motley assemblage consists of insects, which enter into our life and activities in many ways. This group of animals really vies with the mammals, and with man in particular, in its attempt to dominate the animal world.

*Insects and Human Welfare*

Introduction (pp. ix, x)

Harvard University Press. Cambridge, England. 1920

**Čapek, Josef** 1887–1945

Czechoslovakian artist

**Čapek, Karel** 1890–1938

Czechoslovakian author

Chrysalis: The whole earth is quivering,  
Something mighty it is delivering,  
I am being born.

Moth: Unravel life. What are we else, We, woven from daintiest fabrics,

But thought and soul of creation?

*The Life of the Insects*

Oxford University Press, Inc. London, England. 1923

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

"What sort of insects do you rejoice in, where *you* come from?" the Gnat inquired.

"I don't *rejoice* in insects at all," Alice explained...

*Alice's Adventures in Wonderland & Through the Looking-Glass*

Chapter 3 (p. 34)

The Macmillan Company. New York, New York, USA. 1966

**Clare, John** 1793–1864

English poet

Those tiny loiterers on the barleys beard  
& happy units of a numerous herd  
Of playfellows the laughing summer brings  
Mocking the sunshine on their glittering wings.

*The Rural Muse*

Insects

Whittaker & Company. London, England. 1835

**Darwin, Erasmus** 1731–1802

English physician and poet

Rest, silver butterflies, your quivering wings,  
Alight, ye beetles, from your airy rings;  
Ye painted moths, your gold-eyed plumage furl,  
Bow your wide horns, your spiral trunks uncurl;  
Glitter, ye glow-worms, on your mossy beds;  
Descend, ye spiders, on your lengthened threads!

*The Botanic Garden*

The Loves of the Plants

**Dewar, Redcote**

No biographical data available

...even in the matter of weapons and tools they [insects] furnish an appalling arsenal of armor, pincers, augers,



pikes, hooks, horns, rasps, rollers, saws, stings, screws, sickles, lancets, mandibles, dentilated teeth, and cupping-glasses ...

*From Matter to Man: A New Theory of the Universe*  
Chapter XIII (p. 200)  
Chapman & Hall, Ltd. London, England. 1898

...of all animals, insects present the most extraordinary and fantastic of organic combinations, ranging from the most dexterous, wonderful, beautiful, gorgeous, dazzling, amusing, artistic, and intelligent of living things, to the most clumsy, formidable, eccentric, repulsive, exasperating, disgusting, and shocking.

*From Matter to Man: A New Theory of the Universe*  
Chapter XIII (p. 200)  
Chapman & Hall, Ltd. London, England. 1898

The numerous beings comprehended under the name of Insect, offer to our regard so many interesting objects of contemplation and research, that their history has deservedly assumed a prominent place among the natural sciences. Although not to be compared with many other animals in direct utility to man, they are by no means destitute even of the interest produced by that consideration, while they possess advantages as a subject of study and investigation, equal to almost any other branch of zoology.

*Beetles*  
Natural History of Coleopterous Insects (p. 71)  
H.G. Bohn. London, England. 1845?

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

The sky was of the deepest blue, with a few white, fleecy clouds drifting lazily across it, and the air was filled with the low drone of insects or with a sudden sharper note as bee or bluefly shot past with its quivering, long-drawn hum, like an insect tuning-fork.

*Beyond the City*  
A Naval Conquest (p. 46)  
University of Virginia. Charlottesville, Virginia, USA. 1996

**Eisner, Thomas** 1929–2011  
Father of chemical ecology

**Wilson, Edward O.** 1929–  
American biologist and author

Whether fully aware of it or not, we human beings are immersed in a world of insects.

*The Insects: Readings from Scientific American*  
General Introduction: The Conquerors of the Land (p. 2)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Of what use, however, is a general certainty that an insect will not walk with his head hindmost, when what you need to know is the play of inward stimulus that sends

him hither and thither in a network of possible paths?

*The Writings of George Eliot* (Volume 16)  
*Daniel Deronda*, Volume II, Book 3, Chapter 25 (p. 9)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1907–1908

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Whoever looks at the insect world, at flies, aphides, gnats, and innumerable parasites, and even at the infant mammals, must have remarked the extreme content they take in suction, which constitutes the main business of their life. If we go into a library or news-room, we see the same function on a higher plane, performed with like ardor, with equal impatience of interruption, indicating the sweetness of the act.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)  
*The Comic*  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903–1904

**Evans, Howard Ensign** 1919–2002  
American entomologist

The sense that insects belong to a different world than ours is shared by many people, and it is a perfectly valid feeling. After all, the search for a common ancestor of insects and ourselves would take us back more than half a billion years.... In a sense insects are very much of this world, and *Homo sapiens* is a strange and aberrant creature of recent origin who has sought to create his own world, apart from that of nature.

*The Pleasures of Entomology: Portraits of Insects and the People Who Study Them*  
Chapter 18 (p. 215)  
Smithsonian Institution Press. Washington, D.C. 1985

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

An insect, well known to everyone, is often but a stupid creature, while another, of which nothing is known, is of real value. When endowed with talents worthy of attention, it passes unrecognized; when richly clad and of handsome appearance, it is familiar to us. We judge it by its coat and its size, as we judge our neighbour by the fineness of his clothing and the importance of the position which he fills. The rest does not count.

Translated by Alexander Teixeira de Mattos  
*The Life of the Weevil*  
Chapter xv (p. 246)  
Hodder & Stoughton. London, England. nd

Dear insects, my study of you has sustained me and continues to sustain me in my heaviest trials. I must take leave of you for to-day. The ranks are thinning around me and the long hopes have fled. Shall I be able to speak of you again?

Translated by Alexander Teixeira de Mattos  
*Bramble Bees and Others*  
Chapter V (p. 191)  
Dodd, Mead & Co. New York, New York, USA. 1915

**Fish, Henry C.**

No biographical data available

The winged inhabitants of the air, too, have a delightful existence. Have you never stood and admired the nimble and orderly flirtations of a pleasure-party of insects, at the rising or setting sun of a summer's day?

Sermon XVIII

*The National Preacher*, Volume IV, 1861 (p. 271)**Gosse, Philip Henry** 1810–88

English naturalist and popularizer of natural science

**Hill, Richard**

How inexhaustible are the resources of Divine wisdom, when the outgoings of it in the meanest insects are so wonderful!

*A Naturalist's Sojourn in Jamaica*

The Ant Lion (p. 196)

Longman, Brown, Green &amp; Longmans. London, England. 1851

**Gray, Thomas** 1716–71

English poet

Yet hark, how through the peopled air

The busy murmur glows!

The insect-youth are on the wing,

Eager to taste the honied spring

And float amid the liquid noon:

Some lightly o'er the current skim,

Some show their gayly-gilded trim

Quick-glancing to the sun.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*

Ode on the Spring

J. Blackwood. London, England. 1800

**Gregory, Sir Richard Arman** 1864–1952

English scientific writer and journalist

If there is one branch of science more than another in which the infinite patience of genius is required, it is that of the study of insects; not of insects pinned in boxes or arranged in cabinets, but of the living creatures, with the view of discovering something of their life-history or of understanding a type of mental life on lines different from

*Discovery, Or, The Spirit and Service of Science*

Chapter IV (p. 54)

Macmillan &amp; Co Ltd. London, England. 1916

**Heinlein, Robert A.** 1907–88

American science fiction writer

In handling a stinging insect, move very slowly.

*Time Enough for Love*

Second Intermission (p. 365)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Howes, Paul Griswold** 1918–85

Naturalist

It is strange what a vast array of facts are disclosed through the study of the unintelligent invertebrate. I am thinking particularly of insects, dominant creatures of the earth, into whose life-secrets and lore man, through his wretched span of years, may scarce become a trespasser. They are set apart, almost in another world, vastly wise and ruled by an iron discipline that has wrought their world empire of today.

*Insect Behavior*

Chapter III (p. 32)

R.G. Badger. Boston, Massachusetts, USA. 1919

**Kafka, Franz** 1883–1924

German-language novelist

When Gregor Samsa awoke one morning from uneasy dreams he found himself transformed in his bed into a gigantic insect.

The Metamorphosis

**Kellogg, Vernon Lyman** 1867–1937

American zoologist

If man were not the dominant animal in the world, this would be the Age of Insects. Outnumbering in kinds the members of all other groups of animals combined, and showing a wealth of individuals and a degree of prolificness excelled only by the fishes among larger animals, and among smaller animals by the Protozoa, the insects have an indisputable claim on the attention of students of natural history by sheer force of numbers.

*American Insects*

Prefatory Note

Henry Holt &amp; Co. New York, New York, USA. 1908

Perhaps no more uninteresting matter, for the general reader or entomological amateur, can be written about insects than a descriptive catalogue of the parts and pieces of the insect body.

*American Insects*

Chapter I (p. 1)

Henry Holt &amp; Company. New York, New York, USA. 1908

**Kirby, William** 1759–1850

English entomologist

**Spence, William** 1783–1860

English entomologist

The first knowledge that we get of them [insects] is as tormentors; they are usually pointed out to us by those about us as ugly, filthy, and noxious creatures; and the whole insect world, butterflies perhaps and some few others excepted, are devoted by one universal ban to proscription and execration, as fit only to be trodden under our feet and crushed: so that often, before we can persuade ourselves to study them, we have to remove from our minds prejudices deeply rooted and of long standing.



*An Introduction to Entomology; Or, Elements of the Natural History of Insects*

Introductory Letter (p. 3)

Printed for Longman, Hurst, Rees, Orme & Brown. London, England. 1818

...insects, unfortunate insects, are so far from attracting us, that we are accustomed to abhor them from our childhood. The first knowledge that we get of them is as tormentors; they are usually pointed out to us by those about us, as ugly, filthy, and noxious creatures; and the whole insect world, butterflies perhaps and some few other expected, are devoted by one universal to proscription and execration, as fit only to trodden under our feet and crushed...

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Introductory Letter (p. 2)

Longman, Green, Longman & Roberts. London, England. 1860

Insects, indeed, appear to have been nature's favorite productions, in which to manifest her power and skill, she has combined and concentrated almost all that is either beautiful and graceful, interesting and alluring, or curious and singular, in every other class and order of her children.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Introductory Letter (p. 4)

Longman, Green, Longman & Roberts. London, England. 1860

In variegation, insects certainly exceed every other class of animated beings. Nature, in her sportive mood, when painting them, sometimes imitates the clouds of heaven; at others, the meandering course of the rivers of the earth, or the undulations of their waters: many are veined like beautiful marbles; others have the semblance of a robe of the finest net-work thrown over them; some she blazons with heraldic insignia, giving them to bear in fields sable – azure – vert – gules – argent and or fesses – bars – bends – crosses – crescents – stars, and even animals. On many, taking her rule and compasses, she draws with precision mathematical figures; points, lines, angles, triangles, squares, and circles. On others she portrays, with mystic hand, what seem like hieroglyphic symbols, or inscribes them with the characters and letters of various languages, often very correctly formed; and what is more extraordinary, she has registered in others figures which correspond with several dates of the Christian era.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Introductory Letter (pp. 5–6)

Longman, Green, Longman & Roberts. London, England. 1860

What numbers [of insects] vie with the charming offspring of Flora in various beauties! Some in the delicacy and variety of their colours, colours notlike those of flowers evanescent and fugitive, but fixed and durable,

surviving their subject, and adorning it as much after death as they did when it was alive ...

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (Volume 1)

Introductory Letter (p. 8)

Printed for Longman, Hurst, Rees, Orme & Brown. London, England. 1818

Beasts, birds, and fishes...attract our notice; but *insects*, unfortunate insects, are so far from attracting us, that we are accustomed to abhor them from our childhood. The first knowledge that we get of them is as tormentors; they are usually pointed out to us by those about us, as ugly, filthy, and noxious creatures; and the whole insect world, butterflies perhaps and some few others excepted, are tied by one universal ban to proscription and execration, as fit only to be trodden under our feet and crushed; so that often, before we can persuade ourselves to study them, we have to remove from our minds prejudices deeply rooted and of long standing.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter 1 (p. 2)

Longman, Brown, Green, Longmans & Robert. London, England. 1858

Being amongst the most minute of nature's productions, they [insects] do not so readily catch the eye of the observer; and when they do, mankind in general are so apt to estimate the worth and importance of things by their bulk, that because we usually measure them by the duodecimals of an inch instead of in the foot or by the yard, insects are deemed too insignificant parts of the creation, and of too little consequence to its general welfare, to render them worthy of any serious attention or study.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter 1 (p. 2)

Longman, Brown, Green, Longmans & Robert. London, England. 1858

...numerous other sources of pleasure and information will open themselves to you, not inferior to what any other science can furnish, when you enter more deeply into the study. Insects, indeed, appear to have been nature's favourite productions, in which, to manifest her power and skill, she has combined and concentrated almost all that is either beautiful and graceful, interesting and alluring, or curious and singular, in every other class and order of her children. To these, her valued miniatures, she has given the most delicate touch and highest finish of

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter 1 (p. 4)

Longman, Brown, Green, Longmans & Robert. London, England. 1858

...other insects seem emblematical of a different class of unearthly beings; when we behold some tremendous for the numerous horns and spines projecting in horrid array from their head or shoulders – others for their threatening

jaws of fearful length, and armed with cruel fangs: when we survey the dismal hue and demoniac air that distinguish others, the dens of darkness in which they live, the impurity of their food, their predatory habits and cruelty, the nets which they spread, and the pits which they sink to entrap the unwary, we can scarcely help regarding them as aptly symbolising evil demons, the enemy of man...

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Letter I (p. 6)

Longman, Green, Longman & Roberts. London, England. 1860

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

Two-legged creatures we are supposed to love as well as we love ourselves. The four-legged, also, can come to seem pretty important. But six legs are too many from the human standpoint.

*The Twelve Seasons*

August (p. 14)

W. Sloane Associates. New York, New York, USA. 1949

**Le Gallienne, Richard** 1866–1947

English man of letters

All was hushed and dream-like, and there was no sound save the murmur of happy insects, which seemed like the humming of the sunlight itself.

*The Highway to Happiness* (p. 141)

The Morningside Press. New York, New York, USA. 1913

**Levi, Primo** 1919–87

Italian writer and chemist

If a hypothetical zoologist, who specialized in birds and mammals but knew nothing about insects, was told that there exist hundreds of thousands of animal species, very different from one another, who have invented a way of building themselves an armor by exploiting an original derivate from glucose and ammonia; and that when, in growing, these little animals must “jump out of their skins,” that is to say, out of this unextendable armor, then throw it away and make themselves another, larger one... this improbable zoologist would refuse to believe it.

Translated by Raymond Rosenthal

*Other People's Trades*

Butterflies (p. 16)

Summit Books. New York, New York, USA. 1989

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

The insect does not belong to our world. The other animals, the plants even, notwithstanding their dumb life and the great secrets which they cherish, do not seem wholly foreign to us. In spite of all, we feel a certain earthly brotherhood in them. They often surprise and amaze our intelligence, but do not utterly upset it. There is something, on the other hand, about the insect that

does not seem to belong to the habits, the ethics, the psychology of our globe. One would be inclined to say that the insect comes from another planet, more monstrous, more energetic, more insane, more atrocious, more infernal than our own. One would think that it was born of some comet that had lost its course and died demented in space. In vain does it seize upon life with an authority, a fecundity unequalled here below; we cannot accustom ourselves to the idea that it is a thought of that nature of whom we fondly believe ourselves to be the privileged children and probably the ideal to which all the earth's efforts tend.

Maurice Maeterlinck

In Jean-Henri Fabre

*The Life of the Spider*

Preface (pp. 9–10)

Dodd, Mead & Co. New York, New York, USA. 1913

...it is time, under the conduct of an admirable guide, to penetrate behind the scenes of our fairy play and to study at close quarters the actors and supernumeraries [the insects], loathsome or magnificent, as the case may be, grotesque or sinister, heroic or appalling, genial or stupid and almost always improbable and unintelligible.

Maurice Maeterlinck

In Jean-Henri Fabre

*The Life of the Spider*

Preface (pp. 10–11)

Dodd, Mead & Co. New York, New York, USA. 1913

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

insects are not always

going to be bullied

by humanity

some day they will revolt

*The Lives and Times of Archy and Mehitabel*

Certain Maxims of archy (p. 54)

Doubleday, Doran & Co., Inc. Garden City, New York, USA. 1933

i have been organizing the insects

the ants the worms the wasps

the bees the cockroaches

the misquitoses

for a revolt against mankind

*the lives and time of archy & mehitabel*

the return of archy (p. 188)

Doubleday Doran & Co. Garden City, New York, USA. 1934

as a representative of the insect world

i have often wondered

on what man bases his claims

to superiority

everything he knows he has had

to learn whereas we insects are born

knowing everything we need to know

*the lives and times of archy and mehitabel*

quote and only man is vile quote (p. 206)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

one thing that  
shows that  
insects are  
superior to men  
is the fact that  
insects run their  
affairs without  
political campaigns  
elections and so forth

*the lives and times of archy & mehitabel*  
random thoughts by archy (p. 223)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

men  
and insects are the same  
both transient flocks  
of starry dust  
that out of nothing came  
the planets are  
what atoms are  
and neither more nor less

*the lives and time of archy & mehitabel*  
archy turns revolutionist (p. 227)

Doubleday Doran & Co. Garden City, New York, USA. 1934

i look to the day  
when the human race is done  
and we insects romp and play  
freely underneath the sun

*the lives and time of archy & mehitabel*  
as it looks to archy (p. 236)

Doubleday Doran & Co. Garden City, New York, USA. 1934

**Michelet, Jules** 1798–1874  
French historian

The insect has not my languages. He neither speaks by  
voice nor physiognomy. In what manner then, does he  
express himself?

He speaks by his energies.

Translated by W.D.H. Adams

*The Insects*

Chapter III (p. 155)

T. Nelson & Sons. London, England. 1875

**Muir, John** 1838–1914  
American naturalist

Baby grubs, happy fellows, find themselves in a sweet  
world of plenty, feeding their way through the heart of the  
cone from one nut-chamber to another, secure from rain  
and wind and heat, until their wings are grown and they are  
ready to launch out into the free ocean of air and light.

*Steep Trails*

Chapter XIII (pp. 172–173)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Insect swarms are dancing in the sunbeams, burrowing  
in the ground, diving, swimming, a cloud of witnesses  
telling Nature's joy.

*Our National Parks*

Chapter II (p. 70)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...every leaf and flower seems to have its winged repre-  
sentative in the swarms of happy flower-like insects that  
enliven the air above them.

*Our National Parks*

Chapter V (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### **Nedrick Jackson (Fictional character)**

If that is an insect it is from the biggest creature that ever  
lived.

*Praying Mantis*

Film (1957)

**Pallister, William Hales** 1877–1946  
Canadian physician

Of the INSECTS, such numbers of species exist  
That their species have filled up whole volumes of  
books.

Over four hundred thousand are named in their list!

Everyone has six legs, though they differ in looks.

The long warfare with insects gives men little ease,

For four-fifths of the whole earth's species are these!

*Poems of Science* (p. 140)

Playford Press. New York, New York, USA. 1931

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

...in these minute creatures [insects], so nearly akin as  
they are to non-entity, how surpassing the intelligence,  
how vast the resources, and how ineffable the perfection  
which she [Nature] has displayed.

Translated by John Bostock and H.T. Riley

*The Natural History of Pliny* (Volume III)

Book XI (p. 2)

George Bell & Sons. London, England. 1892

**Pouchet, Félix Archimède** 1800–72  
French biologist

If anything in insects surpass the diversity of forms, it is  
the prodigious variety of colouring. Their mantles gleam  
with the richest hues in nature. Their sheen can only be  
compared to that of jewels and metals. The purest gold  
and silver, the sapphire and the emerald, gleam on their  
wings and corsages; their tints mingle and encounter, or  
imperceptibly shade into each other.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book III (p. 93)

Blackie & Son. London, England. 1870

...among insects, there are architects, masons, uphol-  
sterers, paper-makers, joiners, pasteboard-makers, and  
hydraulic-engineers. Others dislike work, and are veri-  
table pirates, always engaged in war and pillage.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book III (p. 93)  
Blackie & Son. London, England. 1870

**Rennie, James** 1787–1867  
Naturalist

If it be granted that making discoveries is one of the most satisfactory of human pleasures, then we may without hesitation affirm, that the study of insects is one of the most delightful branches of natural history, for it affords peculiar facilities for its pursuit.

*Insect Architecture* (2nd edition)  
Chapter I (p. 3)  
Charles Knight. London, England. 1830

A collection of insects is to the true naturalist what a collection of medals is to the accurate student of history.

*Insect Architecture* (2nd edition)  
Chapter I (p. 16)  
Charles Knight. London, England. 1830

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Amid wars and rumours of war, while the acrimonies of disarmament conferences threaten the human race with unprecedented disaster, another conflict perhaps more important is receiving much less notice than it deserves – I mean the conflict between men and insects.

In Harry Ruja (ed.)  
*Mortals and Others* Volume 2  
Men versus Insects (p. 53)

**Swift, Jonathan** 1667–1745  
Irish-born English writer

Then turning to his first minister, who waited behind him with a white staff, near as tall as the mainmast of the *Royal Sovereign*, he observed how contemptible a thing was human grandeur, which could be mimicked by such diminutive insects as I: and yet, said he, I dare engage these creatures have their titles and distinctions of honour; they contrive little nests and burrows, that they call houses and cities; they make a figure in dress and equipage; they love, they fight, they dispute, they cheat, they betray.

*Gulliver's Travels*  
Chapter III (p. 123)  
Printed for Benj. Motte. London, England. 1727

**Teale, Edwin Way** 1899–1980  
American naturalist

If insects had the gift of speech, as we understand it, I am sure a main topic of conversation would begin: "Let me tell you about my molt."

*Near Horizons: The Story of an Insect Garden*  
Chapter 10 (p. 97)  
Dodd, Mead & Company. New York, New York, USA. 1943

## The Minister (Fictional character)

Do you know what you're implying? That we owe our human condition to the intervention of insects.

*Quatermass and the Pit*  
Film (1958)

## Wade, Nicholas

British-born scientific reporter, editor, and author

Tiny, Puny, Pestilential. Apart from a few exceptions like bees and butterflies, insects have a definite image problem. Zoologists may respect them as the most successful class of anthropoids, but to most people they are just bugs, menacing nuisances to be swatted or stepped on.

*The New York Times Book of Insects*  
Introduction (p. 1)  
The Lyons Press. Guilford, Connecticut, USA. 2003

**Webb, Mary** 1881–1927  
English novelist

Insects are the artists of fragrance; they have a genius for it; there seems to be some affinity between the tenuity of their being and this most refined of the sense-impressions.

*Poems and the Spring of Joy*  
Joy of Fragrance (p. 164)  
Jonathan Cape. London, England. 1937

**Wilson, John** 1785–1854  
Scottish writer

Devouring Ephemerals! Can you not suffer the poor insects to sport out their day? They must be insipid eating; but here are some savory exceedingly – it is needless to mention their name – that carry *sauce piquante* in their tails. Do try the taste of this bobber – but anyone of the three you please. There! Hold fast Kirby – for that is

*The Recreations of Christopher North*  
The Moors (p. 146)  
D. Appleton & Co. New York, New York, USA. 1870

**Wood, John George** 1827–1889  
English writer on natural history

The habits of insects are very mines of interesting knowledge, and it is impossible carefully to watch the proceedings of any insect, however insignificant, without feeling that no writer of fiction ever invented a drama of such absorbing interest as is acted daily before our eyes, though to indifferent spectators.

In W.J. Holland  
*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*  
Family Psychidae (p. 360)  
Doubleday, Page & Company. New York, New York, USA. 1904

## ANT

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

Yu never see two ants arguing sum phoolish question that neither ov them didn't understand; they don't kare whether the moon iz inhabited, or not; nor whether a fish weighing two pounds, put into a pail ov water allreddy phull, will make the pail slop over, or weigh more.

*Josh Billings' Wit and Humor*

The Ant (p. 115)

George Routledge & Sons. London, England. 1874

**Darwin, Charles Robert** 1809–82  
English naturalist

...the brain of an ant is one of the most marvelous atoms of matter in the world, perhaps more so than the brain of man.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part I, Chapter II (p. 281)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Dr. Harold Medford (Fictional character)

None of the ants previously seen by man were more than an inch in length – most considerably under that size. But even the most minute of them have an instinct and talent for industry, social organization, and savagery that makes man look feeble by comparison.

*Them*

Film (1954)

The antennae! Shoot the antennae!

*Them*

Film (1954)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The instincts of the ant are very unimportant, considered as the ant's; but the moment a ray of relation is seen to extend from it to man, and the little drudge is seen to be a monitor, a little body with a mighty heart, then all its habits, even that said to be recently observed, that it never sleeps, become sublime.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses and Lectures*

Language (p. 22)

The Library of America. New York, New York, USA. 1983

**Hölldobler, Bert** 1936–  
German myrmecologist

**Wilson, Edward O.** 1929–  
American biologist and writer

The foreign policy aim of ants can be summed up as follows: restless aggression, territorial conquest, and genocidal annihilation of neighboring colonies whenever possible.

If ants had nuclear weapons, they would probably end the world in a week.

*Journey to the Ants: A Story of Scientific Exploration*

War and Foreign Policy (p. 59)

Harvard University Press. Cambridge, Massachusetts, USA. 1994

**Levi, Primo** 1919–87  
Italian writer and chemist

After the planet becomes theirs, many millions of years will have to pass before a beetle particularly loved by God, at the end of its calculations will find written on a sheet of paper in letters of fire that energy is equal to the mass multiplied by the square of the velocity of light. The new kings of the world will live tranquilly for a long time, confining themselves to devouring each other and being parasites among each other on a cottage industry scale.

Translated by Raymond Rosenthal

*Other People's Trades*

Beetles (p. 29)

Summit Books. New York, New York, USA. 1989

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

The Anthropoid apes no doubt approach nearer to man in bodily structure than do any other animals; but when we consider the habits of ants, their social organization, their large communities and elaborate habitations, their roadways, their possession of domestic animals, and even, in some cases, of slaves, it must be admitted that they have a fair claim to rank next to man in the scale of intelligence.

*Ants, Bees and Wasps*

Introduction (p. 1)

D. Appleton & Company. New York, New York, USA. 1884

**Muir, John** 1838–1914  
American naturalist

Ants...whose tiny sparks of life only burn the brighter with the heat...

*My First Summer in the Sierra*

June 3 (pp. 10–11)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Shah, Idries** 1924–96  
Persian author and teacher in the Sufi tradition

Finding I could speak the language of ants, I approached one and inquired, "What is God like? Does he resemble the ant?"

*Thinkers of the East*

Iam Baqir (p. 101)

Jonathan Cape. London, England. 1971

### The Bible (King James Version)

Go to the ant, thou sluggard; consider her ways, and be wise:...

Proverbs 6:6



## The Ellinson girl (Fictional character)

THEM! THEM! THEM!

*Them*

Film (1954)

**Thomas, Lewis** 1913–93

American physician and biologist

Ants are so much like human beings as to be an embarrassment. They farm fungi, raise aphids as livestock, launch armies into wars, use chemical sprays to alarm and confuse enemies, capture slaves. The families of weaver ants engage in child labor, holding their larvae like shuttles to spin out the thread that sews the leaves together for their fungus gardens. They exchange information ceaselessly. They do everything but watch television.

*The Lives of a Cell: Notes of a Biology Watcher*

On Societies as Organisms (pp. 11–12)

The Viking Press. New York, New York, USA. 1974

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

It seems to me that in the matter of intellect the ant must be a strangely overrated bird. During the many summers, now, I have watched him, when I ought to have been in better business, and I have not yet come across a living ant that seemed to have any more sense than a dead one.

*A Tramp Abroad*

Chapter XXII (p. 139)

Penguin Books. New York, New York, USA. 1997

I have had no experience of those wonderful Swiss and African ones which vote, keep drilled armies, hold slaves, and dispute about religion. Those particular ants may be all that the naturalist paints them, but I am persuaded that the average ant is a sham. I admit his industry, of course; he is the hardest working creature in the world – when anybody is looking – but his leather-headedness is the point I make against him. He goes out foraging, he makes a capture, and then what does he do? Go home? No; he goes anywhere but home. He doesn't know where home is. His home may be only three feet away; no matter, he can't find it.

*A Tramp Abroad* (Volume 1) (3rd edition)

Chapter XXII (p. 206)

Chatto & Windus. London, England. 1880

Now and then, while we rested, we watched the laborious ant at his work. I found nothing new in him – certainly nothing to change my opinion of him. It seems to me that in the matter of intellect the ant must be a strangely overrated bird. During many summers now I have watched him, when I ought to have been in better business, and I have not yet come across a living ant that seemed to have any more sense than a dead one.

*A Tramp Abroad* (Volume 1) (3rd edition)

Chapter XXII (p. 206)

Chatto & Windus. London, England. 1880

He [an ant] makes his capture, as I have said; it is generally something which can be of no sort of use to himself or anybody else; it is usually seven times bigger than it ought to be; he hunts out the awkwardest place to take hold of it; he lifts it bodily up in the air by main force, and starts – not toward home, but in the opposite direction; not calmly and wisely, but with a frantic haste which is wasteful of his strength; he fetches up against a pebble, and, instead of going around it, he climbs over it backwards, dragging his booty after him, tumbles down on the other side, jumps up in a passion, kicks the dust off his clothes, moistens his hands, grabs his property viciously, yanks it this way, then that, shoves it ahead of him a moment, turns tail and lugs it after him another moment, gets madder and madder, then presently hoists it into the air and goes tearing away in an entirely new direction; comes to a weed; it never occurs to him to go around it. No; he must climb it, and he does climb it, dragging his worthless property to the top – which is as bright a thing to do as it would be for me to carry a sack of flour from Heidelberg to Paris by way of Strasburg steeple; when he gets up there he finds that that is not the place; takes a cursory glance at the scenery, and either climbs down again or tumbles down, and starts off once more – as usual, in a new direction. At the end of half an hour he fetches up within six inches of the place he started from, and lays his burden down. Meantime, he has been over all the ground for two yards around, and climbed all the weeds and pebbles he came across.

*A Tramp Abroad* (Volume 1) (3rd edition)

Chapter XXII (pp. 206–207)

Chatto & Windus. London, England. 1880

## APHID

**Allen, Grant** 1848–99

Canadian-born writer

To the world at large, the aphides, as we call them, are mere nameless nuisances pests that infest our choicest plants; to the eye of the naturalist, they are a marvelous and deeply interesting group of animals, with one of the oddest pedigrees, one of the queerest biographies, known to science.

*Flashlights on Nature*

Chapter I (p. 2)

Doubleday, Page & Co. New York, New York, USA. 1905

## BEDBUG

**Author undetermined**

The June bug hath a gaudy wing

The lightning bug a flame

The bedbug hath no wings at all  
But he gets there just the same.

In Arnold Mallis

*American Entomologist*

Chapter 8 (p. 205)

Rutgers University Press. New Brunswick, New Jersey, USA. 1971

## BEE

**Burroughs, John** 1837–1921

American naturalist and writer

There is no creature with which man has surrounded himself that seems so much like a product of civilization, so much like the result of development on special lines and in special fields, as the honey-bee.

*Birds and Bees Essays*

Bees (p. 45)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1914

The honey-bee goes forth from the hive in spring like the dove from Noah's ark, and it is not till after many days that she brings back the olive leaf, which in this case is a pellet of golden pollen upon each hip...

*Locusts and Wild Honey*

The Pastoral Bees (p. 13)

Edinburgh University Press. Edinburgh, Scotland. 1884

**Cleveland, John** 1613–58

English poet

Nature's confectioner, the bee.

*The Poems of John Cleveland*

Fuscara, or the Bee Errant

The Grafton Press. New York, New York, USA. 1903

**Dickinson, Emily** 1830–86

American lyric poet

To make a prairie it takes a clover and one bee,  
One clover and a bee,  
And revery.

The revery alone will do,

If bees are few.

*The Complete Poems of Emily Dickinson*

No. 1755 (p. 710)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Gay, John** 1685–1732

English poet and dramatist

The careful insect 'midst his works I view,  
Now from the flow'rs exhaust the fragrant Dew;  
With golden Treasures load his little Thighs,  
And steer his airy Journey through the Skies;  
With liquid Sweets the waxen Cells distend,  
While some 'gainst Hostile Drones their Cave defend;  
Each in Toil a proper Station bears,  
And in the little Bulk a might Soul appears...

*Rural Sports: A Poem*

Canto I, l. 83–90

Printed for J. Tonson. London, England. 1713

**Kidd, Sue Monk** 1948–

American writer

People don't realize how smart bees are, evensmarter than dolphins. Bees know enough geometry to make row after row of perfect hexagons, angles so accurate you'd think they used rulers.

*The Secret Life of Bees*

Chapter Eight (p. 137)

Penguin Books. Middlesex, England. 2002

**Longgood, William**

No biographical data available

**Johnson, Pam**

No biographical data available

How did bees ever become equated with sex? They do not live a riotous sex life themselves.... A hive suggests the cloister more than the bordello.

*Queen Must Die and Other Affairs of Bees and Men*

Chapter Forty-one (p. 117)

W.W. Norton & Co. New York, New York, USA. 1985

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

...the honey bee is sad and cross  
and wicked as a weasel  
and when she perches on you boss  
she leaves a little measel

*the lives and times of archy and mehitable*

certain maxims of archy (p. 53)

Doubleday, Doran & Co., Inc. Garden City, New York, USA. 1933

...the bees got their governmental system settled millions of years ago but the human race is still groping

*the lives and times of archy and mehitable*

certain maxims of archy (p. 55)

Doubleday, Doran & Co., Inc. Garden City, New York, USA. 1933

**Purchas, Samuel (the Younger)** 1577–1626

English travel writer

Bees are political creatures, and destinate all their actions to one common end; they have one common habitation, one common work, all work for all, and one common care and love towards all their young, and that under one Commander...

*A Theatre of Political Flying-Insects* (p. 16)

Printed for T. Parkhurst. London, England. 1657

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...so work the honey-bees,  
Creatures, that by a rule in nature, teach  
The act of order to a peopled kingdom.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Life of King Henry the Fifth*

Act I, Scene ii, l. 187–189

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smythe, Daniel** 1908–81  
American poet

The bees, those intergarden missiles,  
Now make their thin propellers hum  
To landing fields of flowers and thistles  
More certain of their goal than some.

Small Flyers  
*Nature Magazine*, Volume 50, Number 6, June–July 1957 (p. 292)

**Topsell, Edward** 1572–1625?  
English divine and writer

Of all Insects, Bees are the principal and are chiefly to be admired, being the only creature of that kinde framed for the nourishment of Man; but the rest are procreated either to be useful in physic, or for delight of the eyes, the pleasure of the ears, or the completing and ornament of the body...

*The History of Four-Footed Beasts and Serpents*  
The Theater of Insects  
Chapter I (p. 889)  
G. Sawbridge. London, England. 1658

## BEETLE

**Crowson, Roy Albert** 1914–99  
English biologist

The beetles are at once absolutely typical of, and unique among, the Insecta, a paradox of a kind which, though familiar to any practising systematist, is a constant stumbling block to laboratory experimentalists of the modern school.

*The Biology of the Coleoptera*  
Chapter 1 (p. 1)  
Academic Press. London, England. 1981

**Darwin, Charles Robert** 1809–82  
English naturalist

But no pursuit at Cambridge was followed with nearly so much eagerness or gave so much pleasure as collecting beetles. It was the mere passion for collecting, for I did not dissect them, and rarely compared their external characters with published descriptions, but got them named anyhow. I will give proof of my zeal: one day, on tearing off some old bark, I saw two rare beetles, and seized one in each hand; then I saw a third and new kind, which I could not bear to lose, so I popped the one which I held in my right hand into my mouth. Alas! It ejected some intensely acrid fluid, which burnt my tongue so that I was forced to spit the beetle out, which was lost, as was the third one.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 43)  
D. Appleton & Company. New York, New York, USA. 1896

It seems therefore that a taste for collecting beetles is some indication of future success in life!

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 44)  
D. Appleton & Company. New York, New York, USA. 1896

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

...the Sacred beetle never chooses any shape but the sphere, though it necessitates such scrupulous accuracy; she acts as though she knew the laws of evaporation and geometry from beginning to end.

Translated by Alexander Teixeira de Mattos  
*The Sacred Beetle and Others*  
Chapter IV (pp. 67–68)  
Hodder and Stoughton. London, England. 1918

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

When asked by a group of theologians what one could conclude as to the nature of the Creator from a study of His creation, Haldane is said to have answered, “An inordinate fondness for beetles.”

In G. E. Hutchinson  
Homage to Santa Rosalia, or Why Are There So Many Kinds of Animals  
*American Naturalist*, Volume 93, 1959 (p. 146)

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

I am often spoken of as a Coleopterist – he said – but I have no right to so comprehensive a name. The genus *Scarabaeus* is what I have chiefly confined myself to, and ought to have studied exclusively. The beetles proper are quite enough for the labour of one man’s life. Call me a Scarabeeist if you will; if I can prove myself worthy of that name, my highest ambition will be more than satisfied.

*The Poet at the Breakfast Table*  
Chapter II (p. 48)  
J.M. Dent & Co. London, England. 1906

**Levi, Primo** 1919–87  
Italian writer and chemist

After the planet becomes theirs, many millions of years will have to pass before a beetle particularly loved by God, at the end of its calculations will find written on a sheet of paper in letters of fire that energy is equal to the mass multiplied by the square of the velocity of light. The new kings of the world will live tranquilly for a long time, confining themselves to devouring each other and being parasites among each other on a cottage industry scale.

*Other People’s Trades*  
Beetles  
Summit Books. New York, New York, USA. 1989



**Maeterlinck, Maurice** 1862–1949  
Belgian playwright and poet

Hardly has he [the Dung Beetle] begun, by dint of great efforts of his forehead and his bandy legs, to roll the toothsome sphere backwards, when an indelicate colleague, who has been awaiting the completion of the work, appears and hypocritically offers his services. The other well knows that, in this case, help and services, besides being quite unnecessary, will soon mean partition and dispossession; and he accepts the enforced collaboration without enthusiasm. But, so that their respective rights may be clearly marked, the lawful owner invariably retains his original place, that is to say, he pushes the ball with his forehead, whereas the compulsory guest pulls it towards him on the other side. And thus it jogs along between the two gossips, amid interminable vicissitudes, flurried falls, ludicrous tumbles, till it reaches the place chosen to receive the treasure and to become the banqueting-hall.

*Mountain Paths*

Chapter VIII (p. 84)

Methuen & Co. London, England. 1919

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The sense of death is most in apprehension;  
And the poor beetle that we tread upon,  
In corporal sufferance finds a pang as great  
As when a giant dies.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Measure for Measure*

Act III, Scene i, l. 78–81

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wordsworth, William** 1770–1850  
English poet

The beetle, panoplied in gems and gold  
A mailed angel on a battle day.

*The Complete Poetical Works of William Wordsworth*

Stanzas Written in My Pocket-Copy of Thomson's Castle of Indolence

Crowell. New York, New York, USA. 1888

## BUTTERFLY

**Ackerman, Diane** 1948–  
American writer

A hundred million monarchs migrate each year. Gliding, flapping, hitching rides on thermals like any hawk or eagle, they fly as far as four thousand miles and as high as two thousand feet, rivaling the great animal migrations of Africa, the flocking of birds across North America.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

The Winter Palace of Monarchs (p. 132)

Vintage Books. New York, New York, USA. 1997

**Bates, Henry Walter** 1825–92  
English naturalist and explorer

...the study of butterflies – creatures selected as the types of airiness and frivolity – instead of being despised, will some day be valued as one of the most important branches of biological science.

*The Naturalist on the River Amazons* (Volume 2)

Chapter V (p. 346)

John Murray. London, England. 1863

**Borland, Hal** 1900–78  
American writer

...the emergence of a chick from an egg, in itself a marvelous thing, is simplicity itself, for the chick is a miniature of the creature that laid the egg. Here we have a totally different event. A butterfly laid an egg. That egg hatched into a caterpillar with no hint of flight or winged beauty. That caterpillar retired into a cocoon or a chrysalis, and out of that house of change now comes a fragile-winged creature of the air, a living bit of sheer beauty and imagination.

*The Enduring Pattern*

Life – The Pygmy Hordes: Butterflies and Moths (p. 159)

Simon & Schuster. New York, New York, USA. 1959

**Brower, David** 1912–2000  
American environmentalist

“Butterfly is a stupid word,” the Spaniard said; “maripose is so much more beautiful.”

“I much prefer farfalla,” the Italian countered. The woman from Paris said, “papillon, of course.” The Japanese suggested, “I like the softness of chocho-san.” The German bristled and demanded, “What’s the matter with schmetterling?”

*For Earth's Sake: The Life and Times of David Brower*

Chapter I, Butterflies (p. 13)

Peregrine Smith Books, Salt Lake City, Utah, USA. 1990

**Dyson, Freeman J.** 1923–  
American physicist and educator

To me the most astounding fact in the universe, even more astounding than the flight of the Monarch butterfly, is the power of mind that drives my fingers as I write these words. Somehow, by natural processes still totally mysterious, a million butterfly brains working together in a human skull have the power to dream, to calculate, to see and to hear, to speak and to listen, to translate thoughts and feelings into marks on paper which other brains can interpret. Mind, through the long course of biological evolution, has established itself as a moving force in our little corner of the universe. Here on this small planet, mind has infiltrated matter and has taken control.

*Infinite in All Directions*

Part One, Chapter Six (p. 118)

HarperCollins Publishers, Inc. New York, New York, USA. 1988

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Repentance is the weight  
Of indigested meals eat yesterday.  
'Tis for large animals that gorge on prey,  
Not for a honey-sipping butterfly.

*Poems* (Volume 1)

Work

*The Spanish Gypsy*

Estas & Laurait. Boston, Massachusetts, USA. 1895

**Gay, John** 1685–1732  
English poet and dramatist

And what's a Butterfly? At best,  
He's but a caterpillar, drest...

*The Poetical Works of John Gay* (Volume 2)

Fable XXIV, Volume the First, The Butterfly and the Snail, l. 41–42

Lawrence & Bullen. London, England. 1893

**Goudge, Elizabeth** 1900–84  
English author of novels, short stories, and children's books

Butterflies...not quite birds, as they were not quite flow-  
ers, mysterious and fascinating as are all indeterminate  
creatures.

*The Child From The Sea*

Book II, Chapter One (p. 270)

Coward-McCann. New York, New York, USA. 1979

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Butterflies are not insects...they are self-propelled  
flowers.

*The Cat Who Walks Through Walls*

Book Three (p. 369)

The Berkley Publishing Group. New York, New York, USA. 1988

**Jaeger, Benedict** 1789–?  
Austrian born American entomologist

Many to whom the Book of Nature is a sealed book have  
been enticed, by the splendor of their [butterfly] color and  
their fairy-like motions, to hunt for them in meadows,  
fields, and woods, to place them as ornaments in rich  
frame-work upon the walls of their parlors, or to nour-  
ish and raise them with the greatest care in their rooms,  
that they may not lose a single hair of their magnificent,  
variegated dress.

*The Life of North American Insects*

Preface (p. xii)

Harper & Brothers Publishers. New York, New York, USA. 1859

**Kirby, William F.** 1759–1850  
English clergyman and entomologist

The butterfly, adorned with every beauty and every  
grace, borne by radiant wings through the fields of ether,  
and extracting nectar from every flower, gives us some

idea of the blessed inhabitants of happier worlds, of  
angels, and of the spirits of the just arrived at their state  
of perfection.

*An Introduction to Entomology; or, Elements of the Natural History of  
Insects*

Letter I (p. 6)

Longman, Green, Longman & Roberts. London, England. 1860

**Levi, Primo** 1919–87  
Italian writer and chemist

The butterfly's attractiveness derives not only from col-  
ors and symmetry: deeper motives contribute to it. We  
would not think them so beautiful if they did not fly, or if  
they flew straight and briskly like bees, or if they stung,  
or above all if they did not enact the perturbing mystery  
of metamorphosis: the latter assumes in our eyes the  
value of a badly decoded message, a symbol, a sign.

*Other People's Trades*

Butterflies

Summit Books. New York, New York, USA. 1989

**Shelley, Percy Bysshe** 1792–1822  
English poet

What hand would crush the silken-winged fly,  
The youngest of inconstant April's minions,  
Because it cannot climb the purest sky,  
Where the swan sings, amid the sun's dominions?  
Not thine.

*The Complete Poetical Works*

To Mary (On Her Objecting to the Following Poem, Upon the Score of  
its Containing No Human Interest)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Wilcox, Ella Wheeler** 1850–1919  
American poet and journalist

I happened one night in my travels  
To stray into Butterfly Vale,  
Where my wondering eyes beheld butterflies  
With wings that were wide as a sail  
They lived in such houses of grandeur,  
Their days were successions of joys  
And the very last fad these butterflies had  
Was making collections of boys.

*The Butterflies' Fad*

*The New York Times*, 16 June, 1895 (p. 27)

## CATERPILLAR

**Browning, Robert** 1812–89  
English poet

Born, bred, with just one instinct – that of growth:

*The Poetical Works of Robert Browning* (Volume 2)

The Red Cotton Nightcap Country (p. 422)

The Macmillan Co. New York, New York, USA. 1902

**Black, William** 1841–98  
Novelist

“Oh, Jim – a cockroach!” “Very well; it isn’t a kangaroo, is it?” said he, sulkily. “Besides, my revolver isn’t loaded.” “Such a beast! such a monster!”

“Why don’t you get into your hammock, then, instead of sitting there?”

“I’m going directly,” she said; for indeed her dread of these huge insects was such that they had had to rig up a hammock for her in her cabin.

*Yolande: A Novel*

Chapter XII (p. 115)

Harper & Brothers Publishers. New York, New York, USA. 1905

**Caudell, A. N.**

No biographical data available

Cockroaches thrive in British Columbia, as they do almost everywhere. The common species seems to be the German roach.... They are in everything, even the food. On this trip I had them served to me in three different styles, alive in strawberries, a la carte with fried fish, and baked in a biscuit

Notes on Some Orthoptera from British Columbia

*Entomological News and Proceedings of the Entomological Section of the Academy of Natural Sciences*, Volume XV, Number 2, February, 1904 (p. 63)

**Kay (Fictional character)**

I’ve just been down the gullet of an interstellar cockroach. That’s one of a hundred memories I don’t want.

*Men in Black*

Film (1997)

**Macleod, Norman** 1812–72

Scottish clergyman

...the name of cockroach is a double absurdity, as it is neither a cock nor a roach. The name, indeed, is a contraction of a Lingua-Franca word, which signifies light-shunner, and is therefore peculiarly appropriate to the darkness-loving cockroach.

*Good Words*

Only A Cockroach (p. 630)

Isbister & Co. London, England. 1879

**Walton, Izaak** 1593–1683

English writer

And, yet, I will exercise your promised patience by saying a little of the caterpillar, or the palmer-fly or worm; that by them you may guess what a work it were, in a discourse, but to run over those very many flies, worms, and little living creatures with which the sun and summer adorn and beautify the river-banks and meadows, both for the recreation and contemplation of us anglers; pleasures which, I think, I myself enjoy more than any other man that is not of my profession.

*The Complete Angler*

The Fourth Day (p. 92)

T.N. Foulis. London, England. 1913

## CHIGGER

**Hungerford, H. B.**

American entomologist

The thing called a chigger

Is really no bigger

Than the smaller end of a pin.

But the bump that it raises

Just itches like blazes

And that’s where the rub set in.

In Tyler A. Woolley

*Acarology: Mites and Human Welfare*

Chapter 4 (p. 41)

John Wiley & Sons, Inc. New York, New York, USA. 1988

## COCKROACH

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

She thinks that the cockroaches just need employment  
To prevent them from idle and wanton destruction.

So she’s formed from that lot of disorderly louts,

A troop of well-disciplined helpful boy scouts,

With a purpose in life and a good to do –

And she’s even created a Beetle Tattoo.

*The Collected Poems and Plays 1909–1950*

The Old Gumbie Cat (p. 151)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Janowitz, Tama** 1957–

American novelist

Long after the bomb falls and you and your good deeds  
are gone, cockroaches will still be here, prowling the  
street like armored cars.

*Slaves of New York*

Modern Saint #271 (pp. 2–3)

Simon & Schuster. New York, New York, USA. 1991

**Kidd, Sue Monk** 1948–

American writer

A roach is a creature no one can love, but you cannot kill  
it. It will go on and on and on. Just try to get rid of it.

*The Secret Life of Bees*

Chapter Nine (p. 175)

The Viking Press. New York, New York, USA. 2002

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

The cockroach and the birds were both here long before  
we were. Both could get along very well without us,

although it is perhaps significant that of the two the cockroach would miss us more.

*The Twelve Seasons*

November (pp. 118–119)

W. Sloane Associates. New York, New York, USA. 1949

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

one thing the human  
bean never seems to  
get into it is the  
fact that humans  
appear just as unnecessary to  
cockroaches as cockroaches  
do to humans

*the lives and time of archy & mehitabel*

peace – at a price (p. 195)

Doubleday Doran & Co. Garden City, New York, USA. 1934

a good many  
failures are happy because they don't realize it many a  
cockroach believes  
himself as beautiful  
as a butterfly

have a heart o have a heart and let them dream on

*the lives and times of archy & mehitabel*

archygrams (p. 259)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

## CRICKET

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

i can t see for the life of me what there is  
about crickets that makes people  
call them jolly they  
are the parrots of the insect race  
crying cheer up cheer up  
cheer up over and  
over again till you want to  
swat them

*the lives and time of archy & mehitabel*

the cheerful cricket (p. 139)

Doubleday Doran & Co. Garden City, New York, USA. 1934

**Riley, James Whitcomb** 1849–1916

American poet

But thou, O cricket, with thy roundelay,  
Shalt laugh them all to scorn! So wilt thou, pray  
Trill me thy glad song o'er and o'er again:  
In thy sweet prattle, since it sings the lone  
Heart home again.

*The Complete Works of James Whitcomb Riley* (Volume 3)

To the Cricket

P.F. Collier & Son, Company. New York, New York, USA. 1916

## DAMSEL FLY

**Barbault, Anna Laetitia** 1743–1825

English poet

Lo! the bright train their radiant wings unfold,  
With silver fring'd and freckl'd o'er with gold.  
On the gay bosom of some fragrant flower  
They idly fluttering live their little hour;  
Their life all pleasure, and their task all play,  
All spring their age, and sunshine all their day.

*Poems*

To Mrs. Priestley, with some Drawings of Birds and Insects (p. 46)

Printed for Joseph Johnson. London, England. 1773

**Moore, Thomas** 1779–1852

Irish poet

The beautiful blue-damsel flies  
That flutter'd round the jasmine stems,  
Like winged flowers or flying gems...

*The Poetical Works of Thomas Moore*

Paradise and the Pearl, l. 409–11

Lee & Shepard. Boston, Massachusetts, USA. 1873

## DEATH'S HEADED SPHINX

**Poe, Edgar Allan** 1809–49

American short story writer and poet

...let me read to you a schoolboy account of the genus *Sphinx*, of the family *Crepuscularia* of the order *Lepidoptera*, of the class of *Insecta* – or insects. The account runs thus:

'Four membranous wings covered with little colored scales of metallic appearance; mouth forming a rolled proboscis, produced by an elongation of the jaws, upon the sides of which are found the rudiments of mandibles and downy palpi; the inferior wings retained to the superior by a stiff hair; antennae in the form of an elongated club, prismatic; abdomen pointed, The Death's-headed Sphinx has occasioned much terror among the vulgar, at times, by the melancholy kind of cry which it utters, and the insignia of death which it wears upon its corslet.'

*The Works of Edgar Allan Poe* Volume 5

*The Sphinx* (pp. 31–32)

P.F. Colier & Sons. New York, New York, USA. 1914

## DRAGON FLY

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Clouds of insects danced and buzzed in the golden autumn light, and the air was full of the piping of the song-birds. Long, glinting dragonflies shot across the path, or hung tremulous with gauzy wings and gleaming bodies.

*The White Company*  
Chapter XI (p. 90)  
William Morrow & Company. New York, New York, USA. 1988

**Florian, Douglas** 1950–  
American writer and illustrator

I am the dragon,  
The demon of skies.  
Behold my bold  
Enormous eyes.  
I sweep  
I swoop  
I terrorize.  
For lunch I munch  
On flies and bees.  
Mosquitoes with  
My feet I seize.  
I am the dragon:  
Down on your knees!

*Insectlopedia: Poems and Paintings*  
The Dragonfly  
Harcourt Brace. San Diego, California, USA. 1998

**Jefferies, Richard** 1848–87  
English nature writer

On the wings of the dragon fly as he hovers an instant before he darts there is a prismatic gleam. These wing textures are even more delicate than the minute filaments on a swallow's quill, more delicate than the pollen of a flower.

The Pageant of Summer  
*Eclectic Magazine of Foreign Literature, Science, and Art*, Volume XXXVIII, Number 2, August, 1883 (p. 146)

## EARWIG

**Allen, Grant** 1848–99  
Canadian-born writer

Because he is small, he shall not be insulted with impunity. I see a helpless animal unduly exposed to vile detractions, and openly pursued with undeserved asperity. The sight arouses all the latent chivalry of my nature. I will gird on my sword to do battle for the right, and rush in, a scientific St. George, in defense of the innocent but persecuted earwig.

*Flashlights on Nature*  
Chapter VI (p. 122)  
Doubleday, Page & Co. New York, New York, USA. 1905

## FIREFLY

**Beebe, William** 1877–1962  
American ornithologist

A male firefly blazes his trail through the woods. At last he perceives a dim inconspicuous gleam, a mere spark,

but it is his LANDING BEACON and he levels off and steers straight for the wingless mate, who has laboriously climbed to the top of a fern and there hung out her signal...

*High Jungle*  
Chapter XXI (p. 335)  
Duell, Sloan & Pearce. New York, New York, USA. 1949

**Frost, Robert** 1874–1963  
American poet

Here come real stars to fill the upper skies,  
And here on earth come emulating flies,  
That though they never equal stars in size,  
(And they were never really stars at heart)  
Achieve at times a very star-like start.

*Complete Poems of Robert Frost*  
Fireflies in the Garden  
Henry Holt & Company. New York, New York, USA. 1949

**Melville, Herman** 1819–91  
American novelist

A French naturalist maintains, that the nocturnal radiance of the fire-fly is purposely intended as an attraction to the opposite sex; that the artful insect illuminates its body for a beacon to love. Thus: perched upon the edge of a leaf, and waiting the approach of her Leander, who comes buffeting with his wings the aroma of the flowers, some insect Hero may show a torch to her gossamer gallant.

*Mardi, and a Voyage Thither*  
Chapter XXXVIII (p. 109)  
The St. Botolph Society  
Boston, Massachusetts, USA. 1923

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The firefly's flame  
Is something for which science has no name.  
I can think of nothing eerier  
Than flying around with an unidentified  
red glow on a person's posterior.

*Verses from 1929 On*  
The Firefly  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

## FLEA

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

It iz impossible to do ennything well with a flea on you, except sware, and fleas aint afraid ov that; the only way iz tew quit bizzness ov aul kinds and hunt for the flea, and when you have found him, he ain't thare. Thiz iz one ov the flea mysterys, the fackulty they hav ov being entirely lost jist as soon as you hav found them.

*Josh Billings' Wit and Humor*  
The Flea (p. 112)  
George Routledge & Sons. London, England. 1874

**de Balzac, Honoré** 1799–1850  
French novelist

Therefore, before all things, it is necessary to verify three serious things – viz., if the flea be a male, if it be female, or if it be a virgin; supposing it to be a virgin, which is extremely rare, since these beasts have no morals, are all wild hussies, and yield to the first seducer who comes, you will seize her hinder feet, and drawing them under her little caparison you must bind them with one of her hairs, and carry it to the superior, who will decide upon its fate after having consulted the chapter.

Translated by Gustave Doré

*Droll Stories: Collected from the Abbeys of Touraine*

The Merry Tattle of the Nuns of Poissy (p. 265)

John Camden Hotten. London, England. 1934

**Orrington, Julian D.**

No biographical data available

To the zoologist, fleas present one of the most marvelous examples of perfect adaptation to a highly specialized environment anywhere to be found. To the physician he means the dreaded bubonic plague; to the historian, the awful pandemics of this black death that have shaped the destinies of millions of people. To the average person they are some sort of tiny creatures, details unknown, that infest beggars and domestic animals; to the farmer, a serious pest on his livestock; while to the dog they represent an ever-present torment, which no amount of clawing, biting, and rolling over The Flea – Mighty Morician

*The Nature Magazine*, Volume 39, Number 4, April, 1946 (p. 221)

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Nelson would have been afraid of ten thousand fleas, but a flea wouldn't be afraid of ten thousand Nelsons.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

More Maxims of Mark (p. 945)

The Library of America. New York, New York, USA. 1992

Consider the flea! Incomparably the bravest of all the creatures of God, if ignorance of fear were courage.

*Pudd'nhead Wilson*

Chapter XII (p. 115)

Harper & Brothers Publishers. New York, New York, USA. 1904

**Young, Roland** 1887–1953

English actor

And here's the happy bounding flea –  
You cannot tell the he from she.  
The sexes look alike you see;  
But she can tell, and so can he.

*Not for Children*

The Flea

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**FLY**

**Doane, R. W.**

No biographical data available

A few of them [flies] were nice things to have around, to make things seem homelike.... Those that were knocked into the coffee or the cream could be fished out; those that went into the soup or the hash were never missed.

*Insects and Disease*

Chapter V (p. 57)

Henry Holt & Company. New York, New York, USA. 1910

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

An actually existent fly is more important than a possibly existent angel.

In Moncure Daniel Conway

*Emerson at Home and Abroad*

Chapter XXIX (p. 285)

Trübner & Co

London, England. 1883

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

i scurry around

gutters and sewers

and garbage cans

*the lives and times of archy and mehitabel*

a spider and a fly (p. 40)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Nash, Ogden** 1902–71

American writer of humorous poetry

Aunt Betsy was fixing to change her will,

And would have left us out in the chill.

A *Glossina morsitans* bit Aunt Betsy

Tsk, tsk, tsetse.

*Verses from 1929 On*

Glossina Morsitans, or, the Tsetse

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Shapiro, Paul** 1913–2000

No biographical data available

O hideous little bat, the size of snot,

With polyhedral eye and shabby clothes,

To populate the stinking cat you walk

The promontory of the dead man's nose,

Climb with the fine leg of a Duncan-Phyfe

The smoking mountains of my food

And in a comic mood

In mid-air take to bed a wife.

*The Wild Card: Selected Poems, Early & Late*

The Fly

University of Illinois Press. Urbana, Illinois, USA. 1998



**Walton, Izaak** 1593–1683  
English writer

You are to know, that there are so many sorts of flies as there be of fruits: I will name you but some of them; as the dun-fly, the stone-fly, the red-fly, the moor-fly, the tawny-fly, the shell-fly, the cloudy or blackish-fly, the flag-fly, the vine-fly; there be of flies, caterpillars, and canker-flies, and bear-flies; and indeed too many either for me to name, or for you to remember. And their breeding is so various and wonderful, that I might easily amaze myself, and tire you in a relation of them.

*The Complete Angler*  
The Fourth Day (p. 92)  
T.N. Foulis. London, England. 1913

## GNAT

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

Where is it that she [Nature] has united so many senses as in the gnat? – not to speak of creatures that might be mentioned of still smaller size – Where, I say, has she found room to place in it the organs of sight? Where has she centred the sense of taste? Where has she inserted the power of smell? And where, too, has she implanted that sharp shrill voice of the creature, so utterly disproportioned to the smallness of its body? With what astonishing subtlety has she united the wings to the trunk, elongated the joints of the legs, framed that long, craving concavity for a belly, and then inflamed the animal with an insatiate thirst for blood, that of man more especially!

Translated by John Bostock and H.T. Riley  
*The Natural History of Pliny*  
Book XI (p. 2)  
George Bell & Sons. London, England. 1892

**Rudzewicz, Eugene**  
American educator and poet

Gnats are gnumerious  
But small.  
We hardly notice them  
At all.

In John Gardner  
*A Child's Bestiary*  
The Gnat  
Alfred A. Knopf. New York, New York, USA. 1977

## GRASSHOPPER

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

The Grasshopper tribe has its bursts of gladness; it has moreover the advantage of being able to express them with a sound, the simple satisfaction of the artist.

Translated by Alexander Teixeira de Mattos  
*The Life of the Grasshopper*  
Chapter XIII (p. 271)  
Dodd, Mead & Co. New York, New York, USA. 1920

**Lindsay, Vachel** 1879–1931  
American poet

The Grasshopper, the grasshopper,  
I will explain to you: He is the Brownies' racehorse,  
The fairies' Kangaroo.

*Collected Poems*  
The Grasshopper  
The Macmillan Company. New York, New York, USA. 1925

**Lovelace, Richard** 1618–58  
English cavalier and poet

O thou that swing'st upon the waving haire  
Of some well-filled Oaten Beard,  
Drunke ev'ry night with a Delicious teare,  
Dropt thee from Heav'n, where now th'art!  
The joys of Earth and Ayre are thine intire,  
That with thy feet and wings dost hop and flye;  
And when thy Poppy workes, thou dost retire  
To thy carv'd Acorn-bed to lye.

*The Poems of Richard Lovelace*  
Grasse-Hopper (p. 38)  
The Clarendon Press. Oxford, England. 1930

## HORNET

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

The hornet is an inflamibel bugger, sudden in hiz impresshuns and hasty in hiz conclusion, or end. Hiz natral disposishun iz a warm cross between red pepper in the pod and fusil oil, and hiz moral bias iz, "git out ov mi way."

*Josh Billings' Wit and Humor*  
The Hornet (p. 103)  
George Routledge & Sons. London, England. 1874

## KATYDID

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Thou are a female, Katydid!  
I know it by the trill  
That quivers through thy piercing notes  
So petulant and shrill.  
I think there is a knot of you  
Beneath the hollow tree,  
A knot of spinster Katydids –  
Do Katydids drink tea?

*The Complete Poetical Works of Oliver Wendell Holmes*  
To an Insect  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1899



**Riley, James Whitcomb** 1849–1916  
American poet

Sometimes I keep  
From going to sleep,  
To hear the katydids “cheep-cheep!”  
And think they say  
Their prayer that way;  
But katydids don’t have to pray!  
*The Complete Works of James Whitcomb Riley*  
Volume 8, The Katydid  
P.F. Collier & Son, Company. New York, New York, USA. 1916

## LADY BIRD

**Hurdis, James** 1763–1801  
British poet

SIR JOHN: What ye look at?  
CECILIA: A little animal, that round my glove,  
And up and down to ev’ry finger’s tip,  
Has travell’d merrily, and travels still,  
Tho’ it has wings to fly. What its name is  
With learned men I know not. Simple folks  
Call it the Lady-bird.  
*Sir Thomas More: A Tragedy*  
Act 1, Scene Sir Thomas More’s Garden (p. 19)  
Printed for J. Johnson. London, England. 1792

## LIGHTNING BUG

### Author undetermined

The lightning bug seems brilliant  
But he has not any mind  
For he stumbles through existence  
With his head light on behind.  
*Entomological News*, Volume 16, Number 3, 1905 (p. 88)

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

a lightning bug got  
in here the other night a  
regular hick from the real country he was  
awful proud of himself you  
city insects may think  
you are some punkins  
but I don t see any  
of you flashing in the dark  
like we do in  
the country  
*the lives and time of archy & mehitabel*  
the flattered lightning bug (p. 62)  
Doubleday Doran & Co. Garden City, New York, USA. 1934

## LOCUST

**Milton, John** 1608–74  
English poet

As when the potent Rod  
Of Amrams Son in Egypt’s evil day  
Wav’d round the Coast, up call’d a pitchy cloud  
Of Locusts, warping on the Eastern Wind,  
That ore the Realm of impious Pharaoh hung  
Like Night, and darkened all the Land of Nile  
*Paradise Lost*  
Book 1

## LOUSE

**Nicolle, Charles** 1866–1936  
French bacteriologist

Man carries on his skin a parasite, the louse. Civilization rids him of it. Should man regress, should he allow himself to resemble a primitive beast, the louse begins to multiply again and treats man as he deserves, as a brute beast.  
*Nobel Lectures, Physiology or Medicine 1922–1941*  
Investigations on Typhus  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

a louse i  
used to know  
told me that  
millionaires and  
bums tasted  
about alike  
to him.  
*the lives and times of archy and mehitabel*  
random thoughts by archie (p. 224)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

## MOSQUITO

**Allen, Grant** 1848–99  
Canadian-born writer

...that sultry horn is almost more annoying than the bite which it precedes. You lie coiled within your mosquito-curtains, wooing sweet sleep with appropriate reflections, when suddenly, by your ear, comes that still small voice, so vastly more pungent and more irritating than the voice of conscience. You light a candle, and proceed to hunt for the unwelcome intruder. As if by magic, as you strike your match, that mosquito disappears, and you look in vain through every fold and cranny of the thin

gauze curtains. At last you give it up, and lie down again, when straightway, “z-z-z-z,” the humming at your ear commences once more, and you begin the unequal contest all over again. It is a war of extermination on either side you thirst for her life, and she thirsts for your blood. No peace is possible till one or other combatant is finally satisfied.

*Flashlights on Nature*

Chapter X (p. 250)

Doubleday, Page & Co. New York, New York, USA. 1905

### Beaver, Wilfred

No biographical data available

Mosquitoes are like little children – the moment they stop making noises you know they’re getting into something.

*Quote, the Weekly Digest*, November 10, 1968 (p. 378)

### Billings, Josh (Henry Wheeler Shaw) 1818–85

American writer and humorist

The philosophers tell us that the muskeeters who can’t sing won’t bight; this information may be ov grate use to science, but aint worth mutch to a phellow in a hot nite whare muskeeters are plenty.

*Josh Billings’ Wit and Humor*

The Cursid Musketo (p. 101 )

George Routledge & Sons. London, England. 1874

In the dark, still nite, when everything iz az noizeless az a pair of empty slippers, to hear one at the further end ov the room slowly but surely working hiz way up to yu, singing that same hot old sissing tune ov theirs, and harkmg to feel the exackt spot on yure face whare they intend tew lokate, iz simply premeditated sorrow tew me; i had rather look forward to the time when an elephant waz going tew step onto me.

*Josh Billings’ Wit and Humor*

The Cursid Musketo (p. 102)

George Routledge & Sons. London, England. 1874

### Brues, Charles Thomas 1879–1955

American entomologist

No other insects can compete with the mosquitoes as persistent annoyers of man, and none, with the possible exception of the rat-flea, hold over him such power for evil.

*Insects and Human Welfare*

Chapter I (p. 5)

Harvard University Press. Cambridge, England. 1920

### Cuppy, Will 1884–1929

American humorist and critic

I am often asked why Mosquitoes hum loudest when close to one’s ear. I don’t know.

*How to Attract the Wombat*

The Mosquito (fn 2, p. 146)

Rinehart & Company, Inc. New York, New York, USA. 1949

### Pallister, William Hales 1877–1946

Canadian physician

The whole of Africa is our domain,  
Millions of men have fought us, few remain.  
We rule the lowlands of the entire earth,  
The fertile lands, of far the greatest worth;  
Our swarms produce their billions as we wish,  
The world belongs to us, and to the fish.

*Poems of Science*

De Ipsa Natura, Moss Beginnings, Misquitoes (p. 219)

Playford Press. New York, New York, USA. 1931

## MOTH

### Carlyle, Thomas 1795–1881

English historian and essayist

But see! a wandering Night-moth enters,  
Allured by taper gleaming bright.  
What passions in her small heart whirling,  
Hopes boundless, adoration, dread;  
At length her tiny pinions twirling,  
She darts, and – puff! – the moth is dead.  
In Rodger L. Tarr and Flemming McClelland (eds.)  
*The Collected Poems of Thomas and Jane Welsh Carlyle*  
Tragedy of the Night-Moth, Stanza 2, (p. 1)  
The Penkevill Publishing Company. Greenwood, Florida, USA. 1986

### Hooper, Judith

American biology writer

Some might say that butterflies are Lepidoptera that people like while moths are ones they don’t like...

*Of Moths and Men: The Untold Story of Science and the Peppered Moth*  
Chapter 1 (p. 3)

W.W. Norton & Company, Inc. New York, New York, USA. 2002

### Marquis, Don 1878–1937

American newspaperman, poet, and playwright

i was talking to a moth  
the other evening  
he was trying to break into  
an electric light bulb  
and fry himself on the wires

why do you fellows  
pull this stunt i ask him

fire is beautiful  
and we know that if we get too close it will kill us  
but what does that matter  
it is better to be happy  
for a moment  
and be burned up with beauty

than to live a long time  
and be bored all the while  
*the lives and time of archy & mehitabel*  
the lesson of the moth (p. 95)

Doubleday Doran & Co. Garden City, New York, USA. 1934

**Nabokov, Vladimir Vladimirovich** 1899–1977  
Russian-born American novelist

He told me about the odors of butterflies – musk and vanilla; about the voices of butterflies; about the piercing sound given out by the monstrous caterpillar of a Malayan hawkmoth, an improvement on the mouselike squeak of our Death's Head moth; about the small resonant tympanum of certain tiger moths; about the cunning butterfly in the Brazilian forest which imitates the whir of a local bird. He told me about the incredible artistic wit of mimetic disguise...

*Nabokov's Butterflies: Unpublished and Uncollected Writings The Gift* (p. 178)  
Bacon Press. Boston, Massachusetts, USA. 2000

**Sharp, David** 1840–1922  
English entomologist

The only definition that can be given of Heterocera is the practical one that all Lepidoptera that are not butterflies are Heterocera.

*Cambridge Natural History* (Volume 6)  
Chapter VI, Section II (p. 366)  
Macmillan & Company Ltd. London, England. 1901

**Wilson, Edward O.** 1929–  
American biologist and writer

The three-toed sloth feeds on leaves high in the canopy of the lowland forests through large portions of South and Central America. Within its fur live tiny moths, the species *Cryptoses choloepi*, found nowhere else on Earth. When a sloth descends to the forest to defecate (once a week), female moths leave the fur briefly to deposit their eggs on the fresh dung. The emerging caterpillars build nests of silk and start to feed. Three weeks later they complete their development by turning into adult moths, and then fly up into the canopy in search of sloths. By living directly on the bodies of the sloths, the adult *Cryptoses* assure their offspring first crack at the nutrient-rich excrement and a competitive advantage over the myriad of other coprophages.

*Biophilia*  
Bernhardsdorp (p. 9)  
Harvard University Press. Cambridge, Massachusetts. 1984

## PRAYING MANTIS

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

The Mantis is fierce as a tigress, cruel as an ogress.  
Translated by Alexander Teixeira de Mattos

*Fabre's Book of Insects*  
Chapter IV (p. 45)  
Dodd, Mead & Co. New York, New York, USA. 1945

**Florian, Douglas** 1950–  
American writer and illustrator

Upon a twig  
I sit and pray  
For something big  
To wend my may:  
A caterpillar,  
Moth,  
Or bee –  
I swallow them  
Religiously.  
*Insectlopedia: Poems and Paintings*  
The Praying Mantis  
Harcourt Brace. San Diego, California, USA. 1998

## TERMITE

**Capelo, Hermenegildo** 1841–1917  
Portuguese explorer

**Ivens, Roberto** 1850–98  
Portuguese explorer

The termites, ever hard at work, were reconstructing their habitations. Strange *Arachnidios*, such as the silk-weaving spider, *ma-vuvi* (*Nephita bragantina*) were swinging from spray to spray, fastening them together with their delicate yellow webs. The active and obscure *Xylophages* were mining to the very heart the knotted trunks of ancient trees.

*From Benguella to the Territory of Yucca* (Volume 2)  
Entomology (p. 30)  
Sampson Low, Marston, Searle, & Rivington.. London, England. 1882

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Some primal termite knocked on wood  
And tasted it, and found it good,  
And that is why your Cousin May  
Fell through the parlor floor today.

*Verses from 1929 On*  
The Termite  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Thomas, Lewis** 1913–93  
American physician and biologist

When you consider the size of an individual termite, photographed standing alongside his nest, he ranks with the New Yorker and shows a better sense of organization than a resident of Los Angeles.

*The Lives of a Cell: Notes of a Biology Watcher*  
Living Language (p. 133)  
The Viking Press. New York, New York, USA. 1974

## WALKING STICK

**Florian, Douglas** 1950–  
American writer and illustrator

The walkingstick is thin, not thick,  
And has a disappearing trick:

By looking like a twig or stalk,  
It lives another day to walk.

*Insectlopedia: Poems and Paintings*

The Walkingstick

Harcourt Brace. San Diego, California, USA. 1998

## WASP

**Field, Eugene** 1850–95

American poet and journalist

See the wasp. He has pretty yellow stripes around his  
body, and a darning needle in his tail. If you will pat the  
wasp upon the tail we will give you a nice picture book.

*The Complete Tribune Primer* (p. 47)

The Mutual Book Company. Boston, Massachusetts, USA. 1901

**Gay, John** 1685–1732

English poet and dramatist

Of all the plagues that heav'n hath sent,  
A wasp is most impertinent!

*The Poetical Works of John Gay* (Volume 2)

Fable VIII, Volume the First, The Lady and the Wasp, l. 29–30

Lawrence & Bullen. London, England. 1893

**Jefferies, Richard** 1848–87

English nature writer

Fanning so swiftly, the wasp's wings are but just visible  
as he passes; did he pause, the light would be apparent  
through their texture.

The Pageant of Summer

*Eclectic Magazine of Foreign Literature, Science, and Art*, Volume

XXXVIII, Number 2, August, 1883 (p. 146)

**Sexton, Anne** 1928–74

American poet and writer

A red-hot needle  
hangs out of him, he steers by it  
as if it were a rudder, he  
would get in the house any way he could  
and then he would bounce from window  
to ceiling, buzzing and looking for you.

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Wasp

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Topsell, Edward** 1572–1625?

English divine and writer

If you will have the endowments of his minde described,  
he is a political and flocking or regal creature, subject to  
Monarchy, laborious, a lover of his young, and a lover of  
his neighbor, of a very quarrelsome disposition, and very  
prone to cholera.

*The History of Four-Footed Beasts and Serpents*

The Theater of Insects

Chapter I (p. 921)

G. Sawbridge. London, England. 1658

## WEEVIL

**Florian, Douglas** 1950–

American writer and illustrator

We are weevils.

We are evil.

We've aggrieved

Since time Primeval.

*Insectlopedia: Poems and Paintings*

The Weevils

Harcourt Brace. San Diego, California, USA. 1998

## ANIMAL: MAMMAL

**Jefferson, Thomas** 1743–1826

3rd president of the USA

The term *Mammal* has no exact equivalent in the true  
vernacular of any modern language, the word itself, like  
its equivalents, the French *Mammifere* and the German  
*Saugetheir*, being entirely artificial.

*A History of Land Mammals in the Western Hemisphere*

Chapter I (p. 1)

The Macmillan Co. New York, New York, USA. 1913

## AARD-VARK

### Author undetermined

...it's aardvark, but it pays well.

In John S. Crosbie

*Crosbie's Dictionary of Puns* (p. 5)

**Sanderson, Ivan T.** 1911–73

Scottish naturalist and writer

[The aard-vark] stands quite alone in the mammalian tree  
of life, like a single green leaf caught adventitiously in a  
spider's web.

*Living Mammals of the World*

The Aard-Vark (p. 220)

Hanover House. Garden City, New York, USA. nd

## ANTELOPE

**Arnold, Sir Edwin** 1832–1904

English poet and journalist

Antelopes, pied and spotted; antelopes

Like great white bulls and cows; black antelopes

Horned as with spears; and one, purple with cream

Having striped shanks, dropped flanks, and ass's tail

And four soft horns.

*The Voyage of Ithobal*

The Third Day

John Murray. London, England. 1901

**APE**

**Broca, Paul** 1824–80  
French surgeon and anthropologist

I would rather be a transformed ape than a degenerate son of Adam.

In Carl Sagan

*Broca's Brain: Reflections on the Romance of Science*  
Part I, Chapter 1 (p. 6)  
Random House, Inc. New York, New York, USA. 1979

**Collins, Mortimer** 1827–76  
English Writer and Novelist

There was an ape in the days that were earlier;  
Centuries passed, and his hair became curlier;  
Centuries more gave a thumb to his wrist –  
Then he was MAN – and a Positivist.

In Tom Taylor (ed.)

*Pen Sketches by a Vanished Hand* (Volume I)  
Memoir (p. xv)  
Richard Bentley & Son. London, England. 1879

**Ennius, Quintus** c 239 BC–c 169 BC  
Father of Roman Poetry

*Simia, quam similis, turpissima bestia, nobis!*

[The ape, vilest of beast, how like us!]

In Cicero

*De Natura Deorum*  
Book I, 35

**Huxley, Thomas Henry** 1825–95  
English biologist

If you tell me that an Ape differs from a Man because the latter has a soul and the ape has not, I can only say it may be so; but I should uncommonly like to know how [you know] either that the ape has not one or that the man

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley*  
Chapter XVII (p. 262)  
D. Appleton & Co. New York, New York, USA. 1916

**Young, Roland** 1887–1953  
English actor

The sacred ape, now, children, see.  
He's searching for the modest flea.  
If he should turn around we'd find  
He has no hair on his behind.

*Not for Children*

The Ape

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**ARMADILLO**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The armadillo lives inside  
A corrugated plated hide.

Below the border this useful creature  
Of tidy kitchens use a feature,  
For housewives use an armadillo  
To scour their pots, instead of Brillo.

*Everyone but Thee and Me*

The Armadillo

Little, Brown & Company. Boston, Massachusetts, USA. 1962

**ASS**

**de Cervantes, Miguel** 1547–1616  
Spanish novelist, playwright, and poet

... the ass ... will carry the load, but not a double load.

Translated by John Ormsby

*Great Books of the Western World* (Volume 29)

*Don Quixote*

Part II, Chapter 71 (p. 421)

Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

**BABOON**

**Congreve, William** 1670–1729  
English playwright and poet

Baboons and apes ridiculous we find;  
For what? For ill resembling Human-kind.

*The Works of Mr. Congreve in Two Volumes*

Baboons (p. 248)

Printed for W. Lowndes. London, England. 1787

**BAT**

**Ackerman, Diane** 1948–  
American writer

Bats eat so much food each evening that they have weighed in at as much as 50 percent heavier after one night's dining.

*The Moon by Whale Light, and Other Adventures Among Bats and*

*Crocodylians, Penguins and Whales*

Chapter 1 (p. 14)

Random House, Inc. New York, New York, USA. 1991

Suddenly, smoke billowed from underneath the bridge.  
No, not smoke but a column of bats.

*The Moon by Whale Light, and Other Adventures Among Bats and*

*Crocodylians, Penguins and Whales*

Chapter 1 (p. 59)

Random House, Inc. New York, New York, USA. 1991

Bats kept surging out, and soon four columns stretched miles across the sky. A few strays looped and fed near us, passing like shuttles through the weave of the trees. The night was noticeably free of insects, but that was no surprise. These bats would eat five thousand pounds of insects that one night alone.

*The Moon by Whale Light, and Other Adventures Among Bats and*

*Crocodylians, Penguins and Whales*

Chapter 1 (p. 59)

Random House, Inc. New York, New York, USA. 1991

**Author undetermined**

The baby bat Screamed out in fright, "Turn on the dark  
I'm afraid of the light!"

Source undetermined

**Berryman, John** 1914–72

American poet and critic

Bats have no bankers and they do not drink and cannot  
be arrested and pay no tax and, in general, bats have it  
made.

*77 Dream Songs*

No. 63 (p. 70)

Farrar, Straus & Giroux. New York, New York, USA. 1964

**Collins, William** 1721–1759

English poet

Now air is hush'd, save where the weak-eyed bat  
With short shrill shriek flits by on leathern wing.

*Thy Poetical Works of William Collins*

Ode to Evening

William Pickering. London, England. 1827

**Dawkins, Richard** 1941–

English biologist

A bat is a machine, whose internal electronics are so  
wired up that its wing muscles cause it to home in on  
insects, as an unconscious guided missile homes in on  
an aeroplane.

*The Blind Watchmaker*

Chapter 2 (p. 37)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Montgomery, James** 1771–1854

Scottish poet and journalist

What shall I call thee – bird, or beast, or neither?  
– Just what you will; I'm rather both than neither;  
Much like the season when I whirl my flight,  
The dusk of evening – neither day nor night.

*Poetical Works of James Montgomery* (Volume 2)

The Bat

Printed for Longman, Rees, Orme, Brown, Green & Longman. London,  
England. 1836

**Nash, Ogden** 1902–71

American writer of humorous poetry

Myself, I rather like the bat,  
It's not a mouse, it's not a rat.  
It has no feathers, yet has wings,  
It's quite inaudible when it sings.  
It zigzags through the evening air  
And never lands on ladies' hair,  
A fact of which men spend their lives  
Attempting to convince their wives.

*Verses from 1929 On*

The Bat

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Sexton, Anne** 1928–74

American poet and writer

His awful skin  
Stretched out by some tradesman  
is like my skin, here between my fingers,  
a kind of webbing, a kind of frog.

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Bat

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Tabb, John Banister** 1845–1909

American poet

To his cousin the Bat  
Squeaked the envious Rat,  
"How fine to be able to fly!"  
Tittered she, "Leather wings  
Are convenient things;  
But nothing to sit on have I."

*The Poetry of Father Tabb*

Humorous Verse, An Inconvenience

Dodd, Mead & Company. New York, New York, USA. 1928

**Tennyson, Alfred (Lord)** 1809–92

English poet

And bats went round in fragrant skies,  
And wheel'd or lit the filmy shapes  
That haunt the dusk, with ermine capes  
And woolly breasts and beaded eyes...

*Alfred Tennyson's Poetical Works*

In Memoriam, Verse XCIII

Oxford University Press, Inc. London, England. 1953

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

A bat is beautifully soft and silky; I do not know any  
creature that is pleasanter to the touch or is more grateful  
for caressings, if offered in the right spirit.

*Mark Twain's Autobiography* (Volume 1)

Chapters Begun in Vienna (p. 104)

Harper & Brothers Publishers. New York, New York, USA. 1924

**BEAR****Abbey, Edward** 1927–89

American environmentalist and nature writer

If people persist in trespassing upon the grizzlies' terri-  
tory, we must accept the fact that the grizzlies, from time  
to time, will harvest a few trespassers.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 86)

St. Martin's Press. New York, New York, USA. 1989

**du Bartas, Guillaume de Salluste** 1544–90

French poet

Like to the bear which bringeth forth  
In the end of thirty days a shapeless birth;



But after licking, it in shape she draws,  
And by degrees she fashions out the paws,  
The head, and neck, and finally doth bring  
To a perfect beast that first deformed thing.

*Devine Weeks and Works*

**Kipling, Rudyard** 1865–1936

British writer and poet

When the Himalayan peasant meets the he-bear in his  
pride,  
He shouts to scare the monster, who will often turn aside.  
But the she-bear thus accosted rends the peasant tooth  
and nail.

For the female of the species is more deadly than the  
male.

*The Years Between*

The Female of the Species

Doubleday, Page & Co. Garden City, New York, USA. 1919

**Lear, Edward** 1812–88

English humorist and artist

There was an old person of Ware,  
Who rode on the back of a bear;  
When they ask'd, "Does it trot?" he said, "Certainly not!  
He's a Moppsikon Floppsikon bear!"

*Of Pelicans and Pussycats*

Dial Books for Young Readers. New York, New York, USA. 1990

**Muir, John** 1838–1914

American naturalist

Bears are peaceable people and mind their own business,  
instead of going about like the devil seeking whom they  
may devour.

*Our National Parks*

Chapter I (p. 28)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

In my first interview with a Sierra bear we were fright-  
ened and embarrassed, both of us, but the bear's behavior  
was better than mine. After studying his appearance as he  
stood at rest, I rushed toward him to frighten him, that I  
might study his gait in running. But, contrary to all I had  
heard about the shyness of bears, he did not run at all;  
and when I stopped short within a few steps of him, as  
he held his ground in a fighting attitude, my mistake was  
monstrously plain. I was then put on my good behavior,  
and never afterward forgot the right manners of the wil-  
derness.

*Our National Parks*

Chapter VI (p. 174)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1901

**Pope, Alexander** 1688–1744

English poet

The fur that warms a monarch, warm'd a bear.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle III, l. 44

Houghton Mifflin Company. New York, New York, USA. 1903

**Robinson, Phil** 1847–1902

English journalist and writer on natural history

Bears are of three kinds – as every child knows. There is  
the Great Big Bear, the Middle-sized Bear, and the Little  
Wee Bear.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter VIII (p. 228)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

...unless provoked to attack you, these creatures [bears]  
will not do so – so naturalists assure us. A bear's notions  
of provocation, however, are so peculiar that perhaps the  
safest rule for strangers to observe is not to let the animal  
see you. The bear never attacks any person whom it can-  
not see. This is a golden rule for persons who are in the  
habit of meeting bears to observe.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter VIII (p. 229)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

## BEAVER

**Outwater, Alice**

American environmental engineer and writer

The beaver is utterly familiar. Forty inches long and over  
a foot upright, a beaver seems like a little person with a  
fondness for engineering.

*Water: A Natural History*

Chapter Two (p. 19)

Basic Books, Inc. New York, New York, USA. 1996

**St. John de Crevecoeur, Hector**

No biographical data available

The beavers are the philosophers of the animals; the gen-  
tlest, the most humble, the most harmless. Yet brutal Man  
kills them. I was once a witness to the destructin of one of  
their associated confederancies. I saw many of them shed  
tears, and I wept also; nor am I ashamed to confess.

*Letters from an American Farmer*

Thoughts of an American Farmer on Various Rural Subjects, III (p. 301)

Thomas Davies. London, England. 1963

## BIGHORN SHEEP

**Muir, John** 1838–1914

American naturalist

The largest of the canon animals one is likely to see  
is the wild sheep, or Rocky Mountain bighorn, a most  
admirable beast, with limbs that never fail, at home on  
the most nerve-trying precipices, acquainted with all the  
springs and passes and broken-down jumpable places  
in the sheer ribbon cliffs, bounding from crag to crag in



easy grace and confidence of strength, his great horns held high above his shoulders, wild red blood beating and hissing through every fiber of him like the wind through a quivering mountain pine.

*Steep Trails*

Chapter XXIV (p. 375)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## BUFFALO

### Author undetermined

The buffalo is the death  
that makes a child climb a thorn tree....  
He is the butterfly of the savannah:  
He flies along without touching the grass.  
When you hear thunder without rain –  
it is the buffalo approaching.

In Ulli Beier

*Yoruba Poetry*

Buffalo

General Publications Section, Ministry of Education. Ibadan, Nigeria. 1959

### Muir, John 1838–1914

American naturalist

I suppose we need not go mourning the buffaloes. In the nature of things they had to give place to better cattle, though the change might have been made without barbarous wickedness.

*Our National Parks*

Chapter X (p. 335)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## CAMEL

### Carryl, Charles Edward 1842–1920

American children's literature author

There's never a question about my digestion,

Anything does for me!

In Burton Egbert Stevenson (ed.)

*The Home Book of Verse for Young Folks*

The Plaint of the Camel

Henry Holt & Co. New York, New York, USA. 1915

## CAT

### Billings, Josh (Henry Wheeler Shaw) 1818–85

American writer and humorist

The cat, is called a domestik animile – but i never hav bin able tew tell wharefore. You kant trust one, enney more than yu kan a case ov the gout. There iz only one mortal thing, that yu kan trust a cat with, and cum out even, and that iz, a bar ov hard sope.

*Josh Billings' Wit and Humor*

The Cat, and the Kangaroo (p. 86)

George Routledge & Sons. London, England. 1874

They [cats] are as meak as Mosiss, but az full ov develtry as Judus Iskaratt.

*Josh Billings' Wit and Humor*

The Cat, and the Kangaroo (p. 86)

George Routledge & Sons. London, England. 1874

You kant looze a cat – they are az hard to loozs, as a bad reputashun iz.

*Josh Billings' Wit and Humor*

The Cat, and the Kangaroo (p. 86)

George Routledge & Sons. London, England. 1874

### Krutch, Joseph Wood 1893–1970

American naturalist, conservationist, and writer

...cats seem to go on the principle that it never does any harm to ask for what you want.

*The Twelve Seasons*

February (p. 160)

W. Sloane Associates. New York, New York, USA. 1949

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Of all God's creatures there is only one that cannot be made the slave of the lash. That one is the cat. If man could be crossed with the cat it would improve man, but it would deteriorate the cat.

*Mark Twain's Notebook* (p. 237)

Harper & Brothers Publishers. New York, New York, USA. 1935

### Whitehead, Alfred North 1861–1947

English mathematician and philosopher

If a dog jumps in your lap, it is because he is fond of you; but if a cat does the same thing, it is because your lap is warmer.

In Lucien Price

*Dialogues of Alfred North Whitehead*

Chapter XXV, December 10, 1941 (p. 187)

Little Brown. Boston, Massachusetts, USA. 1954

## COW

### Beecher, Henry Ward 1813–87

American Congregational preacher and orator

A cow is the saint of the barn-yard. She could be fat if she would only be selfish. But she economizes beauty that she may be profuse in milk.

In William Drysdale (ed.)

*Proverbs from Plymouth Pulpit*

Nature (p. 9)

D. Appleton & Co. New York, New York, USA. 1887

### Bryson, Bill 1951–

American author

To my mind, the only possible pet is a cow. Cows love you...They will listen to your problems and never ask a thing in return. They will be your friends forever.

And when you get tired of them, you can kill and eat them.

*Neither Here Nor There: Travels in Europe*

Chapter 5 (p. 56)

Harper Perennial. New York, New York, USA. 1993

**Young, Roland** 1887–1953

English poet and actor

The cow's a gentle, patient soul,  
With milk she fills the flowing bowl.  
She's kind to babies, mean to flies,  
She has the most coquettish eyes.

*Not for Children*

The Cow

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## COYOTE

**Austin, Mary Hunter** 1868–1934

American novelist and essayist

When the five coyotes that range the Tejon from Pasteria to Tunawai planned a relay race to bring down an antelope strayed from the band, beside myself to watch, an eagle swung down from Mt. Pinos, buzzards materialized out of invisible ether, and hawks came trooping like small boys to a street fight.

*The Land of Little Rain*

The Scavengers (p. 55)

Houghton Mifflin & Company. Boston, Massachusetts, USA. 1903

**Crabtree, Bob**

No biographical data available

Coyotes are the ultimate icon of success and defiance of humans who think they can control nature.

Quoted in Mike Finkel

The Ultimate Survivor

*Audubon*, Volume 1, Number 3, May-June

**James, William** 1842–1910

American philosopher and psychologist

I saw a moving sight the other morning before breakfast... The young man of the house had shot a little wolf called a coyote in the early morning. The heroic little animal lay on the ground, with his big furry ears, and his clean white teeth, and his jolly cheerful little body, but his brave little life was gone. It made me think how brave all these living things are. Here little coyote was, without any clothes or house or books or anything, with nothing but his own naked self to pay his way with, and risking his life so cheerfully – and losing it – just to see if he could pick up a meal near the hotel. He was doing his coyote-business like a hero...

In Henry James (ed.)

*The Letters of William James* (Volume 2)

Letter to his Son Alexander, August 28, 1898 (pp. 81–82)

The Atlantic Monthly Press. Boston, Massachusetts, USA. 1920

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

The coyote is a living, breathing allegory of Want. He is always hungry. He is always poor, out of luck and friendless. The meanest creatures despise him and even the flea would desert him for a velocipede.

*Roughing It* (Volume 1)

Chapter V (p. 48)

Harper & Brothers Publishers. New York, New York, USA. 1899

**van Dyke, John Charles** 1856–1932

American art historian and critic

When he [the coyote] starts to move, it is with some deliberation. He prefers a dog-trot and often several shots from your rifle will not stir him into a run. He slips along easily and gracefully – a lean, hungry-looking wretch with all the insolence of a hoodlum and all the shrewdness of a thief.

*The Desert*

Chapter IX (p. 159)

Charles Scribner's Sons. New York, New York, USA. 1930

## DEER

**Blake, William** 1757–1827

English poet, painter, and engraver

The wild deer, wand'ring here and there,  
Keeps the Human Soul from Care.

*The Poems of William Blake*

Auguries of Innocence

Basil Montagu Pickering. London, England. 1874

**Muir, John** 1838–1914

American naturalist

Deer give beautiful animation to the forests, harmonizing finely in their color and movements with the gray and brown shafts of the trees as they stand in groups at rest...

*Steep Trails*

Chapter XXII (p. 320)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Scott, Sir Walter** 1771–1832

Scottish historical novelist and poet

The deep recess of the wildwood glen,  
Where roe and red-deer find sheltering den,  
When the sun is in his power.

*The Poetical Works of Sir Walter Scott*

Harold the Dauntless

Phillips, Sampson & Co. Boston, Massachusetts, USA. 1854

## DOG

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

The dog was created specially for children. He is a god of frolic.

In William Drysdale (ed.)  
*Proverbs from Plymouth Pulpit*  
 Nature (p. 8)  
 D. Appleton & Co. New York, New York, USA. 1887

**Butler, Samuel** 1612–80  
 English novelist, essayist, and critic

The greatest pleasure of a dog is that you may make a fool of yourself with him and not only will he not scold you, but he will make a fool of himself.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
 Dog (p. 314)  
 Jonathan Cape. London, England. 1951

**Doyle, Sir Arthur Conan** 1859–1930  
 Scottish writer

A hound it was, an enormous coal-black hound, but not such a hound as mortal eyes have ever seen. Fire burst from its open mouth, its eyes glowed with a smoldering glare, its muzzle and hackles and dewlap were outlined in flickering flame. Never in the delirious dream of a disordered brain could anything more savage, more appalling, more hellish be conceived than that dark form and savage face which broke upon us out of the wall of fog.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Hound of the Baskervilles*, Chapter 14 (p. 100)  
 Wings Books. New York, New York, USA. 1967

**Jerome, Jerome K.** 1859–1927  
 English author

Fox terriers are born with about four times as much original sin in them as other dogs are ...

*Three Men in a Boat, to Say Nothing of the Dog!*  
 Chapter 13 (pp. 151–152)  
 Collins. London, England. 1957

**Nash, Ogden** 1902–71  
 American writer of humorous poetry

The truth I do not stretch or shove  
 When I state the dog is full of love.  
 I've also proved by actual test,  
 A wet dog is the lovingest.

*Everyone but Thee and Me*  
 The Dog (p. 71)  
 Little, Brown & Company. Boston, Massachusetts, USA. 1962

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
 American author and humorist

Heaven goes by favor. If it went by merit, you would stay out and your dog would go in.

In Albert Bigelow Paine  
*Mark Twain: A Biography* (Volume 4)  
 Chapter CCXCII (p. 1567)  
 Harper & Brothers Publishers. New York, New York, USA. 1912

If you pick up a starving dog and make him prosperous, he will not bite you. This is the principal difference between a dog and a man.

*Pudd'nhead Wilson's Calendar*  
 Chapter XVI (p. 158)  
 Harper & Brothers Publishers. New York, New York, USA. 1904

A composite dog is a dog that's made up of all the valuable qualities that's in the dog breed – kind of a syndicate; and a mongrel is made up of the riffraff that's left over.

*Mark Twain in Eruption: Hitherto Unpublished Pages About Men and Events*

In a Writer's Workshop  
 Platform Readings (p. 222)  
 Harper & Brothers Publishers. New York, New York, USA. 1922

## DONKEY

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
 English author

When fishes flew and forests walked  
 And figs grew upon thorn,  
 Some moment when the moon was blood  
 Then surely I was born;

With monstrous head and sickening cry  
 And ears like errant wings,  
 The devil's walking parody  
 On all four-footed things.

*The Wild Knight* (4th edition)  
 The Donkey  
 J.M. Dent & Co. London, England. 1914

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
 American author and humorist

I believe I would rather ride a donkey than any beast in the world. He goes briskly, he puts on no airs, he is docile, though opinionated. Satan himself could not scare him, and he is convenient – very convenient. When you are tired riding you can rest your feet on the ground and let him gallop from under you.

*The Innocents Abroad* (Volume 2)  
 Chapter XXX (pp. 396–397)  
 Harper & Brothers Publishers. New York, New York, USA. 1904

## DUCK-BILLED PLATYPUS

**Flanders, Michael** 1922–75  
 English actor and singer

We call him “Duck-billed Platypus”  
 And mock him for his name:  
 He does not seem to mind it.  
 He feels no sense of shame  
 Because he does not know himself  
 By such a title,

He's a "Golden, Shining Love-Bird"

In Duck-billed Platypese.

*Creatures Great and Small*

The Duck-Billed Platypus

Holt, Rinehart & Winston. New York, New York, USA. 1965

## ELEPHANT

**Atkins, Peter William** 1940–

English theoretical chemist

A great deal of the universe does not need any explanation. Elephants, for instance. Once molecules have learnt to compete and to create other molecules in their own image, elephants, and things resembling elephants, will in due course be found roaming the country side.... Some of the things resembling elephants will be men.

*The Creation*

Chapter 1 (p. 3)

W.H. Freeman & Co. Oxford, England. 1981

**Cuppy, Will** 1884–1929

American humorist and critic

In the Pleistocene Era, there were more than twenty kinds of elephants. Now there are only two. That's plenty.

*How to Get from January to December*

April 24 (p. 85)

Henry Holt & Company. New York, New York, USA. 1951

**Donne, John** 1572–1631

English poet and divine

Nature's great masterpiece, an Elephant.

The only harmless great thing; the giant of beasts.

In A.J. Smith (ed.)

*The Complete English Poems*

The Progress of the Soul, Stanza 39

St. Martin's Press. New York, New York, USA. 1971

**Heinlein, Robert A.** 1907–88

American science fiction writer

An elephant: A mouse built to government specifications.

*The Notebooks of Lazarus Long* (p. 9)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Kipling, Rudyard** 1865–1936

British writer and poet

In the High and Far-Off Times the Elephant, O Best Beloved, had no trunk. He had only a blackish, bulgy nose, as big as a boot, that he could wiggle about from side to side; but he couldn't pick up things with it.

*The Elephant's Child* (p. 1)

A.P. Watt. London, England. 1900

**Lydekker, Richard** 1849–1915

English naturalist and geologist

if elephants were only known to us by their skeletons it would be more than doubtful if we should ever have

attained a correct idea of their true form; since although the conformation of their jaws and teeth would clearly indicate that they must have had some very peculiar method of feeding, yet it would have required a very bold, not to say a very imaginative man to have conceived the idea that these creatures were furnished with that unique organ which we term the trunk or proboscis.

*Life and Rock: a Collection of Zoological and Geological Essays*

Chapter I (p. 1)

The Universal Press. London, England. 1894

**Robinson, Phil** 1847–1902

English journalist and writer on natural history

Elephants are square animals with a leg at each corner – and a tail at both ends.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter V (p. 110)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The elephant hath joints, but none for courtesy. His legs are legs for necessity, not for flexure.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act II, Scene iii, l. 113–115

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Swift, Jonathan** 1667–1745

Irish-born English writer

So Geographers in Afric-Maps

With Savage Pictures fill their gaps;

And o'er unhabitable Downs

Place Elephants for want of Towns.

*The Poetical Works of Jonathan Swift* (Volume 2)

On Poetry

A Rhapsody, l. 177–180

William Pickering. London, England. 1833

Elephants are always drawn smaller than life, but a flea larger.

*The Tale of a Tub and Other Works*

Thoughts on Various Subjects (p. 409)

George Routledge & Sons. London, England. 1889

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

I could easily learn to prefer an elephant to any other vehicle, partly because of that immunity from collisions, and partly because of the fine view one has from up there, and partly because of the dignity one feels in that high place, and partly because one can look in at the windows and see what is going on privately among the family. The Lahore horses were used to elephants, but they were rapturously afraid of them just the same. It seemed curious.

Perhaps the better they know the elephant the more they respect him in that peculiar way. In our own case we are not afraid of dynamite till we get acquainted with it.

*Following the Equator* (Volume 2)

Chapter XXIV (p. 282)

Harper & Brothers Publishers. New York, New York, USA. 1899

## FOX

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

Of all the beasts who roam the hill tops, or clime the plains, there is none who makes so few blunders, and so many good hits as the fox.

*Josh Billings' Wit and Humor*

The Fox (p. 72)

George Routledge & Sons. London, England. 1874

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Plainly the fox belongs to a different order of things from that which reigns in the village. Our courts, though they offer a bounty for his hide, and our pulpits, though they draw many a moral from his cunning, are in few senses contemporary with his free forest life.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2)

(p. 89)

Princeton University Press. Princeton, New Jersey, USA. 1984

## GAZELLE

**Heine, Heinrich** 1797–1856

German journalist, essayist

The gazelles so gentle and clever, Skip lightly in frolicsome mood.

*Book of Songs, Lyrical*

Interlude Number 9

## GIRAFFE

**Young, Roland** 1887–1953

English actor

Now, children, you must never laugh

At the stately tall giraffe.

She's sensitive, as you can tell;

But, my dears, she kicks like hell!

*Not for Children*

The Giraffe

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## GNU

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

GNU, n. An animal of South Africa, which in its domesticated state resembles a horse, a buffalo, and a stag. In its wild condition it is something like a thunderbolt, an earthquake, and a cyclone.

*The Cynic's Word Book*

Gnu (p. 137)

Doubleday, Page & Co. New York, New York, USA. 1906

## GOAT

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

A phatt gote would be a literary curiosity.

*Josh Billings' Wit and Humor*

The Gote (p. 80)

George Routledge & Sons. London, England. 1874

## GORILLA

**Bradley, Mary Hastings**

Geographer, traveler, and writer

The gorilla is a strict vegetarian like the elephant and buffalo – three of the four most dangerous animals in Africa.

It behooves one to walk softly with vegetarians.

*On the Gorilla Trail*

Chapter IX (p. 131)

D. Appleton & Company. London, England. 1922

**Fossey, Dian** 1932–85

American zoologist

The more you learn about the dignity of the gorilla, the more you want to avoid people.

In W.E. Smith

The Case of the Gorilla Lady Murder

*Time*, September 1, 1986 (p. 18)

## GUANACO

**Simpson, George Gaylord** 1902–84

American paleontologist

The guanaco is a camel but

He hasn't got a hump.

He's about three-quarters mountain goat

And seven-eighths a chump.

*Concession to the Improbable: An Unconventional Autobiography*

Chapter 8 (p. 72)

Yale University Press. New Haven, Connecticut, USA. 1978

## HIPPOPOTAMUS

**Belloc, Hilaire** 1870–1953

French-born poet and historian

I shoot the Hippopotamus

With bullets made of platinum,

Because if I use leaden ones  
His hide is sure to flatten 'em.

*Complete Verse*

The Hippopotamus (p. 237)

Gerald Duckworth. London, England. 1970

**Macaulay, Thomas Babington** 1800–59

English historian and writer

I have seen the hippopotamus, both asleep and awake;  
and I can assure you that, awake or asleep, he is the ugliest of the works of God.

In G. Otto Trevelyan

*The Life and Letters of Lord Macaulay* (Volume 2)

Chapter XIII, March 9, 1850 (p. 222)

Harper & Brothers. New York, New York, USA. 1876

**Montgomery, James** 1771–1854

Scottish poet and journalist

Amphibious monsters haunted the lagoon;  
The hippopotamus, amidst the flood,  
Flexile and active as the smallest swimmer;  
But on the bank, ill-balanced and infirm,  
He grazed the herbage, with huge head declined,  
Or lean'd to rest against some ancient tree.

*The Poetical Works of James Montgomery*

The Pelican Island

Little, Brown & Co. Boston, Massachusetts, USA. 1860

## HORSE

**Dickens, Charles** 1812–70

English novelist

“Bitzer,” said Thomas Gradgrind. “Your definition of a horse.”

“Quadruped. Graminivorous. Forty teeth, namely twenty-four grinders, four eye-teeth, and twelve incisive. Sheds coat in the spring; in marshy countries, sheds hoofs, too. Hoofs hard, but requiring to be shod with iron. Age known by marks in mouth.”

*Hard Times*

Book I, Chapter II (p. 208)

Chapman & Hall, Ltd. London, England. 1858

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

The horse is a very gregarious creature.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

Silver Blaze (p. 273)

Wings Books. New York, New York, USA. 1967

**Melville, Herman** 1819–91

American novelist, essayist, and poet

... what is a horse but a species of four-footed dumb man,  
in a leathern overall, who happens to live upon oats, and

toils for his masters, half-requted or abused, like the  
biped hewers of wood and drawers of water?

*Redburn*

Chapter XL (p. 26)

Jonathan Cape. London, England. 1937

**Moore, George** 1852–1933

Irish novelist

There is a touch of divinity even in brutes, and a special halo about a horse, that should forever exempt him from indignities. For as those majestic, magisterial truck-horses of the docks, I would as soon think of striking a judge on the bench, as to lay violent hand upon their holy hides.

*Evelyn Innes*

Chapter XIX

T. Fisher Unwin. London, England. 1898

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

A horse! A horse! My kingdom for a horse!

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Tragedy of King Richard the Third

Act V, Scene iv, l. 7

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

I have known the horse in war and in peace, and there is no place where a horse is comfortable. The horse has too many caprices, and he is too much given to initiative. He invents too many ideas. No, I don't want anything to do with a horse.

*The Complete Works of Mark Twain* (Volume 24)

*Mark Twain's Speeches*, Welcome Home (p. 201)

Harper & Brothers Publishers. New York, New York, USA. 1899

## HYENA

**Atkinson, Nick W.**

No biographical data available

To be top dog in a society of spotted hyenas, you've got to be a real bitch.

No Laughing Matter

*Natural History*, Volume 115 July/August 2006 (p. 12)

## JACKAL

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

The jackal's troop, in gather'd cry,  
Bay'd from afar complainingly,



With a mix'd and mournful sound,  
Like crying babe, and beaten hound.

*The Complete Poetical Works of Byron*  
Siege of Corinth, Stanza 33, l. 1024–27  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Ferry, Gabriel** 1809–52  
Writer

...jackals can only howl while the lion devours.

*The Wood-rangers*  
Chapter XLII (p. 321)  
Carleton. New York, New York, USA. 1875

## KANGAROO

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

Kangaroos liv upon roots, gras, and herbs, and kan out-jump ennything in the wilderness. In the face they resemble the deer, but in the length ov their tails they resemble a whole herd ov deer.

*Josh Billings' Wit and Humor*  
The Cat, and the Kangaroo (p. 88)  
George Routledge & Sons. London, England. 1874

## LEOPARD

**Hemingway, Ernest** 1899–1961  
American novelist, short-story writer and journalist

Close to the western summit [of Kilimanjaro] there is the dried and frozen carcass of a leopard. No one has explained what the leopard was seeking at that altitude.

*The Snows of Kilimanjaro*  
Chapter 1 (p. 3)  
Simon & Schuster. New York, New York, USA. 1995

**Wells, Carolyn** 1862–1942  
American writer

If strolling forth, a beast you view,  
Whose hide with spots is peppered,  
As soon as he has lept on you,  
You'll know it is the leopard.  
'Twill do no good to roar with pain,  
He'll only lep and lep again.

*Baubles*  
How to Tell the Wild Animals  
Dodd, Mead. New York, New York, USA. 1917

## LION

**Allen, Grant** 1848–99  
Canadian-born writer

...if we object to the king of beasts that (as Thersites said of Agamemnon) he devours his people, we may be told

in extenuation that, like Charles I., he is a good husband and a model father.

*Flashlights on Nature*  
Chapter III (p. 47)  
Doubleday, Page & Co. New York, New York, USA. 1905

**Gay, John** 1685–1732  
English poet and dramatist

The Lion is (beyond dispute)  
Allow'd the most majestic brute;  
His valor and his gen'rous mind  
Prove him superior of his kind.

*The Poetical Works of John Gay (Volume 2)*  
The Fables, Volume the Second, Fable IX, The Jackal, Leopard, and Other Beasts  
Lawrence & Bullen. London, England. 1893

**Pringle, Thomas** 1789–1834  
Scottish poet

Wouldst thou view the Lion's den?  
Search afar from haunts of men –  
Where the reed-encircled rill,  
Oozes from the rocky hill,  
By its verdure far descried  
'Mid the desert brown and wide.

*Afar in the Desert: And Other South African Poems; With a Memoir and Notes*  
The Lion and the Giraffe  
Stanza 1  
Longmans. London, England. 1881

## LLAMA

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

The Llama is a woolly sort of fleecy hairy goat,  
With an indolent expression and an undulating throat  
Like an unsuccessful literary man.

*Complete Verse*  
The Llama (p. 245)  
Gerald Duckworth. London, England. 1970

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The one-l lama,  
He's a priest.  
The two-l llama,  
He's a beast.  
And I will bet  
A silk pajama  
There isn't any three-l llama.

*Verses from 1929 On*  
The Lama  
Little, Brown & Company. Boston, Massachusetts, USA. 1959



**MAMMOTH**

**Blackie, John Stuart** 1809–95  
Scottish scholar

Mammoth, Mammoth! mighty old Mammoth!  
Strike with your hatchet and cut a good slice;  
The bones you will find, and the hide of the mammoth,  
Packed in stiff cakes of Siberian ice.

*Lays and Legends of Ancient Greece: With Other Poems*  
A Song of Geology (p. 24)  
Sutherland & Knox. Edinburgh, Scotland. 1857

**MANATEE**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The manatee is harmless  
And conspicuously charmless.  
Luckily the manatee  
Is quite devoid of vanity.

*Verses from 1929 On*  
The Manatee  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**MASTODON**

**Falconer, Hugh** 1808–65  
Scottish geologist, botanist, paleontologist, and paleoanthropologist

What a glorious privilege it would be, could we live  
back – were it but for an instant – into those ancient  
times when these extinct animals peopled the earth! To  
see them all congregated together in one grand natural  
menagerie – these Mastodons and Elephants, so numer-  
ous in species, toiling their ponderous forms and trum-  
peting their march in countless herds through the swamps  
and reedy forests:

In Charles Murchison (ed.)  
*Palaeontological Memoirs and Notes of the Late Hugh Falconer* (Vol-  
ume 1) (p. li)  
Robert Hardwicke. London, England. 1868

**MOLE**

**Grahame, Kenneth** 1859–1932  
English writer

The Mole was bewitched, entranced, fascinated. By  
the side of the river he trotted as one trots, when very  
small, by the side of a man who holds one spell-bound  
by exciting stories; and when tired at last, he sat on the  
bank, while the river still chattered on to him, a bab-  
bling procession of the best stories in the world, sent  
from the heart of the earth to be told at last to the insat-  
iable sea.

*The Wind in the Willows*  
Chapter I  
Charles Scribner's Sons. New York, New York, USA. 1908

**MONKEY**

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

The monkey is an organized sarcasm upon the human  
race, with variations multitudinous.

In William Drysdale (ed.)  
*Proverbs from Plymouth Pulpit*  
Nature (p. 8)  
D. Appleton & Co. New York, New York, USA. 1887

**Oswald, Felix Leopold**

No biographical data available

No monkey submits without “back-talk”...

*Zoological Sketches*  
Chapter I (p. 45)  
W.H. Allen & Co. London, England. 1883

**Robinson, Phil** 1847–1902

English journalist and writer on natural history

...monkeys...seem possessed by a demon of unrest, and  
are perpetually in kaleidoscopic motion.

*Noah's Ark; or, 'Mornings in the Zoo'*  
Chapter IV (p. 64)  
Sampson Low, Marston, Searle & Rivington. London, England. 1882

**SPIDER MONKEY**

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

There is something, particularly in a spider monkey's  
tail, that is too bold and purposeful to be easily called the  
product of simple chance. It floats there like a complete  
little personality. At least it may cause the true philoso-  
pher to pause hesitantly and ponder before he dismisses  
the universe as totally a world of chance.

*The Star Thrower*  
The Ghostly Guardian (p. 82)  
Times Books. New York, New York, USA. 1978

**MOUSE****Author undetermined**

The goal of science is to build better mousetraps. The  
goal of nature is to build better mice.

Source undetermined

Of mice there are many,  
Their kinds are profuse,  
We'd be lost without any  
Yet we ponder their use!

In William H. Carr  
*The Stir of Nature*  
Chapter Seven (p. 92)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

Mice are the epitome of shrewdness; their faces beam with sharp praktiss; their little noses smell ov cunning, and their little black-beaded eyes titter with pettit lar-ceny.

*Josh Billings' Wit and Humor*

The Mouse (p. 67)

George Routledge & Sons. London, England. 1874

**Cuppy, Will** 1884–1929  
American humorist and critic

I have nothing against mice, in moderation.... My own mice just eat whatever I have in the place, including soap. Not an ideal diet, but they'll have to make it do or move elsewhere.

*How to Get From January to December*

January 20

Henry Holt & Company. New York, New York, USA. 1951

**Herford, Oliver** 1863–1935  
American writer and illustrator

Consider now the Humble Mouse. He is an Outlaw in the House. He makes his Hiding in the Wall And lives upon the Crumbs that fall.

*More Animals*

The Mouse (p. 19)

Charles Scribner's Sons. New York, New York, USA. 1901

## MULE

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

The mule is haf hoss and haf Jackass, and then kums tu a full stop, natur diskovering her mistake.

*Josh Billings' Wit and Humor*

The Mule (p. 110)

George Routledge & Sons. London, England. 1874

## OPOSSUM

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

The possum's tail bothers me. I hav looked at it bi the hour; i hav studded it, and tried tew parse it; i hav figgered on it az cluss as i would a proposishun in Euklid; i hav hung over it az fondly az a kemist; i have fretted and wondered, hav got mad, wept and swore, and kant tell to this day whi a possum should hav a hairless caudel.

*Josh Billings' Wit and Humor*

The Possum (p. 99)

George Routledge & Sons. London, England. 1874

**Cuppy, Will** 1884–1929  
American humorist and critic

The opossum is a marsupial and marsupials are animals who carry their young around in an abdominal pouch or marsupium. As they have done this for millions and millions of years, they are not likely to stop, no matter how you and I feel about it. Baby opossums are born in a rudimentary or unfinished state, from four to twenty at once. They are only half an inch long and smaller around than a honey bee. This seems hardly worthwhile, but it suits the mother opossum, and she is the one directly involved.

*How to Attract the Wombat*

The Opossum (pp. 49–50)

Rinehart & Company, Inc. New York, New York, USA. 1949

## ORANG-UTAN

**Maple, Terry**

No biographical data available

Let there always be orang-utans.

*Orang-utan Behavior*

Chapter 8 (p. 245)

van Nostrand Reinhold Co. New York, New York, USA. 1980

## OTTER

**Colum, Padraic** 1881–1972

Irish poet and writer

I'll be an otter, and I'll let you swim  
A mate beside me; we will venture down  
A deep, full river when the sky above  
Is shut of the sun; spoilers are we;  
Thick-coated; no dog's tooth can bite at our veins –  
With ears and eyes of poachers; deep-earthed ones  
Turned hunters; let him slip past,  
The little vole, my teeth are on an edge  
For the King-fish of the River!

*Collected Poems*

Otters

Devin-Adair. New York, New York, USA. 1953

## PANDA

**Schaller, George B.** 1933–

American zoologist

**Jinchu, Hu**

Chinese biologist

There are two giant pandas, the one that exists in our mind and the one that lives in its wilderness home. Soft, furry, and strangely patterned in black and white, with a large, round head and a clumsy, cuddly body, a panda seems like something to play with and hug. No other animal has so entranced the public... The real panda, however, the panda as it lives in the wild, has remained essentially a mystery.

*The Giant Pandas of Wolong*

Preface (p. xiii)

The University Press of Chicago. Chicago, Illinois, USA. 1985

**PANTHER**

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

Lifting her eyes she saw two bright objects starring the darkness with a reddish-green glow. She took them to be two coals on the hearth, but with her returning sense of direction came the disquieting consciousness that they were not in that quarter of the room, moreover were too high, being nearly at the level of the eyes – of her own eyes. For these were the eyes of a panther.

*The Eyes of the Panther*

The Eyes of the Panther (pp. 18–19)

Books for Libraries Press. Plainview, New York, USA. 1976

**PECCARY**

**Wilson, Edward O.** 1929–  
American biologist and writer

A tame peccary watched me with beady concentration from beneath the shadowed eaves of a house. With my own, taxonomist's eye I registered the defining traits of the collared species, *Dicotyles tajacu*: head too large for the piglike body, fur coarse and brindled, neck circled by a pale thin stripe, snout tapered, ears erect, tail reduced to a nub. Poised on still little dancer's legs, the young male seemed perpetually fierce and ready to charge yet frozen in place, like the metal boar on an ancient Gallic standard.

*Biophilia*

Bernhardsdorp (p. 4)

Harvard University Press. Cambridge, Massachusetts. 1984

**PIG**

**Perrin, Noel** 1927–2004  
American essayist

Pigs get bad press. Pigs are regarded as selfish and greedy – as living garbage pails. Pigs are the villains in George Orwell's *Animal Farm*. Pigs have little mean eyes. There is truth in this account – not that it's entirely the fault of the pigs. For perhaps five thousand generations pigs have been deliberately bred to be gluttonous.... Do the same thing with human beings for five thousand generations, and it would be interesting to see what kind of people resulted.

*Second Person Rural: More Essays of a Sometime Farmer*

Pig Tales (p. 143)

D. R. Godine. Boston, Massachusetts, USA. 1980

**PIKAS**

**Muir, John** 1838–1914  
American naturalist

...the mounds in front of their burrows glittering like heaps of jewelry – romantic ground to live in or die in.

*Our National Parks*

Chapter V (p. 162)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**POLAR BEAR**

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

The Polar Bear is unaware  
Of cold that cuts me through:  
For why? He has a coat of hair,  
I wish I had one too!

*Complete Verse*

The Polar Bear (p. 236)

Gerald Duckworth. London, England. 1970

**PORPOISE**

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

Porpoises left the land when mammalian brains were still small and primitive. Without the stimulus provided by agile exploring fingers, these great sea mammals have yet taken a divergent road toward intelligence of a high order. Hidden in their sleek bodies is an impressively elaborated instrument, the reason for whose appearance is a complex enigma. It is as though both man and porpoise were each part of some great eye which yearned to look both outward on eternity and inward to the sea's heart – that fertile entity so like the mind in its swarming and grotesque life.

*The Star Thrower*

The Long Loneliness (p. 43)

Times Books. New York, New York, USA. 1978

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

The porpoise is the kitten of the sea: he never has a serious thought, he cares for nothing but fun and play.

*Following the Equator* (Volume 1)

Chapter IX (p. 108)

Harper & Brothers Publishers. New York, New York, USA. 1899

The porpoise is the clown of the sea – evidently does his wild antics for pure fun; there is no sordid profit in it.

*Mark Twain's Notebook*

Chapter XXIII (p. 267)

Harper & Brothers Publishers. New York, New York, USA. 1935

**PRAIRIE DOG**

**Austin, Mary Hunter** 1868–1934  
American novelist and essayist

Old Peter Prairie-Dog  
Builds him a house

In Dog-Dog Town,  
 With a door that goes down  
 And down and down,  
 And a hall that goes under  
 And under and under,  
 Where you can't see the lightning,  
 You can't hear the thunder,  
 For they don't like thunder  
 In Dog-Dog Town.

*The Children Sing in the Far West*

Dog-Dog Town

Houghton Mifflin Company. Boston, Massachusetts, USA. 1928

## RAT

**Browning, Robert** 1812–89

English poet

Rats! They fought the dogs and killed the cats.  
 And bit the babies in the cradles,  
 And ate the cheeses out of the vats,  
 And licked the soup from the cooks' own ladles.  
 Split open the kegs of salted sprats,  
 Made nests inside men's Sunday hats,  
 And even spoiled the women's chats  
 By drowning their speaking  
 With shrieking and squeaking  
 In fifty different sharps and flats.

*The Complete Poetical Works of Robert Browning*

The Pied Piper of Hamelin

Macmillan & Co Ltd. London, England. 1921

**Zinsser, Hans** 1878–1940

US bacteriologist

Man and the rat will always be pitted against each other  
 as implacable enemies. And the rat's most potent weap-  
 ons against mankind have been its perpetual maintenance  
 of the infectious agents of plague and of typhus fever.

*Rats, Lice and History*

Chapter XII (p. 211)

Little, Brown & Co. Boston, Massachusetts, USA. 1963

## RHINOCEROS

**Belloc, Hilaire** 1870–1953

French-born poet and historian

Rhinoceros, your hide looks all undone,  
 You do not take my fancy in the least:  
 You have a horn where other brutes have none:  
 Rhinoceros, you are an ugly beast.

*Complete Verse*

The Rhinoceros (p. 239)

Gerald Duckworth. London, England. 1970

**Robinson, Philip Stewart** 1847–1902

English journalist and writer on natural history

[The rhinoceros] munches hay – not with any enthusiasm,  
 it is true, but with a subdued satisfaction that bespeaks a  
 philosophic and contented mind.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter VI (p. 140)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

## SHEEP

**Muir, John** 1838–1914

American naturalist

No other animal seems to yield so submissively to the  
 manipulations of culture. Jacob controlled the color of  
 his flocks merely by causing them to stare at objects  
 of the desired hue; and possibly Merinos may have  
 caught their wrinkles from the perplexed brows of their  
 breeders.

*Steep Trails*

Chapter I (p. 17)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

It is almost impossible to conceive of a devastation more  
 universal than is produced among the plants of the Sierra  
 by sheep.... Nine tenths of the whole surface of the  
 Sierra has been swept by the source. It demands legisla-  
 tive interference.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter III, Section 6, September 19, 1873 (p. 173)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

## SHREW

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

Timid atom, furry shrew,  
 Is it a sin to prison you?  
 Through the runways in the grass  
 You and yours in hundreds pass,  
 An unimagined world of shrews,  
 A world whose hurrying twilight news  
 Never stirs but now and then  
 The striding world of booted men.

*The Captive Shrew and Other Poems of a Biologist*

The Captive Shrew

Harper & Brothers. New York, New York, USA. 1933

**Schaefer, Jack** 1907–91

American writer and journalist

Shrews are not mutual murderers. We'll just square off  
 and touch whiskers, assessing each other. Then we'll try  
 to out-sneak each other.

Interview with a Shrew

*Audubon*, Volume 77, Number 6, November, 1975 (p. 2)

**SKUNK**

**Adams, Roger** 1889–1971  
American organic chemist

Many thanks for the sending me the book “Biology of the Striped Skunk”.... Frankly, I doubt whether I shall read it or not, unless I happen to have some intimate contact with a skunk which may induce me to learn more about him.

In D.S. Tarbell and A. Tarbell  
*Roger Adams, Scientist and Statesman* (p. 192)  
American Chemical Society, Washington, D.C. 1981

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

I respect the skunk as a human being in a very humble sphere.

In William H. Carr  
*The Stir of Nature*  
Chapter Four (p. 48)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Young, Roland** 1887–1953  
English actor

In this mechanic age the skunk  
Inspires no terror – he’s the bunk;  
For people in cars,  
Returning from bars,  
Quite frequently flatten the skunk.  
*Not for Children*  
The Skunk  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**SQUIRREL**

**Prelutsky, Jack** 1940–  
American poet

Squirrels, often found in parks,  
have tails resembling question marks,  
it’s just coincidental, though...  
there’s little squirrels care to know.  
*Something Big Has Been There*  
Squirrels  
William Morrow & Company. New York, New York, USA. 1990

**TIGER**

**Charlie Chan (Fictional character)**

Tiger going away from village is never feared.  
*Dangerous Money*  
Film (1946)

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

I consider the tiger as a being, a created being. If you kill all tigers still the tiger-soul continues.... But the point is I don’t want the tiger superseded. Oh, may each she-tigress have seventy seven whelps, and may they all grow in strength and shine in stripes like day and night, and may each one eat at least seventy miserable featherless human birds, and lick red chops of gusto after it.

In James T. Boulton  
*Selected Letters of D.H. Lawrence*  
Chapter III, May, 1921, Letter to Earl and Achsah Brewster, 15 May, 1921 (pp. 204, 205)  
Cambridge University Press. Cambridge, England. 1997

**Wells, Carolyn** 1862–1942  
American writer

Or if some time when roaming round,  
A noble wild beast greets you,  
With black stripes on a yellow ground,  
Just notice if he eats you.  
This simple rule may help you learn  
The Bengal tiger to discern.

*Baubles*  
How to Tell the Wild Animals  
Dodd, Mead. New York, New York, USA. 1917

**TREE MOUSE**

**Scheffer, Victor B.**  
Zoologist

If a tree mouse did not exist and I were told to design one, I could hardly improve on Nature’s product – a small, sure-footed beast dressed in the protective colors of fir-tree cones, adapted to a resinous diet, and adapted to moving about in a narrow ecological niche.  
*Spires of Form*  
Introduction (p. 3)  
University of Washington Press. Seattle, Washington, USA. 1983

**WALRUS**

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“The time has come,” the Walrus said,  
“To talk of many things:  
Of shoes – and ships – and sealing-wax –  
Of cabbages – and kings –  
And why the sea is boiling hot –  
And whether pigs have wings.”  
*The Complete Works of Lewis Carroll*  
Through the Looking-Glass  
Chapter IV (p. 186)  
The Modern Library. New York, New York, USA. 1936

**WHALE**

**Ackerman, Diane** 1948–  
American writer

The ocean transmits sound in strange and unlikely ways. There is a layer of water, known as the deep sound channel, in which sound waves can be trapped and spread great distances because they bend back into the channel over and over, without losing much energy. Under those circumstances, whale sound can travel as much as five hundred miles before blending into background noise.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 3 (p. 118)

Random House, Inc. New York, New York, USA. 1991

Whales navigate through a rich, complicated landscape at a stately pace, slow as zeppelins, majestic and alert.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 3 (p. 129)

Random House, Inc. New York, New York, USA. 1991

When a whale sleeps, it slowly tumbles in any-old-crazy, end-over-end, sideways fashion, and may even bonk its head on the bottom.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 3 (p. 174)

Random House, Inc. New York, New York, USA. 1991

**Beale, Thomas** 1807–49  
English surgeon

Mad with the agonies he endures from these fresh attacks, the infuriated Sperm Whale rolls over and over; he rears his enormous head, and with wide expanded jaws snaps at everything around him; he rushes at the boats with his head; they are propelled before him with vast swiftness, and sometimes utterly destroyed.

*The Natural History of the Sperm Whale*

Dodd, Mead. New York, New York, USA. 1917

**Chief Engineer Scott (Fictional character)**

Admiral, there be whales here!

*Star Trek IV*

Film (1986)

**Davenant, Sir William** 1–88  
English dramatist and poet

...immense as Whales, the motion of whose vast bodies can in a peaceful calm trouble the Ocean till it boyl ...

In J.E. Spingarn (ed.)

*Critical Essays of the Seventeenth Century* (Volume 2)

Preface to Gondibert (p. 41)

At The Clarendon Press. Oxford, England. 1908

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

...the holy, hangs undisturbed over the whales' huge cradle.

*The Star Thrower*

Science and the Sense of the Holy (p. 199)

Times Books. New York, New York, USA. 1978

**Hart, Joseph** 1798–1855  
American novelist

Suddenly a mighty mass emerged from the water, and shot up perpendicularly in the air.... It was the whale....

*Miriam Coffin; or, The Whale Fisherman* (Volume 2)

Chapter X (p. 156)

G. & C. & H. Carvill. New York, New York, USA. 1834

**Payne, Roger**  
Biologist

Remote and imperturbable, the lives of whales are somehow enough to match any fantasy humanity can create. They are what we have lost, what we yearn for.

*Among Whales*, (p. 351)

Scribner. New York, New York, USA. 1995

As a consequence of their great size, whales escape much turmoil. With increasing size comes increasing serenity. Large creatures find less and less that is significant enough to be annoying and therefore experience fewer extremes, less upheaval.

*Among Whales*.

Chapter 1 (p. 20)

Charles Scribner's Sons. New York, New York, USA. 1995

**WOLF**

**Lugosi, Bela** 1882–1956  
Hungarian film star

Listen to them. Children of the night. What music they make.

*Dracula*

Film (1931)

**YAK**

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

As a friend to the children commend me the Yak.

You will find it exactly the thing:

It will carry and fetch, you can ride on its back,

Or lead it about with a string.

*Complete Verse*

The Yak (p. 236)

Gerald Duckworth. London, England. 1970

**Smith, William Jay** 1918–  
American lyric poet

The long-haired Yak has long black hair,  
He lets it grow – he doesn't care.



He lets it grow and grow and grow,  
 He lets it trail along the stair.  
 Does he ever go to the barbershop? NO!  
 How wild and woolly and devil-may-care  
 A long-haired Yak with long black hair  
 Would look when perched in a barber chair!

*Mr. Smith and Other Nonsense*

Yak

Delacorte Press. New York, New York, USA. 1968

## ANIMAL: MOLLUSK

**Pallister, William Hales** 1877–1946

Canadian physician

Next, the MOLLUSCS present forty thousand kinds more,

With a limited life, but adapted for it;

In the space of the tide, with the sea and the shore

And the sunshine, the Molluscs successfully fit;

Some on land, some in lakes which were seas, they exist

And though tideless for ages, the Molluscs persist.

*Poems of Science*

Beginnings, Animal Life (p. 139)

Playford Press. New York, New York, USA. 1931

## CLAM

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

The clam iz a bulbous plant, and resides on the under side ov the water. He iz born az the birds are, but don't cum out ov his shell. He iz deserted by his parents at a young and tender age, but don't bekum clamorous on this akount, but sits still, and keeps watch with hiz mouth, for sumthin tew cum along.

*Josh Billings' Wit and Humor*

The Clam (p. 82)

George Routledge & Sons. London, England. 1874

**Cuppy, Will** 1884–1929

American humorist and critic

Clams lead quiet, uneventful lives for the most part. Buried in the mud and sand between the tide marks, or farther out in the water, they seldom get around much or hear any important news. Clams don't know what it's all about. They have no heads, so they do not bother with that sort of thing.... Clams are very conservative. They voted against having heads in the Ordovician Period and have stuck to it ever since. They never adopt a new idea until it has proven its worth.

*How to Attract the Wombat*

The Clam (p. 112, fn 1)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Nash, Ogden** 1902–71

American writer of humorous poetry

The clam, esteemed by gourmets highly,  
 Is said to live the life of Riley;  
 When you are lolling on a piazza  
 It's what you are as happy as a.

*Verses from 1929 On*

The Clam

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## LIMPET

**Browning, Robert** 1812–89

English poet

...white fishing gulls

Flit where the strand is purple with its tribe

Of nested limpets...

*The Poetical Works of Robert Browning* (Volume 2)

Paracelsus (p. 168)

Smith, Elder & Co. London, England. 1888

## OYSTER

**Babbage, Charles** 1792–1871

English mathematician

I now gave my mind to philosophy: the great object of my ambition was to make out a complete system of the universe, including and comprehending the origin, causes, consequences, and termination of all things. Instead of countenance, encouragement, and applause, which I should have received from everyone who has the true dignity of an oyster at heart, I was exposed to calumny and misrepresentation. While engaged in my great work on the universe, some even went so far as to accuse me of infidelity; such is the malignity of oysters.

*Passages from the Life of a Philosopher*

*Autobiography of an Oyster*

Title page

Longman, Green, Longman, Roberts & Green. London, England 1864

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

OYSTER, *n.* A slimy, gobby shellfish which civilization gives men the hardihood to eat without removing its entrails 1 The shells are sometimes given to the poor.

*The Collected Works of Ambrose Bierce* (p. 244)

The Neale Publishing Co. New York, New York, USA. 1911

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“O Oyster,” said the Carpenter,

“You’ve had a pleasant run!

Shall we be trotting home again?”

But answer came there none –

And this was scarcely odd, because

They’d eaten everyone.



*The Complete Works of Lewis Carroll  
Through the Looking-Glass  
Chapter IV (p. 188)  
The Modern Library. New York, New York, USA. 1936*

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

I cannot think why the whole bed of the ocean is not one solid mass of oysters so prolific the creatures seem.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Adventure of the Dying Detective* (p. 444)  
Wings Books. New York, New York, USA. 1967

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910  
American author and humorist

We know all about the habits of the ant, we know all about the habits of the bee, but we know nothing at all about the habits of the oyster. It seems almost certain that we have been choosing the wrong time for studying the oyster.

*The Tragedy of Pudd'nhead Wilson*  
Chapter XVI (p. 122)  
New American Library. New York, New York, USA. 1980

## SLUG

**Deyrup-Olsen, Ingrith** 1919–2004  
American zoologist

Most people think, “Slugs – yuk!” But I think that whenever you start to study an organism, you become overwhelmed by the beauty and complexity of it. I am always amazed and touched by the way these animals solve the tremendous problems they have, which are always really basically the same as ours. I have come to have very strong respect and admiration for them, and I’ve also found it’s a wonderful area to involve nonscientists in. The minute you begin to show them that slugs are very complicated, interesting animals with their own needs and demands, people begin to look at them with very different eyes. I’m very moved by the slug’s ingenuity and tremendous drive to continue living. I think in the end this is what makes me go on, no matter how frustrating the experiments happen to be at that time.

In Linda Jean Shepherd  
*Lifting the Veil: The Feminine Face of Science*  
Chapter 3 (pp. 69–70)  
Shambhala. Boston, Massachusetts, USA. 1993

## SNAIL

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

Snails are sed tew be delikate eating, but if i kan hav all the hash i want, i will try and struggle along without any

snail. You kant phool me with hash, I kno how that iz made, but i don’t kno how snail are put together. Ignorance iz sed tew be bliss, and i hav often thought that it waz, and if i don’t never kno how snails taste, i don’t think now i shall repent ov it.

*Josh Billings’ Wit and Humor*  
Snails, Snaiks, and Babies (p. 82)  
George Routledge & Sons. London, England. 1874

**Clare, John** 1793–1864  
English poet

There came the snail from his shell peeping out,  
As fearful and cautious as thieves on the rout.

*The Village Minstrel, and Other Poems*  
II (p. 32)  
Printed for Taylor & Hessey. London, England. 1821

**Cuppy, Will** 1884–1929  
American humorist and critic

What is the main thing about a snail? That’s right, the snail is slow. He believes in just taking it easy, and he is so slow at it that one gets all tired out just watching him. Following a snail around for any length of time makes me a total wreck. I don’t know why I do it. When a snail wants to go anywhere, he travels on the underside of his physique, twitching himself along by wave-like contractions of the muscles. This is not a satisfactory means of locomotion, if you’ve ever tried it, and carrying your house on your back at the same time would hardly improve matters. A snail never hurries to an appointment. He is sure that his date will be a day or two late, anyhow, so what’s the use?

*How to Attract the Wombat*  
The Snail (pp. 115–116)  
Rinehart & Company, Inc. New York, New York, USA. 1949

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the snail, whose tender horns being hit,  
Shrinks backward in his shelly cave with pain,  
And there, all smother’d in shade, doth sit,  
Long after fearing to creep forth again.

*The Complete Works of William Shakespeare*  
*Venus and Adonis*, l. 1033–1036  
Oxford University Press. London, England. 1954

## WHELK

**Wood, Robert William** 1868–1955  
American physicist

...if you listen to the shell,  
In which the Whelk is said to dwell,  
And hear a roar, beyond a doubt  
It indicates the Whelk is out.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*  
The Elk. The Whelk (p. 43)  
Dover Publications, Inc. New York, New York, USA. 1959

**ANIMAL: MYTHICAL****AMPHISBAENA**

**Pope, Alexander** 1688–1744  
English poet

Thus Amphisbaena (I have read)  
At either end assails

None knows which leads, or which is led,  
For both Heads are but Tails.

*The Works of Alexander Pope* (Volume 3)

The Dunciad, Book III, Remarks (p. 290)

Longman, Brown & Co. London, England, 1847

**BASILISK**

**Kirchmayer, George Kaspard** b. 1635  
German writer

To deny the existence of the basilisk is to carp at the evidence of men's eyes and their experiences in many different places. Accordingly, we allow the basilisk a place in nature, as the most deadly and venomous creature and plague in the animal creation.

Translated by Edmund Goldsmid

*Un-natural History* (Volume 1)

Chapter II (p. 18)

Privately printed. Edinburgh, Scotland. 1886

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

It is produced in the province of Gyrene, being not more than twelve fingers in length. It has a white spot on the head, strongly resembling a sort of a diadem. When it hisses, all the other serpents fly from it: and it does not advance its body, like the others, by a succession of folds, but moves along upright and erect upon the middle. It destroys all shrubs, not only by its contact, but those even that it has breathed upon; it burns up all the grass too, and breaks the stones, so tremendous is its noxious influence.

Translated by John Bostock, Henry Thomas Riley

*The Natural History of Pliny* (Volume II)

Book VIII, Chapter 33 (p. 282)

George Bell & Sons. London, England. 1890

**BREAD-AND-BUTTER-FLY**

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“Crawling at your feet,” said the Gnat (Alice drew her feet back in some alarm), “you may observe a Bread-and-butter-fly. Its wings are thin slices of bread-and-butter, its body is a crust, and its head is a lump of sugar.” “And what does *it* live on?”

“Weak tea with cream in it.”

In Florence Milner (ed.)

*Through the Looking-glass and What Alice Found There*

Chapter III (p. 52)

Rand McNally & Co. Chicago, Illinois, USA. 1917

**CATOBLEPAS**

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

Near this fountain [fountain of Nigris], there is found a wild beast, which is called the catoblepas; an animal of moderate size, and in other respects sluggish in the movement of the rest of its limbs; its head is remarkably heavy, and it only carries it with the greatest difficulty, being always bent down towards the earth. Were it not for this circumstance, it would prove the destruction of the human race; for all who behold its eyes, fall dead upon the spot.

Book VIII, Chapter 32 (pp. 281–282)

George Bell & Sons. London, England. 1890

**KRAKEN**

**Robinson, Phil** 1847–1902  
English journalist and writer on natural history

In the sea, the Kraken is king. It is the hierophant of the oceanic mysteries, secret as a Prince of the Assassins, or veiled Prophet, and sacred from its very secrecy like the Lama of Tibet or the Unseen God of the Tartars.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter I (p. 8)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

**ORK**

**Baum, Lyman Frank** 1856–919  
American author

The Ork sat upon its haunches much as a cat does, but used the finger-like claws of its front legs almost as cleverly as if they were hands. Perhaps the most curious thing about the creature was its tail, or what ought to have been its tail. This queer arrangement of skin, bones and muscle was shaped like the propellers used on boats and airships, having fan-like surfaces and being pivoted to its body.

*The Scarecrow of Oz*

Chapter III (pp. 37–38)

The Reilly & Britton Co. Chicago, Illinois, USA. 1915

**PHOENIX**

**Herodotus** 484 BCE–432 BCE  
Greek historian

It is said that the phoenix comes when his father dies. If the picture truly shows his size and appearance, his

plumage is partly golden and partly red. He is most like an eagle in shape and bigness.

Translated by Alfred Denis Godley

*Herodotus* (Volume 1)

Book II, 73 (p. 361)

William Heinemann. London, England. 1920

**Kirchmayer, George Kaspard** b. 1635

German writer

I have to enquire, with the help of God, what real truth there is in the Phoenix.

*Hexas Disputationum Zoologicarum*

Houghton Mifflin Company. Boston, Massachusetts, USA. 1939

## ROCKING-HORSE-FLY

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“All right,” said the Gnat. “Half way up that bush, you’ll see a Rocking-horse-fly, if you look. It’s made entirely of wood, and gets about by swinging itself from branch to branch.”

“What does it live on?” Alice asked, with a great curiosity.

“Sap and sawdust,” said the Gnat.

In Florence Milner (ed.)

*Through the Looking-glass, and What Alice Found There*

Chapter III (p. 51)

Rand McNally & Co

Chicago, Illinois, USA. 1917

## SEA SERPENT

### 19th Century Naval Song

Strange things come up to look at us –

The masters of the deep.

*The Modern Traveler*

The Return of the Admiral (p. 107)

Printed for T. Lowndes. London, England. 1776–1777

**Pontoppidan, Erich** 1698–1754

Bishop in Bergen, Norway

Amongst the many great things which are in the ocean, and concealed from our eyes or only presented to our view for a few minutes, is the Kraken. This creature is the largest and most surprising of all the animal creation, and consequently well deserves such an account as the nature of the thing, according to the Creator’s wise ordinance, will admit of.

*Natural History of Norway*

**Tennyson, Alfred (Lord)** 1809–92

English poet

Below the thunders of the upper deep;

Far, far beneath in the abysmal sea,

His ancient, dreamless, uninvaded sleep

The Kraken sleepeth...

*Alfred Tennyson’s Poetical Works*

The Kraken

Oxford University Press, Inc. London, England. 1953

## SNAP-DRAGON-FLY

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“Look on the branch above your head,” said the Gnat, “and there you’ll find a Snap-dragon-fly. Its body is made of plum-pudding, its wings of holly-leaves, and its head is a raisin burning in brandy.”

“And what does it live on?” Alice asked, as before.

“Frumenty and mince-pie,” the Gnat replied; “and it makes its nest in a Christmas-box.”

In Florence Milner (ed.)

*Through the Looking-glass, and What Alice Found There*

Chapter III (p. 51)

Rand McNally & Co

Chicago, Illinois, USA. 1917

## ANIMAL: PROTOZOA

### AMOEBA

#### Author undetermined

When you were a soft amoeba, in ages past and gone,

Ere you were Queen of Sheba, or I King Solomon,

Alone and undivided, we lived a life of sloth,

Whatever you did, I did; one dinner served for both.

Anon came separation, by fission and divorce,

A lonely pseudopodium wandered on my course.

In Arnold Silcock

*Verse and Worse*

Evolution (pp. 167–168)

Faber & Faber Ltd. London, England. 1952

An amoeba named Sam and his brother

Were having a drink with each other.

In the midst of their quaffing

They split their sides laughing,

And each of them now is a mother.

Source undetermined

#### Cudmore, Lorraine Lee

American cell biologist

Ah, the architecture of this world. Amoebas may not have backbones, brains, automobiles, plastic, television, Valium or any other of the blessings of a technologically advanced civilization; but their architecture is two billion years ahead of its time.

*The Center of Life: A Natural History of the Cell*  
The Universal Cell (pp. 15–16)  
New York Times Book Company. New York, New York, USA. 1977

The amoeba had the architectural ideas of R. Buckminster Fuller before there was anyone around capable of having an idea.

*The Center of Life: A Natural History of the Cell*  
The Universal Cell (p. 16)  
New York Times Book Company. New York, New York, USA. 1977

An amoeba never is torn apart through indecision, though, for even if two parts of the amoeba are inclined to go in different directions, a choice is always made. We could interpret this a schizophrenia or just confusion, but it could also be a judicious simultaneous sampling of conditions, in order to make a wise choice of future direction.

*The Center of Life: A Natural History of the Cell*  
Locomotion (p. 73)  
New York Times Book Company. New York, New York, USA. 1977

**Cuppy, Will** 1884–1929  
American humorist and critic

Amoebas not only divide, they also blend. When it's all over there is one amoeba where there were two. Amoebas blend apparently because they enjoy blending for its own sake. The amoeba often frequents laboratories. You'll find quite a number of amoebas at Yale, Princeton, and Harvard.

*How to Get from January to December*  
March 7 (p. 53)  
Henry Holt & Company. New York, New York, USA. 1951

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and writer

Amoeba has her picture in the book,  
Proud Protozoon! – Yet beware of pride,  
All she can do is fatten and divide;  
She cannot even read, or sew, or cook.

*Essays of a Biologist*  
Philosophic-Ants (p. 176)  
Alfred P. Knopf. New York, New York, USA. 1929

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

The difference between the amoeba and Einstein is that, although both make use of the method of trial and error elimination, the amoeba dislikes erring while Einstein is intrigued by it...

*Objective Knowledge: An Evolutionary Approach*  
Chapter 2 (p. 70)  
Clarendon Press. Oxford, England. 1972

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

A process which led from amoeba to man appeared to the philosophers to be obviously a progress – though whether the amoeba would agree with this opinion is not known.

*Our Knowledge of the External World*  
Lecture I (p. 12)  
The Open Court Publishing Company. Chicago, Illinois. 1914

**Spencer, Herbert** 1829–1903  
English social philosopher

...this speck of animated jelly [amoeba] is at once all stomach, all skin, all mouth, all limb, and doubtless, too, all lung.

*The Principles of Biology* (Volume 1)  
Part I, Chapter II (p. 200)  
D. Appleton & Co. New York, New York, USA. 1910

## ANIMAL: REPTILE

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Reptiles, reptiles, reptiles – flying, swimming, waddling, walking...

*Sketch-Book of Popular Geology*  
Lecture Forth (p. 151)  
William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

What, if one reptile sting another reptile?  
Where is the crime? The goodly face of nature  
Hath one disfeaturing stain the less upon it.  
*The Poetical Works of S.T. Coleridge* (Volume 2)  
Remorse  
William Pickering. London, England. 1835

**Huxley, Thomas Henry** 1825–1895  
English biologist

Placed side by side, a Humming-bird and a Tortoise, an Ostrich and a Crocodile, offer the strongest contrast, and a Stork seems to have little but animality in common with the Snake it swallows.

In Michael Foster and Edwin Ray Lankester (ed.)  
*The Scientific Memoirs of Thomas Henry Huxley* Volume 3  
Chapter XV (p. 305)  
Macmillan & Company Ltd. London, England. 1901

**Robinson, Philip Stewart** 1847–1902  
English journalist and writer on natural history

A reptile is not, perhaps, an amiable thing. Its name “that which creeps” prejudices some of us against it. Nor is there anything thoroughly unjustifiable in this. The necessities of speech require a word that shall compendiously express the idea of the contemptible and crawling, and at the same time the potentially hurtful. And “reptile” fulfils this obnoxious duty.

*The Poets and Nature; Reptiles, Fishes, and Insects*  
Chapter 4 (p. 3)  
Chatto & Windus. London, England. 1893

**ALLIGATOR**

**Ackerman, Diane** 1948–  
American writer

Nothing looks more contented than a resting alligator.  
The mouth falls naturally into a crumpled smile, the eyes  
half close in a sleepy sort of way...

*The Moon by Whale Light, and Other Adventures Among Bats and  
Crocodilians, Penguins and Whales*

Chapter 2 (p. 60)

Random House, Inc. New York, New York, USA. 1991

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

ALLIGATOR, N. The crocodile of America, superior  
in every detail to the crocodile of the effete monarchies  
of the Old World. Herodotus says the Indus is, with one  
exception, the only river that produces crocodiles, but  
they appear to have gone West and grown up with the  
other rivers. From the notches on his back the alligator  
is called a sawrian.

*The Collected Works of Ambrose Bierce* (p. 22)

The Neale Publishing Co. New York, New York, USA. 1911

**Dickens, Charles** 1812–20  
English novelist

...there is a poetry in wildness, and every alligator bask-  
ing in the slime is himself an Epic, self contained.

*Life and Adventures of Martin Chuzzlewit*

Chapter XXII (p. 348)

Macmillan & Company Ltd. London, England. 1892

**CROCODILE**

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

How cheerfully he seems to grin,  
How neatly spreads his claws,

And welcomes little fishes in  
With gently smiling jaws!

*The Complete Works of Lewis Carroll*

*Alice's Adventures in Wonderland*

Chapter II (p. 29)

The Modern Library. New York, New York, USA. 1936

**Montgomery, James** 1771–1854  
Scottish poet and journalist

The crocodile, the dragon of the waters,  
In iron panoply, fell as the plague,  
And merciless as famine, cranch'd his prey,  
While from his jaws, with dreadful fangs all serried,  
The life-blood dyed the waves with deadly streams.

*The Poetical Works of James Montgomery*

The Pelican Island

Little, Brown & Co. Boston, Massachusetts, USA. 1860

**Thomson, James** 1700–48  
Scottish poet

...half-conceal'd,  
Like a fallen cedar, far diffused his train,  
Cased in green scales, the crocodile extends.

*The Seasons*

Summer

A.S. Barnes & Burr. New York, New York, USA. 1860

**LIZARD**

**Gardner, John** 1933–82  
American writer and scholar

The Lizard is a timid thing  
That cannot dance or fly or sing;  
He hunts for bugs beneath the floor  
And longs to be a dinosaur.

*A Child's Bestiary*

The Lizard

Alfred A. Knopf. New York, New York, USA. 1977

**Herbert, George** 1593–1633  
Welsh poet, orator, and priest

It is better to be the head of the lizard than the tail of the  
lion.

*The Works of George Herbert in Prose and Verse*

Jacula Prudentum (p. 460)

John Wurtele Lovell. New York, New York, USA. 1881

**Kitching, Arthur Leonard**  
No biographical data available

...He who is bitten by a snake fears a lizard ...

*On the Backwaters of the Nile* (p. 133)

Charles Scribner's Sons. New York, New York, USA. 1912

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

A lizard ran out on a rock and looked up, listening  
no doubt to the sounding of spheres.  
And what a dandy fellow! The right toss of a chin for  
you

And swirl of a tail!

If men were as much men as lizards are lizards  
they'd be worth looking at.

*The Complete Poems of D.H. Lawrence*

The Lizard

Viking Press. New York, New York, USA. 1973

**Mann, Thomas** 1875–1955  
German-born American novelist

Hold fast the time! Guard it, watch over it, every hour,  
every minute! Unregarded it slips away, like a lizard,  
smooth, slippery, faithless, a pixy-wife.

*The Beloved Returns* (p. 297)

Alfred A. Knopf. New York, New York, USA. 1950

**LIZARD: CHAMELEON**

**Montgomery, James** 1771–1854  
Scottish poet and journalist

...the light chameleon climb'd,  
And changed his color as his place he changed;  
The nimble lizard ran from bough to bough,  
Glancing through light, in shadow disappearing ...  
*The Poetical Works of James Montgomery*  
The Pelican Island  
Little, Brown & Co. Boston, Massachusetts, USA. 1860

**Prior, Matthew** 1664–1721  
English poet and diplomat

As the chameleon, who is known  
To have no colours of his own,  
But borrows from his neighbour's hue  
His white or black, his green or blue,

And struts as much in ready light,  
Which credit gives him upon sight,  
As if the rainbow were in tail  
Settled on him and his heirs male.  
*Poems on Several Occasions*  
The Chameleon  
Printed for Jacob Tonson  
London, England. 1718

**Wells, Carolyn** 1862–1942  
American writer

The true Chameleon is small,  
A lizard sort of thing;  
He 'asn't any ears at all,  
And not a single wing.  
If there is nothing on the tree,  
'Tis the Chameleon you see.  
*Baubles*  
How to Tell the Wild Animals  
Dodd, Mead. New York, New York, USA. 1917

**LIZARD: GILA MONSTER**

**Underhill, Ruth Murray** 1883–1984  
American anthropologist

A lizard maiden  
Was thirsty and crying.  
A gila monster ran up  
And comforted her.  
The maiden stopped crying.  
The monster carried her off  
And took her to wife.  
*Singing for Power* (p. 51)  
University of California Press. Berkeley, California, USA. 1938

**LIZARD: HORNED TOAD**

**Dixon, Maynard** 1875–1946  
American painter

If you should desire some news of me,  
Go ask the little horned toad whose home  
is in the dust.  
In Ed Ainsworth  
*Painters of the Desert* (p. 19)  
Desert Magazine. Palm Desert, California, USA. 1960

**SNAKE**

**Boone, John Allen** 1882–1965  
Author

Even the most dreaded of poisonous snakes is a kindly  
disposed fellow at heart. He wants to be understood and  
to understand.  
*Kinship with All Life*  
Tail-Rattlings (p. 94)  
Harper & Brothers. New York, New York, USA. 1954

**Dewar, Redcote**

No biographical data available

...the precocious child's definition of a snake,  
"Nothing with a tail to it."  
*From Matter to Man: A New Theory of the Universe*  
Chapter II (p. 21)  
Chapman & Hall, Ltd. London, England. 1898

**Jones, Thomas Rymer** 1810–80  
English zoologist

...these lithe and elegant beings [snakes]...  
*A General Outline of the Animal Kingdom, and Manual of Comparative Anatomy*  
Reptiles (p. 551)  
John van Voorst. London, England. 1841

**Montgomery, James** 1771–1854  
Scottish poet and journalist

Terribly beautiful, the serpent lay,  
Wreath'd like a coronet of gold and jewels,  
Fit for a tyrant's brow; anon he flew  
Straight as an arrow shot from his own rings,  
And struck his victim, shrieking ere it went  
Down his strain'd throat, that open sepulcher.  
*The Poetical Works of James Montgomery*  
The Pelican Island  
Little, Brown & Co. Boston, Massachusetts, USA. 1860

**Norton, Gayne T. K.**  
No biographical data available

If you are a lover of trees and woodlands, if you enjoy  
excursions through the bush and hardwoods, if you are



interested in the economics of agriculture and forest conservation, let the snake alone. Kill your impulse to kill – not the snake ...

Legless Tree Crop Guards and What they Do  
*Nature Magazine*, Volume I, Number 1, January, 1923 (p. 10)

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

The serpent crest of the king's crown, or of the god's, on the pillars of Egypt, is a mystery; but the serpent itself, gliding past the pillar's foot, is it less a mystery? Is there, indeed, no tongue, except the mute forked flash from its lips, in that running brook of horror on the ground?

*The Queen of the Air*  
Chapter II, 67 (p. 95)  
George Allen. London, England. 1903

The serpent *is* a honeysuckle with a head put on ...

*Deucalion* Volume 2  
Chapter I, 32 (p. 23)  
John Wiley & Sons. New York, New York, USA. 1886

You see that one-half of it can move anywhere without stirring the other; and accordingly you may see a foot or two of a large snake's body moving one way, and another foot or two moving the other way, and a bit between not moving at all; which I, altogether, think we may specifically call 'Parliamentary' motion ...

*Deucalion* (Volume 2)  
Chapter I, 37 (p. 28)  
John Wiley & Sons. London, England. 1886

That rivulet of smooth silver – how does it flow, think you? It literally rows on the earth, with every scale for an oar; it bites the dust with the ridges of its body. Watch it, when it moves slowly – A wave, but without wind! A current, but with no fall! All the body moving at the same instant, yet some of it to one side, some to another, or some forward, and the rest of the coil backwards; but all with the same calm will and equal way – no contraction, no extension; one soundless, causeless march of sequent rings, and spectral procession of spotted dust, with dissolution in its fangs, dislocation in its coils.

*The Queen of the Air*  
Chapter II, 68 (pp. 96–97)  
George Allen. London, England. 1903

Startle it – the winding stream will become a twisted arrow – the wave of poisoned life will lash through the grass like a cast lance. It scarcely breathes with its one lung (the other shriveled and abortive); it is passive to the sun and shade, and is cold or hot like a stone; yet, "it can outclimb the monkey, outswim the fish, outleap the zebra, outwrestle the athlete, and crush the tiger."

*The Queen of the Air*  
Chapter II, 68 (pp. 97–98)  
George Allen. London, England. 1903

It [a snake] is a divine hieroglyph of the demoniac power of the earth – of the entire earthly nature. As the bird is the clothed power of the air, so this is the clothed power of the dust; as the bird the symbol of the spirit of life, so this of the grasp and sting of death.

*The Queen of the Air*  
Chapter II, 68 (p. 98)  
George Allen. London, England. 1903

## ADDER

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

ADDER, *n.* A species of snake. So called from its habit of adding funeral outlays to the other expenses of living.  
*The Collected Works of Ambrose Bierce* (p. 19)  
The Neale Publishing Co. New York, New York, USA. 1911

**Dyer, John** 1699–1757  
Welsh poet

And there the poisonous adder breeds,  
Concealed in ruins, moss and weeds.  
*The Poetical Works of Armstrong, Dyer and Green*  
Grongar Hill  
James Nichol. Edinburgh, Scotland. 1858

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

It is the bright day that brings forth the adder;  
And craves wary walking.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*Julius Caesar*  
Act II, Scene i, l. 14  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ASP

**Flaubert, Gustave** 1821–90  
French novelist

Asp: Animal known through Cleopatra's basket of figs.  
*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

## COBRA

**Nash, Ogden** 1902–71  
American writer of humorous poetry

This creature fills its mouth with venom  
And walks upon its duodenum.  
He who attempts to tease the cobra  
Is soon a sadder he, and sobra.

*Verses from 1929 On*  
The Cobra  
Little, Brown & Company. Boston, Massachusetts, USA. 1959



**COPPERHEAD**

**Harte, Bret** 1884–1929  
American humorist and critic

...he coils in the ooze and the drip  
Like a thong idly flung from the slave-driver's whip...  
*The Poetical Works of Bret Harte*  
The Copperhead  
James R. Osgood & Co. Boston, Massachusetts, USA. 1877

**GARTER SNAKE**

**Cuppy, Will** 1884–1929  
American humorist and critic

The Garter Snake or Striped Snake is our most abundant North American serpent. Although they are always getting killed or driven from their natural homes, there are just as many Garter Snakes as ever, and I can tell you the reason. Garter Snakes are crazy about sex and they don't care who knows it.  
*How to Become Extinct*  
The Garter Snake (p. 53)  
Dover Publications. New York, New York, USA. 1964

**PYTHON**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The python has, and I fib no fibs,  
318 pairs of ribs.  
In stating this I place reliance  
On a séance with one who died for science.  
This figure is sworn to and attested;  
He counted them while being digested.  
*Verses from 1929 On*  
The Python  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Prelutsky, Jack** 1940–  
American poet

A puzzled python shook its head  
and said, "I simply fail  
to tell if I am purely neck,  
or else entirely tail."  
*A Pizza the Size of the Sun: Poems*  
A Puzzled Python  
Greenwillow Books. New York, New York, USA. 1996

**VIPER**

**Cuppy, Will** 1884–1929  
American humorist and critic

Vipers show you what Mother Nature can think up when she puts her mind to it.

*How to Become Extinct*  
The Common Viper (p. 56)  
Dover Publications. New York, New York, USA. 1964

**TORTOISE**

**Herford, Oliver** 1863–1935  
American writer and illustrator

The Tortoise is, to say the Least,  
A very Contradictory Beast.  
Though he may walk the wide world o'er  
He cannot step outside his Door.

*More Animals*  
The Tortoise (p. 3)  
Charles Scribner's Sons. New York, New York, USA. 1901

**von Ebner-Eschenbach, Marie** 1830–1916  
Austrian novelist

Since the well-known victory over the hare by the tortoise, the descendants of the tortoise think themselves miracles of speed.  
Translated by Annis Lee Wister  
*Aphorisms*  
Number 87  
J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

**TURTLE**

**Montgomery, James** 1771–1854  
Scottish poet and journalist

The pregnant turtle, stealing out at eve,  
With-anxious eye, and trembling heart, explored  
The loneliest coves, and in the loose warm sand  
Deposited her eggs, which the sun hatch'd:  
Hence the young brood, that never knew a parent,  
Unburrow'd and by instinct sought the sea;  
Nature herself, with her own gentle hand,  
Dropping them one by one into the flood,  
And laughing to behold their antic joy,  
When launched in their maternal element.

*The Poetical Works of James Montgomery*  
The Pelican Island  
Little, Brown & Co. Boston, Massachusetts, USA. 1860

**Rudloe, Jack** 1943–  
American nature writer

The timeless turtle will look on as man works feverishly to develop destructive nuclear weapons that will blow the world apart many times over. And perhaps one day when he pops his head up from the sea, he'll see a world empty of man, with barnacles growing on the ruins of the cities and buildings. And somewhere, perhaps on a Mexican beach, a handful of Kemp's ridleys filled with eggs will crawl out on the sand, unmolested and free.

*Time of the Turtle*  
Chapter 9 (p. 106)  
Alfred A. Knopf. New York, New York, USA. 1979

**ANIMAL: WORM****EARTHWORM****Author undetermined**

In the eyes of most men...the earthworm is a mere blind, dumb, senseless, and unpleasantly slimy annelid. Mr. Darwin undertakes to rehabilitate his character, and the earthworm steps forth at once as an intelligent and beneficent personage, a worker of vast geological changes, a planer down of mountain sides...a friend of man...and an ally of the Society for the preservation of ancient monuments.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter IX (p. 395)

D. Appleton & Company. New York, New York, USA. 1896

**Beebe, William** 1877–1962

American ornithologist

There are many ways of considering a flatworm. A Creator might rightly be quoted, "He saw that it was good." To an ant accidentally blundering into its slime, the worm would be a certain, evil death. A bird would give it no second glance for its flesh is worse than inedible.

*High Jungle*

Chapter X (p. 171)

Duell, Sloan & Pearce. New York, New York, USA. 1949

**Blake, William** 1757–1827

English poet, painter, and engraver

O rose, thou art sick!  
The invisible worm  
That flies in the night,  
In the howling storm,  
Has found out thy bed  
Of crimson joy,  
And his dark secret love  
Does thy life destroy.

*The Complete Poetry and Prose of William Blake*

Songs of Experience, The Sick Rose

University of California Press. Berkeley, California, USA. 1982

**Boone, John Allen** 1882–1965

Author

...if you should ever encounter me walking along a dirt road and should see me pause, lift my hat and bow to the direction of the ground, you will know that I am paying my respects to a passing earthworm.

*Adventures in Kinship with All Life*

Wormy Ways (p. 123)

Harper & Brothers. New York, New York, USA. 1954

**Darwin, Charles Robert** 1809–82

English naturalist

It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organised creatures.

*Darwin on Humus and the Earthworm: The Formation of Vegetable*

*Mould Through the Action of Worms with Observations on Their Habits*

Chapter VII (p. 148)

Faber & Faber Ltd. London, England. 1945

Archaeologists are probably not aware how much they owe to worms for the preservation of many ancient objects. Coins, gold ornaments, stone implements, &c., if dropped on the surface of the ground, will infallibly be buried by the castings of worms in a few years, and will thus be safely preserved, until the land at some future time is turned up.

*The Formation of Vegetable Mould Through the Action of Worms*

Chapter IV (p. 178)

D. Appleton & Co. New York, New York, USA. 1909

The plough is one of the most ancient and most valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed by earth-worms.

*The Formation of Vegetable Mould Through the Action of Worms*

Chapter VII (p. 316)

D. Appleton & Co. New York, New York, USA. 1907

**Eaton, Burnham**

No biographical data available

The earthworm who, described as lowly,  
Grinds, like the gods, exceedingly slowly,  
Doth also grind exceedingly small.

By diligent, continual

And through subterranean toil,

He doth homogenize the soil.

H-O-M-G-E-N-I-Z-A-T-I-O-N

*Nature Magazine*, Volume 50, Number 1, January, 1957 (p. 41)

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

Few insects enjoy more fame than the Glow-worm, the curious little animal who celebrates the joy of life by lighting a lantern at its tail-end. We all know it, at least by name, even if we have not seen it roaming through the grass, like a spark fallen from the full moon.

Translated by Alexander Teixeira de Mattos

*Fabre's Book of Insects*

Chapter V (p. 60)

Dodd, Mead & Co. New York, New York, USA. 1945

**Garstang, Walter** 1868–1949

English embryologist and amateur poet

The Onchosphere or Hexacanth was not designed for frolic,

His part may be described perhaps as coldly diabolic:

He's born amid some gruesome things, but this should count for virtue,

That steadily, 'gainst fearful odds, he plies his task – to hurt you.

He's now a Cysticerus in the muscles of a pig,  
With just a sporting chance of getting to grow up big.  
If you'll consent to eat your pork half-raw or underdone,  
His troubles will be over, and a Tapeworm will have won:  
He'll cast his anchors out, and on your best digested food

Will thrive, and bud an endless chain to raise a countless brood.

*Larval Forms, and Other Zoological Verses*

The Onchosphere, Stanza 1, 4 (p. 37)

The University of Chicago Press. Chicago, Illinois, USA. 1985

**Gilman, Charlotte Perkins** 1860–1935

American writer and feminist

I don't want to be a fly,

I want to be a worm!

In Burton Egbert Stevenson (ed.)

*The Home Book of Verse*

A Conservative

Henry Holt & Company. New York, New York, USA. 1915

**Hamilton, Jane** 1957–

American author

I spent whole afternoons in the dirt, making my patch of grown flawless. I even cleared the worms away, before I found out that all the tunnels they make give air, and probably other molecules I don't know about yet, to the plants.

*The Book of Ruth*

Chapter Two (p. 18)

Random House, Inc. New York, New York, USA. 1988

**Hooker, Sir Joseph Dalton** 1817–1911

English botanist and explorer

I must own I had always looked on worms as amongst the most helpless and unintelligent members of the creation; and am amazed to find that they have a domestic life and public duties! I shall now respect them, even in our Garden pots; and regard them as something better than food for fishes.

*Life and Letters of Sir Joseph Dalton Hooker* Volume 2

Chapter XL (p. 255)

J. Murray. London, England. 1918

**Martinson, Harry Edmund** 1904–78

Swedish novelist

Who really respects the earthworm,  
the farm worker far under the grass in the soil.

In Robert Bly

*Friends, You Drank Some Darkness: Three Swedish Poets*

The Earthworm (p. 139)

Beacon Press. Boston, Massachusetts, USA. 1975

**Pallister, William Hales** 1877–1946

Canadian physician

Then the WORMS seven thousand of species can show,  
All segmented, possessing a system of nerves:

Life becoming more conscious, beginning to know;  
The small earthworm is soil's great economy serves,  
Bringing earth to the surface, returning again,  
Even thus, he has buried old cities for men!

*Poems of Science*

Beginnings, Animal Life (p. 139)

Playford Press. New York, New York, USA. 1931

**Phillips, Adam**

British child psychotherapist and essayist

What would our lives be like if we took earthworms seriously, took the ground under our feet rather than the skies high above our heads, as the place to look, as well, eventually, as the place to be? It is as though we have been pointed in the wrong direction.

*Darwin's Worms*

Darwin Turns the Worm (pp. 60–61)

Faber & Faber Ltd. London, England. 1999

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

Nature crying out and speaking to country people in these words: Clown, wherefore dost thou behold the heavens? Why dost thou seek after the stars? When thou art now weary with short sleep, the nights are troublesome to thee. So I scatter little stars in the grass, and I shew them in the evening when thy labour is ended, and thou art miraculously allured to look upon them when thou pass-est by: Dost thou not see how a light like fire is covered when she closeth her wings, and she carrieth both night and day with her.

In Thomas Moffett

*The Theater of Insects*

Glow-Worms

Printed by E. Cotes. London, England. 1658

**Sexton, Anne** 1928–74

American poet and writer

Slim inquirer, while the old fathers sleep you are reworking their soil, you have a grocery store there down under the earth and it is well stocked with broken wine bottles, old cigars, old door knobs and earth, that great brown flour that you kiss each day.

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Earthworm

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

Have you no beginning and end? Which heart is the real one? Which eye the seer? Why is it in the infinite plan that you would be severed and rise from the dead like a gargoyle with two heads?

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Earthworm

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

A worm is as good a traveler as a grasshopper or a cricket, and a much wiser settler. With all their activity these do not hop away from drought nor forward to summer. We do not avoid evil by fleeing before it, but by rising above or diving below its plane; as the worm escapes drought and frost by boring a few inches deeper.

*A Week on the Concord and Merrimack Rivers*  
Thursday (pp. 400–401)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

**White, Gilbert** 1720–93  
English naturalist and cleric

The most insignificant insects and reptiles are of much more consequence, and have much more influence in the economy of Nature, than the incurious are aware of; and are mighty in their effect, from their minuteness, which renders them less an object of attention; and from their numbers and fecundity. Earth-worms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm. For, to say nothing of half the birds, and some quadrupeds, which are almost entirely supported by them, worms seem to be the great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and the fibers of plants, by drawing straws and stalks of leaves and twigs into it; and, most of all, by throwing up such infinite numbers of lumps of earth...

*The Natural History of Selborne*  
Letter XXXV  
Robert M. McBride & Company. New York, New York, USA. 1925

## MAGGOT

**Ammons, Archie Randolph** 1926–2001  
American poet

Honor the maggot, supreme catalyst: he spurs the rate of change....

*Collected Poems: 1951–1971*  
Catalyst, I. 1–3  
W.W. Norton & Company, Inc. New York, New York, USA. 1972

## ANIMAL COMMUNITY

**Elton, Charles S.** 1900–91  
English biologist

...the term “animal community” is really a very elastic one, since we can use it to describe on the one hand the fauna of the equatorial forest and on the other hand the fauna of a mouse’s caecum.

*Animal Ecology*  
Chapter II (p. 17)  
Sidgwick & Jackson, Ltd. London, England. 1927

## ANIMAL KINGDOM

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

It is my belief that naturalists are chasing a phantom, in their search after some material gradation among created beings, by which the whole Animal Kingdom may have been derived by successive development from a single germ, or from a few germs.

*Methods of Study in Natural History*  
Preface (pp. iii–iv)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

## ANIMAL LIFE

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

The first steps towards an appreciation of animal life must be taken by the student himself, for no book-lore can take the place of actual observation. The student must wash the quartz and dig for the diamonds, though a book may help him to find these, and thereafter to fashion them into a treasure.

*The Study of Animal Life* (2nd Edition)  
Part I, Chapter I (p. 1)  
John Murray. London, England. 1892

## ANIMAL LIFE, INFLUENCE OF

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

The influence of animal or vegetable life on matter is infinitely beyond the range of any scientific inquiry hitherto entered on. Its power of directing the motions of moving particles, in the demonstrated daily miracle of our human free-will, and in the growth of generation after generation of plants from a single seed, are infinitely different from any possible result of the fortuitous concurrence of atoms; and the fortuitous concurrence of atoms is the sole foundation in Philosophy on which can be founded the doctrine that it is impossible to derive mechanical effect from heat otherwise than by taking heat from a body at a higher temperature, converting at most a definite proportion of it into mechanical effect, and giving out the whole residue to matter at a lower temperature.

*Popular Lectures and Addresses* (Volume 2)  
On the Dissipation of Energy (p. 464)  
Macmillan & Co Ltd. London, England. 1894

## ANIMAL, RIGHTS OF

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

I believe I am not interested to know whether Vivisection produces results that are profitable to the human race or doesn't. To know that the results are profitable to the race would not remove my hostility to it. The pains which it inflicts upon unconsenting animals is the basis of my enmity towards it, and it is to me sufficient justification of the enmity without looking further. It is so distinctly a matter of feeling with me, and is so strong and so deeply-rooted in my make and constitution, that I am sure I could not even see a vivisector vivisected with anything more than a sort of qualified satisfaction. I do not say I should not go and look on; I only mean that I should almost surely fail to get out of it the degree of contentment which it ought, of course, to be expected to furnish.

Letter, London Anti-Vivisection Society, May 26, 1899

## ANIMAL SOUNDS

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

Their [the cricket] song is a monotonous and artless, but well suited in its very lack of art to the simple gladness of reviving life. It is the hosanna of the awakening, the sacred alleluia understood by swelling seed and sprouting blade.

Translated by Alexander Teixeira de Mattos

*Fabre's Book of Insects*

Chapter XII (p. 208)

Dodd, Mead & Co. New York, New York, USA. 1945

**Friend, Tim**

No biographical data available

The different species on this planet may sound different and look different, but all are members of the same extended family, living here for the same essential reasons. And when we open our mouths, it's all animal talk.

*Animal Talk*

Nine (p. 250)

Free Press. New York, New York, USA. 2004

**O'Brien, Flann** 1911–66

Irish novelist and political commentator

"Of the musics you have ever got," asked Conan, "which have you found the sweetest?"...

"I incline to like pig-grunting in Magh Eithne, the bel-lowing of the stag of Ceara, the whinging of fauns in Derrynish. The low warble of water-owls in Loch Barra also, sweeter than life that. I am fond of wing-beating in dark belfries, owl-cries in pregnancy, trout-spurt in a lake-top. Also the whining of small otters in nettle-beds at evening, the croaking of small jays behind a wall, these are heart pleasing.

*At Swim-two-birds*

Chapter I (p. 16)

Maggibbon & Kee. London, England. 1961

## BIRD SONG

**Burroughs, John** 1837–1921

American naturalist and essayist

The charm of the songs of birds, like that of a nation's popular airs and hymns, is so little a question of intrinsic musical excellence and so largely a matter of association and suggestion, or of subjective coloring and reminiscence, that it is perhaps entirely natural for every people to think their own feathered songsters the best.

*Fresh Fields*

English and American Song-birds (p. 123)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1885

## ANIMAL WORLD

**Dr. Hudson**

In the animal world what happiness reigns! What ease, grace, beauty, leisure and content! Watch these living specks as they glide through their forests of algae;, all "without hurry and care," as if their 'span-long lives' could really endure for the thousand years that the old catch pines for. Here is no greedy jostling at the banquet that nature has spread for them, no dread of each other, but a leisurely inspection of the field that shows neither the pressure of hunger nor the dread of an enemy.

Quoted in John Lubbock

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter III (pp. 76–77)

Macmillan & Company Ltd. London, England. 1903

## ANIMAL, CARNIVOROUS

**Joubert, Joseph** 1754–1824

French moralist

Carnivorous animals care not only for their prey, but for the chase. It is their game, their pastime, their pleasure.

All, in fact, hunt gaily – laughingly – so to speak.

Translated by Katharine Lyttelton

*Joubert*

#13 (p. 118)

Dodd, Mead & Co. New York, New York, USA. 1899

## ANIMAL, DISAPPEARANCE OF

**Wilson, Edward O.** 1929–

American biologist and author

It's [the loss of species] like having astronomy without knowing where the stars are.

*Time*, October 13, 1986

## ANIMALCULA

**van Leeuwenhoek, Antony**

1632–1723

Dutch biology researcher and microscope developer

In the past summer I have made many observations upon various waters, and in almost all discovered an abundance of very little and odd animalcules, whereof some were incredibly small, less even than the animalcules which others have discovered in water, and which have been called by the name of Water-flea or Water-louse.

Translated by Clifford Dobell

*Antony van Leeuwenhoek and His "Little Animals"*

Part II, Chapter I (p. 111)

John Bale, Sons, &amp; Danielsson. London, England. 1932

When these animalcula or living Atoms did move, they put forth two little horns, continually moving themselves...

In Clifford Dobell

*Antony van Leeuwenhoek and His "Little Animals"*

Chapter I, Plate XVIII (p. 112)

John Bale, Sons &amp; Danielsson Ltd. London, England. 1932

I now saw very plainly that these were little eels, or worms, lying all huddled up together and wriggling; just as if you say, with the naked eye, a whole tubful of very little eels and water, with the eels a-squirming among one another: and the whole water seemed to be alive with these multifarious animalcules. This was for me, among all the marvels that I have discovered in nature, the most marvellous of all; and I must say, for my part, that no more pleasant sight has ever yet come before my eye than these many thousands of living creatures, seen all alive in a little drop of water ...

Translated by Clifford Dobell

*Antony van Leeuwenhoek and His "Little Animals"*

Part II, Chapter I (p. 144)

John Bale, Sons, &amp; Danielsson. London, England. 1932

...I am persuaded that thirty million of these animalcules together wouldn't take up as much room, or be as big, as a coarse grain of sand.

Translated by Clifford Dobell

*Antony van Leeuwenhoek and His "Little Animals"*

Part II, Chapter I (p. 168)

John Bale, Sons, &amp; Danielsson. London, England. 1932

Here Gentlemen, you have the notes I have kept about my observations on duckweed and little animalcules: in making which I said to myself, How many creatures are still unknown to us, and how little do we yet understand!

In Clifford Dobell

*Antony van Leeuwenhoek and his "Little Animals"*

Part II, Chapter IV (p. 285)

John Bale, Sons &amp; Danielsson Ltd. London, England. 1932

## ANIMOSITY

**Hull, David L.** 1935–

American philosopher of biology

The animosities that arise during the course of science are complicated by the allegiances and alliances scientists form.

*Science As Process*

Chapter One (p. 15)

The University of Chicago Press. Chicago, Illinois, USA. 1988

## ANNUAL MEETING

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

...it is not without some compensating advantages. In these days when science is so much subdivided it is well that students of subjects even so diverse as those with which we have to deal should occasionally meet on common ground, and have the opportunity of learning from each other's lips the kind of work in which they are engaged.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 719)

John Murray. London, England. 1891

## ANOMALY

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Blank accident! Nothing's anomaly!

*The Poetical Works of S. T. Coleridge (Volume 1)*

Human Life

William Pickering. London, England. 1834

**Faraday, Michael** 1791–1867

English physicist and chemist

...the more we can enlarge the number of anomalous facts and consequences the better it will be for the subject; for they can only remain anomalies to us while we continue in error.

In John Tyndall

*Researches on Diamagnetism and Magne-crystalline Action*

Magnetic Remarks by Professor Faraday (p. 218)

Longmans, Green &amp; Co. London, England. 1870

**Iles, George**

No biographical data available

The man of science, like the man of law, has brought before him many an anomaly; but, unlike the judge or the advocate, he knows that the contradictions he studies are



only such in seeming; he feels confident that nature at the core is in agreement with herself.

*Flame, Electricity and the Camera*

Chapter VI (p. 76)

Doubleday & McClure. New York, New York, USA. 1900

**Jevons, William Stanley** 1835–82

English economist and logician

In no part of physical science can we be free from exceptions and outstanding facts, of which our present knowledge can give no account. It is among such anomalies that we must look for the clues to new realms of facts worthy of discovery. They are like the floating waifs which led Columbus to suspect the existence of the New World.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXV (p. 573)

Macmillan & Co Ltd. London, England. 1887

**Lovelock, James Ephraim** 1919–

English scientist

We have had a moon's-eye view of our home in space as it orbits the sun, and we are suddenly aware of being citizens of no mean planet, however mean and squalid the human contribution to this panorama may be in close-up.... [W]e are... a living part of a strange and beautiful anomaly in our solar system.

*Gaia*

Chapter 5 (pp. 59–60)

Oxford University Press. Oxford, England. 1982

## ANSWER

**Adams, Henry Brooks** 1838–1918

American man of letters

Unintelligible answers to insoluble problems.

In Bert Leston Taylor

*The So-Called Human Race* (p. 154)

Alfred A. Knopf. New York, New York, USA. 1922

**Arnold, John E.** 1913–63

American mechanical engineer

... there is no one right answer to creative problems.

In Sidney J. Parnes and Harold F. Harding

*A Source Book for Creative Thinking*

Useful Creative Techniques (p. 252)

Charles Scribner's Sons. New York, New York, USA. 1962

**Atkins, Peter William** 1940–

English physical chemist and writer

The stern and stony eye of science seeks answers that are not grounded in the fundamentality of purpose.

Will Science Ever Fail?

*New Scientist* August 8, 1992 (p. 32)

**Bauer, Henry H.** 1931–

American chemist

That science does not have all the answers does not mean that it has no answers. That science now has inadequate answers in some areas does not mean that the answers will not become adequate in the future; in fact, history teaches that science's answers become better and better as time goes by. That science is fallible does not mean that science is entirely fallible or that it is as fallible as such other modes of human knowledge and belief as folklore, religion, political ideology, or social science. That science has no answers in some matters – such as the value of human life or the purpose of living – does not mean that it has no answers in other areas – those areas that are within its purview, matters of forces and substances and natural phenomena. And that science has no direct answers on matters of human purpose does not mean that its answers on other matters have no bearing on how, and how well, we are able to think about human purpose, free will, and other such things.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 144)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

And his answer trickled through my head,  
Like water through a sieve.

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter VIII (p. 243)

The Modern Library. New York, New York, USA. 1936

**Charlie Chan (Fictional character)**

Even wisest man cannot answer until he knows question.

*Charlie Chan's Greatest Case*

Film (1933)

If answer known, question seem unnecessary.

*Charlie Chan in Shanghai*

Film (1935)

**Dyson, Freeman J.** 1923–

American physicist and educator

At Cornell, I was simply puzzled and mystified by [Richard] Feynman's stuff. I couldn't figure out how he was getting all those amazing answers which turned out to be right. It was just a great mystery. I didn't understand it and, as far as I could tell, nobody else did.

In Christopher Sykes (ed.)

*No Ordinary Genius: The Illustrated Richard Feynman*

Chapter Three (p. 73)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Einstein, Albert** 1879–1955

German-born physicist

The answer is 'yes' or 'no', depending on the interpretation.

On the Generalized Theory of Gravitation

*Scientific American*, Volume 182, Number 4, April, 1950 (p. 13)



**Faraday, Michael** 1791–1867

English physicist and chemist

So much is unknown to the wisest man, that he may often be without an answer: as frequently he is so, because the subject is in the region of hypothesis, and not of facts.

*Experimental Researches in Chemistry and Physics*

Lecture on Mental Education (p. 486)

Richard Taylor & William Francis. London, England. 1859

**Feynman, Richard P.** 1918–88

American theoretical physicist

Quantum Mechanics is the description of the behavior of matter in all its details and, in particular, of the happenings on an atomic scale. Things on a very small scale behave like nothing that we have any direct experience about. They do not behave like waves, they do not behave like particles, they do not behave like clouds, or billiard balls, or weights or springs, or like anything that you have ever seen....

Because atomic behavior is so unlike ordinary experience, it is very difficult to get used to and it appears peculiar and mysterious to everyone, both to the novice and to the experienced physicist.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Quantum Behavior (pp. 116, 117)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Friedlander, Michael W.**

Physicist

There are many more wrong answers than right ones, and they are easier to find.

*At the Fringes of Science*

Chapter 6 (p. 78)

Westview Press. Boulder, Colorado, USA. 1995

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

...people often reach correct answers for wrong or illogical reasons.

*Eight Little Piggies: Reflections in Natural History*

Chapter I (p. 29)

W.W. Norton & Co. New York, New York, USA. 1993

**Hawking, Stephen William** 1942–

English theoretical physicist

There may be ultimate answers, but if there are, I would be sorry if we were to find them. For my own sake I would like very much to find them, but their discovery would leave nothing for those coming after me to seek. Each generation builds on the advances of the previous generation, and this is as it should be. As human beings, we need the quest.

In J.L. Wilhelm

A Singular Man

*Quest*, April, 1979 (p. 39)

**Hodnett, Edward** 1901–84

English illustration historian

You have to ask a precise question to get a precise answer.

*The Art of Problem Solving*

Part I, Chapter 5 (p. 37)

Harper & Brothers. New York, New York, USA. 1955

**McKuen, Rod** 1933–

American poet

Think of all the men who never knew the answers think of all those who never even cared.

Still there are some who ask why who want to know, who dare to try.

*Listen to the Warm*

Here He Comes Again

Random House, Inc. New York, New York, USA. 1967

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932

Latvian-born German chemist

Science will always give a clear answer; if not today, in the near future.

*Letters to a Painter on the Theory and Practice of Painting*

Letter X (p. 92)

Ginn & Co. Boston, Massachusetts, USA. 1907

**Pasteur, Louis** 1822–95

French chemist

Science proceeds by successive answers to questions more and more subtle, coming nearer and nearer to the very essence of phenomena.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter VII (p. 207)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Poe, Edgar Allan** 1809–49

American short story writer and poet

I shall always know what to answer, and my reply will be imposed upon me by the witness of my senses.

Translated by George Bruce Halsted

*The Value of Science* (p. 118)

The Science Press. New York, New York, USA. 1907

**Price, Vincent** 1911–93

American actor

I shall look for the answer tonight at the bottom of a large rum and coke.

*The Eve of St. Mark*

Film (1944)

**Rothman, Tony** 1953–

American cosmologist

You only arrive at the right answer after making all possible mistakes. The mistakes began with the Greeks.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Prologue (p. 1)

Ballentine Books. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

From the point of view of philosophy, however, the discovery that a question is unanswerable is as complete an answer as any that could possibly be obtained.

*Mysticism and Logic: And Other Essays*

Chapter VI (p. 118)

Longmans, Green & Co. London, England. 1919

**Sagan, Carl** 1934–96  
American astronomer and author

We make our world significant by the courage of our questions and by the depth of our answers.

*Cosmos*

Chapter VII (p. 193)

Random House, Inc. New York, New York, USA. 1980

I find it more difficult, but also much more fun, to get the right answer by indirect reasoning and before all the evidence is in. It's what a theoretician does in science. But the conclusions drawn in this way are obviously more risky than those drawn by direct measurement, and most scientists withhold judgment until there is more direct evidence available. The principal function of such detective work – apart from entertaining the theoretician – is probably to so annoy and enrage the observationalists that they are forced, in a fury of disbelief, to perform the critical measurements.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 16 (p. 121)

Dell Publishing, Inc. New York, New York, USA. 1975

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

I was gratified to be able to answer promptly, and I did. I said I didn't know.

*Life on the Mississippi*

Chapter VI (p. 49)

Harper & Row, Publishers. New York, New York, USA. 1951

**van Gulik, Robert Hans** 1910–1967  
Dutch writer

Approach your problems from the right end and begin with the answers. Then, one day, perhaps you will find the final answer.

*The Haunted Monastery and The Chinese Maze Murders*

*The Chinese Maze Murders*

Nineteenth Chapter (p. 259)

Dover Publications. New York, New York, USA. 1977

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

...an answer which cannot be expressed the question too cannot be expressed.

*Tractatus Logico-Philosophicus*

6.5 (p. 187)

Harcourt, Brace & Co. New York, New York, USA. 1922

**Woodson, Thomas T.**  
American engineer

...it is safe money to wager that an unproven answer is wrong...

*Introduction to Engineering Design* (p. 240)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

## ANTHROPIC PRINCIPLE

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

...the Anthropic Principle does not assert that our existence somehow *compels* the laws of physics to have the form they do, nor need one conclude that the laws have been deliberately designed with people in mind. On the other hand, the fact that even slight changes to the way things are might render the universe unobservable is surely a fact of fundamental significance.

*The Mind of God: The Scientific Basis for a Rational World*

Chapter 8 (p. 200)

Simon & Schuster. New York, New York, USA. 1992

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

We are situated in a vast universe and are products of it. We cannot detach ourselves from it and say, "we do not want the rest of the universe; the stars are no good to us; so long as we have our sun all the rest may go." The universe is a mighty organism; its whole aspect and structure assure us of the fact. We are a portion of it, and owe our position, our surroundings, our very existence to it. Looking at it as an evolutionist, I believe that it is only by tracing it back to some necessary earlier state that we shall be able to form some rational conception of how it has evolved, how it has come to be what it is, how we have come to be where we are. Then, and then only, shall we be able to give any probable answer to the question, What advantages have we derived from our nearly central position?

Man's Place in the Universe

*The Independent (New York)* Volume 55, 1903 (p. 2030)

## ANTHROPOMORPHISM

**Ardrey, Robert** 1908–80  
American anthropologist

There are times when anthropomorphisms are almost irresistible to even the most rigorous scientists. As unlikely victims as Niko Tinbergen and David Lack have found the word "righteous" inescapable when describing the behavior of a territorial proprietor threatened by an intruder.

*The Social Contract: A Personal Inquiry into the Evolutionary Sources of Order and Disorder*  
The Alpha Fish (p. 135)  
Atheneum. New York, New York, USA. 1970

## ANTHROPOLOGIST

**Grindal, Bruce** 1940–  
American anthropologist

**Salamone, Frank**  
Anthropologist

Anthropologists working in the USA must deal with a society with many different faces and voices, despite its overall familiarity. They must confront the challenge of being strangers in need of friends to guide them through the maze of assumptions that shape life just around the corner.

*Bridges to Humanity: Narrative on Anthropology and Friendship*  
Eutaw Jack (p. 7)  
Waveland Press, Inc. Prospect Heights, Illinois, USA.

The relationship between the anthropologist and a fellow human being in the field is many times problematic, involving contradictory feelings and the mutual and painful exchange of personhood and value. The anthropologist's understanding of that friendship is often not realized at the time but must await a later-life maturity that awakens the deeper revelations of a life lived.

*Bridges to Humanity: Narrative on Anthropology and Friendship*  
Immortality Denied (p. 63)  
Waveland Press, Inc. Prospect Heights, Illinois, USA.

The dilemma for social scientists is how to apply the precision of science to the ambiguity of human relationships. The particular problem for anthropologists is how to do this among people who live in social worlds created by different assumptions about reality. It is no doubt a comment on the human condition (or nature, if you will) that this cultural abyss is regularly bridged. Scientists and native, self and Other, subject and object become friends, sometimes more.

*Bridges to Humanity: Narrative on Anthropology and Friendship*  
Remembering Cinita (p. 115)  
Waveland Press, Inc. Prospect Heights, Illinois, USA.

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

My dentist, patching up a tooth, warned me that I must understand, of course, that this was only temporary, and he seemed startled when I replied that so, after all, was life itself. What should so temporary a creature as I want with a really permanent set of teeth? They might possibly be of interest to some future anthropologist, but I can have no need for them.

*The Twelve Seasons*  
June (p. 43)  
W. Sloane Associates. New York, New York, USA. 1949

## ANTHROPOLOGY

### Author undetermined

Unfortunately, the vast majority of artists' conceptions are based more on imagination, than evidence.... Much of the reconstruction, however, is guesswork. Bones say nothing about the fleshy parts of the nose, lips, or ears. Artists must create something between an ape and a human being: the older a specimen is said to be, the more ape-like they make it.... Hairiness is a matter of pure conjecture. The guesswork approach often leads to errors.

Anthropological Art  
*Science Digest*, Volume 89, Number 3, April, 1981 (p. 44)

**Barley, Nigel** 1947–  
English anthropologist

Anthropology is not short of facts but simply of anything intelligent to do with them. The notion of "butterfly collecting" is familiar within the discipline and serves to characterize the endeavors of many ethnographers and failed interpreters, who simply amass neat examples of curious customs arranged by area, or alphabetically, or by evolutionary order, whatever the current style may be.

*The Innocent Anthropologist: Notes from a Mud Hut*  
Chapter 1 (pp. 9–10)  
British Museum Publications. London, England. 1983

**Boas, Franz** 1858–1942  
German-born American anthropologist

Anthropology is often considered a collection of curious facts, telling about the peculiar appearance of exotic people and describing their strange customs and beliefs. It is looked upon to an entertaining diversion, apparently without any bearing upon the conduct of life of civilized communities. This opinion is mistaken. More than that, I hope to demonstrate that a clear understanding of the principles of anthropology illuminates the social process of our own times and may show us, if we are ready to listen to its teachings, what to do and what to avoid.

*Anthropology and Modern Life*  
Chapter I (p. 11)  
W.W. Norton & Company, Inc. New York, New York, USA. 1928

...anthropology is the science that endeavors to reconstruct the early history of mankind, and that tries, wherever possible, to express in the form of laws ever-recurring modes of historical happenings.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Anthropology (p. 8)  
The Columbia University Press. New York, New York, USA. 1908

**Diamond, Stanley** 1922–

Anthropology, abstractly conceived as the study of man, is actually the study of men in crisis by men in crisis.

*In Search of the Primitive: A Critique of Civilization*  
Chapter 3 (p. 93)  
Transaction Books. New Brunswick, New Jersey, USA. 1974

**Flannery, Kent V.** 1932–  
American environmental archaeologist

Archaeology is the only branch of anthropology where we kill our informants in the process of studying them. The Golden Marshalltown: A Parable for the Archaeology of the 1980s *American Anthropologist*, Volume 84, 1982

**Geertz, Clifford** 1926–  
American anthropologist

There is not much assurance or sense of closure, not even much sense of knowing what it is one precisely is after, in so indefinite a quest, amid such various people, over such a diversity of times. But it is an excellent way, interesting, dismaying, useful, and amusing, to expend a life. *After the Fact: Two Countries, Four Decades, One Anthropologist* Chapter 6 (p. 168) Harvard University Press. Cambridge, Massachusetts, USA. 1995

**Herskovits, Melville Jean** 1895–1963  
American anthropologist

No branch of anthropology requires more inference, or the weighing of imponderables; in short, the exercise of the scientific imagination, than prehistory. *Man and His Works* Chapter 7 (p. 97) Alfred A. Knopf. New York, New York, USA. 1949

**Huxley, Thomas Henry** 1825–95  
English biologist

Reckoned by centuries, the remoteness of the quaternary, or pleistocene, age from our own is immense, and it is difficult to form an adequate notion of its duration. Undoubtedly there is an abysmal difference between the Neanderthaloid race and the comely living specimens of the blond long heads with whom we are familiar. But the abyss of time between the period at which North Europe was first covered with ice, when savages pursued mammoths and scratched their portraits with sharp stones in central France, and the present day, ever widens as we learn more about the events which bridge it. And, if the differences between the Neanderthaloid men and ourselves could be divided into as many parts as that time contains centuries, the progress from part to part would probably be almost imperceptible.

*Man's Place in Nature and other Anthropological Essays* Chapter VI (p. 328) D. Appleton & Company. New York, New York, USA. 1896

**Kluckhohn, Clyde** 1905–60  
American anthropologist

...anthropology...has explored the gamut of human variability and can best answer the questions: what common ground is there between human beings of all tribes and nations? What differences exist? what is their source? how deep-going are they?

*Mirror for Man: The Relation of Anthropology to Modern Life* Chapter I (p. 2) McGraw-Hill Book Company, Inc. New York, New York, USA. 1949

Moreover, the recipe for action that must be drawn from applied anthropology thus far is that of caution, of modest expectations as to what can be accomplished by planning, of humanity as to what may be predicted with present instruments for observing and conceptualizing, of preference for *vis medicatrix naturae* in many social situations.

*Mirror for Man: The Relation of Anthropology to Modern Life* Chapter X (p. 262) McGraw-Hill Book Company, Inc. New York, New York, USA. 1949

**Marett, Robert Randolph** 1866–1943  
Social anthropologist

Anthropology is the child of Darwin. Darwinism makes it possible. Reject the Darwinian point of view, and you must reject anthropology also.

*Anthropology* Chapter I (p. 8) Henry Holt & Co. New York, New York, USA. 1912

Once people take up anthropology, they may be trusted not to drop it again. It is like learning to sleep with your window open. What could be more stupefying than to shut yourself up in a closet and swallow your own gas? But is it any less stupefying to shut yourself up within the last few thousand years of the history of your own corner of the world, and suck in the stale atmosphere of its own self-generated prejudices?

*Anthropology* Chapter I (p. 10) Henry Holt & Co. New York, New York, USA. 1912

...anthropology is like travel. Everyone starts by thinking that there is nothing so perfect as his own parish. But let a man go aboard ship to visit foreign parts, and, when he returns home, he will cause that parish to wake up.

*Anthropology* Chapter I (p. 10) Henry Holt & Co. New York, New York, USA. 1912

...anthropology has devoted most of its attention to the peoples of rude – that is to say, of simple – culture, who are vulgarly known to us as “savages.” The main reason for this, I suppose, is that nobody much minds so long as the darwinizing kind of history confines itself to outsiders. Only when it is applied to self and friends is it resented as an impertinence.

*Anthropology* Chapter I (p. 11) Henry Holt & Co. New York, New York, USA. 1912

...anthropology is science in whatever way history is science; that it is not philosophy, though it must conform to its needs; and that it is not policy, though it may subserve its designs.

*Anthropology*

Chapter I (p. 12)

Henry Holt &amp; Co. New York, New York, USA. 1912

**Mead, Margaret** 1901–78

American anthropologist

Everything is grist for anthropology's mill.

In Jane Howard

*Margaret Mead: A Life*

Chapter Twenty-One (p. 319)

Simon &amp; Schuster. New York, New York, USA. 1984

[Anthropology demands] the open-mindedness with which one must look and listen, record in astonishment and wonder that which one would not have been able to guess.

*Sex and Temperament in Three Primitive Societies*

Preface (p. ix)

Routledge &amp; Kegan Paul. London, England. 1977

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Isolated amidst a nature where everything was a mystery to him, terrified at each unexpected manifestation of incomprehensible forces, he [primitive man] was incapable of seeing in the conduct of the universe anything but caprice...

*The Foundations of Science* (p. 290)

The Science Press. New York, New York, USA. 1913

**ANTIBIOTIC****Fleming, Alexander** 1881–1955

Scottish bacteriologist

It seems likely that in the next few years a combination of antibiotics with different antibacterial spectra will furnish a "*cribrum therapeuticum*" from which fewer and fewer infecting bacteria will escape.

*Chemotherapy: Yesterday, Today, and Tomorrow* (p. 36)

Cambridge University Press. Cambridge, England. 1946

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It is fortunate for human beings that no Geneva convention forbids the prosecution of germ warfare by germs themselves; if it did, there would be no antibiotics...

*Aristotle to Zoos: A Philosophical Dictionary of Biology*

Antibiotics (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1983

**ANTIBODY****Burnet, Sir Frank Macfarlane** 1899–1985

Australian virologist

The production of antibody is not the only, nor I believe the most important, manifestation of immunity, but for

reasons both historical and of experimental convenience antibody is likely to remain the touchstone of immunological theory. Any formulation of theory must cover the nature of antibody and lay down the conditions under which it will or will not be produced.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Immunological Recognition of Self

Elsevier Publishing Co. Amsterdam, The Netherlands. 1964

**ANTI-EVOLUTIONISM****Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It is naïve to suppose that the acceptance of evolution theory depends upon the evidence of a number of so-

called "proofs"; it depends rather upon the fact that the evolutionary theory permeates and supports every branch of biological science, such as the notion of the roundness of the earth underlies all geodesy and all cosmological theories on which the shape of the earth has a bearing. Thus anti-evolutionism is of the same stature as flat-earthism.

In Alan Bullock and Stephen Trombley (eds.)

*The Norton Dictionary of Modern Thought*

Evolution (p. 293)

W.W. Norton &amp; Co. New York, New York, USA. 1999

**ANTI-MATHEMATICIAN****Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

...the anti-mathematician must belong to the same class as the paradoxer, whose characteristic is to be wise in his ignorance, whereas the really wise man is ignorant in his wisdom.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 7)

D. van Nostrand Co. New York, New York, USA. 1893

**ANTI-MATTER****Furth, Harold P.** 1930–2002

Austrian-American physicist

Well beyond the troprostrata

There is a region stark and stellar

Where, on a streak of anti-matter

Lived Dr. Edward Anti-Teller.

Perils of Modern Living

*The New Yorker*, November 10, 1956 (The Talk of the Town, p. 56)**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

I think that this discovery of antimatter was perhaps the biggest jump of all the big jumps in physics in our century.



In J. Mehra (ed.)

*The Physicist's Conception of Nature: Symposium on the Development of the Physicist's Conception of Nature in the Twentieth Century*  
Chapter 11 (p. 271)

Reidel. Boston, Massachusetts, USA. 1973

**Schuster, Sir Arthur** 1851–1934

English physicist

Astronomy, the oldest and most juvenile of the sciences, may still have some surprises in store. May anti-matter be commended to its care!

Letter to the Editor, Potential Matter – A Holiday Dream  
*Nature*, Volume 58, Number 1503, August 18, 1898 (p. 367)

**Updike, John** 1932–

American novelist, short story writer, and poet

Think binary. When matter meets antimatter, both vanish, into pure energy. But both existed; I mean, there was a condition we'll call "existence." Think of one and minus one. Together they add up to zero, nothing, nada, niente, right? Picture them together, then picture them separating – peeling apart... Now you have something, you have two somethings, where you once had nothing.

*Roger's Version*

Chapter V (p. 304)

Alfred A. Knopf. New York, New York, USA. 1986

## ANTI-SCIENCE

**Asimov, Isaac** 1920–92

American author and biochemist

A public that does not understand how science works can, all too easily, fall prey to those ignoramuses...who make fun of what they do not understand, or to the sloganeers who proclaim scientists to be the mercenary warriors of today, and the tools of the military. The difference ... between ... understanding and not understanding ... is also the difference between respect and admiration on the one side, and hate and fear on the other.

In Lewis Wolpert

*The Unnatural Nature of Science*

Introduction (p. ix)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**France, Anatole (Jean Jacques Brousson)** 1844–1924

French writer

I hate science...for having loved it too much, after the manner of voluptuaries who reproach women with not having come up to the dream they formed of them.

*The Opinions of Jérôme Coignard* (Volume 2)

Chapter 9 (p. 113)

John Lane. London, England. 1923

**Gissing, George** 1857–1903

English novelist

I hate and fear science because of my conviction that for long to come if not forever, it will be the remorseless

enemy of mankind. I see it destroying all simplicity and gentleness of life, all the beauty of the world; I see it restoring barbarism under a mask of civilization; I see it darkening men's minds and hardening their hearts; I see it bringing a time of vast conflicts which will pale into insignificance "the thousand wars of old" and, as likely as not, will wheel all the laborious advances of mankind in blood-drenched chaos.

In Morris Goran

*Science and Anti-Science*

Chapter 3 (p. 23)

Ann Arbor Science Publishers Inc. Ann Arbor, Michigan, USA. 1974

**Green, Celia** 1935–

English philosopher and psychologist

The object of modern science is to make all aspects of reality equally boring, so that no one will be tempted to think about them.

*The Decline and Fall of Science*

Aphorisms (p. 2)

Hamilton. London, England. 1976

## ANTIQUITY

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...antiquities are history defaced, or some remnants of history, which have casually escaped the shipwreck of time.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter II, Section 1 (p. 34)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Antiquities, or remnants of history, are, as was said, "*tanquam tabula naufragii*": when industrious persons, by an exact and scrupulous diligence and observation, out of monuments, names, words, proverbs, traditions, private records and evidences, fragments of stories, passages of books that concern not story, and the like, do not save and recover somewhat from the deluge of time.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter II, Section 3 (p. 34)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...out of genealogies, annals, titles, monuments, coins, proper names and styles, etymologies of words, proverbs, traditions, archives and instruments as well public as private, fragments of histories scattered about in books not historical – contrive, I say, from all these things or some of them, to recover somewhat from the deluge of time ...

In James Spedding, Robert Leslie Ellis and Douglas Denon Heath

*The Works of Francis Bacon* (Volume 4)

*On the Dignity and Advancement of Learning*

Book II, Chapter VI (p. 304)

Longman & Co. London, England. 1858

**Browne, Sir Thomas** 1605–82  
English author and physician

Time which antiquates antiquities, and hath an art to make dust of all things, hath yet spared these minor monuments.

In David Lloyd Roberts  
*Religio Medici and Other Essays*  
*Hydriotaphia*  
Chapter V (p. 294)  
Sherratt & Hughes. Manchester, England. 1902

**Bury, John Bagnell** 1861–1927  
English historian and classical scholar

All the epochs of the past are only a few of the front carriages, and probably the least wonderful, in the van of an interminable procession.

*An Inaugural Lecture*  
The Science of History (pp. 28–29)

**Chapin, Edwin Hubbell** 1840–80  
Universalist minister, author, lecturer, and social reformer

Old ages are like the landscape that shows best in purple distance, all verdant and smooth and bathed in mellow light. But could we go back and touch the reality, we should find many a swamp of disease, and rough and grimy paths of rock and mire.

*Humanity in the City*  
Chapter II (pp. 46–47)  
De Witt & Davenport. New York, New York, USA. 1854

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

As an antiquity of a new order, I have been obliged to learn the art of deciphering and restoring these remains, of discovering and bringing together, in their primitive arrangements, the scattered and mutilated fragments of which they are composed, of reproducing, in all their original proportions and characters, the animals to which these fragments formerly belonged, and then of comparing them with those animals which [are] still on the surface of the earth, an art which is almost unknown, and which presupposes, what had scarcely been obtained before, an acquaintance with those laws which regulate the coexistence of the forms by which the different parts of organized beings are distinguished.

*An Essay on the Theory of the Earth*  
Section I (pp. 1–2)  
Kirk & Mercein. New York, New York, USA. 1818

**de Verminac Saint-Maur, E.**  
No biographical data available

Antiquity is a garden that belongs by natural right to those who cultivate and harvest its fruits.

*Voyage de Luxor*  
Publisher undetermined  
Paris, France. 1835

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and writer

The door to the past is a strange door. It swings open and things pass through it, but they pass in one direction only. No man can return across that threshold, though he can look down still and see the green light waver in the water weeds.

*The Immense Journey*  
The Snout (p. 54)  
Vintage Books. New York, New York, USA. 1957

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

How cunningly nature hides every wrinkle of her inconceivable antiquity under roses and violets and morning dews.

Address  
Literary Societies of Dartmouth College, 22 July 1863

**Erzinclioglu, Zakaria** 1951–2002  
Turkish forensic entomologist

One of the most absurd and persistent misuses of words in science is the use of the word “ancient” to describe species that flourished millions of years ago. The truth is that organisms that lived long ago are “young” relative to those alive today. The animals themselves are not ancient in any sense at all. They died out a long time ago when the Earth was young. Why do we persist in misusing the term in this way.

Ancient Error  
*Nature*, Volume 355, Number 6357, January 16, 1992 (p. 195)

**Fuller, Thomas** 1608–61  
English clergyman and writer

... the pyramids themselves, dotting with age, have forgotten the names of their founders.

*The Holy and Profane State*  
Book III, Chapter XIV, Maxim VI (p. 180)  
Printed for Thomas Tegg. London, England. 1841

**Howell, James** 1594–1666  
English writer

They who make research into antiquity, may be said to pass often through many dark lobbies and dusky places before they come to the Aula Lucis, the great hall of light; they must repair to old archives, and peruse many moulded and moth-eaten records, and so bring light, as it were, out of darkness, to inform the present world what the former did, and make us see truth through our ancestors’ eyes.

*Londonopolis*  
Publisher undetermined

**Irving, Washington** 1783–1859  
American essayist and short story writer

History fades into fable; fact becomes clouded with doubts and controversy; the inscription moulders from



the tablet; the statue falls from the pedestal. Columns, arches, pyramids, what are they but heaps of sand; and their epitaphs, but characters written in the dust?

*The Sketch Book of Geoffrey Crayon*

Westminster Abbey

Belford, Clarke & Co. Chicago, Illinois, USA. 1886

**Joubert, Joseph** 1754–1824

French moralist

Antiquity! I love your ruins better than your restorations.

Translated by H.P. Collins

*Pensées and Letters of Joseph Joubert*

Chapter XVI (p. 108)

Books for Libraries Press, Freeport, New York, USA. 1972

**Mellor, Joseph William** 1863–1938

Chemist

...as man emerged from the mists of prehistoric antiquity, everything must have appeared to be full of wonder and mystery. He was overawed by the wind and the rain; by the lightning and the thunder; by the eclipse and the comet; and by the rainbow and the clouds. The student of nature lived in a bewildering dreamland of mixed magic and myth which led him to ascribe supernatural explanations to inaccurately known facts, and consequently, he seemed to be surrounded on all sides by *un monde invisible des esprits et des demons*.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 2)

Longman, Green, & Co. London, England. 1922

**Oldfield, E.**

No biographical data available

Within no very distant period the study of antiquities has passed, in popular esteem, from contempt to comparative honour.

Introductory Address

*Archaeological Journal*, Volume IX, March, 1852 (p. 1)

**Pallister, William Hales** 1877–1946

Canadian physician

The ruined tombs of Egypt tell their tale,  
Survival-hopes of what was once mankind.  
Now sands are drifted deep as we unwind  
The bones of former rulers, now for sale:  
Thus does the splendor of the tomb avail!

*Poems of Science*

Men and the Stars, In Egypt (p. 91)

Playford Press. New York, New York, USA. 1931

**Pope, Alexander** 1688–1744

English poet

With sharpen'd sight pale Antiquaries pore,  
Th' inscription value, but the rust adore.  
This the blue varnish, that the green endears;  
The sacred rust of twice ten hundred years.

*The Complete Poetical Works*

Epistle to Mr. Addison, l. 35

Houghton Mifflin Company. New York, New York, USA. 1903

**Prior, Matthew** 1664–1721

English poet and diplomat

My copper-lamps, at any rate,  
For being true antique, I bought;  
Yet wisely melted down my plate,  
On modern models to be wrought;  
And trifles I alike pursue,  
Because they're old, because they're new.

*The Poetical Works of Matthew Prior*

Alma, Canto III, l. 458–463

Oxford University Press, Inc. New York, New York, USA. 1950

**Thomas, Cyrus** 1825–1910

American anthropologist

To gather and describe antiquities, although thoroughly and intelligently done, is by no means all of archaeology. True, these are to archaeology what the unfashioned and unadjusted materials of which the house is to be built are to the house, but they are not the house.

*Introduction to the Study of North American Archaeology*

Chapter I (p. 1)

The Robert Clarke Co. Cincinnati, Ohio, USA 1898

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

We do not associate the idea of antiquity with the ocean, nor wonder how it looked a thousand years ago, as we do of the land, for it was equally wild and unfathomable always.

*Cape Cod*

Chapter IX (p. 219)

Thomas Y. Crowell & Co. New York, New York, USA. 1908

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

True the billiard-tables were of the Old Silurian Period and the cues and balls of the Post-Pliocene; but there was refreshment in this, not discomfort; for there are rest and healing in the contemplation of antiquities.

*Life on the Mississippi*

Chapter XXII (p. 189)

Harper & Row, Publishers. New York, New York, USA. 1951

## APHORISM

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Exclusive of the abstract sciences, the largest and worthiest portion of our knowledge consists of *aphorisms*: and the greatest and best of men is but an *aphorism*.

*Aids to Reflection*

Aphorism XXVII (p. 16)

George Bell & Sons. London, England. 1904

**Fitch, Sir Joshua Girling** 1824–1903  
English educationist

No number of facts or aphorisms learned by heart makes a man a thinker, or does him much intellectual service.

*Lectures on Teaching*  
Chapter XI (p. 288)  
The Macmillan Co. New York, New York, USA. 1906

## APOTHECARIES

**Sterne, Laurence** 1713–68  
English novelist and humorist

Attornies are to lawyers, what apothecaries are to physicians only that they do not deal in *scruples*.

*The Works of Laurence Sterne: With a Life of the Author The Koran* (p. 335)  
William Durell & Co. New York, New York, USA. 1814

## APOTHECARY

**Colman, George (the Younger)** 1762–1836  
English playwright

A man, in a country town, we know,  
Professes openly with death to wrestle;  
Ent'ring the field against the grimly foe,  
Armed with a mortar and a pestle.  
Yet, some affirm, no enemies they are;  
But meet just like prize-fighters, in a fair,  
Who first shake hands before they box,  
Then give each other plaguy knocks,  
With all the love and kindness of a brother:  
So, many a suff'ring patient saith,  
Though the Apothecary fights with Death,  
Still they're sworn friends to one another.

In Helen and Lewis Melville  
*An Anthology of Humorous Verse*  
The Newcastle Apothecary  
Dodd, Mead & Company New York, New York, USA. 1924

**Hazlitt, William Carew** 1834–1913  
English bibliographer

One said an Apothecaries house must needs be healthful, because the windows, benches, boxes, and almost all the things in the house, tooke physick.

*Shakespeare Jest Books* (Volume 3)  
Conceit, Clichés, Flashes and Whimzies, Number 41  
Willis & Sotheran. London, England. 1864

**Pope, Alexander** 1688–1744  
English poet

So modern Pothecaries taught the Art  
By Doctor's Bills to play the Doctor's Part,  
Bold in the Practice of mistaken Rules,  
Prescribe, apply, and call their Masters Fools.

*The Complete Poetical Works*  
An Essay on Criticism, Part I, l. 108–111  
Houghton Mifflin Company. New York, New York, USA. 1903

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

I do remember an apothecary –  
And hereabouts he dwells – which late I noted  
In tatter'd weeds, with overwhelming brows,  
Culling of simples; meager were his looks,  
Sharp misery had worn him to the bones:  
And in his needy shop a tortoise hung,  
An Alligator stuff'd, and other skins  
Of ill-shaped fishes; and about his shelves  
A beggarly account of empty boxes,  
Green earthen pots, bladders and musty seeds,  
Remnants of packthread and old cakes of roses,  
Were thinly scatter'd to make up a show.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*Romeo and Juliet*  
Act V, Scene i, l. 37–48  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## APPEARANCE

**Balfour, Arthur James** 1848–1930  
English prime minister

Unless appearances are to be trusted, why should we believe in Science? If Science is true, how can we trust to appearances?

In Wilfred M. Short  
*Arthur James Balfour: As Philosopher and Thinker*  
Science; and Science and Theology (p. 449)  
Longmans, Green & Company. New York, New York, USA. 1912

**Leclerc, George-Louis, Comte de Buffon** 1707–88  
French naturalist

There is a strange variety in the appearance of individuals, and at the same time a constant resemblance in the whole species.

*Buffon's Natural History* (Volume 5) (pp. 128–129)  
London, England. 1812

## APPLICATION

**Babbage, Charles** 1792–1871  
English mathematician

...long intervals frequently elapse between the discovery of new principles in science and their practical application: nor ought this at all to surprise us. Those intellectual qualifications, which give birth to new principles or to new methods, are of quite a different order from those which are necessary for their practical application.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter II (p. 17)

Printed for B. Fellowes. London, England. 1830

**Boole, George** 1815–64

English mathematician

Each new scientific conception gives occasion to new applications of deductive reasoning; but those applications may be only possible through the methods and the processes which belong to an earlier stage.

*A Treatise on Differential Equations*

Preface (p. vi)

Macmillan & Co Ltd. London, England. 1877

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

There cannot be a greater mistake than that of looking superciliously upon practical applications of science. The life and soul of science is its practical application, and just as the great advances in mathematics have been made through the desire of discovering the solution of problems which were of a highly practical kind in mathematical science, so in physical science many of the greatest advances that have been made from the beginning of the world to the present time have been made in the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind.

*Popular Lectures and Addresses* (Volume 1)

Lecture, Institution of Civil Engineers

May 3, 1883 (pp. 79–80)

Macmillan & Company Ltd. London, England. 1894

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

It is no paradox to say that in our most theoretical moods we may be nearest to our most practical applications.

*An Introduction to Mathematics*

Chapter 7 (p. 71)

Oxford University Press, Inc. New York, New York, USA. 1958

## APPARATUS

**Davy, Sir Humphry** 1778–1829

English chemist

The apparatus essential to the modern chemical philosopher is much less bulky and expensive than that used by the ancients. An air pump, an electrical machine, a voltaic battery (all of which may be upon a small scale), a blow-pipe apparatus, a bellows and forge, a mercurial and water gas apparatus, cups and basins of platinum and glass, and the common reagents of chemistry, are what are required. All the implements absolutely necessary may be carried in a small trunk; and some of the best and most refined researches of modern chemists have been made by means of an apparatus

which might with ease be contained in a small travelling carriage, and the expense of which is only a few pounds.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (p. 250)

J. Murray. London, England. 1830

## APPROXIMATE

**Hobson, Ernest William** 1856–1933

English mathematician

Much of the skill of the true mathematical physicist and of the mathematical astronomer consists in the power of adapting methods and results carried out on an exact mathematical basis to obtain approximations sufficient for the purposes of physical measurements. It might perhaps be thought that a scheme of Mathematics on a frankly approximative basis would be sufficient for all the practical purposes of application in Physics, Engineering Science, and Astronomy, and no doubt it would be possible to develop, to some extent at least, a species of Mathematics on these lines. Such a system would, however, involve an intolerable awkwardness and prolixity in the statements of results, especially in view of the fact that the degree of approximation necessary for various purposes is very different, and thus that unassigned grades of approximation would have to be provided for. Moreover, the mathematician working on these lines would be cut off from the chief sources of inspiration, the ideals of exactitude and logical rigor, as well as from one of his most indispensable guides to discovery, symmetry, and permanence of mathematical form.

Address to the Mathematical and Physical Section of the British Association for the Advancement of Science

*Science*, New Series, Volume 32, September 23, 1910 (p. 388)

## APPROXIMATION

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

We live in a system of approximations. Every end is prospective of some other end, which is also temporary; a round and final success nowhere. We are encamped in nature, not domesticated.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

Nature (p. 552)

The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–  
American physicist

Each piece, or part, of the whole of nature is always merely an approximation to the complete truth, or the complete truth so far as we know it. In fact, everything we know is only some kind of approximation, because we know that we do not know all the laws as yet. Therefore, things must be learned only to be unlearned again or, more likely, to be corrected.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–1 (p. 1–1)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA.  
1983

**Hammer, P. C.**

No biographical data available

One grievous error in interpreting approximations is to allow only good approximations.

Mind Pollution

*Cybernetics*, Volume 14, 1971

## ARBITRARY

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Are the law of acceleration, the rule of the composition of forces only arbitrary conventions? Conventions, yes; arbitrary, no; they would be so if we lost sight of the experiments which led the creators of the science to adopt them, and which, imperfect as they may be, suffice to justify them. It is well that from time to time our attention is carried back to the experimental origin of these conventions.

*The Foundations of Science*

*Science and Hypothesis*, Part III

Chapter VI (p. 106)

The Science Press. New York, New York, USA. 1913

## ARCHAEOASTRONOMY

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The intellectual activity of mankind during prehistory is a vast almost uncharted ocean.... There have been only about 200 generations of history [but] upwards of 10,000 generations of prehistory.... Among the great throng, it seems to me likely that some must have gazed up at the sky and wondered earnestly about the sun, moon, and the stars. They would have done so with a basic intelligence equal to our own....

*On Stonehenge*

Chapter 6 (p. 115)

W.H. Freeman & Company. San Francisco, California, USA. 1977

## ARCHAEOLOGICAL EXCAVATION

**Droop, John Percival** 1882–1963

Archaeologist

...I may perhaps venture a short word on the question much discussed in certain quarters, whether in the work of excavation it is a good thing to have cooperation between men and women.... Of a mixed dig...have seen something, and it is an experiment that I would be reluctant to try again. I would grant if need be that women are admirable fitted for the work, yet I would uphold that they should undertake it by themselves...the work of an excavator on the dig and off it lays on those who share it a bond of closer daily intercourse than is conceivable...between men and women, except in chance cases, I do not believe that such close and unavoidable companionship can ever be other than a source of irritation; at any rate, I believe that however it may affect women, the ordinary male at least cannot stand it.... A minor...objection lies in one particular form of constraint..moments will occur on the best regulated dig when you want to say just what you think without translation, which before the ladies, whatever their feelings about it, cannot be done.

*Archaeological Excavation*

Chapter VII (pp. 63, 64)

At the University Press. Cambridge, England. 1915

## ARCHAEOLOGICAL RECORD

**Binford, Lewis R.** 1930–

American archaeologist

The archaeological record is here with us in the present.

*In Pursuit of the Past*

Chapter I (p. 1)University of California Press. Berkeley, California,

USA. 2002

## ARCHAEOLOGIST

**Bahn, Paul G.**

English archaeologist and writer

Field Archaeologists dig up rubbish,  
Theoretical Archaeologists write it down.

*Bluff Your Way in Archaeology* (p. 15)

Ravette Books. West Sussex, England. 1989

**Berryman, John** 1914–72

American poet and critic

Collating bones: I would have liked to do.

Henry would have been hot at that.

I missed his profession.

As a little boy I always thought

“I’m an archaeologist”; who

Could be more respected peaceful serious than that?

*77 Dream Songs*

No. 30 (p. 30)

Farrar, Straus & Giroux. New York, New York, USA. 1964

### Butler, E. M.

No biographical data available

Archaeologists all the world over owe a debt to Schliemann of Troy; the German poets owe none.

*The Tyranny of Greece over Germany* (p. 307)

Beacon Press. Boston, Massachusetts, USA. 1958

### Chesterton, G. K. (Gilbert Keith) 1874–1936

English author

An archaeologist is a man who studies old things and finds they are new.

*The Man who Knew Too Much*

Chapter VI (p. 150)

Harper & Brothers Publishers. New York, New York, USA. 1922

### Christie, Agatha 1890–1976

English author

...the remark attributed to Mrs. [Agatha] Christie that ‘the older you get, the more interesting you become to an archaeologist,’ was the creation of some pundit whose neck Mrs. Christie would be glad to wring if he would care to identify himself – she neither made the remark nor does she consider it particularly complimentary or amusing.

In Gordon C. Ramsey

*Agatha Christie; Mistress of Mystery*

Chapter II (p. 23)

Dodd Mead. New York, New York, USA. 1967

### Crawford, Osbert Guy Stanhope 1886–1957

English archaeologist

The archaeologist has work to do for the good of the race; he is making bricks for the mansions that others build after him shall build. That is his justification for devoting a lifetime to “unpractical” pursuits. He may be wrong, but you will not lightly convince him of his error.

*Man and His Past*

Chapter II (p. 37)

Oxford University Press, Inc. London, England. 1921

It is to the archaeologist that one must look for the completion of the outline the historian has sketched.

*Man and His Past*

Chapter III (p. 42)

Oxford University Press, Inc. London, England. 1921

### Daniel, Glyn 1914–86

Archaeologist and writer

We are all historians, we are all studying the past of man, whether we concentrate on Walpole, Beowulf, Stonehenge or Lascaux. Manuscripts, microliths, mega-

liths – it is all one. The past is the goal of the historian whether he is text abided or not...there are historians, in the strict sense of the word, who are frightened when they see archaeologists advancing toward them with dirt on their boots and a brief case full of air photographs and Carbon 14 dates. Dugdale, Aubrey, Lhwyd and Stukeley did not think they were other than historians, and for that matter, historians who could be members of the Royal Society. We have taken the distinction between a history that is mainly derived from material sources and one that is derived from the aid of texts, too far.

Editorial

*Antiquity*, Volume 41, 1967 (p. 170)

### Day, David Howard

American anthropologist, educator, and writer

The past, at whatever level and at whatever time, has lost none of its power to inspire. Archaeologists, whether on screen or off, hold a key to that treasure box.

*A Treasure Hard to Attain: Images of Archaeology in Popular Film*

Part I, Chapter Nine (p. 44)

Scarecrow Press. Lanham, Maryland. 1997

### Dillehay, Thomas D.

American anthropologist, educator, and writer

Archaeologists are, by necessity, masters of inference. From the meanest, most innocuous of things-discarded oyster shells, broken pots, the subtle bands of color and texture in an excavation wall – we try to re-create an entire world and its inhabitants.

The Battle of Mount Verde

*The Sciences*, Volume 37, Number 1, Jan/Feb 1997 (p. 29)

### Dr. Watson (Fictional character)

Archaeologists. They might have been dug up themselves.

*Pursuit to Algiers*

Film (1942)

### Durrell, Lawrence 1912–90

English writer

Like earnest mastodons petrified in the forest of their own apparatus the archaeologists come and go, each with his pocket Odyssey and his lack of modern Greek. Diligently working upon the refuse-heaps of some township for a number of years they erect on the basis of a few sherds or a piece of dramatic drainage, a sickly and enfeebled portrait of a way of life. How true it is we cannot say: but if an Eskimo were asked to describe our way of life, deducing all his evidence from a search in a contemporary refuse dump, his picture might lack certain formidable essentials.

*Prospero’s Cell and Reflections on a Marine Venus*

Prospero’s Cell, Chapter V (p. 59)

E.P. Dutton & Company, Inc. New York, New York, USA. 1960



**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and writer

The archaeologist, it is said, is a student of the artifact. That harsh, unlovely word, as sharply angled as a fist ax or a brick, denudes us of human sympathy. In the eye of the public we loom, I suppose, as slightly befuddled graybeards scavenging in grave heaps. We caw like crows over a bit of jade or a broken potsherd: we are eternally associated in the public mind with sharp-edged flints and broken statues. The utter uselessness of the past is somehow magnificently incorporated into our activities.

*The Night Country*  
Chapter 6 (pp. 80–81)  
Charles Scribner's Sons. New York, New York, USA. 1971

**Fagan, Brian**  
English archaeologist

To archaeologists, the human past is owned by no one. It represents the cultural heritage of everyone who has ever lived on Earth or will live on it in the future. Archaeology puts all human societies on an equal footing.

*The Oxford Companion to Archaeology*  
Introduction  
Oxford University Press, Inc. New York, New York, USA. 1996

**Hawkes, Jacquetta** 1910–96  
English archaeologist, historian, and writer

**Hawkes, Christopher** 1905–92  
English archaeologist

[The archaeologist] handles the actual things which helped men to pass their lives: the pots from which they ate and drank, the weapons with which they hunted or killed one another, their houses, their hearthstones and their graves. Such material keeps him much closer to the essentials of history. He must be concerned with the lives and achievements of countless ordinary, anonymous people.

*Prehistoric Britain*  
Forward (p. 9)  
Penguin Books. London, England. 1958

**Ogutsch, Edith**  
Fantasy poet

ARCHAEOLOGIST: Someone whose career lies in ruins.  
*Quote, the Weekly Digest*, January 29, 1967 (p. 97)

**Salmon, Merrilee H.** 1935–  
American archaeologist

Surely skill in doubting the familiar and imagining the unfamiliar are every bit as important to the archaeologist as to the philosopher.

*Philosophy and Archaeology*  
Concluding Remarks (p. 182)  
Academic Press. New York, New York, USA. 1982

**Quennell, Marjorie**  
No biographical data available

...the archaeologist is a pick and shovel historian.  
*Everyday Life in the Old Stone Age*  
Chapter I (p. 3)  
G.P. Putnam's Sons. New York, New York, USA. 1922

**Schrire, Carmel**  
South African archaeologist

I became an archaeologist because I wanted to drive around in a big Landrover; smoking, cursing and finding treasure.

*Digging Through Darkness: Chronicles of an Archaeologist* (p. 71)  
University Press of Virginia. Charlottesville, Virginia, USA. 1995

**Spaulding, Albert C.** 1914–90  
American archaeologist

...truth is to be determined by some sort of polling of archaeologists, that productivity is doing what other archaeologists do, and that the only purpose of archaeology is to make archaeologists happy.

Review of James A. Ford  
"Measurements of Some Prehistoric Design Developments in the Southeastern States"  
*American Anthropologist*, Volume 55, Number 4, 1953 (p. 590)

**Steve Banning (Fictional character)**

...many people believe that we archaeologists are just a collection of old fogeys digging around in ruins after old dried up skulls and bones...

*The Mummy's Tomb*  
Film (1942)

**Taylor, Walter W.** 1913–97  
American archaeologist

Archeology *per se* is no more than a method and a set of specialized techniques for the gathering of cultural information. The archeologist, as archeologist, is really nothing but a technician.

*A Study of Archeology*  
Part I, Chapter 2 (p. 41)  
Southern Illinois University Press, Carbondale, Illinois, USA. 1967

**Weigall, Arthur Edward** 1880–1934  
Egyptologist and writer

It is an unfortunate fact that the archaeologist is generally considered to be a kind of rag-and-bone man; one who, sitting all his life in a dusty room, shuns the touch of the wind and takes no pleasure in the vanities under the sun. Actually, this is not so very often a true description of him. The ease with which long journeys are now undertaken, the immunity from insult or peril which the traveler usually enjoys, have made it possible for the archaeologist to seek his information at its source in almost all the countries of the world.

*The Glory of the Pharaohs*

Chapter I (p. 3)

G. Putnam's Sons. New York, New York, USA. 1923

An archaeologist must be a historian. He must conjure up the past; he must play the Witch of Endor. His lists and indices, his catalogues and notebooks, must be but the spells which he uses to invoke the dead.

*The Glory of the Pharaohs*

Chapter I (p. 19)

G. Putnam's Sons. New York, New York, USA. 1923

The true archaeologist does not take pleasure in skeletons as skeletons, for his whole effort is to cover them decently with flesh and skin once more and to put some thoughts back into the empty skulls.

*The Glory of the Pharaohs*

Chapter II (p. 32)

G. Putnam's Sons. New York, New York, USA. 1923

Dead men are not useless; and the excavator must not cheat the world of any part of its great prerequisite. The dead are the property of the living, and the archaeologist is the world's agent for the estate of the grave.

*The Glory of the Pharaohs*

Chapter V (p. 98)

G. Putnam's Sons. New York, New York, USA. 1923

**Wheeler, Sir Mortimer** 1890–1976

English archaeologist

...the archaeologist is digging up, not things, but people.

*Archaeology from the Earth*

Preface (p. v)

At The Clarendon Press. Oxford, England. 1954

A lepidopterist is a great deal more than a butterfly-catcher, and an archaeologist who is not more than a potsherd-catcher is unworthy of his logoi. He is primarily a fact-finder, but his facts are the material records of human achievement; he is also, by the token, a humanist, and his secondary task is that of revivifying or humanizing his materials with a controlled imagination that inevitable partakes of the qualities of art and even philosophy.

*Archaeology from the Earth* (pp. 228–229)

At The Clarendon Press. Oxford, England. 1954

**Willey, Gordon R.** 1913–2002

American archaeologist and writer

**Sabloff, Jeremy**

American museum director

Any attempt on the part of the archaeologist to contribute to the larger problems of cultural understanding was met with an astonishment like that in the classic case of the "talking dog"; it was not what the dog said that was so amazing but the fact that he could do it at all.

*A History of American Archaeology*

Chapter Five (p. 131)

W.H. Freeman & Company. San Francisco, California, USA. No date

**Wilson, J. A.**

No biographical data available

It is necessary that we [archaeologists] attempt to attain a measure of exactness in a study which deals so largely with the unknown and the shifting and the absent.

Archaeology as a Tool in Humanistic and Social Studies

*Journal of Near Eastern Studies*, Volume 1, 1942 (p. 4)

**Wissler, C.** 1870–1947

American archaeologist

So, in short, the real equipment of an archaeologist is a scientific mind.

The New Archaeology

*American Museum Journal*, Volume 17, 1917 (p. 101)

**Zevi, Bruno** 1918–2001

Italian architectural historian and writer

The most incredible thing is to find archaeologists dedicating their lives to the structural features of monuments who depreciate any critical contribution and exult over the discovery of the slightest technical detail, and who, at the same time, are reactionaries with respect to modern architecture.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter V (p. 186)

Horizon Press. New York, New York, USA. 1957

## ARCHAEOLOGY

**Albright, William Foxwell** 1891–1971

American archaeologist and educator

There can be no doubt that archaeology has confirmed the substantial historicity of Old Testament tradition. Divergences from basic historical fact may nearly all be explained as due to the nature of oral tradition, to the vicissitudes of written transmission, and to honest, but erroneous combinations on the part of Israelite and Jewish scholars.

*Archaeology and the Religion of Israel*

Postscript (p. 176)

The Johns Hopkins Press, Baltimore, Maryland, USA; 1968

### Author undetermined

Archaeology is like law; it must be explained by science, not by opinion.

Review of *An Historical, Antiquarian, and Picturesque Account of Kirkstall Alley*

Review of Publications

*The Gentleman's Magazine*, January, 1898 (p. 40)

The greatest contribution archaeology has ever provided to society is the simple fact that everybody is destined to become a feature.

Source undetermined



**Atkinson, Richard John Copeland** 1920–94  
American archaeologist

Foremost among these [qualities for archaeological field work] is the power to observe, and, moreover, to observe critically, to be able to distinguish the important from the trivial. Next comes the ability to record what is observed accurately and neatly and objectively: there is no place in archaeology, any more than in other sciences, for intellectual partiality in the choice of facts. Finally, the archaeologist needs both a broad and a scientific outlook: broad to understand his work not as a subject contained in itself, but just one aspect of the wider study of man; and scientific to realize clearly the purpose and limitations of his methods, and meaning and value of his evidence.

*Field Archaeology*

Introduction (pp. 13–14)

Methuen & Company Ltd. London, England. 1946

**Bahn, Paul G.**

English archaeologist and writer

Archaeology is rather like a vast, fiendish jigsaw puzzle invented by the devil as an instrument of tantalizing torment, since:

- (a) it will never be finished
- (b) you don't know how many pieces are missing
- (c) most of them are lost forever
- (d) you can't cheat by looking at the picture.

*Bluff Your Way in Archaeology* (p. 5)

Ravette Books. West Sussex, England. 1989

As Champollion said, archaeology is a beautiful mistress but she brings a poor dowry.

*Bluff Your Way in Archaeology* (p. 9)

Ravette Books. West Sussex, England. 1989

**Bailey, Geoff**

English archaeologist

...archaeological study is condemned to apply concepts and theories derived from elsewhere rather than to formulate its own, and is thus reduced to an appendix – at best entertaining, at worst dispensable.

In G. Bailey and A. Sheridan (eds.)

*Economic Archaeology: Toward an Integration of Ecological and Social Approaches*

Chapter 9 (p. 104)

B.A.R. Oxford, England. 1981

**Ballard, Chris** 1963–

Australian historian

The search for unifying narratives, for a single logic that might underpin archaeological explanation universally, is a misplaced venture. Rather than grading different narratives for some form of absolute truth content, we should be asking which alternative we find the most useful relative to the immediate question at hand. One law to be

left in cleaning out the legislative cupboard must be the defense against...the notion that there is a single truth, a single narrative, a single past out there to be found, and that there is but one way of telling it.

Writing (pre)history: Narrative and Archaeological Explanation in the New Guinea Highlands

*Archaeology in Oceania*, Volume 38, 2003

**Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

To anyone who considers that, on digging into the earth, such quantities of shells, and in some places bones and horns of animals, are found sound and entire, after having lain there, in all probability, some thousands of years, it would seem probable that gems, medals, and implements in metal or stone might have lasted entire, buried under ground forty or fifty thousand years, if the world had been so old. How comes it then to pass that no remains are found, no antiquities of those numerous ages preceding the Scripture accounts of time; that no fragments of buildings, no public monuments, no intaglios, cameos, statues, medals, inscriptions, utensils, or artificial works of any kind, are ever discovered, which may bear testimony to the existence of those mighty empires, those successions of monarchs, heroes, and demi-gods for so many thousand years?

In Charles Lyell

*Principles of Geology* (Volume 2)

Book III, Chapter XVI (p. 156)

James Kay Jun. & Brothers. Philadelphia, Pennsylvania, USA. 1837

**Bishop, Jim** 1907–87

American newspaper columnist and historian

Archaeology sounds like dull sport in five syllables. It isn't. It's the Peeping Tom of the sciences. It is the sandbox of men who care not where they are going: they merely want to know where everyone else has been.

Sifting the Sea for Time's Treasures

*NY Journal-American*, 14 March, 1961

**Clark, David** 1937–76

English analytical archaeologist

[Archaeology is] the discipline with the theory and practice for the recovery of unobservable hominid behavior patterns from indirect traces in bad samples.

*American Antiquity*, Volume 47, 1973 (p. 100)

**Cornwall, I. W.** 1909–94

British archaeologist

If archaeology itself is popularly regarded as a dry-as-dust study, that of fossil and sub-fossil bones may well seem, in the eyes of the general public, to be the quintessence of dryness and dustiness, the preserve of imaginary bearded professors and museum curators.

*Bones for the Archaeologist*

Introduction (p. 19)

The Macmillan Company. New York, New York, USA. 1956

**Crawford, Osbert Guy Stanhope** 1886–1957  
English archaeologist

Archaeology is an art which employs scientific technique.

In Sir Mortimer Wheeler

*Archaeology from the Earth*

Chapter XVII (pp. 201–202)

At The Clarendon Press. Oxford, England. 1954

### Deuel, Leo

No biographical data available

By nature and purpose – and almost by definition – archaeology belongs to the ground. Down on their knees, shoveling dirt, raising clouds of dust, burrowing into layers of soil, cutting trenches, tunneling warrens through man-made mounds, opening tombs, and divesting the dead of their travel goods to the nether world – amateurs and professionals have toiled for generations to wrest buried relics from lost civilizations.

*Flights into Yesterday: The Story of Aerial Archaeology*

Chapter 1 (p. 3)

St. Martin's Press. New York, New York, USA. 1969

### Editorial

Archaeology can be made very popular by throwing a halo over the past, but there is as much danger of going astray now as in former years, when we knew less. The hints are more suggestive, but the story is none the less fictitious.

The Imaginative Element in Archaeology

*The American Antiquarian and Oriental Journal*, Volume IV, Number 3, September, 1882 (p. 240)

### Eiseley, Loren C.

 1907–77

American anthropologist, educator, and writer

Archaeology is the science of man's evening, not of his midday triumphs.

*The Unexpected Universe*

Chapter 2, Section 4 (p. 39)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

A man who has once looked with the archaeological eye will never see quite normally. He will be wounded by what other men call trifles. It is possible to refine the sense of time until an old show in the bunch of grass or a pile of nineteenth-century beer bottles in an abandoned mining town tolls in one's head like a hall clock. This is the price one pays for learning to read time from surfaces other than an illuminated dial. It is the melancholy secret of the artifact, the humanly touched thing.

*The Night Country*

Chapter 6 (p. 81)

Charles Scribner's Sons. New York, New York, USA. 1971

### Flannery, Kent V.

 1932–

American environmental archaeologist

Is it too late for salvation? If not, please let me have the analytical expertise of the New Archaeology – and the humility and common sense of the Old.

*The Early Mesoamerican Village*

Chapter 12 (p. 373)

Academic Press. New York, New York, USA. 1976

### Foucault, Michel

 1926–84

French philosopher and historian

There was a time when archaeology, as a discipline devoted to silent monuments, inert traces, objects without context, and things left by the past, aspired to the condition of history, and attained meaning only through the restitution of a historical discourse; it might be said, to play on words a little, that in our time history aspires to the condition of archaeology, to the intrinsic description of the monument.

*Archaeology of Knowledge*

Chapter 1 (p. 8)

Routledge. Oxford, England. 2002

### Fowler, Peter J.

No biographical data available

Archaeology in particular has an escapist value offering the chance of academic retreat into the study of times and things past and of intellectual withdrawal similar to the absorbing unrealities of detective fiction and cross-word puzzles.

*Approaches to Archaeology*

Chapter 1 (p. 32)

St. Martin's Press. New York, New York, USA. 1977

### Glob, Peter Vilhelm

 1911–85

Danish archaeologist

The ground is like a beautiful woman. If you treat her gently, she'll tell you all her secrets.

*Washington Post*, 18 December, 1991

### Gordon, Alexander

 1793–1826

Scottish explorer

Seeing Reason and Knowledge are the Characteristicks which distinguish Mankind from the more ignoble Part of the Animal Creation, those Studies, which are the most improving, deserve our greatest application: In the number of which, Antiquity claims a great share, particularly Archeology, which consists of Monuments, or rather Inscriptions, still subsisting...

*Itinerarium Septentrionale; or, A Journey Thro' Most of the Counties and Those in the North of England*

Preface

Printed for the writer. London, England. 1726

### Hester, Thomas R.

American anthropologist

**Heizer, Robert F.** 1915–79  
American archaeologist and anthropologist

It is obvious that there is more to archaeology than finding bones and tools once used by the former inhabitants of an area. If the collecting of artifacts, the thrill of discovery, and the satisfying of curiosity were the primary objectives of excavation, then the archaeologist would be no better than the “pot hunter” or vandal who collects for personal gain or private pleasure.

*Field Methods in Archaeology*

Introduction (p. 3)

Mayfield Publishing Company. Palo Alto, California, USA. 1975

**Hewitt, John**  
No biographical data available

Modern archaeology differs from the old antiquarianism especially in this – that whatever it contributes to knowledge is required to be scrupulously true.

*Ancient Armour*, Part I (p. 2)

John Henry and James Parker. Oxford, England. 1860

### **Indiana Jones (Fictional character)**

Archaeology is the search for fact. Not truth. If it's truth you're interested in, Doctor Tyree's Philosophy class is right down the hall. So forget any idea's you've got about lost cities, exotic travels and digging up the world. We do not follow maps to buried treasure and “X” never, ever, marks the spot. Seventy percent of all archaeology is done in the library.

*Indiana Jones and the Last Crusade*

Film (1989)

...one of the great dangers of archaeology [is]...not to life and limb, although that does sometimes take place... [but] folklore.

*Raiders of the Lost Ark*

Film (1981)

**Isaac, Gyan Llwilyn** 1937–85  
South African archaeologist

Archaeological studies are at their most significant when they attempt to elucidate the development of relations both amongst men, and between man and the material world.... Prehistoric archaeology is thus in its total aims not a natural science, a social science or a branch of the humanities; rather it is a distinctive pursuit in which all of these meet.

Whither Archaeology?

*Antiquity*, Volume 45, Number 178, June 1971 (p. 125)

**Johnson, Matthew**  
No biographical data available

Archaeology can be very boring, distressing and physically uncomfortable. Every year we excavate thousands of sites, some with painstaking and mind-numbing

patience, some in a great and undignified hurry. Every year we get chilled to the marrow or bitten half to death by mosquitoes while visiting some unprepossessing, grassy mound in the middle of nowhere. Miles from a decent restaurant or even a warm bath, we try to look interested while the rain comes down in sheets and some great professor whose best work was twenty years ago witters on in a monotone about what was found in Trench 4B. Every year we churn out thousands of interminable, stultifying dull site reports, fretting over the accuracy of plans and diagrams, collating lists of grubby artifacts to go to microfiche that few will ever consult or use again.

*Archaeological Theory: An Introduction*

Chapter 1 (p. 1)

Blackwell Publishers. Oxford, England. 1999

**Kehoe, Alice Beck**  
American anthropologist

American archaeology is ready to be a mature science, one that accepts the primacy of its empirical data – for these can outlast theories – and the political and human ramifications of its actions, as it reflectively constructs and compares interpretations. Tolerance for ambiguity is as essential as the Marshalltown trowel.

*The Land of Prehistory: A Critical History of American Archaeology*

Chapter 12 (p. 230)

Routledge. New York, New York, USA. 1998

**Leakey, Mary** 1913–96  
English archaeologist

Archaeologists often divide things into three stages, usually ‘lower’, ‘middle’ and ‘upper’ if they are thinking stratigraphically. Afterwards, of course, they argue that the whole thing was continuous anyhow and that the divisions are arbitrary and for convenience only.

*Disclosing the Past: An Autobiography*

By way of prelude (p. 13)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91  
English statesman and poet

It [archaeology] is to the skeleton of a former age that archaeology restores the flesh and the sinews and the lineaments that distinguish it from the countless centuries of which it is a link, clothes it in the very garments that it wore, and rebuilds the very home in which it dwelt.

*Speeches of Edward, Lord Lytton*

Chapter XXXIV (p. 193)

William Blackwood & Sons. Edinburgh, Scotland. 1874

Archaeology has been called the handmaid of history; and, indeed, without its aid, history would as little represent the particular time it endeavors to recall as the drawing of a skeleton would represent the features and

the form by which the individual human being was recognised while in life.

*Speeches of Edward, Lord Lytton* (Volume 2)  
XXXIV (p. 193)

William Blackwood & Sons. Edinburgh, Scotland. 1874

It [archaeology] disinters from neglected tombs the inventions of departed genius, and bids them serve as studies and sources of inspiration to the genius of a later day.

*Speeches of Edward, Lord Lytton* (Volume 2)  
XXXIV (p. 193)

William Blackwood & Sons. Edinburgh, Scotland. 1874

...archeology is not only the handmaid of history, it is also the conservator of art.

*Speeches of Edward, Lord Lytton* (Volume 2)  
XXXIV (p. 193)

William Blackwood & Sons. Edinburgh, Scotland. 1874

### **Moorehead, Warren K.** 1866–1939

American archaeologist

Archaeology is like any other comprehensive subject; it requires study, discriminating care, and enthusiasm. One should further add, it requires inspiration. A man who does not love to hunt specimens for the sake of hunting them has not his heart in the work.

*The Stone Age in North America* (Volume 2)  
Chapter XXXVII (p. 365)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1910

### **Murray, Margaret** 1863–1963

Anthropologist, archaeologist, and Egyptologist

The trend of all knowledge at the present is to specialize, but archaeology has in it all the qualities that call for the wide view of the human race, or its growth from the savage to the civilized, which is seen in all stages of social and religious developments. Archaeology is the study of humanity itself, and unless that attitude toward the subject is kept in mind archaeology will be overwhelmed by impossible theories or a welter of flint chips.

First Steps in Archaeology

*Antiquity*, Volume 35, 1961 (p. 13)

### **Norton, Charles Eliot** 1827–1908

American scholar

“The night of time far surpasseth the day,” said Sir Thomas Browne, and it is the task of archaeology to light up some parts of this long night with its torch, which burns ever with a clearer flame with each advancing step into the darkness.

In Sara Norton and Mark Antony de Wolfe Howe

*Letters of Charles Eliot Norton* (Volume 2)

Chapter X (p. 97)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1913

### **Paglia, Camille** 1947–

American social critic, intellectual, and writer

Archaeology is our voyage to the past, where we discover who we were and therefore who we are.

Mummy Dearest: Archaeology Is Unfairly Maligned by Trendy Academics

*Wall Street Journal*, September 30, 1999 (p. A–26)

### **Parker, John Henry** 1806–84

English writer on architecture

Archaeology differs from history in...that it has to do only with existing remains explained by history, while [history] has to do with the things that have been, without regard to whether there are any visible remains or not.

*The Archaeology of Rome* (Volume 1)

Advertisement (p. vii)

James Parker & Co. Oxford, England. 1874

### **Poe, Edgar Allan** 1809–49

American short story writer

This – all this – was in the olden Time long ago.

*The Best Tales of Edgar Allan Poe*

*The Fall of the House of Usher*

The Haunted Palace (p. 163)

### **Quennell, Marjorie**

No biographical data available

### **Quennell, Charles Henry Bourne**

Archaeology is like the design of a Roman pavement, built up of many small fragments, or tesserae.

*Everyday Life in the Old Stone Age*

Chapter IV (p. 196)

G.P. Putnam's Sons. New York, New York, USA. 1922

### **Renfrew, Colin** 1937–

English archaeologist

### **Bahn, Paul G.**

English archaeologist and writer

*Archaeology* is the ‘past tense of cultural anthropology.’

*Archaeology: Theories, Methods and Practice* (p. 12)

Thames & Hudson. 2008

Archaeology is partly the discovery of the treasures of the past, partly the meticulous work of the scientific analyst, partly the exercise of the creative imagination.... But it is also the painstaking task of interpretation so that we come to understand what these things mean for the human story.

*Archaeology: Theories, Methods and Practice* (p. 12)

Thames & Hudson. 2008

### **Sir Joseph (Fictional character)**

Much more is learned from bits of broken pottery than from all the sensational finds. Our job is to increase the sum of human knowledge of the past, not to satisfy our curiosity.

*The Mummy*

Film (1940)

**Spaulding, Albert C.** 1914–1990  
American anthropologist

Archaeology can be defined minimally as the study of interrelationships of forms, temporal locus, and spatial locus exhibited by artifacts. In other words, archaeologists are always concerned with these interrelationships, whatever broader interests they may have, and these interrelationships are the special business of archaeology.

In Gertrude E. Dole and Robert L. Carneiro (eds.)  
*Essays in the Science of Culture: In Honor of Leslie A. White*  
The Dimension of Archaeology (p. 439)  
Thomas Y. Crowell. New York, New York, USA. 1960

**Taylor, Walter W.** 1913–97  
American archaeologist

Archaeology is neither history nor anthropology. As an autonomous discipline, it consists of a method and a set of specialized techniques for the gathering or “production” of cultural information.

A Study of Archaeology, Memoir Number 69, Part 2  
*American Anthropologist*, Volume 50, Number 3, 1948 (p. 44)

**Thomas, Cyrus** 1825–1910  
American anthropologist

Archaeology in its widest sense and by derivation includes the investigation of the origin, language, beliefs, customs, arts – everything, in a word, that can be learned of the ancient life of a people.

*Introduction to the Study of North American Archaeology*  
Chapter I (p. 1)  
The Robert Clarke Co. Cincinnati, Ohio, USA 1898

**Weigall, Arthur Edward** 1880–1934  
Egyptologist and writer

Archaeology is too often considered to be the pursuit of weak-chested youths and eccentric old men; it is seldom regarded as a possible vocation for normal persons of sound health and balanced mind.

*The Glory of the Pharaohs*  
Chapter I (p. 8)  
G. Putnam’s Sons. New York, New York, USA. 1923

Nothing is more paralyzing to a student of archaeology than continuous book-work. A collection of facts is an extremely beneficial mental exercise, but the deductions drawn from such a collection should be regarded as an integral part of the work.

*The Glory of the Pharaohs*  
Chapter I (p. 18)  
G. Putnam’s Sons. New York, New York, USA. 1923

Archaeology... is a science which bars its doors to all but the most erudite; for, to the layman who has not been vouchsafed the opportunity of studying the dusty volumes of the learned, the bones of the dead will not reveal their secrets, nor will the crumbling pediments of naos

and cenotaph, the obliterated tombstones, or the worm-eaten parchments, tell us their story.

*The Glory of the Pharaohs*  
Chapter II (p. 31)  
G.P. Putnam’s Sons. New York, New York, USA. 1923

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Out of the litter of muds and gravels that makes the soil of the world we have picked some traces of the past of our race and the past of life. In our observatories and laboratories we have gleaned some hints of its future. We have a vision of the opening of the story, but the first pages we cannot read.

*The Undying Fire*  
Chapter the Fourth, Section 1 (pp. 106–107)  
The Macmillan Company. New York, New York, USA. 1919

**Wheeler, Sir Mortimer** 1890–1976  
English archaeologist

...archaeology is a science that must be lived, must be “seasoned with humanity”. Dead archaeology is the driest dust that blows.

*Archaeology from the Earth*  
Preface (p. v)  
At The Clarendon Press. Oxford, England. 1954

Archaeology is not a science, it’s a vendetta.

In Peter Hopkirk  
*Foreign Devils on the Silk Road: The Search for the Lost Treasures of Central Asia*  
Chapter 12 (p. 170)  
Murray. London, England. 1980

If any layman were to ask a number of archaeologists to give, on the spur of the moment, a definition of archaeology, I suspect that such a person might find the answers rather confusing. He would, perhaps, sympathize with Socrates who, when he hoped to learn from the poets and artisans something about the arts they practised, was forced to go away with the conviction that, though they might themselves be able to accomplish something, they certainly could give no clear account to others of what they were trying to do.

*Archaeology*  
Archaeology (p. 5)  
The Columbia University Press. New York, New York, USA. 1908

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

I can understand archaeology being attacked on the ground of its excessive realism, but to attack it as pedantic seems to be very much beside the mark. However, to attack it for any reason is foolish; one might just as well speak disrespectfully of the equator.

*Intentions*  
The Truth of Masks (p. 242)  
Thomas B. Mosher. Portland, Maine, USA. 1904



**Wiley, Gordon R.** 1913–2002  
American archaeologist and writer

**Phillips, Philip** 1900–1994  
American archaeologist

American Archaeology is anthropology or it is nothing.  
*Method and Theory in American Archaeology*  
Introduction (p. 2)  
The University of Chicago Press. Chicago, Illinois, USA. 1958

## ARCHITECT

### Author undetermined

The imperial building is a perfect Babylon of cubes, cylinders, pyramids and prisms, piled together with inconceivable grandeur, and is the achievement of antediluvian architects, who learned their craft of the passionate ‘Sons of God,’ before the human mind had shrunk to its present dimensions.

The Symbol of Darkness  
*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 213)

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

ARCHITECT, n. One who drafts a plan of your house, and plans a draft of your money; who estimates the whole cost, and himself costs the whole estimate.

*The Cynic’s Word Book*  
ARCHITECT (p. 20)  
Doubleday, Page & Co. New York, New York, USA. 1906

**Carr-Saunders, Sir A. M. (Alexander Morris),** 1886–1966  
English sociologist

**Wilson, Paul A.** 1903–  
No biographical data available

The architect therefore is not only a professional man but also an artist, and he shares in some measure both the problems and the qualities of temperament commonly associated with artists. Thus he lives in a world which is dominated by fashion and split up into cliques and coteries, and he brings to the consideration of professional business something of the outlook which characterizes his interest in the subject-matter of his art.

*The Professions*  
Architects (p. 184)  
Frank Cass & Company Ltd. London, England. 1964

**Cowper, William** 1731–1800  
English poet

But ‘tis not timber, lead and stone,  
An architect requires alone,  
To finish a fine building –

The palace were but half complete,  
If he could possibly forget  
The carving and the gilding.  
*The Poetical Works of William Cowper*  
Friendship (pp. 163–168)  
John W. Lovell Company. New York, New York, USA. No date

**Day, Clarence S.** 1874–1935  
American writer

... whenever a building is erected for the use of the public, the convenience of a nonclimbing person is wholly ignored.

I refer, of course, to the debonair habit which architects have of never designing an entrance that is easy to enter. Instead of leaving the entrance on the street level so that a man can walk in, they perch it on a flight of steps, so that no one can get in without climbing. The architect’s defense is, it looks better.

*The Crow’s Nest*  
Legs vs. Architects (p. 44)  
Alfred A. Knopf. New York, New York, USA. 1922

**de Bergerac, Cyrano** 1619–55  
French satirist and dramatist

The Architector that built my Prison, having made my Entries into it, did not bethink himself of making one Outlet.

*The Comical History of the States and Empires of the Worlds of the Moon and Sun* (pp. 25–26)  
Printed for Henry Rhodes. London, England. 1687

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81  
English prime minister, founder of Conservative Party, and novelist

What is wanted in architecture, as in so many things, is – a man. Shall we find a refuge in a Committee of Taste? Escape from the mediocrity of one to the mediocrity of many? We only multiply our feebleness, and aggravate our deficiencies. But one suggestion might be made. No profession in England has done its duty until it has furnished its victim. The pure administration of justice dates from the deposition of Macclesfield. Even our boasted navy never achieved a great victory until we shot an admiral. Suppose an architect were hanged? Terror has its inspiration as well as competition.

*Tancred: Or, The New Crusade* (Volume 1)  
Chapter X (pp. 127–128)  
Bernh. Leipzig, Germany. 1847

**Esar, Evan** 1899–1995  
American humorist

The architect makes an old house look better just by talking about the cost of a new one.

*20,000 Quips and Quotes* (p. 40)  
Doubleday. Garden City, New York, USA. 1968

The architect who always talks shop is probably suffering from an edifice complex.

*20,000 Quips and Quotes* (p. 40)

Doubleday. Garden City, New York, USA. 1968

**Hertzberger, Herman** 1932–

Dutch architect

Just as the painter needs a subject, so too the architect needs to have something to say that rises above the obscure jargon that architects share with one another.

*Space and the Architect: Lessons in Architecture 2*

Chapter 4 (p. 100)

Publishers. Rotterdam, The Netherlands. 2000

Too often we find the creative process of the architect depicted as a succession of flashes of inspiration that the privileged evidently receive as a gift and others vainly keep waiting for, as though ideas are some kind of thunderbolt from on high.

*Space and the Architect: Lessons in Architecture 2*

Chapter 2 (p. 28)

Publishers. Rotterdam, The Netherlands. 2000

Architects, including the seriously gifted, construct their ideas, even if these are keys to utterly new insights, out of raw material that in one way or another had to be already present in their minds. Nothing, after all, can be born of nothing.

*Space and the Architect: Lessons in Architecture 2*

Chapter 2 (p. 28)

Publishers. Rotterdam, The Netherlands. 2000

The architect's most important attributes are not the traditional emblems of professional skill, the ruler and pair of compasses, but his eyes and ears.

*Space and the Architect: Lessons in Architecture 2*

Chapter 2 (p. 39)

010 Publishers. Rotterdam, The Netherlands. 2000

Architects must react to the world, not to each other.

*Space and the Architect: Lessons in Architecture 2*

Chapter 3 (p. 53)

010 Publishers. Rotterdam, The Netherlands. 2000

**Keate, George** 1729–97

When Troy was built, you recollect

I dabbled as an Architect;

A very sorry one, you'll say,

But worse since then have come in play,

And of the art I've understood

Enough, to do more harm than good...

*The Distressed Poet*

Canto the Second, l. 332

Printed for J. Dodsley. London, England. 1787

**Kirby, William** 1759–1850

English entomologist

**Spence, William** 1783–1860

English entomologist

Man thinks that he stands unrivalled as an architect, and that his buildings are without a parallel among the works

of the inferior orders of animals. He would be of a different opinion did he attend to the history of insects: he would find that many of them have been architects from time immemorial; that they have had their houses divided into various apartments, and containing staircases, gigantic arches, domes, colonnades, and the like; nay, that even tunnels are excavated by them so immense, compared with their own size, as to be twelve times bigger than that of Sir M. I. Brunel under the Thames.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter 1 (pp. 7–8)

Longman, Brown, Green, Longmans & Robert. London, England. 1858

**Le Corbusier (Charles-Edouard**

**Jeanneret)** 1887–1965

Swiss architect and city planner

The Architect, by his arrangement of forms, realizes an order which is a pure creation of his spirit; by forms and shapes he affects our senses to an acute degree and provokes plastic emotions; by the relationships which he creates he wakes profound echoes in us, he gives us the measure of an order which we feel to be in accordance with that of our world, he determines the various movements of our heart and of our understanding; it is then that we experience beauty.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 7)

The Architectural Press. London, England. 1965

**Longfellow, Henry Wadsworth** 1807–82

American poet

... The architect

Built his great heart into these sculptured stones,

And with him toiled his children, and their lives

Were builded, with his own, into the walls,

As offerings unto God.

*The Poetical Works of Henry Wadsworth Longfellow*

Christus: A Mystery

The Golden Legend, In the Cathedral (p. 431)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Mangan, James Clarence** 1803–49

Irish poet

“Architect! my handsome country villa

Yesterday took fire, and naught could save it.

It now lies a ruin!” –

“Allah-el-illah!

Fire, like Air, will find or force expansion –

Fire must burn, and woodwork may not brave it!

But – I'll build thee a far handsomer mansion.”

– “Thanks, good Architect! The cost may make me

Poorer, but, Inshallah! ‘twill not break me.”

*Poems of James Clarence Mangan*

The Worst Loss, Stanza II, l. 9–16

O'Donoghue. Dublin, Ireland. 1903



**Milton, John** 1608–74  
English poet

The hasty multitude  
Admiring enter'd, and the work some praise  
And some the architect: his hand was known  
In heaven by many a tower'd structure high,  
Where scepter'd angels held their residence,  
And sat as princes.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book I, l. 730  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**North, Roger** 1585–1652  
English biographer

For a profest architect is proud, opiniative and troublesome, seldom at hand, and a head workman pretending to the designing part, is full of paltry vulgar contrivances; therefore be your owne architect, or sitt still.

In H.M. Colvin  
*A Biographical Dictionary of English Architects, 1600–1840*  
Introduction (p. 13)  
John Murray. London, England. 1954

**Papworth, Wyatt**  
Architect

Architects are, like certain paralytics, always on the watch for some new manifestation that they may at once secure to be a help for their too manifest decrepitude. Every 'new thing' in detail is promptly seized and made available in any practicable way, and then the public are called to admire the great 'knowledge' of the 'architect' and how he has 'authority for every detail.'

The Completion of Saint Paul's  
*The Quarterly Review*, Volume 133, Number 266, August, 1872 (p. 375)

**Reynolds, Joshua** 1723–92  
English painter

What the back-ground is in Painting, in Architecture is the real ground on which the building is erected; and no Architect took greater care than he that his work should not appear crude and hard; that is, it did not abruptly start out of the ground without expectation or preparation.

*The Life and Discourses of Sir Joshua Reynolds*  
Discourse XIII (pp. 244–245)  
Sawyer, Ingersoll & Co. Hudson, Ohio, USA. 1858

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

An architect should live as little in cities as a painter. Send him to our hills, and let him study there what nature understands by a buttress, and what by a dome.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*  
Part 3, The Lamp of Power (p. 129)  
John Wiley & Sons, Inc. New York, New York, USA. 1860

Every citizen may box himself up in as barbarous a tenement as suits his taste or inclination; the architect is his vassal, and must permit him not only to criticise, but to perpetuate.

*The Poetry of Architecture: Cottage, Villa, Etc.*  
Introduction (p. 4)  
John Wiley & Sons. New York, New York, USA. 1877

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

Believe me, that was a happy age, before the days of architects, before the days of builders.

Translated by Richard M. Gummere  
*Ad Lucilium Epistulae Morales* (Volume 1)  
Epistle xc  
Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shipman, T.** 1632–80  
English poet

An Architect should chiefly try  
To please the Owner's Mind and Eye...

*Carolina: or Loyal Poems*  
To the Reader of the following Poem (p. 234)  
S. Heyrick & W. Crook. London, England. 1683

**Shute, John** fl 1563  
English architect

It belongeth also to an Architect, to have sight in Philosophie, which teaching to be of a noble courage as Virtuuius saith, and also gentil, curtious, faithfull and modest, not geuen to auarice and filthy lucre, as not to be troubled or corrupted with rewardes or giftes, but with grauity and Sagenes to coeciue al honor and dignity in all things conseruinge his good name and estimation. Let him also take a charge of workes in hand, being desired and not desirous of workers.

*The First and Chief Groundes of Architecturefolio*  
Chapter iii  
Gregg Press. London, England. 1965

...an Architecte must be sharpe of understandinge and both quicke and apte to conceive the trewe Instructions and meaninges of them that have written thereof: and must also be a perfect distributor of the great misteries that he hath perceued and experymented, that playnlye and briefly he may discusse and open demonstrations of that which shallbe done....

*The First and Chief Groundes of Architecturefolio*  
Chapter iii  
Gregg Press. London, England. 1965

**Swift, Jonathan** 1667–1745  
Irish-born English writer

There was a most ingenious architect who had contrived a new method for building houses, by beginning at the roof, and working downward to the foundation.

*Gulliver's Travels*  
Part III, Chapter V (pp. 107–108)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

True, there are architects so called in this country, and I have heard of one at least possessed with the idea of making architectural ornaments have a core of truth, a necessity, and hence a beauty, as if it were a revelation to him. All very well perhaps from his point of view, but only a little better than the common dilettantism.

*The Writings of Henry David Thoreau* (Volume 2)  
*Walden*

Chapter I (p. 75)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Viollet-le-Duc, Eugène Emmanuel** 1814–79  
French architect and theorist

Our modern architects are like *parvenus* who have come all at once into possession of a large fortune and do not know how to adjust their expenditure with that discretion which belongs only to accustomed opulence.

Translated by B. Bucknal

*Lectures On Architecture* (Volume 2)

Lecture XIII (p. 105)

Samson Low, Marston, Searle & Rivington. London, England. 1881

**Vitruvius** ca 70–ca 25 BCE  
Roman architect

...architects who without culture aim at manual skill cannot gain a prestige corresponding to their labours, while those who trust to theory and literature obviously follow a shadow and not reality. But those who have mastered both, like men equipped in full armor, soon acquire influence and attain their purpose.

*Vitruvius on Architecture* (Volume 1)

Book I, Chapter I, 2 (p. 7)

W. Heinemann Ltd. London, England. 1931–34

**Wightwick, George** 1802–72  
English civil engineer

It is presumed your primary object in securing the services of an Architect involves the recognition of his pretensions as an Artist. The ordinary Builder may construct the edifice required: you apply to an Architect for the superadded graces of correct design and suitable decoration. In matters of Taste he engages to give you what he conceives to be correct, and to the amount only which your means allow, and not to sacrifice without reluctance his repute as an Artist to your individual wishes, not to suffer under your censure for limiting his decorations to their just proportion in the general outlay.

Letter to prospective clients, circa 1825

*Royal Institute of British Architects Proceedings*, New Series, Volume VII, 161, 1891

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

Today the difference between a good and a poor architect is that the poor architect succumbs to every temptation and the good one resists it.

Translated by Peter Winch

*Culture and Value* (p. 3e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wren, Sir Christopher** 1632–1723  
English designer, astronomer, and geometer

An architect ought to be jealous of *novelties* in which fancy blinds the judgment: and to think his judges as well those that are to live five centuries after him, as those of his own time. That which is commendable now for novelty, will not be a new invention to posterity, when his works are often imitated, and when it is unknown which was the original; but the glory of that which is good of itself, is eternal.

*Lives of Eminent Persons*

Sir Christopher Wren (p. 30)

Baldwin & Cradock. London, England. 1833

**Wright, Frank Lloyd** 1867–1959  
American architect

The physician can bury his mistakes, but the architect can only advise his client to plant vines.

Frank Lloyd Wright and His Art

*New York Times Magazine*, 4 October, 1953 (p. 47)

Any good architect is by nature a physicist as a matter of fact, but as a matter of reality, as things are, he must be a philosopher and a physician.

*Frank Lloyd Wright: An Autobiography*

The Character of Form (p. 380)

Duell, Sloan & Pearce. New York, New York, USA. 1943

**Zevi, Bruno** 1918–2001  
Italian architectural historian and writer

Professional architects, who, in order to explore the problems of contemporary architecture, must necessarily have a profound passion for architecture in the living sense of the word, are largely lacking today in the specific cultural background which would qualify them for a knowledgeable entry into the arena of historical and critical debate.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter I (pp. 16–17)

Horizon Press. New York, New York, USA. 1957

## ARCHITECTURAL

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Our object, let it always be remembered, is not the attainment of architectural data, but the formation of taste.

*The Poetry of Architecture: Cottage, Villa, Etc.*

The Cottage (p. 29)

John Wiley & Sons. New York, New York, USA. 1877

Architectural Deceits are broadly to be considered under three heads – First. The suggestion of a mode of structure or support, other than the true one; as in pendants of late Gothic roofs. Second. The painting of surfaces to represent some other material than that of which they actually consist (as in the marbling of wood), or the deceptive representation of sculptured ornament upon them. Third. The use of cast or machine-made ornaments of any kind.

*The Seven Lamps of Architecture*

Chapter 2 (p. 29)

John Wiley & Son. New York, New York, USA. 1865

**van Brunt, Henry** 1832–1903

American architect

Architectural ideas and motifs excite in the minds of architects certain emotions, which are rarely shared in their fullness by the laity.

*Greek Lines and Other Architectural Essays*

Architecture and Poetry (p. 236)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

The language of architectural forms is one of infinite artifice; it is born of traditions, is shaped by conventions, and speaks in parables and apologues, which are patent only to those who have studied the growth of thought in the development of its signs and symbols.

*Greek Lines and Other Architectural Essays*

Architecture and Poetry (p. 241)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

## ARCHITECTURE

### Author undetermined

Architecture is easy: you just stare at the paper until droplets of blood appear on your forehead.

Source undetermined

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

He that builds a fair house upon an ill seat, committeth himself to prison.

In Brian Vickers (ed.)

*Francis Bacon*

Essays of Buildings (p. 427)

Published for the British Council by Longman. Harlow, England. 1978

Houses are built to live in, and not to look on: therefore let use be preferred before uniformity.

In Brian Vickers (ed.)

*Francis Bacon*

Essays of Buildings (p. 427)

Published for the British Council by Longman. Harlow, England. 1978

**Belcher, John** 1841–1913

English architect

Good architecture never deceives the eye, even for a moment.

*Essentials in Architecture: An Analysis of the Principles & Qualities to be Looked for in Buildings*

Chapter I (p. 11)

B.T. Batsford, Ltd. London, England. 1907

**Blomfield, Sir Reginald** 1856–1942

English architect

Fine architecture is like fine literature: it is new inasmuch as it has something personal and individual to say, and it is old inasmuch as it uses familiar idioms, phrases, and words, and the quality of genius is shown in the use of these existing means of expression, not in the attempt to invent new ones as long as there are any old available for the purpose.

Modern London Architecture

*The Living Age*, Volume XXVII, August 12, 1922 (p. 402)

Architecture, if it is to be good, must be efficient for its purpose, but efficiency for its purpose in architecture has a wider range than it has in engineering or in simple building, because in architecture the appeal to the aesthetic sense has to be taken into account, and if that appeal fails the architecture fails with it.

Modern London Architecture

*The Living Age*, Volume 314, Number 4075, August 12, 1922 (p. 402)

...to nail down architecture to merely utilitarian purpose is as unsound critically as it is to limit painting to mere brushwork or mere pattern or whatever the latest fad may be.

Modern London Architecture

*The Living Age*, Volume 314, Number 4075, August 12, 1922 (p. 402)

Good architecture will always be as rare as good painting and good sculpture ...

Modern London Architecture

*The Living Age*, Volume 314, Number 4075, August 12, 1922 (p. 405)

**Bragdon, Claude Fayette** 1866–1945

American architect, writer, and stage designer

Architecture is preeminently the art of significant forms in space – that is, forms significant of their functions.

Wake Up and Dream

*Outlook*, May 27, 1931

**Buchanan, Robert Williams** 1841–1901

English poet and novelist

Thus I taught them architecture –  
How to hew the rocks and fashion  
Monuments that stand forever  
In despite of God and Time.

*The Complete Poetical Works of Robert Buchanan*

The Devil's Case, XVI, I. 1377–80

Chatto & Windus. London, England. 1901

**Carr-Saunders, A. M. (Alexander Morris),**

**Sir** 1886–1966

English sociologist

**Wilson, Paul A.** 1903–

No biographical data available

Architecture differs from every other profession...in that the technique contains an aesthetic element. Indeed, the aesthetic element is fundamental; and no matter how complex the science of building construction is or may become, the architect is only concerned with that science in order to apply it to aesthetic purposes.

*The Professions*

Architects (p. 184)

Frank Cass &amp; Company. Ltd. London, England. 1964

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

All architecture is great architecture after sunset; perhaps architecture is really a nocturnal art, like the art of fire-works.

*Tremendous Trifles*

Chapter XX (p. 152)

Dodd, Mead &amp; Co. New York, New York, USA. 1920

**Cibber, Colley** 1671–1757

English dramatist and actor-manager

Old houses mended,  
Cost little less than new, before they're ended.

*Prologue to the Double Gallant*, l. 15

Printed at the Chiswick Press. London, England. 1817

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

The principle of the Gothic architecture is infinity made imaginable.

In Henry Nelson Coleridge (ed.)

*The Table Talk and Omniana of Samuel Taylor Coleridge*

Table Talk

June 29, 1833 (p. 231)

George Bell &amp; Sons. London, England. 1884

**Coleridge, Stephen** 1854–1936

English author, barrister and opponent of vivisection

In architecture it may be conceded that Science is entitled to a slight participation as a mechanical necessity. For architecture is always in a measure a Science and only sometimes an art. It is always a Science, because a building erected without knowledge of weights and strains will collapse. It is sometimes an art when it advances from mere utility to become a form of expression and to reveal the heart of the builder, and appeal to that of the beholder.

*The Idolatry of Science*

Chapter XI (pp. 87–88)

John Lane Co. London, England. 1920

**Cowper, William** 1731–1800

English poet

Silently as a dream the fabric rose;  
No sound of hammer or of saw was there.

*The Poetical Works of William Cowper*

The Task

Book V, l. 144

John W. Lovell Company. New York, New York, USA. No date

**Dickens, Charles** 1812–70

English novelist

We didn't find that it [London] came to its likeness in the red bills at the shop doors; which I meanersay, added Joe, in an explanatory manner, as it is there drawd too architectooraloal.

*Great Expectations*

Chapter XXVII (p. 224)

Rinehart &amp; Company, Inc. New York, New York, USA. 1948

A man who could build a church, as one may say, by squinting at a sheet of paper.

*Martin Chuzzlewit*

Chapter XXXI (p. 458)

Dodd, Mead &amp; Company. New York, New York, USA. 1944

**Dimnet, Ernest** 1866–1954

French cleric

Architecture, of all the arts, is the one which acts the most slowly, but the most surely, on the soul.

*What We Live By*

Chapter VII (p. 141)

Simon &amp; Schuster. New York, New York, USA. 1932

**Elmes, James**

No biographical data available

He comprehends a whole, he grasps the extremities, he achieves variety – that variety and intricacy which the accomplished Sir Joshua Reynolds considered as a beauty and excellence worthy of being adopted into architecture: but he sees not the detail, he either neglects it or despise it, and certainly does not look at his art with a microscopic eye. He does not finish in architecture like Denner or the Dutch masters in painting; but to pursue the analogy; designs like a painter in fresco, and thinks with Michelangelo, that a finished or exquisite detail in architecture is like oil painting in the sister art, fit employment only for women and children.

*Metropolitan Improvements; Or London in the Nineteenth Century*

Chapter III (p. 92)

Jones &amp; Co. London, England. 1828

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The Gothic cathedral is a blossoming in stone subdued by the insatiable demand of harmony in man. The mountain of granite blooms into an eternal flower.

*Ralph Waldo Emerson: Essays and Lectures**Essays: First Series*

History (p. 246)

The Library of America. New York, New York, USA. 1983

The hand that rounded Peter's dome  
 And groined the aisles of Christian Rome,  
 Wrought in a sad sincerity;  
 Himself from God he could not free;  
 He builded better than he knew;  
 The conscious stone to beauty grew.  
*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
 The Problem (p. 7)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Earth proudly wears the Parthenon  
 As best gem upon her zone.  
*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
 The Problem (p. 7)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Flagg, Wilson** 1805–84  
 American naturalist

Our national architecture is like our national literature.  
 The one is shallow and flippant, the other is showy and  
 mean. It likewise resembles the habits of the people, who  
 live for ambition and not for comfort. In fine, our houses  
 are “follies;” and our national architecture is not Grecian,  
 nor Gothic, nor Roman, nor Italian, nor English: it is the  
*gazebo* style of architecture.  
 Home Architecture – No. 1  
*The Magazine of Horticulture, Botany, and All Useful Discoveries and  
 Improvements in Rural Affairs*, Volume XXIV, Number 2, February,  
 1858 (p. 61)

**Gray, Thomas** 1716–71  
 English poet

Rich windows that exclude the light,  
 And passages that lead to nothing.  
*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson,  
 and Kirke White*  
 A Long Story  
 J. Blackwood. London, England. 1800

**Hertzberger, Herman** 1932–  
 Dutch architect

It is only where architecture generates other space, creates  
 other experiences and satisfies other conditions which  
 cause sensibilities to change, that it signifies anything of  
 value. Architecture is more than just a free-ranging, narcis-  
 sistic phenomenon.  
*Space and the Architect: Lessons in Architecture 2*  
 Chapter 3 (p. 52)  
 010 Publishers. Rotterdam, The Netherlands. 2000

**Jefferson, Thomas** 1743–1826  
 3rd president of the USA

Architecture worth great attention. As we double our  
 numbers every twenty years, we must double our houses.  
 Besides, we build of such perishable materials, that one  
 half of our houses must be rebuilt in every space of  
 twenty years, so that in that time, houses are to be built

for three-fourths of our inhabitants. It is, then, among the  
 most important arts; and it is desirable to introduce taste  
 into an art which shows so much.  
*The Writings of Thomas Jefferson* (Volume 17)  
 Traveling Notes for Mr. Rutledge and Mr. Shippen, June 3, 1788  
 (p. 292)  
 The Thomas Jefferson Memorial Association. Washington, D.C. 1907

**Johnson, Philip**  
 American law professor

Architecture is the art of how to waste space.  
 Article in *Ideas and Men*,  
*New York Times*, Section E, December, 1964 (p. 927)

**King, Thomas Starr** 1824–64  
 American Unitarian clergyman

Architecture is a creation of the human intellect, adding  
 to the stores of beauty in the world.  
*The White Hills: Their Legends, Landscape, and Poetry*  
 Lake Winnipiseogee (p. 60)  
 Crosby & Ainsworth. Boston, Massachusetts, USA. 1866

**Kingsley, Charles** 1819–75  
 English clergyman and writer

Grandeur...consists in form, and not in size: and to the  
 eye of the philosopher, the curve drawn on a paper two  
 inches long, is just as magnificent, just as symbolic of  
 divine mysteries and melodies, as when embodied in the  
 span of some cathedral roof.  
*Prose Idylls: New and Old*  
 My Winter Garden  
 Macmillan & Company. London, England. 1889

**Le Corbusier (Charles-Edouard  
 Jeanneret)** 1887–1965  
 Swiss architect and city planner

The house is a machine for living in.  
 Translated by Frederick Etchells  
*Towards a New Architecture*  
 Argument (p. 4)  
 The Architectural Press. London, England. 1965

Architecture is the first manifestation of man creating his  
 own universe, creating it in the image of nature, submit-  
 ting to the laws of nature, the laws which govern our own  
 nature, our universe. The laws of gravity, of statics and  
 of dynamics, impose themselves by a *reductio ad absurdum*:  
 everything must hold together or it will collapse.  
 Translated by Frederick Etchells  
*Towards a New Architecture*  
 Regulating Lines (pp. 69–70)  
 The Architectural Press. London, England. 1965

There is one profession and one only, namely archi-  
 tecture, in which progress is not considered necessary,  
 where laziness is enthroned, and in which the reference  
 is always to yesterday.



Translated by Frederick Etchells

*Towards a New Architecture*

Eyes Which Do Not See (p. 101)

The Architectural Press. London, England. 1965

**Longfellow, Henry Wadsworth** 1807–82

American poet

In the elder days of Art,  
Builders wrought with greatest care  
Each minute and unseen part;  
For the Gods see everywhere.

*The Poetical Works of Henry Wadsworth Longfellow*

The Builders

Stanza 5

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

Ah, to build, to build!

That is the noblest of all the arts.

*The Poetical Works of Henry Wadsworth Longfellow*

Michael Angelo

Part I, II, I. 54

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Milton, John** 1608–74

English poet

...nor did there want

Cornice or frieze with bossy sculpture graven.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book I, l. 715

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

...architecture is a kind of oratory in forms, sometimes  
persuading or even flattering, sometimes simply com-  
manding.

Translated by Richard Polt

*Twilight of the Idols or, How to Philosophize with the Hammer*

Raids of an Untimely Man, 11 (p. 57)

Hackett Publishing Company, Inc. Indianapolis, Indiana, USA. 1997

**Pope, Alexander** 1688–1744

English poet

Thus when we view some well-proportion'd dome...

No single parts unequally surprise,

All comes united to th' admiring eyes.

*The Complete Poetical Works*

Essay on Criticism, pt. II, l. 47

Houghton Mifflin Company. New York, New York, USA. 1903

**Reynolds, Joshua** 1723–92

English painter

Variety and intricacy is a beauty and excellence in every  
other of the arts which address the imagination; and why  
not in Architecture?

*The Life and Discourses of Sir Joshua Reynolds*

Discourse XIII (p. 244)

Sawyer, Ingersoll & Co. Hudson, Ohio, USA. 1858

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

We may live without her [architecture], and worship  
without her, but we cannot remember without her.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected  
from the Works of John Ruskin*

Part 3, The Lamp of Memory (p. 140)

John Wiley & Sons, Inc. New York, New York, USA. 1860

Ornamentation is the principal part of architecture, con-  
sidered as a subject of fine art.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected  
from the Works of John Ruskin*

Part 4, Sculpture (p. 208)

John Wiley & Sons, Inc. New York, New York, USA. 1860

Architecture is the art which so disposes and adorns the  
edifices raised by man for whatsoever uses, that the sight  
of them contribute to his mental health, power and plea-  
sure.

*The Seven Lamps of Architecture*

Chapter I (p. 7)

John Wiley & Son. New York, New York, USA. 1865

Architecture is an art for all men to learn, because all  
are concerned with it; and it is so simple, that there is no  
excuse for not being acquainted with its primary rules,  
any more than for ignorance of grammar or of spelling,  
which are both of them far more difficult sciences.

*The Seven Lamps of Architecture*

Chapter I (p. 16)

John Wiley & Sons. New York, New York, USA. 1885

We may live without her [architecture], and worship  
without her, but we cannot remember without her.

*The Seven Lamps of Architecture*

Chapter 6 (p. 147)

John Wiley & Son. New York, New York, USA. 1865

The ambition of the old Babel builders was well directed  
for this world: there are but two strong conquerors of the  
forgetfulness of men, Poetry and Architecture; and the  
latter in some sort includes the former, and is mightier  
in its reality; it is well to have, not only what men have  
thought and felt, but what their hands have handled, and  
their strength wrought, and their eyes beheld, all the days  
of their life.

*The Seven Lamps of Architecture*

Chapter 6 (p. 148)

John Wiley & Son. New York, New York, USA. 1865

...the architecture of a nation is great only when it is as  
universal and as established as its language; and when  
provincial differences of style are nothing more than so  
many dialects.

*The Seven Lamps of Architecture*

Chapter VI (p. 202)

George Allen. Sunnyside, England. 1880

...it does not matter one marble splinter whether we  
have an old or new architecture, but it matters everything

whether we have an architecture truly so called or not; that is, whether an architecture whose laws might be taught at our schools from Cornwall to Northumberland, as we teach English spelling and English grammar, or an architecture which is to be invented fresh every time we build a workhouse or a parish school.

*The Seven Lamps of Architecture*

The Lamp of Obedience (p. 203)

George Allen. Sunnyside, England. 1880

[T]he value of architecture depended on two distinct characters – the one, the impression it receives from human power; the other, the image it bears of the natural creation.

*The Seven Lamps of Architecture*

The Lamp of Beauty

Smith, Elder & Company. London, England. 1849

I would have, then, our ordinary dwelling-houses built to last, and built to be lovely; as rich and full of pleasantness as may be within and without...with such differences as might suit and express each man's character and occupation, and partly his history.

*The Seven Lamps of Architecture*

The Lamp of Memory

Smith, Elder & Company. London, England. 1849

We address ourselves, then, first to the task of determining some law of right, which we may apply to the architecture of all the world and of all time; and by help of which, and judgment according to which, we may as easily pronounce whether a building is good or noble, as, by applying a plumb-line, whether it be perpendicular.

*The Stones of Venice*

Chapter II (p. 35)

Smith, Elder & Co. London, England. 1873

Architecture is the work of nations...

*The Complete Works*

*The Stones of Venice*

Part 4, Sculpture (p. 241)

Bryan Taylor & Company. New York, New York, USA. 1894

The Science of Architecture, followed out to its full extent, is one of the noblest of those which have reference only to the creations of human minds.

*The Poetry of Architecture: Cottage, Villa, Etc.*

Introduction (p. 1)

John Wiley & Sons. New York, New York, USA. 1877

It [architecture] is not merely a science of the rule and compass, it does not consist only in the observation of just rule, or of fair proportion: it is, or ought to be, a science of feeling more than of rule, a ministry to the mind, more than to the eye.

*The Poetry of Architecture: Cottage, Villa, Etc.*

Introduction (p. 1)

John Wiley & Sons. New York, New York, USA. 1877

It will always be necessary to obtain some definite knowledge of the distinctive features of a country, before

we can form a just estimate of the beauties or the errors of its architecture.

*The Poetry of Architecture: Cottage, Villa, Etc.*

The Cottage (p. 16)

John Wiley & Sons. New York, New York, USA. 1877

To no one is the architecture of the exterior of a dwelling-house of so little consequence as to its inhabitant.

*The Poetry of Architecture: Cottage, Villa, Etc.*

The Villa (p. 153)

John Wiley & Sons. New York, New York, USA. 1877

All imitation has its origin in vanity, and vanity is the bane of architecture.

*The Poetry of Architecture: Cottage, Villa, Etc.*

The Villa (p. 224)

John Wiley & Sons. New York, New York, USA. 1877

### **Saarinen, Eero** 1910–67

Finnish-born US architect

Architecture is not just to fulfill man's need for shelter, but also to fulfill man's belief in the nobility of his existence on earth.

*The Maturing Modern*

*Time*, July 2, 1956

### **Scott, Geoffrey** 1884–1929

Architect, biographer, and architectural historian

Architecture is the art of organising a mob of craftsmen.

*The Architecture of Humanism: A Study in the History of Taste*

Chapter II (p. 42)

W.W. Norton & Co. New York, New York, USA. 1999

### **Scott, George Gilbert** 1811–78

English architect

Iron architecture is like the unmanageable mechanical man of Frankenstein; and we do not think it astonishing that, now that our architects have "developed" him, they are at a loss to know what to do with him, or rather how to prevent his destroying them!

Article III

*The North British Review*, Volume 28, Number 56, February-May, 1858 (p. 368)

### **Smart, Christopher** 1722–71

English poet

Ma'm, architecture you're not skill'd in,

I don't approve your way of building;

In this there's nothing like design,

Pray learn the use of Gunter's line.

*The Poetical Works of Christopher Smart*

The Blockhead and Beehive, Fable X, l. 59–62

Clarendon Press. Oxford, England. 1980

### **Smollett, Tobias George** 1721–71

Scottish novelist

The external appearance of an old cathedral cannot be but displeasing to the eye of every man who has any idea of



propriety or proportion, even though he may be ignorant of architecture as a science...

*The Miscellaneous Works of Tobias Smollett, M.D.: With Memoirs of His Life*

The Expedition of Henry Clinker (p. 200)  
Printed for Sylvester Doig. Edinburgh, Scotland. 1811

**Statham, H. Heathcote** 1839–1924  
Architect

Architecture... is the art of erecting expressive and beautiful buildings.

*Architecture for General Readers*

Architecture for General Readers (p. 3)  
Charles Scribner's Sons. New York, New York, USA. 1896

**Sturgis, Russell** 1836–1909  
American architect

In trying to train the mind to judge of works of architecture, one can never be too patient.

*How to Judge Architecture: A Popular Guide to the Appreciation of Buildings*

Chapter I (p. 11)  
The Baker & Taylor Co. New York, New York, USA. 1903

**Sullivan, Louis Henry** 1856–1924  
American architect

Form ever follows function.

The Tall Office Building Artistically Considered  
*Lippincott's Magazine*, March, 1896

**Sydney, Lady Morgan** 1776–1859  
Irish novelist

Architecture is the printing-press of all ages, and gives a history of the state of the society in which it was erected; from the cromlech of the Druids to those toyshops of royal bad taste – Carlton House and the Brighton Pavilion. The Tower and Westminster Abbey are glorious pages in the history of time, and tell the story of an iron despotism and the cowardice of unlimited power.

*Passages from My Autobiography*

Diary entry (p. 165)  
Howard Bentley. London, England. 1859

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

What does architecture amount to in the experience of the mass of men?

*Walden: or, Life in the Woods*

Economy (p. 39)  
J.M. Dent & Sons. London, England. 1912

**van Brunt, Henry** 1832–1903  
American architect

If a monument of architecture is like a “song without words,” it certainly touches the mind and heart as much as it moves the senses.

*Greek Lines and Other Architectural Essays*

Architecture and Poetry (p. 237)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

I have found a paper of mine... in which I call architecture “petrified music”.

In Johann Peter Eckermann

*Conversations with Goethe*  
Monday, March 23, 1829 (p. 303)  
J.M. Dent & Sons Ltd. London, England. 1970

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

I saw great and splendid architecture rising about me, more massive than any buildings of our own time, and yet, as it seemed, built of glimmer and mist.

*The Time Machine*

Chapter III (p. 31)  
Berkeley Publishing Corporation. New York, New York, USA. n.d.

**Whewell, William** 1794–1866  
English philosopher and historian

All architecture, to possess genuine beauty, must be mechanically consistent. The decorative members must represent a structure which has in it a principle of support and stability.

*History of the Inductive Sciences from the Earliest to the Present Time*

(3rd edition)  
Book IV, Chapter I (p. 190)  
John W. Parker & Son. London, England. 1857

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

If Nature had been comfortable, mankind would never have invented architecture...

*The Works of Oscar Wilde* (Volume 10)

*Intentions*  
The Decay of Lying (p. 291)  
AMS Press. New York, New York, USA. 1909

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

Remember the impression one gets from good architecture, that it expresses a thought. It makes one want to respond with a gesture.

Translated by Peter Winch

*Culture and Value* (p. 22e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

Architecture is a gesture. Not every purposive movement of the human body is a gesture. And no more is every building designed for a purpose architecture.

Translated by Peter Winch

*Culture and Value* (p. 42e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

Architecture immortalizes and glorifies something. Hence there can be no architecture where there is nothing to glorify.

Translated by Peter Winch

*Culture and Value* (p. 69e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wotton, Henry** 1568–1639

English author and diplomat

...Architecture, can want no commendation, where there are Noble Men, or Noble minds ...

*The Elements of Architecture*

The Preface (p. vii)

Longmans, Green & Co. London, England. 1903

In Architecture as in all other Operative Arts, the end must direct the Operation.

*The Elements of Architecture*

Part I (p. 1)

Longmans, Green & Co. London, England. 1903

**Wren, Sir Christopher** 1632–1723

English designer, astronomer, and geometer

Architecture aims at Eternity

In J. Elmes

*Memoirs of Sir Christopher Wren*

Appendix, Parentalia (p. 126)

Publisher undetermined

London, England. 1823

Architecture has its political use; public buildings being the ornament of a country; it establishes a nation, draws people and commerce; makes the people love their native country, which is assuredly the original of all great actions in a commonwealth. The emulation of the cities of Greece was the true cause of their greatness. The obstinate valor of the Jews, occasioned by the love of their temple, was a cement that held together that people for many ages, through infinite changes. The care of public decency and convenience was a great cause of the establishment of the Low Countries, and of many cities in the world. Modern Rome subsists still by the ruins and imitations of the old; as does Jerusalem, by the Temple of the Sepulcher, and other remains of Helena's zeal.

Quoted in T.A. Buckley

Lecture

*Freemasons' Quarterly Magazine*, Volume 1 1853 (p. 176)

**Wright, Frank Lloyd** 1867–1959

American architect

The only thing wrong with architecture [is] the architects.

In Evan Esar

*20,000 Quips and Quotes* (p. 40)

Doubleday. Garden City, New York, USA. 1968

Machinery, materials and men – yes – these are the stuff by means of which the so-called American architect will

get his architecture.... Only by the strength of his spirit's grasp upon all three – machinery, materials and men – will the architect be able so to build that his work may be worthy the great name architecture.

In Bruce Brooks Pfeiffer and Gerald Nordland (eds.)

*Frank Lloyd Wright: In the Realm of Ideas* (p. 48)

Southern Illinois University Press, Carbondale, Illinois, USA. 1988

Bring out the nature of the materials, let their nature intimately into your scheme.... Reveal the nature of the wood, plaster, brick or stone in your designs; they are all by nature friendly and beautiful.

In Bruce Brooks Pfeiffer and Gerald Nordland (eds.)

*Frank Lloyd Wright: In the Realm of Ideas* (p. 48)

Southern Illinois University Press, Carbondale, Illinois, USA. 1988

Architecture is the triumph of human imagination over materials, methods and men, to put man into possession of his own earth.

In Bruce Brooks Pfeiffer and Gerald Nordland (eds.)

*Frank Lloyd Wright: In the Realm of Ideas* (p. 48)

Southern Illinois University Press, Carbondale, Illinois, USA. 1988

**Wyatt, Mrs. James**

No biographical data available

You must be aware that Architecture is the profession of a Gentleman, and that none is more lucrative when it is properly attended to.

*Egerton Manuscript*

3515, Letter to son Philip, 1808

**Zevi, Bruno** 1918–2001

Italian architectural historian and writer

To look at architecture with any system and intelligence one must already have a lively interest in the subject and be provided with a good deal of good will.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter I (p. 16)

Horizon Press. New York, New York, USA. 1957

*Les yeux qui ne voient pas*, the eyes which do not see the beauty of Purist forms are eyes that today do not see and do not understand the lessons of traditional architecture.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter I (p. 17)

Horizon Press. New York, New York, USA. 1957

Architecture...is like a great hollowed-out sculpture which man enters and apprehends by moving about within it.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (p. 22)

Horizon Press. New York, New York, USA. 1957

A satisfactory history of architecture has not yet been written, because we are still not accustomed to thinking in terms of space, and because historians of architecture

have failed to apply a coherent method of studying buildings from a spatial point of view.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (p. 22)

Horizon Press. New York, New York, USA. 1957

Architecture...does not consist in the sum of the width, length and height of the structural elements which enclose space, but in the void itself, the enclosed space in which man lives and moves.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (pp. 22–23)

Horizon Press. New York, New York, USA. 1957

Decorating, sculpture and painting enter into the grammar of architecture in their proper places as adjectives, not as substantives.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (p. 32)

Horizon Press. New York, New York, USA. 1957

Architecture is not art alone, it is not merely a reflection of conceptions of life or a portrait of systems of living. Architecture is environment, the stage on which our lives unfold.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (p. 32)

Horizon Press. New York, New York, USA. 1957

All the techniques of representation and all the paths to architecture which do not include direct experience are pedagogically useful, of practical necessity and intellectually fruitful; but their function is no more than allusive and preparatory to that moment in which we, with everything in us that is physical and spiritual and, above all, human, enter and experience the spaces we have been studying. That is the moment of architecture.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter III (p. 60)

Horizon Press. New York, New York, USA. 1957

Among the planets of the arts, architecture is the dark side of the moon.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter VI (p. 227)

Horizon Press. New York, New York, USA. 1957

## ARCHITECTURE AND ART

**Belcher, John** 1841–1913

English architect

Architecture is not a science plus art, but a science interpenetrated in all its methods and applications by the true spirit of art.

*Essentials in Architecture: An Analysis of the Principles & Qualities to be Looked for in Buildings*

Introduction (p. 5)

B.T. Batsford, Ltd. London, England. 1907

**Statham, H. Heathcote** 1839–1924

Architect

...architecture, although a form of artistic expression, is not, like painting and sculpture, unfettered by practical considerations; it is an art inextricably bound up with structural conditions and practical requirements.

*Architecture for General Readers*

Architecture for General Readers (p. 5)

Charles Scribner's Sons. New York, New York, USA. 1896

...we must remember that architecture, although a form of artistic expression, is not, like painting and sculpture, unfettered by practical considerations; it is an art inextricably bound up with structural conditions and practical requirements.

*Architecture for General Readers*

Architecture for General Readers (p. 5)

Charles Scribner's Sons. New York, New York, USA. 1896

## ARCHITECTURE AND MUSIC

**Beltrami, Giacomo Costantino** 1779–1855

Italian jurist, author, and explorer

Architecture is like music – one note out of its place is sufficient to destroy the harmony of the whole.

*Pilgrimage in Europe and America*

Letter VII (p. 290)

Printed for Hunt & Clarke. London, England. 1828

**Statham, H. Heathcote** 1839–1924

Architect

Architecture is, like music, a metaphysical art; it deals with the abstract qualities of proportion, balance of form, and direction of line, but without any imitation of the concrete facts of nature.

*Architecture for General Readers*

Architecture for General Readers (pp. 6–7)

Charles Scribner's Sons. New York, New York, USA. 1896

The comparison between architecture and music is an exercise of the fancy which has often been pushed too far.

*Architecture for General Readers* (2nd edition)

Architecture for General Readers (p. 7)

Charles Scribner's Sons. New York, New York, USA. 1896

**van Brunt, Henry** 1832–1903

American architect

Painting has something to say which sculpture cannot say; architecture has a message which cannot be repeated in music; and vice versa.

*Greek Lines and Other Architectural Essays*

Architecture and Poetry (p. 237)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

## ARCHITECTURE AND POETRY

**van Brunt, Henry** 1832–1903  
American architect

...architecture does not reach its highest estate until it is so infused with imagination and fancy – not undisciplined imagination or capricious fancy – that the ordered fabric delights the eye of every intelligent observer and excites emotions like a poem.

*Greek Lines and Other Architectural Essays*

Architecture and Poetry (p. 235)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

## ARCHITECTURE, HISTORY OF

**Beltrami, Giacomo Costantino** 1779–1855  
Italian jurist, author, and explorer

...the history of architecture is like a series of waves, the crests the perfected styles, and the hollows the transition from the one into the next following.

*Pilgrimage in Europe and America*

Letter VIII

*Technology Quarterly and Proceedings of the Society of Arts*

The Study of Architecture

Volume 5, Number 4, December, 1892 (p. 375)

Printed for Hunt & Clarke. London, England. 1828

## ARCHIVE

**Anderson, James H.**

No biographical data available

Stored away in the archives of the nation, carefully guarded against depredation and destruction, are the annals of his struggles, the pean of her triumphs, the register of her defeats, perishable records at best; but graven on tables of stone and clay, in characters that are scattered and in part obliterated, yet capable of being welded into one conforming whole; characters that have withstood, in the main, the ravages of time; characters that are the open sesame to the mysterious past when old earth was young, and have awaited only the genie of intelligence, are evidences whence may be adduced tales of prehistoric marvels, monsters more ingenious than the Grendel of Beowulf, the creature of Frankenstein and peoples who were forgotten long ere the culture of Greece, the grandeur of Rome, were begun.

*Riddles of Prehistoric Times*

Chapter I (pp. 7–8)

Broadway Publishing Co. New York, New York, USA. 1911

## ARGUMENT

**Harvey, William** 1578–1657  
English physician

Some weak and inexperienced persons vainly seek by dialectics and farfetched arguments either to upset or establish things that are only to be founded on anatomical demonstration and believed on the evidence of the senses. He who truly desires to be informed of the question in hand... must be held bound either to look for himself, or to take on trust the conclusions to which they who have looked have come.

*Great Books of the Western World* (Volume 28)

A Second Disquisition to John Riolan (pp. 322–323)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

It would be very improper to adduce any example of a particular, where the force of the argument lies in the generality alone.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter V (p. 159)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Maxwell, James Clerk** 1831–79

Scottish physicist

One great art in argument when you have the first move is to divide everything into that which is and that which is not in some assigned class. In this way you make it the business of the opponent to discover what other important things there may be which may be said of the subject in hand.

Quoted in Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell: With a Selection from His Correspondence and Occasional Writings*

Chapter VIII (p. 233)

Macmillan & Co Ltd. London, England. 1882

**Sagan, Carl** 1934–96

American astronomer and author

...the cure for a fallacious argument is a better argument, not the suppression of ideas.

*Demon-Haunted World: Science As a Candle in the Dark*

Chapter 25 (p. 429)

Random House, Inc. New York, New York, USA. 1995

## ARGYRIA

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

So we must keep doctors awake by telling them that they have not yet shaken off astrology and the doctrine of signatures, as is shown by the form of their prescriptions, and their use of nitrate of silver, which turns epileptics into Ethiopians.

*The Professor at the Breakfast Table*

Chapter V (p. 132)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

## ARITHMETIC

**Author undetermined**

Arithmetic, then, means dealing logically with certain facts that we know, about numbers, with a view to arriving at knowledge which as yet we do not possess.

*Philosophy & Fun of Algebra*

Chapter 1 (p. 11)

C.W. Daniel Ltd. London, England.

**Arnheim, Rudolf** 1904–2007

German-born author, art and film theorist

We supply children with pocket calculators, but we must consider that the saving in time and effort is made at the expense of precious and elementary training of the brain. Genuine productive thinking starts at the simplest level, and the basic operations of arithmetic offer fine opportunities.

*New Essays on the Psychology of Art*

A Plea for Visual Thinking (p. 143)

University of California Press. Berkeley, California, USA. 1986

**Author undetermined**

Arithmetically speaking, rabbits multiply faster than adders add.

Source undetermined

**Bayly, Thomas Haynes** 1797–1839

English poet, songwriter, dramatist, and miscellaneous writer

As a boy, I had sighed over the mysteries of multiplication; addition had added materially to my distress, and subtraction taken away much of my repose.

*Musings and Prosings* (p. 207)

Printed by F. Bible. Boulogne, France. 1833

**Brandeis, Louis Dembitz** 1856–1941

Lawyer, reformer, and Supreme Court justice

Remember, O Stranger, Arithmetic is the first of the sciences and the mother of safety.

*Other People's Money*

Preface (p. viii)

Frederick A. Stokes. New York, New York, USA. 1914

...obsessed with the delusion that two and two make five, he fell at last a victim of the relentless rules of humble arithmetic.

Remember, O Stranger!

Arithmetic is the first of the sciences and the mother of safety.

In Alpheus T. Mason

*Brandeis: A Free Man's Life*

Chapter Thirteen (p. 200)

The Viking Press. New York, New York, USA. 1956

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

I know that two and two make four – & should be glad to prove it too if I could – though I must say if by any sort of process I could convert 2 & 2 into five it would give me much greater pleasure.

In Leslie A. Marchand (ed.)

*Byron's Letters and Journals* (Volume 3)

No. 10, Letter to Annabella Milbanke, November 10th, 1813 (p. 159)

Harvard University Press. Cambridge, Massachusetts, USA. 1973–82

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

...the different branches of Arithmetic – Ambition, Distraction, Uglification, and Derision.

*The Complete Works of Lewis Carroll*

*Alice's Adventures in Wonderland*

Chapter IX (p. 103)

The Modern Library. New York, New York, USA. 1936

Let me see: four times five is twelve, and four times six is thirteen, and four times seven is – oh dear! I shall never get to twenty at that rate!

*Alice's Adventure in Wonderland*

Chapter 2 (pp. 19–20)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1869

**Churchill, Sir Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and writer

You cannot ask us to take sides against arithmetic.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Bias (p. 44)

George Allen & Unwin Ltd. London, England. 1956

**Collodi, Carlo** 1826–1890

Florentine children's writer

In school today, I'll learn to read, to-morrow to write, and the day after to-morrow I'll do arithmetic.

Translated by Carol Della Chiesa

*The Adventures of Pinocchio*

Chapter 9 (p. 32)

The MacMillan Company. New York, New York, USA. 1961

**Davis, Philip J.** 1923–

American applied mathematician

**Hersh, Reuben** 1827–

American mathematician

The sciences of quantity and of space in their simpler forms are known as *arithmetic* and *geometry*.

*The Mathematical Experience, Study Edition*

What Is Mathematics? (p. 6)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1998

**Dewey, John** 1859–1952

American philosopher and educator

The way to enable a student to apprehend the instrumental value of arithmetic is not to lecture him on the benefit it will be to him in some remote and uncertain future, but



to let him discover that success in something he is interested in doing depends on ability to use numbers.

*Democracy and Education: An Introduction to the Philosophy of Education*

Chapter Eighteen (p. 240)

The Free Press, New York, New York, USA. 1916

**Dickens, Charles** 1812–70

English novelist

Herein lay the spring of the mechanical art and mystery of educating the reason without stooping to the cultivation of the sentiments and affections. Never wonder. By means of addition, subtraction, multiplication, and division, settle everything somehow, and never wonder.

*Hard Times*

Book the First, Chapter VIII (p. 43)

J.M. Dent & Sons Ltd. London, England. 1966

**Dostoevsky, Fyodor Mikhailovich** 1821–81

Russian writer

...what do I care for the laws of nature and arithmetic, when, for some reason I dislike those laws and the fact that twice two makes four?

*Notes from the Underground*

Chapter III (p. 8)

Dover Publications. New York, New York, USA. 1992

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

For we do not listen with the best regard to the verses of a man who is only a poet, nor to his problems if he is only an algebraist; but if a man is at once acquainted with the geometric foundations of things and with their festal splendor, his poetry is exact and his arithmetic musical.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Society and Solitude*

Works and Days (p. 179)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Everett, Edward** 1794–1865

Whig Party politician

[Arithmetic] is another of the great master-keys of life. With it the astronomer opens the depths of the heavens; the engineer, the gates of the mountains; the navigator, the pathways of the deep. The skilful arrangement, the rapid handling of figures, is a perfect magician's wand.

*Orations and Speeches on Various Occasions* (Volume 3)

III (p. 47)

Little, Brown & Co. Boston, Massachusetts, USA. 1870

**Fitch, Sir Joshua Girling** 1824–1903

English educationist

It is by Arithmetic more than by any other subject in a school course that the art of thinking – consecutively, closely, logically – can be effectually taught.

*Lectures on Teaching*

Chapter XI (p. 293)

The Macmillan Co. New York, New York, USA. 1906

**Frege, Friedrich Ludwig Gottlob** 1848–1925

German logician

I compare arithmetic with a tree that unfolds upwards in a multitude of techniques and theorems while the root drives into the depths.

In I. Grattan-Guinness

*The Search For Mathematical Roots*

Chapter 1 (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 2000

**Heinlein, Robert A.** 1907–88

American science fiction writer

...an intellectual is a highly educated man who can't do arithmetic with his shoes on, and is proud of his lack.

*The Cat Who Walks Through Walls: A Comedy of Manners*

Chapter XXVIII (p. 359)

G.P. Putnam's Sons. New York, New York, USA. 1985

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I was just going to say, when I was interrupted, that one of the many ways of classifying minds is under the heads of arithmetical and algebraical intellects. All economical and practical wisdom is an extension or variation of the following arithmetical formula:  $2 + 2 = 4$ . Every philosophical proposition has the more general character of the expression  $a + b = c$ . We are the mere operatives, empirics, and egoists, until we learn to think in letters instead of figures.

*The Autocrat of the Breakfast-Table*

Chapter I (p. 1)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hugo, Victor** 1802–85

French writer, lyric poet, and dramatist

Arithmetic, like the sea, is an undulation without any possible end.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 407)

The Heritage Press. New York, New York, USA. 1961

**Kipling, Rudyard** 1865–1936

British writer and poet

A rule to trick th' arithmetic.

*Rudyard Kipling's Verse*

To the True Romance

Hodder & Stroughton. London, England. 1919

**La Touche, Mrs.**

No biographical data available

I do hate sums. There is no greater mistake than to call arithmetic an exact science. There are Permutations and Aberrations discernible to minds entirely noble like mine; subtle variations which ordinary accountants fail to discover; hidden laws of Numbers which it requires a mind like mine to perceive. For instance, if you add

a sum from the bottom up, and then again from the top down, the result is always different.

In Maria Price La Touche

*The Letters of a Noble Woman*

Letter dated July 1878 (p. 49)

George Allen & Sons. London, England, 1908

**Leacock, Stephen** 1869–1944

Canadian humorist

His brain trained by long years of high living and plain thinking had become too subtle, too refined an instrument for arithmetic....

*Literary Lapses*

Lord Oxhead's Secret (p. 23)

John Lane. London, England, 1911

The student of arithmetic who has mastered the first four rules of his art, and successfully striven with money sums and fractions, finds himself confronted by an unbroken expanse of questions known as problems.

*Literary Lapses*

A, B, and C (p. 237)

John Lane. London, England, 1911

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

The pleasure we obtain from music comes from counting, but counting unconsciously. Music is nothing but unconscious arithmetic.

In Oliver Sacks

*The Man Who Mistook His Wife for a Hat and Other Clinical Tales*

The Twins (p. 195)

Summit Books. New York, New York, USA, 1985

**Lieber, Lillian R.**

Mathematician

In other words, without a theory, a plan, the mere mechanical manipulation of the numbers in a problem does not necessarily make sense just because you are using Arithmetic!

*The Education of T.C. MITS*

Part I, Chapter III (p. 36)

W.W. Norton & Company, Inc. New York, New York, USA, 1944

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

The mathematical textbook to which this is intended as an introduction is not yet completed; but when it is completed it will be different from any other treatise on arithmetic in the world. It will have no very large numbers in it, for very large numbers are not only vulgarly ostentatious in themselves (and therefore offensive to persons of taste) but they are immoral as well.

*Prefaces*

Preface to a Moral Book of Arithmetic (p. 193)

D. Appleton & Co. New York, New York, USA, 1919

**Nash, Ogden** 1902–71

American writer of humorous poetry

...the only way I can distinguish proper from improper fractions

Is by their actions.

*Parents Keep Out, Elderly Poems for Younger Readers*

Ask Daddy, He Won't Know

Little, Brown Publishers. Boston, Massachusetts, USA, 1951

**Parker, Francis Wayland** 1837–1902

American educator

The science of Arithmetic may be called the science of exact limitation of matter and things in space, force, and time.

*Talks on Pedagogics*

Chapter IV (p. 64)

A.S. Barnes & Company. New York, New York, USA, 1909

**Plato** 428 BCE–347 BCE

Greek philosopher

SOC: ...if arithmetic, mensuration, and weighing be taken away from any art, that which remains will not be much.

In *Great Books of the Western World* (Volume 7)

*Philebus*

Section 55 (p. 633)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA, 1952

SOC: ...“And so, Gorgias, you call arithmetic rhetoric.” But I do not think that you really call arithmetic rhetoric any more than geometry would be so called by you.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 450 (p. 254)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA, 1952

Can we deny that a warrior should have a knowledge of arithmetic?

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 522 (p. 392)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA, 1952

...arithmetic has a very great and elevating effect, compelling the soul to reason about abstract number, and rebelling against the introduction of visible or tangible objects into the argument.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 525 (p. 393)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA, 1952

...those who have a natural talent for calculation are generally quick at every other kind of knowledge; and even the dull, if they have had an arithmetical training, although they may derive no other advantage from it, always become much quicker than they would otherwise have been...

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 526 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA, 1952



...arithmetic is a kind of knowledge in which the best natures should be trained, and which must not be given up.

In *Great Books of the Western World* (Volume 7)  
*The Republic*

Book VII, Section 526 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Arithmetic does not present to us that feeling of continuity which is such a precious guide; each whole number is separate from the next of its kind and has in a sense individuality; each in a manner is an exception and that is why general theorems are rare in the theory of numbers; and that is why those theorems which may exist are more hidden and longer escape those who are searching for them.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 131)

Government Printing Office. Washington, D.C. 1910

### **Rosenblatt, Roger**

American journalist, writer, and playwright

...Uncle Scrooge preferred to let the poor die “and decrease the surplus population.” Scrooge may not have God on his side, but his arithmetic was impeccable.

*The Man in the Water: Essays and Stories*

Do You Feel the Deaths of Strangers? (p. 177)

Random House, Inc. New York, New York, USA. 1994

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

All knowledge must be recognition, on pain of being mere delusion; Arithmetic must be discovered in just the same sense in which Columbus discovered the West Indies, and we no more create numbers than he created the Indians.... Whatever can be thought of has being and its [arithmetic] being is a precondition, not a result, of its being thought of.

Is Position in Space and Time Absolute or Relative

*Mind*, Volume X, 1901 (p. 312)

At present, in what concerns arithmetic, the boy or girl is given a set of rules, which present themselves as neither true nor false, but as merely the will of the teacher, the way in which, for some unfathomable reason, the teacher prefers to have the game played.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 62)

Longmans, Green & Co. London, England. 1919

### **Safford, Truman Henry** 1836–1901

American calculating prodigy

...arithmetic, as we shall see by and by, is overdone, in a certain sense, in our schools; just so far as the teaching is

based upon the concrete, so far is it profitable; but when the book-makers begin to make it too abstract, as they very often do, it becomes a torture to both teacher and learners, or, at best, a branch of imaginary knowledge unconnected with real life.

*Mathematical Teaching and Its Modern Methods*

Introduction (p. 10)

D.C. Heath & Co. Boston, Massachusetts, USA. 1888

### **Sandburg, Carl** 1878–1967

American poet and biographer

Arithmetic is where numbers fly like pigeons in and out of your head.

*Complete Poems*

Arithmetic

Harcourt, Brace. New York, New York, USA. 1950

Arithmetic is numbers you squeeze from your head to your hand to your pencil to your paper till you get the answer.

*Complete Poems*

Arithmetic

Harcourt, Brace. New York, New York, USA. 1950

If you ask your mother for one fried egg for breakfast and she gives you two fried eggs and you eat both of them, who is better in arithmetic, you or your mother?

*Complete Poems*

Arithmetic

Harcourt, Brace. New York, New York, USA. 1950

### **Schopenhauer, Arthur** 1788–1860

German philosopher

That arithmetic is the basest of all mental activities is proved by the fact that it is the only one that can be accomplished by means of a machine.

Translated by Mrs. Rudolph Dircks

*Essays of Schopenhauer*

Psychological Observations

W. Scott. London, England. 1897

### **Smith, Henry John Stephen** 1826–83

Irish mathematician

Of all those branches of human knowledge which are comprehended under the name of Science, Arithmetic is that which has the most abstract character, and which, at the same time, is of the most universal application in the study of natural phenomena.

*The Collected Mathematical Papers of Henry John Stephen Smith*

(Volume 2)

Appendix II (p. 691)

At The Clarendon Press. Oxford, England. 1894

[Arithmetic] is one of the oldest branches, perhaps the very oldest branch, of human knowledge; and yet some of its most abstruse secrets lie close to its tritest truths.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

**Smith, Sydney** 1771–1845

English clergyman, writer, and wit

What would life be like without arithmetic, but a scene of horrors?

*The Letters of Sydney Smith* (Volume 2)

Letter 692, To Miss Lucie Austin, 22 July 1835 (p. 622)

At The Clarendon Press. Oxford, England. 1953

...Lucy, dear child, mind your arithmetic. You know, in the first sum of yours I ever saw, there was a mistake. You had carried two (as a cab is licensed to do), and you ought, dear Lucy, to have carried but one. Is this a trifle? What would life be without arithmetic but a scene of horrors?

In Sarah Austin

*A Memoir of the Reverend Sydney Smith* (Volume 2)

Letter 356 (p. 345)

Harper & Brothers Publishers. New York, New York, USA. 1855

**Steinbeck, John** 1902–68

American novelist

He was an arithmetician rather than a mathematician. None of the humor, the music, or the mysticism of higher mathematics ever entered his head.

*The Moon Is Down*

Chapter Two (p. 22)

Heinemann. London, England. 1968

**Turnbull, A.**

No biographical data available

Arithmetic is a science as well as an art, and of all the arts and sciences there is none so generally useful in the common concerns of life. A thorough knowledge of it must be of the utmost importance to everyone, whatever be his station in society; but to those engaged in trade or commerce, however trivial, it is indispensable. Beside the general utility of this branch of knowledge, it has another recommendation; it is easy of attainment.

*Arithmetic Made Easy*

Chapter I (p. 1)

Simpkin & Marshall. London, England. 1836

**Vyse, Charles**

No biographical data available

When we consider the utility of ARITHMETIC, on which science almost all the others do absolutely depend, we need not be surprised that so many efforts have been made to bring this useful branch of learning to the utmost degree of perfection: and although the vast extent of the subject does in some measure defeat these attempts, yet, upon account of its real value and use, it certainly merits all the study and pains that can be bestowed upon it.

*The Tutor's Guide*

15th Preface (p. iii)

Printed for G. Wilkie. London, England. 1815

I pretend not to boast of new discoveries, but flatter myself to have selected every necessary and useful rule

or proposition for obtaining a thorough knowledge in those sciences which depend upon Arithmetic...

*The Tutor's Guide*

15th Preface (p. v)

Printed for G. Wilkie. London, England. 1815

**Weaver, Jefferson Hane**

American science author

Arithmetic – not algebra or geometry or the calculus – is the mother lode of mathematical reasoning as well as the foundation from which all mathematics arises.

*Conquering Calculus: The Easy Road to Understanding Mathematics*

Chapter 3 (p. 57)

Plenum Press. New York, New York, USA. 1998

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The first acquaintance which most people have with mathematics is through arithmetic. That two and two make four is usually taken as the type of a simple mathematical proposition which everyone will have heard of. Arithmetic, therefore, will be a good subject to consider in order to discover, if possible, the most obvious characteristic of the science. Now, the first noticeable fact about arithmetic is that it applies to everything, to tastes and to sounds, to apples and to angels, to the ideas of the mind and to the bones of the body.

*An Introduction to Mathematics*

Chapter I (p. 9)

Henry Holt & Co. New York, New York, USA. 1911

The territory of arithmetic ends where the two ideas of “variables” and of “algebraic form” commence their sway.

*An Introduction to Mathematics*

Chapter 5 (p. 48)

Oxford University Press, Inc. New York, New York, USA. 1958

**X. Y. Z.**

It was a notable day when I was equipped with an arithmetic and a slate and set to “doing sums.” “We were told to commit the preliminary definitions to memory, and forthwith commenced the task. At the appointed hour, we told our teacher, with more or less accuracy, that: arithmetic is the science of numbers,” etc. all of which, possibly, sounded very pretty, but was totally destitute of sense; we did not grasp it.

*How I Did (Not) Learn Arithmetic*

*The Indiana School Journal*, Volume 16 1871 (p. 21)

**Yeats, William Butler** 1865–1939

Irish poet and playwright

I have made formations of battle with Arithmetic that have put the hosts of heaven to the rout.

*The Hour-Glass and Other Plays*

The Hour-Glass (p. 14)

The Macmillan Co. New York, New York, USA. 1904

**ADDITION****Author undetermined**

$1 + 1 = 3$ , for large values of 1.

Source undetermined

*Si inaequalibus aequalia addas, omnia errunt inaequalia.*

If equals be added to unequals, the whole will be unequal.

Source undetermined

One and one make two,

But if one and one should marry,

Isn't it queer

Within a year

There's two and one to carry.

Source undetermined

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“What's one and one and one and one and one and one and one and one and one and one?”

“I don't know,” said Alice. “I lost count.”

“She can't do Addition,” the Red Queen interrupted.

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter IX (pp. 252–253)

The Modern Library. New York, New York, USA. 1936

**Dickson, Paul**

American writer

Baldy's Law. Some of it plus the rest of it is all of it.

*The Official Rules* (p. 8)

Delacorte Press. New York, New York, USA. 1978

**Dostoevsky, Fyodor Mikhailovich** 1821–81

Russian writer

Twice two makes four seems to me simply a piece of insolence. Twice two makes four is a pert coxcomb who stands with arms akimbo barring your path and spitting. I admit that twice two makes four is an excellent thing, but if we are to give everything its due, twice two makes five is sometimes a very charming thing too.

*The Short Novels of Dostoevsky*

Notes from Underground (p. 139)

Dial Press. New York, New York, USA. 1945

**Hardy, Thomas** 1840–1928

English poet and regional novelist

...is a woman a thinking unit at all, or a fraction always its integer? How do you argue that marriage was only a clumsy contract – which it is – how you showed all the objections to it – all the absurdities! If two and two made four when we were happy together, surely they make four now? I can't understand it, I repeat!

*Jude the Obscure*

Part Sixth, Chapter 3, At Christminster Again (p. 359)

Harper & Brothers. New York, New York, USA. 1895

**Housman, A. E. (Alfred Edward)** 1859–1936

English poet, scholar, and satirist

To think that two and two are four

And neither five nor three

The heart of man has long been sore

And long 'tis like to be.

*The Collected Poems of A.E. Housman*

Last Poems, XXXV (p. 142)

Henry Holt & Company. New York, New York, USA. 1940

**Ice-T** 1958–

American rapper, singer, and actor

I write rhymes with addition and algebra, mental geometry.

*Mind over Matter*

O.G.: Original Gangster CD

**Orwell, George (Eric Arthur Blair)** 1903–50

English novelist and essayist

“Two and two are four .”

“Sometimes, Winston. Sometimes they are five. Sometimes they are three. Sometimes they are all of them at once. You must try harder. It is not easy to become sane.”

1984

Part III, Chapter III (p. 263)

Alfred A. Knopf. New York, New York, USA. 1992

**Paulos, John Allen** 1945–

American mathematician

Adding, though pleasant and easy, is often inappropriate.... Recall that mathematics as simple as ‘ $1 + 1 = 2$ ’ can be thoughtlessly misapplied: If 1 cup of popcorn is added to 1 cup of water, we do not end up with 2 cups of soggy popcorn.

*Innumeracy: Mathematical Illiteracy And Its Consequences* (p. 67)

**Pope, Alexander** 1688–1744

English poet

Ah! why, ye Gods! Should two and two make four?

*The Complete Poetical Works* (Volume 4)

The Dunciad, Book 2, l. 285

Houghton Mifflin Company. New York, New York, USA. 1903

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Mrs. Bashom: At school I got as far as addition and subtraction; but I never could do multiplication or division.

Newton: Why, neither could I: I was too lazy. But they are quite unnecessary: addition and subtraction are quite sufficient. You ask the logarithms of the numbers; and the antilogarithm of the sum of the two is the answer. Let me see: three time seven?

*The Complete Plays of Bernard Shaw*

*In Good King Charles's Golden Days*, Act I (p. 1335)

Odhams Press. London, England. 1950

**West, Mae** 1893–1980  
American film actress

One figure can sometimes add up to a lot.  
*The Wit and Wisdom of Mae West* (p. 35)  
G.P. Putnam's Sons. New York, New York, USA. 1967

I learned that two and two are four and five will get you ten if you know how to work it.  
*The Wit and Wisdom of Mae West* (p. 52)  
G.P. Putnam's Sons. New York, New York, USA. 1967

## DIVISION

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

It is known that there is an infinite number of worlds, but that not everyone is inhabited. Therefore, there must be a finite number of inhabited worlds. Any finite number divided by infinity is as near to nothing as makes no odds, so if every planet in the Universe has a population of zero then the entire population of the Universe must also be zero, and any people you may actually meet from time to time are merely the products of a deranged imagination.  
*The Original Hitchhiker Radio Script*  
Fit the Fifth (p. 102)  
Harmony Books. New York, New York, USA.

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

Can you do Division? Divide a loaf by a knife – what's the answer to that?  
*The Complete Works of Lewis Carroll*  
*Through the Looking-Glass*  
Chapter IX (p. 253)  
The Modern Library. New York, New York, USA. 1936

**Kemble, William H.**  
No biographical data available

Allow me to introduce you to my particular friend Mr. George O Evans.... He understands Addition, Division, and Silence.  
*New York Sun*, 20 June, 1872

**Mr. Silva (Fictional character)**

You've got so many refinements. I don't think you need to worry about your failure at long division. I mean, after all, you got through short division, and short division is all that a lady ought to be called on to cope with...  
*Baby Doll*  
Film (1956)

## MULTIPLICATION

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

There is no national science, just as there is no national multiplication table; what is national is no longer science.

*Note-Book of Anton Chekhov* (p. 18)  
B.W. Huebsch, Inc. New York, New York, USA. 1921

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

There was nothing to be said about addition and subtraction: they were so simple as to force themselves upon one at first sight. Multiplication spoilt things. There was a certain rule of signs which declared that minus multiplied by minus made plus. How I toiled over that wretched paradox!  
Translated by Alexander Teixeira de Mattos  
*The Life of the Fly*  
Chapter XII (p. 278)  
Dodd, Mead & Co. New York, New York, USA. 1915

**Melrose, A. R.**  
No biographical data available

Two-stymes, noun: 1 arithmetic if it has to do with the number two {2} {which is always a good number to have when doing anything}. 2 multiplication table of the number two {2}.

*The Pooh Dictionary*  
Dutton Children's Books. New York, New York, USA. 1995

**Zamyatin, Yevgeny** 1884–1937  
Russian novelist, playwright, and satirist

The multiplication table is more wise and more absolute than the ancient god, for the multiplication table never (do you understand – never) makes mistakes!  
Translated by Gregory Zilboorg  
*We*  
Record Twelve (pp. 63–64)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1952

There are no more fortunate and happy people than those who live according to the correct, eternal laws of the multiplication table.  
Translated by Gregory Zilboorg  
*We*  
Record Twelve (p. 64)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1952

## SUBTRACTION

**Dickens, Charles** 1812–70  
English novelist

The worst class of sum worked in the every-day world is ciphered by the diseased arithmeticians who are always in the rule of Subtraction as to the merits and successes of others, and never in Addition as to their own.  
*Little Dorrit*  
Book the Second, Chapter VI (p. 462)  
Bradbury & Evans. London, England. 1857

## ARROGANCE

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

Even the best fathers are not without shortcomings. If we must accept arrogance, stubbornness, invectiveness, and vanity along with genius, so be it. If modern science must have a father, let it be Galileo.

*Blind Watchers of the Sky*

Chapter Four (p. 112)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

## ARTIFACT

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Little comes to us through time as a complete monument; much comes as remnants; much as techniques, as practical manual; some things because of their close affinity to man, like mathematics; other things because they are always encouraged, like astronomy and geography; other things because of man's needs, like medicine; and finally some things, because the human being, without wanting to, continues to produce them, like music and the other fine arts.

In Karl J. Fink

*Goethe's History of Science*

Chapter 5 (p. 66)

Cambridge University Press. Cambridge, England. 1991

## ARTIFICIAL LIMBS

**Melville, Herman** 1819–91  
American novelist

Now, for most folks one pair of legs lasts a lifetime, and that must be because they use them mercifully, as a tender-hearted old lady uses her roly-poly old coach horses. But Ahab; oh he's a hard driver. Look, driven one leg to death, and sprained the other for life, and now wears out bone legs by the cord.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 108 (p. 348)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ASSAULT

### The Bible (King James Version)

A certain man went down from Jerusalem to Jericho, and fell among thieves, which stripped him of his raiment, and wounded him, and departed, leaving him half dead.

Luke 10:30

## ASSENT

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

It is as important to withhold assent, when the proof is inadequate, as to yield assent when it is ample.

The Ethical Functions of Scientific Study

*The Journal of Geology*, Volume 2, Number 6, December, 1888 (p. 385)

## ASSERTION

**Faraday, Michael** 1791–1867  
English physicist and chemist

A man who makes assertions, or draws conclusions, regarding any given case, ought to be competent to investigate it. He has no right to throw the onus on others, declaring it their duty to prove him right or wrong. His duty is to demonstrate the truth of that which he asserts, or to cease from asserting.

*Experimental Researches in Chemistry and Physics*

Lecture on Mental Education (p. 486)

Richard Taylor & William Francis. London, England. 1859

**Goddard, Robert H.** 1882–1945  
American physicist

It is dangerous to believe hastily that anything is either possible or impossible, for there are few scientific assertions which have been proved to universal satisfaction. Our firmest scientific beliefs of today may be shattered tomorrow.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted (p. 65)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Huxley, Thomas Henry** 1825–95  
English biologist

...assertion which outstrips evidence is not only a blunder but a crime.

*Science and Education*

Chapter VI (p. 133)

American Home Library Co. New York, New York, USA. 1902

## ASSESSMENT

### Charlie Eppes (Fictional character)

Forgive me if all my years of advanced applied mathematics take issue with that assessment.

*Numbers*

Film (2005)

**Hill, Austin Bradford** 1897–1991  
English epidemiologist

It appears sometimes to be thought that there is some necessary antagonism between the clinical assessment of

a few cases and the “cold mathematics” of the statistically analyzed trial dealing with a larger number. It is difficult to see how in fact there can be any such antagonism. The clinical assessment, or the clinical impression, must itself be numerical in the long run – that patients are reacting in a way different from the way the clinician believes was customary in the past. In the control trial an attempt is made to systematize those impressions (and other measurements) and to add them up.

*Principles of Medical Statistics* (9th edition) (p. 266)  
Oxford University Press. New York, New York, USA. 1971

## ASSOCIATIONS

**von Liebig, Justus** 1803–73  
German organic chemist

One of the most remarkable features of modern times is the combination of large numbers of individuals representing the whole intelligence of nations, for the express purpose of advancing science by their united efforts, of learning its progress, and of communicating new discoveries. The formation of such associations is, in itself an evidence that they were needed.

*Chemistry In Its Application to Agriculture and Physiology*  
Preface (p. 3)  
T.B. Peterson. Philadelphia, Pennsylvania, USA. 1847

## ASSUMPTION

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

When the consequences of either assumption are the same, we should always assume that things are finite rather than infinite in number, since in things constituted by nature that which is infinite and that which is better ought, if possible, to be present rather than the reverse...

In *Great Books of the Western World* (Volume 8)  
*Physics*  
Book VIII, Chapter 7, 259a [5]  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Pick the assumptions to pieces till the stuff they are made of is exposed to plain view – this is the cardinal rule for understanding the basis of our beliefs.

*The Search for Truth*  
Chapter I, Section 5 (p. 25)  
George Allen & Unwin Ltd. London, England. 1935

Mathematicians and scientists of the conservative persuasion may feel that a science constrained by an explicitly formulated set of assumptions has lost some of its freedom and is almost dead. Experience shows that the only

loss is the denial of the privilege of making avoidable mistakes in reasoning. As is perhaps but humanly natural, each new encroachment of the postulational method is vigorously resisted by some as an invasion of hallowed tradition. Objection to the method is neither more or less than objection to mathematics.

*The Development of Mathematics*  
Chapter 3 (p. 72)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

No equation, however impressive and complex, can arrive at the truth if the initial assumptions are incorrect.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 1 (p. 7)  
Harper & Row, Publishers. New York, New York, USA. 1973

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

It is all too easy to make some plausible simplifying assumptions, do some elaborate mathematics that appear to give a rough fit with at least some experimental data, and think one has achieved something. The chance of such an approach doing anything useful, apart from soothing the theorist’s ego, is rather small....

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 10 (pp. 113–114)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Donghia, Angelo** 1935–85  
Italian-American interior designer

Assumption is the mother of screw-up...  
Behind Angelo Donghia’s Gray Flannel Success  
*New York Times*, Section C, January 20, 1983 (p. 6)

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Interesting fallacies are often subtle, often based upon hidden assumptions, unstated and probably unconsciously held.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Seven, Chapter 25 (p. 333)  
Random House, Inc. New York, New York, USA. 1995

**Huxley, Thomas Henry** 1825–95  
English biologist

...nothing can be more incorrect than the assumption one sometimes meets with, that physics has one method, chemistry another, and biology a third.

*Method and Results: Essays*  
The Progress of Science (p. 60)  
D. Appleton & Co. New York, New York, USA. 1898

**Savage-Rumbaugh, Sue**  
American psychologist



**Lewin, Roger Amos** 1946–  
Anthropologist and science writer

We do not realize how deeply our starting assumptions affect the way we go about looking for and interpreting the data we collect. We should recognize that nonhuman organisms need not meet every new definition of human language, tool use, mind, or consciousness in order to have versions of their own that are worthy of serious study. We have set ourselves too much apart, grasping for definitions that will distinguish man from all other life on the planet. We must rejoin the great stream of life from whence we arose and strive to see within it the seeds of all we are and all we may become.

*Kanzi: The Ape at the Brink of the Human Mind*  
Chapter 10 (p. 264)  
John Wiley & Sons, Inc. New York, New York, USA. 1994

**Siegel, Eli** 1902–78  
American philosopher, poet, critic, and founder of Aesthetic Realism

An assumption, as such, is really not more daring than the facts.

*Damned Welcome*  
Aesthetic Realism, Maxims, Part One, #33 (p. 21)  
Definition Press. New York, New York, USA. 1972

**Tinker, John F.**  
No biographical data available

It is well to consider the basic assumptions of science, but unless the consequences are more far reaching than the peace of mind of the philosophers, it seems to me that the emphasis of this consideration should be shifted in favor of more immediate assumptions.

On Scientific Assumptions  
*American Scientist*, Volume 40, Number 3, July 1952 (p. 502)

**Wilford, John Noble** 1933–  
American science writer

Dying dinosaurs and Martian dust storms, atmospheric physics and smoky fires in Brazil – important ideas can have the unlikeliest provenance. It is unwise to assume that any course of study of exploration is irrelevant.

*The Riddle of the Dinosaur*  
Chapter 18 (p. 271)  
Alfred A. Knopf. New York, New York, USA. 1986

## ASTEROID

**Asphaug, Erik**  
American planetary scientist

Neither rocks nor planets, they are something of Earth and Heaven.

The Small Planets  
*Scientific American*, Volume 282, Number 5, May, 2000 (p. 55)

**Barnes-Svarney, Patricia**  
No biographical data available

I do not mean to scare anyone, but there are asteroids out there with our name on them.

*Asteroid: Earth Destroyer or New Frontier?*  
Introduction (p. 1)  
Plenum Press. New York, New York, USA. 1996

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Is he not the celebrated author of the Dynamics of an Asteroid, a book which ascends to such rarefied heights of pure mathematics that it is said that there was no man in the scientific press capable of criticizing it?

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Valley of Fear* (p. 472)  
Wings Books. New York, New York, USA. 1967

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The asteroids are the chips of an old star, and a meteoric stone is a chip of an asteroid.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)  
*Letters and Social Aims*  
Chapter VII (p. 224)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Kowal, Charles T.** 1940–  
American astronomer

In fact, it is safe to say that the situation has degenerated to the point of absurdity. Asteroids have been named after girlfriends, financial supporters, cats, and computers. For the traditionalist like myself, it seems a pity that the naming of asteroids has become so trivialized.

*Asteroids: Their Nature and Utilization*  
Chapter 1 (p. 17)  
Ellis Horwood Ltd. Chichester, England. 1988

**Moulton, Forest Ray** 1872–1952  
American astronomer

I have heard the great geologist Suess, a man of the widest interests and richest imagination, describe a certain astronomer as “one of those who busy themselves with those vermin of the skies – minor planets and comets.”

The Semi-centennial of the Dearborn Observatory  
*Popular Astronomy*, Volume XXIV, Number 9, November, 1916 (p. 555)

**Peebles, Curtis**  
American aerospace historian

Lost amid the stars, there are mountains in the sky.

*Asteroids: A History*  
Chapter 1 (p. 1)  
Smithsonian Institution Press. Washington, D.C. 2000

**Sagan, Carl** 1934–96  
American astronomer and author

The asteroid belt may be a place where a planet was once prevented from forming because of the gravitational



tides of the giant nearby planet Jupiter; or it may be the shattered remains of a planet that blew itself up. This seems improbable because no scientist on Earth knows how a planet might blow itself up, which is probably just as well.

*Cosmos*

Chapter IV (p. 87)

Random House, Inc. New York, New York, USA. 1980

**Shoemaker, Eugene** 1928–97

American geologist

If all the potentially threatening asteroids were discovered, however, the risk to Earth would no longer be a matter of chance. We would know whether a collision is imminent. The time of impact could be predicted centuries in advance, and the place of impact could be predicted fairly accurately decades in advance.

Plaque at Meteor Crater, Arizona, USA

Statement

Near-Earth Asteroids

April 19, 1997

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935

Russian research scientist

To set foot on the soil of the asteroids, to lift by hand a rock from the Moon, to observe Mars from a distance of several tens of kilometers, to land on its satellite or even on its surface, what can be more fantastic? From the moment of using rocket devices a new great era will begin in astronomy: the epoch of the more intensive study of the firmament.

In Firmin Joseph Krieger

*Behind the Sputniks: A Survey of Soviet Space Science* (p. 23)

Public Affairs Press. Washington, D.C. 1958

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Noise proves nothing, often a hen that has merely laid an egg cackles as if she had laid an asteroid.

In Albert Bigelow Paine (ed.)

*Mark Twain's Notebook*

Chapter XXI (p. 241)

Harper & Brothers Publishers. New York, New York, USA. 1899

**ASTROGEOLOGY**

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...astrology...is so full of superstition, that scarce anything sound can be discovered in it ...

*Advancement of Learning: and Novum Organum*

Book I, Chapter IV (p. 86)

The Colonial Press. New York, New York, USA. 1900

**Chapman, Clark R.**

American astronomer and asteroid researcher

Yet it seems to me an intellectual accomplishment of the most awe-inspiring sort that in the few centuries since Galileo invented the telescope we learned so much about the planets merely by studying their faint shimmering light reaching us across the vastness of space. And it is a technological marvel of the space age that we now study pieces of the Moon in our laboratories or direct our remote-controlled robots sitting on ground millions of miles away to hammer at a Martian rock.

*The Inner Planets: New Light on the Rocky Worlds of Mercury, Venus, Earth, the Moon, Mars, and the Asteroids*

Chapter 9 (p. 161)

Charles Scribner's Sons. New York, New York, USA. 1977

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Astronomy to the selfish becomes astrology ...

*Emerson's Complete Works: Essays. 2nd series*

Nature (p. 172)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1886

**Sagan, Carl** 1934–96

American astronomer and author

Apart from an understanding of the solar system as a whole, it is becoming clear that information about any planet or satellite illuminates our knowledge of the others. In particular, if we are to understand the Earth, we must have a comprehensive knowledge of the other planets.

The Solar System

*Scientific American*, Volume 233, Number 3, September, 1975 (p. 27)

**ASTROLOGER**

**Charlie Chan (Fictional character)**

Friend of stars may possess unusual wisdom.

*Castle in the Desert*

Film (1942)

**ASTROLOGY**

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...astrology...is so full of superstition, that scarce anything sound can be discovered in it ...

*Advancement of Learning: and Novum Organum*

Book I, Chapter IV (p. 86)

The Colonial Press. New York, New York, USA. 1900

**Bonnycastle, John** 1751–1821

Mathematician

To make every event depend upon the twinkling of a star, is an absurdity equal to that of the Lapland witches, who pretend to regulate the course of the winds by tying knots in a string.

*An Introduction to Astronomy* (7th edition)

Letter I (p. 6)

Printed for J. Nunn. London, England. 1817

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

Ye stars! Which are the poetry of Heaven,  
If in your bright leaves we would read the fate  
Of men and empires – 'tis to be forgiven,  
That in our aspirations to be great,  
Our destinies o'erleap their mortal state,  
And claim a kindred with you.

*The Complete Poetical Works of Byron*  
Child Harold, Canto iii, Stanza 88  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1933

**Durant, William James** 1885–1981  
American historian and essayist

...astrology antedated – and perhaps will survive –  
astronomy; simple souls are more interested in telling  
futures than in telling time.

*The Story of Civilization Part I*  
Our Oriental Heritage  
Introduction Chapter I (p. 80)  
Simon & Schuster, New York, New York, USA. 1954

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Astronomy to the selfish becomes astrology...

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: Second Series*  
Nature (p. 546)  
The Library of America, New York, New York, USA. 1983

**Johnson, Severance** 1696–1772  
English critic, biographer, and essayist

Astronomy  
Is for the mind of gods, astrology  
For simpletons.

*The Dictator and the Devil*  
Ecnareves Press, New York, New York, USA. 1943

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The fault, dear Brutus, is not in the stars, but in ourselves.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*Julius Caesar*  
Act I, Scene ii, l. 134  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is the stars,  
The stars above us, govern our condition.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*King Lear*

Act IV, Scene iii, l. 34–35  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Astronomy: This is the excellent foppery of the world:  
that when we are sick in fortune – often the surfeits of  
our own behavior – we make guilty of our disasters the

sun, the moon, and stars, as if we were villains on neces-  
sity, fools by heavenly compulsion, knaves, thieves, and  
treachers by spherical predominance, drunkards, liars,  
and adulterers by an enforced obedience of planetary  
influence.... An admirable evasion of whoremaster man,  
to lay his goatish disposition on the charge of a star!

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*King Lear*  
Act I, Scene ii, l. 128 & 137  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smullyan, Raymond** 1919–  
American mathematician and logician

Recently, someone asked me if I believed in astrology.  
He seemed somewhat puzzled when I explained that the  
reason that I don't is because I'm a Gemini.

*5000 B.C. and Other Philosophical Fantasies*  
Chapter 3 (p. 23)  
St. Martin's Press, New York, New York, USA. 1983

## ASTRONAUT

### Apollo 11

Here men from the planet Earth first set foot upon the  
Moon July 1969, A.D. WE CAME IN PEACE FOR ALL  
MANKIND.

Plaque left behind on the moon's surface

**Cernan, Gene** 1934–  
American astronaut

Bob, this is Gene, and I'm on the surface; and, as I take  
man's last step from the surface, back home for some  
time to come – but we believe not too long into the  
future – I'd like to just (say) what I believe history will  
record. That America's challenge of today has forged  
man's destiny of tomorrow. And, as we leave the Moon  
at Taurus-Littrow, we leave as we came and, God willing,  
as we shall return, with peace and hope for all mankind.  
Godspeed the crew of Apollo 17.

Transcript of flight of Apollo 17

**Conrad, Pete** 1930–99  
American astronaut

Whoopee! Man, that may have been a small one for Neil,  
but it's a long one for me.

Transcript of flight of Apollo 12

**Gagarin, Yuri** 1934–68  
Soviet pilot and cosmonaut

*Poyekhali!*

Let's go!

Shouted as Vostok 1 lifted off, 12 April, 1961

**Scott, Dave** 1932–  
American astronaut

Man must explore. And this is exploration at its greatest.  
Transcript of flight of Apollo 15

**Shepherd, Alan** 1923–98  
American astronaut

It's been a long way, but we're here.  
Transcript of flight of Apollo 14

**Swigert, Jack** 1931–1982  
American astronaut

Okay, Houston; we've had a problem.  
Transcript of flight of Apollo 13

**Ward, Fred** 1942–  
American actor

Gus Grissom: What the hell's "astronaut" mean anyway?  
*The Right Stuff*  
Film (1983)

**Young, John** 1930–  
American astronaut

There you are:  
Mysterious and Unknown  
Descartes.  
Highland plains. Apollo 16 is gonna change your image.  
I'm sure glad they got ol' Brer Rabbit,  
here, back in the briar patch where he belongs.  
Transcript of flight of Apollo 16

## ASTRONOMER

### Author undetermined

Every day the astronomer discovers something which quickens his curiosity to discover more. Every day he catches new glimpses of the Almighty Wisdom, which stimulate his desire for a further revelation. And all he learns, and all he anticipates learning, combine to produce in him an emotion of awe. What grandeur lies before him in that endless procession of worlds-in that array of suns and stars extending beyond the limits of the most powerful telescopic vision! How marvellous it is! How beautiful! Observe the combination of simplicity with power; note how a great principle of "law" underlies the apparent intricacy of eccentric and intersecting orbits.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I (p. 7)  
T. Nelson & Sons. London, England. 1889

The astronomer has no fear of feeling the satiety of an Alexander, when he lamented that he had no more worlds

to conquer. What Newton said of himself is true of every astronomer,-he is but as a child on the sea-shore, picking up a shell here and a shell there, but unable to grasp a full conception of the mighty ocean that thunders in his ears!  
*The Story of The Herschels: A Family of Astronomers*  
Chapter I (p. 8)  
T. Nelson & Sons. London, England. 1889

Once an astronomer, always an astronomer; the stars, we may fancy, will not relax the spell they lay upon their votary.  
*The Story of The Herschels: A Family of Astronomers*  
Chapter I (p. 8)  
T. Nelson & Sons. London, England. 1889

The astronomer's must have been very clever to have found out the names of all the stars.  
A View of the Heavens  
*The Physics Teacher*, Volume 8, Number 7, October, 1970 (p. 413)

Astronomers seem to be able to predict everything more and more precisely-except the end of the century.  
Source undetermined

Those who study the stars have fellowship with astronomers of all ages.  
The Stars and the Promises  
*The Quarterly Journal of Prophecy*, Volume VIII, October, 1856 (p. 383)

The astronomer's acuteness of eye is not likely to co-exist with the musician's accuracy of ear.  
The Emotions in Music  
*The New Englander*, Volume 33, Number CXXVII, April, 1874 (p. 266)

**Baring-Gould, Sabine** 1834–1924  
English hagiographer, antiquarian, novelist, and eclectic scholar

Astronomy is certainly an alluring science; set an astronomer before a telescope, and an overwhelming attraction draws his soul away through the tube up into heaven, and leaves his body without mundane interests.  
*Historic Oddities and Strange Events* (2nd edition)  
A Wax and Honey-moon (p. 235)  
Methuen & Co. London, England. 1890

**Barrett, Frank**  
No biographical data available

Couldn't you be an astronomer? There is something majestic in that study, and astronomers live to a great age. They seem to me almost as grand as patriarchs, and I never heard of one falling into bad habits.  
*Lieutenant Barnabas, A Novel* (Volume 3)  
Chapter XIV (p. 230)  
Richard Bentley & Son. London, England. 1881

**Bennett, Jeffrey O.**  
American astrophysicist and writer

This is how astronomers might imagine the set of instructions used by a Creator: Start with a Big Bang, run it through a fraction of a second of inflation to sprinkle it

with seeds for structure, throw in a few simple laws of physics and voila! – 10 billion years or so of cosmic evolution and out pops humanity.

*On the Cosmic Horizon: Ten Great Mysteries for Third Millennium Astronomers*

Mystery 2 (p. 153)

Addison Wesley Longman. New York, New York, USA. 2001

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

Arithmetic and geometry, those wings on which the astronomer soars as high as heaven.

*Works* (Volume 3)

Usefulness of Mathematics to Natural Philosophy (p. 429)

Printed for A. Millary. London, England. 1744

**Bucke, Charles** 1781–1846

English writer

Woman, even to the eye of an astronomer, is the most attractive constellation in the whole range of the universe.

*On the Beauties, Harmonies, and Sublimities of Nature* (Volume 3) (2nd edition)

Book VII, Chapter I (pp. 215–216)

G. & W.B. Whittaker. London, England. 1823

**Campbell, William Wallace** 1862–1938

American astronomer

...the nature of an astronomer's work is seldom understood.

The Nature of An Astronomer's Work

*Publications of the Astronomical Society of the Pacific*, Volume XX, Number 122, October 10, 1908 (p. 251)

The opinion prevails quite generally that an astronomer's duty consists in sitting all night with his eye at the end of the telescope, "sweeping the heavens," in order to discover new bodies – comets, planets, moons, and new stars: and that this is the end and aim of the science.

The Nature of An Astronomer's Work

*Publications of the Astronomical Society of the Pacific*, Volume XX, Number 122, October 10, 1908 (p. 252)

**Carlyle, Thomas** 1795–1881

English historian and essayist

I wish I were an Astronomer. Is it not an interesting reflection to consider, that a little creature such as man – though his eye can see the heaven but as it were for a moment – is able to delineate the aspect which it presented long ages before he came into being – and to predict the aspects which it will present when ages shall have gone by? The past, the present, and the future are before him.

In Charles Eliot Norton

*Early Letters of Thomas Carlyle*

Letter XVII (p. 51)

Macmillan & Co Ltd. London, England. 1886

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

The astronomer has become, in the highest sense of the term, a physicist; while the physicist is bound to be something of an astronomer.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Part II, Chapter I (p. 176)

Adam & Charles Black. London, England. 1893

**Crichton-Browne, Sir James** 1840–1938

English physician

We follow with awe and thrilling interest the prodigious revelation of our astronomers, but after all, our conception of the Stellar Universe does not go much further than: Twinkle, twinkle little star...

*From the Doctor's Notebook*

Matrimonial Obedience (p. 152)

Duckworth. London, England. 1937

The astronomers are wonderful and impressive in their own sphere, but when they stray into literature they become annoying. We have all rejoiced in that beautiful elegy on the Burial of Sir John Moore, and know the essential line:

"By the struggling moonbeam's misty light."

Well, the astronomers have worked it out and found there was no moon the night of the Battle of Corunna.

*From the Doctor's Notebook*

The Astronomers (p. 192)

Duckworth. London, England. 1937

The astronomers with all their hypotheses give us no satisfying or abiding conception of the Universe. We are left as bewildered as ever.

*From the Doctor's Notebook*

Tea (p. 224)

Duckworth. London, England. 1937

**Calder, Nigel** 1931–

English science writer

When astronomers express dissatisfaction with both the Big Bang and the Steady State concepts of the universe, they are in trouble, because it is hard to imagine radical alternatives.

*Violent Universe: An Eyewitness Account of The New Astronomy*

Chapter III (pp. 121–122)

Viking Press. New York, New York, USA. 1970

**Cunningham, Clifford J.**

Canadian amateur astronomer and writer

Today's astronomers live and die by journals and conferences.

The Baron and His Celestial Police

*Sky & Telescope*, Volume 75, Number 3, March, 1988 (p. 271)

**D'Avenant, Sir William** 1606–68  
English poet, playwright, and theatrical producer

You that so wisely studious are  
To measure and to trace each Starr,  
How swift they travaile, and how farr,  
Now number your celestially store,  
Planets, or lesser lights, and trie  
If in the face of all the skie  
You count so many as before!

*Salmacida Spolia*

III, Song, Stanza I

Printed by T.H. for Thomas Walkley. London, England. 1639

**de Fontenelle, Bernard le Bovier** 1657–1757  
French writer

...since the princes have seized on the earth, it is fit the philosophers (who are as proud as the best of them) should reserve the heavens for themselves, without any competitors.

*Conversations on the Plurality of Worlds*

The Fourth Evening (p. 113)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Astronomers! What can avail  
Those who calumniate us;  
Experiment can never fail  
With such an apparatus.

*A Budget of Paradoxes*

The Astronomer's Drinking Song (p. 234)

Longmans, Green. London, England. 1872

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

This asteroid has only once been seen through the telescope. That was by a Turkish astronomer, in 1909. On making his discovery, the astronomer had presented it to the International Astronomical Congress, in a great demonstration. But he was in Turkish costume, and so nobody would believe what he said.

Translated by Katherine Woods

*The Little Prince*

Chapter IV (p. 17)

Harcourt, Brace & Company. New York, New York, USA. 1943

**D'Israeli, Isaac** 1766–1848  
English critic and historian

It does at first appear that an astronomer rapt in abstraction, while he gazes on a star, must feel more exquisite delight than a farmer who is conducting his team.

*Literary Character of Men of Genius: Drawn from Their Own Feelings and Confessions*

On Habituating Ourselves to an Individual Pursuit

James Eastburn & Company. New York, New York, USA. 1818

**Donne, John** 1572–1631  
English poet and divine

If then th' Astronomers, whereas they spie  
A new-found Starre, their Opticks magnifie,  
How brave are those, who with their Engine, can  
Bring man to heaven, and heaven againe to man?

*The Complete Poetry and Selected Prose of John Donne*

To Mr. Tilman After He Had Taken Orders

Random House, Inc. New York, New York, USA. 1941

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

The sun was enter'd into Capricorn;  
Which, by their bad astronomer's account,  
That week the Virgin Balance should remount.

*The Poetical Works of Dryden*

The Hind and the Panther, l. 1892

The Riverside Press. Cambridge, Massachusetts, USA. 1949

As the true height and bigness of a star  
Exceeds the measures of th' astronomer.

*The Poetical Works of Dryden*

Eleonora, l. 264–265

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Dunne, Finley Peter** 1867–1936  
American journalist and humorist

...I know about marriage th' way an astronomer knows about th' stars.

*Mr. Dooley at His Best*

Marriage

Charles Scribner's Sons. New York, New York, USA. 1938

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

...she one day asked Mr. Stelling if all astronomers hated women, or whether it was only this particular astronomer. But, forestalling his answer, she said, "I suppose it's all astronomers; because, you know, they live up in high towers, and if the women came there, they might talk and hinder them from looking at the stars."

*The Mill on the Floss*

Book Second, Chapter I (p. 134)

Harper & Brothers Publishers. New York, New York, USA. 1860

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The astronomer, the geometer, rely on their irrefragable analysis, and disdain the results of observation.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Idealism (p. 37)

The Library of America. New York, New York, USA. 1983

**Fernie, J. D.**  
Astronomer

The definitive study of the herd instincts of astronomers has yet to be written, but there are times when we resemble

nothing so much as a herd of antelope, heads down in tight formation, thundering with firm determination in a particular direction across the plain. At a given signal from the leader we whirl about, and, with equally firm determination, thunder off in a quite different direction, still in tight parallel formation.

The Period-luminosity Relation: A Historical Review  
*Astronomical Society of the Pacific*, Volume 81, Number 483, December, 1969 (pp. 719–720)

**Fort, Charles** 1874–1932

American writer

...if nobody looks up, or checks up, what the astronomers tell us, they are free to tell us anything that they want to tell us.

*The Books of Charles Fort*  
*Lo*, Part 2, Chapter XX  
Henry Holt & Company. New York, New York, USA. 1941

CLOSED

Because it has been discovered that the earth does not revolve around the sun and does not rotate on an axis; because the “stars” have been found to be lights only a few miles away; because almost every pronouncement from this hall of learning issued since its corner-stone was so solemnly laid has been a mistake, a joke, an error or a hoax – the older and more susceptible of the professors who once played whist here in the shadow of the refracting telescope have gone away to die of chagrin while the younger among us take a short trip to what we have so often jokingly referred to as “the constellation Orion”. Back in thirty days.

(signed) The Astronomers

*Lo!*  
Introduction (p. 1)  
Claude Kendall. New York, New York, USA. 1931

**Fosdick, Harry Emerson** 1878–1969

American clergyman and educator

The stars are not so strange as the mind that studies them, analyzes their light, and measures their distance.

*On Being a Real Person*  
Chapter I, Section VI (p. 25)  
Harper & Brothers. New York, New York, USA. 1943

**Friedman, Herbert** 1916–2000

American space scientist and astrophysicist

To the astronomer of today, probing ever deeper with mind and telescope, the universe is more than beautiful: it is amazing, violent, and endlessly mysterious. The revelations of recent research have been so dramatic and so extreme as to leave both scientists and laymen bewildered. Modern astronomy deals with the birth and death of stars; with exotic matter and fantastic energies; with near-infinities of space and time; with creation, evolution, and the ultimate destiny of the universe. As the sum

of knowledge grows, the astronomer continues to seek answers to man’s most profound questions: what is grand design of the universe? How was it created? How did we get here? What are we? Are we alone?

*The Amazing Universe*  
Chapter 1 (p. 10)  
National Geographic Society. Washington, D.C. 1980

**Frost, Robert** 1874–1963

American poet

As a confirmed astronomer  
I’m always for a better sky.

*Complete Poems of Robert Frost*  
A-Wishing Well  
Henry Holt & Company. New York, New York, USA. 1949

**Gay, Mary Ann Harris** 1828–1918

American author

An astronomer who can devote his life to the sublime study of the heavenly bodies, and not exclaim, with deep humility of spirit, Great and marvelous are thy works, Lord God Almighty! Thou art worthy to receive glory, and honor, and power, for thou hast “created all things, and for thy pleasure they were created,” is a madman indeed.

*Prose and Poetry* (2nd edition)  
An Undevout Astronomer is Mad (p. 223)  
South-Western Publishing House. Nashville, Tennessee, USA. 1859

**Geminus of Rhodes** fl. 110 BCE–40 BCE

Greek astronomer and mathematician

For it is no part of the business of an astronomer to know what is by nature suited to a position of rest, and what sort of bodies are apt to move, but he introduces hypotheses under which some bodies remain fixed, while others move, and then considers to which hypotheses the phenomena actually observed in the heavens will correspond.

In T. Heath  
*Greek Astronomy* (p. 125)  
Dover Publications, Inc. New York, New York, USA. 1991

**Giberne, Agnes** 1845–1939

English writer

The wisest astronomer living cannot tell us how far the stars reach...[f]or there is no getting to the borders of space.

*Sun, Moon, and Stars*  
Chapter I (p. 5)  
Seeley, Jackson, & Halliday. London, England. 1880

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

The astronomer may speak to you of his understanding of space, but he cannot give you his understanding.

*The Prophet*  
On Teaching (p. 56)  
Alfred A. Knopf. New York, New York, USA. 1969



**Grondal, Florence Armstrong**

American astronomer and photographer

How thrilling to read of great hunts for treasure! Yet the pirates who dug their spades into the earthy loam never cached such jewels as are hidden along the dark slopes of the sky. Armed with a chart of the heavens, the fledgling astronomer prods about in the depths of the gloom, shovels the dark with the aid of his telescope, and discovers – even more surely than the pirate his chest – some wonderful treasure. Sometimes the find is a star-like diamond, a twinkling emerald, a fire-filled ruby or a cluster of star gems of colorful hues, but it may be, too, a profusion of riches, heaped in a magnificence that leaves one breathless.

*The Music of the Spheres: A Nature Lover's Astronomy*

Chapter I (p. 3)

The Macmillan Company. New York, New York, USA. 1926

**Gunn, James E.** 1923–

American science fiction writer

When they [radio astronomers] grew weary at their electronic listening posts, when their eyes grew dim with looking at unrevealing dials and studying uneventful graphs, they could step outside their concrete cells and renew their dull spirits in communion with the giant mechanism they commanded, the silent, sensing instrument in which the smallest packets of energy, the smallest waves of matter, were detected in their headlong, eternal flight across the universe. It was the stethoscope with which they took the pulse of the all and noted the birth and death of stars, the probe with which, here on an insignificant planet of an undistinguished star on the edge of its galaxy, they explored the infinite.

*The Listeners*

Chapter 1 (p. 12)

Charles Scribner's Sons. New York, New York, USA. 1972

**Hale, George Ellery** 1868–1938

American astronomer

According to the old view, the astronomer, soon after the setting of the Sun, retires to a lofty tower, from whose summit he gazes at the heavens throughout the long watches of the night. His eye, fixed to the end of a telescope tube, perceives wonders untold, while his mind sweeps with his vision through the very confines of the universe.

*The Study of Stellar Evolution: An Account of Some Recent Methods of Astrophysical Research*

Chapter 2 (p. 9)

The University of Chicago Press. Chicago, Illinois, USA. 1908

**Halley, Edmond** 1656–1742

English astronomer and mathematician

We therefore recommend again and again, to the curious investigators of the stars to whom, when our lives are

over, these observations are entrusted, that they, mindful of our advice, apply themselves to the understanding of these observations vigorously. And for them we desire and pray for all good luck, especially that they not be deprived of this coveted spectacle by the unfortunate obscuration of cloudy heavens, and that the immensities of the celestial spheres, compelled to more precise boundaries, may at last yield to their glory and eternal fame.

A Unique Method by Which the Parallax of the Sun, or Its Distance from the Earth, May Be Securely Determined by Means of Observing Venus Against the Sun *Philosophical Transactions of the Royal Society of London*, Number 348, April, May, June, 1716 (p. 460)

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

Astronomers...if they would be more than mere artisans, must be more or less mathematicians, and must separately study the mathematical grounds of their science ...

*Report of the Fifth Meeting of the British Association for the Advancement of Science*

Address by Sir William Hamilton (p. xliii)

John Murray. London, England. 1836

**Harrington, Sir John** 1560?–1612

English writer

Astronomers, Painters and Poets may lye by authoritie.

In G. Gregory Smith

*Elizabethan Critical Essays* (Volume 2)

Sir John Harrington, A Brief Apology for Poetry (p. 201)

Oxford University Press, Inc. London, England. 1904

**Herbert, George** 1593–1633

English metaphysical poet

The fleet Astronomer can bore,  
And thred the spheres with his quick-piercing mind:  
He views their stations, walks from dore to dore,  
Surveys, as if he had design'd  
To make a purchase there: hee sees their dances,  
And knoweth long before,  
Both their full ey'd aspects, & secret glances.

*The Temple*

The Church, Vanity, l. 1–7 (p. 126)

Medieval & Renaissance Texts & Studies. Binghamton, New York, USA. 1995

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...when, after dilating his thoughts to comprehend the grandeur of those ideas his [the astronomer] calculations have called up, and exhausting his imagination and the powers of his language to devise similes and metaphors illustrative of the immensity of the scale on which his universe is constructed, he shrinks back to his native sphere, he finds it, in comparison, a mere point; so lost – even in the minute system to which it belongs – as to be



invisible and unsuspected from some of its principal and remoter members.

*Outlines of Astronomy*

Introduction (pp. 2–3)

D. Appleton & Co. New York, New York, USA. 1876

The magnitudes, distances, arrangement, and motions of the great bodies which make up the visible universe, their constitution and physical condition, so far as they can be known to us, with their mutual influences and actions on each other, so far as they can be traced by the effects produced, and established by legitimate reasoning, form the assemblage of objects to which the attention of the astronomer is directed.

*Outlines of Astronomy*

Chapter I (p. 11)

D. Appleton & Co. New York, New York, USA. 1876

### **Hilliard, George Stillman** 1808–79

American politician

...it seems to me that, if an undevout astronomer be mad, an unpoetical astronomer is monstrous.

*The Relation of the Poet to His Age*

Discourse (p. 38)

Charles C. Little & James Brown. Boston, Massachusetts, USA. 1843

### **Hodgson, Ralph** 1871–1962

English poet

Reason has moons,  
but moons not hers  
Lie mirrored on her sea,  
Confounding her astronomers,  
But O! delighting me.

*Collected Poems*

Reason Has Moons

Macmillan & Company Ltd. London, England. 1961

### **Howard, Neale E.**

No biographical data available

Astronomers work always with the past; because light takes time to move from one place to another, they see things as they were, not as they are.

*The Telescope Handbook and Star Atlas*

The Sky, Chapter III (p. 33)

Crowell. New York, New York, USA. 1975

### **Howe, Herbert Alonzo** 1858–1926

American astronomer

The astronomer, whether in charge of an elaborate observatory, filled with costly instruments, or simply the possessor of a good opera-glass, or small portable telescope, is the man who by patient study of the sky adds to the sum total of astronomical knowledge.

*A Study of the Sky*

Chapter VII (p. 113)

Charles Scribner's Sons. New York, New York, USA. 1901

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The astronomer seems at first sight to be the most helpless of all scientists. He cannot experiment with the Universe. It is a significant matter of nomenclature that whereas we speak of experimental work in other sciences we speak of observational work in astronomy.

*Frontiers of Astronomy*

Prologue (p. xv)

Harper & Row, Publishers. New York, New York, USA. 1955

The astronomer is severely handicapped as compared with other scientists. He is forced into a comparatively passive role. He cannot invent his own experiments as the physicists, the chemist or the biologist can. He cannot travel about the Universe examining the items that interest him. He cannot, for example, skin a star like an onion and see how it works inside.

*The Nature of the Universe*

Chapter 1 (pp. 3–4)

At The University Press. Cambridge, England. 1933

Astronomers seem to live in terror that someday they will discover something important.

*Home is Where the Wind Blows: Chapters from a Cosmologist's Life*

Part II, Chapter 12 (p. 159)

University Science Books. Mills Valley, California, USA. 1994

Here is an example of what seems to be general practice in astronomy: when two alternatives are available, choose the more trivial. It was so with the discovery of pulsars – white dwarfs, everybody said they were, until confrontations with fact showed otherwise. And it is so today throughout cosmology. Astronomers seem to live in terror that someday they will discover something important.

*Home Is Where the Wind Blows: Chapters from a Cosmologist's Life*

Part Two, Chapter 19 (p. 269)

University Science Books, Mill Valley, California, USA. 1994

### **Jacoby, Harold** 1865–1932

American astronomer

The beginner in astronomy is always modest as to his abilities, and blames himself if the universe fails to fit the printed directions. Nor does any real astronomer ever lose this modest characteristic of the beginner; for he who has studied this science most deeply is ever most of all convinced that he is still a beginner.

*Astronomy: A Popular Handbook*

Chapter III (p. 46)

The Macmillan Company. New York, New York, USA. 1926

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The task of the observational astronomer is to survey and explore the universe, and to describe and classify the various

types of objects which it is constituted, discovering what law and order he may in their observed arrangement and behavior. But only the dullest of human minds can rest content with a mere catalogue of observed facts; an alert mind asks always for the why and the wherefore.

*Astronomy and Cosmogony*

Chapter I (p. 1)

Dover Publications, Inc. New York, New York, USA. 1961

**Jeffers, Robinson** 1887–1962

American poet

Or as mathematics, a human invention  
...parallels but never touches reality, gives the astronomer

Metaphors through which he may comprehend

The powers and the flow of things...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 260)

Stanford University Press. Stanford, California. USA. 1988

Nor can the astronomer see his moon-dazzled  
Constellations: let him give one night in the month to  
earth and the moon,

Women and games.

*The Beginning and the End and Other Poems*

Full Moon (p. 41)

Random House, Inc. New York, New York, USA. 1963

**Jones, Sir Harold Spencer** 1890–1960

10th Astronomer Royal of England

The task of the astronomer is to learn what he can about  
the universe as he finds it. To endeavor to understand the  
purpose behind it and to explain why the universe is built  
as it is, rather than on some different pattern which might  
have accorded better with our expectations, is a more dif-  
ficult task; for this the astronomer is no better qualified  
than anybody else.

*Life on Other Worlds*

Chapter X (p. 253)

The Macmillan Company. New York, New York, USA. 1954

**Keats, John** 1795–1821

English Romantic lyric poet

Then I felt like some watcher of the skies

When a new planet swims into his ken.

*The Complete Poetical Works and Letters of John Keats*

On First Looking into Chapman's Homer

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Kepler, Johannes** 1571–1630

German astronomer

That astronomer well performs his office who predicts with  
the greatest measure of approximation the motions and sit-  
uations of the stars: but he does better and is held worthy of  
the greater praise who in addition to this furnishes us with  
true opinions concerning the form of the world.

*Opera Omnia* (Volume 1) (p. 242)

For astronomers ought not simply to enjoy a licence of  
making any fictions they choose without rational grounds.

*Opera Omnia* (Volume 6) (p. 121)

**Kirshner, Robert P.**

American astronomer

Like the fifteenth-century navigators, astronomers  
today are embarked on voyages of exploration, charting  
unknown regions. The aim of this adventure is to bring  
back not gold or spices or silks but something more valu-  
able: a map of the universe that will tell of its origin, its  
texture, and its fate.

In Marcia Bartusiak

*Thursday's Universe*

Chapter 7 (p. 167)

Random House, Inc. New York, New York, USA. 1986

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

...knowledge about the universe is not easily won. In  
spite of tremendous effort, almost all of the time we fail  
to find an answer. Most of the time we even fail to ask  
the right question. But occasionally, through some com-  
bination of serendipity, work, genius, and insight, we do  
see the sky a little more clearly. It is the hope of seeing  
something no one else has seen, or understanding some-  
thing no one has understood before that keep astron-  
omers awake so many nights.

*Blind Watchers of the Sky*

Chapter Eleven (pp. 293–294)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kühnert, Franz** 1852–1918

No biographical data available

Probably another reason why many Europeans consider  
the Chinese such barbarians is on account of the support  
they give to their Astronomers – people regarded by our  
cultivated Western mortals as completely useless. Yet  
there they rank with Heads of Departments and Secretar-  
ies of State. What frightful barbarism!

In Joseph Needham

*Science and Civilisation in China* (Volume 3)

Preface (p. iii)

University Press. Cambridge, England. 1954

**Leo**

No biographical data available

Astronomers live to old age because they dwell on the  
majestic works of God.

We Grow Like That Which We Contemplate

*Bible Review*, Volume III, Number 9, June, 1905 (p. 400)

**Mackay, Charles** 1814–89

English poet and journalist

Upon thy lofty tower,

O lonely Sage,

**Reading at midnight hour**

Heaven's awful page!

*The Collected Songs of Charles Mackay*

The Astronomer

G. Routledge & Company. London, England. 1859

**Malin, David**

No biographical data available

Work on faint objects or that involving the blue end of the spectrum can only be done in dark time. Thus one is more likely to find astronomers whose research involves the infrared part of the spectrum working on nights of the full Moon, which only confirms what we always believed about infrared astronomers.

*A View of the Universe*

Chapter 3

Photographing the Sky at Night (p. 37)

Cambridge University Press. Cambridge, Massachusetts, USA. 1993

**Marschall, Laurence A.**

American physicist

The earliest astronomers...were celestial lookouts, scanning the skies like seamen in a crow's nest.

*The Supernova Story*

Chapter 1 (p. 4)

Plenum Press. New York, New York, USA. 1988

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Astronomers and physicists, dealing habitually with objects and quantities far beyond the reach of the senses, even with the aid of the most powerful aids that ingenuity has been able to devise, tend almost inevitably to fall into the ways of thinking of men dealing with objects and quantities that do not exist at all, e.g., theologians and metaphysicians.

*Minority Report: H.L. Mencken's Notebooks*

No. 74 (p. 60)

Alfred A. Knopf. New York, New York, USA. 1956

**Mitchell, Maria** 1818–89

American astronomer and educator

The Astronomer breaks up the starlight just as the geologist breaks up the rock with his hammer, and with similar results, he finds copper, sodium and other elements in sun and stars.... If you look at the beautiful ribbon of colors which a ray of sunlight gives when passed through a prism, you see that it is crossed by dark bands, sometimes single, sometimes crowded close together – each of these is a black-lettered message from the sun.

In Helen Wright

*Sweeper in the Sky*

Chapter 10 (pp. 188–189)

The Macmillan Company. New York, New York, USA. 1949

I cannot expect to make astronomers, but I do expect that you will invigorate your minds by the effort at healthy modes of thinking.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter VII (p. 138)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Newcomb, Simon** 1835–1909

Canadian-born American astronomer

As the great captain of industry is moved by the love of wealth, and the politician by the love of power, so the astronomer is moved by the love of knowledge for its own sake, and not for the sake of its application.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1895*

Aspect of American Astronomy (p. 87)

Government Printing Office. Washington, D.C. 1896

He who through vast immensity can pierce,  
See worlds on worlds compose one universe;  
Observe how system into system runs,  
What other planets circle suns,  
What varied being peoples every star,  
May tell why Heaven has made us as we are.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Problems of Astronomy (p. 92)

Government Printing Office. Washington, D.C. 1898

**Mitchel, Ormsby MacKnight** 1805–62

American astronomer

...let it be remembered that the astronomer has ever lived, and never dies. The sentinel upon the watchtower is relieved from duty, but another takes his place, and the vigil is unbroken.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*

Lecture I (pp. 21–22)

Baker & Scribner. New York, New York, USA. 1848

**Müller, Max** 1823–1900

German philologist and Orientalist

Would an astronomer be an astronomer who did not know the Ptolemaic system of astronomy and had not worked his way through its errors to the truer views of Copernicus?

In Mayo Williamson Hazeltine

*Orations from Homer to William McKinley* (Volume 20)

On Some Lessons of Antiquity (p. 8597)

P.F. Collier & Son. New York, New York, USA. 1902

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

He who through vast immensity can pierce, See worlds on worlds compose one universe; Observe how system into system runs, What other planets circle other suns, What varied being peoples every star, May tell why Heaven has made us as we are.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter XVII (p. 272)

Harper & Brothers Publishers. New York, New York, USA. 1906

The astronomer of to-day may look back upon Hipparchus and Ptolemy as the earliest ancestors of whom he has positive knowledge. He can trace his scientific descent from generation to generation, through the periods of Arabian and mediaeval science, through Copernicus, Kepler, Newton, Laplace and Herschel, down to the present time.

In Richard Anthony Proctor

*The Skies and the Earth*

Problems of Astronomy (p. 34)

Doubleday, Page & Co. New York, New York, USA. 1902

**Osiander, Andrew** 1498–1552

Lutheran minister

...it is the job of the astronomer to use painstaking and skilled observation in gathering together the history of the celestial movements, and then – since he cannot by any line of reasoning reach the true causes of these movements – to think up or construct whatever causes or hypotheses he pleases such that, by the assumptions of these causes, those same movements can be calculated from the principles of geometry for the past and for the future too...

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Introduction, To the Reader Concerning the Hypothesis of this Work (p. 505)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

...great men, superior to ordinary mortals, who having discovered the laws of these divine bodies, relieved the miserable mind of man from the fear which he had of eclipses, as foretelling some dreadful events or the destruction of the stars.... Hail to your genius, ye interpreters of heaven! ye who comprehend the nature of things, and who have discovered a mode of reasoning by which ye have conquered both gods and men!

*Pliny's Natural History. In Thirty-seven Books*

Book II, Chapter IX (pp. 37–38)

Printed for the Club by G. Barclay. London, England. 1847–1849

**Prior, Matthew** 1664–1721

English poet and diplomat

At night astronomers agree...

*The Literary Works of Matthew Prior* (Volume VI)

Phyllis's Age, Stanza 3, l. 2

Clarendon Press. Oxford, England. 1959

**Proctor, Richard Anthony** 1837–88

English astronomer

The ideas entertained by the non-scientific public regarding the extent and nature of the researches made by astronomers into the constitution of the heavens, are, for the most part, singularly inaccurate.

A New Survey of the Northern Heavens

*Fraser's Magazine*, Volume 5, New Series, January to June, 1872 (p. 78)

**Professor Farrar**

The life of an astronomer is severe, laborious, and confined – If he does what he ought, adieu to the pleasures of the world. If he does not find his pleasure in his employment, adieu to astronomy.

Article LV

*The Boston Journal of Philosophy and the Art*, May 1, 1824 (p. 476)

When we have placed an astronomer in an observatory, well mounted, and furnished with good instruments, it is not to resolve problems in geometry, to give the last finish to algebraical formulas, to purify hydrogen gas, or to light halls and theatres; we require one who loves, and who knows how to use his eyes, who is well acquainted with the heavens, who can make discoveries there, and follow with a lively interest, and exquisite tact, those that he or others have made; and he should above all things, be careful to follow the courses of the heavenly bodies, with perseverance and with intelligence.!

Article LV

*The Boston Journal of Philosophy and the Art*, May 1, 1824 (p. 476)

**Prudhomme, Sully** 1839–1907

French poet

Tis late; the astronomer in his lonely height

Exploring all the dark, descries from far

Orbs that like distant isles of splendor are.

In Morris Kline

*Mathematics in Western Culture*

Chapter V (p. 60)

Oxford University Press, Inc. New York, New York, USA. 1953

**Ptolemy** ca. 90–168

Greek astronomer, geographer, and astrologer

Although a mortal I breathe the air of mortals and also am confined by the boundaries of human knowledge, yet, since with mind uplifted I traverse the paths of heaven and the stars revolving with their incessant motions, I am not a mortal nor is my mind debased in mortal body nor does my foot touch the soil of this earth. But, raising my head aloft in the heavens beyond the clouds, I enjoy ambrosia with celestial Jove.

*On Mathematical Studies*

Translated by Raymond H. Coon

In *Popular Astronomy*, Volume 37, Number 6, June–July 1929 (p. 319)

**Rees, Martin John** 1942–

15th Astronomer Royal of England

Everything astronomers observe turns out to be a small and atypical fraction of what exists.

*Before the Beginning*

Chapter 6 (p. 103)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1997

**Rheticus, Georg Joachim** 1514–74

Austrian-born astronomer and mathematician

The astronomer who studies the motion of the stars is surely like a blind man who, with only a staff [mathematics] to guide him, must make a great, endless, hazardous journey that winds through innumerable desolate places. What will be the result? Proceeding anxiously for a while and groping his way with his staff, he will at some time, leaning upon it, cry out in despair to Heaven, Earth and all the Gods to aid him in his misery.

In Arthur Koestler

*The Sleepwalkers*

Part Three, Chapter I, Section 10 (p. 161)

The Macmillan Company. New York, New York, USA. 1966

**Robinson, Edwin Arlington** 1869–1935

American poet

And thus we die,  
Still searching, like poor old astronomers,  
Who totter off to bed and go to sleep  
To dream of untriangulated stars.

*Collected Poems of Edwin Arlington Robinson*

Octaves, XI (p. 100)

The Macmillan Company. New York, New York, USA. 1922

**Sandage, Allan** 1926–

American astronomer

What are galaxies? No one knew before 1900. Very few people knew in 1920. All astronomers knew after 1924.

*The Hubble Atlas of Galaxies*

Galaxies (p. 1)

Carnegie Institute of Washington. Washington, D.C. 1961

**Sayers, Dorothy L.** 1893–1957

English novelist and essayist

**Eustace, R.**

No biographical data available

The biologist can push it back to the original protist, and the chemist can push it back to the crystal, but none of them touch the real question of why or how the thing began at all. The astronomer goes back untold million of years and ends in gas and emptiness, and then the mathematician sweeps the whole cosmos into unreality and leaves one with mind as the only thing of which we have any immediate apprehension. *Cogito ergo sum, ergo omnia esse videntur*. All this bother, and we are no further than Descartes. Have you noticed that the astronomers and mathematicians are much the most cheerful people of the lot? I suppose that perpetually contemplating things on so vast a scale makes them feel either that it doesn't matter a hoot anyway, or that anything so large and elaborate must have some sense in it somewhere.

*The Documents in the Case*

Letter 22, John Munting to Elizabeth Drake (p. 70)

Victor Gollancz Ltd., London, England. 1978

**Schawlow, Arthur** 1921–99

American physicist

Astronomers are very brave and bold, and make vast assumptions based on very little data. Very clever, though.

In Dennis Brian

*Genius Talk: Conversations with Noble Scientists and Other Luminaries*

Chapter 11 (p. 249)

Plenum Press. New York, New York, USA. 1995

**Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Of the Nebulae and planets do not babble so to me;  
What! is Nature only mighty inasmuch as you can see?  
Inasmuch as you can measure her immeasurable ways,  
As she renders world on world, sun and system to your gaze?

Though through space your object be the Sublimest to embrace,

Never the Sublime abideth – where you vainly search – in space!

Translated by Edward, Lord Lytton

*The Poems and Ballads of Schiller*

To Astronomers (p. 185)

George Routledge &amp; Sons. London, England. 1887

So the Astronomer's art lays out the chart of the heavens  
Better his way to steer through inaccessible space ...

*The Poems of Schiller*

Human Knowledge (p. 303)

H. Holt &amp; Co. New York, New York, USA. 1902

**Schlesinger, Frank** 1871–1943

American astronomer

The astronomer has borrowed almost all his tools from the physicist; the prism, the grating, the photoelectric cell, the interferometer, the photographic plate, even the telescope itself, were all used in the laboratory before they were applied to the sky.

In Lorande Woodruff

*The Development of the Sciences*

Chapter IV (p. 166)

**Schneider, Don**

American astronomer

How anyone can go out at night and look up and not want to be an astronomer is beyond me.

In Richard Preston

*First Light*

Part 3 (p. 182)

Random House, Inc. New York, New York, USA. 1996

**Sedgwick, William Thompson** 1855–1921

American bacteriologist

...the object of an astronomer is to put together the history of the celestial motions from careful observations, and then to set forth their causes or hypotheses about



them, if he cannot find the real causes, so that those motions can be computed on geometrical principles. But it is not necessary that his hypotheses should be true, they need not even be probable; it is sufficient if the calculations founded on them agree with the observations.

*A Short History of Science*

Chapter X (p. 200)

The Macmillan Co. New York, New York, USA. 1917

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

These earthly godfathers of heaven's lights,  
That give a name to every fixed star  
Have no more profit of their shining nights  
Than those that walk, and wot not what they are.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Love's Labor's Lost*

Act I, Scene i, l. 86–89

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...but when he performs astronomers foretell it.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Troilus and Cressida*

Act V, Scene i, l. 102–103

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Shapley, Harlow** 1885–1972

American astronomer

Astronomers must keep their eyes and ears open, watching and listening.... They must dream of the impossible, and promptly design the best way to attain it.

Astronomy

*Scientific American*, Volume 183, Number 3, September, 1950 (p. 25)

### **Shapley, Harlow** 1885–1972

American astronomer

### **Upton, Winslow** 1853–1914

American astronomer

His knees should bend and his neck should curl,  
His back should twist and his face should scowl,  
One eye should squint and the other protrude,  
And this should be his customary attitude.

Harvard Observatory Pinafore

*Popular Astronomy*, Volume 38, Number 3, March, 1930 (pp. 125–127)

### **Shelley, Percy Bysshe** 1792–1822

English poet

Heaven's utmost deep  
Gives up her stars, and like a flock of sheep  
They pass before his eye, are numbered, and roll on.

*The Complete Poetical Works of Percy Bysshe Shelley*

Prometheus Unbound

Act IV, l. 418–420

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### **Silk, Joseph** 1942–

American astronomer and physicist

To many astronomers, the search for intergalactic matter resembles the quest for the holy grail.

*Cosmic Enigmas*

The Intergalactic Medium (p. 177)

AIP Press. Woodbury, New York, USA. 1994

### **Sir John Talbot (Fictional character)**

All astronomers are amateurs. When it comes to the heavens, there's only one professional.

*The Wolf Man*

Film (1941)

### **Smith, James Elishama** 1801–57

Scottish journalist and religious writer

An astrologer is an artist, an astronomer is not; in fact, an astronomer is a mere drudge, a dry, unpoetical, soulless calculator.

*The Coming Man*

Chapter XLII (p. 360)

Strahan & Co. London, England. 1873

### **Sonneberg, Walter**

No biographical data available

Astronomers see stranger things than do inebriates.

*Social Eccentricities*

Social Eccentricities (p. 48)

Broadway Publishing Co. New York, New York, USA. 1906

### **Stoll, Clifford**

American astronomer

The astronomer's rule of thumb: if you don't write it down, it didn't happen.

*The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage*

Chapter 5 (p. 28)

Doubleday. New York, New York, USA. 1989

### **Swift, Jonathan** 1667–1745

Irish-born English writer

This load-stone is under the care of certain astronomers, who from time to time give it such positions as the monarch directs. They spend the greatest part of their lives in observing the celestial bodies, which they do by the assistance of glasses, far excelling ours in goodness.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter III (p. 102)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There was an astronomer who had undertaken to place a sun-dial upon the great weather-cock on the town-house, by adjusting the annual and diurnal motions of the earth and sun, so as to answer and coincide with all accidental turnings of the wind.

In *Great Books of the Western World* (Volume 36)  
*Gulliver's Travels*  
 Part III, Chapter V (p. 108)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thompson, Francis** 1859–1907  
 English writer

Starry amorist, starward gone,  
 Thou art – what thou didst gaze upon!  
 Passed through thy golden garden's bars,  
 Thou seest the Gardner of the Stars.

*Complete Poetical Works of Francis Thompson*  
 A Dead Astronomer, Stanza 1  
 Boni & Liveright, Inc., Publishers. New York, New York, USA. 1923

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

The astronomer is as blind to the significant phenomena,  
 or the significance of phenomena, as the wood-sawyer  
 who wears glasses to defend his eyes from the sawdust.

*Journal (Volume 3: 1848–1851)*  
 August 5, 1851 (p. 354)  
 Princeton University Press. Princeton, New Jersey, USA. 1981

It is interesting to observe with what singular unanimity  
 the farthest sundered nations and generations consent to  
 give completeness and roundness to an ancient fable, of  
 which they indistinctly appreciate the beauty or the truth.  
 By a faint and dream-like effort, though it be only by the  
 vote of a scientific body, the dullest posterity slowly add  
 some trait to the myths. As when astronomers call the  
 lately discovered planet Neptune; or the asteroid Astra,  
 that the Virgin who was driven from earth to heaven at  
 the end of the golden age, may have her local habitation  
 in the heavens more distinctly assigned her – for the  
 slightest recognition of poetic worth is significant. By  
 such slow aggregation has mythology grown from the  
 first.

*A Week on the Concord and Merrimack Rivers*  
 Sunday (pp. 66–67)  
 James R. Osgood & Co. Boston, Massachusetts, USA. 1873

**Tischner, August**  
 No biographical data available

In order to comprehend the observable phenomena, they  
 [astronomers] have resolved to search after their causes,  
 and to produce these, they have imagined theories which  
 are often devoid of sense and not without contradictions.

*The Fixed Idea of Astronomical Theory* (p. 32)  
 Gustav Fock. Leipzig, Germany. 1885

The observable phenomena look to-day as in old times,  
 but the intelligence of man is modified, it may enlarge, and  
 science will be perfected. What they don't comprehend  
 to-day, they will comprehend perhaps tomorrow, and we  
 are persuaded, that the number of those who will occupy  
 themselves earnestly and attentively with the study of

the celestial phenomena, will increase, and then the most  
 sublime object of nature, heaven and its phenomena, will  
 find better commentators than we can exhibit now.

*The Fixed Idea of Astronomical Theory* (p. 32)  
 Gustav Fock. Leipzig, Germany. 1885

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

For three hundred years now, the Christian astronomer  
 has known that his Deity didn't make the stars in  
 those tremendous six days; but the Christian astronomer  
 doesn't enlarge upon that detail. Neither does the priest.

In Bernard Devoto (ed.)  
*Letters from the Earth*  
 Letter III (p. 16)  
 Harper & Row, Publishers. New York, New York, USA. 1959

I do not see how astronomers can help feeling exquisitely  
 insignificant, for every new page of the Book of the  
 Heavens they open reveals to them more & more that  
 the world we are so proud of is to the universe of careering  
 globes as is one mosquito to the winged & hooved  
 flocks & herds that darken the air & populate the plains &  
 forests of all the earth. If you killed the mosquito, would  
 it be missed? Verily, What is Man, that he should be considered  
 of God?

*Mark Twain's Letters (Volume 4, 1870–1871)*  
 Letter to Olivia L. Langdon  
 8 January, 1870 (p. 12)  
 University of California Press. Berkeley, California, USA. 1995

**Walcott, Derek** 1930–  
 West Indian dramatist and poet

I try to forget what happiness was,  
 and when that don't work, I study the stars.

*The Star-apple Kingdom*  
 The Schooner, Flight, Section 11  
 Farrar, Straus & Giroux. New York, New York, USA. 1979

**Watcher, Carl**  
 No biographical data available

I AM a great astronomer; I find a new star every night;  
 And, 'tis a wondrous mystery, Each changes color to my  
 sight.

Translated by Stella Bloch  
*Star Glints*  
 The Astronomer (pp. 15–16)  
 John F. Grabau. Buffalo, New York, USA. 1917

**Whitman, Walt** 1819–92  
 American poet, journalist, and essayist

When I heard the learn'd astronomer,  
 When the proofs, the figures, were ranged in columns  
 before me,  
 When I was shown the charts and diagrams to add, divide,  
 and measure them,



When I sitting heard the astronomer where he lectured  
with much applause in the lecture-room,  
How soon unaccountable I became tired and sick...

*Complete Poetry and Collected Prose*

When I Heard the Learn'd Astronomer

The Library of America. New York, New York, USA. 1982

### Wilkie, Agnes Rollo

No biographical data available

The dear astronomer is indeed a wonderful man, one sent  
out from God.... His power and wisdom is divine inspira-  
tion. He is greater and grander far than all mere learned  
or educated excellence, and his pre-eminent greatness is  
the outcome of daily communion with the Eternal Source  
of all purity and goodness.

*Rosa*

Chapter XXXVII (p. 269)

W. Stewart & Co. London, England. 1882

### Wordsworth, William 1770–1850

English poet

Spirits that crowd the intellectual sphere  
With mazy boundaries, as the astronomer  
With orb and cycle girds the starry throng.

*The Complete Poetical Works of William Wordsworth*

Ecclesiastical Sonnets, Part II, Section 5, l. 12–14

Crowell. New York, New York, USA. 1888

Eyes of some men travel far  
For the finding of a star;  
Up and down the heavens they go...  
Like a sage astronomer.

*The Complete Poetical Works of William Wordsworth*

To the Small Celandine, l. 16–19

Crowell. New York, New York, USA. 1888

### Wright, Thomas 1711–86

English cosmologist

In this great Celestial Creation, the Catastrophy of a  
World such as ours, or even the total Dissolution of a  
System of Worlds, may possibly be no more to the great  
Author of Nature, than the most common Accident in  
Life with us, and in all Probability such final and general  
Doom-Days may be as frequent there as even Birthdays,  
or Mortality with us upon the Earth. This Idea has some-  
thing so cheerful in it, that I own I can never look upon  
the Stars without wondering why the whole World does  
not become Astronomers...

*An Original Theory or New Hypothesis of the Universe*

Letter the Eighth (p. 76)

Printed for the Author. London, England. 1750

### Young, Charles Augustus 1834–1908

American astronomer

Astronomers do not overlook a wide and open valley,  
but rather from the foothills of a mountain range, look

upward into mists and clouds, and every path soon  
disappears into obscurity, except where here and there  
sunlight breaks through.

In George Isles

*The Skies and the Earth*

The Astronomical Outlook (p. 54)

Doubleday, Page & Co. New York, New York, USA. 1902

### Young, Edward 1683–1765

English poet and dramatist

Devotion Daughter of Astronomy

An undevout astronomer is mad!

*Night Thoughts*

Night IX, l. 772–773

Printed by R. Nobels for R. Edwards. London, England. 1797

...Stars malign,  
Which make their fond Astronomer run mad...

*Night Thoughts*

Night IX, l. 1651

Printed by R. Nobels for R. Edwards. London, England. 1797

### Youngblood, Abigail J.

No biographical data available

### Hunter, Diedre A.

No biographical data available

Like all astronomers we assume that our values are the  
correct ones, but in fact we do not have independent evi-  
dence to show that at this time.

The Luminosity Functions and Size Distributions of H II Regions in  
Irregular Galaxies

*The Astrophysical Journal*, Volume 519, July 1, 1999 (p. 59)

## ASTRONOMICAL

### Boethius, Anicius Manlius Severinus ca. 475–524

Roman philosopher and statesman

Think then thus upon it, and see that it is but a slight  
thing of no weight. As you have learnt from astronomers'  
shewing, the whole circumference of the earth is but as  
a point compared with the size of the heavens. That is, if  
you compare the earth with the circle of the universe, it  
must be reckoned as of no size at all.

Translated by W.W. Cooper

*The Consolation of Philosophy*

Book II, Prose VII (pp. 48–49)

J.M. Dent & Sons Ltd. London, England. 1902

### Cook, Joseph

No biographical data available

Bye Baby Bunting,  
Father's gone star-hunting;  
Mother's at the telescope  
Casting baby's horoscope.  
Bye Baby Buntoid,  
Father's found an asteroid;

**Mother takes by calculation**  
**The angle of its inclination.**

In Sara and John E. Brewton and John Brewton Blackburn  
*Of Quarks, Quasars, and Other Quirks: Quizzical Poems for the Supersonic Age*  
 Boston Nursery Rhymes, Rhyme for Astronomical Baby (p. 40)  
 Crowell. New York, New York, USA. 1977

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

*There are no purely observational facts about the heavenly bodies.* Astronomical measurements are, without exception, measurements of phenomena occurring in a terrestrial observatory or station; it is only by theory that they are translated into knowledge of a universe outside.  
*The Expanding Universe*  
 Chapter I, Section IV (p. 17)  
 At the University Press. Cambridge, England. 1952

**Galilei, Galileo** 1564–1642  
 Italian physicist and astronomer

Some years ago I discovered many astronomical facts till then unknown. Their novelty and their antagonism to some physical propositions commonly received by the schools did stir up against me many who professed the vulgar philosophy, as if, forsooth, I had with my own hand placed these things in the heavens to obscure and disturb nature and science.

In Lord Northcliffe (Alfred Harmsworth) and S. S. McClure (eds.)  
*The World's Greatest Books* (Volume 13)  
*The Defenders of Fallacy* (p. 129)  
 McKinlay, Stone & Mackenzie. New York, New York, USA. 1910

**Hoyle, Sir Fred** 1915–2001  
 English mathematician and astronomer

No literary genius could have harvested a story one-hundredth part as fantastic as the sober facts that have been unearthed by astronomical science.

*The Nature of the Universe*  
 Chapter 7 (p. 133)  
 At the University Press. Cambridge, England. 1933

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541  
 Swiss alchemist and mystic

All this you should know exists in man and realize that the firmament is within man, the firmament with its great movements of bodily planets and stars which result in exaltations, conjunctions, oppositions and the like, as you call these phenomena as you understand them. Everything which astronomical theory has searched deeply and gravely by aspects, astronomical tables and so forth – this self-same knowledge should be a lesson and teaching to you concerning the bodily firmament. For, none among you who is devoid of astronomical knowledge may be filled with medical knowledge.

In Allen G. Debus  
*The French Paracelsians*  
 Chapter 1 (p. 9)  
 Cambridge University Press. Cambridge, England. 1991

## ASTRONOMICAL PHOTOGRAPHY

**Stone, Ormond** 1847–1933  
 American astronomer, mathematician, and educator

One would infer, I think, that there is no longer any use for that venerated, but now to-pass-away, class of individuals hereafter to be known as “old fashioned astronomers,” and that hereafter observers skilled in the use of the meridian circle and the micrometer, will bear about the same relation to astronomical photographers as did the astronomers who lived before the invention of the telescope to the Herschels and the Struves of later date.  
 Photographers versus Old Fashioned Astronomers  
*The Sidereal Messenger, or Monthly Review of Astronomy*, Volume 6, Number 1, January, 1887 (p. 2)

## ASTRONOMICAL RESEARCH

**Mitchel, Ormsby MacKnight** 1805–62  
 American astronomer

Rapidly have we descended the current of astronomical research, we have attained the boundary of the known. We stand on the dim confines of the unknown. All behind us is clear, and bright, and perfect; all before us is shrouded in gloom, and darkness, and doubt. Yet the twilight of the known flings its feeble light into the domain of the unknown; and we are permitted to gather some idea, not of all that remains to be done, but of that which must be first accomplished.

*The Orbs of Heaven*  
 Introductory (pp. 15–16)  
 Office of the National Illustrated Library. London, England. 1851

## ASTRONOMICAL SCIENCE

**Miller, Robert Kalley**  
 No biographical data available

...if we consider not so much the study of the science itself, in its profound and recondite details, as the results to which it attains, the magnitude and importance of the subjects it treats of, and the beauty and grandeur of the phenomena it investigates, we shall have to acknowledge that somewhere or other in the ponderous tomes of astronomical science there must lie entombed rich stores of novel and unwonted interest.

*The Romance of Astronomy*  
 The Romance of Astronomy (p. 2)  
 Macmillan & Company Ltd. London, England. 1873

## ASTRONOMICAL STUDY

**Young, Charles Augustus** 1834–1908  
American astronomer

At present the end and object of astronomical study is chiefly knowledge pure and simple; so far as now appears, its development has less direct bearing upon the material interests of mankind than that of any other of the natural sciences.

*A Text-book of General Astronomy for Colleges and Scientific Schools*  
Introduction (p. 1)  
Ginn & Co. Boston, Massachusetts, USA. 1898

## ASTRONOMICAL TIME

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

It was not easy to visualize the vastness of astronomical space, and it is even less easy to conceive of the immensity of astronomical time. A fairly lengthy book contains about 200,000 words averaging five letters each. Let us take the whole of such a book to represent the age of the earth. Then the whole of civilization is represented by the last word or two, and the whole of the Christian era by something less than the last letter. A single lifetime is a good deal less than the final full stop with which the book ends. Such is the age of our won planet, and, whatever view we take, the age of the whole universe, on the same scale, is a matter of volumes. If the view I put forward is correct, it must be represented by a library of some thousands of volumes.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*  
The Size and Age of the Universe (p. 136)  
Government Printing Office. Washington, D.C. 1937

## ASTRONOMY

**Abbot, Charles Greeley** 1872–1973  
American astrophysicist

Astronomy is the distinguished child of the gypsy-like mother, astrology.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*  
Astronomy in Shakespeare's Time and in Ours (p. 109)  
Government Printing Office. Washington, D.C. 1937

**Airy, Sir George Biddell** 1801–92  
English mathematician and astronomer, Astronomer Royal from 1835 to 1881

Astronomy is pre-eminently the science of order.  
Account of Some Circumstances Historically Connected with the Discovery of the Planet Exterior to Uranus  
*Monthly Notices of the Royal Astronomical Society*, Volume 7, 1846

**Andreyev, Leonid** 1871–1919  
Russian writer

Astronomy is the triumph of reason.  
To the Stars  
*Poet Lore*, Volume 18, 1907 (p. 439)

**Arago, Francois** 1786–1853  
French physicist

Astronomy is the science of which the human mind may most justly boast. It owes this indisputable pre-eminence to the elevated nature of its object, to the grandeur of its means of investigation, to the certainty, the utility, and the unparalleled magnificence of its results.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1874*  
Laplace (p. 131)  
Government Printing Office. Washington, D.C. 1875

Astronomy is a happy science, it has not need for decorations.

In L.I. Ponomarev  
*The Quantum Dice* (p. 225)  
Institute of Physics Publishing. Bristol, England. 1993

It may indeed appear extraordinary that no mention should yet have been made of the great desiderata of astronomy – those questions which have exercised the curiosity and employed the time and attention of astronomers ever since the science has assumed its present character – such as the parallax of the fixed stars, their proper motion, the motion or rest of our own system, and its connection with the rest of the universe. But these and many other points are too obviously suggested by their importance to need any distinction which this society can bestow: the applause of the human race attends his labours; and no additional stimulus can be offered to those by which he is impelled.

Report to the First Annual General Meeting  
*Memoirs of the Astronomical Society of London*, 9 February, 1821,  
Volume I, 1822–25 (pp. 24–25)

Astronomy, although the oldest and in many respects the most perfect of the sciences, in many of its questions is still in its infancy.

Scientific Miscellany  
*The Galaxy*, Volume XIII, March, 1872 (p. 419)

GURU: Today I will discourse upon the violence in astronomy.

DISCIPLE: Revered Sir! Will you be describing the violent phenomena in the Universe?

GURU: Yes, and I will also dwell upon the controversies amongst the astronomers about what these events imply – controversies which are no less violent than the phenomena themselves.

In Jayant Narlikar  
*Violent Phenomena in the Universe*  
Chapter 1 (p. 1)  
Oxford University Press. Oxford, England. 1982

**Author undetermined**

Of all the sciences, none would seem to yield a purer intellectual gratification than that of Astronomy.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I

T. Nelson & Sons. London, England. 1889

It has been, said that “an undevout astronomer is mad;” and if Astronomy, of all the sciences, be the one most calculated to gratify the intellect, surely it is the one which should most vividly awaken the religious sentiment.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I

T. Nelson & Sons. London, England. 1889

...because Astronomy cherishes the feelings of awe and reverence and praise, because it inspires a continual yearning after additional knowledge, because it reveals to us something of the character of God, we conceive that of all the sciences it affords the purest intellectual gratification.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I

T. Nelson & Sons. London, England. 1889

It may indeed appear extraordinary that no mention should yet have been made of the great desiderata of astronomy, - those questions which have exercised the curiosity and employed the time and attention of astronomers ever since the science has assumed its present character - such as the parallax of the fixed stars, their proper motion, the motion or rest of our own system, and its connection with the rest of the universe. But these and many other points are too obviously suggested by their importance to need any distinction which this society can bestow: the applause of the human race attends his labours; and no additional stimulus can be offered to those by which he is impelled.

*Memoirs of the Astronomical Society of London*

Report to the First Annual General Meeting, 9 February 1821  
Volume I, 1822–25 (pp. 24–25)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...astronomy...seems to offer Prometheus's sacrifice to the understanding; for as he would have imposed upon Jupiter a fair large hide, stuffed with straw, and leaves, and twigs, instead of the ox itself, so astronomy gives us the number, situation, motion, and periods of the stars, as a beautiful outside of the heavens, whilst the flesh and the entrails are wanting.

*Advancement of Learning: and Novum Organum*

Book I, Chapter IV (p. 85)

The Colonial Press. New York, New York, USA. 1900

**Bayne, Samuel Gamble**

No biographical data available

The large modern telescope, celestial photography, and improved astronomical instruments have opened the field of astronomy to such an extent that the ideas, statements, and figures of a few years ago are no longer authentic. Happily for the credit of astronomers, the wonders of the skies have been underestimated, and those who thought that statements that had been previously made regarding celestial wonders were almost beyond credence will be pleased to find that they were not only true, but that in reality not more than half the truth had been told.

*The Pith of Astronomy Without Mathematics*

Introduction (p. vii)

Harper & Brothers Publishers. New York, New York, USA. 1896

**Bennett, Arnold** 1867–1931

English novelist and playwright

He knew not how to look at a landscape nor at a sky. Of plants and trees he was as exquisitely ignorant as of astronomy. It had not occurred to him to wonder why the days are longer in summer, and he vaguely supposed that the cold of winter was due to an increased distance of the earth from the sun. Still, he had learnt that Saturn had a ring and sometimes he unconsciously looked for it in the firmament, as for a tea-tray.

*Clayhanger*

Book I, Chapter II, Section III (p. 14)

E.P. Dutton & Company. New York, New York, USA. 1910

**Bichat, Xavier** 1771–1802

French physician and pathologist

To say that physiology is made up of the physics of animals is to give a very inaccurate idea of it; as well might we say that astronomy is the physiology of the stars.

*Physiological Researches on Life and Death*

Chapter VII, Section I (p. 81)

Arno Press. New York, New York, USA. 1977

**Black, William** 1841–98

Novelist

“Oh, I hate astronomy,” she says, perhaps glad enough to get away to this new subject. “There is no plan in astronomy, no regularity; everything is different from everything else, and that is what makes it difficult to understand. Now, for example, why shouldn't there be a crescent sun as well as a crescent moon?”

*The Strange Adventures of a House-boat: A Novel*

Chapter VII (p. 73)

Harper & Brothers Publishers. New York, New York, USA. 1904

**Brewster, David** 1781–1868

English physicist

Of all the sciences cultivated by mankind, astronomy is acknowledged to be, and undoubtedly is, the most sublime, the most interesting, and the most useful; for, by knowledge derived from this science, not only the bulk of the earth is discovered, the situation and extent of the

countries and kingdoms upon it ascertained, trade and commerce carried on to the remotest parts of the world, and the various products of several countries distributed for the health, comfort, and conveniency of its inhabitants; but our very faculties are enlarged with the grandeur of the ideas it conveys, our minds exalted above the low contracted prejudices of the vulgar, and our understandings clearly convinced, and affected with the conviction of the existence, wisdom, power, goodness, immutability, and superintendency of the Supreme Being!

*Ferguson's Astronomy, Explained upon Sir Isaac Newton's Principles* (Volume 1)

Chapter I (p. 1)

Printed for the author. London, England. 1756

### **Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Astronomy is not the apex of science or of invention. But it is a test of the cast of temperament and mind that underlies a culture.

*The Ascent of Man*

Chapter 6 (p. 190)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

### **Burnham, Robert, Jr.** 1931–93

American astronomer

No one can date that remote epoch when astronomy “began” – we can say only that the fascination of the heaven is as old as man’s ability to think; as ancient as his capacity to wonder and to dream. And in company with most of the special enchantments of human life, the unique appeal of astronomy is incommunicable; easily understood through direct experience, but not to be precisely defined or explained. Nor should any explanation be thought necessary. The area of astronomy is both intellectual and aesthetic; it combines the thrill of exploration and discovery, the fun of sight-seeing, and the sheer pleasure of firsthand acquaintance with incredibly wonderful and beautiful things.

*Burnham's Celestial Handbook* (Volume 1)

Chapter 1 (p. 5)

Celestial Handbook Publications. Flagstaff, Arizona, USA.

### **Burroughs, John** 1837–1921

American naturalist and essayist

...in astronomy, some of the most important discoveries seem inspirations, or a kind of winged, ecstatic reasoning, quite above and beyond the real facts.

*The Heart of Burroughs's Journals*

Aug. 26, 1865 (p. 41)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

### **Byrd, Deborah** 1951–

American radio host

Astronomy is something a culture does when it wants to understand itself.

Focus

*Sky and Telescope*, Volume 80, Number 6, December, 1990 (p. 580)

### **Carey, George G.**

No biographical data available

Astronomy is one of the most ancient and one of the most pleasing branches of knowledge which has ever engaged the human mind. The grandeur and sublimity of the objects it presents elevate and improve the mind, banish low and frivolous passions, and become a source of never-ceasing pleasure.

*Astronomy, as it is Known at the Present Day*

On the Utility of Astronomy (p. 1)

William Cole. London, England. 1825

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

Thus, astronomy was probably the first exact science, practiced long before the concept of science as such had been formulated. (Mathematics may have been earlier, but I do not consider it a natural science: the mother of many kings is not necessarily a queen.)

*Serious Questions*

Nature (p. 153)

Birkhäuser. Boston, Massachusetts, USA. 1986

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

Astronomy, as nothing else can do, teaches men humility.

*The Challenge of the Spaceship*

The Star of the Magi (p. 86)

Harper & Brothers. New York, New York, USA. 1959

### **Clerke, Agnes Mary** 1842–1907

Irish astronomer

It [physical astronomy] welcomes the most unpretending co-operation. There is no one “with a true eye and a faithful hand” but can do good work in watching the heavens. And not unfrequently prizes of discovery which the most perfect appliances failed to grasp have fallen to the share of ignorant or ill-provided assiduity.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Introduction (p. 6)

Adam & Charles Black. London, England. 1893

Astronomy generalises the results of other sciences. She exhibits the laws of Nature working over a wider area, and under more varied conditions, than ordinary experience presents. Ordinary experience, on the other hand, has become indispensable to her progress. She takes in at one view the indefinitely great and the indefinitely little. The mutual revolutions of the stellar multitude during tracts of time which seem to lengthen out to eternity as the mind attempts to traverse them, she does not admit to be beyond her ken ...

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Introduction (p. 9)

Adam & Charles Black. London, England. 1893



[Astronomy] is a science of hairbreadths and fractions of a second. It exists only by the rigid enforcement of arduous accuracy and unwearying diligence. Whatever secrets the universe still has in store for man will only be communicated on these terms.

*A Popular History of Astronomy During the Nineteenth Century*  
Part I, Chapter VI (p. 123)  
A. & C. Black. London, England. 1908

...the science of the nature of the heavenly bodies...is full of the audacities, the inconsistencies, the imperfections, the possibilities of youth.... It promises everything; it has already performed much; it will doubtless perform much more.

*A Popular History of Astronomy During the Nineteenth Century*  
Part II, Chapter I (p. 142)  
A. & C. Black. London, England. 1908

**Comte, Auguste** 1798–1857

French philosopher

We may therefore define Astronomy as the science by which we discover the laws of the geometrical and mechanical phenomena presented by the heavenly bodies.

*The Positive Philosophy of Auguste Comte*  
Book II, Chapter I (p. 138)  
John Chapman. London, England. 1853

**Conrad, Joseph** 1857–1924

Polish-born English novelist

The demonstration must be against learning-science. But not every science will do. The attack must have all the shocking senselessness of gratuitous blasphemy. Since bombs are your means of expression, it would be really telling if one could throw a bomb into pure mathematics. But that is impossible...What do you think of having a go at astronomy?

*The Secret Agent: A Simple Tale*  
Chapter II (p. 38)

Doubleday, Page & Company. Garden City, New York, USA. 1916

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

And as far as hypotheses go, let no one expect anything in the way of certainty from astronomy, since astronomy can offer us nothing certain, lest, if anyone take as true that which has been constructed for another use, he go away from this discipline a bigger fool than when he came to it.

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*

Book One, To the Reader Concerning the Hypotheses of this Work (p. 506)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Davy, Sir Humphry** 1778–1829

English chemist

Astronomy is the most ancient, and the nearest approaching to perfection, of the sciences; yet, relating to the

immensity of the universe, how unbounded are the objects of inquiry it presents! And, amongst them, how many grand and abstruse subjects of investigation !

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* (Volume 7)

Address of the President (p. 9)

Smith, Elder & Co. London, England. 1840

**de Fontenelle, Bernard le Bovier** 1657–1757

French writer

...astronomy was the daughter of idleness, geometry the daughter of interest; and if we did but examine poetry, we should certainly find her to be the daughter of love.

*Conversations on the Plurality of Worlds*

The First Evening (p. 11)

Printed for Peter Wilson. Dublin, Ireland. 1761

...my soul is not mercenary enough for geometry, nor is it tender enough for poetry; but I have as much time to spare as astronomy requires...

*Conversations on the Plurality of Worlds*

The First Evening (p. 12)

Printed for Peter Wilson. Dublin, Ireland. 1761

...astronomy is the offspring of idleness...

*Conversations on the Plurality of Worlds*

First Evening (p. 12)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

The objects which astronomy discloses afford subjects of sublime contemplation, and tend to elevate the soul above vicious passions and groveling pursuits.

In Elijah H. Burritt

*The Geography of the Heavens, and a Class-book of Astronomy: Accompanied by a Celestial Atlas*

Introduction

Mason Brothers. New York, New York, USA. 1863

Astronomy is that department of knowledge which has for its object to investigate the motions, the magnitudes, and distances of the heavenly bodies; the laws by which their movements are directed, and the ends they are intended to subserve in the fabric of the universe. This is a science which has in all ages engaged the attention of the poet, the philosopher, and the divine, and has been the subject of their study and admiration. Kings have descended from their thrones to render it homage, and have sometimes enriched it with their labours; and humble shepherds, while watching their flocks by night, have beheld with rapture the blue vault of heaven, with its thousand shining orbs, moving in silent grandeur, till the morning star announced the approach of day.

*The Complete Works of Thomas Dick, LL.D.* (Volume 7)

Celestial Scenery, Introduction (p. 8)

Edwards & Bushnell. St. Louis, Missouri, USA. 1857

To consider astronomy merely as a secular branch of knowledge, which improves navigation, and gives scope

to the mathematician's skill, and to overlook the demonstrations it affords of the invisible Divinity, would be to sink this noble study far below its native dignity, and to throw into the shade the most illustrious manifestations of the glories of the Eternal Mind.

*Celestial Scenery, Or, The Wonders of the Planetary System Displayed*  
Chapter V (p. 267)

Merriam & Cooke. West Brookfield, Massachusetts, 1847  
USA.

### Dickson, Frank

No biographical data available

The little boy had received his first lesson in astronomy and was proudly exhibiting his knowledge to his still smaller sister.

"That star," he said, pointing to one of the most brilliant ornaments of the heavens, "is much larger than the earth."

"You can't make me believe that." the sister replied. "If it's as big as that, why doesn't it keep the rain off us?"

Good Stories You Can Use

Quote, *the Weekly Digest*, July 17, 1966 (p. 14)

### Donne, John 1572–1631

English poet and divine

We thinke the heavens enjoy their Spherical,  
Their round proportion embracing all.  
But yet their various and perplexed course,  
Observ'd in divers ages doth enforce  
Men to finde out so many Eccentrique parts,  
Such divers downe-right lines, such overthwarts,  
As disproportion that pure forme. It teares  
The Firmament in eight and forty sneers.

In A.J. Smith (ed.)

*The Complete English Poems of John Donne*

An Anatomie of the World, First Anniversary, l. 251–258

St. Martin's Press. New York, New York, USA. 1971

### Edwards, Tyron 1809–94

American theologian

No one can contemplate the great facts of astronomy without feeling his own littleness and the wonderful sweep of the power and providence of God.

*A Dictionary of Thoughts*

Astronomy (p. 30)

F.B Dickerson Co. Detroit, Michigan, USA. 1908

### Eliot, George (Mary Ann Evans Cross) 1819–80

English novelist

The best introduction to astronomy is to think of the nightly heavens as a little lot of stars belonging to one's own homestead.

*Daniel Deronda*

Book I, Chapter III (p. 21)

Estes & Lauriat. Boston, Massachusetts, USA. 1894

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

It is noticed, that the consideration of the great periods and spaces of astronomy induces a dignity of mind, and an indifference to death.

*The Conduct of Life and Society and Solitude*

*The Conduct of Life*

Culture (p. 128)

Macmillan & Company Ltd. London, England. 1883

No one can read the history of astronomy without perceiving that Copernicus, Newton, Laplace, are not new men, or a new kind of men, but that Thales, Anaximenes, Hipparchus, Empedocles, Aristorchus, Pythagoras, Oenipodes, had anticipated them...

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Fate (p. 951)

The Library of America. New York, New York, USA. 1983

The sciences, even the best – mathematics and astronomy – are like sportsmen, who seize whatever prey offers, even without being able to make any use of it.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

*Representative Men*

Chapter II (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy is excellent; but it must come up into life to have its full value, and not remain there in globes and spaces.

*Representative Men: Seven Lectures*

Chapter III (pp. 106–107)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1879

Astronomy taught us our insignificance in Nature...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Lectures and Biographical Sketches*

Historic Notes of Life and Letters in New England (p. 336)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy is a cold, desert science...

*The Complete Works of Ralph Waldo Emerson* (Volume 12)

*Natural History of Intellect*

Chapter V (p. 166)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy is the science which treats of the motions of the heavenly bodies, and all the phenomena arising therefrom.

*A System of Astronomy: Containing the Investigation and Demonstration of the Elements of that Science*

Astronomy (p. 1)

Printed for J. Nourse. London, England. 1769

The narrow sectarian cannot read astronomy with impunity. The creeds of his church shrivel like dried leaves at the door of the observatory ...

*Letters and Social Aims*

Progress of Culture (p. 201)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1884



**Everett, Edward** 1794–1865

American statesman, educator, and orator

...the unspeakable glories of the rising and the setting sun; the serene majesty of the moon, as she walks in full-orbed brightness through the heavens; the soft witchery of the morning and the evening star; the imperial splendors of the firmament on a bright, unclouded night; the comet, whose streaming banner floats over half the sky – these are objects which charm and astonish alike the philosopher and the peasant, the mathematician who weighs the masses and defines the orbits of the heavenly bodies, and the untutored observer who sees nothing beyond the images painted upon the eye.

An Oration

The Uses of Astronomy, Albany, New York, 28 July 1856 (p. 20)  
Ross & Tousey. New York, New York, USA. 1856

**Fitz, Henry** 1808–63

American telescope manufacturer

Astronomy is truly the handmaid of science, and the road to knowledge. For if the heavens declare the glory of God, that science which opens a door to the investigation into the heavens, which declare God's glory, and furnishes the means of illustration of the firmament, where God's handiwork is seen and exhibited, is a Divine Science.

*The Layman's Legacy* (Volume 2)

Sermon XXIV (p. 471)

P. Price. New York, New York, USA. 1840

**Flammarion, Camille** 1842–1925

French astronomer and writer

Astronomy is the most accurate of the sciences. All the truths which it teaches are absolutely demonstrated, and cannot be disputed by any mind which gives itself the trouble, or rather the pleasure, to gain information in the study of this admirable science.

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter VI (p. 53)

Chatto &amp; Windus. London, England. 1894

The Science of Astronomy is sublime and beautiful. Noble, elevating, consoling, divine, it gives us wings, and bears us through Infinitude. In these ethereal regions all is pure, luminous, and splendid. Dreams of the Ideal, even of the Inaccessible, weave their subtle spells upon us. The imagination soars aloft, and aspires to the sources of Eternal Beauty.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 1)

D. Appleton &amp; Co. New York, New York, USA. 1915

Far from being a difficult and inaccessible science, Astronomy is the science which concerns us most, the one most necessary for our general instruction, and at the same time the one which offers for our study the greatest charms and keeps in reserve the highest enjoyments. We

cannot be indifferent to it, for it alone teaches us where we are and what we are; and, moreover, it need not bristle with figures, as some severe savants would wish us to believe. The algebraical formulæ are merely scaffoldings analogous to those which are used to construct an admirably designed palace. The figures drop off, and the palace of Urania shines in the azure, displaying to our wondering eyes all its grandeur and all its magnificence.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter I (p. 1)

Chatto &amp; Windus. London, England. 1894

It [astronomy] ceases to be a figure and becomes alive. The spectacle of the universe is transfigured before our astonished minds. It is no longer inert bodies rolling in silence in eternal night that the finger of Urania shows us in the depths of the heavens; it is life – life immense, universal, eternal, unfolding itself in waves of harmony out to the inaccessible horizon of an eternal infinite.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter I (p. 3)

Chatto &amp; Windus. London, England. 1894

The science of the stars [astronomy] ceases to be the confidential secret of a small number of the initiated; it penetrates all understandings, it illuminates nature.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter I (p. 4)

Chatto &amp; Windus. London, England. 1894

All the truths which it [astronomy] teaches are absolutely demonstrated, and cannot be disputed by any mind which gives itself the trouble, or rather the pleasure, to gain information in the study of this admirable science.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter VI (p. 53)

Chatto &amp; Windus. London, England. 1894

**Forbes, George** 1849–1936

Physician

In no realm of nature is the principle of cause and effect more conspicuous than in astronomy; and we fall into the habit of thinking of its laws as not only being unchangeable in our universe, but necessary to the conception of any universe that might have been substituted in its place.

*History of Astronomy*

Book I (p. 5)

G.P. Putnam's Sons. New York, New York, USA. 1909

**Friedman, Herbert** 1916–2000

American space scientist and astrophysicist

Astronomy brings us new wonders every day. The store of new knowledge seems inexhaustible.

The Invisible Universe of X-rays and Gamma Rays

*Proceedings, American Philosophical Society*, Volume 141, Number 4, 1977 (p. 416)

Astronomy is a great human endeavor, international in its ideals and performance, and shared by thousands of scientists, technicians, engineers, and craftsmen. Its instruments are the most beautifully precise, exquisitely delicate, and incredibly sensitive that the genius of man can produce.

*The Amazing Universe*

Chapter I (p. 19)

National Geographic Society. 1975

**Frost, Robert** 1874–1963

American poet

“But Cygnus isn’t in the Zodiac,”

Dick longed to say, but wasn’t sure enough

Of his astronomy...

*Complete Poems of Robert Frost*

From Plane to Plane

Henry Holt & Company. New York, New York, USA. 1949

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

Astronomy, for instance, is hardly mentioned, and only the sun, and the moon, and Lucifer are named. Surely, if the holy writers had intended us to derive our astronomical knowledge from the Sacred Books, they would not have left us so uninformed. That they intentionally forbore to speak of the movements and constitution of the stars is the opinion of the most holy and most learned fathers. And if the Holy Spirit has omitted to teach us those matters as not pertinent to our salvation, how can it be said that one view is de Fide and the other heretical? I might here insert the opinion of an ecclesiastic raised to the degree of Eminentissimo: That the intention of the Holy Ghost is to teach us how we shall go to Heaven, and not how the heavens go.

In Lord Northcliffe (Alfred Harmsworth) and S.S. McClure (eds.)

*The World’s Greatest Books* (Volume 13)

*The Authority of Scripture in Philosophical Controversies*

Section I

The Defenders of Fallacy (p. 132)

W.H. Wise. New York, New York, USA. 1910

It is surely harmful to souls to make it a heresy to believe what is proved. The prohibition of astronomy would be an open contempt of a hundred texts of the Holy Scriptures, which teach us that the glory and the greatness of Almighty God are admirably discerned in all His works, and divinely read in the open book of the heavens.

In and J.A. Hammerton (ed.)

*Outline of Great Books* (Volume 2)

*The Authority of Scripture in Philosophical Controversies*

Section II

Scripture and Experimental Truth (p. 364)

W.H. Wise. New York, New York, USA. 1934

...to command the professors of astronomy to confute their own observations is to enjoin an impossibility, for it is to command them to not see what they do see, and not

to understand what they do understand, and to find what they do not discover.

In Arthur Mee and J.A. Hammerton (ed.)

*Outline of Great Books* (Volume 2)

*The Authority of Scripture in Philosophical Controversies*

Section II

Scripture and Experimental Truth (p. 364)

W.H. Wise. New York, New York, USA. 1934

**Grant, Robert** 1814–92

English astronomer

Astronomy is not only one of the most ancient of the physical sciences, but also one of those which present the most alluring invitations to the contemplative mind. The starry heavens, spangling with countless luminaries of every shade of brilliancy, and revolving in eternal harmony round the earth, constitute one of the most imposing spectacles which nature offers to our observation.

*History of Physical Astronomy, from the Earliest Ages to the Middle of the Nineteenth Century*

Introduction (p. 1)

Robert Baldwin. London, England. 1852

**Graves, Robert Perceval** 1895–1985

English poet

Against astronomy, indeed, the objection from utility is singularly infelicitous, and almost ludicrously inapplicable: astronomy, which binding in so close connexion the earth with the visible heaven, and mapping the one in the other, has guided through wastes, which else were trackless, the fleet and the caravan, and made a path over the desert and the deep.

*Life of Sir William Rowan Hamilton* (Volume 1)

Chapter XIV (pp. 650–651)

Hodges, Figgis & Co. Dublin, Ireland. 1882

**Guillemin, Amédée** 1826–93

French journalist and scientific writer

...it is Astronomy that reveals to us the Universe in its majestic whole; it is she who has made us comprehend its structure, and after having gathered its thousand various elements into a gorgeous picture, has initiated us into the eternal laws that govern the Heavens.

In Norman Lockyer and Richard Anthony Proctor

*The Heavens: An Illustrated Handbook of Popular Astronomy* (7th edition)

The Heavens (p. 4)

Richard Bentley & Son. London, England. 1878

**Hale, George Ellery** 1868–1938

American astronomer

At any period in the progress of observational astronomy there are two most important subjects for consideration. One relates to the accomplishment of a great amount of routine observation and the discussion of results, and the other relates to the introduction of new ideas and to

the beginnings of the new methods which will make the astronomy of the future.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Some Opportunities for Astronomical Work with Inexpensive Apparatus (p. 267)

Government Printing Office. Washington, D.C. 1908

### **Hall, Asaph** 1829–1907

American astronomer

Astronomy, in some of its forms, reaches back to the most distant historical epochs, and the changes that it has undergone during this long lapse of time give to this science a peculiar interest. In no other branch of human knowledge have we such a long and continuous history o the search after truth, of the painful struggle through which men have passed in freeing themselves from theories approved by the wise of their own times, and in overthrowing beliefs which had become incorporated into the life am culture of those times.

Address by Professor Asaph Hall

*Science*, Volume 1, September 11, 1880 (p. 123)

It is the spirit of honest, unrelenting criticism, and of impartial examination, that finally eliminates error and awards to everyone his just due, that makes astronomy honorable and attractive; and it is by cultivating this spirit that astronomy confers its chief benefit, for it is this that shall break in pieces and destroy all false assumptions in science and in philosophy.

Address by Professor Asaph Hall

*Science*, Volume 1, September 11, 1880 (p. 127)

The question is sometimes asked, of what use is astronomy? And the reply generally made is that it has conferred great benefits on navigation and on commerce, since it is by means of his astronomical knowledge that the sailor determines the position of his ship on the ocean. There is a truth in this reply, but it is only partial. The great value of astronomy is that it is really a science, and that it has broken the path and led the way through which all branches of science must past if they ever become scientific.

Address by Professor Asaph Hall

*Science*, Volume 1, September 11, 1880 (p. 127)

### **Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

The design of physical science in general is to record and explain appearances ; to classify and generalise facts; to discover the secret unity and constancy of nature, amid its seeming diversity and mutability ; to construct, at least in part, a history of the outward world, adapted to the understanding of man; to account for past and to foresee future phenomena; to learn the language and interpret the oracles of the universe. How well Astronomy has answered this description it does not need to say.

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 1)

Introductory Lecture On Astronomy (p. 501)

Hodges, Figgus & Co. Dublin, Ireland. 1882

The time has returned when, according to the provisions of this our University, we are to join our thoughts together, and direct them in concert to astronomy – the parent of all the sciences, and the most perfect and beautiful of all. And easily and gladly could I now expatiate on the dignity and interest of astronomy, but the very assurance of your complete and perfect sympathy renders needless any attempt at excitement. I must not and cannot suppose that any of those who are assembled here this day, are insensible to the inward impulses, and unconscious of the high aspirations, by which the stars, from their thrones of glory and of mystery, excite and win toward themselves the heart of man; that the golden chain has been let down in vain; and that celestial beauty and celestial power have offered themselves in vain to human view.

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 1)

Introductory Lecture on astronomy (p. 640)

Hodges, Figgis & Co. Dublin, Ireland. 1882

### **Hardy, Thomas** 1840–1928

English poet and regional novelist

...if you are cheerful, and wish to remain so, leave the study of astronomy alone. Of all the sciences, it alone deserves the character of the terrible.

*Two on a Tower* (Volume 1)

Chapter IV (p. 78)

Sampson, Low, Marston, Searle & Rivington. London, England. 1882

...if...you are restless and anxious about the future, study astronomy at once. Your troubles will be reduced amazingly. But your study will reduce them in a singular way, by reducing the importance of everything.

*Two on a Tower* (Volume 1)

Chapter IV (p. 78)

Sampson, Low, Marston, Searle & Rivington. London, England. 1882

### **Harrington, Thomas**

No biographical data available

Each Branch of the human Literature hath had its admirers; but Men of Wisdom in every Age have been unanimous in assigning a Preference to Astronomy.

*Science Improved; or, The Theory of the Universe*

To His Royal Highness George, Prince of Wales (p. 1)

Printed for the Author. London, England. 1774

Astronomy is that refined Science which teaches us a knowledge of the Stars, and in general, of all the heavenly bodies, their form, structure, appearances and motions, their positions in the Heavens, their magnitude and their distance, periods and Eclipses; a large and extensive field!

*Science Improved; or, The Theory of the Universe*

Section XIII (p. 82)

Printed for the Author. London, England. 1774

Astronomy, with the utmost propriety, may be said to enlarge the mind in submitting the very course of the heavenly bodies to our understanding...

*Science Improved; or, The Theory of the Universe*

Section XIV (p. 86)

Printed for the Author. London, England. 1774

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

If proof were wanted of the inexhaustible fertility of astronomical science in points of novelty and interest, it would suffice to adduce the addition to the list of members of our system of no less than eight new planets and satellites during the preparation of these sheets for the press.

*Outlines of Astronomy*

Preface (p. 5)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1849

There is no science which, more than astronomy, stands in need of such a preparation, or draws more largely on that intellectual liberality which is ready to adopt whatever is demonstrated, or concede whatever is rendered highly probable, however new and uncommon the points of view may be in which objects the most familiar may thereby become placed.

*Outlines of Astronomy: By Sir John F. W. Herschel*

Introduction (p. 22)

American Home Library Co. New York, New York, USA. 1902

**Higgins, Sir William**

Physicist and astronomer

...surely in no part of Nature are the noblest and most profound conceptions of the human spirit more directly called forth than in the study of the heavens and the host thereof.

*The New Astronomy*

*The Nineteenth Century*, Volume XLI, June, 1897 (p. 907)

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If I were asked to define theoretical astronomy in one sentence I should say that it consists of discovering the properties of matter, partly by experiments carried out on the Earth and partly through the detailed observation of near-by space, and in then applying the results to the Universe as a whole.

*The Nature of the Universe*

Chapter 1 (p. 5)

At the University Press. Cambridge, England. 1933

**Hubble, Edwin Powell** 1889–1953

American astronomer

Astronomy is something like the ministry.... No one should go into it without a "call."

In Barry Parker

*Creation: The Story of the Origin and Evolution of the Universe*

Chapter 2 (p. 29)

Plenum Press. New York, New York, USA. 1998

...the history of astronomy is a history of receding horizons.

*Science News Letter*, Volume 11, Number 306 (p. 1)

Astronomy is like ministry. You need a calling.

In Alexander S. Sharov and Igor D. Novikov

*Edwin Hubble, The Discoverer of the Big Bang Universe*

Part I, Choosing the Way (p. 8)

Cambridge University Press. Cambridge, England. 1993

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

I turn the handle and the story starts:

Reel after reel is all astronomy,

Till life, enkindled in a niche of sky,

Leaps on the stage to play a million parts.

Life leaves the slime and through the oceans darts;

She conquers earth, and raises wings to fly;

Then spirit blooms, and learns how not to die,

Nesting beyond the grave in others' hearts.

I turn the handle; other men like me

Have made the film; and now I sit and look

In quiet, privileged like Divinity

To read the roaring world as in a book.

If this thy past, where shall thy future climb,

O Spirit, built of Elements and Time!

*Essays of a Biologist*

Evolution: At the Mind's Cinema (p. 2)

Alfred A. Knopf. New York, New York, USA. 1929

**Huxley, Thomas Henry** 1825–95

English biologist

When Astronomy was young "the morning stars sang together for joy," and the planets were guided in their courses by celestial hands. Now, the harmony of the stars has resolved itself into gravitation according to the inverse squares of the distances, and the orbits of the planets are deducible from the laws of the forces which allow a schoolboy's stone to break a window.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 56)

Macmillan & Company Ltd. London, England. 1904

Astronomy – which tells them [men's mind] that this so vast and seemingly solid earth is but an atom among atoms, whirling, no man knows whither, through illimitable space; which demonstrates that what we call the peaceful heaven above us, is but that space, filled by an infinitely subtle matter whose particles are seething and surging, like the waves of an angry sea; which opens up to us infinite regions where nothing is known, or ever seems to have been known, but matter and force, operating according to rigid rules; which leads us to contemplate phenomena the very nature of which demonstrates that they must have had a beginning, and that they must have an end, but the very nature of which also proves that

the beginning was, to our conceptions of time, infinitely remote, and that the end is as immeasurably distant.

*Lay Sermons, Addresses and Reviews*

Chapter I (p. 14)

D. Appleton & Co. New York, New York, USA. 1903

**Jacoby, Harold** 1865–1932

American astronomer

A generation ago, men thought the “perfect science,” for so we love to, call astronomy, could advance only by increasing a little the exact precision of observation.

*Practical Talks by an Astronomer*

The Pole Star (p. 19)

Charles Scribner’s Sons. New York, New York, USA. 1902

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Most sciences progress by pursuing nature into the realms of infinitely small, but for astronomy and cosmogony progress lies in the direction of the infinitely great, or, to be more exact, of the unthinkable great.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*

The New Outlook in Cosmogony (p. 151)

Government Printing Office. Washington, D.C. 1928

Astronomy has always stood aloof from the other sciences; her field of research is apart, her methods are entirely her own, and, most significant of all, her results have different values from those of other sciences. While these reward mankind by utilitarian gifts, new methods for the production of wealth, the increase of pleasure or the avoidance of pain, astronomy has so far given us only food for intellectual contemplation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*

The New Outlook in Cosmogony (p. 151)

Government Printing Office. Washington, D.C. 1928

**Jeffers, Robinson** 1887–1962

American poet

Therefore astronomy is the most noble science: is the most useless.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 291)

Stanford University Press. Stanford, California. USA. 1988

There is nothing like astronomy to pull the stuff out of man, His stupid dreams and red-rooster importance: let him count the star-swirls.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Polar Ice-Caps Are Melting (p. 476)

Stanford University Press. Stanford, California. USA. 1988

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

Among all the Mathematical Sciences which have been continually improved, and are daily improving in the

World, the First Place has, as it were, by general Consent, Been always given to Astronomy.

*An Introduction to the True Astronomy*

To His Grace Jones Duke of Chandos

Printed for Bernard Lintot. London, England. 1721

Astronomy teaches us to observe and discover the Motions of the Heavenly Bodies, and it weighs and considers the Force and Vigor by which they circulate in their Orbs. It is a Science which the greatest Heroes from the beginning of the World have taken Pleasure to Study and improve; so that it was always esteemed as a Science fit for Kings and Emperors to employ themselves in.

*An Introduction to the True Astronomy*

The Preface (p. I)

Printed for Bernard Lintot. London, England. 1721

There is nothing in Nature that does more show the piercing Force of Human Understanding, the sublimity of its Speculations and deep researchers, than true Astronomy. It raises our Minds above our Senses, and even in contradiction to them, shows us the true System of the World: the faculty of Reason by which we have made these great discoveries in the Heavens must needs be derived from Heaven, since no Earthly Principle can attain so great a Perfection.

*An Introduction to the True Astronomy*

Lecture IV (pp. 27–28)

Printed for Bernard Lintot. London, England. 1721

**Kepler, Johannes** 1571–1630

German astronomer

But whoever is too stupid to understand astronomical science, or too weak to believe Copernicus without affecting his faith, I would advise him that, having dismissed astronomical studies and having damned whatever philosophical opinions he pleases, he minds his own business and betakes himself home to scratch in his own dirt patch, abandoning this wandering about the world.

*New Astronomy*

Author’s introduction (pp. 65–66)

At the University Press. Cambridge, England. 1992

It is true that a divine voice, which enjoins humans to study astronomy, is expressed in the world itself, not in words or syllables, but in things themselves and in the conformity of the human intellect and senses with the sequence of celestial bodies and their disposition.

*New Astronomy*

Part II, 7 (p. 183)

At the University Press. Cambridge, England. 1992

Astronomy has two ends, to save the appearances and to contemplate the true form of the edifice of the world.

In Michael Zeilik

*Astronomy: The Evolving Universe* (6th edition)

Chapter Three, The New Cosmic Order (p. 43)

John Wiley & Sons, Inc. New York, New York, USA. 1991



I am much occupied with the investigation of physical causes. My aim in this is to show that the celestial machine is to be likened not to a divine organism, but rather a clockwork...

In Michael Zeilik

*Astronomy: The Evolving Universe* (6th edition)

Chapter Four, The Clockwork Universe (p. 51)

John Wiley & Sons, Inc. New York, New York, USA. 1991

As in every discipline, so in astronomy, too, the conclusions that we teach the reader are seriously intended, and our discussion is no mere game.

*Opera Omnia* (Volume 1) (p. 239)

**Lanczos, Cornelius** 1893–1974

Hungarian mathematician and physicist

Astronomy was the cradle of the natural sciences and the starting point of geometrical theories.

*Space Through the Ages*

Academic Press, Inc. London, England. 1970

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Of all the natural sciences Astronomy is that which presents the longest series of discoveries. There is an immense distance from the first view of the heavens, to that general view by which, at the present day, we comprehend the past and future state of the system of the world.

Translated by John Pond

*The System of the World* (Volume 1)

System of the World (p. 1)

Printed for Richard Phillips. London, England. 1809

Astronomy has already made an important step, in making us acquainted with the motion of the Earth, and the epicycles which the Moon and the satellites describe on the orbits of their respective planets. But if ages were necessary in order to know the motions of the planetary system, what a great length of time must be required for the determination of the motions of the Sun and the stars; notwithstanding this, such motions appear to be already indicated by observations.

Translated Henry H. Harte

*The Systems of the World* (Volume 2) (p. 338)

University Press. Dublin, Ireland. 1830

The progress of astronomy depends on these three things: the measure of time, that of angles, and the perfection of optical instruments. The two first are nearly as perfect as we could wish; it is therefore to the improvement of the latter that our attention should be directed.

Translated Henry H. Harte

*The Systems of the World* (Volume 2) (p. 339)

University Press. Dublin, Ireland. 1830

Contemplated as one grand whole, astronomy is the most beautiful monument of the human mind; the noblest record of its intelligence.

Translated by John Pond

*The System of the World* (Volume 2)

Book V, Chapter VI (p. 373)

Printed for Richard Phillips

London, England. 1809

Astronomy, considered in the most general way, is a great problem of mechanics, the arbitrary data of which are the elements of the celestial movements; its solution depends both on the accuracy of observations and on the perfection of analysis.

*Celestial Mechanics*

Preface

Chelsea Publishing Company. Bronx, New York, USA. 1966

**Lapworth, Charles** 1842–1920

English Geologist

Along the whole range of the concrete sciences there is perhaps not one that has so effectually compelled the respect of men as Astronomy. There is not one in whose progress they have taken so keen an interest, or whose conclusions have been so unhesitatingly accepted.

The Relations of Geology

*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1902 (p. 395)

**Larrabee, Eric** 1922–90

American historian

Astronomy was independently discovered by Copernicus and Kepler, who sent the news to each other (*de nova stella*) by sidereal messenger.

*Humor from Harper's*

Easy Road to Culture, Sort of (p. 89)

Harper. New York, New York, USA. 1961

**Leacock, Stephen** 1869–1944

Canadian humorist

Astronomy teaches the correct use of the sun and the planets.

*Literary Lapses*

A Manual of Education (p. 127)

John Lane. London, England. 1911

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

Astronomy is perhaps the science whose discoveries owe least to chance, in which human understanding appears in its whole magnitude, and through which man can best learn how small he is.

*Lichtenberg: Aphorisms & Letters*

Notebook c, Aphorism 23

Jonathan Cape. London, England. 1969

**Long, Roger** 1680–1770

English astronomer

Astronomy is a science which, in all ages and countries flourishing in arts and politeness, has engaged the attention of the curious: it has not only employed the pens of

the most eloquent orators and embellished the writings of poets of the most elevated genius; but has also been cultivated by the greatest princes, the ablest statesmen, and the wisest philosophers...

*Astronomy, In Five Books* (Volume 1)

Preface (p. iii)

Printed for the Writer. Cambridge, England. 1742

**Lowell, Percival** 1855–1916

American astronomer

Astronomy is usually thought of as the study of the bodies visible in the sky. And such it largely is when the present state of the universe alone is considered. But when we attempt to peer into its past and to foresee its future, we find ourselves facing a new side of the heavens – the contemplation of the invisible there. For in the evolution of worlds not simply must the processes be followed by the mind’s eye, so short the span of human life, but they begin and end in what we cannot see.

*The Evolution of Worlds*

Chapter I (p. 1)

If astronomy teaches anything, it teaches that man is but a detail in the evolution of the universe, and that resembling though diverse details are inevitably to be expected in the host of orbs around him. He learns that, though he will probably never find his double anywhere, he is destined to discover any number of cousins scattered through space.

*Mars*

Conclusion (p. 212)

Longmans, Green, & Co. London, England. 1896

**Mann, Horace** 1796–1859

American educator

Astronomy...one of the sublimest fields of human investigation. The mind that grasps its facts and principles receives something of the enlargement and grandeur belonging to the science itself.

*Annual Reports of the Secretary of the Board of Education of Massachusetts for 1844* (p. 441)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1891

**McFee, Inez Nellie**

No biographical data available

Truly the study of the stars – the science of astronomy – is the science of Infinity and Eternity.

*Secrets of the Stars*

Chapter I (pp. 3–4)

Thomas Y. Crowell Co. New York, New York, USA. 1922

**Melville, Herman** 1819–91

American novelist

I am of a meditative humour, and at sea used often to mount aloft at night, and, seating myself on one of the upper yards, tuck my jacket about me and give loose to reflection. In some ships in which I have done this, the

sailors used to fancy that I must be studying astronomy – which, indeed, to some extent, was the case.... Then, to study the stars upon the wide, boundless sea, is divine ...

*White Jacket: Or, The World in a Man-of-War*

Chapter XIX (pp. 75, 75)

A.L. Burt Co. New York, New York, USA. 1892

“Ay,” cried Media, “the study of astronomy is wonderfully facilitated by wine. Fill up, old Ptolemy, and tell us should you discover a new planet.

*Mardi* (Volume 2)

Chapter XLVII (p. 194)

Harper & Brothers Publishers. New York, New York, USA. 1849

**Miller, Robert Kalley**

No biographical data available

Anyone listening to the conversation of two astronomers, and hearing them descanting enthusiastically about perigees, apogees, and syzygies, right ascensions and declinations, precession of the equinoxes, and the longitude of the moon’s ascending node; or anyone opening at random the pages of a work on the science, and finding an incomprehensible mass of calculations, formulae extending over twenty lines and using up all the letters of two or three alphabets, and diagrams like nothing in the earth beneath, or in the waters under the earth, and only bearing a very faint resemblance to things in heaven above; anyone, we repeat, on getting such an introduction to the subject, would be very much tempted to think that romance and astronomy were altogether incompatible.

*The Romance of Astronomy* (2nd edition)

The Romance of Astronomy (pp. 1–2)

Macmillan & Company Ltd. London, England. 1873

The science which fathoms the infinite and reckons up the eternal, which pierces the abysses of space, grasps the orb which we see now by the light that left it eighty thousand years ago, measures its distance, and traces its movements – the science which accomplishes such marvels as these, and the history of the great men who achieved these noblest triumphs of human intellect – must surely furnish many themes and contain many episodes of a character as wonderful and as truly romantic as we can find within the airy realms of fiction or of poetry.

*The Romance of Astronomy* (2nd edition)

The Romance of Astronomy (pp. 2–3)

Macmillan & Company Ltd. London, England. 1873

...besides the grandeur of the phenomena of astronomy and the romance which gathers round its history in all ages and casts a brilliant gleam here and there upon its sober annals, there often flashes even across the pages of the driest and most mathematical parts of the subject a glimpse of strange and unexpected interest; and a fact here and a figure there will start the mind in a train of fresh and novel speculation, and set the fancy to luxuriate in new and untrodden realms. Many of these points,



moreover, to which we allude, though very interesting and wonderful in themselves, are yet of comparatively little importance from an astronomical point of view; their interest centres in themselves, and the results to which they lead must be regarded as rather curious than valuable; and hence they are but little to be met with in books, or if touched upon at all, are soon abandoned with the remark that it is time to quit such regions of endless and unavailing speculation.

*The Romance of Astronomy* (2nd edition)

The Romance of Astronomy (p. 3)

Macmillan & Company Ltd. London, England. 1873

### **Mitchel, Ormsby MacKnight** 1805–62

American astronomer

To those who have given but little attention to the science of astronomy, its truths, its predictions, its revelations, are astonishing; and but for their rigorous verification, would be absolutely incredible.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*

Lecture II (p. 41)

Baker & Scribner. New York, New York, USA. 1848

### **Mitchell, Maria** 1818–89

American astronomer and educator

Nothing comes out more clearly in astronomical observation than the immense activity of the universe.

In Eve Merriam

*Growing Up Female in America*

Maria Mitchell (p. 89)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

The astronomy which is not mathematical is what is so ludicrously called “Geography of the Heavens” – is not astronomy at all.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 177)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

But star-gazing is not science. The entrance to astronomy is through mathematics.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (pp. 184–185)

Lee & Shepard. Boston, Massachusetts, USA. 1896

I believe in women even more than I do in astronomy.

In Helen Wright

*Sweeper in the Sky*

Chapter 10 (p. 190)

The Macmillan Company. New York, New York, USA. 1949

### **Morrison, Philip**

American physicist

...for the realm of the stars was slow to change. The sun evolves in billions of years, double stars rotate round each other in many decades, and even famous comets return

only after many years. Astronomy deals still in the eternities, but nowadays it cannot neglect the split-second ...

In John Pottage

*Geometrical Investigations: Illustrating the Art of Discovery in the Mathematical Field* (p. 5)

Addison-Wesley Press. Reading, Massachusetts, USA. 1983

### **Murden, James**

No biographical data available

Astronomy is a science, but it is also an exciting voyage of discovery. The sky is free for all to see, town-dwellers and country-dwellers alike. Everything, from the blinding Sun to the dimmest star, waits to be discovered.

*Astronomy Handbook*

Introduction (p. 8)

Arco Publishing, Inc. New York, New York, USA. 1982

### **Murdin, Paul**

British astronomer

The aims of astronomy are nothing less than to search for the origins of the Universe and of its constituent stars and galaxies.

In Derek McNally

*The Vanishing Universe*

The Aims of Astronomy in Science and the Humanities: Why Astronomy Must Be Protected (p. 16)

Cambridge University Press. Cambridge, England. 1994

### **Neugebauer, Otto** 1899–1990

Austrian-American mathematician and astronomer

I do not hesitate to assert that I consider astronomy as the most important force in the development of science since its origin sometime around 500 B.C....

*The Exact Sciences in Antiquity*

Introduction (p. 2)

Princeton University Press. Princeton, New Jersey, USA. 1952

### **National Research Council (U.S.)**

Astronomy...is sustained by two of the most fundamental traits of human nature: the need to explore and the need to understand.

*Astronomy and Astrophysics for the 1980's* (Volume I)

Chapter I (p. 3)

National Academy Press. Washington, D.C. 1982

### **Newcomb, Simon** 1835–1909

Canadian-born American astronomer

[Astronomy] seems to have the strongest hold on minds which are not intimately acquainted with its work. The view taken by such minds is not distracted by the technical details which trouble the investigator, and its great outlines are seen through an atmosphere of sentiment, which softens out the algebraic formulae with which the astronomer is concerned into those magnificent conceptions of creation which are the delight of all minds, trained or untrained.

*Harper's New Monthly Magazine*, February, 1885

The so-called problems of astronomy are not separate and independent, but are rather the parts of one great problem, that of increasing our knowledge of the universe in its widest extent.

In George Iles

*Little Masterpieces of Science*

Problems of Astronomy (p. 33)

Doubleday, Page & Co. New York, New York, USA. 1902

### Orchard, Thomas Nathaniel

No biographical data available

Astronomy is the oldest and sublimest of the sciences. The dazzling splendor of the great Orb of Day; the subdued radiance of the silvery Moon with her ever-recurring phases; the luster and glow of the swift-speeding planets; the number and brilliancy of the stars all moving in harmonious unison and in orderly array excite in the mind of a contemplative observer, thoughts of the deepest wonder and admiration.

*Milton's Astronomy: The Astronomy of "Paradise Lost"*

Chapter I (p. 2)

Longmans, Green & Co. London, England. 1913

### Pagel, Bernard 1930–

British astronomer

Astronomy is a branch of science that enjoys a universal fascination. One of the reasons why it fascinates people is that the sheer romance of the night sky never palls even for the most hard-bitten observer – at least in the warm and comparatively short nights of the summer. In winter it has to be admitted that observing is not quite so romantic after one has been at it for six hours or more, but there are always enough interesting things in the sky itself to compensate one for the effort.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1963*

The Analysis of Starlight (p. 301)

Government Printing Office. Washington, D.C. 1964

### Penrose, Roger 1931–

English mathematical physicist

Yet nature does not always prefer conventional explanations, least of all in astronomy.

Black Holes

*Scientific American*, Volume 226, Number 5, May, 1972 (p. 46)

### Penzias, Arno 1933–

German-American mathematical physicist

Astronomy leads us to a unique event, a universe which was created out of nothing, one with the very delicate balance needed to provide exactly the conditions required to permit life, and one which has an underlying (one might say “supernatural”) plan.

In Henry Margenau and Roy Abraham Varghese (eds.)

*Cosmos, Bios, Theos*

Chapter 16 (p. 83)

The Open Court Publishing Company. La Salle, Illinois, USA. 1992

### Plato 428 BCE–347 BCE

Greek philosopher

SOC: At the Egyptian city of Naucratis, there was a famous old god, whose name was Theuth...and he was the inventor of many arts such as arithmetic and calculation and geometry and astronomy...

In *Great Books of the Western World* (Volume 7)

*Phaedrus*

Section 274 (p. 138)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

For everyone, as I think, must see that astronomy compels the soul to look upwards and leads us from this world to another.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 529 (p. 395)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...in astronomy, as in geometry, we should employ problems, and let the heavens alone if we would approach the subject in the right way and so make the natural gift of reason to be of any real use.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 530 (p. 396)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But the race of birds was created out of innocent light-minded men, who, although their minds were directed toward heaven, imagined, in their simplicity, that the clearest demonstration of the things above was to be obtained by sight...

In *Great Books of the Western World* (Volume 7)

*Timæus*

Section 91 (p. 476)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...astronomy tell us about the motions of the stars and sun and moon, and their relative swiftness.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 451 (p. 254)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Pliny (C. Plinius Secundus) 23–79

Roman savant and author

Most Men are ignorant of that Secret which, by great Study of the Heavens, Men of deep Learning have found out: namely, that it is the Fires of uppermost Planets, which, falling to the Earth, carry the Name of Lightnings ...

*Pliny's Natural History. In Thirty-seven Books*

Book II, Chapter XX (p. 58)

Printed for the Club by G. Barclay. London, England. 1847–1849

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Governments and parliaments must find that astronomy is one of the sciences which cost most dear: the least

instrument costs hundreds of thousands of dollars, the least observatory costs millions; each eclipse carries with it supplementary appropriations. And all that for stars which are so far away, which are complete strangers to our electoral contests, and in all probability will never take any part in them. It must be that our politicians have retained a remnant of idealism, a vague instinct for what is grand; truly, I think they have been calumniated; they should be encouraged and shown that this instinct does not deceive them, that they are not dupes of that idealism.

*The Foundations of Science*

*The Value of Science*

Part II, Chapter VI (p. 289)

The Science Press. New York, New York, USA. 1921

Astronomy is useful because it raises us above ourselves; it is useful because it is grand; that is what we should say. It shows us how small is man's body, how great his mind, since his intelligence can embrace the whole of this dazzling immensity, where his body is only an obscure point, and enjoy its silent harmony.

*The Foundations of Science*

*The Value of Science*

Part II, Chapter VI (p. 289)

The Science Press. New York, New York, USA. 1921

### **Proctor, Richard Anthony** 1837–88

English astronomer

Astronomy...is of all others the science which seems to present to us the most striking instance of waste...

*Our Place Among the Infinities*

Of Seeming Waste in Nature (p. 40)

Chatto & Windus. London, England. 1879

Among the many striking contrasts between the seeming and the real suggested by the study of astronomy, there is none more startling than the contrast which exists between the apparent repose of the heavens and what is really taking place among the star depths.

*Light Science for Leisure Hours* Second series (3rd edition)

Movements in the Star-depths (p. 30)

Longmans, Green & Co. London, England. 1889

### **Ptolemy** 85–165

Greek astronomer

I know that I am mortal,  
The being of a day; But when the starry portal  
Of heaven my eyes survey:

Earth no more I tread with feet,

'Mid stars a guest I rise,

And in ambrosial banquet

Feast with the deities!

n Richard Swainson Fisher

*Select Translations from the Greek Minor Poets*

An Epigram (p. 299)

Simpkin, Marsahl & Co. London, England. 1838

### **Raymo, Chet** 1936–

American physicist and science writer

Astronomy is a science of faint lights. The excitement of astronomy lies in the way grand knowledge is distilled from barely luminous blurs in the night sky.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 3 (p. 28)

The Viking Press. New York, New York, USA. 1991

It is easy to be overawed by the visions of the new astronomy. Many among us would prefer to retreat into a comfortable cloud of unknowing. But if we are truly interested in knowing who we are, then we must be brave enough to accept what our senses and our reason tell us. We must enter into the universe of the galaxies and the light-years, even at the risk of spiritual vertigo, and know what after all must be known.

*The Soul of the Night*

Preface (p. ix)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1985

## **Rectangle**

To fanciful minds and theoretical speculators, the so-called "science" of modern astronomy furnishes a field, unsurpassed in any science for the unrestrained license of the imagination, and the building up of a complicated conjunction of absurdities such as to overawe the simpleton and make him gape with wonder; to deceive even those who truly believe their assumptions to be facts, and to "make men doubt Divine Revelation with as little discrimination as they were formerly called upon to believe.

*Zetetic Cosmogony*

Introduction (p. iii)

T.L. Cullingworth. Durban, South Africa. 1899

Talk about ridicule, the whole of modern astronomy is like a farcical comedy – full of surprises. One never knows what monstrous or ludicrous absurdity may come forth next.

*Zetetic Cosmogony*

Sun's Distance (p. 115)

T.L. Cullingworth. Durban, South Africa. 1899

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In astronomy, the law of gravitation is plainly better worth knowing than the position of a particular planet on a particular night, or even on every night throughout a year. There are in the law a splendor and simplicity and sense of mastery which illuminate a mass of otherwise uninteresting details....

*Basic Writings of Bertrand Russell*

On History

Simon & Schuster. New York, New York, USA. 1961

### **Russell, Henry Norris** 1877–1957

American astronomer

The main object of astronomy, as of all science, is not the collection of facts, but the development, on the basis

of collected facts, of satisfactory theories regarding the nature, mutual relations, and probable history and evolution of the objects of study.

Some Problems of Sidereal Astronomy  
*Proceedings of the National Academy of Sciences*, Volume 5, Number 10, October 15, 1919 (p. 391)

**Ryle, Martin** 1918–84  
English radio astronomer

Astronomy differs from most sciences in that we cannot do experiments; the astronomer must build up from his existing observations a picture or “model” of the Universe, and then look for further effects which should be observable if his model is correct.

Radio Astronomy and Cosmology  
*Proceedings of the Royal Institution*, Volume 38, Number 173, 1961 (p. 439)

**Sagan, Carl** 1934–96  
American astronomer and author

It has been said that astronomy is a humbling and character building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we’ve ever known.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 1 (p. 9)  
Random House, Inc. New York, New York, USA. 1994

**Serviss, Garrett Putnam** 1851–1921  
American science fiction writer

What Froude says of history is true also of astronomy: it is the most impressive where it transcends explanation.

*Curiosities of the Sky*  
Preface (p. xv)  
Harper & Brothers Publishers. New York, New York, USA. 1909

**Seung, T. K.** 1930–  
Korean philosopher

The distinction between pure and empirical astronomy is like the distinction between pure and empirical geometry. Pure geometry is a priori; it is independent of empirical data. Empirical Geometry is a posteriori; it is based on empirical data.

*Plato Rediscovered: Human Value and Social Order*  
Chapter 4 (p. 118)  
Rowman & Littlefield Publishers  
Lanham, Maryland, USA. 1996

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

There’s some ill planet reigns.  
I must be patient till the heavens look  
With an aspect more favorable.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)

*The Winter’s Tale*  
Act II, Scene i, l. 105–107  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Not from the stars do I my judgment pluck,  
And yet methinks I have astronomy...  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Sonnets*  
XIV  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Doubt thou the stars are fire;  
Doubt that the sun doth move...  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Hamlet, Prince of Denmark*  
Act II, Scene ii, l. 116–117  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shapley, Harlow** 1885–1972  
American astronomer

...the most interesting feature of this science astronomy (and of all science) is our eager ignorance.

Astronomy  
*Scientific American*, Volume 183, Number 3, September, 1950 (pp. 25–26)

**Sherrod, P. Clay**  
American astronomer and educator

Astronomy is a unique science in that as we learn more and more, the universe becomes even less known and more mysterious. In the theoretical end of things, astronomy allows the average person to think as far away as the mind will allow.

*A Complete Manual of Amateur Astronomy*  
Preface (p. xii)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1981

Above us, the sparkling stars of the night skies stretch out like thousands of diamonds suspended on the curtain of space. Unfolding through the beauty and the mysteries of this seemingly endless expanse are patterns and answers familiar to those willing to study them...There is an affinity for the eternity of space experienced by all mankind, a kind of motherhood in the stars to those who study space.

*A Complete Manual of Amateur Astronomy*  
Introduction (p. 1)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1981

**Sillman, Benjamin** 1779–1864  
American chemist and geologist

Astronomy is, not without reason, regarded, by mankind, as the sublimest of the natural sciences. Its objects, so frequently visible, and therefore familiar, being always remote and inaccessible, do not lose their dignity.

*Elements of Chemistry* (Volume 1)  
Introduction (p. 11)  
Hezekiah Howe. New Haven, Connecticut, USA. 1830

**Smith, Goldwin** 1823–1910  
British-Canadian historian and journalist

Astronomy has its practical uses, without which man's intellect would scarcely rouse itself to those speculations; but its greatest result is a revelation of immensity pervaded by one informing mind; and this revelation is made by astronomy only in the same sense in which the telescope reveals the stars to the eye of the astronomer.

*The World's Best Orations: From the Earliest Period to the Present Time* (Volume 9)

The Secret Beyond Science (p. 3476)

Ferd. P. Keiser. St. Louis, Missouri, USA. 1899

**Somerville, Mary** 1780–1872  
English mathematician

Physical astronomy is the science which compares and identifies the laws of motion observed on earth with the motions that take place in the heavens; and which traces, by an uninterrupted chain of deduction from the great principle that governs the universe, the revolutions and rotations of the planets, and the oscillations of the fluids at their surfaces; and which estimates the changes the system has hitherto undergone, or may hereafter experience – changes which require millions of years for their accomplishment.

*The Connection of the Physical Sciences* (9th edition)

Introduction (p. 3)

John Murray. London, England. 1858

A complete acquaintance with Physical Astronomy can only be attained by those who are well versed in the higher branches of mathematical and mechanical science: such alone can appreciate the extreme beauty of the results, and of the means by which these results are obtained.

*Mechanism of the Heavens*

Preliminary Dissertation (p. vii)

John Murray. London, England. 1831

A complete acquaintance with Physical Astronomy can only be attained by those who are well versed in the higher branches of mathematical and mechanical science: such alone can appreciate the extreme beauty of the results, and of the means by which these results are obtained.

*Mechanism of the Heavens*

Preliminary Dissertation (p. 2)

John Murray. London, England. 1831

**Steele, Joel Dorman** 1836–86  
American educator

It [astronomy] is, above all others, a science that cultivates the imagination. Yet its theories and distances are based upon rigorous mathematical demonstrations. Thus the study has at once the beauty of poetry and the exactness of Geometry.

*The Story of the Stars: New Descriptive Astronomy*

Introductory Remarks (p. 1)

American Book Co. Chicago, Illinois, USA. 1884

**Struve, Otto** 1897–1963  
Russian-born American chemist and geologist

Astronomy has had three great revolutions in the past four hundred years: The first was the Copernican revolution that removed the earth from the center of the solar system and placed it 150 million kilometers away from it; the second occurred between 1920 and 1930 when, as a result of the work of H. Shapley and R. J. Trumpler, we realized that the solar system is not at the center of the Milky Way but about 30,000 light years away from it, in a relatively dim spiral arm; the third is occurring now, and, whether we want it or not, we must take part in it. This is the revolution embodied in the question: Are we alone in the universe?

*The Universe*

Chapter VI (p. 157)

The MIT Press. Cambridge, Massachusetts, USA. 1962

**Tennyson, Alfred (Lord)** 1809–92  
English poet

These are Astronomy and Geology, terrible Muses!

*Alfred Tennyson's Poetical Works*

Parnassus, Part II, l. 15

Oxford University Press, Inc. London, England. 1953

We fronted there the learning of all Spain,  
All their cosmogonies, their astronomies...

*Alfred Tennyson's Poetical Works*

Columbus, l. 41–42

Oxford University Press, Inc. London, England. 1953

**Thatcher, Oliver Joseph**  
Writer

Astronomy is the soul of geography and hydrography, for the various appearances of the sky in various districts and regions of the earth and sea are known only by astronomy.

*The Library of Original Sources*

On the Principles of Astronomy (p. 311)

University Research Extension Co. Milwaukee, Wisconsin, USA. 1915

It [astronomy] is the science of treating of the causes of those celestial appearances which we who live on the earth observe and which mark the changes of times and seasons; by the studying of which we are able to predict for the future the face of the heavens, that is, the stellar phenomena, and to assign fixed dates for those which have occurred in the past.

*The Library of Original Sources* (Volume 5)

On the Principles of Astronomy (p. 311)

University Research Extension Co. Milwaukee, Wisconsin, USA. 1915

It [astronomy] is...subordinate to the general subject of mathematics and uses arithmetic and geometry as its two wings, studying the extent and form of the bodies and motions of the universe and computing the periods, by



these means expediting its demonstrations and reducing them to use and practical value.

*The Library of Original Sources* (Volume 5)

On the Principles of Astronomy (p. 311)

University Research Extension Co. Milwaukee, Wisconsin, USA. 1915

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Astronomy is a fashionable study, patronized by princes, but not fungi.

*The Journal of Henry D. Thoreau* (Volume 12)

October 15, 1859 (p. 391)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1949

**Todd, David Peck**

No biographical data available

**Lynn, William Thynne**

No biographical data available

Astronomy may be styled a very aristocrat among the sciences; but, while its cosmic conceptions never fail to arouse the broadest general interest, it is an interest that has by no means led to a knowledge of this engrossing science proportionately widespread.

*Stars and Telescopes: A Hand-book of Popular Astronomy*

Introduction (p. 1)

Little, Brown & Co. Boston, Massachusetts, USA. 1899

**Treeby, S.**

No biographical data available

Of all the subjects that engage the lucubrations of the sage, the speculations of the philosopher, or which, enrich the understandings of mankind, Astronomy is, without competition, the most sublime. It is nothing less than the contemplation of the operations of omnipotent power, directed by infinite wisdom, which are circulated through boundless space, for the happiness of an incalculable number of created beings, whether they lire with us upon the earth, are inhabitants of our satellite the Moon, or residents of the purer regions of Mercury, or the denser climates of Saturn; all are the offspring of one benign parent, and partake alike of his fatherly munificence.

*The Elements of Astronomy* (2nd edition)

Preface (p. 7)

Samuel Wood & Son. New York, New York, USA. 1826

**Todhunter, Isaac** 1820–84

English mathematician

Admission to its [astronomy] sanctuary, and to the privileges and feelings of a votary, it is only to be gained by one means, – sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.

*The Conflict of Studies and Other Essays on Subjects Connected with Education*

Private Study of Mathematics (p. 66)

Macmillan & Company Ltd. London, England. 1873

**Trumbull, John** 1756–1843

American painter

Though in astronomy survey'd,

His constant course was retrograde;

O'er Newton's system though he sleeps,

And finds his wits in dark eclipse!

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter II (p. 62)

Government Printing Office. Washington, D.C. 1890

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

I love to revel in philosophical matters – especially astronomy. I study astronomy more than any other foolishness there is. I am a perfect slave to it. I am at it all the time. I have got more smoked glass than clothes. I am as familiar with the stars as the comets are. I know all the facts and figures and I have all the knowledge there is concerning them. I yelp astronomy like a sun-dog, and paw the constellations like Ursa Major.

Letter from Mark Twain, San Francisco, Alta California, August 1, 1869

**van Vleck, Edward B.** 1863–1943

American mathematician

Astronomy is the foe of small thought.

Address at the Dedication of the van Vleck Observatory

*Popular Astronomy*, Volume XXIV, Number 7, August-September, 1916 (p. 418)

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

...may the Muses sweet,

Whose rites I hear with mighty passion pierced,

Receive, and show the paths and stars of heaven,

The sun's eclipses and the labouring moons...

In *Great Books of the Western World* (Volume 13)

*The Georgics*

Book II, l. 475–478

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

Superstition is to religion what astrology is to astronomy!

a very stupid daughter of a very wise mother.

In J. de Finad

*A Thousand Flashes of French Wit, Wisdom, and Wickedness*

D. Appleton & Company. New York, New York, USA. 1890

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

While the illusion of the senses would make the stars stationary in the vault of heaven, Astronomy, by her



aspiring labors, has assigned indefinite bounds to space; and if she have set limits to the great nebula to which our solar system belongs, it has only been to show us in those remote regions of space, which appear to expand in proportion to the increase of our optic powers, islet on islet of scattered nebulae.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 40)

Harper & Brothers Publishers. New York, New York, USA. 1858

### **Warren, Henry White** 1831–1912

American teacher, lecturer, and writer

The greatest triumphs of men's minds have been in astronomy – and ever must be. We have not learned its alphabet yet. We read only easy lessons, with as many mistakes as happy guesses. But in time we shall know all the letters, become familiar with the combinations, be apt at their interpretation, and will read with facility the lessons of wisdom and power that are written on the earth, blazoned in the skies, and pictured by the flowers below and the rainbows above.

*Recreations in Astronomy*

Chapter I (p. 5)

Chautauqua Press. New York, New York, USA. 1886

### **White, William Hale (Mark Rutherford)** 1831–1913

English novelist

The great beauty of astronomy is not what is incomprehensible in it, but its comprehensibility – its geometrical exactitude.

*Miriam's Schooling and Other Papers*

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1890

### **Whitehead, Hal** 1952–

Canadian/British biologist

Studying the behavior of large whales has been likened to astronomy. The observer glimpses his subjects, often at long range; he cannot do experiments, and he must continually try to infer from data that are usually inadequate.

Why Whales Leap

*Scientific American*, Volume 252, Number 3, March, 1985 (p. 86)

### **Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

Physics can teach us only what the laws of nature are today. It is only Astronomy that can teach us what the initial conditions for these laws are.

The Case for Astronomy

*Proceedings of the American Philosophical Society*, Volume 8, Number 1, February, 1964 (p. 6)

### **Wilson, Lee Anne**

No biographical data available

### **Stalio, Roberto**

No biographical data available

Astronomy is like a tree; observations are the leaves, converting photons to fuel; interpretation the trunk, connecting theory and observation; and theory is the roots, connecting astronomy to the rest of science and drawing nourishment from the contact.

*Angular Momentum and Mass Loss for Hot Stars*

Why a Meeting on Angular Momentum and Mass Loss for Stars? (p. 2)

Kluwer Academic Publishers. Dordrecht, Germany. 1990

## ASTROPHYSICIST

### **de Grasse Tyson, Neil** 1958–

American astrophysicist and writer

Whenever cartoonists draw biologists, chemists, or engineers, the characters typically wear protective white lab coats that have assorted pens and pencils poking out of the breast pocket. Astrophysicists use plenty of pens and pencils, but we never wear lab coats unless we are building something to launch into space. Our primary laboratory is the cosmos, and unless you have bad luck and get hit by a meteorite, you are not at risk of getting your clothes singed or otherwise sullied by caustic liquids spilling from the sky.

Over the Rainbow

*Natural History*, Volume 110, Number 7, September, 2001 (p. 30)

### **Zoe (Fictional character)**

I'm an astrophysicist. Pure-mathematics major.

*Dr. Who*

The Wheel in Space: Episode 3, 1963

## ASTROPHYSICS

### **Campbell, William Wallace** 1862–1938

American astronomer

It is not possible to separate entirely the child Astrophysics from the parent Astronomy. The two are mutually dependent in much of their instrumental equipment and in many of their methods, and their results are often intimately related.

Reviews (problems in Astrophysics)

*The Astrophysical Journal*, Volume 18, Number 2, September, 1903 (p. 156)

### **Douglas, A. Vibert** 1894–1988

Canadian astronomer

On the uplifting wings of imagination the astrophysicist roams the universe from atom to atom, from star to star, from star to atom, from atom to star.

From Atoms to Stars

*Atlantic Monthly*, Volume 144, Number 2, August, 1929 (p. 165)

**Greenstein, Jesse L.** 1909–2002  
American astronomer

Theory may often delay understanding of new phenomena observed with new technology unless theorists are quite open-minded as to what types of physical laws may need to be applied: conservatism is unsafe.... In astrophysics, historically, theories have only seldom had predictive usefulness as guides to experimenters.

In W.T. Sullivan III

*The Early Years of Radio Astronomy*

Optical and Radio Astronomers in the Early Years (p. 77)  
Cambridge University Press, Cambridge, England. 1982

**Keeler, James E.** 1847–1900  
American astrophysicist

The degree of importance which we attach to a newly discovered fact or principle is influenced by many circumstances, among which we cannot fail to recognize some of the failings of human nature. When progress is rapid, individual achievements lose their prominence, like mountain peaks rising from a high plateau. The discovery of an asteroid was once a notable event. Now it attracts little attention, outside of a small circle of observers, and it is probable that few of us could say just how many of these little bodies have been brought to light during the past year. In astrophysics discoveries of the highest significance have succeeded one another so rapidly that they are now taken as a matter of course.

The Importance of Astrophysical Research and Their Relation of Astrophysics to Other Physical Sciences

*The Astrophysical Journal*, Volume 6, Number 4, November, 1897 (p. 274)

A feature of astrophysical research which I do not wish to leave unmentioned is the interest which is felt in it by the public. Those who are interested in the results of science, but who care little for methods, and know nothing of elegant forms of analysis, are naturally more attracted by the view of the heavenly bodies which astrophysics presents, than by the view which is obtained from the standpoint of the older astronomy. Astrophysics paints its picture in the brighter colors.

The Importance of Astrophysical Research and Their Relation of Astrophysics to Other Physical Sciences

*The Astrophysical Journal*, Volume 6, Number 4, November, 1897 (p. 275)

What an effort to grasp something tangible we observe in the earlier writing on Fermat's principle! What a groping in the dark after a principle felt rather than seen! And how obvious the same principle is from the standpoint of the wave theory! In a field so wide and so little explored as astrophysics, there must be novelties which can be gathered with comparatively little effort, and which may nevertheless be of no small importance. But there are also problems whose solution calls for the exercise of the highest intellectual faculties, and for the most strenuous exertion.

The Importance of Astrophysical Research and Their Relation of Astrophysics to Other Physical Sciences

*The Astrophysical Journal*, Volume 6, Number 4, November, 1897 (pp. 276–277)

The discovery of unknown laws and principles, as well as the explanation of phenomena by laws already known, is one of its [astrophysics] most important objects.

The Importance of Astrophysical Research and the Relation of Astrophysics to Other Physical Sciences

*The Astrophysical Journal*, Volume 6, Number 4, November, 1897 (p. 277)

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

Astrophysics is a science which should be pursued in the following manner. Drink some vodka on a clear, cold night, wrap your feet in a warm blanket, sit down on your balcony and stare into the sky.... If this prescription is not followed, the science in question will appear as a petrified forest of numbers and equations; but he who observes the prescription will experience a curious state of trance. The algebraic signs will change into violin clefs and out of the bizarre equations will emerge the symphony of the rise and decline of the universe ...

*Arrow in the Blue*

Chapter XXXI (p. 341)

The Macmillan Co. London, England. 1970

**Luminet, Jean-Pierre** 1951–  
French astrophysicist

Astrophysicists have the formidable privilege of having the largest view of the Universe; particle detectors and large telescopes are today used to study distant stars, and throughout space and time, from the infinitely large to the infinitely small, the Universe never ceases to surprise us by revealing its structures little by little.

In Jean-Pierre Luminet

*Black Holes*

Forward to the French Edition (p. xv)

University Press, Cambridge, England. 1991

**Spenser, Edmund** 1552–99  
English poet

For who so list into the heavens looke,  
And search the courses of the rowling spheares,  
Shall find that from the point, where first they tooke  
Their setting forth, in these few thousand years  
They all are wandred much; that plaine appears.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

The Fifth Book, Introduction

Houghton Mifflin Company, Boston, Massachusetts, USA. 1908

## ASYMMETRY

**Weyl, Hermann** 1885–1955  
German mathematician

...seldom is asymmetry merely the absence of symmetry...

*Symmetry*

Bilateral Symmetry (p. 13)

Princeton University Press, Princeton, New Jersey, USA. 1960

## ASYMPTOTE

**Frere, John Hookam** 1769–1846  
British diplomat and man of letters

**Canning, George** 1770–1827  
British statesman and prime minister

Where light Asymptotes o'er her bosom play,  
Nor touch her glowing skin, nor intercept the day.

In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 122–23

Printed for J. Wright, by W. Bulmer & Company. London, England. 1801

## ATHEIST

**Young, Edward** 1683–1765  
English poet

By night an atheist half-believes a God.

*The Poetical Works of Edward Young* (Volume 1)

Night V (p. 83)

William Pickering. London, England. 1844

## ATMOSPHERE

**Baden-Powell, Robert Stephenson**

**Smyth** 1857–1941  
British army lieutenant-general

The atmosphere forms a vast ocean above us, an ocean but little explored. We crawl about the ground like crabs on the bottom of the sea. We make our meteorological observations down on the ground, ignorant of all that is going on in the midst of that great expanse of air above our heads, where the clouds hang about, where the rain and the hail are formed, where the lightning-flashes have their origin.

*Quarterly Journal of the Royal Meteorological Society*, 1907 (p. 193)

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

I say that the blueness we see in the atmosphere is not intrinsic colour, but is caused by warm vapour evaporated in minute and insensible atoms on which the solar rays fall, rendering them luminous against the infinite darkness of the fiery sphere which lies beyond and includes it.

*The Notebooks of Leonardo da Vinci – Complete*

On the Color of the Atmosphere (p. 300)

Publisher undetermined

**Fourcroy, Antoine-François** 1755–1809  
French chemist

The atmosphere is a vast laboratory, in which nature operates immense analyses, solutions, precipitins, and combinations: it is a grand receiver, in which all the attenuated and volatilized productions of terrestrial bodies are received, mingled, agitated, combined, and separated.

*The Philosophy of Chemistry*

Chapter III (p. 15)

Printed for J. Johnson. London, England. 1795

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

We inhabitants of the earth enjoy a piece of good fortune to which we give very little thought, which, indeed, we take almost as much for granted as the air we breathe – I mean the fact that we have a transparent atmosphere. Some of the other planets, for instance Venus and Jupiter, have atmospheres which are so thick with clouds as to be totally opaque. If we had been born on Venus or Jupiter, we should have lived our lives without ever seeing through the clouds, and so should have known nothing of the beauty and poetry of the night sky, and nothing of the intellectual excitement and joy of trying to decipher the meaning of the vast panorama of lights which are scattered round us in all directions in space.

*The Stars in Their Courses*

Chapter 1 (p. 1)

The Macmillan Co. New York, New York, USA. 1931

**Joule, James Prescott** 1818–89  
English physicist

I cannot but be filled with admiration and gratitude for the wonderful provision thus made by the Author of nature for the protection of his creatures. Were it not for the atmosphere which covers us with a shield, impenetrable in proportion to the violence which it is called upon to resist, we should be continually exposed to a bombardment of the most fatal and irresistible character. To say nothing of the larger stones, no ordinary buildings could afford shelter from very small particles striking at the velocity of eighteen miles per second. Even dust flying at such a velocity would kill any animal exposed to it.

*The Scientific Papers of James Prescott Joule*

On Shooting Stars (p. 288)

Taylor & Francis. London, England. 1884

**van Dyke, John Charles** 1856–32  
American art critic

Even the clearest atmosphere has some coloring about it. Usually it is an indefinable blue. Air-blue means the most delicate of all colors – something not of surface depth but of transparency, builded up by superimposed strata of air many miles perhaps in thickness.

*The Desert: Further Stories in Natural Appearance*

Chapter V (p. 82)

Charles Scribner's Sons. New York, New York, USA. 1902

**ATOM****Atkins, Peter William** 1940–

English physical chemist and writer

...one or two atoms can convert a fuel to a poison, change a color, render an inedible substance edible, or replace a pungent odor with a fragrant one. That changing a single atom can have such consequences is the wonder of the chemical world.

*Molecules* (p. 2)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

One of the wonders of this world is that objects so small can have such consequences: any visible lump of matter – even the merest speck – contains more atoms than there are stars in our galaxy.

*Molecules* (p. 4)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

Each new atom brings something of the personality of its element to the molecule, and this conspiracy of atoms results in a molecule with properties that are richer than those of each atom alone.

*Molecules* (p. 13)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

**SCIENCE'S GREATEST DISCOVERY****THE ATOM SPLIT AT 100,000 VOLTS**

Secret of Cambridge Laboratory

**MAKING A NEW WORLD**

A dream of scientists has been realised. The atom has been split, and the limitless energy thus released may transform civilisation. On the authority of Lord Rutherford, the world-famous scientist, Reynold's is able to announce exclusively that yeas of patient experiment at the Cavendish Laboratory at Cambridge have at last been successful. The effect of splitting the atom is that the electrical power now available to mankind may be multiplied 160 times. This is the greatest scientific discovery of the age.

*Reynold's Illustrated News* (London edition) Sunday, May 1, 1932

Nascent atoms are equipped with arms, with which they can combine with other atoms.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

I remember, I remember,  
When an atom was so small  
It really hardly paid you  
To think of one at all.

It was so small that anywhere  
An atom safe could be  
And pass his time in molecules  
In elemental glee.

Past and Present

*Industrial and Engineering Chemistry: News Edition*, Volume 12, Number 3, April 20, 1934 (p. 161)

10 October 1929

Rostow na Donu

USSR

Dear Professor Rutherford,

We students of our university physics club elect you our honorary president because you proved that atoms have balls.

In George Gamow

*My World Line: An Informal Autobiography*

Chapter 3 (p. 76)

The Viking Press. New York, New York, USA. 1979

**Author undetermined**

Old Time is a-flying; the atoms are dying;

Come, list to their parting oration: –

We'll soon disappear to a heavenly sphere

On account of their disintegration.

Our action's spontaneous in atoms uranious

Or radious, actinious or thorious:

But for others, the gleam of a heaven-sent beam

Must encourage their efforts laborious.

'For many a day we've been slipping away

While the savants still dozed in their slumbers;

Till at last came a man with gold-leaf and tin can

And detected our infinite numbers.'

Thus the atoms in turn, we now clearly discern,

Fly to bits with the utmost facility;

They wend on their way, and in splitting, display

An absolute lack of stability.

'Tis clear they should halt on the grave of old Dalton

On their path to celestial spheres;

And a few thousand million – let's say a quadrillion –

Should bedew it with reverent tears.

There's nothing facetious in the way that Lucretius

Imagined the Chaos to quiver;

And electrons to blunder, together, asunder,

In building up atoms forever!

Sung at the Chemical Laboratory dinner, University College, November 17, 1905

*The Death-Knell of the Atom***Baruch, Bernard M.** 1870–1965

American presidential advisor

Science has taught us how to put the atom to work. But to make it work for good instead of evil lies in the domain dealing with the principles of human duty. We are now facing a problem more of ethics than physics.

The Baruch Plan for Banning the Atom Bomb

*Life Magazine*, 24 June, 1946 (p. 35)**Bednyi, Demian** 1883–1945

Soviet Russian poet

The USSR has been labeled the land of the yokel and Khamov.

Quite right! And we have an example in this Soviet fellow named Gamow.

Why, this working-class bumpkin, this dimwit, this Gyorgy Anton'ich called Geo.,  
He went and caught up with the atom and kicked it about like a pro.

In George Gamow

*My World Line: An Informal Autobiography*

Chapter 3 (p. 74)

The Viking Press. New York, New York, USA. 1979

**Benchley, Robert** 1889–1945

American humorist and critic

...the atom is composed of little pieces of old pocket lint.

*Benchley Lost and Found*

Atom Boy (p. 80)

Dover Publications, Inc. New York, New York, USA. 1970

**Bentley, Richard** 1662–1742

English critic and philologist

...the fortuitous or casual concourse of atoms...

*The Works of Richard Bentley* (Volume 3)

Sermon vii (p. 147)

F. Macpherson. London, England. 1836–38

**Berthelot, Marcellin (or Marcelin) Pierre**

**Eugène** 1827–1907

French chemist and politician

I do not want chemistry to degenerate into a religion; I do not want the chemist to believe in the existence of atoms as the Christian believes in the existence of Christ in the communion wafer.

In C. Graebe

Marcellin Berthelot

*Berichte der Deutschen Chemischen Gesellschaft*, Volume 41, 1908 (p. 485)

**Blake, William** 1757–1827

English poet, painter, and engraver

The atoms of Democritus,  
And Newton's particles of light...

*The Complete Poetry and Prose of William Blake*

Mock on Voltaire, Rousseau, I. 9–10

University of California Press. Berkeley, California, USA. 1982

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

When it comes to atoms, language can be used only as in poetry.

In K.C. Cole

On Imagining the Unseeable

*Discovery*, Volume 3, Number 12, December, 1982 (p. 70)

The study of atoms...not only has deepened our insight into a new domain of experience, but has thrown new light on general problems of knowledge.

In Robert K. Adair

*The Great Design* (p. 194)

Oxford University Press, Inc. New York, New York, USA. 1987

...the fuzzy and nebulous world of the atom only sharpens into concrete reality when an observation is made. In the absence of an observation the atom is a ghost. It only materializes when you look for it. Look for its location and you will get an atom at a place. Look for its motion and you get an atom with a speed. But you can't have both. The reality that the observation sharpens into focus cannot be separated from the observer and his choice of measurement strategy.

In P.C.W. Davies

*God and the New Physics*

Chapter 8 (p. 103)

Simon & Schuster. New York, New York, USA. 1983

**Born, Max** 1882–1970

German-born English physicist

The dance of atoms, electrons, and nuclei, which in all its fury is subject to God's eternal laws, has been entangled with another restless universe which may well be the Devil's: the human struggle for power and domination, which eventually becomes history.

*The Restless Universe*

Postscript (p. 279)

Dover Publications, Inc. New York, New York, USA. 1951

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

For beside that which happens in the generation, corruption, nutrition, and wasting of bodies, that which we discover partly by our microscopes of the extreme littleness of even the scarce sensible parts of concretes; and partly by the Chymical resolution of mixt bodies, and by the divers other operations of spagyric alchemical fires upon them, seems sufficiently to manifest their consisting of parts very minute and of differing figures. And that there does also intervene a various local motion of such small bodies, will scarce be denied.

*The Sceptical Chymist*

**Bradley, Omar** 1893–1981

American Army officer

We have grasped the mystery of the atom and rejected the Sermon on the Mount.

*The Collected Writings of General Omar N. Bradley*

Speeches, 1945–1949, (Volume 1) (p. 588)

Publisher undetermined

**Bryson, Bill** 1951–

American author

...atoms are fickle and their time of devotion is fleeting – fleeting indeed. Even a long human life adds up to only about 650,000 hours. And when that modest milestone flashes past, or at some other point thereabouts, for reasons unknown your atoms will shut you down, silently disassemble, and go off to be other things.

*A Short History of Nearly Everything*

Introduction (p. 2)

Broadway Books. New York, New York, USA. 2003



**Burton, Sir Richard Francis** 1821–90

English explorer

Life, atom of that Infinite Space that stretcheth, 'twixt the Here and There.

*The Kasidah of Haji Abdu El-Yezidi*

Chapter III

Haldeman-Julius Company. Girard, Kansas, USA. 1924

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

When people talk of atoms obeying fixed laws, they are either ascribing some kind of intelligence and free will to atoms or they are talking nonsense.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks* (p. 72)

Jonathan Cape. London, England. 1951

Atoms have a mind as much smaller and less complex than ours as their bodies are smaller and less complex.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks* (p. 73)

Jonathan Cape. London, England. 1951

The idea of an indivisible atom is inconceivable by the lay mind. If we can conceive an idea of the atom at all, we can conceive it as capable of being cut in half...

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks* (p. 84)

Jonathan Cape. London, England. 1951

Some things can teach much to some things and little to others; some can be taught much by some things and little by others; some can neither be taught much nor teach much. All depends upon the kind of company into which an atom has got. If it has got into bad hands it will have to part with them before it can get into better. But all atoms being immortal go on learning and unlearning, combining and separating, appointing, disappointing, and being disappointed forever and ever.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Immortality of Atoms and Teaching (p. 126)

Jonathan Cape. London, England. 1951

We shall never get people whose time is money to take much interest in atoms.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Atoms (p. 133)

Jonathan Cape. London, England. 1951

The puzzle which puzzles every atom is the same which puzzles ourselves – a conflict of duties – our duty towards ourselves, and our duty as members of a body of politic. It is swayed by its sense of being a separate thing – of having a life to itself which nothing can share; it is also swayed by the feeling that in spite of this it is only part of an individuality which is greater than itself and which absorbs it.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Unity and Separateness (p. 143)

Jonathan Cape. London, England. 1951

**Čapek, Milič** 1909–97

Czechoslovakian philosopher and physicist

There can hardly be a sharper contrast than that between the everlasting atoms of classical physics and the vanishing "particles" of modern physics.

In Richard F. Kitchener (ed.)

*The World View of Contemporary Physics: Does It Need a New Metaphysics?*

Chapter 6 (p. 99)

State University of New York Press. Albany, New York, USA. 1988

**Cavendish, Margaret, Duchess of Newcastle** 1623–73

English poet, playwright, and biographer

Small Atomes of themselves a World may make,  
As being subtle, and of every shape:  
And as they dance about, fit places finde,  
Such Formes as best agree, make every kinde.

*Poems and Fancies*

A World made by Atomes (p. 5)

Printed by William Wilson. London, England. 1664

...nothing can be less than atoms.

*Poems and Fancies*

The Bell in St Paul's Churchyard

Printed by William Wilson. London, England. 1664

**Chown, Marcus**

English writer

Every breath you take contains atoms forged in the blistering furnaces deep inside stars. Every flower you pick contains atoms blasted into space by stellar explosions that blazed brighter than a billion suns. Every book you read contains atoms blown across unimaginable gulfs of space and time by the wind between the stars.

*The Magic Furnace: The Search For The Origin Of Atoms*

Prologue (p. 1)

Oxford University Press. New York, New York, USA. 2001

...why should the universe be constructed in such a way that atoms acquire the ability to be curious about themselves.

*The Magic Furnace: The Search For The Origin Of Atoms*

Epilogue (p. 218)

Oxford University Press. New York, New York, USA. 2001

**Chu, Steven** 1948–

American physicist

The atoms become like a moth, seeking out the region of higher laser intensity.

In James Gleick

*Lasers Slow Atom for Scrutiny*

*New York Times*, Section 1, 13 July 1986 (p. 1)



**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

The beginnings of all things are small.

In L.I. Ponomarev

*The Quantum Dice* (p. 23)

Institute of Physics Publishing, Bristol, England, 1993

...there are certain minute particles, some smooth, others rough, some round, some angular, some curved or hook-shaped, and others that heaven and earth were created from these, not by compulsion of any natural law but by a sort of accidental colliding...

Translated by H. Rackham

*Cicero in Twenty Eight Volumes (XIX)*

*De Natura Deorum*

I, XXIV, 66 (p. 65)

Harvard University Press, Cambridge, Massachusetts, USA, 1939

### Close, Frank

English writer and physicist

### Martin, M.

No biographical data available

Take a deep breath! You have just inhaled oxygen atoms that have already been breathed by every person who ever lived. At some time or other your body has contained atoms that were once part of Moses or Isaac Newton. The oxygen mixes with carbon atoms in your lungs and you exhale carbon dioxide molecules. Chemistry is at work. Plants will rearrange these atoms, converting carbon dioxide back to oxygen, and at some future date our descendants will breathe some in.... If atoms could speak, what a tale they would tell.

*The Particle Explosion*

Chapter 1 (p. 7)

Oxford University Press, Inc. Oxford, England, 1987

Atoms are the complex end-products of creation. Their best constituents were created within the first seconds of the Big Bang. Several thousand years elapsed before these particles combined to make atoms. The cold conditions where atoms exist today are far removed from the intense heat of the Big Bang. So to learn about our origins we have to see within the atoms, and study the seeds of matter.

*The Particle Explosion*

Chapter 1 (p. 7)

Oxford University Press, Inc. Oxford, England, 1987

### Cole, A. D.

American physicist

...an atom is a world in itself.... How has the indivisible unit evolved into the complex microcosm we now imagine?

Recent Evidence for the Existence of the Nucleus Atom

*Science*, New Series, Volume 41, Number 1046, January 15, 1915

(p. 73)

**Colebrooke, Henry Thomas** 1765–1837  
English orientalist

The mote, which is seen in a sunbeam, is the smallest perceptible quantity. Being a substance and an effect, it must be composed of what is less than itself: and this likewise is a substance and an effect; for the component part of a substance that has magnitude must be an effect. This again must be composed of what is smaller, and that smaller thing is an atom. It is simple and uncomposed: else the series would be endless: and, were it pursued indefinitely, there would be no difference of magnitude between a mustard-seed and a mountain, a gnat and an elephant, each alike containing an infinity of particles. The ultimate atom then is simple.

*Essays on the Religion and Philosophy of the Hindus*

Chapter VII (p. 176)

Williams & Norgate, London, England, 1858

### Cudmore, Lorraine Lee

American cell biologist

Have care of your atoms, for such is the stuff that dreams are made of – the yearning dreams of our immortality.

*The Center of Life: A Natural History of the Cell*

Death (p. 176)

New York Times Book Company, New York, New York, USA, 1977

### Dalton, John

1766–1844

English chemist and physicist

These observations have tacitly led to the conclusion which seems universally adopted, that all bodies of sensible magnitude, whether liquid or solid, are constituted of a vast number of extremely small particles, or atoms of matter...

*A New System of Chemical Philosophy* (Volume 1)

Part I, Chapter II (p. 141)

R. Bickerstaff, London, England, 1810

I have chosen the word atom to signify these ultimate particles in preference to particle, molecule, or any other diminutive term, because I conceive it is much more expressive; it includes in itself the notion of indivisible, which the other terms do not.

In Henry Enfield Roscoe

*John Dalton and the Rise of Modern Chemistry*

Chapter VI (p. 136)

The Macmillan Co. New York, New York, USA, 1895

I should apprehend there are a considerable number of what may properly be called elementary principles, which never can be metamorphosed one into another by any power we can control.

In Henry Enfield Roscoe

*John Dalton and the Rise of Modern Chemistry*

Chapter VI (p. 137)

The Macmillan Co. New York, New York, USA, 1895

**Darrow, Karl Kelchner** 1891–1982  
American physicist

One of the things which distinguishes ours from all earlier generations is this, that WE HAVE SEEN OUR ATOMS.

*The Renaissance of Physics*

Chapter VI (p. 107)

The Macmillan Company. New York, New York, USA. 1936

**Darwin, Erasmus** 1731–1802  
English physician and poet

Dull atheist, could a giddy dance  
Of atoms lawlessly hurl'd  
Construct so wonderful, so wise,  
So harmonised a world?

In Paul H. Barrett and R.B. Freeman (eds.)

*The Works of Charles Darwin* (Volume 29)

*Erasmus Darwin*

Preface (p. 44)

New York University Press. New York, New York, USA. 1989

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

Measure for measure, we are to an atom, what a star is to us.

*Superforce: The Search for a Grand Unified Theory of Nature*

Chapter 1 (p. 18)

Simon & Schuster. New York, New York, USA. 1984

...the rules of clockwork might apply to familiar objects such as snooker balls, but when it comes to atoms, the rules are those of roulette.

*God and the New Physics*

Chapter 8 (p. 102)

Simon & Schuster. New York, New York, USA. 1983

**de Montaigne, Michel Eyquem** 1533–92  
French Renaissance writer

...if atoms do, by chance, happen to combine themselves into so many shapes, why have they never combined together to form a house or a slipper? By the same token, why do we not believe that if innumerable letters of the Greek alphabet were poured all over the market-place they would eventually happen to form the text of the Iliad?

Translated by M.A. Screech

*An Apology for Raymond Sebond* (p. 120)

Penguin Books. London, England. 1987

**Democritus of Abdera** 460 BCE–370 BCE  
Greek philosopher

Nothing exists except atoms and empty space; everything else is opinion.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 1)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

The atoms are at war with one another as they move along in the void owing to their dissimilarity and their other differences, and as they move they collide and are interlaced in a manner which makes them touch and be near to one another, but they never really produce any single existence out of them: for it is quite absurd to suppose that two or more things could ever become one.

In Cyril Bailey

*The Greek Atomists and Epicurus*

Chapter III, Section 3 (p. 136)

Russell & Russell, Inc. New York, New York, USA. 1964

By convention there is colour, by convention sweetness, by convention bitterness, but in reality there are atoms and space.

*Fragments of the Presocratics*

Fragment 125

Publication data not available

[Atoms] have all sorts of shapes and appearances and different sizes...Some are rough, some hook-shaped, some concave, some convex and some have other innumerable variations.

In Samuel Sambursky

*The Physical World of the Greeks*

Chapter V (pp. 110–111)

Routledge & Kegan Paul. London, England. 1956

**Dewar, Redcote**

No biographical data available

With characteristic boldness, present physicists have calculated the size of an atom, and the effort is at least ingenious. Thus, says Lord Kelvin, "If a drop of water be magnified to the size of the earth, the atoms will average something between cricket balls and small shot." (Professor Tait suggests plums.) But this illustration, though lucid enough in its way, is not realisable; it however endorses the principle of atomic size.

*From Matter to Man: A New Theory of the Universe*

Chapter IV (p. 50)

Chapman & Hall, Ltd. London, England. 1898

**Douglas, A. Vibert** 1894–1988

Canadian astronomer

You cannot solve the riddles of the stars without invoking the aid of the atom, nor can you fully comprehend the atom without the aid of the stars. On the uplifting wings of imagination the astrophysicist roams the universe from atom to atom, from star to star, from star to atom, from atom to star. Impelled by curiosity regarding the natural universe, encouraged by the evidence for his faith in the reality of cosmic harmony, he presses on and on – a sweet and a fitting thing it is to toil for the Truth.

From *Atoms to Stars*

*The Atlantic Monthly*, Volume 144, August, 1929 (p. 165)

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

To be the child of chance, and not of care,  
No atoms casually together hurl'd.

*The Poetical Works of Dryden*

To my Honor'd Friend Sir Robert Howard, l. 31–32  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

The airy atoms did in plagues conspire...

*The Poetical Works of Dryden*

Britannia Rediviva, l. 154  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

So many huddled atoms make a play...

*The Poetical Works of Dryden*

Prologue and Epilogue to the University of Oxford, l. 31  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

From harmony, from heav'nly harmony This universal  
frame began: When Nature underneath a heap of jarring  
atoms lay, And could not heave her head...

*The Poetical Works of Dryden*

A Song for St Cecilia's Day, l. 4–8  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

For then our atoms, which in order lay,  
Are scatter'd from their heap, and puff'd away...

*The Poetical Works of Dryden*

Lucretius  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

May, tho' our atoms should resolve by chance...

*The Poetical Works of Dryden*

Lucretius  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Durack, J. J.**

No biographical data available

In the dusty lab'ratory  
'Mid the coils and wax and twine,  
There the atoms in their glory  
Ionize and recombine.

Ions Mine

*The American Physics Teacher*, Volume 7, Number 3, June, 1939 (p. 180)**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The atom is as porous as the solar system.

*The Nature of the Physical World*

Chapter I (p. 1)  
The Macmillan Company. New York, New York, USA. 1930

"A fortuitous concourse of atoms" – that bugbear of the  
theologian – has a very harmless place in orthodox physics.

*The Nature of the Physical World*

Chapter IV (p. 77)  
The Macmillan Company. New York, New York, USA. 1930

...now we realize that science has nothing to say as to  
the intrinsic nature of the atom. The physical atom is,

like everything else in physics, a schedule of pointer  
readings.

*The Nature of the Physical World*

Chapter XII (p. 259)  
The Macmillan Company. New York, New York, USA. 1930

Our method of making an atom work is to knock it about;  
and if it does not do what we want, knock it still harder.

*New Pathways in Science*

Chapter IX, Section V (p. 203)  
The Macmillan Company. New York, New York, USA. 1935

Man is slightly nearer to the atom than to the star.... From  
his central position he can survey the grandest works of  
Nature with the astronomer, or the minutest works with  
the physicist.

*Stars and Atoms*

Lecture I (p. 1)  
Clarendon Press. Oxford, England. 1927

**Eddy, H. T.**

No biographical data available

Chemical atoms are like a chime of bells all cast from the  
same material, but each having its own special series of  
harmonic vibrations.

In Ohio Mechanic's Institute

*Scientific Proceedings of the Ohio Mechanics' Institute* (Volume I)  
Developments in the Kinetic Theory of Solids, Liquids, and Gasses (p. 93)  
Ohio Mechanic's Institute. Cincinnati, Ohio, USA. 1992

**Einstein, Albert** 1879–1955

German-American physicist

The unleashed power of the atom has changed everything  
save our modes of thinking and we thus drift toward  
unparalleled catastrophe.

Atomic Education Urged by Einstein

*New York Times*, Section L+, May, 1946**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

You cannot detach an atom from its holdings, or strip off  
from it the electricity, gravitation, chemic affinity, or the  
relation to light and heat, and leave the atom bare.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

*Society and Solitude*  
Farming (p. 143)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The atoms of the body were once nebulae...

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

*Letters and Social Aims*  
Chapter I (p. 24)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The intellect sees that every atom carries the whole of  
Nature...

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*  
Illusions (p. 1111)  
The Library of America. New York, New York, USA. 1983

For the world was built in order,  
And the atoms march in tune;  
Rhyme the pipe, and Time the warder,  
The sun obeys them and the moon.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
*Monadnock* (p. 69)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Atom from atom yawns as far  
As moon from earth, or star from star.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
*Nature* (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Self-kindled every atom glows ...

*Essays: Second Series*

*Nature* (p. 7)

Duffield & Co. New York, New York, USA. 1909

**Faraday, Michael** 1791–1867

English physicist and chemist

But I must confess I am jealous of the term atom; for though it is very easy to talk of atoms, it is very difficult to form a clear idea of their nature, especially when compound bodies are under consideration.

*Experimental Researches In Electricity* (Volume 1)

Seventh Series, 869 (p. 256)

Richard & John Edward Taylor. London, England. 1839–1855

...I am jealous of the term *atom*; for though it is very easy to talk of atoms, it is very difficult to form a clear idea of their nature, especially when compound bodies are under consideration.

*Experimental Researches in Electricity*

Series II, Section 6 (p. 256)

Bernard Quaritch. London, England. 1839

**Feinberg, J. G.**

No biographical data available

The atom stands as a monument to the wisdom of the Human Race. One day it may stand a tombstone to its folly.

*The Atom Story, Being the Story of the Atom and the Human Race*

Chapter I (p. 1)

Philosophical Library. New York, New York, USA. 1953

The powerful weapon which first smashed the atom was not a massive machine in a physics laboratory but a puny pencil in the hands of a genius. The year was 1905 and the genius was Albert Einstein.

*The Atom Story, Being the Story of the Atom and the Human Race* (p. 91)

Philosophical Library. New York, New York, USA. 1953

**Feynman, Richard P.** 1918–88

American theoretical physicist

The behavior of things on a very tiny scale is simply different. An atom does not behave like weight hanging on a spring and oscillating. An atom does not behave like a

miniature representation of the solar system with little planets going around orbits. Nor does it appear to be somewhat like a cloud or fog of some sort surrounding the nucleus. It behaves like nothing you have ever seen before.

*The Character of Physical Law*

Chapter 6 (p. 128)

British Broadcasting Company. London, England. 1965

I,

a universe of atoms,

an atom of the universe.

*What Do You Care What Other People Think?*

The Value of Science (p. 243)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

...the atoms that are in the brain are being replaced: the ones that were there before have gone away.

So what is this mind of ours: what are these atoms with consciousness? Last week's potatoes! They now can remember what was going on in my mind a year ago – a mind which has long ago been replaced.

To note that the thing I call my individuality is only a pattern or dance, that is what it means when one discovers how long it takes for the atoms of the brain to be replaced by other atoms. The atoms come into my brain, dance a dance, and then go out – there are always new atoms, but always doing the same dance, remembering what the dance was yesterday.

*What Do You Care What Other People Think?*

The Value of Science (p. 244)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

If instead of arranging the atoms in some definite pattern, again and again repeated, on and on, or even forming little lumps of complexity like the odor of violets, we make an arrangement which is always different from place to place, with different kinds of atoms arranged in many ways, continually changing, not repeating, how much more marvelously is it possible that this thing might behave? Is it possible that that "thing" walking back and forth in front of you, talking to you, is a great glob of these atoms in a very complex arrangement, such that the sheer complexity of it staggers the imagination as to what it can do? When we say we are a pile of atoms, we do not mean we are merely a pile of atoms, because a pile of atoms which is not repeated from one to the other might well have the possibilities which you see before you in the mirror.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Atoms in Motion (p. 20)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generation of creatures, what statement would contain the most information in the fewest words? I believe

it is the atomic hypothesis (or the atomic fact, if you wish to call it that) that all things are made of atoms – little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–1 (p. 1–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

Everything is made of atoms. That is the key hypothesis. The most important hypothesis in all of biology, for example, is that everything that animals do, atoms do. In other words, there is nothing that living things do that cannot be understood from the point of view that they are made of atoms acting according to the laws of physics. This was not known from the beginning: it took some experimenting and theorizing to suggest this hypothesis, but now it is accepted, and it is the most useful theory for producing new ideas in the field of biology.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–4 (pp. 1–8)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...if all of this, all the life of a stream of water, can be nothing but a pile of atoms, how much more is possible?

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–4 (pp. 1–9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

Atoms are completely impossible from the classical point of view...

*The Feynman Lectures on Physics* (Volume 3)

Chapter 2–4 (pp. 2–6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Flammarion, Camille** 1842–1925

French astronomer and writer

The visible, tangible, ponderable, and constantly moving universe is composed of invisible, intangible, imponderable, and inert atoms.

Translated by Augusta Rice Stetson

*Urania*

Chapter VI (p. 239)

Chatto & Windus. London, England. 1891

**Freeman, Ira M.**

No biographical data available

O'er the atom's wondrous, useful pieces,

The physicist effuses;

Applauding too as Man releases

The atom's peaceful uses.

Nuclear Situation Unclear

*The Physics Teacher*, Volume 13, Number 5, May, 1975 (p. 319)

**Frisch, Otto Robert** 1904–79

Austrian-born English physicist

Today we no longer ask what really goes on in an atom; we ask what is likely to be observed – and with what likelihood – when we subject atoms to any specified influences such as light or heat, magnetic fields or electric currents.

*What Little I Remember*

Atoms (p. 20)

Cambridge University Press. Cambridge, England. 1979

**Gassendi, Pierre** 1592–1655

French logician and philosopher

As letters are the elements of writing and from letters are formed first syllables, and then successively words, phrases, and speeches, so also atoms are the elements of all things. From the atoms the smallest molecules are joined together first, and then successively somewhat bigger ones, still bigger ones, the finest and the coarsest bodies, and finally the biggest bodies.

In Walter Charleton

*Physiologia Epicuro-Gassendo-Charltoniana; or, a fabric of science natural, upon the hypothesis of atoms founded by Epicurus, repaired by Petrus Gassendus, augmented by Walter Charleton*

Animadversions (p. 108)

**Goeppert-Mayer, Maria** 1906–72

German-American physicist

No one has ever seen, nor probably ever will see, an atom, but that does not deter the physicist from trying to draw a plan of it, with the aid of such clues to its structure as he has.

The Structure of the Nucleus

*Scientific American*, Volume 184, Number 3, March, 1951 (p. 22)

**Guth, Alan** 1947–

American physicist

When one studies the properties of atoms one found that the reality is far stranger than anybody would have invented in the form of fiction.

*Parallel Universes*

BBC broadcast. February 14, 2002

**Hall, John**

No biographical data available

If that this thing we call the world

By chance on atoms was begot

Which through in ceaseless motion whirled

Yet weary not

How doth it prove

Thou art so fair and I in love.

In John D. Barrow

*The World Within the World* (p. 162)

Clarendon Press. Oxford, England. 1988



**Harrow, Benjamin** 1888–1970  
American chemist

If the constituent atoms in a tumbler of water could all be labeled for later identification, and the water were then mixed with all the water in the world, and if, after thoroughly mixing, the tumbler were again filled, it would contain two thousand of the original atoms.

In Bernard Jaffe

*New World of Chemistry* (p. 56)

Silver, Burdett & Company. New York, New York, USA. 1935

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

The atom of modern physics can be symbolized only through a partial differential equation in an abstract space of many dimensions. All its qualities are inferential; no material properties can be directly attributed to it. That is to say, any picture of the atom that our imagination is able to invent is for that very reason defective. An understanding of the atomic world in that primary sensuous fashion...is impossible.

In S.F. Mason

*A History of Science* (p. 502)

Collier Books. New York, New York, USA. 1962

It is not surprising that our language should be incapable of describing the processes occurring within the atoms, for, as has been remarked, it was invented to describe the experiences of daily life, and these consist only of processes involving exceedingly large numbers of atoms. Furthermore, it is very difficult to modify our language so that it will be able to describe these atomic processes, for words can only describe things of which we can form mental pictures, and this ability, too, is a result of daily experience.

*The Physical Principles of the Quantum Theory*

Translated by Carl Eckhart and Frank C. Hoyt (p. 11)

The University of Chicago Press. Chicago, Illinois, USA. 1930

All the qualities of the atom of modern physics are derived, it has no immediate and direct physical properties at all, i.e., every type of visual conception we might wish to design is *eo ipso*, faulty.

Translated by F.C. Hayes

*Philosophic Problems of Nuclear Science*

Chapter 2 (p. 38)

Faber & Faber Ltd. London, England. 1952

It is important that we should understand the “handwriting” of atoms for it is something which has not been thought out by man; it has far deeper meaning. Even when we shall have mastered and understood it, let us not forget that is the content not the words which is important in a tragedy or comedy and that this also holds good for our world.

*Philosophic Problems of Nuclear Science*

Chapter 7 (p. 108)

Faber & Faber Ltd. London, England. 1952

In the experiments about atomic events we have to do with things and facts, with phenomena that are just as real as any phenomena in daily life. But the atoms of the elementary particles are not as real; they form a world of potentialities or possibilities rather than one of things or facts.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter X (p. 186)

Harper & Row, Publishers. New York, New York, USA. 1958

...atoms are neither things nor objects...atoms are part of observational situations...

*Physics and Beyond: Encounters and Conversations*

Chapter 10 (p. 123)

Harper & Row, Publishers. New York, New York, USA. 1972

**Higgins, Bryan** 1737–1820  
Irish physicist

...the atoms of each element are globular or nearly so; and that the spiral, spicular and other figures ascribed to these atoms are fictitious, unnecessary, and are inconsistent with the uniformity of nature, and are repugnant to experience.

In D.S.L. Cardwell (ed.)

*John Dalton & the Progress of Science*

Quoted in B.B. Kelham

Atomic Speculation in the Late Eighteenth Century (p. 112)

Manchester University Press. Manchester, England. 1968

**Hoffman, A. W.**

No biographical data available

Let the croquet balls represent our atoms, and let us distinguish the atoms of different elements by different colours. The white balls are hydrogen, the green ones chlorine atoms; the atoms of fiery oxygen are red, those of nitrogen, blue; the carbon atoms, lastly, are naturally represented by black balls.

On the Combining Power of Atoms

*Proceedings of the Royal Institution*, Volume IV, April 7, 1865 (p. 416)

**Huxley, Aldous** 1894–1963  
English writer and critic

Atoms, or perhaps it would be more accurate to say those aspects of the atom which scientists chose to consider, are immeasurable less complicated than men.

*Proper Studies*

Introduction (p. vii)

Chatto & Windus. London, England. 1957

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The universe was a stage in which always the same actors – the atoms – played their parts, differing in disguises and groupings, but without change of identity. And these actors were endowed with immortality.

*The Mysterious Universe*

Chapter III (p. 56)

The Macmillan Company. New York, New York, USA. 1932



All the innumerable substances which occur on earth – shows, ships, sealing-wax, cabbages, kings, carpenters, walruses, oysters, everything we can think of – can be analyzed into their constituent atoms.... It might be thought that a quite incredible number of different kinds of atoms would emerge from the rich variety of substances we find on earth. Actually the number is quite small. The same atoms turn up again and again, and the great variety of substances we find on earth result, not from any great variety of atoms entering into their composition, but from the great variety of ways in which a few types of atoms can be combined.

*The Universe Around Us*

Chapter II (pp. 97–98)

The Macmillan Company. New York, New York, USA. 1929

**Jeffers, Robinson** 1887–1962

American poet

...Useless intelligence of far stars, dim knowledge of the spinning demons that make an atom...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

Roan Stallion (p. 189)

Stanford University Press. Stanford, California. USA. 1988

**Jenkin, Fleeming** 1833–85

English engineer

We are not wholly without hope that the real weight of each such atom may some day be known...; that the form and motion of the parts of each atom, and the distance by which they are separated, may be calculated; that the motions by which they produce heat, electricity, and light may be illustrated by exact geometrical diagrams.... Then the motion of the planets and music of the spheres will be neglected for a while in admiration of the maze in which the tiny atoms turn.

In Sidney Colvin and J.A. Ewing (eds.)

*Papers, Literary, Scientific, & c., by the Late Fleeming Jenkin* (Volume 1)

Lucretius and the Atomic Theory

1868 (p. 213)

Longmans, Green & Company. London, England. 1887

**Kekulé, Friedrich August** 1829–96

German chemist

The question of whether atoms exist or not has but little significance from a chemical point of view: its discussion belongs rather to metaphysics. In chemistry we have only to decide whether the assumption of atoms is an hypothesis adapted to the explanation of chemical phenomena. More especially have we to consider the question whether a further development of the atomic hypothesis promises to advance our knowledge of the mechanism of chemical phenomena...

Should the progress of science lead to a theory of the constitution of chemical atoms – important as such a knowledge might be for the general philosophy of matter – it

would make but little alteration in chemistry itself. The chemical atoms will always remain the chemical unit...

In Ida Freund

*The Study of Chemical Composition*

Chapter XIX (p. 624)

At the University Press. Cambridge, England. 1904

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

The idea of an atom has been so constantly associated with incredible assumptions of infinite strength, absolute rigidity, mystical actions at a distance and indivisibility, that chemists and many other reasonable naturalists of modern times, losing all patience with it, have dismissed it to the realms of metaphysics, and made it smaller than “anything we can conceive.”

On the Size of Atoms

*Nature*, Volume 1, March 31, 1870 (p. 511)

**Kraus, Arthur Lawrence**

No biographical data available

Every atom in your body was once inside an exploding star...

*The Lee Rogers radio show*

KSFO Radio 560, San Francisco, 11/3/97

**Krauss, Lawrence M.** 1954–

American theoretical physicist

Our atoms are vibrant messengers from the past, and harbingers of the future. They connect us in a definite way to everything we can see about us. Let us enjoy, with them, our moment in the sun.

*Atom: An Odyssey from the Big Bang to Life on Earth...and Beyond*

Chapter 19 (p. 283)

Little, Brown & Company. Boston, Massachusetts, USA. 2001

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

The most important discoveries of the laws, methods and progress of Nature have nearly always sprung from the examination of the smaller objects which she contains.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 2)

Atomic Numbers (p. 842)

Simon & Schuster. New York, New York, USA. 1956

**Le Bon, Gustave** 1841–1931

French social psychologist, author, and amateur physicist

When we study the structure of the atom, we shall arrive at the conclusion that it is an immense reservoir of energy solely constituted by a system of imponderable elements maintained in equilibrium by the rotations, attractions and repulsions of its component parts.

Translated by F. Legge

*The Evolution of Matter*

Book I, Chapter I (p. 10)

The Walter Scott Publishing Co., Ltd. London, England. 1907

**Leacock, Stephen** 1869–1944  
Canadian humorist

When Rutherford was done with the atom all the solidity was pretty well knocked out of it.

*The Boy I Left Behind Me*

Chapter VI (p. 169)

The Bodley Head. London, England. 1947

**Lederman, Leon** 1922–  
American high-energy physicist

Although atoms are way more than 99.99 percent empty space, I have a real problem in walking through a wall.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 5 (p. 184)

Bantam Dell Doubleday Publishing Group. New York, New York, USA. 1993

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

Atoms are the effect of the weakness of our imagination, for it likes to rest and therefore hurries to arrive at a conclusion in subdivisions or analyses; this is not the case in Nature, which comes from the infinite and goes to the infinite. Atoms satisfy only the imagination, but they shock the higher reason.

In John D. Barrow

*The World Within the World* (p. 166)

Clarendon Press. Oxford, England. 1988

**Lemaître, Abbé Georges** 1894–1966  
Belgian astronomer and cosmologist

The atom-world was broken into fragments, each fragment into still smaller pieces. To simplify matters, supposing that this fragmentation occurred in equal pieces, two hundred sixty generations would have been needed to reach the present pulverization of matter into our poor little atoms, almost too small to be broken again. The evolution of the world can be compared to a display of fireworks that has just ended: some few red wisps, ashes and smoke. Standing on a well-chilled cinder, we see the slow fading of the suns, and we try to recall the vanished brilliance of the origin of the worlds.

*The Primeval Atom*

Chapter II (p. 78)

van Nostrand Company, Inc. New York, New York, USA. 1950

**Lewis, Edwin Herbert** 1866–1938  
American rhetorician, novelist, and poet

She wondered why the particles of a metal stick so close together. Lucretius had said it was because the atoms were hooked. It did rather look as if in some way they overlapped, but then it also looked as if the atoms themselves were compressed. She wondered what force could be so tremendous as to squeeze atoms into iron, nickel, ruthenium, rhodium, palladium, and osmium, each a little denser than the preceding.

*White Lightning*

Chapter 76 (p. 309)

Covici-McGee. Chicago, Illinois, USA. 1923

**Lloyd, Seth** 1960–  
American professor of mechanical engineering

It's just hard to string a lot of atoms together. I mean, these things are wicked small.... They're sensitive little buggers too. But people are getting to the point where they can control these things. It's a big technological crapsnoot. In the not-too-distant future people might be able to do full-blown quantum computation.

The Best Computer in All Possible Worlds

*Discover Magazine*, October, 1995

**Locke, John** 1632–1704  
English philosopher and political theorist

...a blind fortuitous concourse of atoms, not guided by an understanding agent...

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book IV, Chapter XX, Section 15 (p. 393)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lodge, Sir Oliver** 1851–1940  
English physicist

We do not in the least know how to harness the energy locked up in the atoms of matter. If it could be liberated at will, we would experience a violence beside which the suddenness of high explosive is gentle and leisurely.

In Thomas Thornely

*Collected Verse*

The Atom

Cambridge, England. 1939

...inside an atom there exist both attractive and repulsive forces; the resolution of an atom into its electron constituents, and the aggregation of these constituents into fresh atoms, are both perfectly thinkable. All we have to do is to ascertain by careful and patient investigation what really happens; and my experience has led me to feel sure of this, that whatever hypotheses and speculations we may frame, we cannot exceed the reality in genuine wonder. And I believe that the simplicity and beauty of the truth concerning even the material universe, when we know it, will be such as to elicit feelings of reverent awe and adoration.

*Modern Views on Matter* (p. 24)

At The Clarendon Press. Oxford, England. 1915

**Macfie, Ronald Campbell** 1867–1931  
Scottish poet and physician

...the atoms and molecules are as real as the ice-crystals in the cirrus clouds that he cannot reach – as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which past us unentangled in the night” – that the atoms are in fact “not

merely helps to puzzled mathematicians, but physical realities.”

*Science, Matter and Immortality*

Chapter IV (p. 42)

William & Norgate. London, England. 1909

...the most wonderful thing about atoms and molecules is not their power of destroying, but their powers of creating. They themselves choose their partners, and their partnerships have made the world as we know it.

*Science, Matter and Immortality*

Chapter 4 (p. 53)

William & Norgate. London, England. 1909

The atoms and molecules, by their aggregation and arrangement, by their weddings and partnerships, make everything. We put a packet of molecules, known as a seed, into the ground, and they attract other molecules from the air and soil – molecules of carbonic acid, and lime, and potassium, and so on, and lo! a lily, or a pine tree. Without mistake they carry out more machinery in each molecular brick than in a chronometer, and more molecular bricks in each leaflet than in a cathedral.

*Science, Matter and Immortality*

Chapter 4 (pp. 53–54)

William & Norgate. London, England. 1909

Atoms and molecules have been weighed; they have been proved to dance, they have been persuaded to wed, and yet their shape is still unknown.

*Science, Matter and Immortality*

Chapter IV (p. 58)

William & Norgate. London, England. 1909

Let us consider even such a minor wonder as a hen’s egg...these atoms in the egg have been gathered together in a few hours, and have come from all quarters of the earth. Not so long ago the oxygen may have come on the wings of the wind from the leaf of a lily, the hydrogen from the teardrop of a maiden, the carbon from a factory chimney, the nitrogen from the plains of Chili, the sulphur from Mount Pelée, and the iron from a meteorite. And behold, there they all are collected together by red rivers of blood into an eggshell, ready to make a chicken!

*Science, Matter and Immortality*

Chapter 17 (pp. 215–216)

William & Norgate. London, England. 1909

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The atomic theory plays a part in physics similar to that of certain auxiliary concepts in mathematics: it is a mathematical model for facilitating the mental reproduction of facts. Although we represent vibrations by the harmonic formula, the phenomena of cooling by exponentials, falls by squares of time, etc., no one would fancy that vibrations in themselves have anything to do with circular functions, or the motion of falling bodies with squares.

*The Science of Mechanics* (5th edition)

Chapter IV, Part IV, Section 9 (p. 590)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

If belief in the reality of atoms is so important to you, I cut myself off from the physicist’s mode of thinking.

In Timothy Ferris

*The Red Limit: The Search for the Edge of the Universe*

Letter to Max Planck (p. 65)

William Morrow & Company, Inc. New York, New York, USA. 1977

The atom must remain a tool for representing phenomena, like the functions of mathematics.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physical Inquiry (p. 207)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

### **Mann, Thomas** 1875–1955

German-born American novelist

The atom was a cosmic system, laden with energy; in which heavenly bodies rioted rotating about a centre like a sun; through whose ethereal space comets drove with the speed of light years, kept in their eccentric orbits by the power of the central body.

*The Magic Mountain*

Chapter V

Research (p. 284)

Alfred A. Knopf. New York, New York, USA. 1966

### **Maxwell, James Clerk** 1831–79

Scottish physicist

At any rate the atoms are a very tough lot, and can stand a great deal of knocking about...

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

Correspondence (p. 391)

Macmillan & Company Ltd. London, England. 1882

At quite uncertain times and places,

The atoms left their heavenly path,

And by fortuitous embraces,

Engendered all that being hath.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

Molecular Evolution (p. 637)

Macmillan & Company Ltd. London, England. 1882

How freely he scatters his atoms before the beginning of years;

How he clothes them with force as a garment, those small incompressible spheres!

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

British Association, 1874 (p. 639)

Macmillan & Company Ltd. London, England. 1882

In the very beginning of science,  
the parsons, who managed things then,

Being handy with hammer and chisel,  
made gods in the likeness o' men;  
Till Commerce arose and at length  
some men of exceptional power  
Supplanted both demons and gods by  
the atoms, which last to this hour.

In John D. Barrow

*The World Within the World* (p. 168)

Clarendon Press. Oxford, England. 1988

[Atoms]...the imperishable foundation-stones of the universe.

In James Jeans

*The Mysterious Universe*

Chapter III (p. 64)

The Macmillan Company. New York, New York, USA. 1932

An atom is a body which cannot be cut in two.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 361)

Dover Publications. New York, New York, USA. 1965

...though many a speculator, as he has seen the vision recede before him into the innermost sanctuary of the inconceivably little, has had to confess that the quest was not for him, and though philosophers in every age have been exhorting each other to direct their minds to some more useful and attainable aim, each generation, from the earliest dawn of science to the present time, has contributed a due proportion of its ablest intellects to the quest of the ultimate atom.

Molecules

*Nature*, September, 1873 (p. 437)

**Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

Chemical atoms may be regarded as separate members of such systems (as, for instance, the sun, planets, comets, and other heavenly bodies), whilst the ether of light may be likened to the cosmic dust which without doubt is distributed throughout space. The present condition of molecular mechanics is, to a certain extent, copied from celestial mechanics, but there is nothing to prove the entire similarity of both worlds, although it appears to the mind that, starting from the primary elements of the unity of creation, such a representation is the most likely.

*The Principles of Chemistry* (Volume 1)

Introduction (p. 29)

Longmans, Green & Co. London, England. 1891

The invisible world of chemical atoms is still waiting for the creator of chemical mechanics.

*The Principles of Chemistry* Part IV

Appendix I (p. 455)

P.F. Collier & Son. New York, New York, USA. 1902

**Nabokov, Vladimir Vladimirovich** 1899–1977

Russian-born American novelist

But the individual atom is free: it pulsates as it wants, in high or low gear; it decides itself when to absorb and when to radiate energy.

*Bend Sinister* (p. 159)

Henry Holt & Company. New York, New York, USA. 1947

**Ostwald, Friedrich Wilhelm** 1853–1932

Latvian-born German chemist

We must renounce the hope of representing the physical world by referring natural phenomena to a mechanics of atoms. "But" – I hear you say – "but what will we have left to give us a picture of reality if we abandon atoms?" To this I reply: "Thou shalt not take unto thee any graven images, or any likeness of anything." Our task is not to see the world through a dark and distorted mirror, but directly, so far as the nature of our minds permits. The task of science is to discern relations among realities...

In Nick Herbert

*Quantum Reality: Beyond the New Physics*

Chapter 1 (pp. 11–12)

Anchor Press. Garden City, New York, USA. 1985

**Pallister, William Hales** 1877–1946

Canadian physician

Each atom is a tiny universe  
In which electrons in orbit rehearse  
The motions of the planets round the sun,  
In miniature the actions there begun.  
It's particles revolve so far apart  
The solar system might have taught the art.

*Poems of Science*

Men and the Stars

Within the Atom

Playford Press. New York, New York, USA. 1931

**Partlow, Vern**

American folk singer and union activist

Well, I'm gonna preach you a sermon 'bout Old Man Atom

I don't mean the Adam in the Bible datum

I don't mean the Adam that Mother Eve mated

I mean that thing that science liberated

Einstein says he's scared

And when Einstein's scared, I'm scared.

*Old Man Atom*

Sung by Sam Hintons

Columbia 38 929, 1950

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

...the long-standing mechanistic and atomistic hypotheses have recently taken on enough consistency to cease almost appearing to us as hypotheses; atoms are no longer a useful fiction; things seem to us in favour of saying that we see them since we know how to count them.... The brilliant determination of the number of atoms made

by M. Perrin has completed this triumph of atomism....  
The atom of the chemist is now a reality.

In Mary Jo Nye

*Molecular Reality: A Perspective on the Scientific Work of Jean Perrin*  
(p. 157)

MacDonald. London, England. 1972

**Pope, Alexander** 1688–1744

English poet

See plastic nature working to this end,  
The single atoms each to other tend,  
Attract, attracted to, the next place  
Form'd and impell'd its neighbor to embrace.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle III, l. 9–12

Houghton Mifflin Company. New York, New York, USA. 1903

Atoms or systems into ruin hurl'd,  
And now a bubble burst, and now a world.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, Of the Nature and State of Man, with  
Respect to the Universe, Argument, l. 89–90

Houghton Mifflin Company. New York, New York, USA. 1903

**Rees, Martin John** 1942–

15th Astronomer Royal of England

If we are to understand an everyday question like “Where  
did the atoms we are made of come from?” we must  
understand the stars.

Interview by Claudia Dreifus

*New York Times*, April 26, 1998

**Robb, Alfred Arthur** 1873–1936

English physicist

What's in an atom  
The innermost substratum?  
That's the problem he is working at today.  
He lately did discover  
How to shoot them down the player,  
And the poor little things can't get away.  
He uses as munitions  
On his hunting expeditions  
Alpha particles which out of Radium sprang.

In Ruth Moore

*Niels Bohr: The Man, His Science, and the World They Changed*  
Chapter 7 (p. 113)

Alfred A. Knopf. New York, New York, USA. 1966

A Corpusele once did oscillate so quickly to and fro,  
He always raised disturbances wherever he did go.  
He struggled hard for freedom against a powerful foe –  
An atom – who wouldn't let him go.

The Revolution of the Corpusele

*The American Physics Teacher*, Volume 17, Number 3, June, 1939  
(p. 180)

All preconceived notions he sets at defiance  
By means of some neat and ingenious appliance

By which he discovers a new law of science  
Which no one had ever suspected before.

All the chemists went off into fits,  
Some of them thought they were losing their wits,  
When quite without warning  
(Their theories scorning)

The atom one morning

He broke into bits.

In Cecilia Payne-Gaposchkin

*Introduction to Astronomy*

On J.J. Thomson (p. 341)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**Roscoe, Henry E.** 1833–1915

English chemist

Atoms are round bits of wood invented by Mr. Dalton.

In William H. Brock

*The Norton History of Chemistry*

Chapter 4 (p. 128)

W.W. Norton & Company, Inc. New York, New York, USA. 1993

**Rothman, Tony** 1953–

American cosmologist

YOU MUST REMEMBER THIS: Atoms cannot be  
seen. To show that the world was made of particles a mil-  
lion times smaller than objects visible to the naked eye  
was so difficult that their existence was not established  
beyond reasonable doubt until the end of the nineteenth  
century.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 2 (p. 47)

Ballentine Books. New York, New York, USA. 1995

**Rowland, Henry Augustus** 1848–1901

American physicist

The round hard atom of Newton which God alone  
could break into pieces has become a molecule com-  
posed of many atoms and each of these smaller atoms  
has become so elastic that after vibrating 100,000 times  
its amplitude of vibration is scarcely diminished. It has  
become so complicated that it can vibrate with as many  
thousand notes. We cover the atom with patches of elec-  
tricity here and there and make of it a system compared  
with which the planetary system, nay the universe itself,  
is simplicity.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aim of the Physicist (p. 671)

Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Rukeyser, Muriel** 1930–80

American poet and activist

The universe is made of stories,  
not of atoms.

*The Speed of Darkness*

The Speed of Darkness

Stanza IX

Random House, Inc. New York, New York, USA. 1968



**Rutherford, Ernest** 1871–1937  
English physicist

The atom will always be a sink of energy and never a reservoir.

In Ritchie Calder  
*Profile of Science*  
Chapter 1 (p. 23)

George Allen & Unwin Ltd. London, England. 1951

My work on the atom goes on in fine style. Several atoms succumb each week.

In Ruth Moore  
*Niels Bohr: The Man, His Science, & the World They Changed*  
Chapter 7 (p. 114)  
Alfred A. Knopf. New York, New York, USA. 1966

[Atom] a nice, hard fellow, red or grey in color according to taste.

*From Quarks to Quasars: A Tour of the Universe*  
Chapter 6 (p. 57)  
Athenaeum. New York, New York, USA. 1987

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

Why must our bodies be so large compared with the atom?

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*  
Chapter I, Section 4 (p. 6)  
At the University Press. Cambridge, England. 1945

**Shapley, Harlow** 1885–1972  
American astronomer

Splitting the atom has been going on for billions of years in the universe. It is an old, old story so far as the suns and stars are concerned. They do it easily, whereas man has toiled to accomplish it, and when he did he caused a world-wide headache and a crisis for humanity.

In S.J. Woolf  
Dr. Harlow Shapley  
*American Scientist*, Volume 34, Number 3, July 1946 (p. 468)

**Siegel, Eli** 1902–784  
American philosopher, poet, critic, and founder of Aesthetic Realism

A pimple has atoms to it; and mucus has electrons.

*Damned Welcome*  
Aesthetic Realism, Maxims, Part Two, #234 (p. 121)  
Definition Press. New York, New York, USA. 1972

**Silver, Brian L.**  
Israeli professor of physical chemistry

In solids, atoms or molecules generally occupy permanent sites from which they rarely stray, but they can be crudely envisaged as a gospel choir, each singer swaying, wobbling, and bobbing up and down, but remaining tethered to their places as a consequence of the close proximity of their neighbors.

*The Ascent of Science*  
Part Five, Chapter 16 (p. 202)  
Solomon Press Book. New York, New York, USA. 1998

**Ray Glaser**  
No biographical data available

**Sir Lancelot** 1903–2001

Some men with brains in their cranium  
Took a piece of uranium  
They did what other men could not do  
They split the atom right in two.

*Atomic Energy*  
Sung by Sir Lancelot  
Charter 102, 1947

**Smith, Robert Angus** 1817–84  
Scottish chemist

We believe in atoms, because Nature seems to use them, and we break them up continuously because we do not know where to stop. There are various methods of spanning the distance from nothing to something.

In Ida Freund  
*The Study of Chemical Composition*  
Chapter XI (p. 301)  
At the University Press. Cambridge, England. 1904

**Smith, Sydney** 1771–1845  
English clergyman, writer, and wit

Let onion atoms lurk within the bowl...

*The Wit and Wisdom of Sydney Smith: A Selection of the Most Memorable Passages in His Writings and Conversations*  
Recipe for a Salad (p. 429)  
G.P. Putnam's Sons. New York, New York, USA. 19–?

**Smollett, Tobias George** 1721–71  
Scottish novelist

I, Nathaniel Peacock, of the parish of St Giles's, haberdasher and author, solemnly declare, That, on the third of last August, sitting alone in my study, up three pair of stairs, between the hours of eleven and twelve at night, meditating upon the uncertainty of sublunary enjoyment, I heard a shrill, small voice, seemingly proceeding from a chink or crevice in my own pericranium, call distinctly three times – "Nathaniel Peacock! Nathaniel Peacock! Nathaniel Peacock!" – Astonished, yea, even affrighted, at this citation, I replied, in a faltering tone – "In the name of the Lord, what art thou?" Thus adjured, the voice answered and said – "I am an Atom."

*The Miscellaneous Works of Tobias Smollett, M.D.: With Memoirs of His Life*  
The Adventures of an Atom (p. 403)  
Printed for Sylvester Doig. Edinburgh, Scotland. 1811

**Snelson, Kenneth** 1927–  
American artist

It seems clear that the mind hungers for pictures of everything – atoms, no less than trees, flowers and creatures.

*Kenneth Snelson Exhibition*  
The Nature of Structure, The New York Academy of Sciences, January–April, 1989, Portraying the Atom



**Soddy, Frederick** 1877–1956

English chemist

Yet the atom, for all that, is not Nature's unit, but ours.

*Matter and Energy*

Chapter V (p. 143)

Henry Holt & Company. New York, New York, USA. 1991

The atoms are to the chemist and physicist what bricks are to the architect – the units supplied ready-made to a certain limited number of standard specifications and dimensions capable of an endless variety of combinations and arrangements, each with its own peculiarities and external relationships.

*The Interpretation of Radium and the Structure of the Atom*

Part I, Chapter I (p. 2)

G.P. Putnam's Sons. New York, New York, USA. 1920

As buildings are built of bricks, so compounds can nowadays be built up out of atoms. The atoms are to the chemist and physicist what bricks are to the architect – the units supplied ready-made to a certain limited number of standard specifications and dimensions capable of an endless variety of combinations and arrangements, each with its own peculiarities and external relationships.

*The Interpretation of Radium and the Structure of the Atom*

Chapter I (pp. 2–3)

J. Murray. London, England. 1909

**Stableford, Brian M.** 1948–

Science fiction writer

The world of the atom is a world we know only by inference. We cannot perceive events in the microcosm, but we can contrive effects by which to detect and study them. Though we cannot see the subatomic particles themselves we can see the tracks which they leave as they pass through cloud-chambers: a wake of condensation which precipitates out around the ions formed as electrons are stripped from atoms by the speeding particles. But these contrived effects are all that we can see and therefore all that we can measure. Everything we know about subatomic particles has to be deduced from their interactions with grosser pieces of matter. This is no mean task, and it puts severe limitations on the kind of thing we can know about microatomic events. It is rather as if an alien intelligence were to try to comprehend the human world on the basis of aerial photographs taken from photographs taken forty thousand feet and nothing else.

*The Mysteries of Modern Science*

Chapter 2 (p. 35)

Routledge & Kegan Paul. London, England. 1977

**Stedman, Edmund Clarence** 1833–1908

American banker, poet, and critic

White orbs like angels pass

Before the triple glass

That men may scan the record of each flame –

Of spectral line and line

The legendary divine

Finding their mould the same, and aye the same,

The atoms that we knew before

Of which ourselves are made – dust, and no more.

*The Poems of Edmund Clarence Stedman*

Poems of Occasion

Corda Concordia

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

There is no evil in the atom; only in men's souls.

Speech

30 April, 1946, House of Commons

**Stoppard, Tom** 1937–

Czech-born English playwright

There is a straight ladder from the atom to the grain of sand, and the only real mystery in physics is the missing rung. Below it, particle physics; above it, classical physics; but in between, metaphysics. All the mystery in life turns out to be this same mystery, the join between things which are distinct and yet continuous, mind and body, free will and causality, living cells and life itself; the moment before the foetus. Who needed God when everything worked like billiard balls?

*Tom Stoppard: Plays*

*Hapgood*, Act I, Scene 5 (p. 545)

Faber & Faber Ltd. London, England. 1999

...make a fist, and if your fist is as big as the nucleus of one atom then the atom is as big as St Paul's, and if it happens to be a hydrogen atom then it has a single electron flitting about like a moth in the empty cathedral, now by the dome, now by the altar ...

*Hapgood* (p. 81)

Samuel French, Inc. New York, New York, USA. 1990

**Tennyson, Alfred (Lord)** 1809–92

English poet

If all be atoms, how then should the Gods

Being atomic not be dissoluble,

Not follow the great law?

*Alfred Tennyson's Poetical Works*

Lucretius, l. 114–116

Oxford University Press, Inc. London, England. 1953

...saw the flaring atom-streams

And torrents of her myriad universe,

Ruining along the illimitable inane,

Fly on to clash together again, and make

Another and another frame of things

Forever ...

In Henry van Dyke and David Laurance Chambers

*Poems of Tennyson*

Lucretius

Ginn & Co. Boston, Massachusetts, USA. 1903

**Tesla, Nikola** 1856–1943  
Croatian-American electrical engineer

But now a mechanism consisting of a finite number of parts and few at that, cannot perform an infinite number of definite motions, hence the impulses which govern its movements must come from the environment. So the atom, the ulterior element of the universe's structure is tossed about in space eternally, a play of external influences, like a boat in a troubled sea. Were it to stop its motion it would die. Matter at rest, if such a thing could exist, would be matter dead. Death of matter! Never has a sentence of deeper philosophical meaning been uttered. . . . There is no death of matter, for throughout the infinite universe, all has to move to vibrate, that is, to live.

*Lectures, Patents, Articles*

On light and other high frequency phenomena, Delivered before the Franklin Institute, Philadelphia, February, 1893. Tesla Museum, Beograd, Yugoslavia, 1956 (p. L–110)

**Thompson, Hunter S.** 1937–2005  
American journalist and writer

He seemed surprised. "You found a knife that can cut off an atom?" he said. "In this town?" I nodded. "We're sitting on the main nerve right now," I said.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?* Chapter 2 (p. 25)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Thomson, Sir Joseph John** 1856–1949  
English physicist

...there are regions in the atom, probably the most interesting of all, about which we know little or nothing, whose investigation will provide intensely interesting work for many generations of physicists, who will most assuredly have no reason to be 'mournful that no new wonder may betide'. No fact discovered about the atom can be trivial, nor fail to accelerate the progress of physical science, for the greater part of natural philosophy is the outcome of the structure and mechanism of the atom.

*The Atomic Theory* (p. 39)

Clarendon Press. 1914

**Tillich, Paul** 1886–1965  
German-born American theologian

Only the eternal can save us from the anxiety of being a meaningless bit of matter in a meaningless vortex of atoms and electrons.

*The Eternal Now* (p. 77)

Charles Scribner's Sons. New York, New York, USA. 1963

**Tyndall, John** 1820–93  
Irish-born English physicist

Take your dead hydrogen-atoms, your dead nitrogen-atoms, your dead phosphorus-atoms, and all the other atoms, dead as grains of shot, of which the brain is formed.

Imagine them separate and sensationless, observe them running together and forming all imaginable combinations. This, as a purely mechanical process, is seeable by the mind. But can you see, or dream, or in any way imagine, how out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to arise?

Address Delivered Before the English Association Assembled at Belfast Report of the 44th Meeting August, 1874 (p. 37)

**Vaihinger, Hans** 1852–1933  
German philosopher

The opponents of the atom are generally content to point to its contradictions and reject it as unfruitful for science. A rash form of caution, for without the atom science falls.

*The Philosophy of "As If"*

Part I, Chapter XV (pp. 70–71)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1925

**Verne, Jules** 1828–1903  
French novelist

An observer endued with an infinite range of vision, and placed in that unknown center around which the entire world revolves, might have beheld myriads of atoms filling all space during the chaotic epoch of the universe. Little by little, as ages went on, a change took place; a general law of attraction manifested itself, to which the hitherto errant atoms became obedient: these atoms combined together chemically according to their affinities, formed themselves into molecules, and composed those nebulous masses with which the depths of the heavens are strewn. These masses became immediately endued with a rotary motion around their own central point. This center, formed of indefinite molecules, began to revolve around its own axis during its gradual condensation; then, following the immutable laws of mechanics, in proportion as its bulk diminished by condensation, its rotary motion became accelerated, and these two effects continuing, the result was the formation of one principal star, the center of the nebulous mass.

*From the Earth to the Moon*

Chapter V

**von Baeyer, Hans Christian** 1938–  
German-born physicist and author

The atom is not a static structure but a dynamic mechanism in constant interaction with its equally dynamic environment. It is not a grain of sand but a wave-tossed buoy blinking from afar. If we want to understand it, we must look beyond still pictures and record the action in a movie.

*Taming the Atom*

Chapter 7 (p. 117)

Random House, Inc. New York, New York, USA. 1992

If atoms obey spooky rules, and we are made of atoms, why don't we follow the same rules? The answer to the quandary must lie on the theoretical ladder that leads from the laboratory down into the world of atoms, precisely at the missing rung between the two regimes, where classical physics loses its relevance and quantum mechanics takes over.

*Taming the Atom*

Chapter 11 (p. 164)

Random House, Inc. New York, New York, USA. 1992

**von Lindemann, Louis Ferdinand** 1852–1939

German mathematician

...the oxygen atom has the shape of a ring, and the sulphur atom, the shape of a clot.

In L.I. Ponomarev

*The Quantum Dice* (p. 40)

Institute of Physics Publishing, Bristol, England. 1993

**von Weizsäcker, Carl Friedrich (Baron)** 1912–2007

German theoretical physicist and philosopher

...only after the atom has lost the last sensible quality does its true meaning for the physical world view become clear; the unity – real, though remote from our immediate perception – of all that our perception knows only as a multitude of appearances is systematically held together and symbolically represented in it, but not mechanically explained.

Translated by Majorie Grene

*The World View of Physics*

Chapter Two (pp. 55–56)

Routledge & Kegan Paul. London, England. 1952

**Wallace, Robert C.** 1881–1955

Scottish-Canadian geologist and educator

It is almost with a sense of shock that we realize that the essence of physics and chemistry alike lies in the arrangements within the atom.

Cooperation in the Natural and Human Sciences

*Canadian Historical Review*, Volume XIV, Number 4, December, 1933 (p. 374)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

A little while ago we thought of the atoms as we thought of bricks, as solid building material, as substantial matter, as unit masses of lifeless stuff, and behold! these bricks are boxes, treasure boxes, boxes full of the intensest force.

*The World Set Free*

Prelude, Section 8

E.P. Dutton. & Company. New York, New York, USA. 1914

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

For every atom belongs to me as good as belongs to you.

*Complete Poetry and Collected Prose*

Song of Myself, I.

The Library of America. New York, New York, USA. 1982

I celebrate myself, and sing myself,  
And what I assume you shall assume,  
For every atom belongs to me as good belongs to you.

*Leaves of Grass*

Song of Myself

Mitchell Kennerley

New York, New York, USA. 1914

**Wordsworth, William** 1770–1850

English poet

To let a creed, built in the heart of things,  
Dissolve before a twinkling atom!

*The Complete Poetical Works of William Wordsworth*

The Borderers, Act III, I. 1220–1221

Crowell. New York, New York, USA. 1888

**Wysong, R. L.**

American veterinary surgeon

A well known principle in physics is the Heisenberg principle of uncertainty. The principle basically argues that the movement of electrons and atoms is a random process. If the atom is governed by random processes, how could there be biochemical bias? If the law of the atom is randomness how can we cite the atom as the source of order?

*The Creation-Evolution Controversy*

Chapter 7 (p. 126)

Inquiry Press. Midland, Texas, USA. 1976

## ATOMIC

**Dr. T (Fictional character)**

Dr. T.: "Is it, is it... atomic?"

Bert Collins: "Yes sir, very atomic!"

*The 5000 Fingers of Dr. T.*

The film (1953)

**Macfie, Ronald Campbell** 1867–1931

Scottish poet and physician

It is often assumed that the atomic theory has divested nature of its mystery, and has reduced natural and evolutionary processes to the level of ordinary mechanics. But this is not so. The atomic theory doubles the mystery and the wonder of life. Any artist might mould a bird or beast of clay, but where is the artist who could make so much as a little finger-nail or a single eyelash out of the dancing molecules? And yet continually this miracle is wrought. The molecules I take for dinner, the molecules I unconsciously breathe, will find their way to the little finger-nail or eyelash, and will take there their appointed places.

*Science, Matter and Immortality*

Chapter 17 (p. 213)

William & Norgate. London, England. 1909

## ATOMIC AGE

### Dr. Harold Medford (Fictional character)

When Man entered the atomic age, he opened a door into a new world. What will he eventually find in that new world, nobody can predict.

*Them*

Film (1954)

## ATOMIC BOMB

### Churchill, Winston Spencer 1882–1965

British prime minister, statesman, soldier, and author

This revelation of the secrets of nature, long mercifully withheld from man, should arouse the most solemn reflections in the mind and conscience of every human being capable of comprehension. We must indeed pray that these awful agencies will be made to conduce to peace among the nations, and that instead of wrecking measureless havoc upon the entire globe, they may become a perennial fountain of world prosperity.

Statement by Prime Minister Attlee and Former Prime Minister Churchill on the Atomic Bomb, August 6, 1945

### Compton, Arthur H. 1892–1962

American physicist

It is hard to think of fissionable materials when fashioned into bombs as being a source of happiness. However this may be, if with such destructive weapons men are to survive, they must grow rapidly in human greatness.

*Atomic Quest: A Personal Narrative*

Prologue (p. xix)

Oxford University Press. London, England. 1956

### Farrell, Thomas Francis 1891–1967

US Army General

The whole country was lighted by a searching light with the intensity many times that of the midday sun.

*Dawn over Zero*

Part III, Chapter Thirteen (p. 194)

Alfred A. Knopf. New York, New York, USA. 1946

### Einstein, Albert 1879–1955

German-born physicist

Often in evolutionary processes a species must adapt to new conditions in order to survive. Today the atomic bomb has altered profoundly the nature of the world as we know it, and the human race consequently finds itself in a new habitat to which it must adapt its thinking.

*New York Times Magazine*, June 23, 1946

### Fulbright, James William 1905–95

American politician

What a curious picture it is to find man, homo sapiens, of divine origin, we are told, seriously considering going

underground to escape the consequences of his own folly. With a little wisdom and foresight, surely it is not yet necessary to forsake life in the fresh air and in the warmth of the sunlight. What a paradox if our own cleverness in science should force us to live underground with the moles.

*Congressional Record* (Volume 91)

*The Effect of the Atomic Bomb on American Foreign Policy*

Appendix (p. A4654)

US Government Printing Office. Washington, D.C. November 2, 194

### Harris Homer 1916–2000

American blues singer

It was early one morning, when all the good work was done

It was early one morning, when all the good work was done  
And that big bird was loaded, with that awful atomic bomb.

*Atomic Bomb Blues*

Sung by Homer Harris (with Muddy Waters)

### Khrushchev, Nikita S. 1894–1971

Russian statesman

I happened to read recently a remark by the American nuclear physicist W. Davidson, who noted that the explosion of one hydrogen bomb releases a greater amount of energy than all the explosions set off by all countries in all wars known in the entire history of mankind. And he, apparently, is right.

*The New York Times*, September 19, 1959 (p. 8)

### Le Guin, Ursula K. 1929–

American writer

...it is only when science asks why, instead of simply describing how, that it becomes more than technology. When it asks why, it discovers Relativity. When it only shows how, it invents the atomic bomb, and then puts its hands over its eyes and says, *My God what have I done?*

In Susan Wood (ed.)

*The Language of the Night*

The Stalin in the Soul (p. 219)

G.P. Putnam's Sons. New York, New York, USA. 1976

### O'Casey, Seán 1889–1964

Irish dramatist and memoirist

The flame from the angel's sword in the garden of Eden has been catalyzed into the atom bomb; God's thunderbolt became blunted, so man's thunderbolt [sic] has become the steel star of destruction.

*Sunset and Evening Star*

An Evening Star (p. 326)

The Macmillan Co. New York, New York, USA. 1954

### Oppenheimer, James Robert 1904–67

American theoretical physicist

There is only one future of atomic explosives that I can regard with any enthusiasm: that they should never be used in war.

*The Open Mind*

Chapter I (p. 5)

Simon & Schuster. New York, New York, USA. 1955

It is possible that in the large light of history, if indeed there is to be history, the atomic bomb will appear not very different than in the bright light of the first atomic explosion.

*The Open Mind*

Atomic Weapons and American Policy (p. 61)

Simon & Schuster. New York, New York, USA. 1955

If atomic bombs are to be added as new weapons to the arsenals of a warring world, or to the arsenals of nations preparing for war, then the time will come when mankind will curse the names of Los Alamos and Hiroshima. The people must unite, or they will perish.

In Alice Kimball Smith and Charles Weiner

Robert Oppenheimer: The Los Alamos Years

*Bulletin of the Atomic Scientists*, Volume 36, Number 6, June, 1980 (p. 14)

But when you come, right down to it, the reason that we did this job [build the atomic bomb] is because it was an organic necessity. If you are a scientist you cannot stop such a thing. If you are a scientist you believe that it is good to find out how the world works; that it is good to find out what the realities are; that it is good to turn over to mankind at large the greatest possible power to control the world and to deal with it according to its lights and values.

In Alice Kimball Smith and Charles Weiner

Robert Oppenheimer: The Los Alamos Years

*Bulletin of the Atomic Scientists*, Volume 36, Number 6, June, 1980 (p. 15)

... we have made a thing, a most terrible weapon, that has altered abruptly and profoundly the nature of the world. We have made a thing that, by all standards of the world we grew up in, is an evil thing. And by doing so, by our participation in making it possible to make these things, we have raised again the question of whether science is good for man, of whether it is good to learn about the world, to try to understand it, to try to control it, to help give to the world of men increased insight, increased power. Because we are scientists, we must say an unalterable yes to these questions; it is our faith and our commitment, seldom made explicit, even more seldom challenged, that knowledge is a good in itself, knowledge and such power as must come with it.

Atomic Weapons

*Proceedings, American Philosophical Society*, Volume 90, Number 1 (p. 7)

**Paglia, Camille** 1947–

American author, teacher, and social critic

There are no accidents, only nature throwing her weight around. Even the bomb merely releases energy that nature has put there. Nuclear war would be just a spark in the grandeur of space. Nor can radiation alter nature: she will absorb it all. After the bomb, nature will pick up

the cards we have spilled, shuffle them, and begin her game again.

*Sexual Personae: Art and Decadence From Nefertiti to Emily Dickinson*

Chapter 1 (p. 38)

Yale University Press. New Haven, Connecticut, USA. 1990

**Pauling, Linus** 1901–94

American chemist

It is the atomic bomb which is responsible for my being here tonight – just as the atomic bomb may be responsible for our all not being here a few years from now.

In Barbara Marinacci

*Linus Pauling in His Own Words*

Chapter VII (p. 145)

Simon & Schuster. New York, New York, USA. 1995

**Pope, Alexander** 1688–1744

English poet

Atoms or systems into ruin hurled, And now a bubble burst, and now a world.

*The Works of Alexander Pope* (Volume 2)

*An Essay of Man*

Epistle I

John Murray. London, England. 1871

**Shaw, George Bernard** 1856–1950

Irish playwright

Now that we, the human race, have began monkeying with the atom may I point out one possible consequence that would end all our difficulties?

For some years past our too few professional astronomers have been reinforced by a body of amateurs whose main activity is the watching and study of variable stars. They have been excited several times by the sudden flaming up of what they call a new star, though it is, in fact, an old star too small and cool to be visible which has suddenly burst and blown up, leaving nothing but a cloud of star dust called a nebula. The heat energy liberated in the explosion is beyond human apprehension. Apparently what has happened to these stars, and may happen to this earth of ours, is that the protons with their planetary electrons, and the heavier planetless neutrons of which their matter is composed, have combined, and produced a temperature at which the whole star has pulverized and evaporated, and its inhabitants, if any, have been cremated with an instantaneous thoroughness impossible at Golder's Green.

*The Times of London*, The Atomic Bomb August 20, 1945 (p. 21)

## ATOMIC COCKTAIL

**Gillard, Slim**

American singer

It's the drink that you don't pour

Now when you take one sip you won't need anymore



You're small as a beetle or big as a whale  
BOOM-Atomic Cocktail

*Atomic Cocktail*  
Atomic 215-A  
Recorded 1945

## ATOMIC ENERGY

**Aston, Francis William** 1877–1945  
English physicist and chemist

Should the research worker of the future discover some means of releasing this [atomic] energy in a form which could be employed, the human race will have at its command powers beyond the dream of scientific fiction, but the remotest possibility must always be considered that the energy once liberated will be completely uncontrollable and by its intense violence detonate all neighboring substances. In this event, the whole of the hydrogen on earth might be transformed at once and the success of the experiment published at large to the universe as a new star.

*Nobel Lectures, Chemistry 1922–1941*  
Mass Spectra and Isotopes (p. 20)  
Elsevier Publishing. Amsterdam, The Netherlands. 1966

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

If indeed, the subatomic energy in the stars is being freely used to maintain their great furnaces, it seems to bring a little nearer to fulfillment our dream of controlling this latent power for the well-being of the human race – or for its suicide.

*The Internal Constitution of Stars*  
*Nature*, Volume 106, Number 2603, 2 September, 1920 (p. 19)

**Einstein, Albert** 1879–1955  
German-American physicist

Since I do not foresee that atomic energy is to be a great boon for a long time, I have to say that for the present it is a menace. Perhaps it is well that it should be. It may intimidate the human race into bringing order into its international affairs, which, without the pressure of fear, it would not do.

*Atomic War or Peace*  
*Atlantic Monthly*, November, 1945

**Lewis, Edwin H.**  
No biographical data available

Now this is the law of Ryerson and this is the price of peace –

That men shall learn to measure or ever their strife shall cease.

They shall measure the cost of killing, and measure the hearts that bleed,

And measure the earth for sowing, and measure the sowing of seed.

When Ryerson rose like a dream, none dreamed of the lightning massed

In the welded heart of an atom.

In Arthur H. Compton  
The First of the Sciences  
*Popular Astronomy*, Volume 47, Number 7, September, 1939 (p. 349)

## ATOMIC LANDSCAPE

**Church, Peggy Pond** 1903–86  
American poet

We had thought the magicians were all dead, but this was the blackest of magic.

There was even the accompaniment of fire and brimstone,

The shape of evil, towering leagues high into the heaven  
In terrible, malevolent beauty, and, beneath, the bare trees

Made utterly leafless in one instant, and the streets where no one

Moved, and some wall still standing

Eyeless, and as silent as before Time.

*Ultimatum for Man*  
The Nuclear Physicist  
Stanford University Press. Stanford, California, USA. 1946

**Eddington, Sir Arthur Stanley** 1882–1944  
English Astronomer and physicist

I am afraid the knockabout comedy of modern atomic physics is not very tender towards our aesthetic ideals. The stately drama of stellar evolution turns out to be more like the hair-breadth escapades in the films. The music of the spheres has a painful suggestion of – jazz.”

*Stars and Atoms*  
Lecture I (p. 27)  
Yale University Press. New Haven, Connecticut, USA. 1927

**Laurence, William Leonard** 1888–1977  
Lithuanian-American journalist

And just at that instant there rose as if from the bowels of the earth a light not of this world, the light of many suns in one.

It was a sunrise such as the world had never seen, a great green super-sun climbing in a fraction of a second to a height of more than 8,000 feet, rising ever higher until it touched the clouds, lighting up earth and sky all around with dazzling luminosity.

Up it went, a great wall of fire about a mile in diameter, changing colors as it kept shooting upward, from deep purple to orange, expanding, growing bigger, rising as it was expanding, an elemental force freed from its bonds after being chained for billions of years.

Drama of the Atomic Bomb Found Climax in New Mexico Test  
*New York Times*, A16, column 5, September 26, 1945



**Narrator**

But the end, when it came, was to be from the sky. Irresistible. Unimaginable. Mushroom shaped.

*The World at War*

Episode 22, Japan

Film documentary

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

[W]hile man still struggles and dreams, his very substance will change and crumble from beneath him.... Suppose, indeed, that is to be the end of our planet; no splendid climax and finale, no towering accumulation of achievements, but just – atomic decay! I add that to the ideas of the suffocating comet, the dark body out of space, the burning out of the sun, the distorted orbit, as a new and far more possible end – as Science can see ends – to this strange by-play of matter that we call human life. I do not believe this can be the end; no human soul can believe in such an end and go on living, but to it science points as a possible thing, science and reason alike. If single human beings – if one single ricketty infant – can be born as it were by accident and die futile, why not the whole race?

*Tono-Bungay*

Book the Third, Chapter the Fourth, V (p. 387)

Duffield & Company. New York, New York, USA. 1921

**ATOMIC PARTICLE****Dalton, John** 1766–1844

English chemist and physicist

In the last lecture we endeavored to shew that matter, though divisible in an *extreme degree*, is nevertheless not infinitely indivisible – that there must be some point beyond which we cannot go in the division of matter. The existence of these ultimate particles of matter can scarcely be doubted, though they are probably much too small ever to be exhibited by microscopic improvements.

In Henry Enfield Roscoe

*John Dalton and the Rise of Modern Chemistry*

Chapter VI (p. 136)

The Macmillan Co. New York, New York, USA. 1895

**ATOMIC POWER****Compton, Arthur H.** 1892–1962

American physicist

The reward for using the atom's power towards man's welfare is great and sure. The punishment for its misuse would seem to be death and the destruction of the civilization that has been growing for a thousand years. These are the alternatives that atomic power, as the steel of Daedalus, presents to mankind. We are forced to grow to greater manhood.

*Atomic Quest: A Personal Narrative*

Prologue (p. xix)

Oxford University Press. London, England. 1956

**Hawkins, Hawkshaw**

American country artist

**Big Slim**

Then a flash, a rumbling roar out across the desert floor  
They had found the atomic power from above  
Then God with His mighty hand showed the world  
it could not stand

When they found the mighty, mighty Atomic Power

*When They Found the Atomic Power*

King 611, 19476

**Kirby, Fred**

American country artist and radio personality

Atomic power, atomic power

Was given by the mighty hand of God

Atomic power, atomic power

It was given by the mighty hand of God

*Atomic Power*

RCA Victor 20–1850, 1946

**ATOMIC THEORY****Sylvester, James Joseph** 1814–97

English mathematician

By the *new* Atomic Theory I mean that sublime invention of Kekule which stands to the *old* in a somewhat similar relation as the Astronomy of Kepler to Ptolemy's, or the System of Nature of Darwin to that of Linnaeus – like the latter it lies outside of the immediate sphere of energetics, basing its laws on pure relations of form, and like the former as perfected by Newton, these laws admit of exact arithmetical definitions.

On An Application of the New Atomic Theory to the Graphical Representation of the Invariants and Covariants of Binary Quantics – With Three Appendices

*American Journal of mathematics*, Volume 1, Number 1, 1878 (p. 64)

**ATOMIC WEIGHT****Crookes, Sir William** 1832–1919

English chemist and physicist

I conceive, therefore, that when we say the atomic weight of, for instance, calcium is 40, we really express the fact that, while the majority of calcium atoms have an actual atomic weight of 40, there are not a few which are represented by 39 or 41, a less number by 38 or 42, and so on.

*Report of the Fifty-sixth Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 569)

John Murray. London, England. 1887

**Richards, Theodore William** 1868–1928  
American chemist

If our inconceivably ancient Universe even had any beginning, the conditions determining that beginning must even now be engraved in the atomic weights. They are the hieroglyphics which tell in a language of their own the story of the birth or evolution of all matter, and the Periodic Table containing the classification of the elements is the Rosetta Stone, which may enable us to interpret them. Until, however, these hieroglyphics are clearly visible in their true form, we cannot hope for an interpretation.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1914

Atomic Weights (p. 282)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

## ATOMICITY

**Sylvester, James Joseph** 1814–97  
English mathematician

The beautiful theory of atomicity has its home in the attractive but somewhat misty border land lying between fancy and reality and cannot, I think, suffer from any not absolutely irrational guess which may assist the chemical enquirer to rise to a higher level of contemplation of the possibilities of his subject.

On An Application of the New Atomic Theory to the Graphical Representation of the Invariants and Covariants of Binary Quantics – With Three Appendices

*American Journal of mathematics*, Volume 1, Number 1, 1878 (p. 79)

## ATOMISM

**Democritus of Abdera** 460 BCE–370 BCE  
Greek philosopher

By convention are sweet and bitter, hot and cold, by convention is color; in truth are atoms and the void.... In reality we apprehend nothing exactly, but only as it changes according to the condition of our body and the things that impinge on or offer resistance to it.

In G.S Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 589 (p. 422)

At the University Press. Cambridge, England. 1963

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

Again after the revolution of many of the sun's years a ring on the finger is thinned on the under side by wearing, the dripping from the eaves hollows a stone, the bent ploughshare of iron imperceptibly decreases in the fields, and we behold the stone-paved streets worn down by

the feet of the multitude.... These things then we see are lessened, after they are thus worn down; but what bodies depart at any given time nature has jealously shut out the means of seeing...

In *Great Books of the Western World* (Volume 12)

*Lucretius: On the Nature of Things*

Book One, l. 311–324 (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ATTENTION

**Lepper, George Henry**

No biographical data available

...the most striking mental peculiarity of mankind in the past has been its proneness, in all ages, to focus attention on the things at a distance rather than on those close at hand, to prefer the abstruse to the simple, the miraculous to the natural, the obscure to the obvious.

*From Nebula to Nebula* (3rd edition)

Introduction (p. 13)

Privately printed. Pittsburgh, Pennsylvania, USA. 1917

**Willmott, Robert Eldridge Aris** 1809–63  
English writer and poet

Attention makes the genius; all learning, fancy, and science, depend upon it. Newton traced back his discoveries to its unwearied employment. It builds bridges, opens new worlds, and heals diseases; without it Taste is useless, and the beauties of literature are unobserved ...

*Pleasures, Objects, and Advantages, of Literature* (4th edition)

Chapter X (p. 37)

G. Routledge & Co. London, England. 1855

## ATTRACTION

**Davy, Sir Humphry** 1778–1829  
English chemist

Attraction, of whatever kind, tends, as it were, to produce rest – a sort of eternal sleep in Nature.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Sixth (p. 179)

Cassell & Co., Ltd. London, England. 1889

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

By the Table in the second Part of the second Book, wherein the thicknesses of colour'd Plates of Water between two Glasses are set down, the thickness of the Plate where it appears very black, is three eighths of the ten hundred thousandth part of an Inch. And where the Oil of Oranges between the Glasses is of this thickness, the Attraction collected by the foregoing Rule, seems to be so strong, as within a Circle of an Inch in diameter, to suffice to hold up a Weight equal to that of a Cylinder of Water of an Inch in diameter, and two or three Furlongs in

length. And where it is of a less thickness the Attraction may be proportionally greater, and continue to increase, until the thickness[es] do not exceed that of a single Particle of the Oil. There are therefore Agents in Nature able to make the Particles of Bodies stick together by very strong Attractions. And it is the Business of experimental Philosophy to find them out.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III: Part I, Query 31

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## AURORA BOREALIS

**Ackerman, Diane** 1948–

American writer

As we flew down across the Canadian Arctic, we were beneath an arc of northern lights, which were pure green and bell-shaped. We and the plane were the clapper of this bell, with the green light over us. And for the first time in my life I felt that I was in the position of the whale that is singing to you when you're in the boat and just listening to it.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

The Moon by Whale Light (p. 130)

Random House, Inc. New York, New York, USA. 1991

### Author undetermined

...those northern lights have this peculiar nature, that the darker the night is, the brighter they seem, and they always appear at night but never by day, most frequently in the densest darkness and rarely by moonlight. In appearance they resemble a vast flame of fire viewed from a great distance. It also looks as if sharp points were shot from this flame up into the sky, they are of uneven height and in constant motion, now one, now another darting highest; and the lights appears to blaze like a living flame... it seems to me not unlikely that the frost and the glaciers have become so powerful there that they are able to radiate forth these flames.

Translated by L.M. Larson

*Scandinavian Monograph* (Volume 3)

The King's Mirror

Chapter XIX (pp. 150, 151)

The American-Scandinavian Foundation. New York, New York, USA. 1917

**Aytoun, William Edmondstone** 1813–65

Scottish poet and parodist

All night long the northern streamers

Shot across the trembling sky:

Fearful lights, that never beckon

Save when kings or heroes die.

Edinburgh after Flodden

*Harper's New Monthly Magazine*, Volume 28, Number 165, February, 1864 (p. 337)

**Burns, Robert** 1759–96

English writer

The cauld blaie North was streaming forth

Her lights, wi' hissing eerie din.

*The Complete Poetical Works of Robert Burns*

A Vision

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Faraday, Michael** 1791–1867

English physicist and chemist

I hardly dare venture, even in the most hypothetical form, to ask whether the Aurora Borealis and Australis may not be the discharge of electricity, thus urged towards the poles of the earth, from whence it is endeavoring to return by natural and appointed means above the earth to the equatorial regions.

*Experimental Researches in Electricity*

Evolution of Electricity from Magnetism (p. 56)

Richard & John Edward Taylor. London, England. 1839

**Haliburton, Thomas C.** 1796–1865

Canadian jurist and writer

The sun has scarcely set behind the dark wavy outline of the western hills, ere the aurora borealis mimics its setting beams, and revels with wild delight in the heavens, which it claims as its own, now ascending with meteor speed to the zenith, then dissolving into a thousand rays of variegated light, that vie with each other which shall first reach the horizon; now flashing bright, brilliant and glowing, as emanations of the sun, then slowly retreating from view pale and silvery white like wandering moonbeams.

*The Old Judge*

The Seasons (p. 210)

Clarke, Irwin & Company Ltd. Toronto, Ontario, Canada. 1968

**Kingsley, Charles** 1819–75

English clergyman and writer

Night's son was driving

His golden-haired horses up;

Over the eastern firths

High flashed their manes.

*Poems*

The Longbeards' Saga

Ticknor & Fields. Boston, Massachusetts, USA. 1856

**Longfellow, Henry Wadsworth** 1807–82

American poet

And now the Northern Lights begin to burn, faintly at first, like sunbeams playing in the waters of the blue sea. Then a soft crimson glow tinges the heavens. There is a blush on the cheek of night. The colors come and go, and change from crimson to gold, from gold to crimson. The snow is stained with rosy light. Twofold from the zenith, east and west, flames a fiery sword; and a broad band passes athwart the heavens like a summer sunset.

Soft purple clouds come sailing over the sky, and through their vapory folds the winking stars shine white as silver. With such pomp as this is Merry Christmas ushered in, though only a single star heralded the first Christmas.

*The Prose Works of Henry Wadsworth Longfellow*

Driftwood-Frithiof's Saga (p. 325)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**von Payer, Julius** 1841–1915

Austro-Hungarian arctic explorer

It is very difficult to characterise the forms of this phenomenon [aurora borealis], not only because they are manifold, but because they are constantly changing. Sometimes the Aurora appears like flaming arches with glowing balls of light; sometimes in irregular meridians painted on the heavens, sometimes in brilliant bands and patches of light on the sky.

*New Lands Within the Arctic Circle* (Volume 1)

Chapter XV (p. 322)

Macmillan & Company Ltd. London, England. 1876

**Nansen, Fridtjof** 1861–1930

Norwegian explorer, oceanographer, and statesman

The glowing fire-masses had divided into glistening, many coloured bands, which were writhing and twisting across the sky both in the south and north. The rays sparkled with the purest, most crystalline rainbow colours, chiefly violet-red or carmine and the clearest green. Most frequently the rays of the arch were red at the ends, and changed higher up into sparkling green.... It was an endless phantasmagoria of sparkling colour, surpassing anything that one can dream. Sometimes the spectacle reached such a climax that one's breath was taken away; one felt that now something extraordinary must happen – at the very least the sky must fall.

*Fridtjof Nansen: The Fram Expedition–Nansen in the Frozen World*

A.G. Holman. Philadelphia, Pennsylvania, USA. 1897

**Remek, Vladimír** 1948–

Czechoslovakian cosmonaut

Firefly meteorites blazed against a dark background, and sometimes the lightning was frighteningly brilliant. Like a boy, I gazed open-mouthed at the fireworks, and suddenly, before my eyes, something magical occurred. A greenish radiance poured from Earth directly up to the station, a radiance resembling gigantic phosphorescent organ pipes, whose ends were glowing crimson, and overlapped by waves of swirling green mist. Consider yourself very lucky, Vladimír, I said to myself, to have watched the northern lights.

The View from Out There: In Words and Pictures

*Life magazine*, Volume 11, Number 13, November, 1988 (p. 195)

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

He knew, by streamers that shot so bright,

That spirits were riding the northern light.

*The Complete Poetical Works of Sir Walter Scott*

The Lay of the Last Minstrel, Canto Second, VIII, l. 91–2

T.Y. Crowell. New York, New York, USA. 1894

**Service, Robert William** 1874–1958

Canadian poet and novelist

Some say that the Northern Lights are the glare of the Arctic ice and snow;

And some that it's electricity, and nobody seems to know.

*Collected Poems of Robert Service*

The Ballad of the Northern Lights

Dodd, Mead & Company New York, New York, USA. 1961

And the Northern Lights in the crystal nights came forth with a mystic gleam.

They danced and they danced the devil-dance over the naked snow;

And soft they rolled like a tide upshoaled with a ceaseless ebb and flow.

They rippled green with a wondrous sheen, they fluttered out like a fan;

They spread with a blaze of rose-pink rays never yet seen of man.

*Collected Poems of Robert Service*

The Ballad of the Northern Lights

Dodd, Mead & Company New York, New York, USA. 1961

**Stosz, Wilhelm**

No biographical data available

Nations that as yet rest close to Nature's breast do not seek explanations of such phenomena [aurora borealis]; while those that have risen to a higher plane of culture are in possession of simple descriptions of these occurrences, and also of crude attempts at investigating Nature's wonders.

Northern Lights

*The Popular Science Monthly*, Volume 36 (p. 801)

**Taylor, Bayard** 1825–78

American journalist and writer

The amber midnight smiles in dreams of dawn.

*The Poetical Works of Bayard Taylor*

From the North

Houghton, Osgood. Boston, Massachusetts, USA. 1880

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

“What are fireworks like?” she asked...

“They are like the Aurora Borealis,” said the King...

“only much more natural. I prefer them to stars myself, as you always know when they are going to appear...”

*Oscar Wilde Selected Writing*

The Remarkable Rocket (p. 196)

Oxford University Press, Inc. London, England. 1961

## AURORAL CURTAIN

**Proctor, Richard Anthony** 1837–88  
English astronomer

The brilliant streamers of coloured light which wave at certain seasons over the heavens have long since been recognised as among the most singular and impressive of all the phenomena which the skies present to our view. There is something surpassingly beautiful in the appearance of the true ‘auroral curtain.’ Fringed with coloured streamers, it waves to and fro as though shaken by some unseen hand.

*Light Science for Leisure Hours* (5th edition)  
Strange Discoveries Respecting the Aurora (p. 1)  
Longmans, Green & Co. London, England. 1884

## AUTHOR

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Friend! were an author privileged to name his own judge – in addition to moral and intellectual competence I should look round for some man, whose knowledge and opinions had for the greater part been acquired experimentally; and the practical habits of whose life had put him on his guard with respect to all speculative reasoning, without rendering him insensible to the desirableness of principles more secure than the shifting rules and theories generalized from observations merely empirical, or unconscious in how many departments of knowledge, and with how large a portion even of professional men, such principles are still a *desideratum*.

*The Complete Works of Samuel Taylor Coleridge* (Volume 2)  
Preface to Second Edition (p. 15)  
Harper & Brothers Publishers. New York, New York, USA. 1884

## AUTHORITY

**Andreski, Stanislaw** 1919–  
Polish sociologist

So long as authority inspires awe, confusion and absurdity enhance conservative tendencies in society. Firstly, because clear and logical thinking leads to a cumulation of knowledge (of which the progress of the natural sciences provides the best example) and the advance of knowledge sooner or later undermines the traditional order. Confused thinking, on the other hand, leads nowhere in particular and can be indulged indefinitely without producing any impact upon the world.

*Social Sciences as Sorcery*  
Chapter 7 (p. 90)  
St. Martin's Press. New York, New York, USA. 1972

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Anyone who in discussion relies upon authority uses, not his understanding, but rather his memory.

*The Literary Works of Leonardo da Vinci* (Volume 2)  
1159 (p. 241)  
University of California Press. Berkeley, California, USA. 1977

**Fort, Charles** 1874–1932  
American writer

The great difficulty that authoritativeness has to contend with is some other authoritativeness.

*The Book of the Damned*  
Chapter III (p. 35)  
Boni & Liveright. New York, New York, USA. 1919

**Gregory, Sir Richard Arman** 1864–1952  
English scientific writer and journalist

In the world of natural knowledge, no authority is great enough to support a theory when a crucial observation has shown it to be untenable.

*Discovery, Or, The Spirit and Service of Science*  
Chapter I (p. 12)  
Macmillan & Co Ltd. London, England. 1918

**Recorde, Robert** 1510?–58  
English mathematician and writer

No man can worthily praise Ptolemy, his travel being so great, his diligence so exact in observations, and conference with all nations, and all ages, and his reasonable examination of all opinions, with demonstrable confirmation of his owne assertion, yet muste you and all men take heed, that both in him and in all mennes workes, you be not abused by their authoritye, but evermore attend to their reasons, and examine them well, ever regarding more what is saide, and how it is proved, than who saieith it for authorite often times deceaveth many menne...

*The Castle of Knowledge*  
The Fourth Treatise (p. 119)  
Imprinted by R. Wolfe. London, England. 1556

**Shah, Idries** 1924–96  
Persian author and teacher in the Sufi tradition

The lecture which you are about to hear from Sheikh Rahimi lacks conviction. Why, he is so unsure of himself that he has actually adducted written proofs and authorities to what he says.

*Thinkers of the East*  
Rahimi (p. 104)  
Jonathan Cape. London, England. 1971

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Authority – the fact, namely, that something has already happened or been said or decided, is of great value; but it is only a pedant who demands authority for everything.



Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
 535 (p. 188)  
 The Macmillan Co. New York, New York, USA. 1906

**Wright, Thomas** 1711–86  
 English cosmologist

...I am an Enemy to the taking of anything for granted, merely because a Person of reputed Judgment, has been heard to say, it absolutely is so...

*An Original Theory or New Hypothesis of the Universe*  
 Letter the Second (p. 9)  
 Printed for the Author. London, England. 1750

## AUTONOMY

**Swartz, Norman**  
 American philosopher

If the physical laws of this world are autonomous, we are not free; if we are free, then the physical laws are not autonomous.

*The Concept of Physical Law*  
 Chapter 10  
 Cambridge University Press. Cambridge, England. 1985

## AUTOPSY

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
 English novelist

Mrs. Dollop became more and more convinced...Dr Lydgate meant to let the people die in the Hospital, if not to poison them, for the sake of cutting them up without saying by your leave or with your leave; for it was a known "fac" that he had wanted to cut up Mrs. Goby, as respectable a woman as any in Parley Street, who had money in trust before her marriage – a poor tale for a doctor, who if he was good for anything should know what was the matter with you before you died, and not want to pry into your inside after you were gone.

*Middlemarch*  
 Book V, Chapter XLV (p. 434)  
 Clarendon Press. Oxford, England. 1986

**Flexner, Abraham** 1866–1959  
 American educator

The effective teaching of pathology is dependent on ease and frequency of access to the autopsy-room.... The post-mortem is in this country relatively rare and precarious.... [N]ot infrequently pathological courses are organized and given whose illustrative material is limited to models, to a small number of preserved specimens, or even to bits of material already cut into microscopic sections or just lacking that last touch.

*Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching*  
 Bulletin 4 (p. 66)  
 The Carnegie Foundation. New York, New York, USA. 1910

The physician is constantly in contact with disease processes that he is unable to correlate with the accompanying structural modifications. Occasionally the surgeon throws a stream of light upon such a situation; too often all is dark until the autopsy reveals the truth.

*Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching*  
 Bulletin 4 (p. 66)  
 The Carnegie Foundation. New York, New York, USA. 1910

**Giles, Roscoe C.**  
 No biographical data available

A check-up of one's clinical findings at the autopsy table is indispensable to the progress of the art and science of medicine. The public is being aroused to the importance of autopsies as a matter of self-protection. I believe it is only a matter of time before physicians as well as hospitals will be rated by the percentage of autopsies they do or see in their practices.

Some Clinical Lessons from a Year's Observation in the Department of Pathology of the University of Vienna  
*Journal of the National Medical Association*, Volume 24, 1932

**Morgagni, Giovanni Battista** 1682–1771  
 Italian anatomist and pathologist

*Taceant colloquia. Effugiat risus.*

*Hic locus est ubi mors gaudet succurrere vitae.*

(Let conversations cease. Let laughter depart.

This is the place where death delights to help the living.)

Attributed

## AVALANCHE

**Heinlein, Robert A.** 1907–88  
 American science fiction writer

If a man pushes a rock, can he ignore an avalanche that follows?

*Time Enough for Love*  
 Chapter IX (p. 238)  
 G.P. Putnam's Sons. New York, New York, USA. 1973

**Muir, John** 1838–1914  
 American naturalist

When the snow first gives way on the upper slopes of their basins a dull muffled rush and rumble is heard, which increasing with heavy deliberation, seems to draw rapidly near with appalling intensity of tone. Presently the white flood comes in sight bounding out over bosses and sheer places, leaping from bench to bench, spreading and narrowing and throwing off clouds of whirling diamond dust like a majestic foamy cataract.

*The Yosemite*  
 Chapter 3 (p. 46)  
 Sierra Club Books. San Francisco, California, USA. 1988

Compared with cascades and falls, avalanches are short-lived, few of them lasting more than a minute or two, and



the sharp clashing sounds so common in dashing water are usually wanting; but in their low massy thunder-tones and purple-tinged whiteness, and in their dress, gait, gestures, and general behavior, they are much alike.

*The Yosemite*

Chapter 3 (pp. 46–47)

Sierra Club Books. San Francisco, California, USA. 1988

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

I heard the rumbling thunder of the falling avalanche and marked the smoke of its passage.

*Frankenstein*

Chapter 9 (p. 108)

The Cornhill Publishing Co. Boston, Massachusetts, USA. 1922

## AVERAGE

**Alderson, M. H.**

No biographical data available

If at first you don't succeed, you are running about average.

In Paul Dickson

*The Official Explanations* (p. A-4)

Delacorte Press. New York, New York, USA. 1980

**Atherton, Gertrude** 1857–1948

American novelist

...but they are more hysterical than the average because they have the opportunity their constituents lack, of shouting in public.

*Senator North*

Book II, VII (p. 172)

John Lane: The Bodley Head. New York, New York, USA. 1900

The average intelligence is always shallow, and in electric climates very excitable.

*Senator North*

Book III, Chapter IX (p. 303)

John Lane: The Bodley Head. New York, New York, USA. 1900

**Author undetermined**

*In medio fortissimus ibis.*

Always choose the middle road.

Source undetermined

**Bailey, Thomas D.**

No biographical data available

There must be such a thing as a child with average ability, but you can't find a parent who will acknowledge that it is his child....

Notable and Quotable

*Wall Street Journal*, December 17, 1962 (p. 16)

**Bernard, Claude** 1813–78

French physiologist

Another very frequent application of mathematics to biology is the use of averages which, in medicine and physiology, leads, so to speak, necessarily to error.... By destroying the biological character of phenomena, the use of averages in physiology and medicine usually give only apparent accuracy to the results.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section IX (p. 134)

Henry Schuman, Inc. New York, New York, USA. 1927

Chemical averages are also often used. If we collect a man's urine during twenty-four hours and mix all this urine to analyze the average, we get an analysis of a urine which simply does not exist; for urine, when fasting, is different from urine during digestion. A startling instance of this kind was invented by a physiologist who took urine from a railroad station urinal where people of all nations passed, and who believed he could thus present an analysis of average European urine!

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section ix (pp. 134–135)

Henry Schuman, Inc. New York, New York, USA. 1927

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

About the hardest thing a phellow can do, iz tew spark two girls at onest, and preserve a good average.

*Old Probability: Perhaps Rain – Perhaps Not*

May, 1870 (Green Section)

G.W. Carleton & Company, Publishers. New York, New York, USA.

1879

**Bowley, Arthur Lyon** 1869–1957

English statistician and economist

Of itself an arithmetic average is more likely to conceal than to disclose important facts; it is the nature of an abbreviation, and is often an excuse for laziness.

*The Nature and Purpose of the Measurement of Social Phenomena* (p. 46)

P.S. King & Son. London, England. 1915

**Brandeis, Louis Dembitz** 1856–1941

Lawyer, reformer, and Supreme Court justice

I abhor averages. I like the individual case. A man may have six meals one day and none the next, making an average of three meals per day, but that is not a good way to live.

In Alpheus T. Mason

*Brandeis: A Free Man's Life*

Chapter Ten (p. 145)

The Viking Press. New York, New York, USA. 1956

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

Have shaving too entailed upon their chins –  
A daily plague, which in the aggregate

May average on the whole with parturition.

*The Complete Poetical Works of Byron*

Don Juan

Canto XIV, 23–24

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Carrel, Alexis** 1873–1944

French surgeon and biologist

The best way of increasing the [average] intelligence of scientists would be to reduce their number.

*Man the Unknown*

Chapter 2, Section 4 (p. 49)

Harper & Brothers Publishers. New York, New York, USA. 1939

**Cohen, Morris Raphael** 1880–1947

American philosopher

The concept of average was developed in the Rhodian laws as to the distribution of losses in maritime risks.

*The Statistical View of Nature*

*Journal of the American Statistical Association*, Volume 31, Number 194, June, 1936 (p. 328)

**Dickens, Charles** 1812–70

English novelist

...the criminal intellect...its own professed students perpetually misread, because they persist in trying to reconcile it with the average intellect of average men instead of identifying it as a horrible wonder apart....

*The Mystery of Edwin Drood*

Chapter XX (p. 225)

Oxford University Press. Oxford, England. 1956

**Foss, Sam Walter** 1858–1911

American librarian and poet

The plain man is the basic clod  
From which we grow the demigod;  
And in the average man is curled  
The hero stuff that rules the world.

*Back Country Poems*

Memorial Day, Stanza 2

Lee & Shepard. Boston, Massachusetts, USA. 1894

**Friedman, Milton** 1912–2006

American laissez-faire economist

True, the average rate for the year as a whole, though on the high side, is not too bad, but that is like assuring the nonswimmer that he can safely walk across a river because its average depth is only 4 feet.

Irresponsible Monetary Policy

*Newsweek*, January 10, 1972 (p. 57)

**Froude, James Anthony** 1818–94

English historian and biographer

Unfortunately, the average of one generation need not be the average of the next.

*Short Studies on Great Subjects* (Volume 1)

The Science of History (p. 26)

Longmans, Green & Company. London, England. 1879

My friends at Rhodes made me so. I cost as much as sixteen gold gods of average size.

*Short Studies on Great Subjects* (Volume 3)

Lucian (p. 225)

Charles Scribner's Sons. New York, New York, USA. 1890

We have to consider the million, not the units; the average, not the exceptions.

*Short Studies on Great Subjects* (Volume 2)

On Progress (p. 261)

Charles Scribner's Sons. New York, New York, USA. 1890

**Grover Snood (Fictional character)**

“You can't fight the law of averages,” Grover said, “you can't fight the curve.”

In Thomas Pynchon

*Slow Learner: Early Stories*

The Secret Integration (p. 142)

Little Brown Publishers. Boston, Massachusetts, USA. 1984

**Harte, Francis Bret** 1839–1902

American writer and poet

Give me a man that is capable of a devotion to anything, rather than a cold, calculating average of all the virtues!

*Two Men of Sandy Bar*

Act IV (p. 425)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1910

**Heller, Walter** 1915–87

American economist

If a man stands with his left foot on a hot stove and his right foot in a refrigerator, the statistician would say that, on the average, he's comfortable.

In Harry Hopkins

*The Numbers Game: The Bland Totalitarianism*

Chapter 12, Faithful Partners, Counter Attack (p. 270)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

But an average, which was what I meant to speak about, is one of the most extraordinary subjects of observation and study.

*The Autocrat of the Breakfast-Table*

Chapter VI (p. 140)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hooke, Robert** 1635–1703

English physicist

On the average, bunting with a man on first loses a lot of runs. On the average, it doesn't increase the probability of scoring at least one run in the inning.

*Statistics: A Guide to the Unknown*

Statistics, Sports, and Some Other Things (p. 192)

Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE  
Roman philosopher and dramatic critic

There is a mean in things, fixed limits on either side of which right living cannot get a foothold.

In Casper J. Kraemer (ed.)

*The Complete Works of Horace*

*The Golden Mean* (p. 6)

The Modern Library. New York, New York, USA. 1936

**Hubbard, Elbert** 1856–1915  
American editor, publisher, and author

The average man believes a thing first, and then searches for proof to bolster his opinion.

*The Philistine: A Periodical of Protest*, Volume XI, July, 1900 (p. 36)

**Huxley, Aldous** 1894–1963  
English writer and critic

Fertilize and bokanovskify – in other words, multiply by seventy-two – and you get an average of nearly eleven thousand brothers and sisters in a hundred and fifty two batches of identical twins, all within two years of the same age.

*Brave New World*

Chapter One (p. 7)

Harper & Brothers. New York, New York, USA. 1950

**Inge, William Ralph** 1860–1954  
English religious leader and writer

...public opinion [is] a vulgar, impertinent, anonymous tyrant who deliberately makes life unpleasant for anyone who is not content to be the average man.

*Outspoken Essays (First Series)*

Our Present Discontents (p. 9)

Longmans, Green & Company. New York, New York, USA. 1920

The average man is rich enough when he has a little more than he has got, and not till then.

*Outspoken Essays (First Series)*

Patriotism (pp. 38–39)

Longmans, Green & Company. New York, New York, USA. 1920

**Jacobs, Joseph** 1854–1916  
Australian writer

Such is the past career, present condition, and certain future of the Middle American. There are as many above him as below him, and especially as many below him as above him.

The Middle American

*American Magazine*, Volume 63, March, 1907

**Jung, Carl G.** 1875–1961  
Swiss psychologist and psychiatrist

Myth is more individual and expresses life more precisely than does science. Science works with concepts of averages which are far too general to do justice to the subjective variety of an individual life.

*Memories, Dreams, Reflections*

Chapter I (p. 3)

Vintage Books. New York, New York, USA. 1963

**Juster, Norton** 1929–  
American architect and writer

“Pardon me for staring,” said Milo, after he had been staring for some time, “but I’ve never seen half a child before.”

“It’s .58 to be precise,” replied the child from the left side of his mouth (which happened to be the only side of his mouth).

“I beg your pardon?” said Milo.

“It’s .58,” he repeated; “it’s a little bit more than a half ... we’re just the average family,” he said thoughtfully; “mother, father, and 2.58 children – and, as I explained, I’m the .58.”...

“But averages aren’t real,” objected Milo, “they’re just imaginary.”

“That may be so,” he agreed, “but they’re also very useful at times. For instance, if you didn’t have any money at all, but you happened to be with four other people who had ten dollars apiece, then you’d each have an average of eight dollars. Isn’t that right?”

*The Phantom Tollbooth*

Chapter 16 (p. 196)

Alfred A. Knopf. New York, New York, USA. 1989

**Keegan, John** 1934–  
English military historian

“...hitting the target”, for centuries the principal military skill, is henceforth to be left to the law of averages.

*The Face of Battle* (p. 307)

The Viking Press. New York, New York, USA. 1979

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

One need not accept Shaw’s own estimate of his intellectual equipment to see that the doctor’s remark cut through a confusion in which psychologists and sociologists flounder. Frequently they make no distinction between what is “normal” and what is “usual”, “average”, or “statistically probable”.

*Human Nature and the Human Condition*

Chapter V (p. 75)

Random House, Inc. New York, New York, USA. 1959

...the question “How many legs does a normal man have?” should be answered by finding a statistical average. And since some men have only one leg, or none, this would lead inevitably to the conclusion that a “normal” man is equipped with one and some fraction legs.

*Human Nature and the Human Condition*

Chapter V (p. 76)

Random House, Inc. New York, New York, USA. 1959

**Lao Tzu** fl. 6th century BCE  
Chinese philosopher and father of Taoism

The wise student hears of the Tao and practices it diligently. The average student hears of the Tao and gives it thought now and again.

Translated by Gia-Fu Feng and Jane English  
*Tao Te Ching*

Forty-one  
Alfred A. Knopf, New York, New York, USA. 1974

**Lathrop, Julia** 1858–1932  
American social reformer

Averages are like the economic man; they are inventions, not real. When applied to salaries they hide gaunt poverty at the lower end.

*Address and Proceedings of the Fifty-Seventh Annual Meeting (Volume 57)*  
The Children's Bureau (p. 115)  
National Educational Association of America. Washington, D.C. 1919

**Leacock, Stephen** 1869–1944  
Canadian humorist

All very old men have splendid educations; all men who apparently know nothing else have thorough classical educations; nobody has an average education.

*Literary Lapses*  
A Manual of Education (p. 127)  
John Lane. London, England. 1911

Dear Sir – We beg to acknowledge your letter of application and cheque for fifteen dollars. After careful comparison of your case with the average modern standard, we are pleased to accept you as a first-class risk.

*Literary Lapses*  
Insurance up to Date (p. 158)  
John Lane. London, England. 1911

**Lieber, Lillian R.**  
American mathematician

What does this mean for The Average Man?

*The Education of T.C. MITS*  
Part I, Chapter VI (p. 71)  
W.W. Norton & Company, Inc. New York, New York, USA. 1944

**Moroney, Michael Joseph** 1918–90  
English statistician

In former times, when the hazards of sea voyages were much more serious than they are today, when ships buffeted by storms threw a portion of their cargo overboard, it was recognized that those whose goods were sacrificed had a claim in equity to indemnification at the expense of those whose goods were safely delivered. The value of the lost goods was paid for by agreement between all of those whose merchandise had been in the same ship. This sea damage to cargo in transit was known as “*havaria*” and the word came naturally to be applied to the compensation money which each individual was called upon to pay. From this Latin word derives our modern word average.

*Facts from Figures*  
On the Average (p. 34)  
Penguin Books Ltd., Harmondsworth, England. 1951

**Nightingale, Florence** 1820–1910  
English nursing pioneer and statistician

A want of the habit of observing and an inveterate habit of taking averages are each of them often equally misleading.

*Notes on Nursing: What It Is and What It Is Not*  
Chapter XIII (p. 67)  
Harrison. London, England. 1859

**Nixon, Richard M.** 1913–94  
37th president of the USA

The average American is just like the child in the family. Statement from Pre Election Interviews with Nixon Outlining 2nd Term Plans  
*The New York Times*, November 10, 1972 (p. 20, column 8)

**O. Henry (William Sydney Porter)** 1862–1910  
American short story writer and journalist

They had on average, about a quarter of a suit of clothes and one shoe apiece. One chap was sitting on the floor of the aisle, looking as if he were working a hard sum in arithmetic. He was trying very solemn, to pull a lady's number two shoe on a number nine foot.

*Tales of O. Henry*  
Holding Up a Train (p. 834)  
Doubleday & Company, Inc. Garden City, New York, USA. 1953

**Pynchon, Thomas** 1937–  
American novelist

...it suggests Haverie – average, you know...  
*Gravity's Rainbow*  
Part 2 (p. 207)  
The Viking Press. New York, New York, USA. 1973

**Quetelet, Adolphe** 1794–1874  
Belgian mathematician, astronomer, and statistician

*l'homme moyen*  
the average man  
*A Treatise on Man and the Development of His Faculties* (p. 100)  
Scholar's Facsimiles & Reprints. Gainesville, Florida, USA. 1969

**Redfield, Roy A.**  
No biographical data available

Make sure that the real average is what you are dealing with.  
*Factors of Growth in a Law Practice* (p. 170)  
Callaghan. Mundelein, Illinois, USA. 1962

**Rickover, Hyman G.** 1900–86  
American naval nuclear engineer

Great minds discuss ideas, average minds discuss events, small minds discuss people.  
The World of the Uneducated  
*The Saturday Evening Post*, November 28, 1959 (p. 59)

**Shaffer, Peter** 1926–  
English playwright

The Normal is the good smile in a child's eyes – all right. It is also the dead stare in a million adults. It both sustains and kills – like a God. It is the Ordinary made beautiful; it is also the Average made lethal.

*Equus and Shrivings: Two Plays*

*Equus*

Act I, Scene 19

Athenaeum. New York, New York, USA. 1974

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

NERISSA. They are as sick that surfeit with too much as they that starve with nothing. It is no mean happiness therefore, to be seated in the mean: superfluity comes sooner by white hairs, but competency lives longer.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Merchant of Venice*

Act I, Scene ii, l. 5

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Slonim, Morris James** 1909–2004  
American statistician

It is a well-known statistical paradox that the average age of women over forty is under forty....

*Sampling in a Nutshell* (p. 26)

Simon & Schuster. New York, New York, USA. 1960

**Stamp, Josiah** 1880–1941  
English economist and financier

Ask a ferryman or a toll-keeper how many visitors come through daily on an average, and with an appearance of great intellectual discomfort he assures you the number varies so much.

*Some Economic Factors in Modern Life*

Chapter VII (p. 253)

P.S. King & Son Ltd. London, England. 1929

**Stewart, Alan**

No biographical data available

Sir – In your issue of December 31 you quoted Mr. B.S. Morris as saying that [among the] many people [that] are disturbed... about half the children in the country are below the average in reading ability. This is only one of many similarly disturbing facts. About half the church steeples in the country are below average height; about half our coal scuttles below average capacity, and about half our babies below average weight. The only remedy would seem to be to repeal the law of averages.

Averages

*The Times*, Monday, January 4, 1954 (p. 7)

**Stoppard, Tom** 1937–  
Czech-born English playwright

GUIL: The law of averages, if I have got this right, means that if six monkeys were thrown up in the air for long enough they would land on their tails about as often as they would land on their –

*Rosencrantz and Guildenstern Are Dead*

Act One (p. 13)

Grove Press, Inc. New York, New York, USA. 1967

GUIL: The equanimity of your average tosser of coins depends upon a law, or rather a tendency, or let us say a probability, or at any rate a mathematically calculable chance, which ensures that he will not upset himself by losing too much nor upset his opponent by winning too often.

*Rosencrantz and Guildenstern Are Dead*

Act One (p. 18)

Grove Press, Inc. New York, New York, USA. 1967

Expectation in the general sense may be considered as a kind of average.

*The Encyclopædia Britannica* (11th edition)

Probability

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

The average man's a coward.... The average man don't like trouble and danger.

*The Adventures of Huckleberry Finn*

Chapter XXII (pp. 187–188)

Grosset & Dunlap Publishers. New York, New York, USA. 1948

The only very marked difference between the average civilized man and the average savage is that the one is gilded and the other painted.

*Mark Twain Laughing: Humorous Anecdotes by and about Samuel Clemens*

1904, #370 (p. 98)

University of Tennessee Press. Knoxville, Tennessee, USA. 1985

**Venn, John** 1834–1923  
English logician

Why do we resort to averages at all?

On the Nature and Uses of Averages

*Journal of the Royal Statistical Society*, Volume 54, 1891 (p. 429)

How can a single introduction of our own [average], and that a fictitious one, possibly take the place of the many values which were actually given to us? And the answer surely is, that it cannot possibly do so; the one thing cannot take the place of the other for purposes in general, but only for this or that specific purpose.

On the Nature and uses of Averages

*Journal of the Royal Statistical Society*, Volume 54, 1891 (p. 430)

If we start with the assumption, grounded on experience, that there is uniformity in this average, and so long as this is secured to us, we can afford to be perfectly indifferent to the fate, as regards causation, of the individuals which compose the average.



*The Logic of Chance: An Essay on the Foundation and Province of the Theory of Probability*

Chance, Causation, and Design, Section 4 (p. 239)  
Macmillan & Company Ltd. London, England. 1888

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

CECILY: Mr. Mancreif and I are engaged to be married, Lady Brocknell.

LADY BROCKNELL [with a shiver, crossing to the sofa and sitting down]: I do not know whether there is anything peculiarly exciting in the air of this particular part of Hertfordshire, but the number of engagements that go on seems to me considerably above the proper average that statistics have laid down for our guidance.

*The Importance of Being Earnest: A Trivial Comedy for Serious People*  
Act III (p. 104)

Walter H. Baker Company. Boston, Massachusetts, USA. 19–?

## AVERAGE MAN

**Irwin, Wallace** 1875–1959

American writer

Statistics declare that the Average Man  
Finds the Average Woman and mates;  
That the Average Family, children all told,  
Is something like two and three-eighths.  
(Though fractional children disturb and appall,  
The Average Man isn't worried at all.)

*Random Rhymes and Odd Numbers*

To the Average Man Stanza 4

The Macmillan Co. New York, New York, USA. 1906

## AVOGADRO'S HYPOTHESIS

**Avogadro, Amedeo** 1776–1856

Italian savant

...the quantitative proportions of substances in compounds seem only to depend on the relative number of molecules which combine, and on the number of composite molecules which result. It must then be admitted that very simple relations also exist between the volumes of gaseous substances and the numbers of simple or compound molecules which form them. The first hypothesis to present itself in this connection, and apparently even the only admissible one, is the supposition that the number of integral molecules in any gases is always the same for equal volumes, or always proportional to the volumes.

Essay on a Manner of Determining the Relative Masses of the Elementary Molecules of Bodies, and the Proportions in Which They Enter into These Compounds

*Journal de Physique*, Volume 73 1811 (p. 58)

## AWARENESS

**Gilkey, Langdon** 1919–2004

American protestant theologian

Surely one of the most important characteristics of a scientific, introverted, specialized, hence infinitely intellectual culture is its drive toward, and faith in, total "awareness". Awareness of almost every conceivable factor influencing almost every conceivable situation is our characteristic panacea or cure-all. In this sense, gnosis, the total consciousness, and self-consciousness are the major goals of our secular culture. We really believe that if we know or are aware of everything, if we can understand all relevant causes and factors, we can control everything.

*Religion and the Scientific Future: Reflections on Myth, Science, and Theology*

Chapter III (p. 78)

Harper & Row, Publishers. New York, New York, USA. 1970

## AXIAL TILT

**Milton, John** 1608–74

English poet

Some say he bid his angels turn ascance  
The poles of Earth twice ten degrees and more  
From the suns axle; they with labour push'd  
Oblique the Centric Globe: Some say the Sun  
Was bid turn Reines from th' Equinoctial Rode  
Like distant breadth to Taurus with the sev'n  
Atlantic Sisters, and the Spartan Twins,  
Up to the Tropic Crab; thence down amain  
By Leo and the Virgin and the Scales,  
As deep as Capricorn, to bring in change  
Of Seasons to each Clime; else had the Spring  
Perpetual smil'd on Earth with vernant Flours,  
Equal in Days and Nights...

The sun, as from Thyestean Banquet, turn'd  
His course intended; else how had the World  
Inhabited, though sinless, more than now  
Avoided pitching cold and scorching heate?

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book X, l. 668–680, 688–691

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## AXIOM

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...though it be true that I am principally in pursuit of works and the active department of the sciences, yet I wait for harvest-time, and do not attempt to mow the



mass or to reap the green corn. For I well know that axioms once rightly discovered will carry whole troops of works along with them, and produce them, not here and there one, but in clusters.

*Instauratio Magna*

The Plan of the Instauration Magna

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

I once told an audience of school children that the world would never change if they did not contradict their elders. I was chagrined to find next morning that this axiom outraged their parents. Yet it is the basis of the scientific method. A man must see, do and think things for himself, in the face of those who are sure that they have already been over all that ground. In science, there is no substitute for independence.

*Science and Human Values*

The Sense of Human Dignity (pp. 60–61)

Harper & Row, Publishers. New York, New York, USA. 1965

**Chargaff, Erwin** 1905–2002

Austrian biochemist

...nowadays our sciences, quick and fickle, wear out dogmas in 10 years, and axioms take only a little longer.

Bitter Fruits from the Tree of Knowledge

*Perspectives in Biology and Medicine*, Volume 16, Number 4, Summer, 1973 (p. 496)

**Clifford, William Kingdon** 1845–79

English mathematician

The danger of asserting dogmatically that an axiom based on the experience of a limited region holds universally will now be to some extent apparent to the reader. It may lead us to entirely overlook, or when suggested at once reject, a possible explanation of phenomena. The hypotheses that space is not homaloidal, and again, that its geometrical character may change with the time, may or may not be destined to play a great part in the physics of the future; yet we cannot refuse to consider them as possible explanations of physical phenomena, because they may be opposed to the popular dogmatic belief in the universality of certain geometrical axioms – a belief which has arisen from centuries of indiscriminating worship of the genius of Euclid.

*The Common Sense of the Exact Sciences* (5th edition)

Chapter IV (p. 226)

Kegan Paul, Trench, Trubner & Co. London, England. 1907

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

It has long been an axiom of mine that the little things are infinitely the most important.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Case of Identity* (p. 414)

Wings Books. New York, New York, USA. 1967

**Dumas, Alexandre** 1824–95

French dramatist and novelist

...it is one of the axioms of mathematics that the container must be greater than the contained.

*Romances* (Volume 1)

*The Vicomte de Bragellone or Ten Years Later*

Chapter XX (p. 193)

Estes & Lauriat. Boston, Massachusetts, USA. 1893

**Frayn, Michael** 1933–

English dramatist

For hundreds of pages the closely-reasoned arguments unroll, axioms and theorems interlock. And what remains with us in the end? A general sense that the world can be expressed in closely-reasoned arguments, in interlocking axioms and theorems.

*Constructions*

No. 277

Wildwood House. London, England. 1974

**Planck, Max** 1858–1947

German physicist

There is scarcely a scientific axiom that is not nowadays denied by somebody. And at the same time almost any nonsensical theory that may be put forward in the name of science would be almost sure to find believers and disciples Translated by James Murphy

*Where is Science Going?*

Chapter II (p. 65)

George Allen & Unwin. London, England. 1933

Axioms are instruments which are used in every department of science, and in every department there are purists who are inclined to oppose with all their might any expansion of the accepted axioms beyond the boundary of their logical application.

*Where Is Science Going?*

Chapter VI (p. 179)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Raju, Poolla Tirupati** 1904–

Indian philosopher

We are driven to conclude that science, like mathematics, is a system of axioms, assumptions, and deductions; it may start from being, but later leaves it to itself, and ends in the formation of a hypothetical reality that has nothing to do with existence; or it is the discovery of an ideal being which is, of course, present in what we call actuality, and renders it an existence for us only by being present in it.

*Idealistic Thought of India*

Chapter II, Section VII (p. 84)

The Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Reid, Thomas** 1710–96  
Scottish philosopher

The science [mathematics], once firmly established upon the foundation of a few axioms and definitions, as upon a rock, has grown from age to age, so as to become the loftiest and the most solid fabric that human reason can boast.

In James Walker

*Essays on the Intellectual Powers of Man* (6th edition) (p. 369)  
Phillips, Sampson, & Co. Boston, Massachusetts, USA. 1855

**von Neumann, John** 1903–57  
Hungarian-American mathematician

**Morgenstern, Oskar** 1902–77  
German-born American economist

A choice of axioms is not purely a subjective task. It is usually expected to achieve some definite aim – some specific theorem or theorems are to be derivable from the axioms – and to this extent the problem is exact and objective. But beyond this there are always other important desiderata of a less exact nature: the axioms should not be too numerous, their system is to be as simple and transparent as possible, and each axiom should have an immediate intuitive meaning by which its appropriateness can be judged directly.

*Theory of Games and Economic Behavior*

Chapter 3.5.2 (p. 25)

Princeton University Press. Princeton, New Jersey, USA. 1947

## AXIOMIZE

**Weyl, Hermann** 1885–1955  
German mathematician

– I should not pass over in silence the fact that today the feeling among mathematicians is beginning to spread that the fertility of these abstracting methods is approaching exhaustion. The case is this: that all these nice general notions do not fall into our laps by themselves. But definite concrete problems were conquered in their undivided complexity, singlehanded by brute force, so to speak. Only afterwards the axiomaticians came along and stated: Instead of breaking in the door with all your might and bruising your hands, you should have constructed such and such a key of skill, and by it you would have been able to open the door quite smoothly. But they can construct the key only because they are able, after the breaking in was successful, to study the lock from within and without. Before you can generalize, formalize and axiomatize, there must be a mathematical substance. I think that the mathematical substance in the formalizing of which we have trained ourselves during the last decades, becomes gradually exhausted. And so I foresee that the generation now rising will have a hard time in mathematics.

Emmy Noether

*Scripta Mathematica*, Volume 3, 1935

## B

### BABY

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

The human baby, the human being, is a mosaic of animal and angel.

*The Ascent of Man*  
Lower than the Angels (p. 31)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

### BACKBONELESS

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Backboneless marine animals are the creatures of the sea in which they live. Like the sea itself they are sluggish, if not entirely sedentary. Like the rest of us they are products of their environment.

*Parade of the Living*  
Part I, Chapter V (p. 55)  
Coward-McCann, Inc. New York, New York, USA. 1930

### BACTERIA

**Cohn, Ferdinand Julius** 1828–98  
German botanist and bacteriologist

At last, in the most recent times, an unexpected knowledge of the secret life energies of bacteria has been revealed, through which they rule with demoniacal power over the weak and woe, and even over the life and death of man.

*Bacteria: The Smallest of Living Organisms*  
Lüder. Berlin. 1872

If one could inspect a man under a similar lens-system he would appear as big as Mont Blanc or even as Mt. Chimborazo. But even under these colossal magnifications the smallest bacteria look no larger than the periods and commas of good print; little or nothing can be distinguished of their inner parts, and of them their very existence would have remained unsuspected if it had not been for their countless numbers.

In Kenneth Thimann  
*The Life of Bacteria: Their Growth, Metabolism, and Relationships*  
Chapter II (p. 33)  
The Macmillan Company. New York, New York, USA. 1963

**Dyer, Betsey Dexter** 1954–  
American biologist

Before refrigeration, when seafood might be kept a few days in a chilly basement, this phenomenon of glowing decay [from bacteria] was observed and noted. Charles Dickens, in *A Christmas Carol*, likens Marley's face in the knocker of Scrooge's door to a glowing lobster: "Marley's face...had a dismal light about it, like a bad lobster in a dark cellar." How many nonmicrobiologists have passed over that line, unable to decipher what image Dickens had in mind?

*A Field Guide to Bacteria*  
Chapter 8 (p. 131)  
Cornell University Press. Ithaca, New York, USA. 2003

**Feynman, Richard P.** 1918–88  
American theoretical physicist

The proteins of bacteria and the proteins of humans are the same. In fact it has recently been found that the protein-making machinery in the bacteria can be given orders from the red cells to produce red cell proteins. So close is life to life.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 11)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Grassé, Pierre P.** 1895–1985  
French zoologist

Bacteria, the study of which has formed a great part of the foundation of genetics and molecular biology, are the organisms which, because of their huge numbers, produce the most mutants. This is why they gave rise to an infinite variety of species, called strains, which can be revealed by breeding or tests. Like *Erophila verna*, bacteria, despite their great production of intraspecific varieties, exhibit a great fidelity to their species. The bacillus *Escherichia coli*, whose mutants have been studied very carefully, is the best example. The reader will agree that it is surprising, to say the least, to want to prove evolution and to discover its mechanisms and then to choose as a material for this study a being which practically stabilized a billion years ago!

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 87)  
Academic Press. New York, New York, USA. 1977

**Haber, Fritz** 1868–1934  
German physical chemist

Nitrogen bacteria teach us that Nature, with her sophisticated forms of the chemistry of living matter, still understands and utilizes methods, which we do not as yet know how to imitate.

*Nobel Lectures, Chemistry 1901–1921*  
The Synthesis of Ammonia from Its Elements  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

### Harrisons' Nurseries

The work of bacteria is like that of the buzzards, which gather from everywhere and consume a dead body.

*How to Grow and Market Fruit*

Lime Action (p. 21)

Harrison's Nurseries. Berlin, Maryland, USA. 1911

### Helmuth, William Tod 1833–1902

American physician

Oh, powerful bacillus,  
With wonder how do you fill us,  
Every day!

While medical detectives,  
With powerful objectives,  
Watch you play.

*"Scratches" of a Physician*

Ode to the Bacillus

W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

### Mayo, Charles Horace 1865–1939

American physician

The philosophic view of bacteria is to consider them necessary to life as the minute chemists of the air, waste, and the soil.

Stone in the Kidney

*Annals of Surgery*, Volume 7 1920

### Paulos, John Allen 1945–

American mathematician

We are trying to measure bacteria with a yardstick.

*New York Times*, 22 November, 2000 (p. A31)

### Peattie, Donald Culross 1898–1964

American botanist, naturalist, and author

No picture of life today is even worth a glance that does not show the bacteria as the foundation of life itself, the broad base of the pyramid on which all the rest is erected.

*An Almanac for Moderns*

November Twenty-Seventh (p. 275)

G.P. Putnam's Sons. New York, New York, USA. 1935

The bacteria are only the most primitive, and adaptable-to-the-primitive beings that are at present known. They may have had – may still have – antecedents even more hardy and fitted to digest the raw stuff of the universe, perhaps even the interstellar calcium that is one of the recent discoveries of the watchers of the skies.

*An Almanac for Moderns*

November Thirtieth (p. 278)

G.P. Putnam's Sons. New York, New York, USA. 1935

### Postgate, John

No biographical data available

Life manages very well without oxygen, evolving into flourishing communities of anaerobes. Acidity... presents

no problem, as sulphur bacteria and their co-habitants illustrate, nor does a considerable degree of alkalinity bother alkophiles.... Water purity is a trivial matter: saturated salt brines support abundant bacterial life. And pressure is quite irrelevant, with bacteria growing happily in a near vacuum or at the huge hydrostatic pressure of deep ocean trenches. Temperature, too, presents little problem: boiling hot springs support bacterial life, and bacteria have been found growing at 112° C in super-heated geothermal water under hydrostatic pressure; conversely, other types of bacteria thrive at well below zero, provided the water is salty enough not to freeze. And even if they do get frozen, many bacteria revive when their habitat thaws. Even organic food is not a prerequisite ...

*The Outer Reaches of Life*

Chapter 18 (p. 251)

Cambridge University Press. Cambridge, England. 1994

### Tyndall, John 1820–93

Irish-born English physicist

We have been scourged by invisible throngs, attacked from impenetrable ambuscades, and it is only today that the light of science is being let in upon the murderous dominion of our foes.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

In Edwin O. Jordan

*The Bacteria* (p. 215)

The University of Chicago Press. Chicago, Illinois, USA. 1927

### Wallin, Ivan E. 1883–1969

American biologist

It is a rather startling proposal that bacteria, the organisms which are popularly associated with the disease, may represent the fundamental causative factor in the origins of species.

*Symbioticism and the Origin of Species*

Chapter I (p. 8)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

### Zinsser, Hans 1878–1940

U.S. bacteriologist

...infectious disease is merely a disagreeable instance of a widely prevalent tendency of all living creatures to save themselves the bother of building, by their own efforts, the things they require. Whenever they find it possible to take advantage of the constructive labors of others, this is the path of least resistance. The plant does the work with its roots and its green leaves. The cow eats the plant. Man eats both of them; and bacteria (or investment bankers) eat the man.

*Rats, Lice and History*

Chapter II (pp. 8–9)

Transaction Publishers

Somerset, New Jersey, USA. 2007

**BACTERIOLOGIST**

**Andrewes, Frederick William** 1859–1932  
British pathologist

It may very properly be asked whether the attempt to define distinct species, of a more or less permanent nature, such as we are accustomed to deal with amongst the higher plants and animals, is not altogether illusory amongst such lowly organised forms of life as the bacteria. No biologist nowadays believes in the absolute fixity of species...but there are two circumstances which here render the problem of specificity even more difficult of solution. The bacteriologist is deprived of the test of mutual fertility or sterility, so valuable in determining specific limits amongst organisms in which sexual reproduction prevails. Further, the extreme rapidity with which generation succeeds generation amongst bacteria offers to the forces of variation and natural selection a field for their operation wholly unparalleled amongst higher forms of life.

‘The Evolution of the Streptococci’  
*The Lancet*, Volume 2, 1906 (p. 1415)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

I’m a bacteriologist, you know. I live in a nine-hundred-diameter microscope. I can hardly claim to take serious notice of anything that I can see with my naked eye. I’m a frontiersman from the extreme edge of the Knowable, and I feel quite out of place when I leave my study and come into touch with all you great, rough, hulking creatures.

*The Lost World*  
Chapter II (p. 18)

Hodder & Stroughton. New York, New York, USA. 1912

**BAG-LIMIT**

**Hornaday, William Temple** 1854–1937  
American naturalist

The fatalistic idea that bag-limit laws can save the game is today *the curse of all our game birds, mammals and fishes!* It is a fraud, a delusion and a snare. That miserable fetch has been worshipped much too long. Our game is being exterminated, everywhere, by blind insistence upon “open seasons,” and solemn reliance upon “legal bag-limits.”

*Our Vanishing Wild Life: Its Extermination and Preservation*  
Preface (p. x)

Charles Scribner’s Sons. New York, New York, USA. 1913

**BALANCE**

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

A balance that does not tremble cannot weigh.

*Heracleitean Fire: Sketches from a Life Before Nature*  
Part III

The Trembling of a Balance (p. 179)

Rockefeller University Press. New York, New York, USA. 1978

**Johnston, James Finlay Weir** 1796–1855  
Scottish chemist

...the first object one notices is a glass case standing on a table. It is the balance. How much light this fragile, simple instrument has shed on the natural sciences! How many phenomena it has explained! How many hidden truths it has revealed! Who could enumerate the discussions it has ended, the hypotheses it has destroyed! Who, in former times, would have believed that the determination of abstract truths and the development of the laws of nature would depend on the oscillations of this moving beam!

In Mary Elvira Weeks

*The Discovery of the Elements* (pp. 533–534)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**von Liebig, Justus** 1803–73  
German organic chemist

For all great discoveries chemists are indebted to the “balance” – that incomparable instrument which gives permanence to every observation, dispels all ambiguity, establishes truth, detects error, and guides us in the true path of inductive science.

*Familiar Letters in Chemistry*

Letter I (p. 6)

Taylor & Walton. London, England. 1843

**BAROMETER**

**Berry, John J.**

No biographical data available

We often hear it said that however reliable the fluctuations of the barometer may be in other sections, as indicating the approach of storms, upon the Pacific Coast some exceptional rule or, rather, no rule exists, and that the variations of the barometer really indicate nothing. And when we find, as we often do, that the movement of the mercury accompanies, instead of preceding by hours and days, storms of wind or rain, we are very apt to regard instrument and indications alike as wholly unreliable.

*Life of David Belden*

Chapter V (p. 105)

Beldon Brothers. New York, New York, USA. 1891

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

BAROMETER, n. An ingenious instrument which indicates what kind of weather we are having.

*The Cynic's Word Book*

Barometer (p. 28)

Doubleday, Page & Co. New York, New York, USA. 1906

## BATHYBIUS

**Huxley, Thomas Henry** 1825–95  
English biologist

Bathybius [is] a vast sheet of living matter, enveloping the whole earth beneath the seas.

On Some Organisms Living at Great Depths in the North Atlantic Ocean  
*Microscopical Journal*, October, 1868

## BAYESIAN

**Kadane, Joseph**  
Statistician

I believe that assumptions are useful to state in statistical practice because they impose a discipline on the user. Once a full set of assumptions is stated, the conclusion should follow. (Actually, only a Bayesian analysis can meet this standard, but that's another topic for another time.)

Comment

*Statistical Science*, Volume 1, Number 1, February, 1986 (p. 12)

**Wang, Chamont** 1949–  
Statistician

...there are at least 46,656 varieties of Bayesians.

*Sense and Nonsense of Statistical Inference: Controversy, Misuse, and Subtlety*

Chapter 6 (p. 158)

Marcel Dekker. New York, New York, USA. 1993

## BEACH

**Jones, Thomas Rymer** 1810–80  
English surgeon and zoologist

And now, gentle reader, let us hasten to the beach: the tide is near its ebb, and yonder rocks, baring their shoulders to the sunshine, seem to rest themselves in grim repose.

This is the time for work. Come boy! The fishing basket and the muslin landing-net – a hammer and an iron chisel. Mind, too, you don't forget the large glass jar with handles made of rope, wherein to put what specimens we find.

*The Aquarian Naturalist: A Manual for the Sea-Side*

John van Voorst. London, England. 1858

**Morton, Ron L.**  
No biographical data available

Beaches are nomads, have been nomads, and always will be nomads. Our attempts to shape them into our image of what we think they should be is a lost cause if ever there was one.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 8 (p. 227)

Plenum Press. New York, New York, USA. 1996

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Here about the beach I wandered, nourishing a youth sublime

With the fairy tales of science, and the long results of time.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 6

Oxford University Press, Inc. London, England. 1953

## BEAK

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

I do not think it is distinctly enough felt by us that the beak of a bird is not only its mouth, but its hand, or rather its two hands. For, as its arms and hands are turned into wings, all it has to depend upon, in economical and practical life, is its beak. The beak, therefore, is at once its sword, its carpenter's tool-box, and its dressing-case; partly also its musical instrument; all this besides its function of seizing and preparing the food, in which functions alone it has to be a trap, carving-knife, and teeth, all in one.

*Love's Meinie*

Lecture 1, 20 (pp. 20–21)

John Wiley & Son. New York, New York, USA. 1873

## BEAUTY

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

All we have, it seems to me, is the beauty of art and nature and life, and the love which that beauty inspires.

*The Journey Home: Some Words in Defense of the American West*

Chapter 4 (p. 57)

E.P. Dutton. New York, New York, USA. 1977

**Angier, Natalie** 1958–  
Writer and science journalist

The beauty of the natural world lies in the details, and most of those details are not the stuff of calendar art.

*The Beauty of the Beastly: New Views on the Nature of Life*

Introduction (p. xi)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1995



**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Now since the good and the beautiful are different... those who assert that the mathematical sciences say nothing of the beautiful or the good are in error. For these sciences say and prove a great deal about them; if they do not expressly mention them, but prove attributes which are their results or definitions, it is not true that they tell us nothing about them. The chief forms of beauty are order and symmetry and definiteness, which the mathematical sciences demonstrate in a special degree.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book XIII, Chapter 3, 1078a [30]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The mathematical sciences particularly exhibit order, symmetry, and limitation; and these are the greatest forms of the beautiful.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book XIII, Chapter 3 (p. 610)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Awiakta, Marilou** 1936–  
Native American writer

Beauty is no threat to the wary  
who treat the mountain in its way,  
the copperhead in its way,  
and the deer in its way,  
knowing that nature is the human heart  
made tangible.

*Selu: Seeking the Corn-Mother's Wisdom*

Trail Warning (p. 39)

Fulcrum Publishers. Golden, Colorado, USA. 1993

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

There is no excellent beauty that hath not some strangeness in the proportion.

In Brian Vickers (ed.)

*Francis Bacon*

Essays of Beauty (p. 425)

Published for the British Council by Longman. Harlow, England. 1978

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

Certain methods have frequently yielded the most beautiful results, and many persons have been tempted to believe that the development of science to the end of all time would consist in the systematic and unremitting application of them. But suddenly they begin to show indications of impotency, and all efforts are then bent upon discovering new and antagonistic methods. Then there usually arises a conflict between the adherents of the old method and those of the new. The point of view of

the former is characterized by its opponents as antiquated and obsolete; whilst its upholders in their turn look down with scorn upon the innovators as perverters of true classical science.

The Recent Development of Method in Theoretical Physics

*The Monist*, Volume 11, 1901 (p. 229)

**Bridges, Robert Seymour** 1844–1930  
English poet

For beauty being the best of all we know  
Sums up the unsearchable and secret aims  
Of nature.

*Poetical Works of Robert Bridges* (Volume 1)

The Growth of Love, 8 (p. 226)

Smith, Elder & Company. London, England. 1898

**Bryan, J. Ingram**  
No biographical data available

Nature seems to exist only to satisfy man's thirst for beauty; it is her way of teaching him confidence in the integrity of the Universe...

*The Interpretation of Nature in English Poetry*

Chapter I (p. 1)

Kaitakusha. Tokyo, Japan. 1932

**Burke, Edmund** 1729–97  
British statesman and philosopher

The stomach, the lungs, the liver, as well as other parts, are incomparably well adapted to their purposes; yet they are far from having any beauty.

*On the Sublime and the Beautiful*

Part III, Section VI (p. 196)

Printed for F.C. & J Rivington & others. London, England. 1812

**Cayley, Arthur** 1821–95  
English mathematician

It is difficult to give an idea of the vast extent of modern mathematics. The word "extent" is not the right one: I mean extent crowded with beautiful detail – not an extent of mere uniformity such as an objectless plain, but of a tract of beautiful country seen at first in the distance, but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower. But, as for everything else, so for mathematical theory – beauty can be perceived but not explained.

*The Collected Mathematical Papers of Arthur Cayley* (Volume 11)

Presidential Address, British Association, September, 1883 (p. 449)

The University Press. Cambridge, England. 1889–97

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

This "shuddering before the beautiful," this incredible fact that a discovery motivated by a search after the beautiful in mathematics should find its exact replica in Nature, persuades me to say that beauty is that to

which the human mind responds at its deepest and most profound.

*Truth and Beauty: Aesthetics and Motivations in Science*

Chapter 3, Section VI (p. 54)

The University of Chicago Press. Chicago, Illinois, USA. 1987

All of us are sensitive to nature's beauty. It is not unreasonable that some aspects of this beauty are shared by the natural sciences.

*Beauty and the Quest for Beauty in Science*

*Physics Today*, Volume 32, Number 7, July 1979 (p. 25)

### **Coleridge, Stephen** 1854–1936

English author, barrister, and opponent of vivisection

Science strives day and night to blind men's eyes so that they shall not see it, and where it succeeds men are robbed of a perfect and stainless happiness; for the appreciation and perception of beauty is its own reward, it confers pleasure that is utterly pure, it fosters in the mind refined and tender feelings and emotions, it elevates the character and fills the heart with wonder and love and gratitude...

*The Idolatry of Science*

Chapter XII (p. 99)

John Lane Co. London, England. 1920

### **Collins, Wilkie** 1824–89

English novelist

Admiration of those beauties of the inanimate world, which modern poetry so largely and so eloquently describes, is not, even in the best of us, one of the original instincts of our nature. As children, we none of us possess it. No uninstructed man or woman possesses it. Those whose lives are exclusively passed amidst the ever-changing wonders of sea and land are also those who are most universally insensible to every aspect of Nature not directly associated with the human interest of their calling. Our capacity of appreciating the beauties of the earth we live on is, in truth, one of the civilized accomplishments which we all learn, as an art; and, more, that very capacity is rarely practiced by any of us except when our minds are most indolent and most unoccupied.

*The Woman in White*

The Story Begun by Walter Hartright

Chapter VIII (p. 43)

Everyman's Library. London, England. nd

### **Copernicus, Nicolaus** 1473–1543

Polish astronomer

Among the many and varied literary and artistic studies upon which the natural talents of man are nourished, I think that those above all should be embraced and pursued with the most loving care which have to do with things that are very beautiful and very worthy of knowledge.

*In Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One (p. 510)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Curie, Marie Skłodowska** 1867–1934

Polish-born French physicist and chemist

I am among those who think that science has great beauty.... A scientist in his laboratory is not only a technician but also a child placed in front of natural phenomena which impresses him like a fairy tale.

In *Eve Curie*

*Madame Curie*

Chapter XXIV (p. 341)

The Literary Guild of America, Inc. New York, New York, USA. 1937

### **da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Even though the genius of man might make various inventions, attaining the same end by various means, it will not invent anything more beautiful, or more economical, or more direct than nature, for in nature's inventions nothing is wanting and nothing is superfluous.

In *Theodosius Dobzhansky*

*Evolution of Genes and Genes in Evolution*

*Cold Spring Harbor Symposia on Quantitative Biology*

Volume XXIV, 1959 (p. 15)

Cold Spring Harbor Laboratory. Cold Spring Harbor, New York, USA.

### **Darwin, Charles Robert** 1809–82

English naturalist

How the sense of beauty in its simplest form – that is, the reception of a peculiar kind of pleasure from certain colours, forms, and sounds – was first developed in the mind of man and of the lower animals, is a very obscure subject. The same sort of difficulty is presented, if we enquire how it is that certain flavours and odours give pleasure, and others displeasure.

*The Origin of Species* (6th edition)

Chapter VI (p. 162)

John Murray. London, England. 1882

### **Davy, Sir Humphry** 1778–1829

English chemist

Amidst the various infinitely diversified changes of things, nothing can be said to be accidental or without design. Even the most terrible of the ministrations of nature in their ultimate operation are pregnant with blessings and with benefits. Beauty and harmony are made to result from apparent confusion, and all the laws of the material world are ultimately made subservient to the preservation of life and the promotion of happiness.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Lecture Ten (p. 139)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

### **Dickinson, Emily** 1830–86

American lyric poet

Beauty – be not caused – It is...

*The Complete Poems of Emily Dickinson*

No. 516 (p. 252)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Dirac, Paul Adrien Maurice** 1902–84  
English theoretical physicist

We may try to make progress by following in Hamilton's footsteps, taking mathematical beauty as our guiding beacon, and setting up theories which are of interest, in the first place, only because of the beauty of their mathematics. We may then hope that such equations will ultimately prove their value in physics, basing this hope on the belief that Nature demands mathematical beauty in her laws.  
Hamiltonian Methods and Quantum Mechanics  
*Proceedings of the Royal Irish Academy*, Volume 63, Section A, Number 3, January, 1964 (p. 59)

The researcher worker, in his efforts to express the fundamental laws of Nature in mathematical form, should strive mainly for mathematical beauty. He should still take simplicity into consideration in a subordinate way to beauty.... It often happens that the requirements of simplicity and beauty are the same, but where they clash the latter must take precedence.

The Relation Between Mathematics and Physics  
*Proceedings of the Royal Society (Edinburgh)*, Volume LIX, February 25, 1939 (p. 124)

It is quite clear that beauty does depend on one's culture and upbringing for certain kinds of beauty, pictures, literature, poetry and so on.... But mathematical beauty is of a rather different kind. I should say perhaps it is of a completely different kind and transcends these personal factors. It is the same in all countries and at all periods of time.

In Helge Kragh  
*Dirac: A Scientific Biography*  
Chapter 14 (p. 288)  
Cambridge University Press. Cambridge, England. 1990

**Dretske, Fred I.** 1932–  
American philosopher

Beauty is in the eye of the beholder, and information is in the head of the receiver.

*Knowledge and the Flow of Information*  
Preface (p. vii)  
Center for the Study of Language and Information, Leland Stanford Junior College, USA. 1999

**Duhem, Pierre-Maurice-Marie** 1861–1916  
French physicist and mathematician

It is impossible to follow the march of one of the greatest theories of physics, to see it unroll majestically its regular deductions starting from initial hypotheses, to see its consequences represent a multitude of experimental laws down to the smallest detail, without being charmed by the beauty of such a construction, without feeling keenly that such a creation of the human mind is truly a work of art.

*The Aim and Structure of Physical Theory*  
Part I, Chapter II (p. 24)  
Princeton University Press. Princeton, New Jersey, USA. 1954

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Beauty is the form under which the intellect prefers to study the world.

*The Conduct of Life*  
Beauty (p. 225)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1894

We ascribe beauty to that which is simple; which has no superfluous parts; which exactly answers its end.

*Ralph Waldo Emerson: Essays and Lectures*  
*The Conduct of Life*  
Beauty (p. 1093)  
The Library of America. New York, New York, USA. 1983

Beauty rests on necessities. The line of beauty is the line of perfect economy.

*Ralph Waldo Emerson: Essays and Lectures*  
*The Conduct of Life*  
Beauty (p. 1097)  
The Library of America. New York, New York, USA. 1983

For the world is not painted, or adorned, but is from the beginning beautiful; and God has not made some beautiful things, but Beauty is the creator of the Universe.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: Second Series*  
The Poet (p. 449)  
The Library of America. New York, New York, USA. 1983

**Erdős, Paul** 1913–96  
Hungarian mathematician

It's like asking why Beethoven's Ninth Symphony is beautiful. If you don't see why, someone can't tell you. I *know* numbers are beautiful. If they aren't beautiful, nothing is.

Quoted in Paul Hauffman  
The Man Who Loves Only Numbers  
*The Atlantic Magazine*, Volume 260, Number 5, November, 1987 (p. 44)

**Gross, David J.** 1941–  
American particle physicist

At the fundamental level nature, for whatever reason, prefers beauty and is marvelously inventive in inventing new forms of beauty.

The Role of Symmetry in Fundamental Physics  
*Proceedings of the National Academy of Science USA*, Volume 93, Number 25, December 10, 1996

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

If nature leads to mathematical forms of great simplicity and beauty – to forms that no one has previously encountered – we cannot help thinking that they are true and that they revealed genuine features of Nature.

*Selected Papers S. Chandrasekhar* (Volume 7)  
The Series Paintings of Claude Monet and the Landscape of General Relativity (p. 138)  
The University of Chicago Press. Chicago, Illinois, USA. 1997

...beauty in exact science, no less than in the arts is the most important source of illumination and clarity.

*Across the Frontiers*

Chapter XIII (p. 183)

Harper & Row, Publishers. New York, New York, USA. 1974

### **Hilbert, David** 1862–1943

German mathematician

Our Science, which we loved above everything, had brought us together. It appeared to us as a flowering garden. In this garden there were well-worn paths where one might look around at leisure and enjoy oneself without effort, especially at the side of a congenial companion. But we also liked to seek out hidden trails and discovered many an unexpected view which was pleasing to our eyes; and when the one pointed it out to the other, and we admired it together, our joy was complete.

In Constance Reid

*Hilbert – Courant*

Hilbert

Chapter XV (p. 121)

Springer-Verlag. New York, New York, USA. 1986

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

...wisdom is the abstract of the past, but beauty is the promise of the future.

*The Professor at the Breakfast Table*

Chapter II (p. 44)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

### **Huntley, Henry Edwards**

No biographical data available

Nature's beauty dies. The day dawns when the nautilus is no more. The rainbow passes, the flower fades away, the mountain crumbles, the star grows cold. But the beauty in mathematics – the divine proportion, the golden rectangle, *spira mirabilis* – endures for evermore.

*The Divine Proportion: A Study in Mathematical Beauty*

Chapter XIII (p. 176)

Dover Publications. New York, New York, USA. 1970

### **Jefferies, Richard** 1848–87

English nature writer

The exceeding beauty of the earth, in her splendor of life, yields a new thought with every petal. The hours when the mind is absorbed by beauty are the only hours when we really live ....[A]ll else is illusion, or mere endurance.

The Pageant of Summer

*Eclectic Magazine of Foreign Literature, Science, and Art*, Volume

XXXVIII, Number 2, August, 1883 (p. 146)

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

The scientific man sees and feels beauty as much as any mere observer – as much as any artist or painter. But he also sees something underlying that beauty; he wishes to learn something of the actions and forces producing those beautiful results.

*Popular Lectures and Addresses* (Volume 2)

The Bangor Laboratories

Address

Physical and Chemical Laboratories in University College

Bangor, North Wales, February 2, 1885 (p. 477)

Macmillan & Company Ltd. London, England. 1894

### **Kolb, Edward W. (Rocky)** 1951–

American cosmologist

To those who say Newton removed the hand of God from the heavens, I say he replaced a toilsome hand of brute force with a sublime hand of beauty.

*Blind Watchers of the Sky*

Chapter Five (p. 135)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1996

### **Kragh, Helge** 1944–

Science historian

The main problem is that beauty is essentially subjective and hence cannot serve as a commonly defined tool for guiding or evaluating science. It is, to say the least, difficult to justify aesthetic judgment by rational arguments.... The sense of aesthetic standards is part of the socialization that scientists acquire; but scientists, as well as scientific communities, may have widely different ideas of how to judge the aesthetic merit of a particular theory. No wonder that eminent physicists do not agree on which theories are beautiful and which are ugly.

*Dirac: A Scientific Biography*

Chapter 14 (pp. 287–288)

Cambridge University Press. Cambridge, England. 1990

### **Lax, Peter** 1926–

Hungarian-born American mathematician

I like to start with some phenomenon, the more striking the better, and then use mathematics to try to understand it.... There's an aesthetic quality, yes, but if you try to pin that down, you are just begging the question. What is beautiful is purely subjective. Saying something is beautiful may be no different from saying that you have a feeling that something is important. You know, one of the complaints that pure mathematicians have against applied mathematicians is that it is ugly. ...Beauty is in the eye of the beholder. It's a poor guide, aesthetics is. You have to feel that what you are doing is beautiful but, after all, someone used to classical art regards modern art as horrible and ugly.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 155)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

The beauty of nature is so great and its contemplation so sweet...whoever tastes it can't help but view all other amusements as inferior.

Translated by Elizabeth Oehlkers

In Ernest Peter Fischer

*Beauty and the Beast*

Chapter 2 (p. 47)

Plenum Trade. New York, New York, USA. 1999

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Generally speaking, anything that is constructed according to fixed and logically followed rules, is a product of tolerable beauty.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physical Inquiry (p. 91)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Maxwell, James Clerk** 1831–79  
Scottish physicist

Nothing beautiful can be produced by Man except by the laws of mind acting in him as those of Nature do without him; and therefore the kind of beauty he can thus evolve must be limited by the very small number of correlative sciences which he has mastered; but as the Theoretic and imaginative faculty is far in advance of Reason, he can apprehend and artistically reproduce natural beauty of a higher order than his science can attain to; and as his Moral powers are capable of a still wider range, he may make his work the embodiment of a still higher beauty, which expresses the glory of nature as the instrument by which our spirits are exercised, delighted,

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell*

Appendix A (p. 343)

Macmillan & Co Ltd. London, England. 1884

**Mendeleev, Dmitry Ivanovich** 1834–1907  
Russian chemist

To conceive, understand, and grasp the whole symmetry of the scientific edifice, including its unfinished portions, is equivalent to tasting that enjoyment only conveyed by the highest forms of beauty and truth.

Translated by George Kamensky

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. ix)

Longmans, Green & Co. London, England. 1891

**Misner, Charles W.**  
American physicist

**Thorne, Kip S.** 1940–  
American theoretical physicist

Some day a door will surely open and expose the glittering central mechanism of the world in all its beauty and simplicity.

In Charles W. Misner et al

*Gravitation*

Part X, Chapter 44 (p. 1197)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Moore, Benjamin**  
No biographical data available

The ordered beauty of the world of Nature suggests an infinite intelligence with powers of action such as no man...possesses ...

*The Origins of Nature and Life*

Chapter I (p. 23)

Henry Holt & Co.. New York, New York, USA. 1913

**Muir, John** 1838–1914  
American naturalist

Everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul alike.

*The Yosemite*

Chapter 15 (p. 192)

Sierra Club Books. San Francisco, California, USA. 1988

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Science is not everything. But science is very beautiful.

With Oppenheimer on an Autumn Day

*Look*, Volume 30, Number 26, December 27, 1966 (p. 63)

The profession I'm part of has, as its whole purpose, the rendering of the physical world understandable and beautiful. Without this you have only tables and statistics.

With Oppenheimer on an Autumn Day

*Look*, Volume 30, Number 26, December 27, 1966 (p. 63)

**Penrose, Roger** 1931–  
English mathematical physicist

A beautiful idea has a much greater chance of being a correct idea than an ugly one.

*The Emperor's New Mind: Concerning Computers, Minds, and the*

*Laws of Physics*

Chapter 10 (p. 421)

Oxford University Press, Inc. Oxford, England. 1989

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

...what are the mathematical entities to which we attribute this character of beauty and elegance, and which are capable of developing in us a kind of aesthetic emotion?



They are those whose elements are harmoniously disposed so that the mind without effort can embrace their totality while realizing the details. This harmony is at once a satisfaction of our aesthetic needs and an aid to the mind, sustaining and guiding.

*The Foundations of Science*

*Science and Method*

Book I, Chapter III, Section I (p. 391)

The Science Press. New York, New York, USA. 1913

**Proust, Marcel** 1871–1922

French novelist

...beauty is a sequence of hypotheses which ugliness cuts short when it bars the way that we could already see opening into the unknown.

Translated by C.K. Scott Moncrief

*Within a Budding Grove*

Part Two, Place-Names: The Place (p. 14)

The Modern Library. New York, New York, USA. 1951

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

The concept of beauty defies abstract analysis.

*The New Physics: Talks on Aspects of Science*

Chapter IV (p. 23)

Philosophical Library, New York. 1951

**Reddy, Francis**

Science writer

**Walz-Chojnacki, Grey**

Science writer

We live in an age when the complex and forbidding explanations of science often masks the simple beauty of nature.

*Celestial Delights*

Introduction (p. ix)

Celestialarts. Berkeley, California, USA. 1992

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

In every star, in every flower, in every blade of grass, in every grain of sand, in every tiling visible and invisible, there is life, light, and beauty.

*Nature and Culture*

Chapter III (p. 129)

**Robbins, R. Robert**

American Archaeoastronomer

**Jefferys, William H.** 1940–

American astronomer

The beauty of the night sky can be overwhelming.

*Discovering Astronomy* (3rd edition)

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

In all arts or sciences, before we can determine what is just or beautiful in a group, we must ascertain what is desirable in the parts which compose it...

*The Poetry of Architecture: Cottage, Villa, Etc*

The Villa (p. 81)

John Wiley & Sons. New York, New York, USA. 1877

**Sartre, Jean-Paul** 1905–80

French existentialist philosopher and novelist

The real is never beautiful. Beauty is a value which applies only to the imaginary and which entails the negation of the world in its essential structure.

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 5 (p. 102)

The New American Library, Inc. New York, New York, USA. 1967

**Shaftesbury, Anthony Ashley Cooper** 1671–1713

English philosopher

There is no one who, by the least progress of science or learning, has come to know barely the principles of mathematics, but has found, that in the exercise of his mind on the discoveries he there makes, though merely of speculative truths, he receives a pleasure and delight superior to that of sense. When we have thoroughly searched into the nature of this contemplative delight, we shall find it of a kind which relates not in the least to any private interest of the creature, nor has for its object any self-good or advantage of the private system.

*Characteristics of Men, Manners, Opinions, Times, etc.* (Volume 1)

Treatise IV, Book II, Part II, Section I (p. 296)

G. Richards. London, England. 1900

**Smale, Stephen** 1930–

American mathematician

Beauty is very integrated with rarity... Beauty is connected so much with innovation and priority... [In mathematics], it has to be something special to make it beautiful. If it's just ordinary, it's not beautiful.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 320)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Steensen, Niels** 1638–86

Danish anatomist and naturalist

Beautiful are the things we see

More beautiful those we understand

Much the most beautiful those we do not comprehend.

Introductory Lecture

Copenhagen Anatomical Theater 1673

**Thurston, William Paul** 1946–

American mathematician



The inner force that drives mathematicians isn't to look for applications; it's to understand the structure and inner beauty of mathematics.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 335)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Wallace, Lew** 1827–1905

American statesman and writer

...beauty is altogether in the eye of the beholder:...

*The Prince of India: or, Why Constantinople Fell* (Volume 1)  
Book III, Chapter VI (p. 178)  
Harper & Brothers Publishers. New York, New York, USA. 1893

**Weil, Simone** 1909–43

French philosopher and mystic

The true subject of science is the beauty of the world.

Translated by Elizabeth Oehlkers  
In Ernest Peter Fischer  
*Beauty and the Beast*  
Chapter 5 (p. 91)  
Plenum Trade. New York, New York, USA. 1999

**Wheeler, John Archibald** 1911–

American physicist and educator

The beauty in the laws of physics is the fantastic simplicity that they have.

In Paul Buckley and F. David Peat (eds.)  
*Glimpsing Reality: Ideas in Physics and the Link to Biology*  
John Archibald Wheeler (p. 96)  
University of Toronto Press. Toronto, Ontario, Canada. 1996

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Beauty is a form of Genius – is higher, indeed, than Genius, as it needs no explanation.

*The Picture of Dorian Gray*  
Chapter 2 (pp. 24–25)  
The Modern Library. New York, New York, USA. 1992

**BEGINNING**

**Ramsay, Sir William** 1852–1916

English chemist

Like every other endeavor, the beginning is in small things. Anyone who tries to look into anything with sufficient care will find something new. A drop of water; a grain of sand; an insect; a blade of grass; we know indeed little about them when all is told.

*Essays Biographical and Chemical*  
Chemical Essays  
How Discoveries Are Made (p. 116)  
Archibald Constable & Company Ltd. London, England. 1908

**Snyder, Carl** 1869–1946

American economist and statistician

A veil hides from us the beginning of things. So far as we can now see, it will never be lifted. Equally from our view is veiled the end.

*The World Machine: The First Phase the Cosmic Mechanism*  
Chapter XXXIV (p. 459)  
Longmans Green. London, England. 1904

**BEHAVIOR**

**Dostoevsky, Fyodor Mikhailovich** 1821–81

Russian writer

...every insect, ant, and golden bee, all so marvelously know their path, though they have not intelligence ...

Translated by Constance Garnett  
*Great Books of the Western World* Volume 52  
*The Brothers Karamazov*  
Book VI, Chapter 1 (p. 153)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Goodness knows how it [genetics of behavior] is to be got at. It may be outflanked or it may yield to attrition, but probably not to direct assault. No scientist is admired for failing in the attempt to solve problems that lie beyond his competence. The most he can hope for is the kindly contempt earned by the Utopian politicians.

*The Strange Case of the Spotted Mice and Other Classic Essays*  
Chapter 4 (p. 42)  
Oxford University Press. Oxford, England. 1996

**BELIEF**

**Buchner, Ludwig** 1824–99

German physician and philosopher

Individual human qualities and imperfections are transferred to philosophical notions, and belief is made to occupy the place of actual knowledge.

*Force and Matter*  
Chapter I (p. 7)  
Trubner & Co  
London, England. 1864

**Darwin, Charles Robert** 1809–82

English naturalist

Thus disbelief crept over me at a very slow rate, but was at last complete. The rate was so slow that I felt no distress, and have never since doubted even for a second that my conclusion was correct. I can indeed hardly see how anyone ought to wish Christianity to be true; for if so the plain language of the text seems to show that the men who do not believe, and this would include my Father, Brother and almost all of my friends, will be everlastingly punished.

And this is a damnable doctrine.

*The Autobiography of Charles Darwin, 1809–1882: With Original Omissions Restored*  
Religious Belief (p. 87)  
Harcourt, Brace. New York, New York, USA. 1959

At some future period, not very distant as measured by centuries, the civilised races of man will almost certainly exterminate, and replace, the savage races throughout the world. At the same time the anthropomorphous apes, as Professor Schaaffhausen has remarked, will no doubt be exterminated. The break between man and his nearest allies will then be wider, for it will intervene between man in a more civilised state, as we may hope – [more civilized] than the Caucasian, and some ape as low as a baboon, instead of as now between the negro or Australian and the gorilla.

In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
Part I, Chapter VI (p. 336)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Morgan, Augustus** 1806–71

English mathematician and logician

...belief is but another name for imperfect knowledge...

*Formal Logic: Or, The Calculus of Inference, Necessary and Probable*  
Chapter IX (p. 173)  
Taylor & Walton. London, England. 1847

**Dewar, Redcote**

No biographical data available

Man's beliefs are generally, but not always, according to his knowledge, hence, if his knowledge be scant, his opinions are correspondingly grotesque.

*From Matter to Man: A New Theory of the Universe*  
Chapter XI (p. 131)  
Chapman & Hall, Ltd. London, England. 1898

**Heinlein, Robert A.** 1907–88

American science fiction writer

I don't "believe" in anything. I know certain things – little things, not the Nine Billion Names of God – from experience. But I have no beliefs. Belief gets in the way of learning.

*Time Enough for Love*  
Prelude, Chapter II (p. 41)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Huxley, Thomas Henry** 1825–95

English biologist

Every belief is the product of two factors: the first is the state of mind to which the evidence in favor of that belief is presented; and the second is the logical cogency of the evidence itself.

*Collected Essays* (Volume 2)  
*Darwiniana*  
The Coming of Age of "The Origin of Species" (p. 230)  
Macmillan & Company Ltd. London, England. 1904

**Redi, Francesco** 1626–78

Italian physician

Belief [that worms in meat were derived from the droppings of flies] would be vain without the confirmation of experiment, hence in the middle of July, I put a snake, some fish, some eels of the Arno, and a slice of milk-fed veal in four large, wide-mouthed flasks; having well closed and sealed them, I then filled the same number of flasks in the same way, only leaving these open.

Translated by Mab Bigelow  
*Experiments on the Generation of Insects*  
Meat in Sealed Flasks (p. 33)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1909

**Robinson, James Harvey** 1863–1936

American historian and educator

We are incredibly heedless in the formation of our beliefs, but find ourselves filled with an illicit passion for them when anyone proposes to rob us of their companionship. It is obviously not the ideas themselves that are dear to us, but our self-esteem, which is threatened.

*The Mind in the Making*  
Chapter II (p. 40)  
Harper & Brothers Publishers. New York, New York, USA. 1921

**Sayers, Dorothy L.** 1893–1957

English novelist and essayist

But you see, I can believe a thing without understanding it. It's all a matter of training.

*Strong Poison and Have His Carcase*  
Have His Carcase  
Chapter XXII (p. 301)  
Harcourt, Brace & Company. New York, New York, USA. No date

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

There is no harder scientific fact in the world than the fact that belief can be produced in practically unlimited quantity and intensity, without observation or reasoning, and even in defiance of both, by the simple desire to believe founded on a strong interest in believing.

*The Doctor's Dilemma*  
Preface on Doctors  
Credulity and Chloroform (p. xviii)  
Brentano's. New York, New York, USA. 1920

## BELIEFS

**Sagan, Carl** 1934–96

American astronomer and author

We are constantly prodding, challenging, seeking contradictions or small, persistent residual errors, proposing alternative explanations, encouraging heresy. We give our highest rewards to those who convincingly disprove established beliefs.

*Demon-Haunted World: Science As a Candle in the Dark*  
Chapter 2 (p. 33)  
Random House, Inc. New York, New York, USA. 1995

## BENEFACTOR

**Rowland, Henry Augustus** 1848–1901  
American physicist

He who makes two blades of grass grow where one grew before is the benefactor of mankind; but he who obscurely worked to find the laws of such growth is the intellectual superior as well as the greater benefactor of the two.

*The Physical Papers of Henry Augustus Rowland*  
The Highest Aims of the Physicist (p. 669)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

## BENZENE THEORY

**Kekule, August** 1829–96  
German organic chemist

Someone has said that the benzene theory appeared like a meteor from the sky. It came absolutely new and uninitiated. The human mind does not work in this manner. Nothing has ever been thought of which is absolutely new, certainly not in chemistry...

In Harry Clary Jones  
*A New Era in Chemistry*  
Chapter I (p. 13)  
D. van Nostrand Co. New York, New York, USA. 1913

## BESSEL FUNCTION

**Feynman, Richard P.** 1918–88  
American theoretical physicist

When I see equations, I see the letters in colors – I don't know why. As I'm talking, I see vague pictures of Bessel functions from Jahnke and Ernde's book, with light-tan j's, slightly violet-bluish n's, and dark brown x's flying around. And I wonder what the hell it must look like to the students.

*What Do You Care What Other People Think?*  
It's as Simple as One, Two, Three... (p. 59)  
W.W. Norton & Company, Inc. New York, New York, USA. 1988

## BETA DECAY

**Wu, Chien-Shiung** 1912–97  
Chinese-American physicist

Beta decay was...like a dear old friend. There would always be a special place in my heart reserved especially for it.

In H. B. Newman and T. Ypsilantis (eds.)  
*History of Original Ideas and Basic Discoveries in Particle Physics*  
Parity Violation (pp. 390–391)  
Plenum Press. New York, New York, USA. 1996

## BEWILDERED

**Darwin, Charles Galton** 1809–82  
English naturalist

...the more I think the more bewildered I become...

In Francis Darwin  
*The Life and Letters of Charles Darwin* (Volume 2)  
Darwin to Asa Gray, May 22, 1860 (p. 106)  
D. Appleton & Co. New York, New York, USA. 1887

## BIBLIOGRAPHER

**Minot, Charles Sedgwick** 1852–1914  
American anatomist

The biological bibliographer is like an explorer in a forest – he finds no open way to travel, but must laboriously hunt for the specimens which belong in the same class according to our intellectual systems, and which he must discover as they lie scattered, unclassified, and, all too often, concealed.

*Biological Lectures Delivered at the Marine Biological Laboratory of Wood's Hole*  
Tenth Lecture (pp. 149–150)  
Ginn & Co. Boston, Massachusetts, USA. 1896

## BIBLIOGRAPHY

**de Cervantes, Miguel** 1547–1616  
Spanish novelist, playwright, and poet

Now let us come to those references to authors which other books have, and you want for yours. The remedy for this is very simple; You have only to look out for some book that quotes them all, from A to Z as you say yourself, and then insert the very same alphabet in your book, and though the imposition may be plain to see, because you have so little need to borrow from them, that is no matter; there will probably be some simple enough to believe that you have made use of them all in this plain, artless story of yours. At any rate, if it answers no other purpose this long catalogue of authors will serve to give a surprising look of authority to your book.

In *Great Books of the Western World* (Volume 29)  
*The History of Don Quixote de la Mancha*  
Preface (p. xiii)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Weil, André** 1906–98  
French mathematician

We know only too well...that one should not invariably assume a mathematician to be fully aware of the work of his predecessors, even when he includes it among his references; which one of us has read all the books he has listed in the bibliographies of his own writings?

In Raymond George Ayoub  
*Musings of the Masters: An Anthology of Mathematical Reflections*  
History of Mathematics (p. 210)  
Mathematical Association of America. Washington, D.C. 2004

## BIFOCAL VISION

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

I have no doubt that you, ladies, have frequently received delicate compliments upon your eyes, but I feel sure that no one has ever told you, and I know not whether it will flatter you, that you have in your eyes, be they blue or black, little geometricians. You say you know nothing of them? Well, for that matter, neither do I. But the facts are as I tell you.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

Why Has Man Two Eyes? (pp. 71–72)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

## BIG BANG

**Alphonsus X** 1221–84

Castilian monarch and patron of the sciences

...a certain King of Castile, a great mathematician, (but not much troubled with religion) said, that, “had God consulted him when he made the world, he would have told him how to have framed it better.”

In Bernard de Fontenelle

*Conversations on the Plurality of Worlds*

The First Evening (pp. 13–14)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Ball, Philip** 1962–

English science writer

Origins are seldom uncontentious. Current fashion sometimes has it that the idea of a cosmic Big Bang is best regarded as our latest cultural myth, as much a social construct as the slaying of Ymir. On the one hand, it can only be arrogant to suggest otherwise; on the other, it’s this particular kind of confidence that makes science possible.

*Life’s Matrix: A Biography of Water*

Part One, Chapter 1 (p. 5)

Farrar, Straus &amp; Giroux. New York, New York, USA. 2000

**Čapek, Milič** 1909–97

Czechoslovakian philosopher and physicist

World history thus began by a “super-radioactive explosion” of the original single quantum, and the development of the universe is a continuation of this process of fragmentation of energy into the increasing number of smaller and smaller quanta. The enormous energy of the cosmic rays is merely a “fossil remnant” of the high-frequency radiation from the original phase of cosmic history.

*The Philosophical Impact of Contemporary Physics*

Chapter XVII (p. 352)

D. van Nostrand Company, Inc. Toronto, Ontario, Canada. 1961

**Cardenal, Ernesto** 1925–

Nicaraguan poet and Roman Catholic priest

And that was Big Bang.

The Great Explosion.

The universe subjected to relations of uncertainty, its radius of curvature undefined,

its geometry imprecise

with the uncertainty principle of Quantum Mechanics.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 1, Big Bang (p. 11)

Curbstone Press. Willimantic, Connecticut, USA. 1993

**Ehrenreich, Barbara** 1941–

American social critic and essayist

If that’s how it all started, then we might as well face the fact that what’s left out there is a great deal of shrapnel and a whole bunch of cinders (one of which is, fortunately, still hot enough and close enough to be good for tanning).

*The Worst Years of Our Lives*

Blocking the Gates to Heaven (p. 267)

Pantheon Books. New York, New York, USA. 1981

**Ferris, Timothy** 1944–

American science writer

We have at present only two kinds of physics to choose from, classical and quantum; and classical physics, as Alex Vilenkin notes, “fails to describe the beginning of the universe.” Its breakdown is clearly signaled by the fact that general relativity invokes a singularity at time zero, which is to say that its equations yield infinities and can produce no meaningful result. Roger Penrose and a youthful Stephen Hawking proved this in 1970, in theorems demonstrating that if gravitation is always attractive and if the universe has anything like the matter density we observe to have, then there must have been a singularity at the outset of time. So we are left with quantum cosmology – the attempt to apply quantum precepts, previously employed in studying subatomic particles and fields, to the universe as a whole.

*The Whole Shebang: A State-of-the-Universe’s Report*

The Origin of the Universe (p. 249)

Simon &amp; Schuster. New York, New York, USA. 1996

The term “big bang” was coined with derisive intent by Fred Hoyle, and its endurance testifies to Sir Fred’s creativity and wit. Indeed, the term survived an international competition in which three judges – the television science reporter Hugh Downs, the astronomer Carl Sagan, and myself – sifted through 13,099 entries from 41 countries and concluded that none was apt enough to replace it. No winner was declared, and like it or not, we are stuck with “big bang.”

*The Whole Shebang: A State-of-the-Universe’s Report*

Notes, 10 (p. 323)

Simon &amp; Schuster. New York, New York, USA. 1996

**Gamow, George** 1904–68  
Russian-born American physicist

God was very much disappointed, and wanted first to contract the Universe again, and to start all over from the beginning. But it would be much too simple. Thus, being almighty, God decided to correct His mistake in a most impossible way.

And God said: "Let there be Hoyle." And there was Hoyle. And God looked at Hoyle...and told him to make heavy elements in any way he pleased.

And Hoyle decided to make heavy elements in stars, and to spread them around by supernova explosions.

*My World Line: An Informal Autobiography*

Chapter 6 (p. 127)

The Viking Press. New York, New York, USA. 1979

**Guth, Alan** 1947–  
American physicist

...the big bang theory is not really a theory of a bang at all. It is only a theory of the aftermath of a bang...the standard big bang theory says nothing about what banged, why it banged, or what happened before it banged.

*The Inflationary Universe: The Quest For a New Theory of Cosmic Origins*

Preface (p. xiii)

Addison-Wesley Publishing Company, Inc. Reading, Massachusetts, USA. 1997

**Hoyle, Sir Fred** 1915–2001  
English mathematician, astronomer, and writer

The big bang theory requires a recent origin of the Universe that openly invites the concept of creation.

*The Intelligent Universe*

Chapter 9 (p. 237)

Holt, Rinehart & Winston. New York, New York, USA. 1983

On scientific grounds this big bang assumption is much the less palatable of the two [steady state theory or point source origin theory]. For it is an irrational process that cannot be described in scientific terms.

*The Nature of the Universe*

Chapter 6 (p. 124)

The University Press. Cambridge. 1933

A major reason for the popularity of big-bang theory is undoubtedly that it is simple enough to place no burden on the mind. Undoubtedly, too, there are many who are attracted by its retreat into metaphysics. For myself, I find the retreat into nonexplanation unsatisfactory, contrasting so markedly with the exquisite subtlety of all science outside cosmology. Can the Universe really be so crude while the rest is so refined?

*Home Is Where the Wind Blows: Chapters from a Cosmologist's Life*

Part Three, Chapter 24 (p. 354)

University Science Books, Mill Valley, California, USA. 1994

Big-bang cosmology is a form of religious fundamentalism, as is the furor over black holes, and this is why

these peculiar states of mind have flourished so strongly over the past quarter century. It is in the nature of fundamentalism that it should contain a powerful streak of irrationality and that it should not relate, in a verifiable, practical way, to the everyday world. It is also necessary for a fundamentalist belief that it should permit the emergence of gurus, whose pronouncements can be widely reported and pondered on endlessly – endlessly for the reason that they contain nothing of substance, so that it would take an eternity of time to distill even one drop of sense from them. Big-bang cosmology refers to an epoch that cannot be reached by any form of astronomy, and, in more than three decades, it has not produced a single successful prediction.

*Home Is Where the Wind Blows: Chapters from a Cosmologist's Life*

Part Three, Chapter 28 (pp. 413–414)

University Science Books, Mill Valley, California, USA. 1994

An ultimate theory, like the Holy Grail, is something the physicist must always seek but will never find.

*Ten Faces of the Universe*

The Physicist's Universe (p. 34)

W.H. Freeman & Company. San Francisco, California, USA. 1977

It is a suspicious feature of the explosion theory that no obvious relics of a superdense state of the Universe can be found.

*Frontiers of Astronomy* (p. 322)

Harper & Row, Publishers. New York, New York, USA. 1955

**Jeffers, Robinson** 1887–1962  
American poet

...there is no way to express that explosion; all that exists

Roars into flame, the tortured fragments rush away from each other into all the sky, new universes

Jewel the black breast of night; and far off the outer nebulae like charging spearmen again

Invade emptiness.

No wonder we are so fascinated with fire-works.

*The Beginning and the End and Other Poems*

The Great Explosion (p. 3)

Random House, Inc. New York, New York, USA. 1963

**Levi, Primo** 1919–87  
Italian writer and chemist

Twenty billion years before now,

Brilliant, soaring in space and time

There was a ball of flame, solitary, eternal,

Our common father and our executioner.

It exploded, and every change began.

Even now the thin echo of this one reverse catastrophe

Resounds from the furthest reaches.

Translated by Ruth Feldman and Brian Swann

*Collected Poems*

In the Beginning

Faber & Faber. Boston, Massachusetts, USA. 1988



**MacRobert, Alan**

Editor

The idea of an oscillating universe, in which the Big Bang resulted from the recollapse of a previous phase of the universe, gained currency merely because it avoided the issue of creation – not because there was the slightest evidence in favor of it.

Beyond the Big Bang  
*Sky & Telescope*, Vols. 65–66, March, 1983 (p. 211)

**Maddox, John Royden** 1925–

Welsh chemist and physicist

The microwave background radiation, which fills even the corners of the universe, would psychologically have been more compelling evidence for the Big Bang if it had been predicted before its discovery in 1965. That it was not is something of a surprise, which is nevertheless now irrelevant.

The Best Cosmology There Is  
*Nature*, Volume 372, Number 6501, 3 November, 1994 (p. 15)

**Mather, John C.** 1946–

American astrophysicist

“The Big Bang Theory comes out a winner. This is the ultimate in tracing one’s cosmic roots.” He added, “We are seeing the cold glow still remaining from the initially very hot Big Bang.... The closer we examine the Big Bang the simpler the picture gets.”

In P. Cleggett-Haleim  
Big Bang Theory Passes Toughest Test  
*NASA Press Release*, Washington, D.C., January 7, 1993

**Parker, Barry**

Canadian physicist

If we accept the big bang theory, and most cosmologists now do, then a “creation” of some sort is forced upon us.  
*Creation: The Story of the Origin and Evolution of the Universe*  
Chapter 11 (p. 202)  
Plenum Press. New York, New York, USA. 1998

**Poe, Edgar Allan** 1809–49

American short story writer

I am fully warranted in announcing that the Law which we have been in the habit of calling Gravity exists on account of Matter’s having being irradiated, at its origin, atomically, into a limited sphere of Space, from one, individual, unconditional, irrelative, and absolute Particle Proper, by the sole process in which it is possible to satisfy, at the same time, the two conditions, irradiation and generally equable distribution throughout the sphere, that is to say, by a force varying in direct proportion with the squares of the distances between the irradiated atoms, respectively, and the Particular centre of Irradiation.

*Eureka*  
Line 8 (p. 67)  
Geo. P. Putnam. New York, New York, USA. 1848

**Silk, Joseph** 1942–

American astronomer and physicist

It’s impossible that the Big Bang is wrong.  
In Eric J. Lerner  
*The Big Bang Never Happened*  
Chapter 1 (p. 11)  
Random House, Inc. New York, New York, USA. 1991

**Smoot, George** 1945–

American astrophysicist

What we have found is evidence for the birth of the universe.... It’s like looking at God.  
In T.H. Maugh  
Relics of “Big Bang” Seen for First Time  
*Los Angeles Times*, April 24, 1992:A1

**Turner, Michael S.**

American astrophysicist

The significance of this cannot be overstated. They have found the Holy Grail of cosmology.  
American Scientists Find a “Holy Grail”  
*International Herald Tribune*, London, April 24, 1992:1

**Updike, John** 1932–

American novelist, short story writer, and poet

Space-time. Three spatial dimensions, plus time. It knots. It freezes. The seed of the universe has come into being. Out of nothing. Out of nothing and brute geometry, laws that can’t be otherwise, nobody handed them to Moses, nobody had to. Once you’ve got that little seed, that little itty-bitty mustard seed – ka-boom! Big Bang is right around the corner.

*Roger’s Version*  
Chapter V (p. 303)  
Alfred A. Knopf. New York, New York, USA. 1986

**Weinberg, Steven** 1933–

American nuclear physicist

In the beginning there was an explosion. Not an explosion like those familiar on earth, starting from a definite center and spreading out to engulf more and more of the circumambient air, but an explosion which occurred simultaneously everywhere, filling all space from the beginning, with every particle of matter rushing apart from every other particle.

*The First Three Minutes*  
Chapter I (p. 5)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Weldon, Fay** 1931–

English novelist

Who cares about half a second after the big bang; what about the half second before?  
In Paul Davies  
*About Time: Einstein’s Unfinished Revolution*  
Header (p. 129)  
Simon & Schuster. New York, New York, USA. 1995



**Wheeler, John Archibald** 1911–

American physicist and educator

Not only particles and the fields of force had to come into being at the big bang, but the laws of physics themselves, and this by a process as higgledy-piggledy as genetic mutation or the second law of thermodynamics.

The Computer and the Universe

*International Journal of Theoretical Physics*, Volume 21, Numbers 6/7, June 1982 (p. 565)

**Zeldovich, Yakov Borisovich** 1914–87

Russian physicist

The point of view of a sinner is that the church promises him hell in the future, but cosmology proves that the glowing hell was in the past.

In Joseph Silk

*The Big Bang* (p. 101)

W.H. Freeman. New York, New York, USA. 1989

**BINARY****Author undetermined**

In the binary system we count on our fists instead of on our fingers.

Source undetermined

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

It was thus that Leibnitz believed he saw the image of creation in his binary arithmetic where he employed only the two characters, unity and zero. He imagined, since God can be represented by unity and nothing by zero, that the Supreme Being had drawn from nothing all beings, as unity with zero expresses all the numbers in this system of arithmetic. This idea was so pleasing to Leibnitz that he communicated it to the Jesuit Grimaldi, president of the tribunal of mathematics in China, in the hope that this emblem of creation would convert to Christianity the emperor there who particularly loved the sciences.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter XVI (p. 169)

John Wiley &amp; Sons. New York, New York, USA. 1902

**BINOMIAL EXPANSION****Kaminsky, Kenneth**

American mathematics professor, writer, and editor

...yeah, our apartment was small. It was so small, we had to go out in the hall just to use the binomial expansion.

Professor Fogelfro

*Mathematical Magazine*, Volume 69, Number 2, April, 1996 (p. 142)**BINOMIAL THEOREM****Fabre, Jean-Henri** 1823–1915

French entomologist and author

And now we are together, O mysterious tome, whose Arab name breathes a strange mustiness of occult lore and claims kindred with the sciences of almagest and alchemy. What will you show me? Let us turn the leaves at random. Before fixing one's eyes on a definite point in the landscape, it is well to take a summary view of the whole. Page follows swiftly upon page, telling me nothing. A chapter catches my attention in the middle of the volume; it is headed, Newton's Binomial Theorem.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 282)

Dodd, Mead &amp; Co. New York, New York, USA. 1925

**BIOCENTRIC****Taylor, Paul W.**

No biographical data available

To accept the biocentric outlook and regard ourselves and the world from its perspective is to see the whole natural domain of living things and their environment as an order of interconnected objects and events.

*Respect for Nature: A Theory of Environmental Ethics*

The Natural World As A System of Interdependence (p. 116)

Princeton University Press. Princeton, New Jersey, USA. 1986

**BIOCHEMIST****Chargaff, Erwin** 1905–2002

Austrian biochemist

There are few things in the world before which the biochemist feels as uncomfortable as when he has to deal with life itself.

*Voices in the Labyrinth: Nature, Man and Science* (p. 73)

The Seabury Press. New York, New York, USA. 1977

**BIOCHEMISTRY****Chantrenne, H.**

No biographical data available

Biochemistry is no longer the chemistry of death and decay; it is the chemistry of the living cell, with its essential irreversible, oriented processes admirably organized and controlled.

In Nathan O. Kaplan and Eugene P. Kennedy (eds.)

*Current Aspects of Biochemical Energetics: Fritz Lipmann Dedicatory Volume*

For the 25th Anniversary of ~ P (p. 37)

Academic Press. New York, New York, USA. 1966

**Chargaff, Erwin** 1905–2002

Austrian biochemist

...biochemistry is helpless before life, having to kill the organism before investigating it. Biochemistry is, in fact, much more successful in practicing the second part of its composite name than in following the prefix.

Triviality in Science: A Brief Meditation on Fashions  
*Perspectives in Biology and Medicine*, Volume 19, Number 3, Spring, 1976 (p. 333)

What I liked about chemistry was its clarity surrounded by darkness; what attracted me, slowly and hesitatingly, to biology was its darkness surrounded by the brightness of the givenness of nature, the holiness of life. And so I have always oscillated between the brightness of reality and the darkness of the unknowable. When Pascal speaks of God in hiding, *Deus absconditus*, we hear not only the profound existential thinker, but also the great searcher for the reality of the world. I consider this unquenchable resonance as the greatest gift that can be bestowed on a naturalist.

*Heraclitean Fire: Sketches from a Life before Nature*

The Silence of the Heavens (p. 55)

Rockerfeller University Press. New York, New York, USA. 1978

**Darling, David** 1953–

Freelance science writer

Every human being, and every human mind, has roots that extend indefinitely far back through time. The genes that regulate all aspects of our physical development, including the prenatal fabrication of our brains, were in existence long before we or our parents were born. Those genes, in turn, evolved, step by step, from more primitive genetic material that can trace its ancestry back to the first biochemical reactions on Earth. And we do not have to stop there. We can carry the search for the ultimate origin of ourselves back still further – back to the very beginning of the universe.

*Equations of Eternity: Speculations on Consciousness, Meaning, and the Mathematical Rules That Orchestrate the Cosmos*

Chapter 2 (p. 22)

Hyperion. New York, New York, USA. 1993

**Deutscher, Murray**

No biographical data available

To dialyze, or not to dialyze – that is the question: –  
Whether 'tis better for the protein to suffer  
The wear and tear of defective Visking  
Or to take the chances against a sea of buffers  
By chromatography instead?

Biochemist's Soliloquy

*Perspectives in Biology and Medicine*, Volume VIII, Number 2, Winter 1965 (p. 277)

**Fruton, Joseph S.** 1912–

Polish-born American biochemist

**Simmonds, Sophia**

No biographical data available

The ultimate goal of biochemistry is to describe the phenomena that distinguish the “living” from the “non-living” in the language of chemistry and physics.

*General Biochemistry* (2nd edition)

Chapter 1 (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1958

**Hopkins, Frederick Gowland** 1844–89

English biochemist

The task of the biochemist wishing to get to the heart of his problem is exceptional in that he must study systems in which the organization of chemical events counts for more, and is carried far beyond, such simpler coordinations as may be found in non-living systems. He would be over-bold were he to claim at present that such high organization can depend alone upon adjusted concentrations and ordered structural distributions among specialized colloidal catalysts, but he is justified, I think, in feeling sure that such factors contribute to that organization in a significant sense. The biochemist, when he aims at describing living systems in his own language, comes in contact with philosophical thought.... His may not be the last word in the description of life, but without his help the last word will never be said.

In Joseph Needham and Ernest Baldwin (eds.)

*Hopkins & Biochemistry*

Problems of Specificity in Biochemical Catalysis

33rd Robert Boyle Lecture, 1931 (p. 223)

W. Heffer & Sons Ltd. Cambridge, England. 1949

**Meyerhof, Otto** 1884–1951

German biochemist

Biochemistry has an important bearing on the progress of medicine. But because of this, it must itself remain a pure science, whose initiates are inspired by a craving for understanding and by nothing else.

Biochemistry

*Scientific American*, Volume 183, Number 3, September, 1950 (p. 68)

**Ochoa, Severo** 1905–93

Spanish biochemist and molecular biologist

In recent years biochemistry – the chemistry of life – has come more and more into the foreground of biological research. This is natural since chemical reactions are at the bottom of all life.

*Les Prix Nobel. The Nobel Prizes in 1959*

Nobel banquet speech for award received in 1959

Nobel Foundation. Stockholm, Sweden. 1960

**Rose, Steven Peter Russell** 1938–

No biographical data available

Biochemists are different from organic and natural-product chemists in a number of important ways. First,

for us the structure, sequence and molecular properties of substances derived from living organisms are not of great interest in their own right, but only insofar as they may be seen as providing information which casts light on the biological role of the substance.... Second...we are likely to be less interested in the properties of "pure" molecules in isolation, and more concerned with the ways in which they are involved in complex interactions with other molecules.

Reflections on Reductionism

*Trends in Biochemical Sciences*, Volume 13, 1988 (p. 161)

### van Bergeijk, W. A.

No biographical data available

Biology implies biochemistry, but not the other way around.

In George Gaylord Simpson

*Biology and Man*

Chapter Two (p. 19)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

## BIODIVERSITY

### Terborgh, John 1936–

Tropical biologist

...to save biodiversity, we must act before the virgin forest disappears, because no effort at ecosystem rehabilitation, however sophisticated, will ever recreate nature in its primeval state.

*Diversity and the Tropical Rain Forest*

Chapter 9 (p. 232)

Scientific American Library. New York, New York, USA. 1992

### Wilson, Edward O. 1929–

American biologist and writer

Biological diversity – "biodiversity" in the new parlance – is the key to the maintenance of the world as we know it. Life in a local site struck down by a passing storm springs back quickly because enough diversity still exists. Opportunistic species evolved for just such an occasion rush in to fill the spaces. They entrain the succession that circles back to something resembling the original state of the environment.

*The Diversity of Life*

Chapter One (p. 15)

W.W. Norton & Company, Inc. New York, New York, USA. 1992

The most wonderful mystery of life may well be the means by which it created so much diversity from so little physical matter.

*The Diversity of Life*

Chapter Four (p. 35)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

We should judge every scrap of biodiversity as priceless while we learn to use it and come to understand what

it means to humanity. We should not knowingly allow any species or race to go extinct. And let us go beyond mere salvage to begin the restoration of natural environments in order to enlarge wild populations and stanch the hemorrhaging of biological wealth. There can be no purpose more enspiriting than to begin the age of restoration, reweaving the wondrous diversity of life that still surrounds us.

*The Diversity of Life*

Chapter Fifteen (p. 351)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

## BIOGENESIS

### Davies, Paul Charles William 1946–

British-born physicist, writer, and broadcaster

A law of nature of the sort we know and love will not create biological information, or indeed any information at all.... The secret of life lies, not in its chemical basis, but in the logical and informational rules it exploits.... Real progress with the mystery of biogenesis will be made, I believe, not through exotic chemistry, but from something conceptually new.

*The Fifth Miracle: The Search for the Origin and Meaning of Life*

Chapter 18 (pp. 210, 216)

Simon & Schuster. New York, New York, USA. 1999

## BIOGEOGRAPHY

### Darwin, Charles Robert 1809–82

English naturalist

In considering the distribution of organic beings over the face of the globe, the first great fact which strikes us is, that neither the similarity nor the dissimilarity of the inhabitants of various regions can be wholly accounted for by climatal and other physical conditions.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XII (p. 181)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A third great fact...is the affinity of the productions of the same continent or sea, though the species themselves are distinct at different points and stations. It is a law of the widest generality, and every continent offers innumerable instances. Nevertheless the naturalist in traveling, for instance, from north to south never fails to be struck by the manner in which successive groups of beings, specifically distinct, yet clearly related, replace each other.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XII (p. 182)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Forbes, Edward 1815–54

English naturalist

**Godwin-Austin, Robert Alfred Cloyne** 1808–84  
English geologist

Everyone knows that the same animals and plants are not found everywhere...but that they are distributed so as to be gathered in distinct zoological and botanical provinces, of greater or less extent, according to their degree of limitation by physical conditions, whether features of the earth's outline, or climate.

*The Natural History of the European Seas*

Chapter I (p. 1)

J. van Voorst. London, England. 1859

## BIO-GEOLOGY

**Kingsley, Charles** 1819–75  
English clergyman and author

Bio-geology, then, begins with asking every plant or animal you meet, large or small, not merely – What is your name? That is the collector and classifier's duty; and a most necessary duty it is, and one to be performed with the most conscientious patience and accuracy, so that a sound foundation may be built for future speculations. But young naturalists should act not merely as Nature's registrars and census-takers, but as her policemen and gamekeepers; and ask everything they meet – How did you get there? By what road did you come? What was your last place of abode? And now you are here, how do you get your living? Are you and your children thriving, like decent people who can take care of themselves, or growing pauperized and degraded, and dying out?

*Scientific Essays and Lectures*

On Bio-Geology (p. 3)

Publisher undetermined

## BIOINFORMATICS

**Spengler, Sylvia J.**  
American researcher in genetics

Perhaps bioinformatics – the shotgun marriage between biology and mathematics, computer science, and engineering – is like an elephant that occupies a large chair in the scientific living room.... There are probably many biologists who feel that a major product of this bioinformatics elephant is large piles of waste material.

Bioinformatics in the Information Age

*Science*, Volume 287, Number 5456, 18 February, 2000 (p. 1221)

## BIOLOGICAL

**Arber, Agnes Robertson** 1879–1960  
English botanist

Since the first step in biological research involves the decision as the question on which to concentrate, the researcher is at once put upon his mettle, for the full

recognition and appreciation of a problem may task him even more severely than its solution.

*The Mind and the Eye: A Study of the Biologist's Standpoint*

Chapter I (p. 6)

At the University Press. Cambridge, England, USA. 1954

**Bernard, Claude** 1813–78  
French physiologist

If we mean to build up the biological sciences, and to study fruitfully the complex phenomena which occur in living beings, whether in the physiological or the pathological state, we must first of all lay down principles of experimentation, and then apply them to physiology, pathology and therapeutics.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 2)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bird, J. M.**

No biographical data available

...we shall have to have a philosophy of biological life which gives the human animal something to survive with, a universe which gives us a place to survive into, and a covering of cosmic philosophy which recognizes all this as an aspect of reality. If the necessity arises it will be met and in that event we shall be able to say with obvious truth that science and religion have come together.

In Edward H. Cotton

*Has Science Discovered God?*

Chapter XVI (p. 293)

Thomas Y. Crowell Company, Publishers. New York, New York, USA. 1931

**Brower, David** 1912–2000  
American environmentalist

A fallen tree supports a biological community that may be essential to the existence of the forest itself.

In Jonathan White

*Talking on the Water: Conversations About Nature and Creativity*

The Archdruid Himself (p. 41)

The Sierra Club. San Francisco, California, USA. 1994

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

An observer of our biological sciences today sees dark figures moving over a bridge of glass. We are faced with an ever expanding universe of light and darkness. The greater the circle of understanding becomes, the greater is the circumference of surrounding ignorance.

*Essays on Nucleic Acids*

Chapter 8 (p. 109)

Elsevier Publishing Company. Amsterdam. 1963

**Comte, Auguste** 1798–1857  
French philosopher

If biological phenomena are incomparably more complex than those of any preceding science, the study of them

admits of the most extensive assemblage of intellectual means (many of them new) and develops human faculties hitherto inactive, or known only in a rudimentary state.

*The Positive Philosophy of Auguste Comte* (Volume 2)  
Book V, Chapter 1 (p. 12)  
George Bell & Sons. London, England. 1896

### **Dayton, P. K.**

No biographical data available

### **Mordida, B. J.**

No biographical data available

Geological history and oceanographic processes are the warp and woof of the biological understanding of any marine habitat.

Polar Marine Communities  
*American Zoologist*, Volume 34, 1994 (p. 90)

### **Dunn, R. A.**

No biographical data available

### **Davidson, R. A.**

No biographical data available

Biologic categorization is one of the most conspicuous aspects of successful behavior, not only of man, but of all animals, in meeting the requirements for survival in a complex environment.

Pattern Recognition in Biological Classification  
*Pattern Recognition*, Volume 1, 1968 (p. 75)

### **Durant, William James** 1885–1981

American historian and essayist

So the first biological lesson of history is that life is competition. Competition is not only the life of trade, it is the trade of life – peaceful when food abounds, violent when the mouths outrun the food. Animals eat one another without qualm; civilized men consume one another by due process of law.

*The Lessons of History*  
Chapter III (p. 19)  
Simon & Schuster. New York, New York, USA. 1968

### **Handler, Philip** 1917–81

American biochemist

Biology has become a mature science as it has become precise and quantifiable. The biologist is no less dependent upon his apparatus than the physicist.

*Biology and the Future of Man*  
Chapter 1 (p. 6)  
Oxford University Press, Inc. London, England. 1970

### **Loewy, A. G.**

No biographical data available

### **Siekevitz, P.**

No biographical data available

A dramatic demonstration of the importance of biological structure was provided by the experiments of Skoultchi

and Morowitz, who cooled the eggs of the brine shrimp *Artemia* to temperatures below 2 degrees K (–271 C) and showed that upon rewarming their hatch rate was the same as that of control eggs held at room temperature. Since at that temperature we have structure but presumably no process, it is reasonable to conclude that structure is not only a necessary condition, but even a sufficient condition for initiating biological function. It would thus appear that living processes could be generated by putting together the proper structures, the synthesis of life becoming “merely” a very complicated exercise in organic chemistry.

*Cell Structure and Function*  
Chapter 4 (p. 33)  
Holt, Rinehart & Wilson, Inc. New York, New York, USA. 1969

### **Mason, Otis T.**

No biographical data available

To begin with activities that are purely biological, thoughts in common are shared with the animals. The revolution of the earth on its axis, producing day and night, causes nature to awaken in concert in the morning and to fall asleep in unison in the evening. There is no leader to the orchestra in the former, nor authoritative command or lullaby in the latter.

The Ripening of thoughts in Common  
*Proceedings of the American Philosophical Society*, Volume XLIII,  
April 9, 1904 (p. 149)

### **Pittendrigh, Colin S.** 1918–96

English biologist

The study of adaptation is not an optional preoccupation with fascinating fragments of natural history, it is the core of biological study.

In A. Roe and G.G. Simpson (eds.)  
*Behavior and Evolution*  
Adaptation, Natural Selection, and Behavior (p. 395)  
Yale University Press. New Haven, Connecticut, USA. 1958

### **Snyder, Gary** 1930–

American poet, essayist, and environmental activist

We’re so impressed by our civilization and what it’s done, with our machines, that we have a difficult time recognizing that the biological world is infinitely more complex.

*The Real Work*  
Tracking Down the Natural Man (p. 87)  
New Directions Publishing Corporation. New York, New York, USA.  
1980

### **Trivers, Robert** 1943–

American biologist

I want to change the way people think about their everyday lives. How you think is going to affect who you marry, what kind of relationship you establish, whether and in what manner you reproduce. That’s day-to-day thinking, right? But they don’t even teach courses on that



stuff.... Life is intrinsically biological. It's absurd not to use our best biological concept.

In Roger Bingham

*A Passion to Know: 20 Profiles in Science*

Robert Trivers: Biologist of Behavior (p. 75)

Charles Scribner's Sons. New York, New York, USA. 1984

**von Bunge, Gustav** 1844–1920

Physiologist

I think that the more thoroughly and conscientiously we endeavor to study biological problems, the more we are convinced that even those processes which we have already regarded as explicable by chemical and physical laws are in reality infinitely more complex, and at present defy any attempt at a mechanical explanation.

Translated by Florance Starling

*Text-book of Physiological and Pathological Chemistry* (2nd edition)

Lecture I (p. 2)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1902

**Wheeler, William Morton** 1865–1937

American entomologist

And so far as the actual, fundamental, biological structure of our society is concerned and notwithstanding its stupendous growth in size and all the tinkering to which it has been subjected, we are still in much the same infantile stage. But if the ants are not despondent because they have failed to produce a new social invention or convention in 65 million years, why should we be discouraged because some of our institutions and castes have not been able to evolve a new idea in the past fifty centuries?

*Social Life Among the Insects: Being a Series of Lectures Delivered at the Lowell Institute in Boston in March, 1922*

Lecture I (pp. 8–9)

Harcourt, Brace & Company. New York, New York, USA. 1923

**Wilson, Andrew** 1852–1912

No biographical data available

Biological science, which was formerly regarded as closing its investigations when it approached the human domain, has now boldly entered the precincts of man's own and special order. In a sphere within which biology was formerly regarded as an intruder, it is now welcomed by the latest culture as a friend.

*Leisure-time Studies, Chiefly Biological: A Series of Essays and Lectures*

Chapter I (p. 1)

Chatto & Windus. London, England. 1898

**Woodger, Joseph Henry** 1894–1981

English biologist

If we make a general survey of biological science we find that it suffers from cleavages of a kind and to a degree which is unknown in such a well unified science as, for example, chemistry. Long ago it has undergone that inevitable process of subdivision into special branches which we find in other sciences, but in biology

this has been accompanied by a characteristic divergence of method and outlook between the exponents of the several branches which has tended to exaggerate their differences and has even led to certain traditional feuds between them. This process of fragmentation continues, and with it increases the time and labour requisite for obtaining a proper acquaintance with any particular branch.

*Biological Principles: A Critical Study*

General Introduction (p. 11)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1929

**Young, Michael Dunlop** 1915–

English lawyer

Every bodily process is pulsing to its own beat within the overall beat of the solar system.

*The Metronomic Society: Natural Rhythms and Human Timetables*

Chapter Two (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1988

## BIOLOGICAL MOLECULE

**Gerstein, Mark**

American physical and biological scientist

**Levitt, Michael**

No biographical data available

When scientists publish models of biological molecules in journals, they usually draw their models in bright colors and place them against a blank, black background. We now know that the background in which these molecules exist – water – is just as important as they are.

Simulating Water and the Molecules of Life

*Scientific American*, November, 1998 (p. 105)

## BIOLOGICAL TEACHING

**Patten, William** 1861–1932

American biologist

Much of our biological teaching is like a shop window display of nature's competitive goods, with a varied assortment of human notions thrown in, but with no guarantee as to their significance, or quality, or usefulness.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*

Appendix (p. 424)

Richard G. Badger. Boston, Massachusetts, USA. 1920

## BIOLOGIST

**Allee, Warder C.** 1885–1955

American zoologist

Our tasks as biologists, and as citizens of a civilized country, is a practical engineering job. We need to help arrange so that the existing trend toward a workable world organization will be guided along practical lines



which accord with sound biological theory. And we must remember always that in such matters the idealist with the long-range view is frequently the true realist.

Where Angels Fear to Tread: A Contribution from General Sociology to Human Ethics  
*Science*, Volume 97, 1943 (p. 517?)

**Allen, Durward L.** 1910–87

Wildlife biologist

The biologist has a term for the progress of the seasons; he calls it phenology. It becomes a matter of habit to interpret almost any observation in terms of what has happened and what is going to happen. The present is a moment in a sequence of changes. The basis of phenology is, of course, the climatic cycle through the year.

*Wolves of Minong: Their Vital Role in a Wild Community*  
Chapter 7 (p. 142)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1979

**Author undetermined**

A group of goose biologists were meeting to brainstorm about the migration tactics of Canada geese. They were particularly interested in applying for a \$100,000 Federal grant to investigate the ‘V’ formation of goose flight. It had been observed that one side of the ‘V’ is always longer than the other side. This group would put together a research proposal to apply for the \$100,000 grant and hopefully find out why this happens.

To start off the discussion, Todd, the Consulting Firm Biologist stands up and says in typical consultant fashion, ‘I say we ask for \$200,000, and attempt to model the wind drag coefficients. We can have our geologists record and map the ground topography and then our staff meteorologists can predict potential updraft currents. Our internal CAD department can then produce 3D drawings of the predicted wing tip vortices. Then, after several years of study, our in-house publications department could produce a nice thick report full of charts and graphs.’

The Senior Research Biologist, a professor at the local university, cleared his throat and responded, ‘No, no!, That’s not it at all. We only need \$150,000. We can train a group of domesticated geese to fly in formations of equal length and then compare their relative fitness to wild geese. We can then publish the results in the *Journal of Wildlife Management*.

About then, the hardworking field biologist stands up and begins walking for the door. ‘Where are you going?’ the group asks. ‘I’m leaving’ he replies, ‘I’ve heard enough. No one has to give me \$100,000 to find out that the reason one side of the ‘V’ is longer is simply because there are more geese on that side!’

Source undetermined

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

Great mathematicians are like fastball pitchers. They’re at their peak in their 20s, and after that they’re finished. Great chemists are like curveball or screwball pitchers. They make their contributions in their 30s. But great biologists are like knuckle-ball pitchers. They can go on for years because they don’t burn out. In fact, biologists get better with age.

Fisheries Biologist William Ricker is a Real Hall of Famer in His Field  
*Sports Illustrated*, November 12, 1984 (p. 129)

**Connolly, Cyril** 1903–74

English critic and editor

The answer seems to rest with three categories of thinkers; the physicists, who incline to believe in God, but are now all busy making explosives; the biologists and chemists who can produce almost everything except life, and who, if they could create life, would prove that it might have arisen accidentally; and the psychologists and physiologists, who are struggling to discover the relation of mind to brain, the nature of consciousness.

*The Unquiet Grave*

Part III (p. 80)

Hamish Hamilton. London, England. 1945

**Cudmore, Lorraine Lee**

American cell biologist

All cell biologists are condemned to suffer an incurable secret sorrow: the size of the objects of their passion.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 5)

New York Times Book Company. New York, New York, USA. 1977

We are a sad lot, the cell biologist. Like the furtive collectors of stolen art, we are forced to be lonely admitters of spectacular architecture, exquisite symmetry, dramas of violence and death, nobility, self-sacrifice and yes, rococo sex.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 6)

New York Times Book Company. New York, New York, USA. 1977

**Darbishire, Arthur Dukinfield** 1879–1915

Statistician

The cocksureness of the scientific biologist should surely be the cause of the gravest misgivings. The more certain a man is that he is right the more probable is it that he is wrong; because it means that facts are as soft clay in his hands, and his certainty moulds them to his purpose.

*An Introduction to a Biology*

Chapter I (p. 32)

Funk & Wagnalls Co. New York, New York, USA. 1917

Those who prefer swimming out of their depth may speculate upon first causes and on what happens after death. But the biologist, whose business is the difficult task of understanding life, must be careful to undertake a much less ambitious and precarious task.

*An Introduction to a Biology*

Appendix to an Introduction to Biology (p. 105)

Funk & Wagnalls Co. New York, New York, USA. 1917

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

The physicist's problem is the problem of ultimate origins and ultimate natural laws. The biologist's problem is the problem of complexity.

*The Blind Watchmaker*

Chapter 1 (p. 15)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Eve, A. S.**

No biographical data available

Biologists are divided into three camps, vitalists, mechanists, and those who sit on the boundary fence.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1914*

Modern Views on the Constitution of the Atom (p. 183)

Government Printing Office. Washington, D.C. 1915

**Flannery, Maura C.**

American biologist

The patterns and rhythms of nature, science as a search for order, form as a central problem in biology, are themes that are rarely emphasized in research reports and in texts, they are nevertheless powerful concepts that direct and inform biologists' work.

*Biology Is Beautiful*

*Perspectives in Biology and Medicine*, Volume 35, Number 3, Spring 1992 (p. 427)

**Hull, David L.** 1935–

American philosopher of biology

Evolutionary biologists are currently confronted by a... dilemma: If they insist on formulating evolutionary theory in terms of commonsense entities, the resulting laws are likely to remain extremely variable and complicated; if they want simple laws, equally applicable to all entities of a particular sort, they must abandon their traditional ontology. This reconceptualization of the evolutionary processes is certainly counter-intuitive; its only justification is the increased scope, consistency, and power of the theory that results.

Individuality and Selection

*Annual Review of Ecology and Systematics*, Volume 11, 1980 (pp. 316–317)

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

“Know me, know my frog” – that is, I think, a legitimate adaptation of the old proverb for the biologist.

*Essays in Popular Science*

The Frog and Biology (p. 189)

Chatto & Windus. London, England. 1926

**Huxley, Thomas Henry** 1825–95

English biologist

I do not question for a moment, that while the Mathematician is busied with deductions from general propositions, the Biologist is more especially occupied with observations, comparisons, and those processes which lead to general propositions.

*Lay Sermons, Addresses, and Views*

On the Educational Value of the Natural History Sciences (p. 87)

New York, New York, USA. 1872

The Biologist deals with a vast number of properties of objects, and his inductions will not be completed, I fear, for ages to come; but when they are, his science will be as deductive and as exact as the Mathematics themselves.

*Lay Sermons, Addresses and Reviews*

Chapter V (p. 87)

D. Appleton & Co. New York, New York, USA. 1903

**Kellogg, Vernon Lyman** 1867–1937

American zoologist

...the biologist seems unable to escape from the use of a terminology that is to be found in the larger dictionaries – and these dictionaries are at home, while the public is in the lecture-hall.

The Biologist Speaks of Death

*The Atlantic Monthly*, June, 1921 (p. 778)

**Loeb, Jacques** 1859–1924

German physiologist

...the investigations of the biologist differ from those of the chemist and physicist in that the biologist deals with the analysis of the mechanism of a special class of machines. Living organisms are chemical machines, made of essentially colloidal material which possess the peculiarity of developing, preserving and reproducing themselves automatically. The machines ... have thus far been reproducing themselves, though no one can say with certainty that such machines might not one day be constructed artificially.

The Recent Development of Biology, I

*Science*, Volume 20, Number 519, December 9, 1904 (p. 778)

**Martin, Charles-Noël** 1923–

French physicist

Despite the vast number of facts he has at his fingertips, the modern biologist still knows next to nothing about life itself, its origins, or its workings.

Translated by A.J. Pomerans

*The Role of Perception in Science*

Chapter 4 (p. 76)

Hutchinson of London. London, England. 1963

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Biologists work very close to the frontier between bewilderment and understanding. Biology is complex, messy and richly various, like real life; it travels faster nowadays than physics or chemistry (which is just as well, because it has so much farther to go), and it travels nearer to the ground.

*Pluto's Republic*

Induction and Intuition in Scientific Thought (p. 73)  
Oxford University Press, Inc. Oxford, England. 1982

**Pearson, Will**

American speaker

Molecular biologists are like mechanics at a small-town garage – drive in any model of vehicle and they want to pop the hood to see what makes it run. Microbiologists are like dealership mechanics, working only on certain makes.

In Will Pearson, Mangesh Hattikudur and Elizabeth Hunt  
*Mental Floss Presents Condensed Knowledge*  
Condensed Biology (p. 38)  
HarperCollins. New York, New York, USA. 2004

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

...the more anyone knows about the two kingdoms, animate and vegetating, the less he perceives any boundary between them, until finally he comes to deny the existence of that boundary. Holding the passport of investigation which is stamped with the one great seal of life itself, a biologist travels unchallenged from one realm to the other.

*Flowering Earth*

Chapter 4

G.P. Putnam's Sons. New York, New York, USA. 1939

**Reiger, George** 1939–

American writer

Biologists are like engineers in imagining they can fine-tune the workings of nature. Such fine-tuning, however, only works in computer models.

*The Striped Bass Chronicles: The Saga of America's Great Game Fish*  
Chapter 9 (p. 108)

Lyons Press. Guilford, Connecticut, USA. 2006

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

Biologists seldom have the mathematical view that is required to spot problems in the mathematics of biology that are staring at them. A biologist will never see anything deeper than binomial coefficients. It is not that the problems aren't there; rather, biologists don't have the view that comes with a solid education in mathematics.

*Indiscrete Thoughts*

Chapter XX (p. 213)

Birkhäuser. Boston, Massachusetts, USA. 1997

**Salter, William T.**

No biographical data available

As he picks up his beautiful new tool...it is well for the modern biologist to remind himself how subtly and completely a fascination for gadgets can betray sound sense. A Background for Biological Studies with Radioiodine  
*Science*, Volume 109, Number 2836, May 6, 1949 (p. 454)

**Salthe, Stanley N.**

American biologist

...we are, as evolutionary biologists, indirectly working on nothing less than an important part of our culture's very own creation myth. Is the combination of the pointlessness of chance with the tyranny of necessity, competitive exclusion, expedience, and obedience to material forces what we really want to think of as the sources of our origins.

In Max K. Hecht (ed.)

*Evolutionary Biology at the Crossroads*

Commentaries (p. 175)

Queens College Press. Flushing, New York, USA. 1989

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

I have no powder, no bottle, no tabloid. I am not a quack: I am a biologist.

*Back to Methuselah*

Part II, XXXIII (p. 84)

Constable &amp; Company Ltd. London, England. 1921

**Simpson, George Gaylord** 1902–84

American paleontologist

When bright young biologists speak of genetics without genes and wise old biologists of life without organisms it is evident that something peculiar is going on in the science of biology, so peculiar that "crisis" is not too strong a word. I would diagnose this as combining monomania and schizophrenia.

*Biology and Man*

Chapter One (p. 3)

Harcourt, Brace &amp; World, Inc. New York, New York, USA. 1969

**Standen, Anthony**

Anglo-American science writer

...since biologists deal constantly in analogies, they are easily misled by them.

*Science Is a Sacred Cow*

Chapter IV (p. 113)

E.P. Dutton. New York, New York, USA. 1950

A biologist, if he wishes to know how many toes a cat has, does not "frame the hypothesis that the number of feline digital extremities is 4, or 5, or 6," he simply looks at a cat and counts.

*Science Is a Sacred Cow*

Chapter VI (p. 151)

E.P. Dutton. New York, New York, USA. 1950

**Steinbeck, John** 1902–68  
American novelist

We sat on crates of oranges and thought what good men most biologists are, the tenors of the scientific world – temperamental, moody, lecherous, loud laughing and healthy.... Your true biologist will sing you a song as loud and off-key as will a blacksmith, for he knows that morals are too often diagnostic of prostatitis and stomach ulcers. Sometimes he may proliferate a little too much in all directions, but he is as easy to kill as any other organism, and meanwhile he is very good company, and at least he does not confuse a low hormone productivity with moral ethics.

*Sea of Cortez*

Chapter 4 (p. 28–29)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Stockbridge, Frank B.**

No biographical data available

A little bit of this, a little more of that, a pinch of something else, boil blank minutes, and set aside in the same vessel – thus might read the biologists' formula for creating life...

*Creating Life in the Laboratory*

*Cosmopolitan*, Volume 52, May, 1912 (p. 775)

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The world is like a change-office, without increase or decrease in its initial stock. We always stand in the middle of an equation, past equalling future. It is for the biologist to correct this partial view, for to him the possible that grows out of the past is new and in some measure unpredictable.

*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* Volume 2

Lecture XI (p. 358)

Henry Holt & Co. New York, New York, USA. 1920

**Vogel, Steven** 1940–

American biologist

With the ratification of long tradition, the biologist goes forth, thermometer in hand, and measures the effects of temperature on every parameter of life. Lack of sophistication poses no barrier; heat storage and exchange may be ignored or Arrhenius abused; but temperature is, after time, our favorite abscissa. One doesn't have to be a card-carrying thermodynamicist to wield a thermometer.

*Life in Moving Fluids: The Physical Biology of Flow*

Chapter 1 (p. 1)

W. Grant Press. Boston, Massachusetts, USA. 1981

**Waddington, Conrad Hal** 1905–75

Developmental biologist and paleontologist

And, after all, I am a biologist; it is plants and animals that I'm interested in, not clever exercises in algebra or even chemistry.

*Towards a Theoretical Biology: An IUBS Symposium* (p. 81)

Aldine Publishing Co. Chicago, Illinois, USA. 1968

**Weisz, Paul B.** 1919–

German-born American chemical engineer and biomedical researcher

Man probably was a biologist before he was anything else. His own body in health and disease; the phenomenon of birth, growth and death; and the plants and other animals which gave him food, shelter, and clothing undoubtedly were matters of serious concern to even the first of his kind.

*Elements of Biology* (p. 13)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1981

**Wilson, Edmund Beecher** 1856–1939

American zoologist

Perhaps it is not amiss to remark that the biologist may not hope to solve the ultimate problems of life any more than the chemist and physicist may hope to penetrate the final mysteries of existence in the non-living world.

*Lectures on Science, Philosophy and Art, 1907–1908*

Biology (p. 5)

The Columbia University Press. New York, New York, USA. 1908

**Wilson, Edward O.** 1929–

American biologist and writer

The role of science, like that of art, is to blend proximate imagery with more distant meaning, the parts we already understand with those given as new into larger patterns that are coherent enough to be acceptable as truth. Biologists know this relation by intuition during the course of fieldwork, as they struggle to make order out of the infinitely varying patterns of nature.

*In Search of Nature*

The Bird of Paradise: The Hunter and the Poet (p. 129)

Island Press. Washington, D.C. 1996

**Zinsser, Hans** 1878–1940

U.S. bacteriologist

Nature sets the conditions under which the biologist works, and he must accept her terms or give up the task altogether.

*Rats, Lice and History*

Chapter II (p. 15)

Little, Brown & Co. Boston, Massachusetts, USA. 1963

## BIOLOGIST, MOLECULAR

**Zack, Michael H.**

The situation [copying to a short stretch of the long message coded in DNA] for a molecular biologist is like that

of a spy who knows that there was a paragraph in a vital document that started with “sometimes a...“and ends with”...originally planned”. The spy knows the document has been mixed with millions of other documents and refuse at the local dump. The goal is to read the paragraph.

*Knowledge and Strategy*

Part Two, Chapter 5 (p. 76)

Butterworth-Heinemann. Boston, Massachusetts, USA. 1999

## BIOLOGY

**Abbey, Edward** 1927–89

American environmentalist and nature writer

The basic science is not physics or mathematics but biology – the study of life. We must learn to think both logically and bio-logically.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 10 (p. 94)

St. Martin's Press. New York, New York, USA. 1989

### Author undetermined

Biology is the only science in which multiplication means the same thing as division.

Source undetermined

Biology is really Chemistry, Chemistry is really Physics, Physics is really Mathematics, and Mathematics is really Philosophy.

Source undetermined

**Bartlett, Elisha** 1804–55

American physician

With certain limited exceptions, the laws of physical science are positive and absolute, both in their aggregate, and in their elements, – in their sum, and in their details; but the ascertainable laws of the science of life are approximative only, and not absolute.

*An Essay on the Philosophy of Medical Science*

Part II, Chapter 11

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

**Bates, Marston** 1906–74

American zoologist

Natural history is not equivalent to biology. Biology is the study of life. Natural history is the study of animals and plants – of organisms. Biology thus includes natural history, and much else besides.

*The Nature of Natural History*

Chapter 1 (p. 7)

Scribner. New York, New York, USA. 1950

**Berlinski, David** 1942–

American mathematician

Mathematical sciences require *theories*, molecular biology *facts*.

*A Tour of Calculus*

Chapter 26 (p. 306)

Pantheon Books. New York, New York, USA. 1995

**Bernard, Claude** 1813–78

French physiologist

...the science of vital phenomena must have the same foundations as the science of phenomena of inorganic bodies, and...there is no difference in this respect between the principles of biological science and those of physico-chemical science.

Translatede by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

**Burroughs, John** 1837–1921

American naturalist and essayist

at their everlasting tasks, but biology is as a flower that cometh in a day and on the morrow is cut down.

*Under the Apple Tree*

The Primal Mind (p. 129)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Capra, Fritjof** 1939–

Austrian-born American physicist

The exploration of the atom has forced physicists to revise their basic concepts about the nature of physical reality in a radical way. The result of the revision is a coherent dynamic theory, quantum mechanics, which transcends the principal concepts of Cartesian-Newtonian science. In biology, on the other hand, the exploration of the gene has not led to a comparable revision of basic concepts, nor has it resulted in a universal dynamic theory.

*The Turning Point: Science, Society, and the Rising Culture*

Chapter 4 (p. 121)

Simon & Schuster. New York, New York, USA. 1982

**Carson, Rachel** 1907–64

American marine biologist and author

I like to define biology as the history of the earth and all its life – past, present, and future. To understand biology is to understand that all life is linked to the earth from which it came; it is to understand that the stream of life, flowing out of the dim past into the uncertain future, is in reality a unified force, though composed of an infinite number and variety of separate lives....

*Humane Biology Projects*

Introduction

Animal Welfare Institute. Washington, D.C. 1977

Any concept of biology is not only sterile and profitless, it is distorted and untrue, if it puts its primary focus on unnatural conditions rather than on those vast forces not



of man's making that shape and channel the nature and direction of life.

*Humane Biology Projects*

Introduction

Animal Welfare Institute. Washington, D.C. 1977

**Chargaff, Erwin** 1905–2002

Austrian biochemist

In the old times, the knowledge of biology was perhaps similar to what could be made out in a very large, very dark house. Many objects could be more felt than seen with equal dimness, once the eyes got used to the darkness; and scientists were conscious of the limiting conditions under which they worked. In our time, however, a few very powerful and very narrow beams of light have been thrown into a few corners of this dark house, and several things can be seen in clarity and illumination that almost distort their significance. But at the same time we have lost our dark-adaptation; and since we all have a tendency to follow the light, we have moved into these cozy corners, to the detriment of the rest, which still is, by far, the major part of nature. In pointing this out one runs the risk of being accused of trying to spread the darkness.

*Essays on Nucleic Acids*

Chapter 3 (pp. 39–40)

Elsevier Publishing Company. Amsterdam, Netherlands. 1963

In no other science[ than biology] is the span so wide between what it ought to understand and what it can understand.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 163)

The Rockefeller University Press. New York, New York, USA. 1978

**Cohen, Joel**

No biographical data available

Physics-envy is the curse of biology.

Mathematics as Metaphor

*Science*, Volume 172, May, 1971 (p. 675)

**Comte, Auguste** 1798–1857

French philosopher

The time however has arrived when biology must, like the other sciences, make a fresh start in a purely speculative direction, free from all entanglement with medical or any other art.

*The Positive Philosophy of Auguste Comte* (Volume 2)

Book V, Chapter I (pp. 4–5)

George Bell & Sons. London, England. 1896

**Conklin, Edwin Grant** 1863–1952

American zoologist

The teachings of biology and of human history indicate that further social progress must lie in the direction of the rational coöperation of all mankind.

*The Direction of Human Evolution* Volume 2

Evolution And Democracy (p. 142)

Charles Scribner's Sons. New York, New York, USA. 1922

**Conn, Herbert William** 1859–1917

Biologist

Biology is often described as the most recent of the sciences, despite the fact that it was one of the first to be studied.

*Biology: An Introductory Study for Use in Colleges*

Chapter I (p. 1)

Silver, Burdett & Co. Boston, Massachusetts, USA. 1912

**Crick, Francis Harry Compton** 1916–2004

English biochemist

The development of biology is going to destroy to some extent our traditional grounds for ethical belief, and it is not easy to see what to put in their place.

*Thinking About the Brain*

*Scientific American*, Volume 241, Number 3, September, 1979 (p. 185)

The ultimate aim of the modern movement in biology is in fact to explain all biology in terms of physics and chemistry.

*Of Molecules and Men*

The Nature of Vitalism (p. 10)

University of Washington Press. Seattle, Washington, USA. 1966

**Darbishire, Arthur Dukinfield** 1879–1915

Statistician

The function of biology, if we adopt the literal, etymological meaning of the word, is to describe and interpret the essential manifestations of life, and to extract from these interpretations a conception, or theory, of life. But the word "biology" has come to be used in certain very much restricted senses, of which it will suffice to mention two. In its commonest signification it merely serves as a convenient common term for the subject matter of both botany and zoology. Another common meaning of it is the study of the habits of a particular animal or plant.

*An Introduction to a Biology*

Chapter I (pp. 1–2)

Funk & Wagnalls Co. New York, New York, USA. 1917

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

What lies at the heart of every living thing is not a fire, not warm breath, not a "spark of life." It is information, words, instructions. If you want a metaphor, don't think of fires and sparks and breath. Think, instead, of a billion discrete, digital characters carved in tablets of crystal. If you want to understand life, don't think about vibrant, throbbing gels and oozes, think about information technology.

*The Blind Watchmaker*

Chapter 5 (p. 112)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

Biology is the study of the complex things in the Universe. Physics is the study of the simple ones.

The Necessity of Darwinism

*New Scientist*, Volume 94, Number 1301, 15 April 1982 (p. 130)



But, however many ways there may be of being alive, it is certain that there are vastly more ways of being dead, or rather not alive.

*The Blind Watchmaker*

Chapter 1 (p. 9)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Seen in the light of evolution, biology is, perhaps, intellectually the most satisfying and inspiring science. Without that light it becomes a pile of sundry facts – some of them interesting or curious but making no meaningful picture as a whole.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

Nothing in Biology Make Sense Except in the Light of Evolution (p. 18)

Oryx Press, Phoenix, Arizona, USA. 1983

**Driesch, Hans** 1867–41

German biologist and philosopher

The analysis of the Aristotelian theory of life must therefore be one of the corner-stones of any historical works on biology.

*The History & Theory of Vitalism*

Chapter 1 (p. 11)

Macmillan & Company. London, England. 1914

**Dwyer, Herbert A.**

No biographical data available

If biology is the science of life and all its manifestations then some coordinating principle should have been derived, long ago, between the existing facts so that they would be helpful to the youth of the nation.

*The American Biology Teacher*, Volume 1, Number 1, October, 1938

(p. 22)

**Emmeche, Claus** 1956–

Danish theoretical biologist

Biology belongs to one of the surprising sciences, where each rule must always be supplemented with several exceptions (except this rule, of course).

Translated by Steven Sampson

*The Garden in the Machine: The Emerging Science of Artificial Life*

Chapter Six (p. 144)

Princeton University Press. Princeton, New Jersey, USA. 1994

**Fauset, Jessie Redmon** 1884–1961

American writer

Biology transcends society!

*The Chinaberry Tree: A Novel of American Life*

Chapter XIX (p. 121)

Negro University Press. New York, New York, USA. 1931

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

Biology is truly a land of unlimited possibilities; we may have the most surprising revelations to expect from it,

and cannot conjecture what answers it will offer in some decades to the questions we have put to it. Perhaps they may be such as to overthrow the whole artificial structure of hypotheses.

Translated by James Strachey

*Beyond the Pleasure Principle*

Chapter VI (p. 54)

W.W. Norton & Company, Inc. New York, New York, USA. 1961

**Goodwin, Brian Carey** 1931–

Canadian mathematician and biologist

The discovery of appropriate variables for biology is itself an act of creation.

In C.H. Waddington (ed.)

*Towards a Theoretical Biology: An IUBS Symposium* (Volume 2)

Appendix notes on the second symposium (p. 337)

Aldine Publishing Company. Chicago, Illinois, USA. 1968

A biology of parts becomes a medicine of spare parts and organisms become aggregates of genetic and molecular bits with which we can tinker as we please.... This is the path of ecological and social destruction.

*How the Leopard Changed Its Spots*

Chapter 7 (p. 215)

Phoenix Giant Paperback. London, England. 1994

**Gore, Rick**

American science and nature journalist

If anything illustrates what has happened in biology, it is this profound new ability to take the very stuff of life out of a cell, to isolate it in a test tube, to dissect it, and to probe the deep mysteries borne in its fragments.

The Awesome Worlds Within a Cell

*National Geographic*, Volume 150, Number 3, September, 1976 (p. 355)

**Grassé, Pierre P.** 1895–1985

French zoologist

Biology, despite the brilliance of its appearance, stammers in the presence of the essentials. We know neither all the properties of living matter, nor all of its astonishing possibilities.

In Joseph Wood Krutch

*The Great Chain of Life*

Chapter 11 (p. 192)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1957

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

If physics and biology one day meet, and one of the two is swallowed up, that one will not be biology.

In J. Needham

*Time: The Refreshing River*

A Biologist's View of Whitehead's Philosophy (p. 204)

The Macmillan Company. New York, New York, USA. 1943

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

From the standpoint of biology, our presence on the Earth depends on a remarkable and even fantastic sequence of

chemical processes. From the standpoint of physics, the very material of which we are constituted has experienced an evolution scarcely less remarkable.

*Ten Faces of the Universe*

The Astrophysicist's Universe (p. 79)

W.H. Freeman & Company, San Francisco, California, USA. 1977

I wouldn't go into biology if I were starting again now. In twenty years' time it is the biologists who will be working behind barbed wire.

In G. Rattray Taylor

*The Biological Time Bomb*

Chapter I (p. 17)

The World Publishing Company, New York, New York, USA. 1968

**Huxley, Aldous** 1894–1963

English writer and critic

Solved by standard Gammas, unvarying Deltas, uniform Epsilons. Millions of identical twins. The principle of mass production at last applied to biology.

*Brave New World*

Chapter One (pp. 6–7)

Harper & Brothers, New York, New York, USA. 1950

**Huxley, Thomas Henry** 1825–95

English biologist

In the first place it is said – and I take this point first, because the imputation is too frequently admitted by Physiologists themselves – that Biology differs from the Physico-chemical and Mathematical sciences in being “inexact”.

*Lay Sermons, Addresses, and Reviews*

On the Educational Value of the Natural History Sciences (pp. 78–79)

New York, New York, USA. 1872

**Judson, Horace**

Science historian

Biology has proceeded not by great set-piece battles, but by multiple small-scale encounters – guerrilla actions – across the landscape. In biology, no large-scale, closely interlocking, fully worked out, ruling set of ideas has ever been overthrown.... Revolution in biology, from the beginnings of biochemistry and the study of cells, and surely in the rise of molecular biology and on to the present day, has taken place not by overturnings but by openings-up.

*The Eighth Day of Creation: Makers of the Revolution in Biology*

Afterword (p. 612)

Simon & Schuster, New York, New York, USA. 1979

**Kac, Mark** 1914–84

Polish mathematician

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Schwartz, Jacob T.** 1930–

American mathematician and

The lack of real contact between mathematics and biology is either a tragedy, a scandal, or a challenge, it is hard to decide which.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

Chapter One (p. 2)

Springer-Verlag, New York, New York, USA. 1992

**Kauffman, Stuart A.** 1939–

Theoretical biologist

If biologists have ignored self-organization, it is not because self-ordering is not pervasive and profound. It is because we biologists have yet to understand how to think about systems governed simultaneously by two sources of order. Yet who seeing the snowflake, who seeing simple lipid molecules cast adrift in water forming themselves into cell-like hollow lipid vesicles, who seeing the potential for the crystallization of life in swarms of reacting molecules, who seeing the stunning order for free in networks linking tens upon tens of thousands of variables, can fail to entertain a central thought: if ever we are to attain a final theory in biology, we will surely, surely have to understand the commingling of self-organization and selection. We will have to see that we are the natural expressions of a deeper order. Ultimately, we will discover in our creation myth that we are expected after all.

*At Home in the Universe: The Search for Laws of Complexity*

Chapter 5 (p. 112)

Oxford University Press, Inc. New York, New York, USA. 1995

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

A sound Physics of the Earth should include all the primary considerations of the earth's atmosphere, of the characteristics and continual changes of the earth's external crust, and finally of the origin and development of living organisms. These considerations naturally divide the physics of the earth into three essential parts, the first being a theory of the atmosphere, or Meteorology, the second a theory of the earth's external crust, or Hydrogeology, and the third a theory of living organisms, or Biology.

Translated by Albert V. Carozzi

*Hydrogeology*

Forward (p. 18)

University of Illinois Press, Urbana, Illinois, USA. 1964

**Lapworth, Charles** 1842–1920

English geologist

Biology is pre-eminent today among the natural sciences, because its younger sister, Geology, gave it the means.

*Report of the British Association for the Advancement of Science (1892)*

Presidential Address to the Geology Section (p. 696)

**Lorenz, Konrad** 1903–89

Austrian zoologist

There are no good biologists whose vocation was not born of deep joy in the beauties of living nature.

In Jean Rostand

Translated by Lowell Bair

*Humanly Possible: A Biologist's Note on the Future of Mankind*

A Biologist's Mail (p. 20)

Saturday Review Press. New York, New York, USA. 1970

**Lovelock, James Ephraim** 1919–

English scientist

The successes of molecular biology are so beguiling that we forget the organism and its physiology. Schrödinger's disciples, who founded the church of molecular biology, have turned his wisdom into the dogma that life is self-replicating and corrects its errors by natural selection. There is much more to life than this naïve truth, just as there is more to the Universe than atoms alone – grandmothers live and enjoy the shade of Lombardy poplar trees not knowing that they and the trees are deemed by this dogma to be dead.

Living Alternatives

*Nature*, Volume 320, Number 6063, 17 April, 1986 (p. 646)

**Mayr, Ernst** 1904–2005

German-born American biologist

There is more to biology than rats, *Drosophila*, *Caenorhabditis*, and *E. coli*.

In Lynn Margulis and Dorion Sagan

*Acquiring Genomes: A Theory of the Origins of Species*

Forward (p. xiv)

Basic Books, Inc. New York, New York, USA. 2002

Biology was referred to as a “dirty science,” an activity, according to the physicist Ernest Rutherford, not much better than “postage stamp collecting.” At best it was a second-class, “provincial” science.

*Toward a New Philosophy of Biology: Observations of an Evolutionist*

Is Biology an Autonomous Science? (p. 9)

Harvard University Press. Cambridge, Massachusetts, USA. 1988

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

If the task of scientific methodology is to piece together an account of what scientists actually do, the testimony of biologists should be heard with specially close attention. Biologists work very close to the frontier between bewilderment and understanding. Biology is complex, messy and richly various, like real life; it travels faster nowadays than physics or chemistry (which is just as well, since it has so much farther to go) and it travels nearer to the ground. It should therefore give us a specially direct and immediate insight into science in the making.

*Induction and Intuition in Scientific Thought*

Chapter I, Section 1 (p. 1)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

**Monod, Jacques** 1910–76

French biochemist

Biology occupies a position among the sciences at once marginal and central. Marginal because – the living world constituting but a tiny and very “special” part of the universe – it does not seem likely that the study of living beings will ever uncover general laws applicable outside the biosphere. But if the ultimate aim of the whole of science is indeed, as I believe, to clarify man's relationship to the universe, then biology must be accorded a central position since of all disciplines it is the one that endeavors to go most directly to the heart of the problems that must be resolved before that of “human nature” can be framed in other than metaphysical terms.

Translated by Austryn Wainhouse

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Preface (p. xi)

Vintage Books. New York, New York, USA. 1972

**Morrison, David**

No biographical data available

Astrobiology is the scientific study of the origin, distribution, and future of life in the universe.

In J. Kelly Beatty, Carolyn Collins Petersen and Andrew Chaikin

*The New Solar System* (4th edition)

Exploring the Solar System (p. 12)

Cambridge University Press. Cambridge, England. 1999

**Needham, James G.** 1868–1957

American entomologist

It is a monstrous abuse of the science of biology to teach it only in the laboratory.... Life belongs in the fields, in the ponds, on the mountains and by the seashore.

In Allen H. Benton and William E. Werner

*Field Biology and Ecology* (p. 3)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

**Olson, Steve** 1956–

American science writer

Biology is not just the science of what we are and how we came to be – it is also the science of what we can become.

*Shaping the Future: Biology and Human Values*

Afterword (p. 110)

National Academy Press. Washington, D.C. 1989

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Biology touches the problems of life at every point, and may claim, as no other science, completeness of view and a comprehensiveness which pertains to it alone. To all those whose daily work lies in her manifestations

the value of a deep insight into her relations cannot be overestimated. The study of biology trains the mind in accurate methods of observation and correct methods of reasoning, and gives to a man clearer points of view, and an attitude of mind serviceable in the working-day-world than that given by other sciences, or even by the humanities.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
The Leaven of Science (pp. 91–92)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

I say that it touches a man that his blood is sea water and his tears are salt, that the seed of his loins is scarcely different from the same cells in a seaweed, and that of stuff life his bones are coral made. I say that a physical and biologic law lies down with him, and wakes when a child stirs in the womb, and that sap in the smell of the loam, where the bacteria bestir themselves in darkness and the path of the sun in the heaven, these are facts of first importance to his mental conclusions, and that a man who goes in no consciousness of them is a drifter and a dreamer, without a home or any contact with reality.

*An Almanac for Moderns*  
April First (p. 14)  
G.P. Putnam's Sons. New York, New York, USA. 1935

...grant but a single teleological explanation in biology, and you have left the path of scientific thinking. Plan there may be, but only a working plan, a vast experimentation still in course.

*An Almanac for Moderns*  
May Nineteenth (p. 64)  
G.P. Putnam's Sons. New York, New York, USA. 1935

### **Peter Griffin (Fictional character)**

Math. Math my dear boy is nothing more than the lesbian sister of biology.

*Family Guy*  
Film (1999)

**Pycraft, W. P.**  
Nature documentary filmmaker

So long as we insist on regarding biology as a crystallized creed, requiring no more than a possible rectification of some of its tenets, so long shall we continue groping in the dark to get an insight into the mysteries we are professedly trying to solve.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*  
Some New Aspects of Evolution (p. 241)  
Government Printing Office. Washington, D.C. 1937

**Rashevsky, Nicolas** 1899–1972  
Mathematical biophysicist

There is no successful mathematical theory which would treat the integrated activities of the organism as a whole.... The fundamental manifestation of life drops out from all our theories in mathematical biology.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)  
Chapter XXVIII (p. 306)  
The University of Chicago Press. Chicago, Illinois, USA. 1948

Let us, however, appraise the problem [of dealing with forces] realistically. In celestial mechanics, where we deal with forces varying as simply as the inverse square of the distance and acting on rigid masses, the three-body problem, let alone the n-body problem, still defies in its generality the ingenuity of mathematicians. The forces between cells are much more complex; they are non-conservative, and the cells themselves are not merely displaced but also changed externally and internally by these forces. What are the chances within a foreseeable number of generations to even approximately master the problem of an organism as an aggregate of cells, considering that this organism consists of some 10<sup>14</sup> of cells, hundreds of different tissues, and thousands of complex interrelated structures. Pessimism is not a healthy thing in science, but neither is unrealistic optimism.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)  
Chapter XXVIII (p. 307)  
The University of Chicago Press. Chicago, Illinois, USA. 1948

When we observe the phenomena of biological integration we notice, however, not quantities, varying continuously or discontinuously, but certain rather complex relations.... Topological analogies go much deeper in the realm of the living when we observe not merely structural but functional (in a biological sense) relations. The unity of the organism and the unity of all life is expressed by just that kind of relation.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)  
Chapter XXVIII (p. 308)  
The University of Chicago Press. Chicago, Illinois, USA. 1948

**Roberts, Catherine**  
No biographical data available

The driving force of biology and medical science is not unalloyed idealism but a complex of factors including prestige, publication, professional advancement, grants and business interests.

The Use of Animals in Medical Research – Some Ethical Considerations  
*Perspectives in Biology and Medicine*, Volume VIII, Number 1, Autumn 1964 (p. 116, fn 4)

**Root, R. K.**  
No biographical data available

I can hear my good friend, the Professor of Biology, rather impatiently reporting that his science asks assent only to what it can demonstrate. "Come with me to my laboratory, and I will give you proofs...." But how am I, quite untrained in his science, to weigh his arguments or interpret what his microscopes may show?

The Age of Faith

*The Atlantic Monthly*, Volume cx, July, 1912 (p. 114)

**Rostand, Jean** 1894–1977

French historian and biologist

[Biology] is the least self-centered, the least narcissistic of the sciences – the one that, by taking us out of ourselves, leads us to re-establish a link with nature and to shake ourselves free from our spiritual isolation.

Translated by Jonathan Griffin

*Can Man Be Modified?*

Victories and the Hopes of Biology (p. 31)

Basic Books, Inc. New York, New York, USA. 1959

**Sam (Fictional character)**

Biology, now there's something you can sink your teeth into, so to speak. Your problem is real. The solution is real.

*Ginger Snaps*

Film (2000)

**Sandeman, George** 1863–1952

Spanish-born American philosopher

...the outstanding evil is that every science suffers from an insular ignorance of what is meant by the others; philosophy, for instance, at present knows little of animals and plants but what it has learned through the biology of hypothesis, and accepts the results of the latter for observation; and biology is content to find the true differences of organisms in the structure of small particles within them, through an inadequate knowledge of the methods of physics. In a word, one science is only too ready to accept the abstractions of others as answering to the nature of the matter studied.

*Problems of Biology*

Chapter I (p. 13)

Swan Sonnenschein & Co., Ltd. London, England. 1896

**Sears, Paul Bigelow** 1891–1990

American plant ecologist and conservationist

Biology is the link – still too largely a missing link – between the physical and social sciences. Through it, and it alone, can the student come to understand the natural communities of plants and animals which, during the centuries, have shaped his own region for its present human utility.

The Importance of Biology Teaching for Secondary School Pupils

*The American Biology Teacher*, Volume 1, Number 4, January, 1939 (p. 67)

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

There is nothing like biology. "The cloud-capped towers, the solemn binnacles, the gorgeous temples, the great globe itself: yea, all that it inherit shall dissolve, and, like this influential parent faded, leave not a rack behind." That's biology, you know. Good sound biology.

*Back to Methuselah*

Part II, XXXIII (p. 48)

Constable & Company Ltd. London, England. 1921

**Simpson, George Gaylord** 1902–84

American paleontologist

Experimental biology...may reveal what happens to a hundred rats in the course of ten years under fixed and simple conditions, but not what happened to a billion rats in the course of ten million years under the fluctuating conditions of earth history. Obviously, the latter problem is more important.

*Tempo and Mode in Evolution*

Introduction (p. xvii)

Columbia University Press. New York, New York, USA. 1944

Biology, then, is the science that stands at the centre of all science. It is the science most directly aimed at science's major goal and most definitive of that goal. And it is here, in the field where all the principles of all the sciences are embodied, that science can truly become unified.

*This View of Life: The World of an Evolutionist*

Chapter Five (p. 107)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

**Standen, Anthony**

Anglo-American science writer

Analogy is a wonderful, useful and most important form of thinking, and biology is saturated with it. Nothing is worse than a horrible mass of undigested facts, and facts are indigestible unless there is some rhyme or reason to them. The physicist, with his facts, seeks reason; the biologist seeks something very much like rhyme, and rhyme is a kind of analogy....

*Science Is a Sacred Cow*

Chapter IV (p. 98)

E.P. Dutton. New York, New York, USA. 1950

In its central content, biology is not accurate thinking, but accurate observation and imaginative thinking, with great sweeping generalizations.

*Science Is a Sacred Cow*

Chapter IV (pp. 99–100)

E.P. Dutton. New York, New York, USA. 1950

**Sullivan, John William Navin** 1886–1937

Irish mathematician

It is possible, nevertheless, that our outlook on the physical universe will again undergo a profound change. This change will come about through the development of biology. If biology finds it absolutely necessary, for the description of living things, to develop new concepts of



its own, then the present outlook on “inorganic nature” will also be profoundly affected.... The notions of physics will have to be enriched, and this enrichment will come from biology.

*The Limitations of Science*

Chapter 7, Section 8 (pp. 188, 189)

New American Library. New York, New York, USA. 1956

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Biology has a particular end – that of describing the life of plants and animals, and that end is not necessarily achieved by discoveries in the physics and chemistry of living bodies.

*Introduction to Science*

Chapter II (p. 53)

Henry Holt & Co. New York, New York, USA. 1911

...questions that the biologist must ask and answer before he can go far in generalization appear at first sight to be very numerous and varied, but, from a certain distance, we see that there are only four: What is this living creature as regards form and structure? How does it work? Whence has it arisen? How has it come to be as it is?

*Introduction to Science*

Classification of the Sciences (p. 110)

Henry Holt & Co. New York, New York, USA. 1911

**Tiffany, Lewis**

No biographical data available

We believe that there is a unified science of life, a general biology that is distinct from a shotgun marriage of botany and zoology, or any others of the special life sciences. We believe that this science has a body of established and working principles. We believe that literally nothing on earth is more important to a rational living than basic acquaintance with those principles.

*Life: An Introduction to Biology* (2nd edition)

Preface from First Edition (p. v)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

**Ulam, Stanislaw** 1909–84

Polish-born mathematician

After reading about [the biological developments] which were coming fast, I became curious about a conceptual role which mathematical ideas could play in biology. If I may paraphrase one of President Kennedy’s famous statements, I was interested in “not what mathematics can do for biology but what biology can do for mathematics.” I believe that new mathematical schemata, new systems of axioms, certainly new systems of mathematical structures will be suggested by the study of the living world.

Some ideas and prospects in biomathematics

*Annual Review of Biophysics and Bioengineering 1*, 1972 (p. 285)

**Weaver, Warren** 1894–1978

American mathematician

The century of biology upon which we are now well embarked is no matter of trivialities. It is a movement of really heroic dimensions, one of the great episodes in man’s intellectual history. The scientists who are carrying the movement forward talk in terms of nucleoproteins, of ultra-centrifuges, of biochemical genetics, of electrophoresis, of the electron microscope, or molecular morphology, of radioactive isotopes. But do not be fooled into thinking this is more gadgetry. This is the dependable way to seek a solution of the cancer and polio problems, the problem of rheumatism and of the heart. This is the knowledge on which we must base our solution of the population and food problems. This is the understanding of life.

In R.B. Fosdick

*The Story of the Rockefeller Foundation*

Letter to H.M.H. Carson, 17 June, 1949 (p. 166)

Harper & Brothers Publishers. New York, New York, USA. 1952

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Unfortunately in this book of nature the biologists fare badly. Every expression of life takes time. Nothing that is characteristic of life can manifest itself at an instant. Murder is a prerequisite for the absorption of biology into physics as expressed in these traditional concepts.

Supplementary

*Aristotelian Society*, Volume II, Time, Space and Material (p. 45)

The living cell is to biology what the electron and the proton are to physics.

*Science and the Modern World*

Chapter VI (p. 146)

The Macmillan Company. New York, New York, USA. 1929

Science is taking on a new aspect that is neither purely physical nor purely biological. It is becoming the study of the larger organisms; whereas physics is the study of the smaller organisms.

*Science and the Modern World*

Chapter VI (p. 150)

The Macmillan Company. New York, New York, USA. 1929

Accordingly, biology apes the manners of physics. It is orthodox to hold that there is nothing in biology but what is physical mechanism under somewhat complex circumstances.

*Science and the Modern World*

Chapter VI (p. 150)

The Macmillan Company. New York, New York, USA. 1929

**Wilson, Andrew** 1852–1912

No biographical data available

There are many less effective things, in the way of modern culture, than a popular training in biology.



*Leisure-time Studies, Chiefly Biological: A Series of Essays and Lectures*  
Preface  
Chatto & Windus. London, England. 1898

**Wilson, Edward O.** 1929–  
American biologist and writer

Society increasingly has neglected the substructure of biology to its own peril.

In Pamela Weintraub (ed.)  
*The Omni Interviews*  
Genetic Destiny (p. 221)  
Ticknor & Fields. New York, New York, USA. 1984

**Woodger, Joseph Henry** 1894–1981  
English biologist

Biology is being forced in spite of itself to become biological.

In Herbert J. Muller  
*Science and Criticism: The Humanistic Tradition in Contemporary Thought*  
Chapter V (p. 110)  
G. Braziller. New York, New York, USA. 1943

## BIOLOGY, HISTORY OF MARINE

**Deacon, G. E. R.**  
No biographical data available

An attempt to follow the history of marine biology is like a journey through a labyrinth, the most important signposts of which are obscured by moss.

*Seas, Maps, and Men: An Atlas-History of Man's Exploration of the Oceans*  
Life in the Sea (p. 77)  
Doubleday. Garden City, New York, USA. 1962

## BIONIC ORGANS

### Television Introduction

We can make him better than he was. We have the technology.

*Bionic Man*  
Preamble to the television series

## BIOSTRATIGRAPHY

**Darwin, Charles Robert** 1809–82  
English naturalist

...every year tends to fill up the blanks between the stages, and to make the proportion between the lost and existing forms more gradual. In some of the most recent beds...only one or two species are extinct, and only one or two are new.... Yet if we compare any but the most closely related formations, all the species will be found to have undergone some change.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter XI (p. 167)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, Alan B.**  
No biographical data available

Each objectively definable extinct fossil taxon divides geologic time into three segments – the time before it appeared, the time during which it existed, and the time since its disappearance.

*Time in Stratigraphy*  
Chapter 17 (p. 102)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1964

## BIRTH CONTROL

**Dickens, Charles** 1812–70  
English novelist

...accidents will occur in the best-regulated families...

*David Copperfield* (Volume 1)  
Chapter 28 (p. 454)  
P.F. Collier & Son Company. New York, New York, USA. 1917

**Farris, Jean**  
No biographical data available

Birth control: Banned parenthood.  
*Quote, the Weekly Digest*, February 18, 1968 (p. 137)

**Gäbor, Dennis** 1900–79  
Hungarian-English physicist

The technique of birth control can be suppressed only if one abolishes also the technique of death control: medicine and hygiene.

*Inventing the Future*  
Overpopulation (p. 82)  
Secker & Warburg. London, England. 1963

**Sanger, Margaret** 1879–1966  
American pioneer birth control advocate

The menace of another pregnancy hung like a sword over the head of every poor woman...

*My Fight for Birth Control*  
Awaking and Revolt (p. 49)  
Farrar & Rinehart, Incorporated. New York, New York, USA. 1931

“Yes, yes – I know, Doctor,” said the patient with trembling voice, “but,” and she hesitated as if it took all of her courage to say it, “what can I do to prevent getting that way again?”

“Oh, ho! laughed the doctor good naturedly. You want your cake while you eat it too, do you? Well, it can't be done.... I'll tell you the only sure thing to do. Tell Jake to sleep on the roof!”

*My Fight for Birth Control*  
Awaking and Revolt (pp. 52–53)  
Farrar & Rinehart, Inc. New York, New York, USA. 1931

**BLACK HOLE**

**Asimov, Isaac** 1920–92  
American author and biochemist

Since 1960 the universe has taken on a wholly new face. It has become more exciting, more mysterious, more violent, and more extreme as our knowledge concerning it has suddenly expanded. And the most exciting, most mysterious, most violent, most extreme phenomena of all has the simplest, plainest, calmest, and mildest name – nothing more than a “black hole.”

*The Collapsing Universe*

Chapter 1 (p. 1)

Walker. New York, New York, USA. 1977

**Author undetermined**

A black hole is where God divides by zero.  
Source undetermined

**Cardenal, Ernesto** 1925–  
Nicaraguan poet and Roman Catholic priest

But a star a little heavier than a neutron star  
is a black hole.

The forces of a black hole.

Like a cosmic vacuum cleaner.

Where gravitation is so great, the curvature so great,  
that light is swallowed up.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 3, Autumn Fugue (p. 32)

Curbstone Press. Willimantic, Connecticut, USA. 1993

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

The black holes of nature are the most perfect macroscopic objects there are in the universe: the only elements in their construction are our concepts of space and time. And since the general theory of relativity provides only a single unique family of solutions for their descriptions, they are the simplest objects as well.

*The Mathematical Theory of Black Holes*

Prologue (p. 1)

Oxford University Press, Inc. Oxford, England. 1992

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

I think there should be a law of Nature to prevent a star  
from behaving in this absurd way!

Relativistic Degeneracy

*Observatory*, Volume 58, Number 729, 1935(p. 37)

**Gardner, Martin** 1914–  
American writer and mathematics games editor

Our entire universe may slowly stop expanding, go into a contracting phase, and finally disappear into a black hole, like an acrobatic elephant jumping into its anus.

*Science: Good, Bad, and Bogus*

Chapter 32 (p. 336)

Prometheus Books. Buffalo, New York, USA. 1981

The healthy side of the black-hole craze is that it reminds us of how little science knows, and how vast is the realm about which science knows nothing.

*Science: Good, Bad, and Bogus*

Chapter 32 (p. 343)

Prometheus Books. Buffalo, New York, USA. 1981

**Hawking, Stephen William** 1942–  
English theoretical physicist

Although Bekenstein’s hypothesis that black holes have a finite entropy requires for its consistency that black holes should radiate thermally, at first it seems a complete miracle that the detailed quantum-mechanical calculations of particle creation should give rise to emission with a thermal spectrum. The explanation is that the emitted particles tunnel out of the black hole from a region of which an external observer has no knowledge other than its mass, angular momentum and electric charge. This means that all combinations or configurations of emitted particles that have the same energy, angular momentum and electric charge are equally probable. Indeed, it is possible that the black hole could emit a television set or the works of Proust in 10 leather-bound volumes...

*The Quantum Mechanics of Black Holes*

*Scientific American*, Volume 236, Number 1, January, 1977 (p. 40)

**Israel, Werner** 1931–  
Canadian physicist

It is one of the little ironies of our times that while the layman was being indoctrinated with the stereotype of black holes as the ultimate cookie monsters, the professionals have been swinging round to the almost directly opposing view that black holes, like growing old, are really not so bad when you consider the alternative.

In John D. Barrow

*The World Within the World* (p. 312)

Clarendon Press. Oxford, England. 1988

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

Young Archie, the intrepid mole,  
Went down to explore a Black Hole.

A stark singularity,

Devoid of all charity,

Devoured the mole as a whole.

In Bernard Dixon (ed.)

*From Creation to Chaos: Classic Writings in Science*  
Cosmic Limerick (p. 108)  
Basil Blackwell Ltd. Oxford, England. 1989

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

There exist in the heavens therefore dark bodies, as large as and perhaps as numerous as the stars themselves. Rays from a luminous star having the same density as the Earth and a diameter 250 times that of the Sun would not reach us because of its gravitational attraction; it is therefore possible that the largest luminous bodies in the Universe may be invisible for this reason.

In Jean-Pierre Luminet  
*Black Holes* (p. 6)  
Cambridge University Press. New York, New York, USA. 1992

A luminous star, of the same density as the Earth, and whose diameter should be two hundred and fifty times larger than that of the Sun, would not, in consequence of its attraction, allow any of its rays to arrive at us; it is therefore possible that the largest luminous bodies in the universe, may, through this cause, be invisible.

*The System of the World* (Volume 2)  
Book V, Chapter VI (p. 367)  
Printed for Richard Phillips  
London, England. 1809

**Lasota, Jean-Pierre**  
No biographical data available

Black holes may still be black, but they can no longer hide in disguise. We are learning how to unmask them.  
Unmasking Black Holes  
*Scientific American*, Volume 280, Number 5, May, 1999 (p. 47)

**Levi, Primo** 1919–87  
Italian writer and chemist

The sky is strewn with horrible dead suns,  
Dense sediments of mangled atoms.  
Only desperate heaviness emanates from them,  
Not energy, not messages, not particles, not light.  
Light itself falls back down, broken by its own weight.  
Translated by Ruth Feldman and Brian Swann  
*Collected Poems*  
The Black Stars  
Faber & Faber Ltd. Boston, Massachusetts, USA. 1988

**Longair, Malcolm** 1941–  
Scottish physicist

“Just keep away from the black hole garbage bin by the door as you leave,” said the Caterpillar. “It’s very useful for getting rid of theoretical papers and weak students!”  
*Alice and the Space Telescope*  
Chapter 7 (p. 68)  
The Johns Hopkins University Press. Baltimore, Maryland, USA. 1989

**Michell, John** 1724–93  
English geologist and astronomer

If the semi-diameter of a sphere of the same density as the Sun in the proportion of five hundred to one, and by supposing light to be attracted by the same force in proportion to its [mass] with other bodies, all light emitted from such a body would be made to return towards it, by its own proper gravity.

On the Means of discovering the Distance, Magnitude, etc. of the Fixed Stars  
*Philosophical Transactions of the Royal Society of London*, 1784

**Milne, A. A. (Alan Alexander)** 1882–1956  
English playwright, poet, and story writer

A great enormous thing, like – like nothing. A huge big – well, like a – I don’t know – like an enormous big nothing.  
*The Complete Tales & Poems of Winnie-the-Pooh*  
Winnie-the-Pooh. Piglet Meets a Heffalump (p. 68)  
Dutton Children’s Books. New York, New York, USA. 2001

**Ruffini, Remo** 1940–  
American theoretical physicist

What was once the core of a star no longer visible. The core like a Cheshire cat fades from view. One leaves behind only its grin, the other, only its gravitational attraction. Gravitational attraction, yes; light, no. No more than light do any particles emerge. Moreover, light and particles incident from outside emerge and go down the black hole only to add to its mass and increase its gravitational attraction.

Our Universe: The Known and the Unknown  
*American Scientist*, Volume 56, Number 1, Spring 1968 (p. 9)

**Sagan, Carl** 1934–96  
American astronomer and author

Black holes may be apertures to elsewhere. Were we to plunge down a black hole, we would re-emerge, it is conjectured, in a different part of the universe and in another epoch of time.... Black holes may be the entrances to Wonderland. But are there Alices or white rabbits?

*Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 36 (p. 248)  
Anchor Press/Doubleday. Garden City, New York, USA. 1973

**Smolin, Lee** 1940–  
American theoretical physicist

...each black hole is a bud that leads to a new universe of moments.

*The Life of the Cosmos*  
Part Two, Chapter Seven (p. 94)  
Oxford University Press, Inc. New York, New York, USA. 1997

**Thorne, Kip S.** 1940–  
American theoretical physicist

Of all the conceptions of the human mind from unicorns to gargoyles to the hydrogen bomb the most fantastic is the black hole: a hole in space with a definite edge over which anything perhaps can fall and nothing can escape;

a hole with a gravitational field so strong that even light is caught and held in its grip; a hole that curves space and warps time.

*Cosmology + 1*

Chapter 8 (p. 63)

W.H. Freeman & Company, San Francisco, California, USA. 1977

**Wheeler, John Archibald** 1911–

American theoretical physicist and educator

Every black hole brings an end to time and space and the laws of physics.

*Geons, Black Holes, and Quantum Foam: A Life in Physics*

Chapter 16 (p. 350)

W.W. Norton & Company, Inc. New York, New York, USA. 1998

## BLADDER STONE

**Donne, John** 1672–1731

English Jacobean poet

Know'st thou but how the stone doth enter in The bladder's cave, and never break the skin?

In E.K. Chambers

*Poems of John Donne* (Volume 2)

On the Progress of the Soul. Anniversary Two

Charles Scribner's Sons. New York, New York, USA. 1896

## BLINDNESS

**Keats, John** 1795–1821

English Romantic lyric poet

There is a budding morrow in midnight;  
There is a triple sight in blindness keen.

*The Complete Poetical Works and Letters of John Keats*

To Homer

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Sophocles** 496 BCE–406 BCE

Greek playwright

Oedipus: ...in sound is my sight...

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

Oedipus at Colonus, l. 135

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wordsworth, William** 1770–1850

English poet

It is not now as it hath been of yore –

Turn wheresoe'er I may,

By night or day,

The things which I have seen I can now see no more.

*The Complete Poetical Works of William Wordsworth*

Recollections of Early Childhood

Ode: Intimations of Immortality

Crowell. New York, New York, USA. 1888

## BLOOD PRESSURE

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

A man's life may be said to be a gift of his blood pressure, just as Egypt is a gift of the Nile.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 2) (p. 297)

Clarendon Press. Oxford, England. 1925

## BLUEPRINT

**Ridley, Matt** 1958–

English science writer

Incidentally, you will not find the tired word “blueprint” in this book, after this paragraph, for three reasons. First, only architects and engineers use blueprints and even they are giving them up in the computer age, whereas we all use books. Second, blueprints are very bad analogies for genes. Blueprints are two-dimensional maps, not one-dimensional digital codes. Third, blueprints are too literal for genetics, because each part of a blueprint makes an equivalent part of the machine or building; each sentence of a recipe book does not make a different mouthful of cake.

*Genome: The Autobiography of a Species in 23 Chapters*

Introduction (p. 8)

HarperCollins Publishers, Inc. New York, New York, USA. 2000

## BOOK

**Adair, Robert K.**

American physicist

It has been said that all expository books are simply forms of selected plagiarism.

*The Great Design: Particles, Fields, and Creation*

Preface (p. vi)

Oxford University Press. Oxford, England. 1989

## Advertisement

If you are young, do not read this book; it is not fit for you; If you are old, throw it away; you have nothing to learn from it; If you are unambitious, light the fire with it; you do not need its guidance.

But, if you are neither less than twenty-five years old, nor more than thirty; And if you are ambitious withal, and your spirit hankers... Read, and may your soul (if you have a soul) find mercy!

*Microcosmographia Academica*

Bowes & Bowes, Publishers. Cambridge, England. 1908

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

If you study Nature in books...when you go out of doors you cannot find her.

Quoted in David Starr Jordan

*Science Sketches*

Agassiz at Penikese (p. 134)

A.C. McClurg & Co. Chicago, Illinois, USA. 1896

**Alvarez, Luis Walter** 1911–88

American experimental physicist

*Ex libro lapidum historia mundi* – from the book of rocks comes the history of the Earth.

*T. Rex and the Crater of Doom*

Chapter 2 (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

But the images of men's wits and knowledges remain in books, exempted from the wrong of time, and capable of perpetual renovation. Neither are they fitly to be called images, because they generate still, and cast their seeds in the minds of others, provoking and causing infinite actions and opinions in succeeding ages ...

*The Advancement of Learning* (Volume 1)

The First Book (p. 66)

Macmillan & Co Ltd. London, England. 1905

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

...a physics book, unlike a novel, not only has no happy ending, but has no real ending at all.

*Elementary Particles and Their Currents*

Chapter 15 (p. 318)

W.H. Freeman. San Francisco, California, USA. 1968

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

...if judicious men skilled in chymical affaires shall once agree to write clearly and plainly of them, and thereby keep men from being stunned, as it were, or imposed upon by dark or empty words; 'tis to be hoped that these men finding that they can no longer write impertinently and absurdly, without being laughed at for doing so, will be reduced either to write nothing, or books that may teach us something, and not rob men, as formerly, of invaluable time; and so ceasing to trouble the world with riddles or impertinencies, we shall either by their books receive an advantage, or by their silence escape an inconvenience.

*The Sceptical Chymist*

The Fourth Part (pp. 116–117)

J.M. Dent & Sons. London, England. 1911

**Brewster, George**

No biographical data available

A very considerable number of books, which, year after year, emanate from the press, and no small share of the

lectures delivered upon the sciences, are nothing more nor less than the repetition of old ideas in a new garb, to prevent the petty plagiarism from being too barefaced, and that garb too oftentimes made less elegant and less attractive than the original.

*A New Philosophy of Matter; Showing the Identity of All the Imponderables* (3rd edition)

Chapter I (p. 15)

Edward H. Fletcher. New York, New York, USA. 1858

**Brown, Hugh Auchincloss** 1878–1975

American electrical engineer

For the earth is a great stone book

With strata of stone for pages;

In which we'll find if we look

The living record of ancient ages.

*Cataclysms of the Earth*

The Earth Is a Great Stone Book (p. 275)

Twayne Publishers. New York, New York, USA. 1967

**Cloos, Hans** 1885–1951

German geologist

By far the most important books for geology students were the quarries and clay pits, the cliffs and creek beds, the road and railroad cuts in woods and fields. Our words and letters were the imprints of plants and animals in stone, the minerals and crystals, and our vast inexhaustible, incorruptible, and infallible library was nature itself.

*Conversation with the Earth*

Chapter II (p. 28)

Alfred A. Knopf. New York, New York, USA. 1953

**Comstock, John Henry** 1849–1931

American entomologist

Fill your note-book with descriptions, but digest them carefully, sifting out for publication only those that exhaustive study and repeated observations prove to be valuable.

*Insect Life: An Introduction to Nature-Study and a Guide for Teachers, Students, and Others*

Part II, Chapter III (p. 323)

D. Appleton & Co. New York, New York, USA. 1898

**Cornford, Francis M.** 1874–1943

English academic

Books are the sources of material for lectures. They should be kept from the young; for to read books and remember what you read well enough to reproduce it is called 'cramming', and this is destructive of all true education. The best way to protect the young from books is, first, to make sure that they shall be so dry as to offer no temptation; and, second, to store them in such a way that no one can find them without several years' training.

*Microcosmographia Academica*

The Principles of Government, of Discipline (Including Religion), and of Sound Learning

Bowes & Bowes, Publishers. Cambridge, England. 1908

**Cushing, Harvey** 1869–1939  
American neurosurgeon

Books are the most important tools of our craft when assembled in mass in our great medical libraries.

In R. Kagan (ed.)  
*Leaders of Medicine*  
Chapter VII (p. 72)  
The Medico-Historical Press. Boston, Massachusetts, USA. 1941

**Darwin, Charles Robert** 1809–82  
English naturalist

I have heard, by roundabout channel, that Herschel says my book [*The Origin of the Species*] “is the law of higgledy-piggledy.” What this exactly means I do not know, but it is evidently very contemptuous. If true this is a great blow and discouragement.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin*  
Letter to C. Lyell  
December 12, 1859 (p. 37)  
D. Appleton & Company. New York, New York, USA. 1896

What a book a devil’s chaplain might write on the clumsy, wasteful, blundering, low, and horribly cruel works of nature!

In Sir Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
Letter 48 (p. 95)  
D. Appleton & Co. New York, New York, USA. 1903

**Darwin, Erasmus** 1731–1802  
English physician and poet

Now, happier lot! Enlighten’d realms possess  
The learned labours of the immortal Press;  
Nursed on whose lap the births of science thrive,  
And rising Arts the wrecks of Time survive.

*The Temple of Nature*  
Canto IV

**Day, Clarence S.** 1874–1935  
American writer

The world of books is the most remarkable creation of man. Nothing else that he builds ever lasts. Monuments fall; nations perish, civilizations grow old and die out; and after an era of darkness, new races build others. But in the world of books are volumes that have seen this happen again and again, and yet live on, still young, still as fresh as the day they were written, still telling men’s hearts of the hearts of men centuries dead.

*The Story of the Yale University Press Told by a Friend* (p. 7)  
At the Earl Trumbull Williams Memorial. New Haven, Connecticut, USA. 1920

**de Bury, Richard** 1287–1345  
English bibliophile

...all the glory of the world would be buried in oblivion, unless God had provided mortals with the remedy of books.

Translated by E.C. Thomas  
*The Love of Books Being the Philobiblon of Richard de Bury*  
Chapter I (p. 9)  
Chatto & Windus. London, England. 1925

**de Morgan, Augustus** 1806–71  
English mathematician and logician

The *Theorie des Probabilites* is the Mont Blanc of mathematical analysis; but the mountain has this advantage over the book, that there are guides always ready near the former, whereas the student has been left to his own method of encountering the latter.

Article IV  
*The Dublin Review*, Number IV, April, 1837 (p. 347)

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

There are for each one of us, according to his turn of mind, certain books that open up horizons hitherto undreamed of and mark an epoch in our mental life. They fling wide the gates of a new world wherein our intellectual powers are henceforth to be employed; they are the spark which lights the fuel on a hearth doomed, without its aid, to remain indefinitely bleak and cold.

Translated by Alexander Teixeira de Mattos  
*The Hunting Wasps*  
Chapter I (p. 1)  
Dodd, Mead & Co. New York, New York, USA. 1916

**Flammarion, Camille** 1842–1925  
French astronomer and writer

Such a book [a popular treatise on astronomy], altho of more real interest and more attractive than a novel, should be read with attention, and only on this condition can the ideas it contains impart lasting scientific instruction. But whereas when we reach the last page of a novel we know just as much as when we began the first, we must be either blind or oblivious to all intellectual apprehension if the reading of a scientific work does not greatly extend the sphere of our knowledge, and does not more and more elevate the level of our judgment.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter I (pp. 1–2)  
Chatto & Windus. London, England. 1894

**French, John** 1616–57  
English physician

There is a glut of chemical books, but a scarcity of chemical truths.

*Art of Distillation*  
To the Reader  
By E. Cotes for Thomas Williams. London, England. 1653

**Goldsmith, Oliver** 1728–74  
Anglo-Irish writer, poet, and physician

There are an hundred faults in this thing, and an hundred things might be said to prove them beauties. But it is



needless. A book may be amusing with numerous errors, or it may be very dull without a single absurdity.

*The Miscellaneous Works of Oliver Goldsmith*

*The Vicar of Wakefield*

Advertisement (p. 1)

Macmillan & Company Ltd. London, England. 1881

**Gutenberg, Beno** 1889–1960

German-American seismologist

Books and papers dealing with hypotheses on the development of the earth's crust are as the sands of the sea.

*Internal Constitution of the Earth*

Hypotheses on the Development of the Earth (p. 178)

Dover. New York, New York, USA. 1951

**Huxley, Thomas Henry** 1825–95

English biologist

Books are the money of Literature, but only the counters of Science.

*Collected Essays* (Volume 3)

*Science and Education*

Universities: Actual and Ideal (p. 213)

Macmillan & Company Ltd. London, England. 1904

You may read any quantity of books, and you may be almost as ignorant as you were at starting, if you don't have, at the back of your minds, the change for words in definite images which can only be acquired through the operation of your observing faculties on the phenomena of nature.

*Collected Essays* (Volume 3)

*Science and Education*

On the Study of Biology (p. 283)

Macmillan & Company Ltd. London, England. 1904

... a single book tells us more than Methuselah could have learned, had he spent every waking hour of his thousand years in learning ...

*Hume*

Chapter VII (p. 129)

Macmillan & Company Ltd. London, England. 1902

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Boswell: But, Sir is it not somewhat singular that you should happen to have Cocker's Arithmetic about you on your journey?

Dr. Johnson: Why, Sir if you are to have but one book with you upon a journey, let it be a book of science. When you read through a book of entertainment, you know it, and it can do no more for you; but a book of science is inexhaustible.

In James Boswell

*The Life of Samuel Johnson, LL.D.* Part Two

Chapter XIV (p. 268)

P.F. Collier & Son. New York, New York, USA. 1901

Sir, to leave things out of a book merely because people tell you they will not be believed, is meanness.

In James Boswell

*The Life of Samuel Johnson, LL. D.*

1772–AETAT. 63 (p. 281)

George Dearborn. New York, New York, USA. 1833

**Kant, Immanuel** 1724–1804

German philosopher

I did not enter on the prosecution of this undertaking [writing the book] until I saw myself in security regarding the duties of religion. My zeal was redoubled when at every step I saw the clouds disperse that appeared to conceal monsters behind their darkness; and when they were scattered I saw the glory of the Supreme Being break forth with the brightest splendor.

Translated by W. Hastie

*Kant's Cosmogony*

Preface (p. 18)

James Maclehose & Sons. Glasgow, Scotland. 1900

**King, Charles William** 1818–88

English writer

I have therefore once again gone with a will into the mines of antiquity to dig out fresh ore – no fear of exhausting the endless veins; have again wandered lovingly through the true Aladdin's Garden of Eastern literature, plucking its fruits, which be all manner of precious stones – no fear of thinning the teeming crop; or, to descend to prose, have carefully referred to my copious stock of notes and collectanea, and selected much therefrom that struck me as calculated to increase the interest and the utility of numerous portions of the work before me.

*The Natural History, Ancient and Modern, of Precious Stones and Gems, and of the Precious Metals*

Preface (p. vi)

Bell & Daldy. London, England. 1867

**Lemery, Nicolas** 1645–1715

French chemist

My Lord, the Treatise I now offer you, is not writ after the usual way of ordinary Chymists, it has none of the bombastik Expressions nor ridiculous Pretences, none of the Melancholick dreams and wretched Enthusiasms, none of the palpable Falsities, and even Impossibilites, wherewith the common rate of Chymical Books has been stuff'd hitherto.

*Course of Chemistry* (English edition)

Dedication

London. 1677

**Locke, John** 1632–1704

English philosopher and political theorist

Things in print must stand and fall by their own worth, or the reader's fancy.

*An Essay Concerning Human Understanding*

Dedication (p. iii)

Printed for Thomas Tegg. London, England. 1841

I here put into thy hands, what has been the diversion of some of my idle and heavy hours: if it has the good luck to prove so of any of thine, and thou hast but half so much pleasure in reading, as I had in writing it, thou wilt as little think thy money, as I do my pains, ill bestowed.

*An Essay Concerning Human Understanding*

Epistle to the Reader (p. v)

Printed for Thomas Tegg, London, England. 1841

**Maxwell, James Clerk** 1831–79

Scottish physicist

...the perusal of it [Isaac Taylor's *Physical Theory of Another Life*] has a tendency rather to excite speculation than to satisfy curiosity, and the author obtains the approbation of the reader, while he fails to convince him of the soundness of his views ...

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell*

Appendix A (p. 341)

Macmillan & Co Ltd. London, England. 1884

**Mills, Simeon**

No biographical data available

To learn from books, stores the mind with the wisdom of the past, but teaches us nothing that was not known before the books were made.

*Readings from the Book of Nature*

Chapter I (p. 11)

Charles H. Kerr & Co. Chicago, Illinois, USA. 1893

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

The style of the book certainly suggests teamwork. It is by turns waggish, pompous, chummy, coy, brutal, arch, rude, man-to-man, Air Force crisp, energetic, tongue-tied, pretentious, ingenuous, spastic, ironical, savage, malapropos, square-bashing and moralistic. Solecisms, pleonasms and jargon abound; The clichés and fused participles are spectacular; there are many sad examples of...cannibalism – words devouring their own kind.

Book review of *Thermonuclear War*

*Scientific American*, Volume 204, Number 2, March, 1961 (p. 197)

**Mitchell, Maria** 1818–89

American astronomer and educator

Newton rolled up the cover of a book; he put a small glass at one end, and a large brain at the other – it was enough.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 180)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

I am firmly convinced that the best book in medicine is the book of Nature, as written large in the bodies of men.

The Natural Method of Teaching the Subject of Medicine

*Journal of the American Medical Association*, Volume 36, 1901

**Pascal, Blaise** 1623–62

French mathematician and physicist

The last thing one settles in writing a book is what one should put in first.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 19

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

We may learn a great deal from books, but we learn much more from the contemplation of nature – the reason and occasion for all books.

*Advice for a Young Investigator*

Chapter 4 (p. 62)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**Richardson, David Lester** 1801–65

Poet and writer

It is an exquisite encouragement to the toiling heart of genius to remember that books are immortal!

*Literary Chit-Chat*

Chapter X (p. 85)

P.S. D'Rozario and Co. Calcutta, India. 1848

**Rota, Gian-Carlo** 1932–

Italian-born American mathematician

When too many books are written on a subject, one of two suspicions arises: either the subject is understood and the book is easy to write – as is the case with books on real variables, convexity, projective geometry in the plane, or compact orientable surfaces. Or the subject is important, but nobody understands what is going on; such is the case with quantum field theory, the distribution of primes, pattern recognition, and cluster analysis.

*Indiscrete Thoughts*

Chapter XX (p. 216)

Birkhäuser. Boston, Massachusetts, USA. 1997

**Sagan, Carl** 1934–96

American astronomer and author

Books permit us to voyage through time, to tap the wisdom of our ancestors. The library connects us with the

insights and knowledge, painfully extracted from Nature, of the greatest minds that ever were, with the best teachers, drawn from the entire planet and from all of our history, to instruct us without tiring, and to inspire us to make our own contribution to the collective knowledge of the human species.

*Cosmos*

Chapter XI (p. 233)

Ballentine Books. New York, New York, USA. 1985

**Schuster, Arthur** 1851–1934

German-born English physicist

If we ransack old books of science we often come across passages of long-forgotten writings, in which, when they are properly construed, when new meanings are given to old words and obscure expressions are freely translated, we may trace a faint prophetic glimmering of a modern theory.

The Influence of Mathematics on the Progress of Physics

*van Nostrand's Engineering Magazine*, Volume XXVI, Number CLX, April, 1882 (p. 317)

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

The Book of Nature is issued only in uncut editions, and the scientist has to open its pages one by one as he reads.

*Keeping Up with Science*

Introduction (p. vi)

Jonathan Cape. London, England. 1924

One obstacle in the way of spreading science, that is, of inculcating the scientific habit of mind, is that people have learned to read too well. Books may become an impediment to learning. Our students are taught how to learn to read but not always how to read to learn.

*Digest of the Proceedings of the Second Annual Meeting of the American Association for Adult Education*

Adult Education in Science, 1927 (p. 53)

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

What then is the aim of this book? It is to give the intelligent student-citizen, otherwise called “the man in the street,” a bunch of intellectual keys by which to open doors which have been hitherto shut to him, partly because he got no glimpse of the treasures behind the doors, and partly because the portals were made forbidding by an unnecessary display of technicalities.

*The Outline of Science: A Plain Story Simply Told*

Introductory Notes (p. iii)

G.P. Putnam's Sons. New York, New York, USA. 1922

**Thompson, Silvanus P.** 1851–1916

English physics professor and author

One other thing will the professed mathematicians say about this thoroughly bad and vicious book: that the

reason why it is so easy is because the author has left out all the things that are really difficult. And the ghastly fact about this accusation is that – it is true!

*Calculus Made Easy: Being a Very-Simplest Introduction to Those Beautiful Methods of Reckoning Which Are Generally Called by the Terrifying Names of the Differential Calculus and the Integral Calculus* (2nd edition)

Epilogue and Apologue (p. 284)

The Macmillan Company. New York, New York, USA. 1929

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Our books of science, as they improve in accuracy, are in danger of losing the freshness and vigor and readiness to appreciate the real laws of Nature, which is a marked merit in the oftentimes false theories of the ancients.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimack Rivers*

Friday (pp. 479–480)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

I would keep some book of natural history always by me as a sort of elixir, the reading of which should restore the tone of the system. To the sick, indeed, nature is sick, but to the well, a fountain of health.

*The Writings of Henry David Thoreau* (Volume 5)

*Natural History of Massachusetts* (p. 105)

Houghton Mifflin & Co. New York, New York, USA. 1906

One studies books of science merely to learn the language of naturalists, to be able to communicate with them.

In Harrison Gray Otis Blake (ed.)

*The Writings of Henry David Thoreau*

March 23, 1853 (p. 212)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

**Tyndall, John** 1820–93

Irish-born English physicist

It is one of the disadvantages of reading books about natural scenery that they fill the mind with pictures, often exaggerated, often distorted, often blurred, and, even when well drawn, injurious to the freshness of first impressions.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews*

Chapter VII (p. 175)

D. Appleton & Co. New York, New York, USA. 1897

Half of our book writers describe experiments which they never made, and their descriptions often lack both force and truth; but, no matter how clever or conscientious they may be, their written words cannot supply the place of actual observation.

*Fragments of Science*

Part One

A Lecture to School Masters (p. 365)

P.F. Collier & Son. New York, New York, USA. 1901

**Valéry, Paul** 1871–1945

French poet and critic

Nearly all the books I prize, and absolutely all that have been of any use to me, are books that don't make easy reading.

Translated by Stuart Gilbert

*The Collected Works of Paul Valery* (Volume 14)

*Analects*

Odds and Ends (p. 17)

Princeton University Press, Princeton, New Jersey, USA. 1979

**Willmott, Robert Eldridge Aris** 1809–63

English writer, poet

Every noble book is a stronghold of the mind, built upon some high place of contemplation, and overlooking wide tracts of intellectual country.

*Pleasures, Objects, and Advantages, of Literature* (4th edition)

Chapter X (p. 37)

G. Routledge & Co. London, England. 1855

Whether a book be read from the oak lectern of a college library, in the parlor window, or beneath the trees of summer, no fruit will be gathered unless the thoughts are steadily given up to the perusal.

*Pleasures, Objects, and Advantages, of Literature* (4th edition)

Chapter X (p. 37)

G. Routledge & Co. London, England. 1855

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

The popular scientific books by our scientists aren't the outcome of hard work, but are written when they are resting on their laurels.

Translated by Peter Winch

*Culture and Value* (p. 42e)

The University of Chicago Press, Chicago, Illinois, USA. 1980

## BOOK REVIEW

**Chapman, C. H.**

No biographical data available

In a review article it is impossible to do more than point out with hasty gestures the landmarks which must guide the traveler who would explore the vast intellectual territory ...

Book Review of *The Theory of Transformation Groups*

*Bulletin of the New York Mathematical Society*, Volume 2, Number 4, January, 1893 (p. 69)

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

boss a new book

has appeared

which should be read by every one

it is entitled

the cockroach

its life history

and how to deal with it and

the author

is frederick laing

who is assistant

in the department

of entomology in the

british museum

of natural history

it is one of the

best books i ever

tasted i am eating

the binding from

a copy with

a great deal of

relish and recommend it

to all other

insects

*the lives and time of archy & mehitabel*

book review (p. 253)

Doubleday Doran & Co. Garden City, New York, USA. 1934

## BOSON

**Gilmore, Robert**

No biographical data available

Bosons *like* to get together in the same state. Bosons are easily led; they are inherently gregarious.

*Alice in Quantum Land*

Chapter 5 (p. 85)

Springer-Verlag, New York, New York, USA. 1955

## BOTANICAL

**Goebel, Karl** 1855–1932

German botanist

If we may use a metaphor, we might say that Botanical Science is like a mountaineer, who, after long, weary climbing, only discovers that after all there still rises – steep and apparently impossible to scale – the real peak; but, notwithstanding this, on casting his eyes around, he finds himself well rewarded for the toil he has undergone.

On the Study of Adaptations in Plants

*Science Progress*, 1894

## BOTANIST

**Allen, Grant** 1848–99

Canadian-born writer

...if you ever venture to say again behind my back that the botanist is a dull, dried-up, unimaginative person, who cares nothing for the beauty of the lovely flowers, but goes in only for classification, herbariums, and sesquipedalian Latin names, I will arise and slay you with

my hand in another article just as long and every bit as argumentative as this one.

The Joy of Living

*Murray's Magazine*, Volume I, Number 3, April, 1877 (p. 405)

### Author undetermined

We botanists cannot be so mathematically exact as geographers, and where an isthmus is very narrow, [the geographers] must class the peninsula with the island. How often does it happen that two large orders, say of five hundred to two thousand or three thousand species, totally distinct from each other in all these species by a series of constant characters, are yet connected by some small isolated genus of a dozen, half a dozen, nay a single species in which these characters are so inconstant, uncertain or variously combined as to leave no room for the strait, through which we ought to navigate between the two islands.

De Candolle's Prodrromus

*London Journal of Botany*, Volume IX, 1845 (p. 232)

My mother is a botanist, and she even names a flower after me. It's called the Bloomin' Idiot.

Source undetermined

...a botanist is too commonly looked upon as merely one who can call plants by name. Making specimens and naming plants no more make a botanist than taking an altitude makes an astronomer.

Sketch of Professor Gray

*The Popular Science Monthly*, August, 1872 (p. 491)

### Barton, Benjamin Smith 1766–1815

American scientist

No man [can] become a nice, discriminating, and eminent botanist, without possessing that acumen in perception in proportion, colour, harmony of design, and obscure differences in the objects of the vegetable world, which alone belong to the eye of the painter.

In William Paul Crillon Barton,

*A Biographical Sketch Read Pursuant to Appointment before the Philadelphia Medical Society* (p. 7)

The Philadelphia Medical Society. Philadelphia, Pennsylvania, USA. 1816

### Brandes, Georg Morris Cohen 1842–1927

Danish literary critic

It makes the plant neither more nor less interesting that it smells sweet or stings; but the dispassionate interest of the botanist is often accompanied by the purely human pleasure in the beauty of the flower.

*Main Currents in Nineteenth, Century Literature*

Introduction (p. 3)

The Macmillan Co. New York, New York, USA. 1906

### Butler, Samuel 1612–80

English novelist, essayist, and critic

Why should the botanist, geologist or other-ist give himself such airs.... Is it because he names his plants or specimens with Latin names, and divides them into genre and species...

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Botanists and Draper's Shopman (p. 264)

Jonathan Cape. London, England. 1951

A botanist is a person whose aim is to uproot, kill and exterminate every plant that is at all remarkable for rarity or any special virtue, and the rarer it is the more bitterly he will hunt it down.

*The Note-books of Samuel Butler*

Chapter XVII (p. 281)

E.P. Dutton & Co. New York, New York, USA. 1917

### Croll, Oswald 1560–1609

German chemist and physician

Oh that the Botanists of our time, who being ignorant of the internal Form of plants, know only their matter, substance, and body, would devote as much care to the discernment of the Signatures of Plants as they do to their manifold and frequently frivolous disputes about the accurate naming of them, it would render a much richer and more beneficial service to medicine.

*Basilica Chymica*

Tractatus de Signaturis (p. 1)

Printed for John Starkey. London, England. 1670

### Crothers, Samuel McChord 1857–1927

American clergyman and writer

Here are botanists who love the growing things in the fields and woods better than the specimens in their herbariums. They love to describe better than to analyze. Now and then one may meet a renegade who carries a geologist's hammer. It is a sheer hypocrisy, like a fishing rod in the hands of a contemplative rambler. It is merely an excuse for being out of doors and among the mountains.

*The Gentle Reader*

The Hinter-Land of Science (pp. 236–237)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

### Darwin, Charles Robert 1809–82

English naturalist

But there is a growing pleasure in comparing the character of the scenery in different countries, which to a certain degree is distinct from merely admiring its beauty. It depends chiefly on an acquaintance with the individual parts of each view. I am strongly induced to believe that as in music, the person who understands every note will, if he also possesses a proper taste, more thoroughly enjoy



the whole, so he who examines each part of a fine view, may also thoroughly comprehend the full and combined effect. Hence, a traveler should be a botanist, for in all views plants form the chief embellishment.

*The Voyage of the Beagle*

Chapter XXI (pp. 502–503)

Heron Books. Sheridan, Oregon, USA. 1968

**Farley, Harriet** 1817–1907

American writer and editor

The Botanist looks with a more earnest eye upon the beauties of Nature, than does the Painter or the Poet; and in those plants which escape the notice of the latter, he can find both occupation and amusement.

*Shells from the Strand of the Sea of Genius*

The Pleasure of Science (p. 12)

J. Munroe and Co. Boston, Massachusetts, USA. 1847

**Fisher, Robert**

No biographical data available

To be a Botanist is to be like a traveler, going from country to country, and in each finding new wonders and new beauties.

*Flower-Land: An Introduction to Botany* (p. 3)

Bemrose & Sons. London, England. 1889

**Holder, Charles Frederick** 1851–1915

American sportsmen and naturalist

The field botanist is one who, being passionately fond of plants, and having mastered the rudiments of botany and become familiar with the names and classification of plants, searches the country for new and rare species, and for new localities for old ones ...

*Charles Darwin, His Life and Work*

Chapter XX (p. 243)

G.P. Putnam's Sons. New York, New York, USA. 1899

**Hunter, Maddy**

Writer

You know how most women go into a clothing store and have to finger all the soft fabrics and fur collars? Botanists are like that, too, except instead of touching merchandise, we're all over the local flora. We can't keep our hands off those unfamiliar leaves and flowers, and unfortunately, nature tends to be thorny.

*G'day to Die: A Passport to Peril Mystery* (p. 102)

Pocket Books. New York, New York, USA. 2006

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

“Are you a botanist, Dr. Johnson?”

“No, Sir, (answered Johnson,) I am not a botanist; and, (alluding no doubt, to his near sightedness) should I wish to become a botanist, I must first turn myself into a reptile.”

*Boswell's "Life of Samuel Johnson"*

Summer 1762 (p. 267)

Oxford University Press, Inc. Oxford, England. 1965

**Kett, Henry** 1761–1825

English college teacher and writer

The botanist follows nature into her most retired abodes, and views her in her simple taste, and native majesty.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 125)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

The botanist enjoys a pleasing and innocent amusement, most agreeably combined with a love of rural retirement, and which gives a new and growing interest to every walk and ride, in the most delightful season of the year. He collects a harvest from all countries for the purpose of reviewing his treasures at leisure, and growing rich in scientific acquisitions.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 126)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Kington, Miles** 1941–

English journalist, jazz musician and broadcaster

The way botanists divide up flowers reminds me of the way Africa was divided into countries by politicians.

*Nature Made Ridiculously Simple, or, How to Identify Absolutely Everything*

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

To you, my dearly-beloved botanists, I submit my rules, the rules which I have laid down for myself, and in accordance with which I intend to walk. If they seem to you worthy, let them be used by you also; if not, please propound something better!

*Critica Botanica*

Preface (pp. xxiii–xxiv)

The Ray Society. London, England. 1938

**Masters, M. T.**

No biographical data available

On the principle of recognising Hercules from his foot, or a lion by his claw, a botanist is too often expected to recognise some miserable scrap of a specimen, smashed it may be beyond hope of certain recognition in its transit through the post, and rendered unrecognisable by the stupid practice of enveloping the “specimen” in cotton wool. On the Nomenclature of Garden Plants

*Journal of the Royal Horticultural Society*, Volume V 1879 (p. 127)

**Moore, Jared Sparks** 1879–1951

American psychologist

The dissecting botanist is interested in the ugliest weed as much as in the beautiful flower ...



*The Foundations of Psychology*

Book II, Chapter IV (p. 100)

Princeton University Press. Princeton, New Jersey, USA. 1921

**Rousseau, Jean-Jacques** 1712–78

Swiss-French philosopher

...I know no rational study which is only a science of words: and to which of the two, I pray you, shall I grant the name of botanist, – to him who knows how to spit out a name or a phrase at the sight of a plant, without knowing anything of its structure, or to him who, knowing that structure very well, is ignorant nevertheless of the very arbitrary name that one gives to the plant in such and such a country?

Quoted in John Ruskin

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Book IX, Chapter VI (pp. 127–128)

George Allen. London, England. 1882

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

...the recent phrenzy for the investigation of digestive and reproductive operations in plants may by this time have furnished the microscopic malice of botanists with providentially disgusting reasons, or demoniacally nasty necessities, for every possible spur, spike, jag, sting, rent, blotch, flaw, freckle, filth, or venom, which can be detected in the construction, or distilled from the dissolution, of vegetable organism.

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Part VII, Chapter I (p. 6)

George Allen. London, England. 1882

**Sayre, G. Armington**

No biographical data available

A fundamental principle in the higher education of botanists is embodied in the simple lines – “To love the flower and leave it on its stalk.” To do this requires more heroism than the majority of collectors possess.

Devastation of Nature

*The American Botanist*, Volume I, Number 1, July 1901 (p. 2)

**Teale, Edwin Way** 1899–1980

American naturalist

Today I had lunch in the city with two scientists, a botanist and an ichthyologist. The botanist said he never kept a garden and the ichthyologist said he never went fishing.

*Circle of the Seasons*

December 8 (p. 282)

Dodd, Mead & Company. New York, New York, USA. 1953

**Timiriazeff, C. A.**

Russian botanist

It is not, I think, much beside the mark to say that the word ‘botanist’ still calls up in the minds of many even well educated people not conversant with science one of two

pictures. Either they expect in the botanist a tedious pedant with an inexhaustible vocabulary of double-barrelled Latin names, sometimes most barbarous, who is able to name at a glance any kind of plant, and also ready on occasion, it may be, to describe (quite incorrectly) their medicinal properties – the type of botanist who bores one to death and is certainly incapable of exciting any interest in his subject: or, on the other hand, ‘botanist’ depicts the somewhat less sombre figure of the passionate lover of flowers, who flits like a butterfly from one bloom to another, admiring their bright colouring, inhaling their perfume, singing the praises of the proud rose and the modest violet – in other words, the elegant adept of the *amabilis scientia*, as botany was called in olden times.

Translated by Anna Sheremeteva

*Die Sinne der Pflanzen*

Chapter I (p. 1)

Longmans, Green & Co. London, England. 1912

A botanist is either a pedantic nomenclator or an amateur horticulturist, an apothecary or an aesthete; but in no sense is he a man of science.

Translated by Anna Sheremeteva

*Die Sinne der Pflanzen*

Chapter I (p. 1)

Longmans, Green & Co. London, England. 1912

**Tolstoy, Leo** 1828–1910

Russian writer

...the botanist who finds that the apple falls because the cellular tissue decays and so forth is equally right with the child who stands under the tree and says the apple fell because he wanted to eat it and prayed for it.

Translated by Leo Wiener

*War and Peace*

Book 9, Chapter I (p. 8)

J.M. Dent & Co. London, England. 1904

**BOTANY**

**Abbot, Charles** 1761–1817

Grammar school teacher

The fair daughters of Albion have evinced a zeal and ardor in Botanical researches which have not only done the highest honor to themselves, but have eminently contributed to rescue these pursuits from unmerited reproach, to elevate them into reputation, and to impart to them, if not a superior value, at least a superior currency and fashion. – That such excellence should have been attained in this branch of science by so many of the female sex, notwithstanding the disadvantages they labour under from the want of scholastic and technical instruction, is a convincing proof of the liberality with which Nature has endowed the female mind.

*Flora Bedfordiensis*

Printed by W. Smith. London, England. 1798

**Author undetermined**

I hate botany. What is the good of having a set of rules which divide flowers off into classes, and teach one how to analyse them? I shouldn't care for a flower a bit better for knowing how it is constructed. Only fancy, on the very first page, the book told me to cut up an anemone. I couldn't do it – it went to my heart; so I cut up the book instead and threw it into the kitchen-fire.

Reata: Or, What's in a Name (part III)  
*Blackwood's Edinburgh Magazine*, Volume 25, Number 763, May, 1879 (p. 529)

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

BOTANY, n. The science of vegetables – those that are not good to eat, as well as those that are. It deals largely with their flowers, which are commonly badly designed, inartistic in color, and ill-smelling.

*The Cynic's Word Book*  
Botany (p. 37)  
Doubleday, Page & Co. New York, New York, USA. 1906

**Burroughs, John** 1837–1921

American naturalist and writer

We study botany so hard that we miss the charm of the flower entirely.

In the Noon of Science  
*The Atlantic Monthly*, Volume cx, September, 1912 (p. 324)

**Cable, George W.** 1844–1925

American writer and reformer

She loved no other part of botany quite so much as its Latin.

*Strong Hearts*  
The Entomologist  
Chapter II (p. 97)  
MSS Information Corporation. New York, New York, USA. 1970

**Coffin, Henry Sloane** 1877–1954

American Presbyterian clergyman

Botany differs from century to century as men learn more; but the plants and trees remain the same.

*University Sermons*  
The Fallacy of Origins (p. 207)  
Yale University Press. New Haven, Connecticut, USA. 1914

**Corner, E. H. J.**

No biographical data available

Botany needs help from the tropics. Its big plants will engender big thinking.

In Margaret D. Lowman  
*Life in the Treetops: Adventures of a Woman in Field Biology*  
Introduction (p. 1)  
Yale University Press. New Haven, Connecticut, USA. 1999

**Dickens, Charles** 1812–70

English novelist

B-o-t, bot, t-i-n, tin, bottin, n-e-y, ney, bottinney, noun substantive, a knowledge of plants. When he has learned that bottinney means a knowledge of plants, he goes and knows 'em. That's our system, Nickleby: what do you think of it?

*The Life and Adventures of Nicholas Nickleby* (Volume 1)  
Chapter VIII (p. 95)  
James R. Osgood & Co. Boston, Massachusetts, USA. 1875

**Dickinson, Emily** 1830–86

American lyric poet

I pull a flower from the woods, –  
A monster with a glass  
Computes the Stamens in a breath,  
And has her in a class.

*The Complete Poems of Emily Dickinson*  
No. 70 (p. 36)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

It is foolish to call them “flowers” –  
Need the wiser tell?  
If the Savants “Classify” them,  
It is just as well!

*The Complete Poems of Emily Dickinson*  
No. 168 (p. 79)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Einstein, Albert** 1879–1955

German-born physicist

One ought to be ashamed to make use of the wonders of science embodied in a radio set, the while appreciating them as little as a cow appreciates the botanic marvels in the plants she munches.

*Cosmic Religion, with Other Opinions and Aphorisms*  
On Radio (p. 93)  
Covici-Fiede. New York, New York, USA. 1931

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

To science there is no poison; to botany no weed; to chemistry no dirt.

*The Complete Works of Ralph Waldo Emerson* (Volume 12)  
*Natural History of Intellect*  
Chapter I (p. 55)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

But these young scholars, who invade our hills,  
Bold as the engineer who fells the wood,  
And travelling often in the cut he makes,  
Love not the flower they pluck, and know it not  
And all their botany is Latin names.

The old men studied magic in the flowers.  
*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
*Blight* (p. 140)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Our botany is all names, not powers: poets and romancers talk of herbs of grace and healing, but what does the botanist know of the virtues of his weeds?

*The Conduct of Life*

Beauty (p. 281)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Gerard, John** 1545–1612

English herbalist

Although my paines have not been spent (curteous Reader) in the gratuitous discoveries of golden mines, nor in the tracing after silver veins, whereby my native country might be enriched with such merchandize as it hath most in request and admiration; yet hath my labor (I trust) been otherwise profitably employed, in descrying of such a harmless treasure of herbes, trees, and plants, as the earth frankly without violence offereth unto our most necessarie uses.

*The Herbal of John Gerard*

Preface

Publisher undetermined

**Gilmour, John** 1906–86

English plant taxonomist and horticulturist

Botany is perhaps the least sensational of sciences. The importance of the vegetable kingdom in human affairs is basic rather than immediate, and only rarely – as in the case of penicillin – does plant science enjoy the bold type of a headline.

*British Botanists*

Introductory (p. 7)

Collins. London, England. 1946

**Gray, Asa** 1810–88

American botanist

Great as the merits of the work undoubtedly are, we must nevertheless be excused from adopting the terms of extravagant and sometimes equivocal eulogy employed by a popular author, who gravely informs his readers that no book, since printed Bibles were first sold in Paris by Dr. Faustus, ever excited so much surprise and wonder as did Dr. Torrey's edition of Lindley's *Introduction to the Natural System of Botany*.

In Charles Sprague Sargent

*Scientific Papers of Asa Gray* (Volume 1)

Lindley's *Natural System of Botany* (pp. 1–2)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1869

**Hale, Sarah Josepha Buell** 1788–1879

American writer

The explanations of these [classes and orders] must necessarily be very brief; my aim being rather to stimulate curiosity respecting the subject of Botany than to impart instruction is the science.

*The Book of Flowers*

Introduction (p. vii)

Saunders & Otley. London, England. 1836

**Henry, Thomas**

No biographical data available

The sciences of Natural History and Botany require so much time to be devoted to them that, however pleasing, they may be justly considered as improper objects for the man of business to pursue scientifically, so as to enter into the exact arrangement and classification of the different bodies of the animal, vegetable, and mineral kingdoms. But reading and personal observation will supply him with ample matter for reflection and admiration.

*Memoirs and Proceedings – Manchester Literary and Philosophical Society*

On the Advantages of Literature and Philosophy in General and Especially on the Consistency of (p. 79)

Literary and Philosophical with Commercial Pursuits

Taylor & Francis. London, England. 1883

**Henslow, John Stevens** 1796–1861

English botanist

To obtain a knowledge of a science of observation, like botany, we need make very little more exertion at first than is required for adapting a chosen set of terms to certain appearances of which the eye takes cognizance, and when this has been attained, all the rest is very much like reading a book after we have learned to spell, where every page affords a fresh field of intellectual enjoyment.

On the Requisites Necessary for the Advance of Botany

*Magazine of Zoology and Botany*, Volume 1, 1837 (p. 115)

**Herbert, Edward** 1856–1925

Old Testament scholar

**Lee, Sidney L.**

No biographical data available

I conceive it is a fine study, and worthy a gentleman to be a good botanic, that so he may know the nature of all herbs and plants, being our fellow-creatures, and made for use of man.

*The Autobiography of Edward* (p. 57)

John C. Nimo. London, England. 1886

**Howitt, William** 1792–1879

English author

Botany has introduced us to a more intimate acquaintance with the names and characters, and with something also of the physical economy of both “the trees of the wood” and of the smallest plants which flourish at their feet; so that wherever we cast our eyes, we behold matter for both admiration and research.

*The Book of the Seasons*

October (pp. 353–354)

Henry Colburn & Richard Bentley. London, England. 1831

**Jefferson, Thomas** 1743–1826

3rd president of the USA

And botany I rank with the most valuable sciences, whether we consider its subjects as furnishing the principal subsistence of life to man and beast, delicious

varieties for our tables, refreshment from our orchards, the adornments of our flower-borders, shade and perfume of our groves, materials for our buildings or medicaments for our bodies ...

In Eva Beard

Thomas Jefferson, Statesman and Scientist

*Nature Magazine*, April, 1958 (p. 202)

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Forty years ago I asked Liebig walking somewhere in the country, if he believed that the grass and flowers which we saw around us grew by mere chemical forces; he answered, “NO, no more than I could believe that a book of botany describing them grew by mere chemical force.”

In P. Thompson

*The Life of William Thomson* (Volume 2)

Letter to *The Times*, May 2, 1903 (pp. 1099–1100)

**Lincoln, Almira H.** 1793–1884

Botanist

A person ignorant of Botany, on beholding the profusion of flowers which adorn the face of nature, would discover general resemblances, and form in his mind some order of arrangement; but the Botanist learns to distinguish the least conspicuous parts of a plant as most important in a system of classification.

*Familiar Lectures on Botany, Practical, Elementary and Physiological*  
Introduction (p. 10)

F.J. Huntington & Co. New York, New York, USA. 1853

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

What toils, what science would be more wearisome and painful than Botany, did not some singular spell of desire, which I myself cannot define, often hurry us into this pursuit, so that the love of plants often overcomes our self-love? Good God! When I observe the fate of Botanists, upon my word I doubt whether to call them sane or mad in their devotion to plants.

*Critica Botanica*

Generic Names (p. 65)

The Ray Society. London, England. 1938

**Nuttall, Thomas** 1786–1859

English naturalist

Let us not, however, imagine that the science of Botany ends in the mere acquisition of imposed names; we may become acquainted with the structure of plants and their curious economy, like the human anatomist, without troubling ourselves materially with the particular name given to the individual subject. But we cannot proceed far, without employing something like definite language for the several parts of the object under view.

*An Introduction to Systematic and Physiological Botany*

Part I, Chapter I (pp. 1–2)

Hillard & Brown. Cambridge, England. 1830

**Phelps, Almira Hart Lincoln** 1793–1884

American educator and writer

The study of Botany seems peculiarly adapted to females; the objects of its investigation are beautiful and delicate; its pursuits, leading to exercise in the open air, are conducive to health and cheerfulness. It is not a sedentary study which can be acquired in the library, but the objects of the science are scattered over the surface of the earth, along the banks of the winding brooks, on the borders of precipices, the sides of mountains, and the depths of the forest. concerns, it is indispensable to the success of the one, and to the comfort of those interested in the other.

*Familiar Lectures on Botany, Practical, Elementary and Physiological*  
(5th edition)

Lecture I (p. 14)

F.J. Huntington & Co. New York, New York, USA. 1837

You are now to study Botany; here the objects about which you are to learn, will be placed before you, to *see*, to *touch*, and to *smell*. Thus three of your *senses* will be called upon to aid the *memory* and *understanding*; and as flowers are objects of much beauty and interest, your *imagination* also may be gratified.

*Botany for Beginners*

Chapter I (p. 9)

Huntington & Savage. 1849

**Queneau, Raymond** 1903–76

French poet, novelist, and publisher

After nearly taking root under a heliotrope, I managed to graft myself on to a vernal speedwell where my hips and haws were squashed indiscriminately and where there was an overpowering axillary scent. There I ran to earth a young blade or garden pansy whose stalk had run to seed and whose nut, cabbage or pumpkin was surmounted by a capsule encircled by snakeweed. This corny, creeping sucker, transpiring at the palms, nettled a common elder who started to tread his daisies and give him the edge of his bristly ox-tongue, so the sensitive plant stalked off and parked himself. Two hours later, in fresh woods and pastures new, I saw this specimen again with another willowy young parasite who was shooting a line, recommending the sap to switch the top bulbous vegetable ivory element of his mantle blue to a more elevated apex – as an exercise in style.

*Exercises in Style*

Botanical (pp. 171–172)

New Direction Publishing Corporation. New York, New York, USA. 1981

**Richards, Herbert Maul** 1871–1928

No biographical data available

Botany consists in the gathering of plants, and the dismembering of them, in connection with the use of a complicated terminology. That is the beginning and end of botany as it is understood by the majority; there is nothing more to be said.

*Lectures on Science, Philosophy and Art, 1907–1908*

Botany (p. 5)

The Columbia University Press. New York, New York, USA. 1908

### **Rousseau, Jean-Jacques** 1712–78

Swiss-French philosopher

I understand, my dear, that one is vexed to take so much trouble without learning the names of the plants one examines; but I confess to you in good faith that it never entered into my plan to spare you this little chagrin. One pretends that Botany is nothing but a science of words, which only exercises the memory, and only teaches how to give plants names.

Quoted in John Ruskin

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Book IX, Chapter V (p. 127)

George Allen. London, England. 1882

It is the chain of accessory ideas that makes me love botany

*Reveries of the Solitary Walker*

Seventh Walk (p. 120)

Penguin Books. London, England. 1979

### **Schleiden, Matthias Jacob** 1804–81

German botanist

Botany, as an inductive science, comprehends the study of the laws and forms of the Vegetable Kingdom. As an experimental science, it takes a very low position; and, at present, embraces but a very narrow circle of actually established facts, few indications of natural laws, and no fundamental principles and ideas by which it might be developed. This becomes very obvious when even the answer to the question, “What is a Plant?” is yet a problem of Botany.

Translated by Edwin Lankester

*Principles of Scientific Botany; Or, Botany as an Inductive Science*

Introduction (p. 1)

Longman, Brown, Green & Longmans. London, England. 1849

### **van Rensselaer, Schuyler**

No biographical data available

To a person who knows nothing of botany, the trees and flowers which he calls familiar are like the attractive faces that meet him day after day in the street – unnamed faces representing lives and souls which are hidden from his ken.

*Art Out-of-doors: Hints on Good Taste in Gardening*

Part XVI (p. 333)

Charles Scribner’s Sons. New York, New York, USA. 1893

### **Wakefield, Priscilla** 1750–1832

English writer and philanthropist

Botany is a branch of Natural History that possesses many advantages; it contributes to health of body and cheerfulness of disposition, by presenting an inducement to take air and exercise; it is adapted to the simplest capacity, and the objects of its investigation offer themselves without expense or difficulty, which renders them attainable to every rank in life; but with all these allurements, till of late years, it has been confined to the circle of the learned, which may be attributed to those books that treat of it, being principally written in Latin; a difficulty that deterred many, particularly the female sex, from attempting to obtain the knowledge of a science, thus defended, as it were, from their approach.

*An Introduction to Botany, in a Series of Familiar Letters, with Illustrative Engravings*

Thomas Burnside. Dublin, Ireland. 1796

### **White, Gilbert** 1720–93

English naturalist and cleric

The standing objection to botany has always been, that it is a pursuit that amuses the fancy and exercises the memory, without improving the mind or advancing any real knowledge; and, where the science is carried no farther than a mere systematic classification, the charge is but too true. But the botanist that is desirous of wiping off this aspersion should be by no means content with a list of names; he should study plants philosophically, should investigate the laws of vegetation, should examine the powers and virtues of efficacious herbs, should promote their cultivation; and graft the gardener, the planter, and the husbandman, on the phytologist.

*The Natural History and Antiquities of Selborne*

Letter XL (pp. 160–161)

Nathaniel Cooke. London, England. 1853

### **Wordsworth, Dorothy** 1771–1855

English author, poet and diarist

The woods extremely beautiful with all autumnal variety and softness. I carried a basket for mosses, and gathered some wild plants. Oh ! that we had a book of botany. All flowers now are gay and deliciously sweet.

*Journals of Dorothy Wordsworth* (Volume 1)

Friday Morning, 16th (p. 32)

Macmillan & Co Ltd. London, England. 1904

## **BOTANY, HISTORIAN OF**

### **von Sachs, Julian**

No biographical data available

...the task of the historian of Botany...is a very difficult one, for it is only with great labour that he succeeds in



picking the real thread of scientific thought out of an incredible chaos of empirical material.

Translated by E.F. Garnsey  
*History of Botany (1530–1860)*  
 Preface (p. vi)

At The Clarendon Press. Oxford, England. 1890

## BOTANY, STUDY OF

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Balfour's "Manual of Botany." "Sap," – yes, at last. "Article 257. Course of fluids in exogenous stems." I don't care about the course just now: I want to know where the fluids come from. "If a plant be plunged into a weak solution of acetate of lead," – I don't in the least want to know what happens. – From the minuteness of the tissue, it is not easy to determine the vessels through which the sap moves." Who said it was? If it had been easy, I should have done it myself. "Changes take place in the composition of the sap in its upward course." I dare say; but I don't know yet what its composition is before it begins going up. "The Elaborated Sap by Mr. Schultz has been called 'latex.'" I wish Mr. Schultz were in a hogshead of it, with the top on. "On account of these movements in the latex, the laticiferous vessels have been denominated cin-enchymatous." I do not venture to print the expressions which I here mentally make use of.

*Proserpina* (Volume 1)

Lecture III, 14 (pp. 47–48)

John Wiley & Sons. New York, New York, USA. 1886

## BOULDER

**Burroughs, John** 1837–1921

American naturalist and essayist

The grazing or ruminating cattle add a picturesque feature, but the gray granite boulders have been lying there chewing their stony cuds vastly longer. How meditative and contented they look, dreaming the centuries away!

*The Writings of John Burroughs* (Volume 19)

Chapter II (p. 42)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

## BOWEL MOVEMENT

**Hippocrates** 460 BCE–377 BCE

Greek physician

The excrement is best which is soft and consistent, is passed at the hour which was customary to the patient when in health, in quantity proportionate to the ingesta; for when the passages are such, the lower belly is in a healthy state.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Book of Prognostics, 11 (p. 21)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## BRACTS

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

These, and such undeveloping leaves, wherever they occur, are called "bracts" by botanists, a good word, from the Latin "bractea," meaning a piece of metal plate, so thin as to crackle. They seem always a little stiff, like bad parchment, – born to come to nothing – a sort of infinitesimal fairy-lawyer's deed.

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Part VII, Chapter I (p. 16)

George Allen. London, England. 1882

## BREATH

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

This breath of life, so precious and so fated, is to plants and animals a common inspiration. Every leaf of Burnham beeches, of the jungles of Minas Geraes, respire oxygen, day and night, like the panting jungle beasts. Deprived of free oxygen, some cells, bacteria and yeasts and molds, may still breathe, in a sort of smothered ferment. But breathe, in one sense or another, they must. Very low drops the breathing of the frog, frozen at the bottom of the pond, and low the breathing of the butternut, in all its crusty coats. But never while life is in them will it stop.

*Flowering Earth*

Chapter 4 (p. 46)

G.P. Putnam's Sons. New York, New York, USA. 1939

## BRIDGE

**Andric, Ivo** 1892–1975

Yugoslavian writer

When the angels saw how unfortunate men could not pass those abysses and ravines to finish the work they had to do, but tormented themselves and looked in vain and shouted from one side to the other, they spread their wings above those places and men were able to cross. So men learned from the angels of God how to build bridges, and therefore, after fountains, the greatest blessing is to build a bridge...

*The Bridge on the Drina*

Chapter XVI (pp. 208–209)

George Allen & Unwin Ltd. London, England. 1959

**Broun, Heywood** 1888–1939

American writer, journalist, and critic

Men build bridges and throw railroads across deserts, and yet they contend successfully that the job of sewing on a button is beyond them. Accordingly, they don't have to sew buttons.



*Seeing Things at Night*  
Holding a Baby (p. 168)  
Harcourt, Brace. New York, New York, USA. 1921

## Magna Carta

No township or subject shall be compelled to make bridges at river banks, except those who by ancient usage are legally bound to do so.

In J.C. Dickinson  
*The Great Charter*  
Chapter 23 (p. 22)  
Published by the Historical Association by G. Philip. London, England. 1955

**McGonagall, William** ca. 1825–1902  
Scottish weaver, actor and poet

Oh! ill fated Bridge of the Silv'ry Tay,  
I must now conclude my lay  
By telling the world fearlessly and without the least dismay,  
That your central girders would not have given way,  
At least many sensible men do say,  
Had they been supported on each side with buttresses,  
At least many sensible men confesses,  
For the stronger we our houses do build,  
The less chance of being killed.

*Last Poetic Gems Selected from the Works of William McGonagall, Poet and Tragedian*  
The Tay Bridge Disaster (p. 92)  
David Winter & Son. Dundee, Scotland. 1968

**Mermin, Norman David** 1935–  
Mathematician

Bridges would not be safer if only people who knew the proper definition of a real number were allowed to design them.

Topological Theory of Defects  
*Review of Modern Physics*, Volume 51, Number 3, July 1979

**Petroski, Henry** 1942–  
American civil engineer

Designing a bridge or any other large structure is not unlike planning a trip or vacation. The end may be clear and simple: to go from here to there. But the means may be limited only by our imagination.

*To Engineer Is Human: The Role of Failure in Successful Design*  
(p. 64)  
St. Martin's Press. New York, New York, USA. 1985

**Roebing, John** 1806–69  
German-American civil engineer

The contemplated work, when constructed in accordance with my designs, will not only be the greatest Bridge in existence, but it will be the greatest engineering work

of this continent, and of the age. Its most conspicuous features, the great towers, will serve as landmarks to the adjoining cities, and they will be entitled to be ranked as national monuments.

*Report to the New York Bridge Company*  
1867

**Schuyler, Montgomery** 1814–96  
American journalist and architectural critic

It so happens that the work which is likely to be our most durable monument, and to convey some knowledge of us to the most remote posterity, is a work of bare utility; not a shrine, not a fortress, not a palace but a bridge.

The Bridge as a Monument  
*Harper's Weekly*, Volume XXVII, Number 137927, May, 1883 (p. 326)

**Steinman, D. B.**  
American engineer

Between two towers soaring high  
A parabolic arc is swung  
To form a cradle for the stars;  
And from this curve against the sky  
A span of gleaming steel is hung –  
A highway of speeding cars.  
Between the cable and the span  
A web of silver strands is spaced,  
With sky above and ships below  
In human dream was born the plan  
Of strength and beauty interplaced –  
A harp against the sunset glow!  
Suspension Bridge  
*American Engineer*, February 22–28, 1953 (p. 33)

**Woodson, Thomas T.**  
No biographical data available

Poor arithmetic will make the bridge fall down just as surely as poor physics, poor metallurgy, or poor logic will.

*Introduction to Engineering Design* (p. 245)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

## BROOK

**Rooke, Octavius**  
No biographical data available

If the ocean is like the organ in the world's great orchestra, is not the brook as the sweet flute, whose notes melodious sink into the heart of all?

*The Channel Islands: Pictorial, Legendary and Descriptive*  
Chapter XIV (p. 113)  
L. Booth. London, England. 1857

**BROWNIAN MOTION**

**Brown, Robert** 1773–1858  
Scottish scientist

These [Brownian] motions were such as to satisfy me, after frequently repeated observation, that they arose neither from currents in the fluid, nor from its gradual evaporation, but belonged to the particle itself.

*The Miscellaneous Botanical Works of Robert Brown* (Volume 1)  
A Brief Account of Microscopical Observations made in the Middle of June, July, and August, 1827, on the Particles Contained in the Pollen of Plants (p. 467)

Robert Hardwicke. London, England. 1846

**BRUTES**

**Melville, Herman** 1819–91  
American novelist

There are unknown worlds of knowledge in brutes; and whenever you mark a horse, or a dog, with a peculiarly mild, calm, deep-seated eye, make sure he is an Aristotle or a Kant, tranquility speculating upon the mysteries in man.

*Redburn*

Chapter XL (p. 226)

Jonathan Cape. London, England. 1937

**BUBBLE**

**Boys, Charles Vernon** 1855–1944  
English inventor and physicist

I do not suppose that there is any one in this room who has not occasionally blown a common soap-bubble, and while admiring the perfection of its form, and the marvellous brilliancy of its colours, wondered how it is that such a magnificent object can be so easily produced.

I hope that none of you are yet tired of playing with bubbles, because, as I hope we shall see during the week, there is more in a common bubble than those who have only played with them generally imagine.

*Soap-bubbles and the Forces which Mould Them* (p. 9)

Society for Promoting Christian Knowledge. London, England. 1896

...a soap bubble is a beautiful thing. It appeals to several senses and to many kinds of minds; it is a source of delight to children, and we who know what somewhat of the mysteries of molecular physics which it helps to reveal look at it with admiration.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1912)

Experiment with Soap Bubbles (p. 211)

Government Printing Office. Washington, D.C. 1913

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

But the pressure was too great. He would have to find something to make good the equilibrium. Something must come with him into the hollow void of death in his soul, fill it up, and so equalise the pressure within to the pressure without. For day by day he felt more and more like a bubble...

*Women in Love*

Chapter XXIV (p. 308)

The Viking Press. New York, New York, USA. 1950

**Maxwell, James Clerk** 1831–79  
Scottish physicist

On an Etruscan vase in the Louvre figures of children are seen blowing bubbles. Those children probably enjoyed their occupation just as modern children do. Our admiration of the beautiful and delicate forms, growing and developing themselves, the feeling that it is our breath that is turning dirty soap suds into spheres, the fear lest by an irreverent touch we may cause the gorgeous vision to vanish with a sputter of soapy water in our eyes, our wistful gaze as we watch the perfect bubble when it sails away from the pipe's mouth to join, somewhere in the sky, all the other beautiful things that have vanished before it.

Plateau on Soap-Bubbles

*Nature*, Volume 10, Number 242, Thursday, June 18, 1874 (p. 119)

**Mukaiyama, Teruaki** 1927–  
Japanese chemist and scientific statesman

Vigorous evolution of gas, quick coloration to brown, and the formation of precipitates; there hidden, was the treasure of possibility in the bubbles of foam on the surface, which were observed in the reaction vessel in a corner of our small laboratory! For organic chemists, facing such an unpredictable phenomenon is not uncommon. In flasks, that which can be predicted by thought or discussion with co-workers often happens.

*Challenges In Synthetic Organic Chemistry*

Prologue (p. 1)

Clarendon Press. Oxford, England. 1990

**BUG****Author undetermined**

The Lightning-bug has wings of gold.

The June-bug wings of flame.

The Bed-bug has no wings at all.

But he gets there all the same!

Filler material

*The Conductor and Brakeman*, Volume II, Number 4, April, 1885 (p. 215)

**Beard, Dan** 1850–1941  
American illustrator, writer, and social reformer

Bugs, like women, seem to be very fond of perfume, but, like some of the women, the perfume they use is not always the kind we would choose.

*The American Boys' Book of Bugs, Butterflies and Beetles*  
Fore Talk (p. 10)  
J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1915

Bugs, butterflies and beetles are a busy lot, they need watching, they are mischievous little gnomes, but the Great Creator supplied the earth with birds to keep these little insect fairies in subjection.

*The American Boys' Book of Bugs, Butterflies and Beetles*  
Chapter One (p. 31)  
J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1915

**Beatty, Warren** 1937-  
American actor, producer, screenwriter, and director

A bug is nothing! A bug does not exist. The word has no meaning. It's only used out of ignorance or malice. You know what a bug is? A bug is a colloquialism which has no basis in reality. Insects include a wide variety of living creatures that fly and crawl, but none of them can be called a bug!

*Bugsy*  
Film (1991)

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

A musketo will fight you in broad dalite, at short range, and giv you a chance tew knock in hiz sides – the flea iz a game bugg, and will make a dash at you even in Broadway – but the bed-bugg iz a garroter, who waits till you strip, and then picks out a mellow place tew eat you. They dassent tackle a man bi dalite, but sneak in, after dark, and chaw him while he iz fast asleep.

*Josh Billings' Wit and Humor*  
Bed Bugs (p. 111)  
George Routledge & Sons. London, England. 1874

Whenever i cum akros enny bug, that i dont know what they waz built for, i dont blame the bug.

I hav grate phaith in ennything that kleeps, krawls, or even wiggles, and tho i haint been able tew satisfy myself all about the usefulness ov bed bugs, musketoze, and striped snaix, i hav phaith that Divine Providence did not make them in vain.

*Josh Billings' Wit and Humor*  
The Lady Bug (p. 143)  
George Routledge & Sons. London, England. 1874

**Carryl, Charles Edward** 1841–1920  
American writer

...we carry home as prizes Funny bugs, of handy sizes,

Just to give the day a scientific tone.

In Edward Hodnett (ed.), rev. edition, (1967)  
*Poems to Read Aloud*  
Davy and the Goblin, l. 40–42  
W.W. Norton & Company, Inc. New York, New York, USA. 1967

**Cuppy, Will** 1884–1929  
American humorist and critic

You are a bug only if you belong to the order Hemiptera, formerly the suborder Heteroptera. Is that clear now?

*How to Attract the Wombat*  
The Ladybug (fn 5, p. 164)  
Rinehart & Company, Inc. New York, New York, USA. 1949

**Dekker, Thomas** 1570–1632  
English dramatist

We have bugs sir.  
*The Dramatic Works of Thomas Dekker: The Virgin Martir* (p. 56)  
Printed by B.A. for Thomas. London, England. 1622

**Glover, Townend** 1813–83  
American entomologist

From red-bugs and bed-bugs, from sand-flies and land-flies,

Mosquitoes, gallnippers and fleas,  
From hog-ticks and dog-ticks, from hen-lice and men-lice,

We pray thee, good Lord, give us ease.

In Arnold Mallis  
*American Entomologist*  
Chapter 3 (pp. 64–65)  
Rutgers University Press. New Brunswick, New Jersey, USA. 1971

**Harding, George Canady** 1829–1881  
Writer

And then the bugs; there were round bugs, and flat bugs, and oblong bugs, and spiral bugs – humbugs and bugaboos – bugs emitting a deadly stench when, as invariably happened, they procured themselves to be crushed.

*The Miscellaneous Writings of George C. Harding*  
Shifting Scenes from the Drama of the Late War (p. 283)  
Carlton & Hollenbeck. Indianapolis, Indiana, USA. 1882

**Holland, W. J.**  
No biographical data available

When the moon shall have faded out from the sky, and the sun shall shine at noonday a dull cherry-red, and the seas shall be frozen over, and the ice-cap shall have crept downward to the equator from either pole, and no keels shall cut the waters, nor wheels turn in mills, when all cities shall have long been dead and crumbled into dust, and all life shall be on the very last verge of extinction on this globe; then, on a bit of lichen, growing on the bald rocks beside the eternal snows of Panama, shall be seated a tiny insect, preening its antenna in the glow of the worn-out sun, representing the sole survival of animal life on this our earth, – a melancholy “bug”.

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*  
The End (p. 445)  
Doubleday, Page & Company. New York, New York, USA. 1904

**Little, Arthur D.** 1863–1935

American chemist

“Ladybird, ladybird, fly away home,” becomes impossible when one is forced to address the prettily spotted beetle as *Coccinella dipunctata*.

*The Fifth Estate* (p. 6)

The Franklin Institute. Philadelphia, Pennsylvania, USA. 1924

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

if all the bugs  
in all the worlds  
twixt earth and betelgoose  
should sharpen up  
their little stings  
and thrun their feelings loose  
they soon would show  
all human beans

in saturn  
earth  
or mars

their relative significance  
among the spinning stars

*the lives and time of archy & mehitabel*

archy turns revolutionist (p. 226)

Doubleday Doran &amp; Co. Garden City, New York, USA. 1934

**Morley, Margaret Warner** 1858–1923

American biologist, educator, and writer

They call every insect a “bug,” but bugs are bugs, flies are flies, ants are ants, and neither flies nor ants are bugs. Indeed, no insects are bugs – excepting just bugs!

*The Insect Folk*

The Great Bug Family (p. 115)

Ginn &amp; Co. Boston, Massachusetts, USA. 1903

**Oemler, Marie Conway** 1879–1932

American novelist

“Where the Sam Hill,” he blazed, “do all these footy little devils come from, anyhow? Where am I to put a beast of a bug when the next one that’s exactly like it is entirely different the next time you look at it? There’s too much beginning and no end at all to this game!”

*Slippy Magee, Sometimes Known as Butterfly Man* (p. 72)

Grosset &amp; Dunlap. New York, New York, USA. 1921

**Prelutsky, Jack** 1940–

American poet

Bugs! Bugs!  
I love bugs,  
yes I truly do,

great big pink ones,  
little green stink ones,  
yellow bugs and blue.  
I put you in my pockets,  
and I wear you in my hair.  
You are my close companions,  
I take you everywhere.

*A Pizza the Size of the Sun: Poems*

Bugs! Bugs!

Greenwillow Books. New York, New York, USA. 1996

**Southall, John**

No biographical data available

A Bugg’s Body is shaped and shelled and the Shell as transparent and finely striped as the most beautiful amphibious Turtle; has six legs most exactly shaped, jointed and bristled as the Legs of a Crab. Its Neck and Head much resembles a Toad’s. On its Head are three Horns picqued and bristled; and at the end of their Nose they have a Sting sharper and much smaller than a Bee’s. The Use of their Horns is in Fight to assail their Enemies, or defend themselves. With the Sting they penetrate and wound our Skins, and then (tho’ the Wound is so small as to be almost imperceptible) they thence by Suction extract their most delicious Food, our Blood.

*A Treatise of Buggs* (p. 19)

1730

**Trollope, Anthony** 1815–82

English novelist

I hope men and women will not give way to bugs and fleas ...

*Lady Anna* (Volume 1)

Chapter IV (p. 48)

Chapman &amp; Hall, Ltd. London, England. 1874

**BUILD****Author undetermined**

Those who personally dominate are heroes for the hour; those who build are immortal.

*Journal of Engineering Education*, Volume 30, Number 3, November, 1939 (p. 314)**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

The most powerful drive in the ascent of man is his pleasure in his own skill. He loves to do what he does well and, having done it well, he loves to do it better. You see it in his science. You see it in the magnificence with which he carves and builds, the loving care, the gaiety,

the effrontery. The monuments are supposed to commemorate kings and religions, heroes, dogmas, but in the end the man they commemorate is the builder.

*The Ascent of Man*

The Grain in the Stone (p. 116)

Little, Brown & Co. Boston, Massachusetts, USA. 1973

Those who personally dominate are heroes for the hour; those who build are immortal.

*Journal of Engineering Education*, Volume 30, Number 3, November, 1939 (p. 314)

**Longfellow, Henry Wadsworth** 1807–82

American poet

Michael A: Ah, to build, to build!  
That is the noblest art of all the arts.  
Painting and sculpture are but images,  
Are merely shadows cast by outward things  
On stone or canvas, having in themselves  
No separate existence. Architecture,  
Existing in itself, and not seeming  
A something it is not, surpasses them  
As substance shadow.

*The Poetical Works of Henry Wadsworth Longfellow*

Michael Angelo, III, San Silvestro

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

...to build, to build That is the noblest art of all the arts.  
Painting and sculpture are but images, Are merely shadows  
cast by outward things On stone or canvas, having in  
themselves No separate existence. Architecture, Existing  
in itself, and not in seeming A something it is not, sur-  
passes them As substance shadow.

*The Complete Poetical Works of Henry Wadsworth Longfellow*

Michael Angelo (p. 420)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1899

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Therefore when we build, let us think that we build (public edifices) forever. Let it not be for present delight, nor for present use alone, let it be such work as our descendants will thank us for, and let us think, as we lay stone to stone, that a time is to come when those stones will be held sacred because our hands have touched them, and that men will say as they look upon the labor and wrought substance of them, "See!"

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 3, The Lamp of Memory (pp. 142–143)

John Wiley & Sons, Inc. New York, New York, USA. 1860

To build, literally to confirm, is by common understanding to put together and adjust the several pieces of any edifice or receptacle of a considerable size. Thus we have church building, house building, ship building, and coach building.

*The Seven Lamps of Architecture*

Chapter I (p. 7)

John Wiley & Son. New York, New York, USA. 1865

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

When we mean to build,  
We first survey the plot, then draw the model.  
And when we see the figure of the house,  
Then must we rate the cost of the erection,  
Which if we find outweighs ability,  
What do we then but draw anew the mode  
In fewer offices, or at least desist  
To build at all?

*In Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Second Part of King Henry the Fourth*

Act I, Scene iii, l. 41

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wooten, Henry**

No biographical data available

In *Architecture* as in all other *Operative Arts*, the end must direct the *Operation*.

The *end* is to build well.

Well building hath three Conditions.

Commodities, Firmness, and Delight.

*The Elements of Architecture*

The I. part (p. 1)

Printed by John Bill. London, England. 1624

## BUILDER

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

No person who is not a great sculptor or painter can be an architect. If he is not a sculptor or painter, he can only be a builder.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 4, Sculpture (p. 209)

John Wiley & Sons, Inc. New York, New York, USA. 1860

But of them [the builders], and their life, and their toil upon the earth, one reward, one evidence, is left to us in those gray heaps of deep-wrought stone. They have taken with them to the grave their powers, their honors, and their errors; but they have left us their adoration.

*The Seven Lamps of Architecture*

Chapter I (p. 24)

John Wiley & Son. New York, New York, USA. 1865

In no art is there closer connection between our delight in the work, and our admiration of the workman's mind, than in architecture, and yet we rarely ask for a builder's name.

*The Stones of Venice*  
Chapter II (p. 38)  
Smith, Elder & Co. London, England. 1873

## BUILDING

### de Staël (Anne-Louise-Germaine),

**Mme.** 1766–1817  
French romantic writer

The sight of such a building [St. Peter's Cathedral] is like a ceaseless, changeless melody ...

Translated by Isabel Hill  
*Corinne*  
Chapter II (p. 62)  
New York, New York, USA. 1876

### Disraeli, Benjamin, 1st Earl of Beaconsfield

1804–81  
English prime minister, founder of Conservative Party, and novelist

Nothing more completely represents a nation than a public building.

*Tancred, Or The New Crusade*  
Chapter X (p. 112)  
Longmans, Green & Co. London, England. 1900

### Hertzberger, Herman

1932-  
Dutch architect

We will have to accept that buildings, like household and other appliances, are showing less and less of their contents and their workings, and starting to behave increasingly like urban containers.

*Space and the Architect: Lessons in Architecture 2*  
Chapter 4 (p. 102)  
010 Publishers. Rotterdam, The Netherlands. 2000

### Ruskin, John

1819–1900  
English writer, art critic, and social reformer

All that is fantastic in form, or frivolous in detail, annihilates the aristocratic air of a building: it at once destroys its sublimity and size, besides awakening, as is almost always the case, associations of a mean and low character.

*The Poetry of Architecture: Cottage, Villa, Etc*  
The Cottage (p. 26)  
John Wiley & Sons. New York, New York, USA. 1877

Everything about it [a building] should be natural, and should appear as if the influences and forces which were in operation around it had been too strong to be resisted, and had rendered all efforts of art to check their power, or conceal the evidence of their action, entirely unavailing.

*The Poetry of Architecture: Cottage, Villa, Etc*  
The Cottage (p. 44)  
John Wiley & Sons. New York, New York, USA. 1877

...the material which Nature furnishes, in any given country, and the form which she suggests, will always render the building the most beautiful ...

*The Poetry of Architecture: Cottage, Villa, Etc*  
The Cottage (p. 48)  
John Wiley & Sons. New York, New York, USA. 1877

...the more polished the mind of its designer, the less national will be the building; for its architect will be led away by a search after a model of ideal beauty, and will not be involuntarily by deep-rooted feelings, governing irresistibly his heart and hand.

*The Poetry of Architecture: Cottage, Villa, Etc*  
The Villa (p. 82)  
John Wiley & Sons. New York, New York, USA. 1877

### Statham, H. Heathcote

1839–1924  
Architect

...a building ought to express in its external design its internal planning and arrangement; in other words, the architectural design should arise out of the plan and disposition of the interior, or be carried on concurrently with it, not designed as a separate problem.

*Architecture for General Readers*  
Architecture for General Readers (p. 5)  
Charles Scribner's Sons. New York, New York, USA. 1896

## BUILDINGS

### Glog, John

1896–1981  
Architectural writer

Architecture cannot lie, and buildings, although inanimate, are to that extent morally superior to men.

Presentation  
The Significance of Historical Research in Architectural and Industrial Design  
Royal Society of Arts, 20 March, 1963

### Hugo, Victor

1802–85  
French author, lyric poet, and dramatist

Great edifices, like great mountains, are the work of ages.

*Notre-Dame de Paris*  
Book III, Chapter 1 (p. 107)  
J.M. Dent & Sons Ltd. London, England. 1910

### Ruskin, John

1819–1900  
English writer, art critic, and social reformer

Better the rudest work that tells a story or records a fact, than the richest without meaning. There should not be a single ornament put upon great civic buildings, without some intellectual intention.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*



Part 3, The Lamp of Memory (p. 142)  
John Wiley & Sons, Inc. New York, New York, USA. 1860

...we require from buildings, as from men, two kinds of goodness: first, the doing their practical duty well: then that they be graceful and pleasing in doing it; which last is itself another form of duty.

*The Works of John Ruskin*

*The Stones of Venice* (Volume 1)

Chapter II, Section 1 (p. 36)

John Wiley & Sons, Inc. New York, New York, USA. 1887

## BUTTERFLY NET

**Gibson, William Hamilton** 1850–96

American illustrator, author, and naturalist

My butterfly-net and pocket magnifying-glass are rare companions for a walk in the country.

*Sharp Eyes: A Rambler's Calendar*

The Sweep-Nest Harvest

July 21<sup>st</sup> (p. 117)

Harper & Brothers Publishers. New York, New York, USA. 1900

## C

### CALCINATION

**Rey, Jean** 1583–1645  
French physician and chemist

Let now all the greatest minds in the world be fused into one mind, and let this great mind strain every nerve beyond its power; let him seek diligently on the earth and in the heavens, let him search every nook and cranny of nature: he will only find the cause of this augmentation in the air when the Sun's rays heat it, and render it dense and heavy, so that it then mixes with the calx as the anti-mony on calcination crumbles and becomes adherent in its minutest particles.

*Essays of Jean Rey*  
Essay XXV (p. 51)  
William F. Clay. Edinburgh, Scotland. 1895

### CALCULATE

**Poe, Edgar Allan** 1809–49  
American short story writer

...to calculate is not in itself to analyse.  
*Tales of Mystery and Imagination*  
*The Murders in the Rue Morgue* (p. 83)  
Henry Frowde. London, England. 1903

**Shanks, William** 1812–82  
English amateur mathematician

Whether any other Mathematician will appear, possessing sufficient leisure, patience, and facility of computation, to calculate the value of  $[\pi]$  to a still greater extent, remains to be seen: all that the Author can say is, he takes leave of the subject for the present ...

*Contributions to Mathematics*  
Introductory Remarks and Historical Notes (p. xvi)  
G. Bell. London, England. 1853

### CALCULATING

**Browning, Robert** 1812–89  
English poet

That low man goes on adding one to one,  
His hundred's soon hit;  
This high man, aiming at a million,  
Misses a unit.

*Poems of Robert Browning*  
A Grammarian's Funeral  
Oxford University Press. London, England. 1913

### CALCULATING MACHINE

**Babbage, Charles** 1792–1871  
English mathematician

On two occasions, I have been asked [by the members of Parliament], – “Pray, Mr. Babbage, if you put into the machine wrong figures, will the right answers come out?” In one case, a member of the Upper, and in the other a member of the Lower, House put this question. I am not able rightly to apprehend the kind of confusion of ideas that could provoke such a question.

*Passages from the Life of a Philosopher*  
Chapter V (p. 67)  
Longman, Green, Longman, Roberts & Green. London, England. 1864

**Hamilton, William** 1788–1856  
Scottish philosopher

It is the highest compliment to the ingenuity of a Pascal, a Leibnitz, and a Babbage, in their invention of the arithmetical machine, that there would not be required, in those who use it, more than the dexterity of a turnspit.

*Discussions on Philosophy and Literature, Education and University Reform*  
On the Study of Mathematics as an Exercise of the Mind (p. 283)  
Harper & Brothers Publishers. New York, New York, USA. 1861

### CALCULATION

**Austen, Jane** 1775–1817  
English novelist

...if the first calculation is wrong, we make a second better...

*Mansfield Park*  
Chapter V (p. 38)  
J.M. Dent & Sons Ltd. London, England. 1906

### Author undetermined

As I was going to St. Ives,  
I met a man with seven wives;  
Every wife had seven sacks,  
Every sack had seven cats,  
Every cat had seven kit.  
Kits, cats, sacks, and wives,  
How many were going to St. Ives?  
Source undetermined

Integral z-squared dz  
From 1 to the square root of 3  
Times the cosine  
Of three pi over 9  
Equals log of the cube root of 'e'  
Source undetermined

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The student must be careful in calculations involving the decimal point to put it in its exact place, neither too much to the right nor too much to the left.

*The Aftermath*

Appendix (fn, p. 147)

Duckworth &amp; Company. London, England. 1910

**Bennett, Charles H.**

No biographical data available

Multiplication is vexation,  
Division is as bad;  
The Rule of Three doth puzzle me,  
And Practice drives me mad.

In Charles H. Bennett

*Old Nurse's Book of Rhymes, Jingles and Ditties* (p. 25)

Holp Shuppan. Tokyo, Japan. 1981

**Berkeley, Edmund C.** 1909–88

American computer theoretician

The moment you have worked out an answer, start checking it – it probably isn't right.

Right Answers – A Short Guide for Obtaining Them

*Computers and Automation*, Volume 18, Number 10, September, 1969 (p. 20)**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

Tew kno exackly whare the sighn iz, multiply the day ov the month bi the sighn, then find a dividend that will go into a divider four times without enny remains, subtrakt this from the sighn, add the fust quoshunt tew the last divider, then multiply the whole ov the man's boddy bi all the sighns, and the result will be jist what yu are looking after.

*Old Probability: Perhaps Rain – Perhaps Not*

Signs of the Zodiac

G.W. Carleton &amp; Company, Publishers. New York, New York, USA. 1879

**Bloch, Felix** 1905–83

American physicist and educator

Erwin with his psi can do  
Calculations quite a few.  
But one thing has not been seen  
Just what psi really mean.

In John D. Barrow

*The World Within the World* (p. 141)

Clarendon Press. Oxford, England. 1988

**Bolton, Henry Carrington** 1843–1903

American chemist, bibliographer, and historian

In his calculations the chemist relies on the supposed chemical relations of the invisible, intangible, and immeasurable particles he calls atoms. These relations

have been determined by others in whom he has confidence, and the accuracy of these constants has to be accepted on faith.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 8 (p. 115)

Longmans. London, England. 1967

**Buck, Pearl S.** 1892–1973

American writer

“And if hydrogen, what about the hydrogen in sea water? Might not the explosion of the atomic bomb set off an explosion of the ocean itself? Nor was this all that Oppenheimer feared. The nitrogen in the air is also unstable, though less in degree. Might not it, too, be set off by an atomic explosion in the atmosphere?”

“The earth would be vaporized,” I said.

“Exactly,” Compton said, and with what gravity! “It would be the ultimate catastrophe. Better to accept the slavery of the Nazis than to run the chance of drawing the final curtain on mankind!”

Again Compton took the lead in the final decision. If, after calculation, he said, it were proved that the chances were more than approximately three to one million that the earth would be vaporized by the atomic explosion, he would not proceed with the project. Calculation proved the figures slightly less – and the project continued.

The Bomb – The End of the World?

*American Weekly*, March 8, 1959**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

The real dilemma, which I have had to face, is this: given that the brain is in so wakeful a condition that, do what I will, I am certain to remain awake for the next hour or so, I must choose between two courses, viz. either to submit to the fruitless self-torture of going through some worrying topic, over and over again, or else to dictate to myself some topic sufficiently absorbing to keep the worry at bay. A mathematical problem is, for me, such a topic; and is a benefit, even if it lengthens the wakeful period a little. I believe that an hour of calculation is much better for me than half-an-hour of worry.

*Curiosa Mathematica* Part I (3rd edition)

Preface to the Second Edition (p. viii)

Macmillan &amp; Co Ltd. London, England. 1894

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

The human story does not always unfold like a mathematical calculation on the principle that two and two make four. Sometimes in life they make five or minus three; and sometimes the blackboard topples down in the middle of the sum and leaves the class in disorder and the pedagogue with a black eye.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
 Calculation (p. 59)  
 George Allen & Unwin Ltd. London, England. 1956

**de Saint-Exupéry, Antoine** 1900–44  
 French aviator and writer

The sailing vessel itself was once a machine born of the calculations of engineers, yet it does not disturb our philosophers. The sloop took its place in the speech of men. There is a poetry of sailing as old as the world. There have always been seamen in recorded time. The man who assumes that there is an essential difference between the sloop and the airplane lacks historic perspective.

*Wind, Sand and Stars*  
 Chapter 3 (p. 72)  
 Reynal & Hitchcock. New York, New York, USA. 1939

**Dickens, Charles** 1812–70  
 English novelist

...with affection beaming in one eye and calculation shining out of the other.

*Martin Chuzzlewit*  
 Chapter VIII (p. 127)  
 Dodd, Mead & Company. New York, New York, USA. 1944

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81  
 English prime minister, founder of Conservative Party, and novelist

Everything in this world is calculation ...

*Sybil, or, The Two Nations*  
 Chapter VI (p. 78)  
 Longmans, Green, & Co. London, England. 1910

**Dobel, Clifford**  
 No biographical data available

It is surely worthy of remembrance, even now, that the most flawless mathematical calculations may sometimes be wholly erroneous.

Translated by Clifford Dobell  
*Antony van Leeuwenhoek and His "Little Animals"*  
 Part II, Chapter II (p. 192)  
 John Bale, Sons, & Danielsson. London, England. 1932

**Einstein, Albert** 1879–1955  
 German-born physicist

Your calculations are correct, but your physics is abominable.

In A. Berger  
*The Big Bang and Georges Lemaitre*  
 Monsignor Georges Lemaitre (p. 370)  
 D. Reidel Publishing Company. Hingham, Massachusetts, USA. 1984

**Eisenhower, Dwight David** 1890–1969  
 34th president of the USA

...these calculations overlook the decisive element: what counts is not necessarily the size of the dog in the fight – it's the size of the fight in the dog.  
 Address to Republican National Committee  
 January 31, 1958

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

Nature hates calculators; her methods are salutatory and impulsive.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: Second Series*  
 Experience (p. 483)  
 The Library of America. New York, New York, USA. 1983

**Fabre, Jean-Henri** 1823–1915  
 French entomologist and author

There was a certain rule of signs which declared that minus multiplied by minus made plus. How I toiled over that wretched paradox! It would seem that the book did not explain this subject clearly, or rather employed too abstract a method. I read, reread, and meditated in vain: the obscure text retained all its obscurity. That is the drawback of books in general: they tell you what is printed in them and nothing more. If you fail to understand, they never advise you, never suggest an attempt along another road which might lead you to the light. The merest word would sometimes be enough to put you on the right track; and that word the books, hidebound in a regulation phraseology, never give you.

Translated by Alexander Teixeira de Mattos  
*The Life of the Fly*  
 Chapter XII (p. 285)  
 Dodd, Mead & Co. New York, New York, USA. 1925

**FitzGerald, Edward** 1809–83  
 English poet

For "IS" and "IS-NOT" though with Rule and Line  
 And "UP-AND-DOWN" by Logic I define,

Of all that one should care to fathom, I  
 Was never deep in anything but – Wine.  
 Ah, but my Computations, People say,  
 Reduced the Year to better reckoning? – Nay,  
 'Twas only striking from the Calendar  
 Unborn To-morrow and dead Yesterday.

*The Rubaiyat of Omar Khayyam*  
 Stanza LVI & LVII  
 Thomas Y. Crowell & Company. New York, New York, USA. 1800

**Galois, Evariste** 1811–32  
 French mathematician

Since the beginning of the century, computational procedures have become so complicated that any progress

by those means has become impossible, without the elegance which modern mathematicians have brought to bear on their research, and by means of which the spirit comprehends quickly and in one step a great many computations. It is clear that elegance, so vaunted and so aptly named, can have no other purpose...

Go to the roots, of these calculations! Group the operations. Classify them according to their complexities rather than their appearances! This, I believe, is the mission of future mathematicians. This is the road on which I am embarking in this work.

In R. Bourgne and J.P. Azra

*Ecrits et Memoires Mathematiques d' Evariste Galois*

Preface

Gauthiers-Villars, Paris, France. 1962

### Gay-Lussac, Joseph Louis 1778–1850

French chemist and physicist

To be in a position to discover the laws which link phenomena together, it is important to make use of the very powerful instrument of calculation (“*le calcul*”) by means of which one may more easily grasp the relations between bodies.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 62)

Cambridge University Press, Cambridge, England. 1978

...we are perhaps not far removed from the time when we shall be able to submit the bulk of chemical phenomena to calculation.

Read before the Philomath Society December 31, 1808

Memoir on the Combination of Gaseous Substances with Each Other

### Graham, L. A.

No biographical data available

The professor went to the board one day  
And posed to his students, just for fun,  
The question, “What is the only way  
To link e, i, p, zero and one?”  
Up spake little Euclid, our DIAL hero,  
Who handles de Moivre with infinite ease,  
“Sure,  $ei\pi + 1 = 0$ ,  
Give us a hard one. Next question, please!”

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 21

Dover Publications, Inc. New York, New York, USA. 1959

Jack be nimble, Jack be quick,  
Jack jump over the candlestick,  
But figure out b and also time T,  
“a” due to gravity, velocity V,  
And don’t forget  $y = VT \sin b$   
Minus  $1/2 a T^2$ , or you’ll regret later.  
Figure trajectory right to the inch  
Or it might be a “sing” instead of a cinch!

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 10

Dover Publications, Inc. New York, New York, USA. 1959

### Heisenberg, Werner Karl 1901–1976

German physicist and philosopher

If one finds a difficulty in a calculation which is otherwise quite convincing, one should not push the difficulty away; one should rather try to make it the centre of the whole thing.

In Jagdish Mehra and Helmut Rechenberg

*The Historical Development of Quantum Theory* (Volume 3)

The Formulation of Matrix Mechanics and Its Modifications, 1925–1926 (p. 94)

Springer-Verlag, New York, New York, USA. 1982

### Hesiod ca. 700 BCE

Greek pastoral poet

...they do not how much more the half is than the whole.

Translated by M.L. West

*Theogony and Work and Days*

Works and Days (p. 38)

Oxford University Press, Inc. Oxford, England. 1999

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

Who can calculate the passage of a particle?

*Les Miserables*

Volume IV, Book III, Chapter 3 (p. 67)

The Heritage Press, New York, New York, USA. 1938

### Huxley, Aldous 1894–1963

English writer and critic

The demon of calculation possesses the mind.

*Along the Road*

Part II, Views of Holland (p. 105)

Nan’-do. Tokyo, Japan. 1954

### Johnson, Samuel 1696–1772

English critic, biographer, and essayist

...Nay, Madam, when you are declaiming, declaim; and when you are calculating, calculate.

Quoted in James Boswell

*The Life of Samuel Johnson*

April 26, 1776

Everyman’s Library. London, England. USA. 1906

### Mulliken, R. S.

No biographical data available

...the more accurate the calculations became, the more the concepts tended to vanish into thin air.

Molecular Scientists and Molecular Science: Some Reminiscences

*The Journal of Chemical Physics*, Volume 43, Number 10, 15 November, 1965 (p. S2)

### Nietzsche, Friedrich Wilhelm 1844–1900

German philosopher

No more fiction for us: we calculate; but that we may calculate, we had to make fiction first.

In Tobias Dantzig  
*Number: The Language of Science* (4th edition)  
 Chapter Eight (p. 139)  
 The Macmillan Company, New York, New York, USA. 1954

**Novalis (Friedrich von Hardenberg)** 1772–1801  
 German poet

There may be mathematicians of the first order who cannot make calculations. A man may be a great calculator, and yet never dream of mathematics.

Quoted in Panthea  
*The Reasoner*  
 Eclectic Gatherings  
 Volume 6 1849 (p. 374)

**Peirce, Benjamin** 1809–80  
 American mathematician

...you cannot think that any man, with a man's soul in his body, could devote his life to the drudgery of addition, subtraction, multiplication, and division, for the mere pleasure of the thing.

*Ideality in the Physical Sciences*  
 Lecture I (p. 10)  
 Little, Brown & Co. Boston, Massachusetts, USA. 1881

**Plato** 428 BCE–347 BCE  
 Greek philosopher

He who can properly define and divide is to be considered a god.

In Francis Bacon  
*Novum Organum*  
 Second Book, Section 26 (p. 157)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I can show you that the art of computation has to do with odd and even numbers in their numerical relations to themselves and to each other.

*Charmides*  
 Section 166 (p. 8)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49  
 American short story writer

...to calculate is not in itself to analyze.

*The Complete Edgar Allan Poe Tales*  
*The Murders in the Rue Morgue*  
 Avenel Books. New York, New York, USA. 1980

**Pohl, Frederik** 1919–  
 American science fiction writer

I sat down in the back, calculating as best I could. Number forty-two. Say, at the most optimistic, an average of a minute and a half a case. That meant the judge would get to me in a little over an hour.

*The Coming of the Quantum Cats*  
 August 18, 1983, 11:15 A.M. Nicky DeSota (p. 21)  
 Bantam Books. Toronto, Ontario, Canada. 1986

**Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana)** 1863–1952  
 Spanish-born American philosopher

...it is a pleasant surprise to him [the mathematician], and an added problem, if he finds that the arts can use his calculations, or that the senses can verify them; much as if a composer found that the sailors could have better when singing his songs.

*Some Turns of Thought in Modern Philosophy*  
 Chapter III (pp. 50–51)  
 Books for Libraries Press. Freeport, New York, USA. 1967

**Shaw, George Bernard** 1856–1950  
 Irish comic dramatist and literary critic

And nobody can get far without at least an acquaintance with the mathematics of probability, not to the extent of making its calculations and filling examination papers with typical equations, but enough to know when they can be trusted, and when they are cooked. For when their imaginary numbers correspond to exact quantities of hard coins unalterably stamped with heads and tails, they are safe within certain limits; for here we have solid certainty...but when the calculation is one of no constant and several very capricious variables, guesswork, personal bias, and pecuniary interests, come in so strong that those who began by ignorantly imagining that statistics cannot lie end by imagining, equally ignorantly, that they never do anything else.

In James R. Newman (ed.)  
*The World of Mathematics* (Volume 3)  
 The Vice of Gambling and the Virtue of Insurance (p. 1531)  
 Simon & Schuster. New York, New York, USA. 1956

**Thurber, James** 1894–1961  
 American writer and cartoonist

...I have figured for you the distance between the horns of a dilemma, night and day, and A and Z. I have computed how far is Up, how long it takes to get Away, and what becomes of Gone. I have discovered the length of the sea serpent, the price of priceless, and the square of the hippopotamus. I know where you are when you are at Sixes and Sevens, how much Is you have to have to make an Are, and how many birds you can catch with the salt in the ocean – 187,796,132, if it would interest you?  
 “There aren't that many birds,” said the King.  
 “I didn't say there were,” said the Royal Mathematician.  
 “I said if there were.”

*Many Moons*  
 Harcourt Brace & Company. San Diego, California, USA. 1971

**Verne, Jules** 1828–1905  
 French novelist

Either my calculation is correct, or there is no truth in figures.



*A Journey to the Center of the Earth*

Chapter 15 (p. 104)

The Limited Editions Club. New York, New York, USA. 1966

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

He resumed: “In order to ascertain the height of the tree I must be in such a position that the top of the tree is exactly in a line with the top of a measuring stick or any straight object would do, such as an umbrella which I shall secure in an upright position between my feet. Knowing then that the ratio that the height of the tree bears to the length of the measuring stick must equal the ratio that the distance from my eye to the base of the tree bears to my height, and knowing (or being able to find out) my height, the length of the measuring stick and the distance from my eye to the base of the tree, I can, therefore, calculate the height of the tree.”

“What is an umbrella?”

*Mr. Fortune's Maggot*

Mr. Fortune's Maggot (p. 115)

New York Review of Books. New York, New York, USA. 1927

**Weinberg, Gerald M.** 1933–

No biographical data available

Before you can count on anything, you've got to know something.

*Rethinking Systems Analysis and Design*

Part II, What Is the System – and Why Does the Question Count? (p. 32)

Little, Brown & Company. Boston, Massachusetts, USA. 1982

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

The process of calculating brings about just this intuition.

Calculation is not an experiment.

Translated by D.F. Pears and B.F. McGuinness

*Tractatus Logico-Philosophicus*

6.2331 (p. 134)

Routledge & Kegan Paul. London, England. 1961

## CALCULUS

### Author undetermined

Alcohol and calculus don't mix. Never drink and derive.

Source undetermined

O Lord, hear my anxious plea

Calculus is killing me

I know not of 'dx' or 'dy'

And probably won't until the day I die.

Please, Lord, help me in this hour

As I take my case to the highest power.

I care not for fame or loot

Just help me find one square root.

And Lord, please let me see

One passing mark in organic chemistry.

Oh such a thing I constantly dread

I'd just as soon join the Marines instead.

Lord, please give me a sign

That you've been listening all the time.

Please lead me out of this constant coma

And give me a shot at my diploma.

Source undetermined

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

It may be emphasized once for all that a close description of how mathematics handles the problem of continuous change is neither possible nor desirable in a first approach. Further, to turn aside for a moment if I may be allowed to vent a heretical opinion, I strongly disbelieve in ever giving either engineers or mathematical physicists a rigorous course in the calculus – the mathematics of continuous change. By rigorous I mean going right down to the ambiguous logical roots of the number system. Any professional mathematician who is not also an analytical bigot knows that the foundations of analysis are in a terrible mess. And any scientifically literate mathematician who follows what mathematical physicists are doing with this analysis, and who criticizes them for their bold use of their dangerous mathematical machinery, proclaims himself a mathematical bigot of the first magnitude.

*The Handmaiden of the Sciences*

Chapter 4 (pp. 62–63)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Berlinski, David** 1942–

American mathematician

If science begins in awe as the eye extends itself throughout the cold of space, past the girdle of Orion and past the galaxies pinwheeling on their axes, then in the calculus mankind has created an instrument commensurate with its capacity to wonder.

*A Tour of the Calculus*

Introduction (pp. xi–xii)

Pantheon Books. New York, New York, USA. 1995

The overall structure of the calculus is simple. The subject is defined by a fantastic leading idea, one basic axiom, a calm and profound intellectual invention, a deep property, two crucial definitions, one ancillary definition, one major theorem, and the fundamental theorem of the calculus.

*A Tour of the Calculus*

The Frame of the Book (p. xvii)

Pantheon Books. New York, New York, USA. 1995

If the calculus is much like a cathedral, its construction the work of centuries, it remained until the nineteenth century a cathedral suspiciously suspended in midair, the thing simply hanging there, with no one absolutely convinced that one day the gorgeous and elaborate structure

would not come crashing down and fracture in a thousand pieces.

*A Tour of the Calculus*

Chapter 8 (p. 49)

Pantheon Books. New York, New York, USA. 1995

...the calculus serves to demonstrate with an eerie aptness the extent to which ordinary concepts are not ordinary at all. Simple speed seems a concept on the margins of the infinite, and yet the strangest thing of all, stranger by far than those black holes in space, is the fact that the cat's cradle of words that Cauchy offered the world [as a definition of limit] is sufficient to purge speed of its paradoxes.

*A Tour of the Calculus*

Chapter 14 (p. 119)

Pantheon Books. New York, New York, USA. 1995

**Boas, Jr., Ralph P.** 1913–92

Mathematician

Rewards in Math are plenty

But this obstacle looms big:

How can you shine in calculus

If you won't learn any trig?

Reprinted in Ralph P. Boas, Jr.

*Lion Hunting and Other Mathematical Pursuits* (p. 102)

Mathematical Association of America. Washington, D.C. 1995

### Cambridge Conference on School Mathematics

The calculus is one of the grandest edifices constructed by mankind.

*Goals for School Mathematic* (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1963

**Condorcet, Marie Jean** 1743–94

French philosopher and mathematician

[All phenomena] are equally susceptible of being calculated, and all that is necessary, to reduce the whole of nature to laws similar to those which Newton discovered with the aid of the calculus, is to have a sufficient number of observations and a mathematics that is complex enough.

Quoted in Frank Edward Manuel

*The Prophets of Paris* (p. 65)

Harper & Row Publishers. 1965

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

The calculus is to mathematics no more than what experiment is to physics, and all the truths produced solely by the calculus can be treated as truths of experiment.

Quoted in Michael S. Mahoney

In David C. Lindberg and Robert S. Westman

*Reappraisals of the Scientific Revolution*

Infinitesimals and Transcendent Relations: The Mathematics of Motion in the Late Seventeenth (p. 489, fn 46)

Century

Cambridge University Press. Cambridge, England. 1990

**de Morgan, Augustus** 1806–71

English mathematician and logician

There are no limits in mathematics, and those that assert there are, are infinite ruffians, ignorant, lying blackguards. There is no differential calculus, no Taylor's theorem, no calculus of variations, &c. in mathematics. There is no quackery whatever in mathematics...

*A Budget of Paradoxes*

John Walsh's Delusion (p. 155)

Longmans, Green. London, England. 1872

**Fredrickson, Hal**

No biographical data available

Hooray for calculus.

Old Newton's rootin' tootin' calculus.

The class were letting delta x near zero

Can make a hero of students.

Teachers will say,

Just take the limit,

Be brief not dim, it's

likely to be finite and you're on your way.

Hooray for Calculus

*Mathematical Magazine*, Volume 61, Number 3, June, 1988 (p. 147)

**Klein, Felix** 1849–1925

German mathematician

Everyone who understands the subject will agree that even the basis on which the scientific explanation of nature rests, is intelligible only to those who have learned at least the elements of the differential and integral calculus, as well as of analytical geometry.

*Jahresbericht der Deutschen Mathematiker Vereinigung*, Volume 11, 1902 (p. 131)

**Kline, Morris** 1908–92

American mathematics professor and writer

Bertrand Russell...wrote in My Philosophical Development, "Those who taught me the infinitesimal calculus did not know the valid proofs of its fundamental theorems and tried to persuade me to accept the official sophistries as an act of faith."

*Mathematics: The Loss of Certainty*

Chapter VII (p. 162)

Oxford University Press, Inc. New York, New York, USA. 1980

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Thus, differential calculus has all the exactitude of other algebraic operations.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter V (p. 45)

John Wiley & Sons. New York, New York, USA. 1902

## Mathematical Sciences Education Board

Although discrete mathematics and statistics provide necessary foundations for computer engineering and social sciences, calculus remains the archetype of higher mathematics. It is a powerful and elegant example of the mathematical method, leading both to major applications and to major theories. The language of calculus has spread to all scientific fields; the insight it conveys about the nature of change is something that no educated person can afford to be without.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Curriculum (pp. 51–52)

National Academy Press. Washington, D.C. 1989

### Modjeski, Ralph 1861–1940

Polish-born American engineer

### Waddell, John Alexander Low 1854–1938

American bridge engineer

Mathematics higher than the calculus is of small value to the engineer, except possibly as a training for the mind . . . The Teaching of Mathematics to Students of Engineering *Science*, New Series, Volume 28, Number 710, August 7, 1908 (p. 165)

### Newman, James Roy 1911–66

Mathematician and mathematical historian

...it is to the definite integral that structural engineers must render thanks for the Golden Gate Bridge, for it rests on this even more than on concrete and steel.

*Mathematics and the Imagination*

Chance and Chanceability – The Calculus (p. 340)

Simon & Schuster. New York, New York, USA. 1940

### O'Brien, Katharine

American mathematician

How dear to my heart are cylindrical wedges,  
when fond recollection presents them once more,  
and boxes from tin by upturning the edges,  
and ships landing passengers where on the shore.  
The ladder that slid in its slanting projection,  
the beam in the corridor rounding the ell,  
the rarest of all in that antique collection  
the leaky old bucket that hung in the well –  
the creaky old bucket, the squeaky old bucket,  
the leaky old bucket that hung in the well.

The Old Oaken Calculus Problem

*The American Mathematical Monthly*, Volume 73, Number 8, October, 1966 (p. 881)

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

The Calculus required continuity, and continuity was supposed to require the infinitely little; but nobody could discover what the infinitely little might be. It was plainly

not quite zero, because a sufficiently large number of infinitesimals, added together, were seen to make up a finite whole. But nobody could point out any fraction which was not zero, and yet not finite. Thus, there was a deadlock.

*Mysticism and Logic: And Other Essays*

Chapter V (p. 82)

Longmans, Green & Co. London, England. 1919

### Thompson, Silvanus P. 1851–1916

English physics professor and author

Considering how many fools can calculate, it is surprising that it should be thought either a difficult or a tedious task for any other fool to learn how to master the same tricks. Some calculus-tricks are quite easy. Some are enormously difficult. The fools who write the textbooks of advanced mathematics – and they are mostly clever fools – seldom take the trouble to show you how easy the easy calculations are. On the contrary, they seem to desire to impress you with their tremendous cleverness by going about it in the most difficult way. Being myself a remarkably stupid fellow, I have had to unteach myself the difficulties, and now beg to present to my fellow fools the parts that are not hard. Master these thoroughly, and the rest will follow. What one fool can do, another can.

*Calculus Made Easy: Being a Very-Simplest Introduction to Those Beautiful Methods of Reckoning Which Are Generally Called by the Terrifying Names of the Differential Calculus and the Integral Calculus* (2nd edition)

Prologue (p. xi)

The Macmillan Company. New York, New York, USA. 1929

### Tolstoy, Leo 1828–1910

Russian writer

If they'd told me at college that other people understood the integral calculus, and I didn't, then pride would have come in. But in this case one wants first to be convinced that one has certain qualifications for this sort of business, and especially that all this business is of great importance.

*Anna Karenina*

Part III, Chapter III (p. 228)

Barnes & Noble Books. New York, New York, USA. 2003

### Weaver, Jefferson Hane

American science author

Calculus is both one of the most intriguing and one of the most intimidating branches of mathematics to the general public. The very word “calculus” suggests an accessibility that is limited to only a chosen few, typically those who wear glasses with thick lenses and keep their pens and pencils neatly arranged in the plastic sheaths of their breast pockets.

*Conquering Calculus: The Easy Road to Understanding Mathematics*

Chapter I (p. 1)

Plenum Press. New York, New York, USA. 1998

If one is happy running the milkshake machine or flipping hamburgers or watching restaurant training films in the back room, then, quite frankly, there is little point in acquiring a knowledge of calculus. Oh, one can impress one's fellow shift members by writing various ominous-looking mathematical symbols on the bathroom walls or by tossing such words as "derivative" and "integral" into everyday conversations, but the ordinary demands of a food management career will probably not involve the knowledge of calculus.

*Conquering Calculus: The Easy Road to Understanding Mathematics*  
Chapter 1 (p. 2)  
Plenum Press. New York, New York, USA. 1998

Liberal arts majors may quibble with the idea that calculus should be studied purely because more and more of our society's better-paying jobs are in industries in which quantitative analysis is required. But we should point out that William Shakespeare must have agreed with the sentiment expressed in this book regarding the value of studying calculus because he never actually wrote a play in which the protagonist said, "Sod the calculus." Nowhere will you find Hamlet asking himself, "To study the calculus or not to study the calculus – that is the question." Nor will you hear Romeo calling up to Juliet on her balcony, urging her to toss aside her calculus book and run away with him.

*Conquering Calculus: The Easy Road to Understanding Mathematics*  
Chapter 1 (p. 3)  
Plenum Press. New York, New York, USA. 1998

## CALORIE

### High school chemistry student

A calorie is the amount of pressure required to push 1 g of water 1°C.

Classroom Emanations  
*Journal of Chemical Education*, Volume 2, Number 7, July, 1925 (p. 611)

## CAMERA

### Iles, George

No biographical data available

Turned to the heavens [the camera], this power to grasp the invisible brings into view a breadth of the universe unseen by the acutest observer using the most powerful telescope.

In *George Isles*  
*The Skies and the Earth*  
Photography of the Skies (p. 80)  
Doubleday, Page & Co. New York, New York, USA. 1902

### Le Corbusier (Charles-Edouard

**Jeanneret)** 1887–1965  
Swiss architect and city planner

Today we are saturated with images. That impassive machine, the camera lens, has gone beyond the human retina. This mechanism fears neither heat nor cold; it is never tired. In consequence, it has the advantage of exceptional sight to such an extent that its products are a revelation to us. They permit us to enter into the mysteries of the cosmos through investigations that our human possibilities could not hope to attain.

*Architecture and the Arts*  
*Daedalus*, Volume 89, Number 1, Winter, 1960 (p. 46)

## CANALS OF MARS

### Lowell, Percival 1855–1916

American astronomer

Girdling their globe and stretching from pole to pole, the Martian canal system not only embraces their whole world, but is an organized entity. Each canal joins another, which in turn connects with a third, and so on over the entire surface of the planet.

*Mars and Its Canals*  
Chapter XXXII (pp. 376–377)  
The Macmillan Co. New York, New York, USA. 1906

## CANDLE

### Faraday, Michael 1791–1867

English physicist and chemist

There is no law under which any part of this universe is governed which does not come into play and is touched upon in these phenomena. There is no better, there is no more open door by which you can enter into the study of natural philosophy, than by considering the physical phenomena of a candle.

*The Chemical History of a Candle* (p. 1)  
Larlin Corporation. Marietta, Georgia. 1978

## CANYON

### Peattie, Donald Culross 1898–1964

American botanist, naturalist, and author

This earth, this third planet from the sun, was lifeless once. The rocks tell that much. There is one place in the world where the complete record is written on a single stone tablet. The Grand Canyon of the Colorado River is a cross section of geologic time. Cut by a master hand, the testimony appears to our eyes marvelously magnified. The strata burn with their intense elemental colors; they are defined as sharply as chapters, and the book is flung wide open. A silver thread of river underscores the bottom-most line, the dark Vishnu schist where no life ever was.

*Flowering Earth*  
Chapter 6 (p. 60)  
G.P. Putnam's Sons. New York, New York, USA. 1939

## CAPRICE

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

[Caprice is] an essential source of branch beauty: being in reality the written story of all the branch's life, – of the theories it formed, the accidents it suffered, the fits of enthusiasm to which it yielded in certain delicious warm springs; the disgusts at weeks of east wind, the mortifications of itself for its friends' sakes; or the sudden and successful inventions of new ways of getting out to the sun.

*Modern Painters* (Volume 5)

Part VI, Chapter 8 (p. 69)

John Wiley & Sons. New York, New York, USA. 1879

## CARBOHYDRATE

**Fischer, Emil Hermann** 1852–1919  
German chemist

And so, progressively, the veil behind which Nature has so carefully concealed her secrets is being lifted where the carbohydrates are concerned.

*Nobel Lectures, Chemistry 1901–1921*

Syntheses in the Purine and Sugar Group

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

## CATALOGUE

**Darwin, Sir George Howard** 1845–1912  
English astronomer and mathematician

A mere catalogue of facts, however, well arranged has never led to any important scientific generalisation.

Address to British Association

*Nature*, Section A, Volume 34, Number 879, September 2, 1886 (p. 420)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Consider what you have in the smallest chosen library. A company of the wisest and wittiest men that could be picked out of all civil countries, in 1,000 years, have set in best order the results of their learning and wisdom. The men themselves were hid and inaccessible, solitary, impatient of interruption, fenced by etiquette; but the thought which they did not uncover to their bosom friend is here written out in transparent words to us, the strangers of another age.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

*Society and Solitude*

Books (p. 190)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Herschel, Friedrich Wilhelm**  
(Sir William) 1738–1822

English astronomer

In this research, it became necessary to look out for proper stars. I took some pains to find out what double stars had been recorded by astronomers, but my situation permitted me not to consult extensive libraries. Nor indeed was it very material; for, as I intended to view the heavens myself, Nature, that great volume appeared to me to contain the best catalogue upon this occasion.

On the Parallax of the Fixed Stars

*Philosophical Transactions of the Royal Society of London*, Volume 72, 1782 (p. 97)

**Melancon, Robert**

No biographical data available

A great public library, in its catalogue and its physical disposition of its books on shelves, is the monument of literary genres.

*World Literature Today*, Spring 1982 (p. 231)

## CATALOGUING

**Margenau, Henry** 1901–97  
American physicist

Much practical good can come from careful cataloguing of reliable knowledge, but the pretense of ultimacy implied by the movement, whose adherents are with few notable exceptions not scientists in the strictest sense, must be exposed as spurious. Science is more than a record of results which can be stated with precision; indeed facts can be so fully certain as to be trivial and uninteresting to science, as most facts are.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 2 (pp. 18–19)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1950

## CATARACT

## FALLS OF MONTMORENCY

**Sears, Robert**

No biographical data available

...the true lover of nature – he who looks with the eye of an enthusiast upon the sublime and the beautiful, as it came from the hand of the Creator – can spend many an hour of pleasure and delight in watching the Montmorency, as it comes rushing and thundering down the steep precipice, sending forth its rainbows of light spray, in token of joy that the rough way is passed over, and that



its waters may afterward roll on in peace and quiet.

*The Wonders of the World*

Cataracts (p. 18)

Robert Sears. New York, New York, USA. 1848

## NIAGARA FALLS

### Sears, Robert

No biographical data available

This the name [Niagara Falls] given to unquestionably the finest and most celebrated waterfalls in the known world. The power of language can give but a very faint and inadequate idea of their imposing grandeur and sublimity.

*The Wonders of the World*

Cataracts (p. 13)

Robert Sears. New York, New York, USA. 1848

## CATASTROPHE

### Gould, Stephen Jay 1941–2002

American paleontologist, evolutionary biologist, and historian of science

[T]he catastrophists were much more empirically minded than [Sir Charles] Lyell. The geologic record does seem to record catastrophes: rocks are fractured and contorted; whole faunas are wiped out .... To circumvent this literal appearance, Lyell imposed his imagination upon the evidence. The geologic record, he argued, is extremely imperfect and we must interpolate into it what we can reasonably infer but cannot see. The catastrophists were the hardnosed empiricists of their day, not the blinded theological apologists.

This View of Life. Catastrophes and Steady State Earth

*Natural History*, Volume 84, Number 2, February, 1975 (pp. 16–17)

In the great debates of early nineteenth century geology, catastrophes followed the stereotypical method of objective science – empirical literalism. They believed what they saw, interpolated nothing, and read the record of the rocks directly.

*Hen's Teeth and Horse's Toes*

The Stinkstones of Oeningen (p. 105)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

It seems the height of antiquated hubris to claim that the universe carried on as it did for billions of years in order to form a comfortable abode for us. Chance and historical contingency give the world of life most of its glory and fascination. I sit here happy to be alive and sure that some reason must exist for “why me?” Or the earth might have been totally covered with water, and an octopus might now be telling its children why the eight-legged God of all things had made such a perfect world for cephalopods. Sure we fit. We wouldn't be here if we didn't. But the world wasn't made for us and it will endure without us.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 14 (p. 206)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

In the bad old days, before men rose from their armchairs to look at rocks in the field, biblical limitations of the Mosaic chronology precluded any understanding of our earth's history.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 5)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

### Vitaliano, Dorothy

American geologist

For unless human nature has changed considerable through the ages, what is considered news, and therefore may be remembered when the normal events of daily life are long forgotten, is the unusual, particularly the violently unusual. And what is more violently unusual than a natural catastrophe?

*Legends of the Earth*

Chapter 2 (p. 11)

Indiana University Press. Bloomington, Indiana, USA. 1973

## CATASTROPHIC PROCESS

### Ager, Derek Victor 1923–98

Geologist

...have been trying to show how I think geology got into the hands of the theoreticians who were conditioned by the social and political history of their day more than by observation in the field.... In other words, we have allowed ourselves to be brain-washed into avoiding any interpretation of the past that involves extreme and what might be termed ‘catastrophic’ processes.

*The Nature of the Stratigraphical Record*. (2nd edition)

Chapter 4 (p. 46)

Macmillan & Company Ltd. London, England. 1981

## CATASTROPHISM

### Huxley, Thomas Henry 1825–95

English biologist

Catastrophism has insisted upon the existence of a practically unlimited bank of force, on which the theorist might draw; and it has cherished the idea of the development of the earth from a state in which its form, and the forces which it exerted, were very different from those we now know. That such difference of form and power once existed is a necessary part of the doctrine of evolution.

*Lay Sermons, Addresses and Reviews*

Chapter XI (p. 242)

Macmillan & Co Ltd. London, England. 1874



## CATHEDRAL

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The Gothic cathedral is a blossoming in stone subdued by the insatiable demand of harmony in man. The mountain of granite blooms into an eternal flower with the lightness and delicate finish as well as the aerial proportions and perspective of vegetable beauty.

*Essays*

History (p. 18)

James Munroe & Co. Boston, Massachusetts, USA. 1841

## CAUSALITY

**Einstein, Albert** 1879–1955

German-born physicist

It is only in the quantum theory that Newton's differential method becomes inadequate, and indeed strict causality fails us. But the last word has not yet been said. May the spirit of Newton's method give us the power to restore unison between physical reality and the profoundest characteristic of Newton's teaching – strict causality.

*Nature*, March 26, 1927 (p. 467)

**Gell-Mann, Murray** 1929–

American physicist

Physical causality can be traced directly to the existence of a simple initial condition of the universe. But how does that initial condition enter into the theory?

*The Quark and the Jaguar: Adventures in the Simple and the Complex* (p. 216)

W.H. Freeman. New York, New York, USA. 1994

**Planck, Max** 1858–1947

German physicist

The law of causality is neither true nor false. It is rather a heuristic principle, a signpost – an in my opinion, our most valuable signpost – to help us find our bearings in a bewildering maze of occurrences, and to show us the direction in which scientific research must advance in order to achieve fertile results.

*Scientific Autobiography and Other Papers*

The Concept of Causality in Physics (p. 149)

Philosophical Library. New York, New York, USA. 1949

## CAUSATION

**Murchison, Roderick Impey** 1792–1871

English geologist

...we should greatly err, if we endeavored to assimilate the intensity of causation of all ancient nature with existing operations.

*Siluria: A History of the Oldest Fossiliferous Rocks and Their Foundations* (3rd edition)

Chapter XX (p. 527)

John Murray. London, England. 1859

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

All philosophers, of every school, imagine that causation is one of the fundamental axioms or postulates of science, yet, oddly enough, in advanced sciences such as gravitational astronomy, the word “cause” never occurs.... The reason why physics has ceased to look for causes is that, in fact, there are no such things. The law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm.

In C.A. Fritz, Jr. (ed.)

*On the Philosophy of Science*

On the Notion of Cause (p. 163)

Bobbs-Merrill. Indianapolis, Indiana, USA. 1965

## CAUSE

**Aristotle** 384 BCE–322 BCE

Greek philosopher

It is evident, then...that all men seem to seek the causes named in the *Physics*, and that we cannot name any beyond these; but they seek these vaguely; and though in a sense they have all been described before, in a sense they have not been described at all. For the earliest philosophy is, on all subjects, like one who lisp, since it is young and in its beginnings.

In *Great Books of the Western World* (Volume 1)

*Metaphysics*

Book I, Chapter 10 (p. 511)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

The art of discovering the causes of phenomena, or true hypotheses, is like the art of deciphering, in which an ingenious conjecture often greatly shortens the road.

Translated by Alfred Gideon Langley

*New Essays Concerning Human Understanding*

Book IV, Chapter XII (p. 526)

The Open Court Publishing Co. Chicago, Illinois, USA. 1916

**Metcalf, Samuel Lytler**

No biographical data available

Nor is it possible that men should avail themselves fully of the powers which are in nature, without knowing the cause of these powers.

*Caloric* (Volume 1)

Preface (p. xiii)

William Pickering. London, England. 1843

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

If all the parts of the universe are interchained in a certain measure, any one phenomenon will not be the effect of a single cause, but the resultant of causes infinitely numerous; it is, one often says, the consequence of the state of the universe the moment before.

Translated by George Bruce Halsted

*The Value of Science*

Part I, Chapter II (p. 33)

The Science Press. New York, New York, USA. 1907

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

To speak of *the* cause of an event is therefore misleading. Any set of antecedents from which the event can theoretically be inferred by means of correlations might be called a cause of the event. But to speak of the cause is to imply a uniqueness which does not exist.

*Mysticism and Logic: And Other Essays*

Chapter VII (p. 136)

Longmans, Green & Co. London, England. 1919

**Shelley, Mary Wollstonecraft** 1797–1851  
English Romantic writer

I paused, examining and analysing all the minutiae of causation ...

*Frankenstein: Or, The Modern Prometheus*

Chapter IV (p. 70)

George Routledge & Sons. London, England. 1888

**Tyndall, John** 1820–93  
Irish-born English physicist

have no reason to believe that the sheep or the dog, or indeed any of the lower animals, feel an interest in the laws by which natural phenomena are regulated. A herd may be terrified by a thunderstorm; birds may go to roost, and cattle return to their stalls, during a solar eclipse; but neither birds nor cattle, as far as we know, ever think of inquiring into the causes of these things. It is otherwise with man.

*Fragments of Science*

Part One

A Lecture to School Masters (p. 362)

P.F. Collier & Son. New York, New York, USA. 1901

**von Liebig, Justus** 1803–73  
German organic chemist

If we do not succeed in discovering causes by our researches, we have no right to create them by the imagination.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter I (p. 17)

Walton & Maberly. London, England. 1859

**Whewell, William** 1794–1866  
English philosopher and historian

...in order to discover the principles on which the mechanical sciences truly rest, we must examine the nature and origin of our knowledge of Causes.

*The Philosophy of the Inductive Sciences: Founded Upon Their History*  
(Volume 1) (2nd edition)

Part I, Book II, Chapter XII (p. 165)

John W. Parker. London, England. 1847

## CAUSE AND EFFECT

**Akenside, Mark** 1721–70  
English poet and physician

Give me to learn each secret cause;  
Let number's figure motion's laws  
Revealed before me stand;  
These to great Nature's secret apply,  
And round the Globe, and through the sky,  
Disclose her working hand.

*The Poetical Works of Mark Akenside*

Hymn to Science in Works of the English Poets

Associated University Presses. Cranbury, New Jersey, USA. 1996

**Aquinas, St. Thomas** 1227?–74  
Dominican philosopher and theologian

The universal cause is one thing, a particular cause another. An effect can be haphazard with respect to the plan of the second, but not of the first. For an effect is not taken out of the scope of one particular cause save by another particular cause which prevents it, as when wood dowsed with water, will not catch fire. The first cause, however, cannot have a random effect in its own order, since all particular causes are comprehended in its causality. When an effect does escape from a system of particular causality, we speak of it as fortuitous or a chance happening...

*Summa Theologiae*

Part I, Question 22. God's Providence, Article 2, Is Everything Subject to Divine Providence?

McGraw-Hill Book Company, Inc. New York, New York, USA. 1975

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Thus, all the action of men must necessarily be referred to seven causes: chance, nature, compulsion, habit, reason, anger, and desire.

*The Art of Rhetoric*

Book I, Chapter X

Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Arthur, Timothy Shay** 1809–85  
American writer

Only a few look at causes, and trace them to their effects.

In Donald A. Koch (ed.)

*Ten Nights in a Bar Room and What I Saw There*  
Night the Fifth  
Harvard University Press. Cambridge, Massachusetts, USA. 1964

**Atherton, Gertrude** 1857–1948  
American novelist

The law of cause and effect does not hide in the realm of the unexpected when intelligent beings go looking for it.  
*Senator North*  
Book II, XXI (p. 240)  
John Lane: The Bodley Head. New York, New York, USA. 1900

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

In the series of things those which follow are always aptly fitted to those which have gone before...  
In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
Book IV, # 45 (p. 267)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Author undetermined

I am not a heretic; I do believe in causality.  
Source undetermined

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The end of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible.  
*New Atlantis* (p. 288)  
D. van Nostrand Company, Inc. New York, New York, USA. 1942

**Bergson, Henri** 1859–1941  
French philosopher

...the present contains nothing more than the past, and what is found in the effect was already in the cause.  
Translated by Arthur Mitchell  
*Creative Evolution*  
Chapter I (p. 17)  
The Modern Library. New York, New York, USA. 1944

**Bernard, Claude** 1813–78  
French physiologist

First causes are outside the realm of science; they forever escape us in the sciences of living as well as in those of inorganic bodies.  
Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter I, Section iv (p. 66)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Boole, George** 1815–64  
English mathematician

So to apprehend in all particular instances the relation of cause and effect, as to connect the two extremes in thought according to the order in which they are

connected in nature (for the *modus operandi* is, and must ever be, unknown to us), is the final object of science.

*An Investigation of the Law of Thought*  
Chapter XX (p. 320)  
Dover Publications, Inc. New York, New York, USA. 1951

**Burnet, Thomas** 1635–1715  
English cleric and scientist

There is nothing doth more awaken our thoughts or excite our minds to enquire into the causes of such things, than the actual view of them; as I have had experience myself when it was my fortune to cross the Alps and Apennine Mountains; for the sight of those wild, vast and indigested heaps of Stones and Earth, did so deeply strike my fancy, that it was not easier till I could give myself some tolerable account how that confusion came in Nature.  
*The Sacred Theory of the Earth* (2nd edition)  
Book I, Chapter XI (p. 110)  
Printed by R. Norton. London. 1691

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

There is no nobler aspiration of the human intellect than desire to compass the cause of things. The disposition to find explanations and to develop theories is laudable in itself. It is only ill use that is reprehensible. The vitality of study quickly disappears when the object sought is a mere collection of dead unmeaning facts.  
The Method of Multiple Working Hypotheses  
*Science*, Volume 148, Number 3671, 7, 1965 (p. 755)

**Chuang Tzu** 4th or 3rd century BCE  
Taoist philosopher

Everything can be a “that”; everything can be a “this.” One man cannot see things as another sees them.... Therefore it is said “That” comes from “this” and “this” comes from “that” – which means “that” and “this” give birth to one another.  
Translated by Gia-Fu Feng and Jane English  
*Chuang-Tzu: Inner Chapters*  
Chapter Two (p. 29)  
Alfred A. Knopf. New York, New York, USA. 1974

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

The Causes of events are ever more interesting than the events themselves.  
*Epistolae ad atticum*  
Book IX, Section 5  
Belles Lettres. Paris, France. 1984

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

We know the effects of many things, but the causes of few; experience, therefore, is a surer guide than imagination, and inquiry than conjecture.  
*Lacon; or Many Things in a Few Words* (p. 111)  
William Gowans. New York, New York, USA. 1849

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

There is no result in nature without a cause; understand the cause and you will have no need for the experiment.

*Leonardo da Vinci's Note Books*  
Of the Intellectual Life (p. 54)  
Duckworth & Company. London, England. 1906

**Spinoza, Baruch de** 1632–77  
Dutch philosopher

I understand that to be CAUSE OF ITSELF (*causa sui*) whose essence involves existence and whose nature cannot be conceived unless existing.

*Ethics*  
Concerning God, Definition I  
J.M. Dent & Sons Ltd. London, England. 1941

...all men are born ignorant of the causes of things, and... all have a desire of acquiring what is useful...

*Ethics*  
Concerning God, Appendix  
J.M. Dent & Sons Ltd. London, England. 1941

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81  
English prime minister, founder of Conservative Party, and novelist

But great things spring from causalities.

*Sybil, or The Two Nations*  
Book V, III (p. 345)  
T.A. Contall Ltd. Edinburgh, Scotland. 1927

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

...you have erred perhaps in attempting to put colour and life into each of your statements, instead of confiding yourself to the task of placing upon record that severe reasoning from cause to effect which is really the only notable feature about the thing.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of the Copper Beeches* (p. 114)  
Wings Books. New York, New York, USA. 1967

A coincidence! Here is one of the three men who we had named as possible actors in this drama, and he meets a violent death during the very hours when we know that the drama was being enacted. The odds are enormous against its being a coincidence. No figures could express them. No, my dear Watson, the two events are connected – must be connected. It is for us to find the connection.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Adventure of the Second Stain* (p. 308)  
Wings Books. New York, New York, USA. 1967

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

Happy the man, who studying Nature's laws,  
Through known effects can trace the secret cause –  
His mind, possessing in a quiet state,  
Fearless of fortune and resigned to fate.

*The Poetical Works of Dryden*  
Translation of Virgil, The Second Book of the Georgics  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Yea, the first Morning of Creation wrote  
What the Last Dawn of Reckoning shall read.

*The Nature of the Physical World*  
Chapter XIV (p. 293)  
The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955  
German-born physicist

In classical mechanics, and no less in the special theory of relativity, there is an inherent epistemological defect which was, perhaps for the first time, clearly pointed out by Ernst Mach.... No answer can be admitted as epistemologically satisfactory, unless the reason given is an observable fact of experience. The law of causality has not the significance of a statement as to the world of experience, except when observable facts ultimately appear as causes and effects.

*The Principles of Relativity* (pp. 112–113)  
Cambridge University Press. Cambridge, England. 1922

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Some play at chess, some at cards, some at the Stock Exchange. I prefer to play at Cause and Effect.

*The Journals of Ralph Waldo Emerson* (p. 234)  
Random House, Inc. New York, New York, USA. 1960

Shallow men believe in luck, believe in circumstances.... Strong men believe in cause and effect.

*Ralph Waldo Emerson: Essays and Lectures*  
*The Conduct of Life*  
Worship (p. 1065)  
The Library of America. New York, New York, USA. 1983

Cause and effect, the chancellors of God.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: First Series*  
Prudence (p. 282)  
The Library of America. New York, New York, USA. 1983

Cause and effect, means and ends, seed and fruit, cannot be severed; for the effect already blooms in the cause; the end preexists in the means, the fruit in the seed.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: First Series*  
Compensation (p. 290)  
The Library of America. New York, New York, USA. 1983

Do not clutch at sensual sweetness until it is ripe on the slow tree of cause and effect.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: First Series*  
 Prudence (p. 360)  
 The Library of America. New York, New York, USA. 1983

Cause and effect are two sides of one fact.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: First Series*  
 Circles (p. 410)  
 The Library of America. New York, New York, USA. 1983

Shallow men believe in luck, believe in circumstances:  
 It was somebody's name, or he happened to be there at  
 the time, or, it was so then, and another day it would have  
 been otherwise. Strong men believe in cause and effect.

*The Conduct of Life*  
 Worship (p. 173)  
 Houghton Mifflin Co. Boston, Massachusetts, USA. 1894

**Empiricus, Sextus** fl. Second century AD  
 Medical doctor and teacher

...if there were no causes, everything would come from  
 everything, and by chance. For example, perhaps horses  
 would come from mice, and elephants from ants; and in  
 Egyptian Thebes there would have been rainstorms and  
 snow and the south would have no rain, if there had not  
 been a cause on account of which the south is stormy in  
 winter, and the east is dry.

Translated by Benson Mates  
*The Skeptic Way: Sextus Empiricus's Outlines of Pyrrhonism*  
 Sextus Empiricus: Outlines of Pyrrhonism  
 Book III, Section 5 (p. 176)  
 Oxford University Press, Inc. New York, New York, USA. 1996

**Fourier, (Jean Baptiste-) Joseph** 1768–1830  
 French mathematician and physicist

Primary causes are unknown to us; but are subject to  
 simple and constant laws, which may be discovered by  
 observation, the study of them being the object of natural  
 philosophy.

In *Great Books of the Western World* (Volume 43)  
*The Analytical Theory of Heat*  
 Preliminary Discourse (p. 169)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Froude, James Anthony** 1818–94  
 English historian and biographer

Every effect has its cause.

*Short Studies on Great Subjects* (Volume 2)  
 Calvinism (p. 12)  
 Charles Scribner's Sons. New York, New York, USA. 1890

**Heise, David R.** 1937–  
 American sociologist and mathematician

Causation depends on an extraordinary turning of reality  
 at a particular instant such that one event transmutes into  
 another.

*Causal Analysis* (p. 6)  
 John Wiley & Sons, Inc. New York, New York, USA. 1975

**Heisenberg, Werner Karl** 1901–76  
 German physicist and philosopher

The chain of cause and effect could be quantitatively  
 verified only if the whole universe were considered as a  
 single system – but then physics has vanished, and only a  
 mathematical scheme remains. The partition of the world  
 into observing and observed system prevents a sharp  
 formulation of the law of cause and effect.

*The Physical Principles of the Quantum Theory*  
 Translated by Carl Eckhart and Frank C. Hoyt (p. 58)  
 The University of Chicago Press. Chicago, Illinois, USA. 1930

**Holbach, Paul Henri Thiry** 1723–89  
 French philosopher

...it is thus that in the universe everything is connected;  
 it is itself but an immense chain of causes and effects,  
 which flow without ceasing one from the other.

Translated by H.D. Robinson  
*The System of Nature, Or, Laws of the Moral and Physical World*  
 Chapter III (p. 31)  
 J.P. Mendum. Boston, Massachusetts, USA. 1868

**Holmes, Oliver Wendell** 1809–94  
 American physician, poet, and humorist

But he who, blind to universal laws,  
 Sees but effects, unconscious of the causes, –  
*The Complete Poetical Works of Oliver Wendell Holmes*  
 A Metrical Essay  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Hume, David** 1711–76  
 Scottish philosopher and historian

Here is a billiard ball lying on the table, and another  
 ball moving toward it with rapidity. They strike; the  
 ball which was formerly at rest now acquires a motion.  
 This is as perfect an instance of the relations of cause  
 and effect as any which we know either by sensation or  
 reflection.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
 An Abstract of a Treatise of Human Nature (pp. 186–187)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In a word, then, every effect is a distinct event from its  
 cause.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
 Section IV, Part I (p. 460)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

From causes which appear similar we expect simi-  
 lar effects. This is the sum of all our experimental  
 conclusions.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
 Section IV, Part II (p. 462)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



It is universally allowed that nothing exists without a cause of its existence, and that chance, when strictly examined, is a mere negative word, and means not any real power which has anywhere a being in nature.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section VIII, Part I (p. 478)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

All effects follow not with like certainty from their supposed causes.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section X (p. 489)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Huxley, Thomas Henry** 1825–95

English biologist

All that can be ascertained concerning the structure, succession of conditions, actions, and position in space of the earth, is the matter of fact of its natural history. But, as in biology, there remains the matter of reasoning from these facts to their causes, which is just as much science as the other, and indeed more; and this constitutes geological etiology.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

Geological Reform (p. 318)

Macmillan & Company Ltd. London, England. 1904

### **Jackson, Hughlings** 1835–1911

English neurologist

The study of the causes of things must be preceded by the study of things caused.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter One (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **James, William** 1842–1910

American philosopher and psychologist

With earth's first clay they did the last man knead,  
And there of the last harvest sowed the seed.

And the first morning of creation wrote

What the last dawn of reckoning shall read.

The Dilemma of Determinism

*Unitarian Review and Religious Magazine*, Volume XXII, Number 3, September, 1884

As in the night all cats are gray, so in the darkness of metaphysical criticism all causes are obscure.

*The Principles of Psychology* (Volume 1)

Chapter V (p. 140)

Harvard University Press. Cambridge, Massachusetts, US. 1981

### **Kant, Immanuel** 1724–1804

German philosopher

Pure mathematics can never deal with the possibility, that is to say, with the possibility of an intuition answering to

the conceptions of the things. Hence it cannot touch the question of cause and effect, and consequently, all the finality there observed must always be regarded simply as formal, and never as a physical end.

In Ernst Behler (ed.)

*Philosophical Writings*

*The Critique of Judgment*

Critique of Teleological Judgment, p. 63, fn

Continuum. New York, New York, USA. 1986

### **Kepler, Johannes** 1571–1630

German astronomer

Some physical causes are recognized by all; others, by only very few people; indeed, many things exist naturally, but from causes hitherto known to no man. And of the causes, which we know, there are some whose kind and nature we all usually understand, and others whose kind or indirect cause are understood by very few people, or by nobody.

*Fundamentis. Astrologiae Certioribus*

Thesis IV

Prague, Czechoslovakia. 1602

### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

We ought to regard the present state of the universe as the effect of its anterior state and as the cause of the one that is to follow.

*A Philosophical Essay on Probabilities*

Chapter II (p. 4)

Dover Publications, Inc. New York, New York, USA. 1951

An intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it – an intelligence sufficiently vast to submit these data to analysis – it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atoms; for it, nothing would be uncertain and the future, as the past, would be present to its eyes. The human mind offers, in the perfection which it has been able to give to astronomy, a feeble idea of this intelligence.

*A Philosophical Essay on Probabilities*

Chapter II (p. 4)

Dover Publications, Inc. New York, New York, USA. 1951

### **Lee, Hannah Farnham** 1780–1865

American writer

Causes are often disproportionate to effects.

*The Log Cabin, or, the World Before You*

Part the Second

Appleton. Philadelphia, Pennsylvania, USA. 1844

### **Levins, Richard** 1930–

American evolutionary ecologist, biomathematician, and philosopher of science

### **Lewontin, Richard C.** 1929–

American evolutionary geneticist and philosopher of science



Lines of causality run from part to whole, from atom to molecule, from molecule to organism, from organism to collectivity. As in society, so in all of nature, the part is ontologically prior to the whole.

*The Dialectical Biologist*

Introduction (p. 2)

Harvard University Press. Cambridge, Massachusetts, USA. 1985

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

Man is a creature who searches for causes; he could be named the cause-searcher within the hierarchy of minds.

*Lichtenberg: Aphorisms and Letters*

Aphorisms (p. 62)

Jonathan Cape. London, England. 1969

**Lyell, Sir Charles** 1797–1875

English geologist

When we are unable to explain the monuments of past changes, it is always more probable that the difference arises from our ignorance of all the existing agents, or all their possible effects in an indefinite lapse of time, than that some cause was formerly in operation which has ceased to act...

*Principles of Geology* (Volume 1)

Chapter IX (pp. 164–165)

John Murray. London, England. 1830

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

In speaking of cause and effect, we arbitrarily give relief to those elements to whose connection we have to attend in the reproduction of a fact in the respect in which it is important to us. There is no cause nor effect in nature; nature has but an individual existence; nature simply is. Recurrences of like cases in which A is always connected with B, that is, like results under like circumstances, that is again, the essence of the connection of cause and effect, exist but in the abstraction which we perform for the purpose of mentally reproducing the facts.

*The Science of Mechanics* (5th edition)

Chapter IV, Part IV, Section 3 (p. 580)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

To all facts there are laws,  
The effect has its cause, and I mount to the cause.

*Lucile*

Part II, Canto III, Stanza 8

Belford, Clarke & Company. Chicago, Illinois, USA. 1889

**Mill, John Stuart** 1806–73

English political philosopher and economist

The truth that every fact which has a beginning has a cause, is coextensive with human experience.

*A System of Logic, Ratiative and Inductive* (Volume 1)

Book III, Chapter V, Section 1 (p. 363)

Longman, Green, Reader & Dyer. London, England. 1868

**Miller, Hugh** 1802–56

Scottish geologist and theologian

It has been well remarked that writer would be equally in danger or error who would assign very abstruse motives for the conduct of great bodies of men, or very obvious causes for the great phenomena of nature.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Tenth (p. 392)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

Before the effect one believes in other causes than after the effect.

*The Complete Works of Fredrich Nietzsche* (Volume 10)

*The Joyful Wisdom*, III, Number 217

T.N. Foulis. Edinburgh, Scotland. 1910

**Ovid** 43 BCE–17 AD

Roman poet

The cause is hidden, but the enfeebling power of the fountain is well known.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 1)

Book IV, l. 287 (p. 199)

William Heinemann. London, England. 1916

**Pascal, Blaise** 1623–62

French mathematician and physicist

*Rem Viderunt, Causomnon Viderunt*

They saw the thing, but not the cause

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 235

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95

French chemist

All things are hidden, obscure, and debatable if the cause of the phenomena be unknown, but everything is clear if this cause be known.

*The Harvard Classics* (Volume 38)

*The Germ Theory and Its Application to Medicine and Surgery* (p. 366)

P.F. Collier & Son. New York, New York, USA. 1938

**Pettie, George** 1548–89

English writer

Sutch as the cause of everything is, sutch wilbe the effect.

*A Petite Pallace of Pettie His Pleasure* (Volume 1)

Germanicus and Agrippina

AMS Press. New York, New York, USA. 1970

**Plotinus** ca. 205–270  
Egyptian-Roman philosopher

On the assumption that all happens by Cause, it is easy to discover the nearest determinants of any particular act or state to trace it plainly to them.

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Third Ennead I. 1 (p. 78)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Polybius** ca. 203 BCE–120 BCE  
Greek historian

We must rather seek for a cause, for every event whether probable or improbable must have some cause.

*The Histories*

Book II, 38.5

Harvard University Press. Cambridge, Massachusetts, USA. 1960

**Prakash, Satya**  
No biographical data available

If the law of the relation of effect and cause does not exist, then the non-existence of cause will follow also from non-existence of effect. Non-existence of effect is not instrumental towards the non-existence of cause; but non-existence of cause is instrumental towards non-existence of effect.

*Founders of Sciences in Ancient India* (p. 322)

The Research Institute of Ancient Scientific Studies. New Delhi, India. 1965

**Priestley, Joseph** 1733–1804  
English theologian and scientist

One of the most intimate of all associations in the human mind is that of cause and effect. They suggest one another with the utmost readiness upon all occasions; so that it is almost impossible to contemplate the one, without having some idea of, or forming some conjecture about the other.

*The History and Present State of Electricity*

Part III, Section I (p. 441)

Printed for J. Dodsley. London, England. 1767

**Rohault, Jacques** 1618–72  
French philosopher and physicist

Every Effect Presupposes some Cause.

*Rohault's System of Natural Philosophy*

Volume I, Part I, Chapter 5, 6

Johnson Reprint Corporation. New York, New York, USA. 1969

**Rousseau, Jean-Jacques** 1712–78  
Swiss-French philosopher

...for no more by the law of reason than by the law of nature can anything occur without a cause.

Translated by G.D.H. Cole

*The Social Contract*

Book II, Chapter 4

E.P. Dutton & Company. New York, New York, USA. 1950

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

But we are not likely to find science returning to the crude form of causality believed in by Fijians and philosophers of which the type is “lightning causes thunder.”

*The Analysis of Matter*

Chapter XI (p. 102)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

The notion of causality has been greatly modified by the substitution of space–time for space and time.... Thus geometry and causation become inextricably inter-twined.

*The Analysis of Matter*

Chapter XXX (p. 313)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

**Scrope, George Poulett** 1797–1876  
English geologist and political economist

...in the process of argument from effects up to causes, no chain of reasoning can be stronger, no conclusion can be more imperative, than when...we are possessed of a considerable number of facts, all, without one exception, going to support a certain origin, and that not an imaginary species of phenomenon invented for the occasion, but the same which is observed in its continual operation on other spots to produce the same results, and the only one amongst all known natural processes that is capable of producing them.

*Considerations on Volcanoes*

Appendix, Number 2 (pp. 269–270)

W. Phillips & George Yarp. London, England. 1825

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Thou art the cause, and most accursed effect.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Tragedy of King Richard the Third*

Act I, Scene ii, l. 120

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There is occasions and causes why and wherefore in all things.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Life of King Henry the Fifth*

Act V, Scene i, l. 3

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...and now remains

That we find out the cause of this effect,

Or rather say, the cause of this defect,

For this effect defective comes by cause.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*

Act II, Scene ii, l. 100

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thompson, Francis** 1859–1907  
English writer

All things by immortal power,  
Near or far  
Hiddenly  
To each other linked are,  
That thou canst not stir a flower  
Without troubling of a star.

*Complete Poetical Works of Francis Thompson*  
The Mistress of Vision, Stanza XXII  
Boni & Liveright, Inc., Publishers. New York, New York, USA. 1923

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Our last deed, like the young of the land crab, winds its way to the sea of cause and effect as soon as born, and makes a drop there to eternity.

*Journal (Volume 1): 1837–1844*  
March 14, 1838 (p. 38)  
Princeton University Press. Princeton, New Jersey, USA. 1981

**Tolstoy, Leo** 1828–1910  
Russian writer

Man’s mind cannot grasp the causes of events in their completeness, but the desire to find those causes is implanted in man’s soul. And without considering the multiplicity and complexity of the conditions any one of which taken separately may seem to be the cause, he snatches at the first approximation to a cause that seems to him intelligible and says: “This is the cause!”

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
Book Thirteen, Chapter I (p. 563)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tyndall, John** 1820–93  
Irish-born English physicist

Taking our facts from Nature, we transfer them to the domain of thought: look at them, compare them, observe their mutual relations and connections, and bringing them ever clearer before the mental eye, finally alight upon the cause which unites them. This is the last act of the mind, in this centripetal direction in its progress from the multiplicity of facts to the central cause on which they depend. But, having guessed the cause, we are not yet contented. We set out from the center and travel in the other direction. If the guess be true, certain consequences must follow from it, and we appeal to the law and testimony of experiment whether the thing is so. Thus is the circuit of thought completed from without inward, from multiplicity to unity, and from within outward, from unity to multiplicity.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 1)  
Chapter 11 (p. 282)  
D. Appleton & Co. New York, New York, USA. 1896

**Virgil** 70 BCE–19 BCE  
Roman epic, didactic, and idyllic poet

How blest the sage! Whose soul can pierce each cause  
Of changeful Nature, and her wondrous laws.

*The Georgics of Virgil*  
II, (p. 55)  
I Riley. New York, New York, USA. 1808

## CAUTION

**Hogben, Lancelot** 1895–1975  
English zoologist

There is nothing particularly scientific about excessive caution. Cautious explorers do not cross the Atlantic of truth.

*Science for the Citizen: A Self-Educator Based on the Social Background of Scientific Discovery*  
Part I, Chapter VI (p. 337)  
Alfred A. Knopf. New York, New York, USA. 1938

## CAVE

**Cowen, Richard**  
No biographical data available

Caves are wonderful places for lairs  
For sabertooth tigers and bears  
“But try to eject us!”  
Said Homo erectus  
“We need this place for our heirs.”

*History of Life*  
Chapter Nineteen (p. 414)  
Blackwell Scientific Publications. Boston, Massachusetts, USA. 1990

**Shaler, Nathaniel Southgate** 1841–1906  
American geologist

It is the unseen which most attracts us. Therefore, in all times men have speculated as to the contents of the nether earth. Its crevices and caverns afford in their dark recesses a world which the imagination can people at its will.

*Aspects of the Earth: A Popular Account of Some Familiar Geological Phenomena*  
Caverns and Cavern Life (p. 98)  
Charles Scribner’s Sons. New York, New York, USA. 1889

**Teilhard de Chardin, Pierre** 1881–1955  
French Jesuit, paleontologist, and biologist

Caves are the privileged homes of the documents of prehistory.

*The Appearance of Man*  
Chapter I (p. 18)  
Harper and Row, Publishers. New York, New York, USA. 1965

**CAVERN****Harrington, Thomas**

No biographical data available

If we could descend into the bowels of the Earth, we should there see dark chambers and apartments, strange subterraneous passages, holes and caverns, some filled with smoke and fire, some with water, and some with vapour and mouldy air...

*Science Improved, or The Theory of the Universe*

Section III (p. 18)

Printed for the Author. London, England. 1774

**CAVITY****Davies, Robertson** 1913–95

Canadian novelist

I went to my dentist today in a high state of apprehension. None of my teeth were hurting me, but I know from bitter experience that a tooth of mine can have a cavity as big as the Grotto at Lourdes before it informs me of the fact.

*The Table Talk of Samuel Marchbanks* (p. 202)

Clarke, Irwin. Toronto, Ontario, Canada. 1949

**Walis, Claudia**

No biographical data available

Tooth decay was a perennial national problem that meant a mouthful of silver for patients, and for dentists a pocketful of gold.

Today's Dentistry: A New Drill

*Time*, September 9, 1985 (p. 73)

**CELESTIAL****Aristotle** 384 BCE–322 BCE

Greek philosopher

The glory, doubtless, of the heavenly bodies fills us with more delight than the contemplation of these lowly things, but the heavens are high, and far off, and the knowledge of celestial things that our senses give us, is scanty and dim.

In Edith Hamilton

*The Greek Ways*

Chapter II (p. 32)

W.W. Norton & Company, Inc. New York, New York, USA. 1993

**Smyth, William Henry** 1788–1865

English admiral and scientific writer

Such study [of celestial objects] constitutes a sort of scrutiny into futurity, and truly elevates the mind above the mundane system. We cannot see, without peculiar

emotion, that the great law of gravitation, so recently acknowledged and demonstrated in our own system, is decidedly extended throughout the vast heavens; and it is palpable, that all the perceptible universe is amenable to the operation of time and space, motion and force, in similar relations with our own, and equally open to mathematical disquisition.

*A Cycle of Celestial Objects, Observed, Reduced and Discussed* (p. 680)

At The Clarendon Press. London, England. 1881

**Spinrad, Hyron** 1934–

American astronomer

It is a very human tendency to climb a celestial mountain. So it stands for any race, including that of finding individual objects at greater and greater distances ...

The Most Distant Galaxies

*Astrophysics Update*, August 22, 2003 (p. 6)

**CELESTIAL BODY****Burroughs, John** 1837–1921

American naturalist and essayist

An infinity of celestial bodies ruled by rigidly mechanical laws, going their inevitable rounds at the risk of cosmic collisions and disruptions in which suns and systems are at times shipwrecked, unutterably sublime and awe-inspiring, but lifeless, mindless, unhuman.

*Under The Apple Tree*

The Primal Mind (p. 126)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Morehouse, George Wilkinson** 1840–?

American naturalist

They [celestial bodies] are scattered as lavishly and wastefully as are pollen grains, or the grains of sand on the shores of the ocean. Nature, with infinite resources, can well afford to be prodigal, even of worlds.

*The Wilderness of Worlds*

Chapter IV (p. 21)

Peter Eckler, Publisher. New York, New York, USA. 1898

**CELESTIAL MECHANICS****Lowell, Percival** 1855–1916

American astronomer

Ever since celestial mechanics in the skillful hands of Leverrier and Adams led to the world-amazed discovery of *Neptune* a belief has existed begotten of that success that still other planets lay beyond, only waiting to be found.

*Memoirs* (Volume 1)

A Trans-Neptunian Planet (p. 3)

Thomas P. Nichols & Son. Lynn, Massachusetts, USA. 1915

## CELESTIAL MOTION

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

...we must well grasp the principle of things above, the principle by which the courses of the sun and moon go on, the force by which everything on earth proceeds.

In *Great Books of the Western World* (Volume 12)

*Lucretius: On the Nature of Things*

Book One, l. 124–127 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Milton, John** 1608–74  
English poet

That day, as other solemn dayes, they spent  
In song and dance about the sacred Hill,  
Mystical dance, which yonder starrie Sphere  
Of Planets and of fixt in all her Wheeles  
Resembles nearest, mazes intricate,  
Eccentric, intervovl'd, yet regular  
Then most, when most irregular they seem:  
And in their motions harmonic Divine  
So smooths her charming tones, that God's own ear  
Listens delighted.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book V, l. 618–627

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CELESTIAL SOUND

**Radcliffe, Ann Ward** 1764–1823  
English author

...celestial sounds have sometimes been heard on earth.

*The Mysteries of Udolpho*

Chapter XXVI (p. 270)

Derby & Jackson. New York, New York, USA. 1859

## CENTRAL LIMIT THEOREM

**Massey, William A.**  
No biographical data available

When you are listening to corn pop, are you hearing the Central Limit Theorem?

Correspondence with J. Laurie Snell

*Chance News*, January 9, 1996

## CEREMONY

**Faraday, Michael** 1791–1867  
English physicist and chemist

Ceremony is useless in many cases, and sometimes impertinent; now between you and me it may not be the last, yet I conceive it is the first: therefore I have banished

it at this time.

In Bence Jones

*The Life and Letters of Faraday* (Volume I)

Chapter I (p. 16)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

## CERTAINTY

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...if a man will begin with certainties he shall end in doubts, but if he will be content to begin with doubts, he shall end in certainties.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

First Book, Chapter V, Section 8 (p. 16)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Baggott, Jim**  
Science writer

It is in the nature of theoretical science that there can be no such thing as certainty. A theory is only “true” for as long as the majority of the scientific community maintain the view that the theory is the one best able to explain the observations.

*The Meaning of Quantum Theory*

Chapter 4 (p. 157)

Oxford University Press, Inc. Oxford, England. 1992

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

Oh! let us never doubt  
What nobody is sure about!

*Complete Verse*

The Microbe

Gerald Duckworth. London, England. 1970

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

There is one thing certain, namely that we can have nothing certain; and therefore it is not certain that we can have nothing certain.

*Samuel Butler's Notebooks* (p. 195)

Jonathan Cape. London, England. 1951

**Camus, Albert** 1913–60  
Algerian-French novelist, essayist, and playwright

...we're not sure, we can't be sure. Otherwise, there would be a solution; at least one could get oneself taken seriously.

*The Fall* (p. 74)

Alfred A. Knopf. New York, New York, USA. 1958

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

There is no certainty where one can neither apply any of the mathematical sciences nor any of those which are based upon the mathematical sciences.

In Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I: Life (p. 54)

Duckworth & Co. London, England. 1906

**Dampier-Whetham, William** 1867–1952

English science writer

Sometimes the probability in favor of a generalization is enormous, but the infinite probability of certainty is never reached.

*Science and the Human Mind*

Chapter X

Longmans, Green & Company. New York, New York, USA. 1912

**Froude, James Anthony** 1818–94

English historian and biographer

It was not a PERHAPS; it was a certainty.

*Short Studies on Great Subjects* (Volume 1)

Times of Erasmus, Desiderius and Luther, Lecture I (p. 52)

Longmans, Green & Company. London, England. 1879

**Galsworthy, John** 1867–1933

English novelist and dramatist

If one thing is more certain than another – which is extremely doubtful –

*End of the Chapter*

Maid in Waiting, Chapter 13 (p. 108)

Charles Scribner's Sons. New York, New York, USA. 1937

**Hesiod** ca. 700 BCE

Greek pastoral poet

He is a fool who leaves certainties for uncertainties.

*Fragments*

Frag 18, Quoted by Plutarch, *Moralia*, Section 505D (p. 278)

**Hoffer, Eric** 1902–83

American longshoreman and philosopher

We can be absolutely certain only about things we do not understand.

*The True Believer*

Part 3, Chapter XII, Section 57 (p. 79)

Harper & Row, Publishers, New York 1951

**Holmes, Jr., Oliver Wendell** 1841–1935

American jurist

But certainty generally is illusion, and repose is not the destiny of man.

*The Path of the Law*

*Harvard Law Review*, Volume 10, Number 7, February 25, 1897 (p. 466)

Certitude is not the test of certainty. We have been cocksure of many things that were not so.

*Natural Law*

*Harvard Law Review*, Volume 32, Number 1, November, 1918

Heads I win, Tails you lose.

*The Professor at the Breakfast-Table*

Chapter VIII (p. 252)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Iyer, S. Sandaram**

No biographical data available

Man has two means of attaining certainty – mathematics and common sense.

*Thoughts on the Metaphysics of Theosophy*

*The Paradoxes of the Highest Science*

Synthetic Recapulation (p. 91)

The Calcutta Central Press. Calcutta, India. 1883

Outside complete, universal, and absolute certainty there are only beliefs or opinions.

*Thoughts on the Metaphysics of Theosophy*

Synthetic Recapulation (p. 91)

The Calcutta Central Press. Calcutta, India. 1883

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

Anyone who takes the sure road is as good as dead.

*Memories, Dreams, Reflections*

Chapter X (p. 297)

Vintage Books. New York, New York, USA. 1970

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

Yet I shall not deny that the number of phenomena which are happily explained by a given hypothesis may be so great that it may be taken as morally certain.

*Philosophical Papers and Letters* (Volume 1)

On the Elements of Natural Science (p. 347)

The University of Chicago Press. Chicago, Illinois, USA. 1956

**Locke, John** 1632–1704

English philosopher and political theorist

...the highest probability amounts not to certainty, without which there can be no true knowledge.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book IV, Chapter III, Section 14 (p. 316)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mansfield, Lord, William Murray** 1705–93

Chief justice of England

As mathematical and absolute certainty is seldom to be attained in human affairs, reasoning and public utility require that judges and all mankind in forming their opinion of the truth of facts should be regulated by the superior number of probabilities on the one side or the other.

In Francis Wellman

*The Art of Cross-Examination* (p. 168)

The Macmillan Company. New York, New York, USA. 1923

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

With the idol of certainty (including that of degrees of imperfect certainty or probability) there falls one of the



defences of obscurantism which bar the way of scientific advance. For the worship of this idol hampers not only the boldness of our questions, but also the rigor and the integrity of our tests. The wrong view of science betrays itself in the craving to be right; for it is not his possession of knowledge, of irrefutable truth, that makes the man of science, but his persistent and recklessly critical quest for truth.

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (pp. 280–281)

Basic Books, Inc. New York, New York, USA. 1959

### **Sagan, Carl** 1934–96

American astronomer and science writer

Humans may crave absolute certainty; they may aspire to it; they may pretend, as partisans of certain religions do, to have attained it. But the history of science – by far the most successful claim to knowledge accessible to humans – teaches that the most we can hope for is successive improvement in our understanding, learning from our mistakes, an asymptotic approach to the Universe, but with the proviso that absolute certainty will always elude us. We will always be mired in error. The most each generation can hope for is to reduce the error bars a little, and to add to the body of data to which error bars apply.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 28)

Random House, Inc. New York, New York, USA. 1995

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

Not a resemblance, but a certainty.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Measure for Measure*

Act IV, Scene ii, l. 203

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

I must have certainty. Give it to me; or I will kill you when next I catch you asleep.

*Back to Methuselah*

Part I, Act I (p. 15)

Constable & Company Ltd. London, England. 1921

### **Walker, Marshall John**

American physicist

All predictions are statistical, but some predictions have such a high probability that one tends to regard them as certain.

*The Nature of Scientific Thought*

Chapter VI (p. 70)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

## CHAIN REACTION

### **Compton, Arthur H.** 1892–1962

American physicist

The Italian Navigator has reached the New World.

In Laura Fermi

*Atoms in the Family*

Chapter 19 (p. 198)

University of Chicago Press. Chicago, Illinois, USA. 1954

### **Fermi, Enrico** 1901–54

Italian-born American physicist

Pull it out another foot.... Now the pile will chain-react.

In Laura Fermi

*Atoms in the Family*

Chapter 19 (p. 197)

University of Chicago Press. Chicago, Illinois, USA. 1954

### **Woods, Leona**

When do we become scared?

In Laura Fermi

*Atoms in the Family*

Chapter 19 (p. 197)

University of Chicago Press. Chicago, Illinois, USA. 1954

## CHANCE

### **Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

A tree is known by its fruits – and the fruits of chance are incoherence, incompleteness, unsteadiness, the stammering utterance of blind, unreasoning force.

*Geological Structures*

Chapter I (p. 21)

Ticknor & Fields. Boston, Massachusetts, USA. 1866

### **Ambler, Eric** 1909–98

English novelist

A Frenchman named Chamfort, who should have known better, once said that chance was a nickname for Providence.

*A Coffin for Dimitrios*

Chapter I (p. 1)

Sun Dial Press. New York, New York, USA. 1939

### **Aquinas, St. Thomas** 1227?–74

Dominican philosopher and theologian

In all such beings chance occurs, not in the sense that everything about them occurs by chance, but that in each of them there is room for chance and this very fact is a sign that they are subject to someone's rule.

*Summa Theologiae*

Part I, Question 103, God's Government Taken as a Whole, Article 5,

Whether All Things Are Subject to God's Government

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

To understand the Theory of *Chance* thoroughly, requires a great Knowledge of Numbers, and a pretty competent on of *Algebra*.

*An Essay on the Usefulness of Mathematical Learning* (3rd edition) (p. 20)  
Printed for J. Barrett  
London, England. 1745

**Aron, Raymond** 1905–83  
French sociologist and historian

...rational action is merely a question of calculating the chances.

*The Opium of the Intellectuals*  
Chapter VI (p. 165)  
Secker & Warburg. London, England. 1957

**Astaire, Fred** 1899–1955  
American dancer, actor, and singer

Chance is the fool's name for fate.  
*The Gay Divorcee*  
Film (1934)

### Author undetermined

*Omnium versatur urna serius ocius sors exitura.*

Age at death is a chance variable.  
Source undetermined

No more chance than a snowball in Hell.  
Source undetermined

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Even the effects already discovered are due to chance and experiment, rather than to the sciences; for our present sciences are nothing more than peculiar arrangements of matters already discovered, and not methods for discovery or plans for new operations.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 8 (p. 107)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Men are further beholding...generally to chance, or anything else, than to logic, for the invention or arts and sciences.

In *Great Books of the Western World* (Volume 30)  
*The Advancement of Learning*  
Second Book, Chapter XIII, Section 2 (p. 57)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Games of chance are probably as old as the human desire to get something for nothing; but their mathematical

implications were appreciated only after Fermat and Pascal in 1654 reduced chance to law.

*The Development of Mathematics* (p. 154)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Blake, William** 1757–1827  
English poet, painter, and engraver

Every night and every morn  
Some to misery are born;  
Every morn and every night  
Some are born to sweet delight.

*The Complete Poetry and Prose of William Blake*  
Auguries of Innocence, l. 119–121  
University of California Press. Berkeley, California, USA. 1982

**Boethius, Anicius Manlius Severinus** ca. 475–524  
Roman philosopher and statesman

Then said she, “Think you that this universe is guided only at random and by mere chance? or think you there is any rule of reason constituted in it?”

*The Consolation of Philosophy* (Trans. W.V. Cooper; 1902)  
Book I (p. 22)  
J.M. Dent & Sons Ltd. London, England. 1902

Chance, too which seems to rush along with slack reins, is bridled and governed by law

*The Consolation of Philosophy*  
Book V, Poem I (p. 93)  
Dover Publications. Mineola, New York, USA. 2002

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

Can there be laws of chance? The answer, it would seem should be negative, since chance is in fact defined as the characteristic of the phenomena which follow no law, phenomena whose causes are too complex to permit prediction.

Translated by Maurice Baudin  
*Probabilities and Life*  
Introduction (p. 1)  
Dover Publications. New York, New York, USA. 1962

**Born, Max** 1882–1970  
German-born English physicist

...the conception of chance enters into the very first steps of scientific activity in virtue of the fact that no observation is absolutely correct. I think chance is a more fundamental conception than causality; for whether in a concrete case, a cause–effect relationship holds or not can only be judged by applying the laws of chance to the observation.

*Natural Philosophy of Cause and Chance*  
Chapter VI (p. 47)  
At The Clarendon Press. Oxford, England. 1949

**Bridgman, Percy Williams** 1882–1961  
American physicist

Chance has no meaning except in the setting of order.

*The Nature of Physical Theory*

Chapter IX (p. 123)

Princeton University Press. Princeton, New Jersey, USA. 1936

**Buchner, Ludwig** 1824–99

German physician and philosopher

What we still designate as chance, merely depends on a concatenation of circumstances, the internal connection, and the final causes of which we have as yet been unable to unravel.

*Force and Matter*

The Fitness of Things in Nature (p. 179)

Truth Seeker. New York, New York, USA. 1950

**Buckle, Henry Thomas** 1821–62

English historian

...in the ordinary march of society, an increasing perception of the regularity of nature destroys the doctrine of Chance, and replaces it by that of Necessary Connexion.

*History of Civilization* (Volume 1)

Chapter I (p. 7)

D. Appleton & Co. New York, New York, USA. 1866

**Burroughs, John** 1837–1921

American naturalist and essayist

The collisions and disruptions that take place in the vast depths of sidereal space show that chance takes a hand in the game even there, though the universal law of gravitation is not annulled.

*Under The Apple Tree*

Life and Chance (p. 243)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

There are no rational checks in Nature – all is left to chance; and the scheme works because Nature has all power and all time. There is no other, no rival. The All can go its own way; to play the game, to win and lose – the stakes are Nature’s in any event.

*Under The Apple Tree*

Life and Chance (p. 288)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

It must always be remembered that man’s body is what it is through having been molded into its present shape by the chances and changes of an immense time...

*Erewhon; and Erewhon Revisited*

Chapter XXIV (p. 242)

The Modern Library. New York, New York, USA. 1955

We see but a part, and being thus unable to generalize human conduct, except very roughly, we deny that it is subject to any fixed laws at all, and ascribe much both of a man’s character and actions to chance, or luck, or fortune...

*Erewhon and Erewhon Revisited*

Chapter XXV (p. 246)

The Modern Library. New York, New York, USA. 1955

Quoth She: I’ve heard old cunning Stagers

Say, Fools for Arguments use wagers.”

*The Poetical Works of Samuel Butler* (Volume 1)

The Second Part, Canto I, l. 298–299

Bell & Daldy. London, England. 1835

**Chamfort, Sebastien Roch** 1741–94

French writer

*Quelqu’un disait que la providence strat le nom de bapteme du hasard....* Chance is a nickname of Providence.

*Maximes et Pensées*

I, b. 62

Le Livre de Poche. Paris, France. 1970

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English writer

“Proof!” he cried. Good God! the man is looking for proof! Why, of course, the chances are twenty to one that it has nothing to do with them. But what else can we do? Don’t you see we must either follow one wild possibility or else go home to bed.

*Favorite Father Brown Stories*

The Blue Cross (p. 8)

Dover Publications. New York, New York, USA. 1993

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

...but things that happen by chance cannot be certain.

Translated by William Armistead Falconer

*Cicero: De Senectute, De Amicitia, De Divinatione*

De Divinatione, II, IX (p. 397)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Claude, Albert** 1898–1983

Belgian-American cytologist

Of course, we know the laws of trial and error, of large numbers and probabilities. We know that these laws are part of the mathematical and mechanical fabric of the universe, and that they are also at play in biological processes. But, in the name of the experimental method and out of our poor knowledge, are we really entitled to claim that everything happens by chance, to the exclusion of all other possibilities?

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company. Singapore. 1992

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

As in the game of billiards, the balls are constantly producing effects from mere chance, which the most skillful player could neither execute nor foresee, but which, when they do happen, serve mainly to teach him how much he has still to learn...

*Lacon; or, Many Things in a Few Words* (p. 345)

William Gowans. New York, New York, USA. 1849

**Comfort, Alex** 1920–2000  
English gerontologist and author

One has to be extraordinarily lucky, in our society, to meet one nymphomaniac in a lifetime.

*Darwin and the Naked Lady: Discursive Essays on Biology and Art*  
The Rape of Andromeda (p. 87)  
G. Braziller. New York, New York, USA. 1961

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

And if you ask me how, wherefore, for what reason? I will answer you: Why, by chance! By the merest chance, as things do happen, lucky and unlucky, terrible or tender, important or unimportant; and even things which are neither, things so completely neutral in character that you would wonder why they do happen at all if you didn't know that they, too, carry in their insignificance the seeds of further incalculable chances.

*Chance: A Tale in Two Parts*  
Chapter IV (pp. 99–100)  
Doubleday, Page & Company. New York, New York, USA. 1924

.... Chance, whose ally is Time that cannot be hurried, and whose enemy is Death, that will not wait.

*Lord Jim*  
Chapter XXXIV (p. 278)  
Rinehart & Company, Inc. New York, New York, USA. 1957

**Cowper, William** 1731–1800  
English poet

A fool must now and then be right, by chance.

*The Poetical Works of William Cowper*  
Conversation, l. 96  
John W. Lovell Company. New York, New York, USA. No date

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

When times get tough, true novelty is needed – novelty whose important features cannot be preplanned – and for this we must rely on chance. Chance is the only source of true novelty.

*Life Itself: Its Origin and Nature*  
Chapter 4 (p. 58)  
Simon & Schuster. New York, New York, USA. 1981

**da Costa, J. Chalmers** 1863–1933  
American physician

Even in the tangled threads of what we call “Chance,” there is order, and there was law in the tangling. We don't happen to see the order and know the law, but both are there.

*The Trials and Triumphs of the Surgeon*  
Stepping Stones and Stumbling Blocks (p. 235)  
Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**Dante, Alighieri** 1265–1321  
Italian poet and writer

When the game of hazard is broken up, he who loses remains sorrowful...

*In Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
Purgatory, Canto VI, l. 1–2  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Darwin, Charles Galton** 1809–82  
English naturalist

I cannot anyhow be contented to view this wonderful universe, and especially the nature of man, and to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance.

In Francis Darwin  
*The Life and Letters of Charles Darwin* (Volume 2)  
Darwin to Asa Gray, May 22, 1860 (p. 105)  
D. Appleton & Co. New York, New York, USA. 1887

**Darwin, Charles Robert** 1809–82  
English naturalist

When we look at the plants and bushes clothing an entangled bank, we are tempted to attribute their proportional numbers and kinds to what we call chance. But how false a view this is!

*In Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter III (p. 37)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
C. Darwin to Asa Gray, May 22nd [1860] (p. 105)  
D. Appleton & Company. New York, New York, USA. 1896

I cannot think that the world as we see it is the result of chance; and yet I cannot look at each separate thing as the result of Design.... I am, and shall ever remain, in a hopeless muddle.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
Darwin to Gray, 26 November, 1860 (p. 146)  
D. Appleton & Company. New York, New York, USA. 1896

**de Moivre, Abraham** 1667–1754  
French-born mathematician

...some of the Problems about Chance having a great appearance of Simplicity, the Mind is easily drawn into a belief, that their Solution may be attained by the meer Strength of natural good Sense; Which generally providing otherwise and the Mistakes occasioned thereby being not unfrequent. 'Tis presumed that a Book of this Kind, which teaches to distinguish Truth from what seems nearly to resemble it, will be looked upon as a help to good reasoning.

*The Doctrine of Chances*  
Preface (p. iii)  
Printed for W. Pearson. London, England. 1718

And thus in all cases it will be found, that although Chance produces irregularities, still the Odds will be infinitely great, that in process of Time, those Irregularities will bear no proportion to the recurrency of that Order which naturally results from Original Design.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play* (3rd edition)

A Method of Approximating the Sum of the Terms of the Binomial... (p. 251)

Printed for Millar. London, England. 1756

...there are Writers, of a Class indeed very different from that of James Bernoulli, who insinuate as if the Doctrine of Probabilities could have no place in any serious Enquiry; and that studies of this kind, trivial and easy as they be, rather disqualify a man for reasoning on every other subject. Let the Reader chuse.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play* (3rd edition)

A Method of Approximating the Sum of the Terms of the Binomial... (p. 254)

Printed for Millar. London, England. 1756

**de Morgan, Augustus** 1806–71

English mathematician and logician

Montucla remarked, that if any subject might be expected to baffle the mathematician, it would be *chance*.

Article IV

*The Dublin Review*, Number IV, April, 1837 (p. 338)

...the notion of chance, probability, likelihood, or by whatever name it may be called, is as much of its own nature the object of mathematical reasoning, as force or colour: it contains in itself a distinct application of the notion of relative magnitude; it is *more* or *less*, and the only difficulty (as in many other cases) lies in the assignment of the test of quantity, *how much* more or less.

Article IV

*The Dublin Review*, Number IV, April, 1837

**Democritus of Abdera** 460 BCE–370 BCE

Greek philosopher

Nothing can come into being from that which is not, or pass away into what is not.

In Diogenes Laertius

*Lives of Eminent Philosophers*

Chapter IX

**Disraeli, Benjamin, First Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

If you mean by chance an absence of accountable cause, I do not believe such a quality as chance exists. Every incident that happens, must be a link in a chain.

*Venetia*

Chapter VIII (p. 435)

Longmans, Green & Co. London, England. 1897

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Chance has put in our way a most singular and whimsical problem, and its solution is its own reward.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of the Blue Carbuncle* (p. 467)

Wings Books. New York, New York, USA. 1967

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Be juster, Heaven: such virtue punished thus,  
Will make us think that Chance rules all above,  
And shuffles, with a random hand, the Lots  
Which Man is forc'd to draw.

*The Poetical Works of Dryden*

*All For Love*

Act V

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

The laws of chance have rendered, and will continue to render, immense services to science. It is inconceivable that we could do without them, but they only express an admirable, subjective interpretation of certain inorganic phenomena and of their evolution. They are not a true explanation of objective reality.

*Human Destiny*

Chapter 3 (p. 37)

Longmans, Green & Company. London, England. 1947

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

There was once a brainy baboon,  
Who always breathed down a bassoon,  
For he said "It appears  
That in billions of years,  
I shall certainly hit on a tune."

*New Pathways in Science*

Chapter III, Section IV (p. 62)

The Macmillan Company. New York, New York, USA. 1935

We have swept away the anti-chance from the field of our current physical problems, but we have not got rid of it. When some of us are so misguided as to try to get back milliards of years into the past we find the sweepings piled up high like a high wall, forming a boundary – a beginning of time – which we cannot climb over.

*New Pathways in Science*

Chapter III, Section III (p. 60)

The Macmillan Company. New York, New York, USA. 1935

**Einstein, Albert** 1879–1955

German-born physicist

In our scientific expectation, we have grown antipodes. You believe in God playing and I in perfect laws in the world of things existing as real objects, which I try to grasp in a wildly speculative way.

Letter to Max Born, 7 November, 1944



**Eldridge, Paul** 1888–1982  
American educator

Value depends upon price and price upon chance and caprice.

*Maxims for a Modern Man*  
1855

T. Yoseloff. New York, New York, USA. 1965

**Euripides** ca. 480 BCE–406 BCE  
Greek playwright

Great Jove!

What shall I say? that thou from Heaven look'st down  
Upon mankind, or have they rashly formed

A vain opinion, deeming that the race  
Of gods exists, though fortune governs all?

In *Great Books of the Western World* (Volume 5)

*The Plays of Euripides*

*Hecuba*, l. 486

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Fermi, Enrico** 1901–54  
Italian-born American physicist

A general is a man who takes chances. Mostly, he takes a 50-50 chance; if he happens to win three times in succession he is considered a great general.

In Leo Szilard

*Leo Szilard: His Version of the Facts*

Chapter V (p. 147)

The MIT Press. Cambridge, Massachusetts, USA. 1978

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

The effects of chance are the most accurately calculable, and therefore the least doubtful of all the factors of an evolutionary situation.

Croonian Lecture: Population Genetics

*Proceedings of the Royal Society of London*, Volume 141, 1955 (p. 515)

**Galsworthy, John** 1867–1933  
English novelist and dramatist

It's all chance, but we can't stop now.

*End of the Chapter*

Maid in Waiting, Chapter 28 (p. 229)

Charles Scribner's Sons. New York, New York, USA. 1937

**Guest, Judith** 1936  
American writer

He had left off being a perfectionist then, when he discovered that not promptly kept appointments; not a house circumspectly clean, not even membership in Onwentsa, or the Lake Forest Golf and Country Club, or the Lawyer's Club, not power – not anything – cleared you through the terrifying office of chance; that it is chance and not perfection that rules the world.

*Ordinary People*

Chapter 11 (p. 90)

The Viking Press. New York, New York, USA. 1976

**Helvetius, Claude Adrien** 1715–1771  
French philosopher

...chance, that is, an infinite number of events, with respect to which our ignorance will not permit us to perceive their causes, and the chain that connects them together. Now, this chance has a greater share in our education than is imagined. It is this that places certain objects before us and, in consequence of this, occasions more happy ideas, and sometimes leads us to the greatest discoveries...

*On Mind*

Essay III, Chapter I

Printed for the translator. London, England. 1751

If chance be generally acknowledged to be the author of most discoveries in almost all the arts, and if in speculative sciences its power be less sensibly perceived, it is not perhaps less real...

*On Mind*

Essay III, Chapter IV (p. 331)

Printed for the translator. London, England. 1751

**Herodotus** 484 BCE–432 BCE  
Greek historian

...it is well to bear in mind that chances rule men, and not men chances.

In *Great Books of the Western World* (Volume 6)

*The History of Herodotus*

The Seventh Book, Section 49 (p. 225)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heyward, DuBose**

Roll dem bones...

*Carolina Chansons: Legends of the Low Country*

Gamesters All

Macmillan & Company Ltd. London, England. 1922

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Chance, if such a thing exists, is far-seeing.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter VI (p. 434)

The Heritage Press. New York, New York, USA. 1961

**Hume, David** 1711–76

Scottish philosopher and historian

Though there be no such thing as Chance in the world, our ignorance of the real cause of any event has the same influence on the understanding, and begets a like species of belief or opinion.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section VI (p. 469)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Jevons, William Stanley** 1835–82

English economist and logician



Happily the Universe in which we dwell is not the result of chance, and where chance seems to work it is our own deficient faculties which prevent us from recognizing the operating of Law and of Design.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book I, Chapter I (p. 2)  
Macmillan & Company Ltd. London, England. 1887

**John of Salisbury** ca. 1115–1180  
English author and diplomatist

Chance blows together the atoms into an immense heap so that this very globe of the world comes into being, and so that the elements are fixed in their places under an eternal law.

In John van Laarhoven (ed.)  
*Entheticus Maior and Minor* (Volume One)  
Part II, Section I, Notes from Epicurus, I. 567–569  
E.J. Brill. Leiden, Netherlands. 1987

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

Nothing was ever said with uncommon felicity, but by the cooperation of chance; and therefore, wit, as well as valor must be content to share its honors with fortune.

*The Yale Edition of The Works of Samuel Johnson*  
The Idler and the Adventurer, Idler Number 58  
Yale University Press. New Haven, Connecticut, USA. 1978

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

...chance has not reality in itself; it is only a term fit to designate our ignorance concerning the manner in which the different parts of a phenomenon are arranged among themselves and in relation to the rest of Nature.

In K.M. Baker  
*Condorcet: From Natural Philosophy to Social Mathematics*  
Chapter 3 (p. 168)  
The University of Chicago Press. Chicago, Illinois, USA. 1975

Amid the variable and unknown causes which we comprehend under the name of chance, and which render uncertain and irregular the march of events, we see appearing, in the measure that they multiply, a striking regularity which seems to hold to a design and which has been considered as a proof of Providence.

*A Philosophical Essay on Probabilities*  
Chapter VIII (p. 60)  
John Wiley & Sons. New York, New York, USA. 1902

**Longfellow, Henry Wadsworth** 1807–82  
American poet

I shot an arrow into the air,  
It fell to earth I know not where,  
For so swift it flew, the sight  
Could not follow it in its flight.

*The Poetical Works of Henry Wadsworth Longfellow*  
The Arrow and the Song  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Masters, Dexter** 1908–89  
American writer

“I should estimate,” this scientist was supposed to have said, “that there is one chance in ten nothing will happen with the bomb, and one chance in a hundred that it will ignite the atmosphere.”

*The Accident*  
Part I, Chapter 3 (p. 16)  
Alfred A. Knopf. New York, New York, USA. 1955

But then I was reading in the paper just the other day about one of them saying there wasn't more than one chance in God-knows-what, a trillion maybe, that these Bikini bombs could blow up the world. I said to myself, this seems pretty safe odds. But then I said to myself, hey! how come any odds at all? Who's running this show anyway? I sort of get to wondering every once in a while whether anybody knows the middle and the end of what's going on as well as the beginning.

*The Accident*  
Part VII, Chapter 7 (p. 382)  
Alfred A. Knopf. New York, New York, USA. 1955

**Merz, John Theodore** 1840–1922  
German-born British industrial chemist and philosopher

The study of blind chance in theory and practice is one of the great performances of the nineteenth century.

*A History of European Thought in the Nineteenth Century* (Volume 2)  
(p. 624)  
William Blackwood & Sons. Edinburgh, Scotland. 1903

**Milton, John** 1608–74  
English poet

...that power which erring men call Chance.

*The Poetical Works of John Milton* (Volume 2)  
Comus, I. 587  
AMS Press. New York, New York, USA. 1973

.... Chance governs all.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book II, I. 910  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Monod, Jacques** 1910–76  
French biochemist

...chance alone is at the source of every innovation, of all creation in the biosphere. Pure chance, absolutely free but blind, at the very root of the stupendous edifice of evolution: this central concept of modern biology is no longer one among other possible or even conceivable hypotheses. It is today the sole conceivable hypotheses, the only one that squares with observed and tested fact.... There is no scientific concept, in any of the sciences, more destructive of anthropocentrism than this one, and no other so arouses an instinctive protest from the intensely teleonomic creatures that we are.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*  
Chapter VI (pp. 112–113)  
Vintage Books. New York, New York, USA. 1972

**Motz, Lloyd** 1910–2004  
American astronomer

Thus, the very chance and randomness that prevent man from predicting the future are the tools that nature uses to insure not only the emergence of life in each expansion cycle of the universe but also the approach to perfection and complete harmony as more and complex forms of life evolve.

*The Universe: Its Beginning and End*  
Epilogue (p. 325)  
Charles Scribner's Sons. New York, New York, USA. 1975

**Nietzsche, Friedrich Wilhelm** 1844–1900  
German philosopher

No conqueror believes in chance.

*The Complete Works of Friedrich Nietzsche* (Volume 10)  
*The Joyful Wisdom*, III, Number 217  
T.N. Foulis. Edinburgh, Scotland. 1910

**Paley, William** 1743–1805  
English theologian

There must be chance in the midst of design; by which we mean, that events which are not designed, necessarily arise from the pursuit of events which are designed. One man traveling to York, meets another man traveling to London.

*The Works of William Paley, D.D.*  
*Natural Theology*  
Chapter XXVI (p. 254)  
Ward, Lock & Company. London, England. No date

The appearance of chance will always bear a proportion to the ignorance of the observer.

*The Works of William Paley, D.D.*  
*Natural Theology*  
Chapter XXVI (p. 254)  
Ward, Lock & Company. London, England. No date

**Pasteur, Louis** 1822–95  
French chemist

In the field of experimentation, chance favors only the prepared mind.

In René Dubos  
*Louis Pasteur: Free Lance of Science*  
Chapter IV (p. 101)  
Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Peers, John**  
No biographical data available

Nick the Greek's Law of Life. All things considered, life is 9 to 5 against.

*1001 Logical Laws, Accurate Axioms, Profound Principles, Trusty Truisms, Homey Homilies, Colorful Corollaries, Quotable Quotes, and Rambunctious Ruminations for All Walks of Life* (p. 50)  
Doubleday & Company, Inc. Garden City, New York, USA. 1979

**Plato** 428 BCE–347 BCE  
Greek philosopher

The lover of intellect and knowledge ought to explore causes of intelligent nature first of all, and, second, of those things which, being moved by others, are compelled to move others. And this is what we too must do. Both kinds of causes should be acknowledged by us, but a distinction should be made between those which are endowed with mind and are the workers of things fair and good, and those which are deprived of intelligence and always produce chance effects without order or design.

In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
Section 46 (p. 455)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

CRITO: But you see, Socrates, that the opinion of the many must be regarded, for what is now happening shows that they can do the greatest evil to anyone who has lost their good opinion.

SOC: I only wish it were so, Crito; and that the many could do the greatest evil; for then they would be able to do the greatest good – and what a fine thing this would be! But in reality they can do neither, for they cannot make a man either wise or foolish; and whatever they do is the result of chance.

In *Great Books of the Western World* (Volume 7)  
*Crito*  
Section 44 (p. 214)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

ATHENIAN STRANGER: They say that the greatest and fairest things are the work of nature and of chance, the lesser of art, which, receiving from nature the greater and primeval creations, molds and fashions all those lesser works which are generally termed artificial.

In *Great Books of the Western World* (Volume 7)  
*Laws*  
Book X, 889 (p. 760)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...in human affairs chance is almost everything.

In *Great Books of the Western World* (Volume 7)  
*Laws*  
Book IV, 709 (p. 679)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49  
American short story writer

The history of human knowledge has so uninterruptedly shown that to collateral, or incidental, or accidental events we are indebted for the most numerous and most valuable discoveries, that it has at length become

necessary, in any prospective view of improvement, to make not only large, but the largest allowances for inventions that shall arise by chance.

*Tales of Mystery and Imagination*

The Mystery of Marie Roget (p. 155)

Henry Frowde. London, England. 1902

**Pohl, Frederik** 1919–

American science fiction writer

But from outside there is no knowing which is true. From outside, there is a five-tenths chance that the cat's alive. But a cat can't be five-tenths alive.

*The Coming of the Quantum Cats*

22 August, 1983, 4:20 A.M., Senator Dominic DeSota (p. 69)

Bantam Books. Toronto, Ontario, Canada. 1986

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Every phenomenon, however minute, has a cause; and a mind infinitely powerful, infinitely well-informed about the laws of nature, could have foreseen it from the beginning of the centuries. If such a mind existed, we could not play with it at any game of chance; we should always lose.

*The Foundations of Science*

*Science and Method*, Book I

Chapter IV, Section I (p. 395)

The Science Press. New York, New York, USA. 1913

And first, what is chance? The ancients distinguished between phenomena seemingly obeying harmonious laws, established one and for all, and those which they attributed to chance; these were the ones unpredictable because rebellious to all law. In each domain, the precise laws did not decide everything, they only drew limits between which chance might act. In this conception, the word chance had a precise and objective meaning: what was chance for one was also chance for another and even for the gods.

*The Foundations of Science*

*Science and Method*, Book I

Chapter IV, Section I (p. 395)

The Science Press. New York, New York, USA. 1913

Chance is only the measure of our ignorance.

*The Foundations of Science*

*Science and Method*, Book I

Chapter IV, Section I (p. 395)

The Science Press. New York, New York, USA. 1913

The greatest bit of chance is the birth of a great man. It is only by chance that the meeting of two germinal cells, of different sex, containing precisely, each on its side, the mysterious elements whose mutual reaction must produce the genius. One will agree that these elements must be rare and that their meeting is still more rare. How slight a thing it would have required to deflect from its route the carrying spermatozoon. It would have suffered to deflect it a tenth of a millimeter and Napoleon would not have been born and the destinies of a

continent would have been changed. No example can better make us understand the veritable characteristics of chance.

*The Foundations of Science*

*Science and Method*, Book I

Chapter IV, Section IX (pp. 410–411)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

All chance, direction, which thou canst not see;

All discord, harmony, not understood,

All partial evil, universal good:

And, spite of Pride, in erring Reason's spite,

One truth is clear, "Whatever is, is Right."

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle, I, 289

Houghton Mifflin Company. New York, New York, USA. 1903

**Priestley, Joseph** 1733–1804

English theologian and scientist

...more is owing to what we call chance...than to any proper design or preconceived theory in this business.

*Experiments and Observations on Different Kinds of Air* (Volume 2)

Book IV, Part I, Section I (p. 102–103)

Thomas Pearson. Birmingham, England. 1790

**Reichenbach, Hans** 1891–1953

German philosopher of science

Like pebbles on the beach, biological species are ordered through a selective cause; chance in combination with selection produces order.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 199)

University of California Press. Berkeley, California, USA. 1951

**Quetelet, Adolphe** 1794–1874

Belgian mathematician, astronomer, and statistician

Chance, that mysterious, much abused word, should be considered only a veil for our ignorance; it is a phantom which exercises the most absolute empire over the common mind, accustomed to consider events only as isolated, but which is reduced to naught before the philosopher, whose eye embraces a long series of events and whose penetration is not led astray by variations, which disappear when he gives himself sufficient perspective to seize the laws of nature.

*The Calculus of Probabilities*

Conclusion (p. 230)

Publisher undetermined

**Rey, Jean** 1583–1645

French physician and chemist

...to commit that to chance and adventure would be offensive to the incomparable wisdom of the Author of Nature, who has made nothing therein without weight, number, and measure, and established in it such order that nothing happens fortuitously and without cause.

*Essays of Jean Rey*

Essay XIII 30

William F. Clay. Edinburgh, Scotland. 1895

**Rhinehart, Luke (George Cockcroft)** 1932–

American writer

In the beginning was Chance, and Chance was with God and Chance was God. He was in the beginning with God. All things were made by Chance and without him was not anything made that was made. In Chance was life and the life was the light of men.

*The Dice Man*

Chapter Ninety-Three (p. 410)

The Overlook Press. Woodstock, New York, USA. 2001

**Rohault, Jacques** 1618–72

French philosopher and physicist

Thus we must content ourselves for the most part, to find out how Things may be; without pretending to come to a certain knowledge and determination of what they really are.

*Rohault's System of Natural Philosophy*

Volume I, Part I, Chapter 3

Johnson Reprint Corporation. New York, New York, USA. 1969

**Runyon, Damon** 1884–1946

American newspaperman and writer

I long ago came to the conclusion that all life is 6 to 5 against.

A Nice Place

*Collier's*, 8 September, 1934 (p. 8)

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

There's no such thing as chance;  
And what to us seems merest accident  
Springs from the deepest source of destiny.

*The Death of Wallenstein*

Act II, Scene III

F.A. Nichols. Boston, Massachusetts, USA. 1902

**Schopenhauer, Arthur** 1788–1860

German philosopher

Consider that chance, which, with error, its brother, and folly, its aunt, and malice, its grandmother, rules in this world; which every year and every day, by blows great and small, embitters the life of every son of earth, and yours too.

*Parerga and Paralipomena: Short Philosophical Essays*

Wisdom of Life: Aphorisms

Clarendon Press. Oxford, England. 2000

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

Chance will not do the work – Chance sends the breeze;  
But if the pilot slumbers at the helm,  
The very wind that wafts us toward the port

May dash us on the Shelves – The steersman's part is vigilance,

Blow it or rough or smooth.

*Fortunes of Nigel*

Chapter XXII (p. 320)

Oxford University Press. London, England. 1912

**Selye, Hans** 1907–82

Austrian endocrinologist

Chance is a lady who smiles only upon those who know how to appreciate her artful charms; those connoisseurs she rarely neglects – the secret of the game is art appreciation.

*From Dream to Discovery: On Being a Scientist*

Chapter 3 (p. 92)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...I spake of most disastrous chances...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Othello, The Moor of Venice*

Act I, Scene iii, l. 134

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

You must take your chance,  
And either not attempt to choose at all  
Or swear before you choose, if you choose wrong...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Merchant of Venice*

Act II, Scene i, l. 38

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In terms of choice I am not solely led  
By nice direction of a maiden's eyes;  
Besides, the lottery of my destiny  
Bars me the right of voluntary choosing.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Merchant of Venice*

Act II, Scene i, l. 13

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Give up yourself merely to chance and hazard,  
From firm security.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Anthony and Cleopatra*

Act III, Scene vi, l. 48

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If chance will have me King, why, chance may crown me...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Macbeth*

Act I, Scene iii, l. 143

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shelley, Percy Bysshe** 1792–1822

English poet

Of Fate, and Chance, and God, and Chaos old...

*The Poems of Percy Bysshe Shelley**Prometheus Unbound*, Act II, Scene III, l. 92

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Fate, Time, Occasion, Chance and Change – to these all things are subject.

*The Complete Poetical Works of Percy Bysshe Shelley**Prometheus Unbound*, Act II, Scene IV, l. 119

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Tennyson, Alfred (Lord)** 1809–92

English poet

And grasps the skirt of happy chance...

*Alfred Tennyson's Poetical Works*

In Memoriam A.H.H., Part I, xiv

Oxford University Press, Inc. London, England. 1953

**Terence** 190 BCE–158 BCE

Roman comic dramatist

Blessed be the gods, by whose aid things happen that we wouldn't even dare hope for!

In George E. Duckworth

*The Complete Roman Drama**Phormio*

Act V, Scene 4, l. 757

Random House, Inc. New York, New York, USA. 1942

**The Bible (King James Version)**

... Come, and let us cast lots, that we may know for whose cause this evil is upon us.

Jonah 1:7

**Thierry, Paul Henri, Baron d'Holbach** 1723–89

German-born French philosopher

...chance; a word void of sense, which we always oppose to that of intelligence without attaching to it any certain ideas.

Translated by M. Mirabaud

*System of Nature; or The Laws of the Moral and Physical World*

(Volume First)

Part First, Chapter II (p. 71)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

How many things are now at loose ends! Who knows which way the wind will blow tomorrow.

*The Writings of Henry David Thoreau* (Volume 4)*Paradise (to Be) Regained* (p. 283)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Thucydides** ca. 460 BCE–ca. 400 BCE

Athenian aristocrat

For sometimes the course of things is as arbitrary as the plans of man; indeed this is why we usually blame chance

for whatever does not happen as we expected.

In *Great Books of the Western World* (Volume 6)*The History of the Peloponnesian War*

Book I, 140 (p. 384)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tillotson, John** 1630–94

Archbishop of Canterbury

How often might a man, after he had jumbled a set of letters in a bag, fling them out upon the ground before they would fall into an exact poem, yea, or so much as make a good discourse in prose! And may not a little book be as easily made by chance, as this great volume of the world!

In Charles Dexter Cleveland

*A Compendium of English Literature*

Evidence of A Creator in the Structure of the World (pp. 837–838)

E.C. &amp; J. Biddle &amp; Co. Philadelphia, Pennsylvania, USA. 1860

**Tolstoy, Leo** 1828–1910

Russian writer

Why did it happen in this and not in some other way? Because it happened so!

In *Great Books of the Western World* (Volume 51)*War and Peace*

First Epilogue, Chapter II (p. 646)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tupper, Martin Farquhar** 1810–89

English writer and poet

The mines of knowledge are oft laid bare through the forked hazlewand of chance ...

*Proverbial Philosophy*

26th Of Education (p. 177)

T. Hatchard. London, England. 1856

**Tyndall, John** 1820–93

Irish-born English physicist

Your atoms are individually without sensation, much more are they without intelligence. May I ask you, then, to try your hand upon this problem. Take your dead hydrogen atoms, your dead oxygen atoms, your dead carbon atoms, your dead nitrogen atoms, your dead phosphorus atoms, and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless; observe them running together and forming all imaginable combinations. This, as a purely mechanical process, is seeable by the mind. But can you see, or dream, or in any way imagine, how out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to rise? Are you likely to extract Homer out of the rattling of dice, or the differential calculus out of the clash of billiard-balls?

Supposed quotation by Bishop Butler

*Fragments of Science: A Series of Detached Essays, Addresses, and**Reviews* (Volume 2)

Chapter IX (p. 167)

D. Appleton &amp; Co. New York, New York, USA. 1896



**Whately, Richard** 1787–1863  
English theologian

Chance is a name given, for convenience, to a modification of our own ignorance.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D.*

Apothegm 41 (p. 4)

Longman, Green, Longman, Roberts & Green. London, England. 1865

## CHANGE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

When chemists have brought their knowledge out of their special laboratories into the laboratory of the world, where chemical combinations are and have been through all time going on in such vast proportions, – when physicists study the laws of moisture, of clouds and storms, in past periods as well as in the present, – when, in short, geologists and zoologists are chemists and physicists, and vice versa, – then we shall learn more of the changes the world has undergone than is possible now that they are separately studied.

*Geological Sketches*

Chapter III (p. 73)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1886

**Alexander, Christopher** 1936–  
Austria-born English architect

Even the most aimless changes will eventually lead to well-fitting forms, because of the tendency to equilibrium inherent in the organization of the process. All the agent need do is recognize failures when they occur, and to react to them. And this even the simplest man can do. For although only few men have sufficient integrative ability to invent form of any clarity, we are all able to criticize existing forms. It is especially important to understand that the agent in such a process needs no creative strength. He does not need to be able to improve the form, only to make some sort of change when he notices a failure. The changes may not always be for the better; but it is not necessary that they should be, since the operation of the process allows only the improvements to persist.

*Notes on the Synthesis of Form*

Chapter 4 (pp. 52–53)

Harvard University Press. Cambridge, Massachusetts, USA. 1964

**Allen, Robert Porter** 1905–63  
American author and conservationist

A million years have done little to change the aspect of a hidden pool inside the mangrove. If you don't believe it, crawl with crocodiles and terrapin through the slime and

watch the lowly gastropod leave his smooth track beside yours. A million years have not changed them. Best of all, stay out there at night. You will listen to the silence of centuries and you will hear, as I have, the noiseless murmur of the Pleistocene.

*On the Trail of Vanishing Birds*

Chapter II (p. 19)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1957

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

But the whole vital process of the earth takes place so gradually and in periods of time which are so immense compared with the length of our life, that these changes are not observed, and before their course can be recorded from beginning to end whole nations perish and are destroyed.

In *Great Books of the Western World* (Volume 8)

*Meteorology*

Book I, Chapter 14 (p. 457)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Beattie, James** 1735–1803  
Scottish poet and essayist

Of chance or change O let not man complain,  
Else shall he never, never cease to wail:

For, from the imperial dome, to where the swain

Rears the lone cottage in the silent dale, All feel the  
assault of fortune's fickle gale;

Art, empire, earth itself to change are doom'd;

Earthquakes have raised to heaven the humble vale,

And gulphs the mountain's mighty mass entomb'd,

And where the Atlantic rolls wide continents have  
bloom'd.

*The Minstrel; or, the Progress of Genius* – Book II

G. Routledge. London, England. 1858

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Common experience teaches us that continual, varying change is the order of nature. As the old hymn has it, 'Change and decay in all around I see,' which seems a needlessly pessimistic paraphrase of the dictum of Heraclitus, 'All things flow'.

*The Handmaiden of the Sciences*

Chapter 4 (p. 61)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Bergson, Henri** 1859–1941  
French philosopher

...for a conscious being, to exist is to change, to change is to mature, to mature is to go on creating oneself endlessly.

*Creative Evolution*

Chapter I (p. 7)

Henry Holt & Co. New York, New York, USA. 1911



**Burns, Robert** 1759–96  
Scottish poet

Look abroad through Nature's range  
Nature's mighty law is change.

*The Complete Poetical Works of Robert Burns*  
Inconstancy in Love

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

We now propose to examine those changes which still take place on our globe, investigating the causes which continue to operate on its surface.... This portion of the history of the earth is so much the more important, as it has been long considered possible to explain the more ancient revolutions on its surface by means of these still existing causes.... But we shall presently see that unfortunately this is not the case in physical history; the thread of operations is here broken, the march of nature is changed, and none of the agents that she now employs were sufficient for the production of her ancient works.

*An Essay on the Theory of the Earth*  
Section 8 (p. 44)

Kirk & Mercein. New York, New York, USA. 1818

**de Quincey, Thomas** 1785–1859  
English author

For, listen: – Where now the mightiest of oceans rolls in pacific beauty, once were anchored continents and boundless forests. Where the south pole now shuts her frozen gates inhospitably against the intrusions of flesh, once were probably accumulated the ribs of empires; man's imperial forehead, woman's roseate lips, gleamed upon ten thousand hills; and there were innumerable contributions to antarctic journals almost as good (but not quite) as our own [English].

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 170)  
Adam & Charles Black. Edinburgh, Scotland. 1871

Not otherwise by secular periods, known to us geologically as facts, though obscure as durations, Tellus herself, the planet, as a whole, is forever working by golden balances of change and compensation of ruin and restoration. She recasts her glorious habitations in decomposing them; she lies down for death, which perhaps a thousand times she has suffered; she rises for a new birth, which perhaps for the thousandth time has glorified her disc. Hers is the wedding-garment, hers is the shroud, that eternally is being woven in the loom of palingenesis.

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 171)  
Adam & Charles Black. Edinburgh, Scotland. 1871

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

All change is relative. The universe is expanding relatively to our common material standards; our material

standards are shrinking relatively to the size of the universe. The theory of the "expanding universe" might also be called the theory of the "shrinking atom".

*The Expanding Universe*

Chapter III, Section VI (p. 90)

At the University Press. Cambridge, England. 1952

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

There are no fixtures in nature. The universe is fluid and volatile. Permanence is but a word of degrees. Our globe seen by God is a transparent law, not a mass of facts. The law dissolves the fact and holds it fluid.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

Circles (p. 403)

The Library of America. New York, New York, USA. 1983

**Grainger, Elena**

No biographical data available

Our earth is vigorous with life, and like all living things must change. Change will continue constructively if we allow it to continue, and perhaps therein lies the future role of geologists. They seek to understand scenery of the earth, the life upon it, the resources under its soil and waters, in its rocks, came into being. It is they who can direct the way from destruction to preservation and restoration, restraining humankind from impending or even destroying the immemorial process of change and evolution.

*The Remarkable Reverend Clarke: The Life and Times of the Father of Australian Geology*

Chapter 23 (p. 254)

Oxford University Press, Inc. Melbourne, Australia. 1982

**Hazen, Robert M.**

No biographical data available

Life's most poignant hallmark is inescapable, inexorable change.

*Gen e sis*

Chapter 18 (p. 233)

Joseph Henry Press. Washington, D.C. 2005

**Hertzberger, Herman** 1932–  
Dutch architect

Changes, small ones as well as big, are the sparks that feed fresh impulses to the motor of architecture and keep it ticking over.

*Space and the Architect: Lessons in Architecture 2*

Chapter 3 (p. 52)

Publishers. Rotterdam, The Netherlands. 2000

**Hussey, Russell C.**

No biographical data available

Nothing is static forever in nature; change is going on everywhere.

*Historical Geology: The Geologic History of North America*  
Chapter XXI (p. 445)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1947

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

...from the top of the mountain to the shore of the sea, which are the two extremities of our land, everything is in a state of change; the rock and solid strata dissolving, breaking, and decomposing, for the purpose of becoming soil; the soil traveling along the surface of the earth, in its way to the shore; and the shore wearing and wasting by the agitation of the sea...

*The Theory of the Earth* (Volume 2)  
Part II, Chapter VII (p. 236)  
Messrs. Cadwell, Junior & Davies. London, England. 1795

**Lyell, Sir Charles** 1797–1875  
English geologist

Never was there a dogma more calculated to foster indolence, and to blunt the keen edge of curiosity, than this assumption of the discordance between the ancient and existing causes of change.

In *George Isles*  
*The Skies and the Earth*  
Uniformity in Geological Change (p. 134)  
Doubleday, Page & Co. New York, New York, USA. 1902

When we are unable to explain the monuments of past changes, it is always more probable that the difference arises from our ignorance of all the existing agents, or all their possible effects in an indefinite lapse of time, than that some cause was formerly in operation which has ceased to act...

*Principles of Geology* (Volume 1)  
Chapter IX (p. 164)  
John Murray. London, England. 1830

**Mitchell, Maria** 1818–89  
American astronomer and educator

We may turn our gaze [to other stars] as we turn a kaleidoscope, and the changes are infinitely more startling, the combinations infinitely more beautiful; no flower garden presents such a variety and such delicacy of shades.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter XI (p. 235)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

**Ovid** 43 BCE–17 AD  
Roman poet

All things are in a state of flux, and everything is brought into being with a changing nature. Time itself flows on in constant motion, just like a river. For neither the river nor the swift hour can stop its course; but, as wave is pushed on by wave, and as each wave as it comes is both pressed on and itself presses the wave in front, so time both flees and follows and is ever new.

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 2)  
Book XV, l. 178–182 (p. 377)  
William Heinemann. London, England. 1916

Nothing retains its own form; but Nature, the great renewer, ever makes up forms from other forms. Be sure, there's nothing perishes in the whole universe; it does but vary and renew its form.

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 2)  
Chapter XV, l. 252 (p. 383)  
William Heinemann. London, England. 1916

**Planck, Max** 1858–1947  
German physicist

But the circumstance which calls for ever greater wonderment, because it is not self-evidently a matter of course by any means, is that the new world picture does not wipe out the old one, but permits it to stand in its entirety, and merely adds a special condition for it... As the multitude of the natural phenomena observed in all fields unfolds in an ever richer and more variegated profusion, the scientific world picture, which is derived from them, assumes an always clearer and more definite form. The continuing changes in the world picture do not therefore signify an erratic oscillation in a zigzag line, but a progress, an improvement, a completion.

Translated by F. Gaynor  
*Scientific Autobiography and Other Papers* (p. 98)  
Philosophical Library. New York, New York, USA. 1949

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

...a change 'in the animal kingdom seems to be a part of the order of nature, and is visible in instances to which human power cannot have extended.'

*The Works of John Playfair* (Volume 1)  
*Illustrations of the Huttonian Theory*, Paragraph 413 (p. 459)  
Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**Rohault, Jacques** 1618–72  
French philosopher and physicist

Daily Experience, and a Thousand Observations made by the Industry of Men in past Ages, and which we ourselves have confirmed, do sufficiently convince us, that there is no part of the Earth, be it never so great or small, but that in Time it undergoes some Alteration...

*Rouhault's System of Natural Philosophy* (Volume 2)  
Part III, Chapter I  
Johnson Reprint Corporation. New York, New York, USA. 1969

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

the truths of nature are one eternal change – one infinite variety. There is no bush on the face of the globe exactly like another bush; – there are no two trees in the forest whose boughs bend into the same network, nor two

leaves on the same tree which could not be told one from the other, nor two waves in the sea exactly alike.

*Modern Painters* (Volume 1)

Part II, Section I, Chapter II (p. 55)

John Wiley & Sons. New York, New York, USA. 1888

**Sagan, Carl** 1934–96

American astronomer and science writer

Our epoch is unpredictable because it is simultaneously complex and changing rapidly. This seems also to be the reason for the madness of our times. There is in no moment in the history of mankind when so many changes in so many different areas – social, political, economic, scientific, technological, sexual, and educational – have occurred. They are happening too fast for too many people. Madness is one way of coping.

*Other Worlds* (p. 139)

BantamBooks. New York, New York, USA. 1975

**Sexton, Anne** 1928–74

American poet and writer

Rocks crumble, make new forms,  
oceans move the continents,  
mountains rise up and down like ghosts  
yet all is natural, all is change.

*The Complete Poems*

The Wall

Houghton Mifflin Company. Boston, Massachusetts, USA. 1981

**Stewart, Ian** 1945–

English mathematician

The universe may appear to be a storm-tossed ocean of change, but...change obeys rules.

*Nature's Numbers*

Chapter 4 (p. 48)

BasicBooks. New York, New York, USA. 1995

**Tennyson, Alfred (Lord)** 1809–92

English poet

O earth, what changes hast thou seen!

*Alfred Tennyson's Poetical Works*

In Memoriam A.H.H., Part CXXIII, Stanza 1

Oxford University Press, Inc. London, England. 1953

Forward, Forward let us range,

Let the great world spin for ever down the ringing groves of change.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 91

Oxford University Press, Inc. London, England. 1953

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Change is the handmaiden Nature requires to do her miracles with.

*Roughing It* (Volume 2)

Chapter XV (p. 150)

Harper & Brothers Publishers. New York, New York, USA. 1899

## CHANGE, INSTRUMENTS OF

**Lyell, Sir Charles** 1797–1875

English geologist

...should we ever establish by unequivocal proofs, that certain agents have, at particular periods of past time, been more potent instruments of change over the entire surface of the earth than they now are, it will be more consistent with philosophical caution to presume, that after an interval of quiescence they will recover their pristine vigour, than to regard them as worn out.

*Principles of Geology*

Chapter IX (p. 165)

John Murray. London, England. 1830

## CHAOS

**Adams, Henry Brooks** 1838–1918

American man of letters

Chaos often breeds life, when order breeds habit.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XVI (p. 249)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

Briefly, chaos is all that science can logically assert of the supersensuous.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XXXI (p. 451)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

... Chaos was the law of nature; Order was the dream of man.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XXXI (p. 451)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Blackie, John Stuart** 1809–95

Scottish scholar

Chaos, Chaos, infinite wonder!

Wheeling and reeling on wavering wings....

*Musa Burschicosa: A Book of Songs for Students and University Men*

A Song of Geology, Second stanza

Edmonston & Douglas. Edinburgh, Scotland. 1869

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

From the smallest satellite slave of the smallest star to the largest super-galaxy of worlds in space, everything bows to the first law of nature. Chaos and caprice do not exist.

*Parade of the Living*

Part I, Chapter I (p. 3)

Coward-McCann, Inc. New York, New York, USA. 1930

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

There is no such thing as chaos, it tacitly asserts, in the sidereal world or outside of it. For chaos is the negation of law, and law is the expression of the will of God.

*Problems in Astrophysics*

Introduction (p. 10)

Adam & Charles Black. London, England. 1903

### **Devaney, Robert L.**

No biographical data available

It has been said that the three great developments in twentieth century science are relativity, quantum mechanics, and chaos. That strikes me the same as saying that the three great developments in twentieth century engineering are the airplane, the computer, and the pop-top aluminum can. Chaos and fractals are not even twentieth century ideas: chaos was first observed by Poincaré and fractals were familiar to Cantor a century ago, although neither man had the computer at his disposal to show the rest of the world the beauty he was seeing.

Introduction: Special Issue on Dynamical Systems

*College Mathematics Journal*, Volume 22, Number 1, January, 1991 (p. 2)

### **Dylan, Bob** 1941–

American pop-folk singer, composer, and musician

Chaos is a friend of mine.

The Two Lives of Bob Dylan

*Newsweek*, 9 December, 1985 (p. 93)

### **Figenbaum, Mitchell** 1944–

American mathematical physicist

What will prove altogether remarkable is that some very simple schemes to produce erratic numbers behave identically to some of the erratic aspects of natural phenomena.

Universal Behavior in Nonlinear Systems

*Los Alamos Science*, Summer, 1980 (p. 4)

### **Ford, Joseph**

No biographical data available

Unfortunately, non-chaotic systems are very nearly as scarce as hen's teeth, despite the fact that our physical understanding of nature is largely based upon their study.

How Random Is a Coin Toss?

*Physics Today*, Volume 36, Number 4, April, 1983 (p. 40)

### **Frost, Robert** 1874–1963

American poet

Let chaos storm!

Let cloud shapes swarm!

I wait for form.

*Complete Poems of Robert Frost*

Pertinax

Henry Holt & Company. New York, New York, USA. 1949

### **George, William H.**

No biographical data available

One man's explanation may be another man's chaos.

*The Scientist in Action: A Scientific Study of His Methods*

Personal Basis (p. 331)

William & Norgate. London, England. 1936

### **Gleick, James** 1954–

American author, journalist, and essayist

Where chaos begins, classical science stops. For as long as the world has had physicists inquiring into the laws of nature, it has suffered a special ignorance about disorder in the atmosphere, in the fluctuations of the wildlife populations, in the oscillations of the heart and the brain. The irregular side of nature, the discontinuous and erratic side these have been puzzles to science, or worse, monstrosities.

*Chaos: Making a New Science*

Prologue (p. 3)

The Viking Press. New York, New York, USA. 1987

### **Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

History includes too much chaos, or extremely sensitive dependence on minute and unmeasurable differences in initial conditions, leading to massively divergent outcomes based on tiny and unknowable disparities in starting points. And history includes too much contingency, or shaping of present results by long chains of unpredictable antecedent states, rather than immediate determination by timeless laws of nature. *Homo sapiens* did not appear on the earth, just a geologic second ago, because evolutionary theory predicts such an outcome based on themes of progress and increasing neural complexity. Humans arose, rather, as a fortuitous and contingent outcome of thousands of linked events, any one of which could have occurred differently and sent history on an alternative pathway that would not have led to consciousness.

The Evolution of Life on Earth

*Scientific American*, Volume 271, Number 4, October, 1994 (pp. 85–86)

### **Grassé, Pierre P.** 1895–1985

French zoologist

Although everything is not as it should be, the living world is not at all chaotic and life results from a very well-defined order. As soon as some disorder, even slight, appears in an organized being, sickness, then death follow. There is no possible compromise between the phenomenon of life and anarchy.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*

Chapter IV (p. 9)

Academic Press. New York, New York, USA. 1977

### **Harrison, Edward Robert** 1919–2007

English-born American cosmologist

Perhaps, in the ultimate and unimaginable chaos of a big bang, there lurks the cosmogenic genie who conjures and launches multitudes of universes, each equipped with its own unique laws and fundamental constants...

*Cosmology, the Science of the Universe*

Chapter 15 (p. 300)

Cambridge University Press. Cambridge, England. 1981

### Heim, F.

No biographical data available

Chaos engenders order.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Biologic Relations Between Plants and Ants (p. 454)

Government Printing Office. Washington, D.C. 1898

### Hofstadter, Douglas R. 1945–

American academic

It turns out that an eerie type of chaos can lurk just behind a facade of order – and yet, deep inside the chaos lurks an even eerier type of order.

In James Gleick

*Chaos: Making a New Science*

Back cover

Penguin Books. New York, New York, USA. 1988

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

In disorder there can be no fecundation. Chaos is a celibate.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 406)

The Heritage Press. New York, New York, USA. 1961

### Keats, John 1795–1821

English Romantic lyric poet

There is nothing stable in the world; uproar's your only music.

*The Complete Poetical Works and Letters of John Keats*

Letter to George and Thomas Keats

13 January, 1818 (p. 280)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

### Kettering, Charles Franklin 1876–1958

American engineer and inventor

Developmental work is always a slightly organized chaos.

In T.A. Boyd

*Professional Amateur*

Part II Chapter IX (p. 71)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

### Maxim, Hiram S.

No biographical data available

...the grandest words ever uttered by any man on this planet were spoken by Lord Kelvin when he said that if all the matter in the Universe were reduced to its ultimate atoms and equally divided through all space, the disturbance caused by the beating of the wing of one mosquito

would bring about everything we find in the material Universe today.

Matter and Motion in Space

*Nature*, Volume 66, Number 1705, July 3, 1902 (p. 223)

### Millay, Edna St. Vincent 1892–1950

Poet and playwright

I will put Chaos into fourteen lines  
And keep him there; and let him thence escape  
If he be lucky; let him twist and ape  
Flood, fire, and demon – his adroit designs  
Will strain to nothing in the strict confines  
Of this sweet Order, where, in pious rape,  
I hold his essence and amorphous shape,  
Till he with Order mingles and combines.  
Past are the hours, the years, of our duress,  
His arrogance, our awful servitude:  
I have him. He is nothing more nor less  
Than something simple not yet understood;  
I shall not even force him to confess;  
Or answer. I will only make him good.

*Mine the Harvest: A Collection of New Poems*

I Will Put Chaos into Fourteen Lines 130

Harper. New York, New York, USA. 1954

### Miller, Henry 1891–1980

American writer

The world is what it is and I am what I am.... This out there and this in me, all this, everything, the resultant of inexplicable forces. A Chaos whose order is beyond comprehension. Beyond human comprehension.

*Black Spring*

Third or Fourth Day of Spring (p. 25)

Grove Press. New York, New York, USA. 1963

...chaos is the score upon which reality is written.

*Tropic of Cancer* (p. 2)

Grove Press. New York, New York, USA. 1961

### Milton, John 1608–74

English poet

In the Beginning, how the Heav'ns and Earth

Rose out of Chaos...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book I, l. 9–10

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

May hope, when everlasting Fate shall yield  
To fickle Chance, and Chaos judge the strife...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book II, l. 232–233

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...where eldest Night

And chaos, ancestors of nature, hold

Eternal anarchy amidst the noise



Of endless wars.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
 Book II, l. 894  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

To whom these most adhere,  
 He rules a moment: Chaos Umpire sits,  
 And by decision more embroils the fray  
 By which he reigns.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
 Book II, l. 907–909  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### National Research Council (USA)

Physicists know how to deal with total chaos – disorganized complexity... What gives physicists trouble... organized complexity ...

*Physics in Perspective* (Volume 1)  
 Chapter 3 (p. 61)  
 National Academy of Sciences  
 Washington, D.C. 1972

**Nietzsche, Friedrich Wilhelm** 1844–1900  
 German philosopher

You must have chaos in your heart to give birth to a dancing star.

In Eugene F. Mallove  
*The Quickening Universe: Cosmic Evolution and Human Destiny*  
 Prologue (p. xiii)  
 St. Martin's Press. New York, New York, USA. 1987

**Ovid** 43 BCE–17 AD  
 Roman poet

...chaos: a rough, unordered mass of things...

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 1)  
 Book I, l. 7 (p. 3)  
 William Heinemann. London, England. 1916

### Packard, Norman

American physicist

The phenomenon of chaos could have been discovered long, long ago. It wasn't, in part because this huge body of work on the dynamics of regular motion didn't lead in that direction. But if you just look, there it is.

In James Gleick  
*Chaos: Making a New Science*  
 The Dynamical Systems Collective (p. 251)  
 The Viking Press. New York, New York, USA. 1987

### Peterson, Ivars

Mathematics and computer writer and editor

We have found chaos, but what it means and what its relevance is to our place in the universe remains shrouded in a seemingly impenetrable cloak of mathematical uncertainty.

*Newton's Clock*  
 Chapter 12 (p. 293)  
 W.H. Freeman & Co. New York, New York, USA. 1993

**Pope, Alexander** 1688–1744  
 English poet

Here she beholds the Chaos dark and deep,

Where nameless something's in their causes sleep...

*The Complete Poetical Works* (Volume 4)  
 The Duncaid, Book I, l. 55–56  
 Houghton Mifflin Company. New York, New York, USA. 1903

Then rose the seed of Chaos, and of Night,  
 To blot out Order, and extinguish Light...

*The Complete Poetical Works* (Volume 4)  
 The Duncaid, Book IV, l. 13–14  
 Houghton Mifflin Company. New York, New York, USA. 1903

Lo! thy dread empire, Chaos! is restor'd;  
 Light dies before thy uncreating word;  
 Thy hand great Anarch! lets the curtain fall;

And universal Darkness buries all.  
*The Complete Poetical Works* (Volume 4)  
 The Duncaid, Book IV, l. 653–656  
 Houghton Mifflin Company. New York, New York, USA. 1903

Not chaos-like, together crust'd and bruise'd,  
 But, as the world, harmoniously confused:

Where order in variety we see,  
 And where, tho' all things differ, all agree.

*The Complete Poetical Works*  
 Windsor Forest, l. 13–16  
 Houghton Mifflin Company. New York, New York, USA. 1903

**Prigogine, Ilya** 1917–2003  
 Russian-born Belgian physical chemist

**Stengers, Isabelle** 1949–  
 Belgian philosopher

Curiously, the unexpected complexity that has been discovered in nature has not led to a slowdown in the progress of science, but on the contrary to the emergence of new conceptual structures that now appear as essential to our understanding of the physical world – the world that includes us.

*Order Out of Chaos*  
 Introduction (p. 2)  
 Shambhala Publications. Boulder, Colorado, USA. 1984

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952  
 Spanish-born American philosopher

Chaos is a name for any order that produces confusion in our minds...

Chaos is perhaps at the bottom of everything: which would explain why perfect order is so rare and precarious.  
*Dominations and Powers: Reflections on Liberty, Society, and Government*



Book First, Part One, Chapter 1 (p. 33)  
Charles Scribner's Sons. New York, New York, USA. 1951

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Chaos is come, again.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Othello, The Moor of Venice*  
Act III, Scene iii, l. 92  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shapley, Harlow** 1885–1972

American astronomer

Chaos is but unperceived order; it is a word indicating the limitations of the human mind and the paucity of observational facts. The words “chaos,” “accidental,” “chance,” “unpredictable” are conveniences behind which we hide our ignorance.

*Of Stars and Men: Human Response to an Expanding Universe*  
Chapter 4 (fn, p. 63)  
Beacon Press. Boston, Massachusetts, USA. 1958

**Stoppard, Tom** 1937–

Czech-born English playwright

The ordinary-sized stuff which is our lives, the things people write poetry about – the clouds – daffodils – waterfalls – and what happens in a cup of coffee when the cream goes in – these things are full of mystery, as mysterious to us as the heavens were to the Greeks. We're better at predicting events at the edge of the galaxy or inside the nucleus of an atom than whether it'll rain on auntie's garden party three Sundays from now.... We can't even predict the next drip from a dripping tap when it gets irregular.

*Arcadia*  
Act One (p. 48)  
Samuel French, Inc. New York, New York, USA. 1993

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Do you see O my brothers and sisters? It is not chaos or death – it is form, union, plan – it is eternal life – it is Happiness.

*Complete Poetry and Collected Prose*  
Leaves of Grass  
Song of Myself  
The Library of America. New York, New York, USA. 1982

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Is this the end of all that primal force  
Which, in its changes being still the same,  
From eyeless Chaos cleft its upward course,  
Through ravenous seas and whirling rocks and flame,  
Till the suns met in heaven and began  
Their cycles, and the morning stars sang, and the Word  
was Man!

*Poems*  
Humanitad, Stanza 72  
George Munro's Sons. New York, New York, USA. 1896

**Yorke, James**

American mathematician

The first message is that there is disorder... People say what use is disorder. But people have to know about disorder if they are going to deal with it. The auto mechanic who doesn't know about sludge in valves is not a good mechanic.

In James Gleick  
*Chaos: Making a New Science*  
Life's Ups and Downs (p. 68)  
The Viking Press. New York, New York, USA. 1987

## CHARACTER

**Young, Thomas** 1773–1829

English polymath

A man who has a proper regard for the dignity of his own character, although his sensibility may sometimes be awakened by the unjust attacks of interested malevolence, will esteem it in general more advisable to bear, in silence, the temporary effects of a short-lived injury, than to suffer his own pursuits to be interrupted, in making an effort to repel the invective, and to punish the aggressor.

In George Peacock  
*Miscellaneous Works of the Late Thomas Young*  
Number X (p. 192)  
John Murray. London, England. 1855

## CHARACTERISTIC

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

That is the aim of that great science which I am used to calling Characteristic, of which what we call Algebra, or Analysis, is only a very small branch since it is this Characteristic which gives words to languages, letters to words, numbers to Arithmetic, notes to Music. It teaches us how to fix our reasoning, and to require it to leave, as it were, visible traces on the paper of a notebook for inspection at leisure. Finally, it enables us to reason with economy, by substituting characters in the place of things in order to relieve the imagination...

*On the Method of Universality* (p. 4)  
Charles Scribner's Sons. New York, New York, USA. 1951

## CHARM

**Ellis, John** 1946–  
English theoretical physicist

Charm was the lever that turned the world.  
Quoted in Michael Riordan  
*The Hunting of the Quark*

Chapter 14 (p. 322)  
Simon & Schuster. New York, New York, USA. 1987

### Yabsley, D. B.

No biographical data available

The awkwardness of the charm mass thus puts limits on both symmetry- and quark-based thinking as guides to charm physics. If light hadron work is like swimming in the ocean, and b-physics is like flying through the air, then in charm studies one is wading knee-deep through the brown muck.

In Harry W.K. Chueng and Tracy S. Pratt  
*Lepton and Photon Interactions at High Energies*  
Experimental Physics on New Physics from Charm Decay (p. 168)  
World Scientific Publishing Co. River Edge, New Jersey, USA. 2004

## CHEMICAL

### Author undetermined

Chemical: A substance that:  
An organic chemist turns into a foul odor;  
An analytical chemist turns into a procedure;  
A physical chemist turns into a straight line;  
A biochemist turns into a helix;  
A chemical engineer turns into a profit.  
Source undetermined

What are mortals made of?  
By analization  
I've tried all the nation,  
Defined each gradation,  
And prov'd every station,  
With Sir Humphry's best  
New chemical test,  
And found what mortals are made of.  
Source undetermined  
*Analization*

Unless the evils resulting from every person who deems that he has made an improvement introducing new-fangled combinations be remedied...chemical science would soon become a perfect chaos.

*Athenaeum*  
Fourth Meeting of the British Association for the Advancement of Science, 20 September, 1834 (p. 698)

### Berzelius, Jöns Jacob 1779–1848

Swedish chemist

The devil may write chemical textbooks...because every few years the whole thing changes.  
In Bernard Jaffe  
*Crucibles: The Story of Chemistry*  
Chapter IX (p. 116)  
Dover Publications. New York, New York, USA. 1976

It is easier to write an abbreviated word than to draw a figure. The chemical signs ought to be letters for the greater ease of writing and not to disfigure a printed

book. I shall therefore take for the chemical sign the initial letter of the Latin name of each chemical element, thus, C, H, N, O, S, and P. If the first letter be common to two metals, I shall use both the initial letter and another letter they have not in common...

In Bernard Jaffe  
*New World of Chemistry*  
Chapter 6 (p. 66)  
Silver, Burdett & Company. New York, New York, USA. 1935

### Callen, Charles Lane

No biographical data available

"Does accident often play a part in chemical discoveries?" I inquired. "At times it does, but not as rule," Dr. Stine replied. "Even when it does, the circumstance is not, strictly speaking, accidental...the chemist invariably has to put in some mighty hard work in order to bring about fortunate accidents."

If the Chemist Stepped Out of Your Life  
*The American Magazine*, May, 1926. (p. 189)

### Carson, Rachel 1907–64

American marine biologist and author

The chemicals to which life is asked to make its adjustment are no longer merely the calcium and silica and copper and all the rest of the minerals washed out of the rocks and carried in rivers to the sea; they are the synthetic creations of man's inventive mind, brewed in his laboratories, and having no counterparts in nature.

*Silent Spring*  
Chapter 2 (p. 17)  
Fawcett Publications. Greenwich, Connecticut, USA. 1962

For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death.

*Silent Spring*  
Chapter 3 (p. 24)  
Fawcett Publications. Greenwich, Connecticut, USA. 1962

### Cook, Joseph

No biographical data available

Oh, sing a song of phosphates,  
Fibrine in a line,  
Four-and-twenty follicles  
In the van of time.  
When the phosphorescence  
Evolved brain,  
Superstition ended,  
Men began to reign.

In Sara and John E. Brewton and John Brewton Blackburn  
*Of Quarks, Quasars, and Other Quirks: Quizzical Poems for the Supersonic Age*  
Boston Nursery Rhymes, Rhyme for a Chemical Baby (p. 41)  
Crowell. New York, New York, USA. 1977

### Davy, Sir Humphry 1778–1829

English chemist

Whilst chemical pursuits exalt the understanding, they do not depress the imagination or weaken genuine feeling; whilst they give the mind habits of accuracy, by obliging it to attend to facts, they likewise extend its analogies; and, though conversant with the minute forms of things, they have for their ultimate end the great and magnificent objects of nature.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (p. 245)

John Murray. London, England. 1830

[The chemical philosopher's mind] should always be awake to devotional feeling, and in contemplating the variety and the beauty of the external world, and developing its scientific wonders, he will always refer to that infinite wisdom through whose beneficence he is permitted to enjoy knowledge; and, in becoming wiser, he will become better, he will rise at once in the scale of intellectual and moral existence, his increased sagacity will be subservient to a more exalted faith, and in proportion as the veil becomes thinner through which he sees the causes of things, he will admire more the brightness of the divine light by which they are rendered visible.

*Consolations in Travel; or the Last Days of a Philosopher*

Dialogue V (p. 255)

John Murray. London, England. 1830

The foundations of chemical philosophy, are observation, experiment, and analogy. By observation, facts are distinctly and minutely impressed on the mind. By analogy, similar facts are connected. By experiment, new facts are discovered; and, in the progression of knowledge, observation, guided by analogy, lends to experiment, and analogy confirmed by experiment, becomes scientific truth.

*Elements of Chemical Philosophy* (Volume 4)

Part I, Volume I, Introduction (p. 2)

Printed for J. Johnson & Company. London, England. 1812

**Dickinson, Emily** 1830–86

American lyric poet

The Chemical conviction

That Nought be lost

Enable in Disaster

My fractured Trust –

*The Complete Poems of Emily Dickinson*

No. 954 (p. 446)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

## Editorial

Our chemical heritage – the record of our achievements and our shortcomings – has a vital role to play in developing a more adequate public understanding of science. The past must be preserved, deployed, and made known. We all – whether Chief Executive officers, chemical scientists, school teachers, or representatives of the media – need a better understanding of the human dimensions of the chemical sciences. Chemical history,

our chemical heritage, can help inform our decision making. A positive view of the past chemical achievements will lend a modest but firm realism to our plans for the future.

*Beckman Center for the History of Science*, Volume 9, Spring 1992

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

The ingredients are known; they can be had on any drug-store shelf. You can take them yourself and pour them and wait hopefully for the resulting slime to crawl. It will not. The beautiful pulse of streaming protoplasm, that unknown organization of an unstable chemistry which makes up the life process, will not begin. Carbon, nitrogen, hydrogen, and oxygen you have mixed, and the same dead chemicals they remain.

*The Immense Journey* (p. 1)

Victor Gollancz. London, England. 1958

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

'Tis a superstition to insist on a special diet. All is made at last of the same chemical atoms.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Culture (p. 1027)

The Library of America. New York, New York, USA. 1983

**Fischer, Emil Hermann** 1852–1919

German chemist

To use a picture, I will say that enzyme and glucoside must join one another as lock and key, in order to be able to exert a chemical effect.

*Berichte der Deutschen Chemischen Gesellschaft*, Column 27, 1894 (p. 2992)

**Frederick the Great** 1712–86

King of Prussia

Is it not true that the doctrine of attraction and gravity has done nothing but astonish our imagination? Is it not true that all the chemical discoveries have done only the same?

Letter to Jean le Rond D'Alembert, January 7, 1768

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

Shelly and Keats were the last English poets who were at all up to date in their chemical knowledge.

Paper read to the Heretics, Cambridge, England

*Daedalus, or Science and the Future*, February 4th, 1923

**Hinshelwood, Sir Cyril** 1897–1967

English chemist

Nobody, I suppose, could devote many years to the study of chemical kinetics without being deeply conscious of the fascination of time and change: this is something that goes outside science into poetry; but science, subject to

the rigid necessity of always seeking closer approximations to the truth, itself contains many poetical elements.

*Nobel Lectures, Chemistry 1942–1962*

Nobel lecture for award received in 1956

Chemical Kinetics in the Past Few Decades (p. 474)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Hoffmann, Roald** 1937–

Polish-born American chemist

The chemical article is an artistic creation.... It is not a laboratory notebook, and one knows that that notebook in turn is only a partially reliable guide to what took place. It is a more or less (one wishes more) carefully constructed, man- or woman-made text.... If one is lucky, it creates an emotional or aesthetic response in its readers.

Under the Surface of the Chemical Article

*Angewandte Chemie International Edition in English*, Volume 27, 1988

**Kornberg, Arthur** 1918–

American biochemist

Life is a chemical process.

*Biochemistry*, Volume 26, 1987 (p. 6888)

**Lavoisier, Antoine Laurent** 1743–94

French chemist

The principle object of chemical experiments is to decompose natural bodies, so as separately to examine the different substances which enter into their composition. By consulting chemical systems, it will be found that this science of chemical analysis has made rapid progress in our own times.... Thus, as chemistry advances towards perfection, by dividing and subdividing, it is impossible to say where it is to end; and these things we at present suppose simple may soon be found quite otherwise. All we dare venture to affirm of any substance is, that it must be considered as simple in the present state of our knowledge, and so far as chemical analysis has hitherto been able to show.

*Elements of Chemistry in a New Systematic Order*

Part II, Section 1 (p. 176)

W. Creech. Edinburgh, Scotland. 1790

...one day the precision of the data might be brought to such perfection that the mathematician in his study would be able to calculate any phenomenon of chemical combination in the same way...as he calculates the movement of the heavenly bodies.

*Mémoires de l'Académie Royale des Sciences*

Mémoire sur l'affototé du principe oxygène (p. 534)

1782 [Published 1785]

**Lehn, Jean-Marie** 1939–

French chemist

The essence of chemical science thus finds its full expression in the words of Leonardo da Vinci: "Where nature finishes producing its own species, man begins, using natural things and in harmony with this very nature, to create an infinity of species."

Perspectives in Supramolecular Chemistry

*Angewandte Chemie International Edition in English*, Volume 29, Number 11, 1990 (p. 1337)

**Ostwald, Friedrich Wilhelm** 1853–1932

Latvian-born German chemist

Thus, there was for him nothing small or great in Nature. Every phenomenon embraced for him an endless diversity of factors, and in the yellow flame of an ordinary alcohol lamp whose wick was sprinkled with salt, he saw the possibility of accomplishing the chemical analysis of the most distant stars.

In Mary Elvira Weeks

The Discovery of the Elements

*Journal of Chemical Education*. Easton Pennsylvania, USA. 1956 (p. 363)

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

A chemical compound might be expected to be quite as much a proposition as like an algebraic invariant.

The Logic of Relations

*Monist*, Volume 7, 1896 (p. 169)

**Shoemaker, Sydney** 1931–

American philosopher

If what I want when I drink fine wine is information about its chemical properties, why don't I just read the label?

In Daniel C. Dennett

*Consciousness Explained*

Chapter 12 (p. 383)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Süskind, Patrick** 1931–

German writer and screenwriter

There's jasmine! Alcohol there! Bergamot there! Grenouille went on crowing, and at each name he pointed to a different spot in the room, although it was so dark that at best you could only surmise the shadows of the cupboards filled with bottles.

Translated by John E. Woods

*Perfume: The Story of a Murder*

Chapter 14 (p. 75)

Alfred A. Knopf. New York, New York, USA. 1986

**Teeple, John E.** 1874–1931

American chemist

The manufacturer of chemicals has all the griefs of a maker of shoes, or bolts and nuts, or ready-to-wear clothes, and has just one more grief in addition – i.e., troubles occurring in chemical transformations.

Is the Practice of Chemistry a Profession, a Trade, or a Tool?

*The Journal of Industrial and Engineering Chemistry*, Volume 17, Number 7, July, 1925 (p. 666)

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Warned by such errors as that of Comte, who declared that Man could never know anything as to the chemical

composition of the heavenly bodies, we have learned to be cautious in not putting in “full stops”.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 15)

William & Norgate. London, England. 1920

### **Winkler, C.**

No biographical data available

The world of chemical reaction is like a stage, on which scene after scene is ceaselessly played. The actors on it are the elements.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 2)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

### **Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Getting hold of the difficulty deep down is what is hard. Because if it is grasped near the surface it simply remains the difficulty it was. It has to be pulled out by the roots; and that involves our beginning to think about these things in a new way. The change is as decisive as, for example, that from the alchemical to the chemical way of thinking. The new way of thinking is what is so hard to establish.

Translated by Peter Winch

*Culture and Value* (p. 48e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

## CHEMICAL AFFINITIES

### **Aesop** ca. 620 BCE–560 BCE

Greek fabulist and author

There can be little liking where there is no likeness.

*Fables*

The Collier and the Fuller

The University of Chicago Press. Chicago, Illinois, USA. 1960

### **Berthollet, C. L.** 1748–1822

French chemist

A theory of chemical affinities solidly established, and serving as a basis for the explanation of all chemical questions, ought to be a collection of, or contain, all the principles from which the causes of chemical phenomena can proceed, in every possible variety of circumstances; because observation has proved that all these phenomena are only the various effects of that affinity, to which all the various chemical powers of bodies may be attributed.

Translated by M. Farrell

*Researches into the Laws of Chemical Affinity*

Researches

Article I (pp. 1–2)

Philip H. Nicklin & Company. 1809

### **Duckham, Sir Arthur**

No biographical data available

Many times in the short existence of the Institution have the Council endeavored to describe a chemical engineer.... We have come to the conclusion that a chemical engineer as such does not in reality exist today.

Presidential Address

*Transactions of the Institute for Chemical Engineering*, Volume 2, 1924 (p. 15)

### **Macquer, Pierre Joseph** 1718–84

French chemist

...perhaps time, experience, the increase of chemical knowledge, lastly, the zeal of persons skilled in mathematics and chemistry, will hereafter throw much more light upon these subjects, of which now we have but confused notions. However, I cannot but consider them as the true key of the most hidden phenomena of chemistry, and consequently of all natural philosophy.

In D.S.L. Cardwell (ed.)

*John Dalton & the Progress of Science*

Quoted by Arnold Thackeray

*Quantified Chemistry – The Newtonian Dream* (p. 102)

Manchester University Press. Manchester, England. 1968

### **McGee, Jr., H. A.**

No biographical data available

As a profession we are justly proud of our great breadth, for we are the only applied science profession with in-depth training in chemistry as well as in physics and mathematics. Our background and perspective as scientist-engineers make for flexibility and adaptability that is the envy of our sister disciplines.

*Chemical Engineering Education*, Volume 9, Number 2, 1974( (p. 94)

### **Pigford, R. L.**

No biographical data available

The chemical engineer...needs to understand chemistry, physics, and mathematics in approximately equal proportion in order that he, apparently better than those from other backgrounds, can assemble and evaluate whatever knowledge is required to “bring things together.”

*Chemical Engineering Technology: The Past 100 Years*

*Chemical Engineering News*, Volume 54, Number 15, 1976 (p. 190)

### **Reese, C. L.**

No biographical data available

Our friends from the Massachusetts Institute of Technology have, perhaps, done more to establish the idea of what a chemical engineer is than anyone else, and there idea is that a chemical engineer is one who understands and knows and has learned the fundamentals of the elementary processes such as distillation, filtration, precipitation, flow of gases and liquids, heat transmission, and so on.

Presidential Address

*Transactions of the Institute of Chemical Engineering*, Volume 2, 1924 (p. 16)



## CHEMICAL ANALYSIS

### Author undetermined

A qualitative chemical analysis is like a judicial inquiry: It is a rigorous examination and confrontation of witnesses – of witnesses who can be compelled to answer truly only by the strictest candor and painstaking on the part of the interrogator, but who thus interrogated will not fail to give reliable evidence.

Experimental Science as the Basis of General Education  
*The London Lancet*, 1868 (p. 316)

### Dalton, John 1766–1844

English chemist and physicist

Chemical analysis and synthesis go no farther than to the separation of particles one from another, and to their reunion. No new creation or destruction of matter is within the reach of chemical agency. We might as well try to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen.

*John Dalton*

Chapter VII

J.M. Dent & Co. London, England. 1906

### Doyle, Sir Arthur Conan 1859–1930

Scottish writer

I found Sherlock Holmes alone, however, half asleep, with his long, thin form curled up in the recesses of his armchair. A formidable array of bottles and test-tubes, with the pungent cleanly smell of hydrochloric acid, told me that he had spent his day in the chemical work which was so dear to him.

“Well, have you solved it?” I asked, as I entered.

“Yes. It was the bisulphate of baryta.”

“No, no, the mystery!” I cried.

*The Adventures of Sherlock Holmes*

*A Case of Identity* (pp. 69–70)

Harper & Brothers Publishers. New York, New York, USA. 1892

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

Supposing the entity of the poet to be expressed by the number ten, it is certain that a chemist in analyzing... would find it to be composed of one part self-interest to nine parts of self-esteem.... Gringoire’s nine parts of self-esteem, swollen and inflated by the breath of popular admiration, were in a state of prodigious enlargement, obliterating that almost imperceptible molecule of self-interest ...

Translated by Jessie Haynes

*Notre Dame de Paris*

Chapter 3 (pp. 28–29)

P.F. Collier & Son. New York, New York, USA. 1902

### von Liebig, Justus 1803–73

German organic chemist

The chemist, by his questions, compels a mineral to speak, to disclose its composition; it tells him that it contains sulphur, iron, chromium, silica, alumina, or any other word of the chemical language of phenomena, arranged in a certain order. This is CHEMICAL ANALYSIS.

In John Blyth

*Familiar Letters on Chemistry* (4th edition)

Letter I (p. 10)

Walton & Maberly. London, England. 1859

## CHEMICAL BOND

### Boyle, Robert 1627–91

English natural philosopher and theological writer

But there may be some clusters of particles, wherein the particles are so minute, and the coherence so strict, or both, that when bodies of differing denominations, and consisting of such durable clusters, happen to be mingl’d, though the compound body made up of them may be very differing from either of the ingredients, yet each of the little masses or clusters may so retain its own nature, as to be again separable, such as it were before.

*The Sceptical Chymist*

The Second Part (p. 87)

J.M. Dent & Sons. London, England. 1911

### Brown, I. David

No biographical data available

It is unlikely that, left to themselves, theoretical chemists in the twentieth century would have ever created the idea of a chemical bond had not the concept already been central to the language of structural chemistry. To this day, the chemical bond remains largely an empirical concept.

*The Chemical Bond in Inorganic Chemistry: The Bond Valence Model*

Chapter 1 (p. 30)

Oxford University Press, Inc. Oxford, England. 2002

## CHEMICAL CHANGE

### Author undetermined

The difference between a physical and a chemical change is that a chemical change evaporates and a physical change remains the same.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July, 1925

(p. 611)

### Mendeleev, Dmitry Ivanovich 1834–1907

Russian chemist

...the unseen world of chemical changes is closely analogous to the visible world of the heavenly bodies, since our atoms form distinct portions of an invisible world,



as planets, satellites, and comets form distinct portions of the astronomer's universe; our atoms may therefore be compared to the solar systems, or to the systems of double or of single stars: for example, ammonia (NH<sub>3</sub>) may be represented in the simplest manner by supposing the sun, nitrogen, surrounded by its planets of hydrogen; and common salt (NaCl) may be looked on as a double star formed of sodium and chlorine.

*The Principles of Chemistry* Part IV

Appendix I (p. 454)

P.F. Collier & Son. New York, New York, USA. 1902

## CHEMICAL COMBINATION

**Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

Thanks to the genius of Lavoisier and of Dalton, man has been able, in the unseen world of chemical combinations, to recognise laws of the same simple order as those which Copernicus and Kepler proved to exist in the planetary universe. Man discovered, and continues every hour to discover, what remains unchanged in chemical evolution, and how changes take place in combinations of the unchangeable.

*The Principles of Chemistry* Part IV

Appendix I (p. 455)

P.F. Collier & Son. New York, New York, USA. 1902

## CHEMICAL COMPOUND

### ACETYL-CHOLINE

**Dale, Sir Henry Hallett** 1875–1968

English physiologist

The question of a possible physiological significance, in the resemblance between the action of choline esters and the effects of certain divisions of the involuntary nervous system, is one of great interest, but one for the discussion of which little evidence is available. Acetyl-choline is, of all the substances examined, the one whose action is most suggestive in this direction. The fact that its action surpasses even that of adrenaline, both in intensity and evanescence, when considered in conjunction with the fact that each of these two bases reproduces those effects of involuntary nerves which are absent from the action of the other, so that the two actions are in many directions at once complementary and antagonistic, gives plenty of scope for speculation. The Action of Certain Esters and Ethers of Choline, and Their Relation to Muscarine

*The Journal of Pharmacology and Experimental Therapeutics*, Volume 6 1914–15 (p. 188)

## CALCIUM CHLORIDE

### Advertisement

Paradoxical stuff, calcium chloride: Sort of like the man who warms his hands and cools his soup with the same breath. It's a dandy ice melter – far better than salt; yet as refrigerating brine it's the ideal ice maker.

Advertisement by Allied Chemical

*Scientific American*, Volume 204, Number 1, January, 1961 (p. 35)

## CARBON DIOXIDE

### Author undetermined

When you smell an odorless gas, it is probably carbon dioxide.

Source undetermined

## CHLORACETENE

**Schorlemmer, Carl** 1834–92

German chemist

They [Kekule and Zincke] found, as the result of their research, that Kegnault's statements were perfectly correct, and that chloracetene possessed, besides other remarkable properties, that of non-existence!

*The Rise and Development of Organic Chemistry* (p. 152)

Macmillan & Co Ltd. London, England. 1894

## CHLOROPHYLL

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

For inert and inorganic elements – water and carbon dioxide of the air, the same that we breathe out as a waste – chlorophyll can synthesize with the energy of sunlight. Every day, every hour of all the ages, as each continent and, equally important, each ocean rolls into sunlight, chlorophyll ceaselessly creates. Not figuratively, but literally, in the grand First Chapter Genesis style. One instant there are a gas and water, as lifeless as the core of earth or the chill of space; and the next they are become living tissue-mortal yet genitive, progenitive, resilient with all the dewy adaptability of flesh, ever changing in order to stabilize some unchanging ideal of form.

*Flowering Earth*

Chapter 3 (pp. 24–25)

G.P. Putnam's Sons. New York, New York, USA. 1939

**NITRE****Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

It is easy for sugar to be sweet and for nitre to be salt.

*Representative Men*

Uses of Great Men (p. 12)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1883

**Poe, Edgar Allan** 1809–49

American short story writer

“The nitre!” I said; “see, it increases. It hangs like moss upon the vaults. We are below the river’s bed.”

Translated by Jessie Haynes

*The Fall of the House of Usher*

The Cask of Amontillado (p. 81)

Walter Scott. London, England. 1889

**SODA****Alcott, Louisa May** 1832–88

American author

“Ask Asia for a cup of sour cream, then your cakes will be light without much soda, which I don’t like,” was the first order.

Demi tore down-stairs, and returned with the cream, also a puckered-up face, for he had tasted it on his way, and found it so sour that he predicted the cakes would be uneatable. Mrs. Jo took this occasion to deliver a short lecture from the step-ladder on the chemical properties of soda, to which Daisy did not listen, but Demi did, and understood it, as he proved by the brief but comprehensive reply \_\_\_

“Yes, I see, soda turns sour things sweet, and the fizzling up makes them light.”

*Little Men*

Chapter V (p. 85)

Bernhard Tauchnitz

Leipzig, Germany. 1879

**CHEMICAL ELEMENT****Muller, Herbert Joseph** 1905–80

American historian and educator

To say, for example, that a man is made up of certain chemical elements is a satisfactory description only for those who intend to use him as a fertilizer.

*Science and Criticism* (p. 107)

Yale University Press. New Haven, Connecticut, USA. 1943

**CHEMICAL ENGINEERING****Davis, George E.**

No biographical data available

Chemical Engineering must not be confounded with either Applied Chemistry or with Chemical Technology, as the three studies are distinct. Chemical Engineering runs through the whole range of manufacturing chemistry, while Applied Chemistry simply touches the fringes of it and does not deal with the engineering difficulties even in the slightest degree, while Chemical Technology results from the fusion of the studies of Applied Chemistry and Chemical Engineering, and becomes specialised as the history and details of certain manufactured products.

*A Handbook of Chemical Engineering* (Volume 1)

Chapter I (p. 4)

Davis Brothers. Manchester, England. 1904

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

Chemistry was the plaything of magicians, monks and pure-science teachers centuries before chemical engineering became a comprehensible term.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry

*Science*, Volume 65, Number 1862, March 25, 1927 (p. 288)

**CHEMICAL EQUILIBRIUM****La Chatelier, Heuri** 1850–1936

No biographical data available

Every system in chemical equilibrium undergoes, in consequence of a variation of one of the factors of equilibrium, a transformation in such a sense as to produce a variation of sign opposite to that of the factor in question.

In Harry Clary Jones

*A New Era in Chemistry*

Chapter VI (p. 80)

D. van Nostrand Co. New York, New York, USA. 1913

**CHEMICAL NAME****Author undetermined**

2,6-Dichlorotolerate

Ethyl decapitate

Copper keystoneate

Polyvinyl fluortile

Appropriatic acid

Hydrofuriosic acid

Tetraphallic myriskit acid

Arsenic hydroxyexterminate

I-Soslaptic triptoepain

Tetra bromoseltzer

Ultrasonic lactone

2,4-Sixonote-hoodoo we appreciate

*p*-Natalsuccinate

*o*-Pedic methoxysuicide  
 Vinylasbestos fluoride  
 Formyl invitation amide  
 1,2,3-Trimethyl tricycle  
 Chemical Names  
*Chemtech*, October, 1978 (p. 608)

## CHEMICAL OPERATIONS

**Marcet, Mrs. (Jane Haldimand)** 1769–1858  
 English expository author in chemistry, botany, religion, and economics

Nature also has her laboratory which is the universe, and there she is incessantly employed in chemical operations. *Conversations on Chemistry In Which the Elements of that Science Are Familiarly Explained and Illustrated by Experiments* Conversation X (pp. 1–2)  
 Oliver D. Cooke  
 Hartford, Connecticut, USA. 1822

## CHEMICAL PHILOSOPHY

**Davy, Sir Humphry** 1778–1829  
 English chemist

The foundations of chemical philosophy are, observation, experiment, and analogy. By observation, facts are distinctly and minutely impressed on the mind. By analogy, similar facts are connected. By experiment, new facts are discovered; and, in the progression of knowledge, observation, guided by analogy, leads to experiment, and analogy confirmed by experiment, becomes scientific truth.  
 In J. Davy  
*The Collected Works of Sir Humphry Davy* (Volume 4)  
 Historical View of the Progress of Chemistry (p. 2)  
 Smith, Elder & Co. London, England. 1840

## CHEMICAL PROCESS

**Nicholson, William**  
 No biographical data available

The beginning and end of every exact chemical process consists in weighing.  
*A Dictionary of Practical and Theoretical Chemistry*  
 Balance  
 Printed for Richard Phillips. 1808

**von Helmholtz, Hermann** 1821–94  
 German scientist and philosopher

Accurate experiments have shown that the quantity of heat which is developed by a chemical process – for instance, in burning a pound of pure carbon into carbonic acid – is perfectly constant, whether the combustion is slow or rapid, whether it takes place all at once or by intermediate stages.  
 Translated by E. Atkinson  
*Popular Lectures on Scientific Subjects*, First Series  
 On the Conservation of Force (p. 343)  
 D. Appleton & Co. New York, New York, USA. 1897

## CHEMICAL PROPORTIONS

**Berzelius, Jöns Jacob** 1779–1848  
 Swedish chemist

The fact that bodies combine in definite proportions when other forces do not oppose their re-union, added to the observation that when two bodies, A and B, combine in different proportions, the additional portions of the one are always multiples by whole numbers, 1, 2, 3, 4, &c. lead us to conclude the existence of a cause in consequence of which all other combinations become impossible. Now what is that cause? It is obvious that the answer to this question must constitute the principal basis of chemical theory.

II. On the Cause of Chemical Proportions

*Annals of Philosophy*

Essay on the Cause of Chemical Proportions, and on Some Circumstances Relating to Them: Together with a Short and Easy Method of Expressing Them  
 Volume 2 1813

## CHEMICAL TABLE

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

Every substance is negatively electric to that which stands above it in the chemical tables, positively to that which stands below it.

*Essays*

Intellect (p. 303)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1873

## CHEMIST

**Adams, John**  
 No biographical data available

Chymists! Pursue your experiments with indefatigable ardour and perseverance. Give us the best possible Bread, Butter, and Cheese, Wine, Beer and Cider, Houses, Ships and Steamboats, Gardens, Orchards, Fields, not to mention Clothiers or Cooks. If your investigations lead accidentally to any deep discovery, rejoice and cry “Eureka!” But never institute any experiment with a view or a hope of discovering the first and smallest particles of matter.

In Paul R. Heyl

*Annual Report of the Board of Regents of the Smithsonian Institution* (1933)

Romance or Science? (p. 285)

Government Printing Office. Washington, D.C. 1934

**Armstrong, Henry Edward** 1848–1937  
 English chemist

The fact is, there has been a split of chemistry into two schools since the intrusion of the Arrhenic faith, rather it should be said, the addition of a new class of worker into our profession – people without knowledge of the laboratory arts and with sufficient mathematics at their

command to be led astray by curvilinear agreements; without the ability to criticize, still less of giving any chemical interpretation.

The fact is, the physical chemists never use their eyes and are most lamentably lacking in chemical culture. It is essential to cast out from our midst, root, and branch, this physical element and return to our laboratories.

*Historical Studies in the Physical Sciences* (Volume 7)

In R.G.A. Dolby

Debates Over the Theory of Solution

Volume 7, 1976 (p. 389)

Princeton University Press. Princeton, New Jersey, USA. 1976

### **Arnheim, Rudolf** 1904–2007

German-born author, film theorist, and psychologist

Just as chemists “isolate” a substance from contaminations that distort his view of nature and effects, so the work of art purifies significant appearance. It presents abstract themes in their generality, but not reduced to diagrams.

*Visual Thinking*

Chapter 14 (p. 273)

Faber & Faber Ltd. London, England. 1969

### **Atkins, Peter William** 1940–

English physical chemist and writer

Chemists currently strive to achieve the fine control exercised by nature. To do so, they stir, pour, heat, and distill, just as they have done ever since their intellectual ancestors vainly sought a reaction that would produce gold from lead. These crude processes seem to be ways of bending matter to our will and forcing it to undergo specific change. Modern chemists, though, use these techniques to direct reactions more precisely and rationally than alchemists, cooks, and Faraday’s contemporaries. They may seek to build complex molecules, and to do so proceed by stealth and subtlety.... They have found ways to emulate (and sometimes improve on) nature by mixing, stirring, and heating in such a way that they do not break asunder what they have already joined – even though they cannot manipulate the atoms directly.

Atoms, Electrons, and Change

*Scientific American Series*, Number 36, 1991 (p. 11)

### **Author undetermined**

A microchemist is a man who does microanalysis or microsynthesis. He studies microreactions in microtest-tubes. He collects microprecipitates on microfilters and weighs them on a microbalance, or makes microtitrations with microburets, and records the results in a micronote-book. Then he writes Macropapers for the microjournals.

A Microtreatise on Microchemistry

*Industrial and Engineering Chemistry: News Edition*, Volume 13, Number 14, July 20, 1935 (p. 312)

The Chemist’s rule: Never take more than three data points. There will always be some kind of graph paper on which they fall in a straight line.

The Chemist’s rule, first corollary: if you have only one kind of graph paper, never take more than two data points.

Source undetermined

To the optimist, the glass is half full.

To the pessimist, the glass is half empty.

To the chemist, the glass is twice as big as it needs to be.

Source undetermined

A chemist, a physicist, and a geologist were walking along a beach when the physicist suddenly said that he wanted to measure the depth of the sea, and then he jumped into the sea. The geologist said that he wanted to see the seabed and he followed suit. The chemist waited for a while for them to reappear and then concluded, physicists and geologists are soluble in sea water.

Source undetermined

It’s amino world without chemists.

Source undetermined

### **Ball, Philip** 1962–

English science writer

Geologists brave the awesome fury of volcanoes and earthquakes; oceanographers plumb the hidden depths of the world. What do chemists do? Well, they make paint, among other things.

*Designing the Molecular World: Chemistry at the Frontier*

Introduction (p. 4)

Princeton University Press. Princeton, New Jersey, USA. 1994

### **Becher, Johann Joachim** 1635–82

German physician, alchemist, and early chemist

The chymists are a strange class of mortals impelled by an almost insane impulse to seek their pleasure among smoke and vapour, soot and flame, poisons and poverty; yet among all these evils I seem to live so sweetly, that may I die if I would change places with the Persian King.

In H.E. Howe (ed.)

*Chemistry in Industry* (Volume 1)

Frontispiece

The Chemical Foundation, Inc. New York, New York, USA. 1924

### **Black, Joseph** 1728–99

Scottish chemist and physician

The chemist studies the effects produced by heat and by mixture, in all bodies, or mixtures of bodies, natural or artificial, and studies them with a view to the improvement of arts and the knowledge of nature.

*Lectures on the Elements of Chemistry* (Volume 1)

Lectures on the Elements of Chemistry (11)  
Volume II (p. 415)  
Printed for Mathew Carey. Philadelphia, Pennsylvania, USA. 1807

**Bogert, Marston Taylor** 1868–1954  
American physical chemist

Practically everything you eat, taste, wear, smell, and see has resulted in some way from the ingenuity of chemists.

The New Marvels of Chemistry in Your Everyday Life  
*The American Magazine*, September, 1921 (p. 19)

**Bowley, Arthur Lyon** 1869–1957  
English statistician and economist

The chemist experimenting in his laboratory is like the statistician; the chemist theorising in his study is like the economist.

*Elements of Statistics* (4th edition)  
Part I, Chapter I (p. 8)  
P.S. King & Son. London, England. 1920

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

And indeed, I fear that the chief Reason why Chymists have written so obscurely of their three Principles, may be, That not having Clear and Distinct Notions of them themselves, they cannot write otherwise than Confusedly of what they but Confusedly Apprehend...

*The Sceptical Chymist*  
The Fourth Part (pp. 202–203)  
Dawsons of Pall Mall. London, England. 1965

...me thinks the chymists, in their searches after truth, are not unlike the Navigator of Solomon's Tarshish Fleet, who brought home from their long and tedious voyages, not only gold, and silver, and ivory, but apes and peacocks too; for so the writings of several...of your hermetick philosophers present us, together with divers substantial and noble experiments, theories, which either like peacock feathers make a great shew, but are neither solid nor useful; or else like apes, if they have some appearance of being rational, are blemished with some absurdity or other, that when they are attentively considered, makes them appear ridiculous.

*The Sceptical Chymist*  
The Conclusion (pp. 429–430)  
Dawsons of Pall Mall. London, England. 1965

**Bridges, Robert Seymour** 1844–1930  
English poet

... 'twas no unique, ultimately separable thing, as is a chemic element; far rather our moods, influences and spiritual affections are like those many organic substances which, tho' to sense wholly dissimilar and incomparable in kind, are yet all combinations of the same simples, and even in like proportions differently disposed;

so that whether it be starch, oil, sugar, or alcohol 'tis ever our old customers, carbon and hydrogen, pirouetting with oxygen in their morris antics; the chemist booketh all of them as CHO.

*The Testament of Beauty*  
Book III, l. 928–938  
Oxford University Press, Inc. Oxford, England. 1930

**Browning, Robert** 1812–89  
English poet

Once I saw a chemist take a pinch of powder  
– Simple dust it seemed – and half unstop a phial.  
– Outdropped harmless dew.

*The Poems and Plays of Robert Browning*  
Two Camels, l. 109–111  
The Modern Library. New York, New York, USA. 1934

**Bullock, J. Lloyd**  
No biographical data available

There is a further use in thus becoming a good practical chemist; it will enable you to be the counselor of the agriculturalist, of the manufacturer, of the physician – to spread the love and practice of chemistry.

A Lecture on the State of Pharmacy in England and Its Importance to the Public; with remarks on the Pharmaceutical Society  
*The Chemist*, Volume 5, 1844 (p. 282)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Chemists do not have to bother about the sociology of molecules...

*Voices in the Labyrinth: Nature, Man and Science*  
Chapter 1 (p. 5)  
The Seabury Press. New York, New York, USA. 1977

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

The eyeless Chemist heard the process rise,  
The stormy Chalice bubbled up in sighs....

*The Complete Poems of Samuel Taylor Coleridge*  
Kisses, l. 11–12  
Harper & Brothers. New York, New York, USA. 1884

**Collins, Wilkie** 1824–89  
English novelist

Mind, they say, rules the world. But what rules the mind? The body. The body (follow me closely here) lies at the mercy of the most omnipotent of all potentates – the Chemist. Give me – Fosco – chemistry; and when Shakespeare has conceived Hamlet, and sits down to execute the conception – with a few grains of powder dropped into his daily food, I will reduce his mind, by the action of his body, till his pen pours out the most abject drivel that has ever degraded paper. Under similar circumstances, revive me the illustrious Newton. I guarantee that, when he sees the apple fall, he shall eat it, instead



of discovering the principle of gravitation. Nero's dinner shall transform Nero into the mildest of me before he has done digesting it; and the morning draught of Alexander the Great shall make Alexander run for his life, at the first sight of the enemy, the same afternoon. On my sacred word of honor, it is lucky for society that modern chemists are, by incomprehensible good fortune, the most harmless of mankind. The mass are worthy fathers of families who keep shops. The few are philosophers besotted with admiration for the sound of their own lecturing voices; visionaries who waste their lives on fantastic impossibilities; or quacks whose ambition soars no higher than our corns. Thus Society escapes; and the illimitable power of chemistry remains the slave of the most superficial and the most insignificant ends.

*The Woman in White*

The Third Epoch, The Count's Narrative (p. 528)

Harper & Brothers. New York, New York, USA. 1873

### Corey, E. J.

No biographical data available

The synthetic chemist is more than a logician and strategist; he is an explorer strongly influenced to speculate, to imagine, and even to create. These added elements provide the touch of artistry which can hardly be included in a cataloguing of the basic principles of Synthesis, but they are very real and extremely important...

General Methods for the Construction of Complex Molecules

*Pure and Applied Chemistry*, Volume 14, 1967 (p. 30)

### Crookes, Sir William 1832–1919

English chemist and physicist

Chemists do not usually stutter. It would be very awkward if they did, seeing that they have at times to get out such words as methylethylamylophenylium.

In William H. Brock

*The Norton History of Chemistry*

Introduction (p. xxvi)

W.W. Norton & Company, Inc. New York, New York, USA. 1933

It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned to plenty.

*Report of the British Association for the Advancement of Science* (p. 4)

1898

### Crowther, Greg

American biologist

Mamas don't let your babies grow up to be chemists.  
Don't let 'em teach or go or work at the Hutch;  
Make 'em be bankers and lawyers and such.  
Mamas don't let your babies grow up to be chemists.  
With every involvement, they end up in solvent,  
Smelling bad and inhaling too much.

*Mamas Don't Let Your Babies Grow Up to Be Chemists*

Sung to the tune of "Mamas Don't Let Your Babies Grow Up To Be Cowboys"

### Curie, Eve 1904–

French concert pianist and journalist

By definition, a chemist only believes in the existence of a new substance when he has seen the substance, touched it, weighed and examined it, confronted it with acids, bottled it, and when he has determined its "atomic weight."

*Madame Curie*

Chapter XIII (p. 165)

The Literary Guild of America, Inc. New York, New York, USA. 1937

### Davy, Sir Humphry 1778–1829

English chemist

The person who wishes to understand the higher departments of chemistry, or to pursue them in their most interesting relations to the economy of Nature, ought to be well-grounded in elementary mathematics; he will oftener have to refer to arithmetic than algebra, and to algebra than to geometry. But all these sciences lend their aid to chemistry ...

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 172)

Cassell & Co., Ltd. London, England. 1889

I will say a few words of the intellectual qualities necessary for discovery or for the advancement of the science. Amongst them patience, industry, and neatness in manipulation, and accuracy and minuteness in observing and registering the phenomena which occur, are essential. A steady hand and a quick eye are most useful auxiliaries ...

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 174)

Cassell & Co., Ltd. London, England. 1889

A steady hand and a quick eye are most useful auxiliaries; but there have been very few great chemists who have preserved these advantages throughout life; for the business of the laboratory is often a service of danger and the elements, like the refractory spirits of romance, through the obedient slave of the magician, yet sometimes escape the influence of his talisman and endanger his person. Both the hands and the eyes of others however may sometimes advantageously [be] made use of.

*Consolations in Travel; or The Last Days of a Philosopher*

Dialogue V (pp. 251–252)

John Murray. London, England. 1830

### Dibdin, Charles Isaac Mungo 1768–1833

English songwriter

Thee, wond'rous chemist! Who canst make, at will,  
Wash-balls from dew-drops; and canst blooms distil;  
With blooms and dews, Dame Nature's self canst pose,  
And brew, like spiders, poison from the rose!

*Mirth and Metre*

The Age

A Satire, an Argument, l. 262–265

Printed for Vernon, Hood & Sharpe. London, England. 1807



**Dickens, Charles** 1812–70  
English novelist

...like a gloomy Analytical Chemist; always seeming to say, after “Chablis, Sir?” – “You wouldn’t if you knew what it was made of.”

*Our Mutual Friend*

Book the First, Chapter 2 (p. 11)

The Modern Library. New York, New York, USA. 1960

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

A man so various that he seemed to be  
Not one, but all mankind’s epitome.  
Stiff in opinions, always in the wrong;  
Was everything by starts, and nothing long:  
But, in the course of one revolving moon,  
Was chemist, fiddler, statesman, and buffoon.

*The Poetical Works of Dryden*

Absalom and Achitophel

Part 1, l. 545–560

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The sea is the chemist that dissolves the mountains and the rocks, pulverizes old continents and builds new, forever redistributing the solid matter of the globe.

In Bernard Jaffe

*New World of Chemistry*

Chapter 14 (p. 182)

Silver, Burdett & Company. New York, New York, USA. 1935

**Farrell, Hugh**  
No biographical data available

The chemist is revolutionizing industry. He is developing new products and new ideas every hour of every day. As a result of his work, flourishing industries are being scrapped overnight. There is no industry – not one – that is not in danger of waking up tomorrow and finding that the chemist has made a discovery that might revolutionize it.

In Bernard Jaffe

*New World of Chemistry*

Chapter 34 (p. 495)

Silver, Burdett & Company. New York, New York, USA. 1935

**Fischer, Emil Hermann** 1852–1919  
German chemist

The abundance of substances of which animals and plants are composed, the remarkable processes whereby they are formed and then broken down again have claimed the attention of mankind of old, and hence from the early days they also persistently captivated the interest of chemists.

*Nobel Lectures, Chemistry 1901–1921*

Syntheses in the Purine and Sugar Group

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Frost, Robert** 1874–1963  
American poet

Even while we talk some chemist at Columbia  
Is stealthily contriving wool from jute...

*Complete Poems of Robert Frost*

Build Soil

Henry Holt & Company. New York, New York, USA. 1949

**Fry, Harold Shipley** 1878–1949  
American chemist

The structural formula of the organic chemist is not the canvas on which the cubist artist should impose his drawings which he alone can interpret.

A Pragmatic System of Notation for Electronic Valance Conceptions in Chemical Formulas

*Chemical Reviews*, Volume 5, 1928 (pp. 558–559)

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

Nature has made certain things which we call natural, and everything else is “man-made”, ergo artificial. But what one learns in chemistry is that Nature wrote all the rules of structuring; man does not invent chemical structuring rules; he only discovers the rules. All the chemist can do is find out what Nature permits, and any substances that are thus developed or discovered are inherently natural.

*The Buckminster Fuller Reader* (p. 318)

Jonathan Cape. London, England. 1970

**Girtanner, Christopher** 1760–1800  
Swiss chemist and physician

Every chemist and every artist will make gold; kitchen utensils will be of silver, and even gold, which will contribute more than anything else to prolonged life, poisoned at present by the oxides of copper, lead, and iron, which we daily swallow with our food.

*Philosophical Magazine*, Volume vi (p. 383)

**Grosser, Arthur E.**  
American physical chemist

When we decode a cookbook, every one of us is a practicing chemist. Cooking is really the oldest, most basic application of physical and chemical forces to natural materials.

*New York Times*, May 29, 1984

**Hafiz, Mohammed Shems-ed-Deen** ca. 1300–88  
Persian poet

The chemist of love  
Will this perishing mould,  
Were it made out of mire,  
Transmute into gold.

*Divan*

**Herbert, George** 1593–1633  
English metaphysical poet

The subtle chymick can devest  
 And strip the creature naked, till he finde  
 The callow principles within their nest:  
 There he imparts to them his minde,  
 Admitted to their bed-chamber before  
 They appeare trim and drest  
 To ordinate suitours at the doore.

*The Temple*

The Church, Vanity, l. 15–21 (p. 126)  
 Medieval & Renaissance Texts & Studies. Binghamton, New York,  
 USA. 1995

**Hertwig, Oscar** 1849–1922  
 German embryologist

If the problem of the chemist is to investigate the numberless combinations of different kinds of atoms to form molecules, he can, in strictness, not touch upon the problem of life, for this begins where his inquiry ends. Over the structure of the chemical molecule rises the structure of the living substance as a broader and higher kind of organization. Over the structure of the cell rises again the structure of plants and animals, which exhibit the yet more complicated, elaborate combinations of millions and milliards of cells coordinated and differentiated in the most extremely various ways.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
 Growth of Biology in the Nineteenth Century (p. 475)  
 Government Printing Office. Washington, D.C. 1901

**Hoffmann, Roald** 1937–  
 Polish-born American chemist

I had written three pages on how insects are such good chemists, citing the silkworm sex attractant, and the bombardier beetle, spraying out hot hydrogen peroxide when threatened.

*Gaps and Verges*

Evolution (p. 3)  
 University of Central Florida Press. Orlando, Florida, USA. 1990

**Holmes, Harry N.**  
 No biographical data available

The chemist deals with a very material world, even though philosophers assure him that he doesn't really know matter, that he only perceives its attributes or properties. However, he is not to be argued out of his dinner by mere words.

*Out of the Test Tube*

Chapter II (p. 24)  
 Emerson Books, Inc. New York, New York, USA. 1941

**Ihde, Aaron J.**  
 No biographical data available

The person who is merely trained to carry out analyses or syntheses can do his job quite satisfactorily without knowing any history of chemistry. On the other hand, the chemist who is in a position where he has significant

responsibility for the planning of investigations needs to know something about the past history of chemical investigation and the development of chemical thought. Without such knowledge, he is merely a chemical technologist.

Let's Teach History of Chemistry to Chemists!

*Journal of Chemical Education*, Volume 48, 1971 (pp. 686–687)

**Kiernan, James G.**  
 No biographical data available

Chemists are like mathematicians, peculiarly liable to a dogmatic cast of mind, which precludes them from seeing the forest for the trees.

Mental Advance in Women and Race Suicide

*Alienist and Neurologist*, Volume 30 (p. 594)

**Laitinen, H. A.**  
 No biographical data available

The analytical chemist properly serves his role as a chemical measurements specialist only if he is a full partner in the interdisciplinary team concerned with solving the problem.

*Annals of Chemistry*, Volume 47, 1975 (p. 2073)

**Lavoisier, Antoine Laurent** 1743–94  
 French chemist

It ought likewise to be considered, that very little of chemistry can be learned in a first course, which is hardly sufficient to make the language of the science familiar to the ears, or the apparatus familiar to the eyes. It is almost impossible to become a chemist in less than three or four years of constant application.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xix)

Printed for William Creech. Edinburgh, Scotland. 1790

**Lehn, Jean-Marie** 1939–  
 French chemist

Like the artist, the chemist engraves into matter the products of creative imagination. The stone, the sounds, the words do not contain the works that the sculptor, the composer, the writer express from them. Similarly, the chemist creates original molecules, new materials, and novel properties from the elements produced by nature, indeed entire new worlds, that did not exist before they were shaped at the hands of the chemist, like matter is shaped by the hands of the artist, as so powerfully rendered by August Rodin.

*Supramolecular Chemistry: Concepts and Perspectives: A Personal Account Built upon the George Fisher Baker Lectures in Chemistry at Cornell University (and the) Lezione Lincee, Accademia Nazionale dei Lincei, Roma*

Chapter 10.3 (p. 206)

VCH. Weinheim, Germany. 1995

**Leonard, Jonathan Norton** 1903–75  
 American writer

It isn't the fault of the chemists that this change of pace has occurred. It is because chemistry, more than other sciences, is limited by definition. Its province is the molecule and its transformations. It does not penetrate into the atom. That is physics. It does not pry into the living cell. That is biology. There's an invisible line beyond which a modern chemist cannot go without becoming a physicist or a biologist. The chemists are like a group of settlers on a large and fertile island who have pushed their frontier to the sea on all sides and are left with the choice of migrating to other lands or staying at home to develop the ground they have won.

*Crusaders of Chemistry: Six Makers of the Modern World*  
The Harvest of Peaceful Middle Age  
Doubleday, Doran. Garden City, New York, USA. 1930

**Levi, Primo** 1919–87  
Italian writer and chemist

A chemist cannot find, already in his mind, the laws and the phenomena which govern matter.

*The Natural History of a Savant*

Chapter XI (p. 126)

J.M. Dent & Sons Ltd. London, England. 1927

**Lewis, Gilbert Newton** 1875–1946  
American chemist

A detective with his murder mystery, a chemist seeking the structure of a new compound; use little of the formal and logical modes of reasoning. Through a series of intuitions, surmises, fancies, they stumble upon the right explanation, and have a knack of seizing it when it once comes within reach.

*The Anatomy of Science*

Chapter I (p. 6)

Yale University Press. New Haven, Connecticut, USA. 1926

**Melville, Herman** 1819–91  
American novelist

As I am no chemist, I cannot give a scientific analysis of the water.

*Typee*

Chapter XXI (p. 171)

John Murray. London, England. 1847

**Minsk, Louis M.**  
No biographical data available

Here's to the chemist – a most extraordinary guy.  
Who does lots of things, he doesn't know why.  
The number of errors he throws down the sink,  
Lends one to believe that he seldom does think.  
His words are so blunt, his manner so rough  
Five minutes with him is more than enough.  
But don't pity him, he leads a great life,  
Rather pity the woman he chose for a wife.  
God bless her and keep her and please make her brave

To share with her husband all cares slight and grave.  
But, too, make her thankful – to this hark and list,  
She might have done worse – with some physicist.

Ode to a Chemist and his Wife

*Industrial and Engineering Chemistry: News Edition*, Volume 15,  
Number 22, December, 1937

**Moore, Jared Sparks** 1879–1951  
American psychologist

...the chemist cares for the constitution of the deadly poison as much as for that of the helpful drug.

*The Foundations of Psychology*

Book II, Chapter IV (p. 100)

Princeton University Press. Princeton, New Jersey, USA. 1921

**Mukaiyama, Teruaki** 1927–  
Japanese chemist and scientific statesman

In studies of new synthetic reactions, a detailed study of the observed phenomenon will provide you with a hint that could be a 'seed' to open an entirely new area of promising development. To cherish the 'seed' that is picked up by your own hands, and to let its roots spread deep into the soil, will surely lead you to further interesting possibilities. Chemists should always bear in mind that to realize their goals they need to practice their bench work daily. It will surely make your dreams come true.

*Challenges in Synthetic Organic Chemistry*

Chapter 13 (pp. 210–211)

**Nickon, Alex**  
Organic chemist

**Silversmith, Ernest E.**  
No biographical data available

Organic chemists need to keep a great many facts and concepts in their heads. Not surprising, therefore, they sometimes name compounds after head coverings, protecting, as it were, this storehouse of knowledge.

*Organic Chemistry: The Name Game*

Chapter 2 (p. 20)

Chemists spend a good deal of time inside buildings, so it is natural for them to relate the shapes of molecules to the ubiquitous structures.

*Organic Chemistry: The Name Game*

Chapter 4 (p. 50)

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932  
Latvian-born German chemist

All these sticky, mucilaginous, resinous, tarry masses which refuse to crystallize, and which are the abomination of the normal organic chemist; those substances which he carefully sets toward the back of his cupboard and marks "not fit for further use," just these are the substances which are the delight of the colloid chemist.

*An Introduction to Theoretical and Applied Colloid Chemistry*  
*The World of Neglected Dimensions*  
 Fourth Lecture (p. 134)

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

The chemist, indeed, is flattered more than anyone else with the hopes of discovering in what the essence of matter consists; and Nature, while she keeps the astronomer and the mechanic at a great distance seems to admit him to a more intimate acquaintance with her secrets. The vast powers which he has acquired over matter, the astonishing transformations which he effects, his success in analysing almost all bodies, and in reproducing so many, seem to promise that he shall one day discover the essence of a substance which he has so thoroughly subdued ...

Biographical account of the Late James Hutton

*Transactions of the Royal Society of Edinburgh*, Column 5 1805 (p. 74)

**Pope, Alexander** 1688–1744

English poet

The starving chemist in his golden views

Supremely blest.

*The Complete Poetical Works of Pope*

*An Essay on Man*

Epistle II

**Primo, Levi** 1919–87

Italian writer and chemist

I thought of another moral, more down to earth and concrete, and I believe that every militant chemist can confirm it: that one must distrust the almost-the-same (sodium is almost the same as potassium, but with sodium nothing would have happened), the practically identical, the approximate, all surrogates, and all patchwork. The differences can be small, but they can lead to radically different consequences, like a railroad's switch points: the chemist's trade consists in good part of being aware of these differences, knowing them close up and foreseeing their effects. And not only the chemist's trade.

Translated by Raymond Rosenthal

*The Periodic Table*

Potassium (p. 60)

New York, New York, USA. 1984

We chemists...are here for this – to make mistakes and to correct ourselves, to stand the blows and hand them out. We must never feel disarmed: nature is immense and complex, but it is not impermeable to the intelligence; we must circle around it, pierce and probe it, looking for the opening or making it.

Translated by Raymond Rosenthal

*The Periodic Table*

Nickel (p. 75)

New York, New York, USA. 1984

The trade of chemist (fortified, in my case, by the experience of Auschwitz), teaches you to overcome, indeed to ignore, certain revulsions that are neither necessary or congenital: matter is matter, neither noble nor vile, infinitely transformable, and its proximate origin is of no importance whatsoever. Nitrogen is nitrogen, it passes miraculously from the air into plants, from these into animals, and from animals into us; when its function in our body is exhausted, we eliminate it, but it still remains nitrogen, aseptic, innocent.

Translated by Raymond Rosenthal

*The Periodic Table*

Nitrogen (pp. 180–181)

New York, New York, USA. 1984

...to see if I could convey to the layman the strong and bitter flavor of our trade, which is only a particular instance, a more strenuous version of the business of living. I told him that it did not seem fair to me that the world should know everything about how the doctor, prostitute, sailor, assassin, countess, ancient Roman, conspirator, and Polynesian lives and nothing about how we [the chemist] transformers of matter live....

Translated by Raymond Rosenthal

*The Periodic Table*

Silver (p. 203)

New York, New York, USA. 1984

**Prudhomme, Sully** 1839–1907

French poet

Surrounded by beakers, by strange coils,  
 By ovens and flasks with twisted necks,  
 The chemist, fathoming the whims of attractions,  
 Artfully imposes on them their precise meetings.

In Helen Plotz

*Imagination's Other Place*

The Naked World

Thomas Y. Crowell Company. New York, New York, USA. 1955

**Richet, Charles** 1850–1935

French physiologist

A chemist cannot find, already in his mind, the laws and the phenomena which govern matter.

*The Natural History of a Savant*

Chapter XI (p. 126)

Printed for J. & A. Arch. London, England. 1837

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

A man would make but a very sorry chemist if he attended to that department of human knowledge alone. If your wish is to become really a man of science, and not merely a petty experimentalist, I should advise you to apply to every branch of natural philosophy, including mathematics.

*Frankenstein: Or, The Modern Prometheus*

Chapter III (p. 66)

George Routledge & Sons. London, England. 1891

**Sidgwick, N. V.**

No biographical data available

The chemist... must resist the temptation to make his own physics; if he does it will be bad physics – just as the physicist has sometimes been tempted to make his own chemistry, and then it was bad chemistry.

In Joseph Needham and Ernest Baldwin

*Hopkins & Biochemistry* (p. 204)

W. Heffer &amp; Sons Ltd. Cambridge, England. 1949

**Standen, Anthony**

American science writer

Chemists are, on the whole, like physicists, only “less so”. They don’t make quite the same wonderful mistakes, and much what they do is an art, related to cooking, instead of a true science. They have their moments, and their sources of legitimate pride. They don’t split atoms, as the physicists do. They join them together, and a very praiseworthy activity that is.

*Science Is a Sacred Cow*

Chapter III (pp. 77–78)

E.P. Dutton &amp; Company. New York, New York, USA. 1950

**Sylvester, James Joseph** 1814–97

English mathematician

I think that young chemists desirous of raising their science to its proper rank would act wisely in making themselves master betimes of the theory of algebraic forms. What mechanics is to physics, that I think is algebraic morphology, founded at option on the theory of partitions or ideal elements, or both, is destined to be to the chemistry of the future... invariants and isomerism are sister theories.

*American Journal of Mathematics*, Volume 1, 1878 (p. 126)**Thompson, Sir D’Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

The learned chemist is still a learned man; in love and knowledge of the arts the chemists are hardly beaten by the scholars.

*Science and the Classics*

Chapter I (p. 4)

Oxford University Press, Inc. London, England. 1940

**Turgenev, Ivan** 1818–83

Russian novelist and dramatist

“A good chemist is twenty times more useful as any poet,” broke in Bazarov.

Translated by Constance Garnett

*Fathers & Sons*

Chapter VI (p. 28)

Harper &amp; Brothers. New York, New York, USA. 1951

**Verne, Jules** 1828–1903

French novelist

If I were a chemist, I would tell him that the aerolites, bodies evidently formed exteriorly of our terrestrial globe, have, upon analysis, revealed indisputable traces of carbon, a substance which owes its origin solely to organized beings, and which, according to the experiments of Reichenbach, must necessarily itself have been *endued with animation*.

*From the Earth to the Moon*

Chapter XIX (p. 96)

Charles Scribner’s Sons. New York, New York, USA. 1890

**von Liebig, Justus** 1803–73

German organic chemist

The loveliest theories are being overthrown by these damned experiments; it is no fun being a chemist any more.

In William H. Brock

*Justus von Liebig*

Letter to J.J. Berzelius, 22 July, 1834 (p. 72)

Cambridge University Press. Cambridge, England. 1997

**West, Philip**

No biographical data available

There is no quick way to become a chemist. Simply reading books and learning chemical theories can no more produce a true chemist than learning the theory of music can produce a real musician.

*Annals of Chemistry*, Volume 46, 1974 (p. 784A)**CHEMIST, PHYSICAL****Luhr, Overton** 1907–42

Physicist

A chemist is a person who makes inaccurate measurements on very pure materials; a physicist is one who makes very accurate measurements on impure materials; while a physical chemist is one who makes inaccurate measurements on impure materials.

*Physics Tells Why: An Explanation of Some Common Physical Phenomena*

Chapter One (p. 4)

Jaques Cattell Press. Lancaster, Pennsylvania, USA. 1943

**CHEMIST, RESEARCH****National Research Council (USA)**

One might follow a research chemist around all day, from spectrograph to computer to electronic shop to vacuum chamber, without deducing from external evidence that he was not a physicist, unless, as might still happen today, the smell of his environment gave it away.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 68)

National Academy of Sciences

Washington, D.C. 1972



**CHEMISTRY****Adams, Henry Brooks** 1838–1918

American man of letters

The bit of practical teaching he afterwards reviewed with most curiosity was the course in Chemistry, which taught him a number of theories that befogged his mind for a lifetime.

*The Education of Henry Adams: An Autobiography*

Chapter IV (p. 60)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA. 1918

**Aldersey-Williams, Hugh** 1959–

Author and journalist

Chemistry is the science of molecules, and it is a messy science.

*The Most Beautiful Molecule*

Chapter 1 (p. 14)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1995

**Armstrong, Henry Edward** 1848–1937

English chemist

Prof. W.L. Bragg asserts that in sodium chloride there appear to be no molecules represented by NaCl. The equality in numbers of sodium and chlorine atoms is arrived at by a chessboard pattern of these atoms; it is a result of geometry and not of a pairing-off of these atoms.... Chemistry is neither chess nor geometry, whatever X-ray physics may be.... It were time the chemists took charge of chemistry once more and protected neophytes against the worship of false gods; at least taught them to ask for something more than chessboard evidence.

Letter to the Editor, Poor Common Salt

*Nature*, Volume 120, Number 3022, October 1, 1927 (p. 478)

**Asimov, Isaac** 1920–92

American author and biochemist

Beginning students of chemistry often think of the science as a mere collection of disconnected data to be memorized by brute force. Not at all! Just look at it properly and everything hangs together and makes sense. Of course, getting the hang of the proper look isn't always easy.

*From Earth to Heaven*

To Tell a Chemist (p. 113)

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1996

**Atkins, Peter William** 1940–

English physical chemist and writer

Chemistry stands at the pivot of science. On the one hand, it deals with biology and provides explanations for the processes of life. On the other hand, it mingles with physics and finds explanations for chemical phenomena in the fundamental processes and particles of the universe. Chemistry links the familiar with the fundamental.

*Molecules* (p. 2)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

Immediately south of nitrogen is phosphorus, which was first isolated by the distillation and treatment of urine – an indication of the lengths to which chemists are prepared to go, or perhaps only a sign of the obsessive, scatological origins of their vocation.

*The Periodic Kingdom: A Journey into the Land of the Chemical Elements*

Chapter 2 (p. 20)

Basic Books, Inc., Publishers. New York, New York, USA. 1995

**Austin, Alfred** 1835–1913

English author

LUCIFER: Only the chemistry of love can make

Two atoms one.

*Prince Lucifer*

Act IV, Scene V, l. 64–65

Macmillan &amp; Company Ltd. London, England. 1891

**Author undetermined**

Chemistry is physics without thought; mathematics is physics without purpose.

Source undetermined

Light a match and say 'This is chemistry'. Then blow it out and let it fall to the floor and say 'This is physics.'

Source undetermined

**Bailar, Jr., John C.** 1904–91

No biographical data available

**Moeller, Therald**

No biographical data available

Look around you. That's how chemistry began – in the limitless curiosity of human beings about their surroundings.

*Chemistry*

Chapter 1 (p. 1)

Academic Press. New York, New York, USA. 1978

**Bartlett, Elisha** 1804–55

American physician

Let chemistry push her researches into the remotest accessible recesses of the living economy, and let her claim, for her own, every process, every act, every transformation, over which she can establish a legitimate jurisdiction.

*An Essay on the Philosophy of Medical Science*

Part II, Chapter 15

Lea and Blanchard. Philadelphia, Pennsylvania, USA. 1844

**Bartow, Edward** 1870–1958

American chemist

...chemistry is dependent on other sciences in the building of what we might call The House of Chemistry... The House of Chemistry, or perhaps we should call it the Mansion, Castle, or Palace of Chemistry, cannot stand alone. Can we not imagine that it is built on the rocks of geology and mineralogy?... This mansion is built in



the garden of agriculture. Its foundation is in the healing art of medicine... Physics is the window, where physical instruments shed light on the intricacies of the composition of matter.... Astronomy is the upper story, from which chemistry looks out on the universe, and studies the composition of the stars. History is the walls, which bind the various parts together, and includes chemistry and the sciences in one homogeneous system.

Presidential Address, Progress in Sanitation

*Industrial and Engineering Chemistry: News Edition*, Volume 14, Number 19, 10 October, 1936 (p. 385)

**Beguinus, Jean** ca. 1550–ca. 1620

French chemist and first published chemist

Chymistry is the Art of dissolving natural mixed bodies, and of coagulating the same when dissolved, and of reducing into salubrious, safe, and grateful medicaments.

*Tyrocinium Chymicum: Chemical Essays Acquired from Nature & Manual Experience*

Book One, Chapter I (p. 1)

Heptangle Books. Gillette, New Jersey, USA. 1983

**Bent, Henry Albert**

No biographical data available

Chemistry is the central subject in a liberal arts curriculum. It stands between the traditional humanities on the one hand and modern physics on the other hand.

*Chemical and Engineering News*, March 12, 1984 (p. 44)

**Bernal, John Desmond** 1901–71

Irish-born physicist and X-ray crystallographer

Chemistry, far more than physics, was the dominant science of the nineteenth century. This is so, in spite of the fact that the major physical discoveries found their development and application in the steam engine at the beginning and electric power at the end of the century. With chemistry, however, there was a far larger number of new processes that could be turned more immediately to profitable use, and this afforded directly and indirectly for the training and employment of an ever-increasing number of chemists. Indeed from the beginning of the century and increasingly till its end the chemists were the most numerous of the newly differentiated groups of scientists.

*Science and Industry in the Nineteenth Century* (pp. 70–72)

Indiana University Press. Bloomington, Indiana, USA. 1953

...the old chemistry was largely a matter of memory, a set of cookery recipes that had, for no apparent reason but to worry the student, to be learnt by heart.

In H.N. Parton

*Science Is Human*

Science and the Liberal Arts (p. 17)

University of Otago Press. Dunedin, New Zealand. 1972

**Berthelot, Marcellin (or Marcelin)**

**Pierre Eugène** 1827–1907

French chemist and politician

Chemistry creates its objects.

In Jean-Marie Lehn

*Supramolecular Chemistry: Concepts and Perspectives: A Personal Account Built upon the George Fisher Baker Lectures in Chemistry at Cornell University (and the) Lezione Lincee, Accademia Nazionale dei Lincei, Roma*

Chapter 10.3 (p. 206)

VCH. Weinheim, Germany. 1995

Chemistry is not a primitive science, like geometry or astronomy; it is constructed from the debris of a previous scientific formation; a formation half chimerical and half positive, itself founded on the treasure slowly amassed by the practical discoveries of metallurgy, medicine, industry, and domestic economy. It has to do with alchemy, which pretended to enrich its adepts by teaching them to manufacture gold and silver, to shield them from diseases by the preparation of the panacea, and finally to obtain for them perfect felicity by identifying them with the soul of the world and the universal spirit.

Quoted in Matthew Moncrieff Pattison Muir

*A History of Chemical Theories and Laws*

Part I, Chapter I (p. 2)

John Wiley & Sons. New York, New York, USA. 1907

**Berzelius, Jöns Jacob** 1779–1848

Swedish chemist

Of all the sciences contributing to medicine, chemistry is the primary one, and, apart from the general light it throws on the entire art of healing, it will soon bestow on some of its branches a perfection such as one never could have anticipated.

In J. Erik Jorpes

*Jac. Berzelius* (p. 7)

University of California Press. Berkeley, California, USA. 1970

**Biggs, Noah** fl. 1651

English medical practitioner

I praise God who hath been so bountiful to me as to call me to the practise of Chymistry, out of the dregs of other Professions: Since Chymistry hath principles not drawn from fallacious reasonings, but such as are known by nature, and conspicuous by fire; and she prepared the Intellect to penetrate, not the upper deck or surface of things, but the deep hold, the concentric and hidden things of nature, and makes an investigation into the America of nature...

*The Vanity of the Craft of Physick* (p. 57)

Printed for Edward Blackmore. London, England. 1651

**Black, Joseph** 1728–99

Scottish chemist and physician

Chemistry is not yet a science. We are very far from the knowledge of first principles. We should avoid everything that has the pretensions of a full system. The whole of chemical science should, as yet, be analytical, like Newton's Optics, in the form of a general law, at the very end of our induction, as the reward of our labour.

*Lectures on the Elements of Chemistry* (Volume 1) (p. 547)  
Mundell & Son. Edinburgh, Scotland. 1803

**Boerhaave, Herman** 1668–1738

Dutch chemist, physician, and botanist

But if anyone shall still retain a doubt of the worth and abilities of chymistry, to reward those who cultivate it: let him consider the practice and procedure of the happiest philosopher the world ever yet cou'd boast, the great Sir Isaac Newton: who, when he demonstrates the laws, the actions, and the powers of bodies, from a consideration of their effects, always produces chymical experiments for his vouchers; and when, to solve other phenomena, he makes use of these powers, his refuge is to chymistry.

In Arnold Thackray

*Atoms and Powers: An Essay on Newtonian Matter – Theory and the Development of Chemistry*

Chapter 2 (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1970

Chemistry is an Art, that teaches us how to perform certain physical operations, by which bodies that are discernible by the senses, or that may be rendered so, and that are capable of being contained in vessels, may by suitable instruments be so changed, that particular determin'd effects may be thence produced, and the causes of those effects understood by the effects themselves, to the manifold improvement of various Arts.

*Elements of Chemistry*

Part II, Which Delineates the Theory (p. 19)

Printed for J. and J. Pemberton. London, England. 1735

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

For I observed, that of late Chymistry begins, as indeed it deserves, to be cultivated by Learned Men who before dispis'd it, and to be pretended to by many who never cultivated, that they may be thought not to ignore it...

*The Sceptical Chymist*

A Preface, Introductory (p. A2)

Dawsons of Pall Mall. London, England. 1965

**Bredwell, Stephen**

English physician

I say in like manner, the art of Chimistrie is in it selfe the most noble instrument of naturall knowledges; but through the ignoraunce and impietie, partly of those that most audaciously professe it without skill and partly of them that impudently condemne that they knowe not, it is of all others most basely despised and scornfully rejected.

In John Gerarde

*The Herball or Generall Historie of Plantes*

Prefatory letter

Bonham & I. Norton. London, England. 1597

**Bridges, Robert Seymour** 1844–1930

English poet

From Universal Mind the first-born atoms draw  
their function, whose rich chemistry the plants transmute

to make organic life, whereon animals feed  
to fashion sight and sense and give service to man,  
who sprung from them is conscient in his last degree  
of ministry unto God, the Universal Mind,  
whither all effect returneth whence it first began.

*The Testament of Beauty*

Book IV, I. 116–122

Oxford University Press, Inc. Oxford, England. 1930

**Buchanan, Robert Williams** 1841–1901

English poet and novelist

He read the great stone Book whereon is writ  
The riddle of the world from age to age;  
Knew the fair marvels of the Zodiac,  
The stars and their processions; had by heart  
The elemental truths of chemistry...

And zealously, within a mental maze,

As dense as that which covered Rosamond,

His teacher guarded him against the creeds.

*The Complete Poetical Works of Robert Buchanan* (Volume 2)

Justinian; Or, The New Creed, I. 256–263

Chatto & Windus. London, England. 1901

**Buchner, Eduard** 1860–1917

German chemist

It is difficult, however, for a person to be comprehensible  
and at the same time remain scientific, so I must ask you  
to bear with me.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1907

Cell-Free Fermentation (p. 103)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

We must never, therefore, let ourselves fall into the way  
of thinking “ignorabimus” (“We shall never know”), but  
must have every confidence that the day will dawn when  
even those processes of life which are still a puzzle today  
will cease to be inaccessible to us natural scientists.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1907

Cell-Free Fermentation (p. 119)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Meredith, Owen (Edward Robert  
Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

“Friend, I believe in miracles?” said he,  
“And I believe in chemistry as well...”

*Glenaveril; or, the Metamorphoses*

Volume II, Book The Fourth The Guardians, Canto ii. John Steel, I. 463–464

D. Appleton & Company, New York, New York, USA. 1885

Chemistry, Soldier, trust me, is a science  
Which now-a-days we sceptred students need  
To study more than your rough art of war.

*Chronicles and Characters* (Volume 2)

The Duke's Laboratory, I. 234–236

Chapman & Hall, London, England. 1868

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

No Chemistry for them unfolds her gases,  
No Metaphysics are let loose in lectures,  
No Circulating Library amasses  
Religious novels, moral tales, and strictures  
Upon the living manners, as they pass us;  
No Exhibition glares with annual pictures;  
They stare not on the stars from out their attics,  
Nor deal (thank God for that!) in Mathematics.

*The Complete Poetical Works of Byron*

Beppo: A Venetian Story, I. 617–624

Houghton Mifflin Company, Boston, Massachusetts, USA. 1933

**Cady, Varian**

No biographical data available

I think that I shall never see  
A test as hard as Chemistry,  
A test that makes you stir and squirm  
And wonder if you'll pass this term,  
A test that makes you tear your hair  
And wish you were not sitting there,  
A test that turns your hair to snow  
Because it asks you what you don't know.  
Tests are flunked by fools like me  
Especially when in Chemistry.

(Chemis)TREES

*Industrial and Engineering Chemistry: News Edition*, Volume 12,  
Number 22, 20 November, 1934 (p. 419)

**Caglioti, Luciano**

Italian chemist

Chemistry has invaded our lives, has provided us with  
new foods and new materials, has replaced wood and  
metal with less expensive products, has enabled low-  
income classes to acquire things that otherwise would  
have been inaccessible.

*The Two Faces of Chemistry*

Preface (p. xv)

The MIT Press, Cambridge, Massachusetts, USA. 1983

Chemistry... is one of the broadest branches of science, if  
for no other reason that, when we think about it, every-  
thing is chemistry.

*The Two Faces of Chemistry*

Preface (p. xv)

The MIT Press, Cambridge, Massachusetts, USA. 1983

**Chakrabarti, C. L.**

No biographical data available

Analytical chemistry, like Cleopatra's beauty, is of infi-  
nite variety.

*Journal of Chemical Education*, Volume 47, 1970 (p. 58)

**Chaptal, Jean-Antoine-Claude**

No biographical data available

How immense is the empire of chemistry! It embraces  
in its studies all the phenomena which nature presents to  
our view, in the infinite variety of her productions, and  
all the processes of the arts for which we are indebted to  
human ingenuity.

*Chemistry Applied to Arts and Manufacturing*

Book I (pp. 2–3)

R. Phillips, London, England. 1807

**Charlie Chan (Fictional character)**

Interesting problem in chemistry: sweet wine often turn  
nice woman sour.

*Charlie Chan in Rio*

Film (1941)

**Collingwood, Robin George** 1889–1943

English historian and philosopher

Egregious blunder! A beginner in physics or chemistry  
does not know what matter is, and if he thinks he does it  
is the duty of his teacher to disabuse him; but he knows  
what physics or chemistry is; it is the stuff in this red text-  
book, or the stuff old So-and-So teaches, or the stuff we  
have on Tuesday mornings.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part I, Chapter I, aphorism 1.42 (p. 3)

At The Clarendon Press, Oxford, England. 1942

**Cooke, Josiah Parsons** 1827–94

American chemist

The elementary principles and more conspicuous facts of  
chemistry are so intimately associated with the experi-  
ence of every-day life, and find such important applica-  
tions in the useful arts, that no man at the present day can  
be regarded as educated who is ignorant of them.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 6)

D. Appleton & Co. New York, New York, USA. 1855

**Cram, Donald J.** 1919–2001

American chemist

The chemistry of the day, to get done, had to be driven by  
the thought that it is the most important thing in the world,  
but the chemistry of the paper, thesis, or monograph  
requires perspective, context, and balanced judgment.

*From Design to Discovery*

Personal Notes (p. 3)

American Chemical Society, Washington, D.C. 1990

**Cullen, William** 1710–90

Scottish physician and chemist

Chemistry is the art of separating mixt bodies into their constituent parts and of combining different bodies or the parts of bodies into new mixts for the purposes of philosophy and arts, that is, for the purposes of philosophy by explaining the composition of bodies, the nature of mixture and the properties of bodies thereon depending, and for the purposes of arts by producing several artificial substances more suitable to the intention of various arts than any natural productions are.

In A.L. Donovan

*Philosophical Chemistry in the Scottish Enlightenment*

Chapter 6 (p. 98)

At The University Press, Edinburgh, Scotland. 1975

### **Curie, Marie Skłodowska** 1867–1934

French physical chemist

...we have here an entirely separate kind of chemistry for which the current tool we use is the electrometer, not the balance, and which we might well call the chemistry of the imponderable.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1911

Radium and the New Concepts in Chemistry (p. 211)

Elsevier Publishing Company, Amsterdam, Netherlands. 1966

### **Dana, James Dwight** 1813–95

American geologist

Science has no explanation for the origin of Life. The living organism instead of being a product of physical or chemical forces, controls these forces for its highest forms.

*Manual of Geology, Treating of the Principles of the Science with Special Reference to American Geological History*

Iverson, Blakeman, Taylor & Co. New York, New York, USA. 1880

### **Davy, Sir Humphry** 1778–1829

English chemist

The higher mathematics and pure physics appear to me to offer much more noble objects of contemplation and fields of discovery, and, practically considered, the results of the chemist are much more humble, belonging principally to the apothecary's shop and the kitchen.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 158)

Cassell & Co., Ltd. London, England. 1889

...in general, both the principles of chemistry are followed, and series of experiments performed without any view to utility; and a great noise is made if a new metal or a new substance is discovered, or if some abstracted law is made known relating to the phenomena of nature; yet, amongst the variety of new substances, few have been applied to any trifling use even, and the greater number have had no application at all.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 166)

Cassell & Co., Ltd. London, England. 1889

The results of this science [chemistry] are not like the temples of the ancients, in which statues of the gods were placed, where incense was offered and sacrifices were performed, and which were presented to the adoration of the multitude founded upon superstitious feelings; but they are rather like the palaces of the moderns, to be admired and used, and where the statues, which in the ancients raised feelings of adoration and awe, now produce only feelings of pleasure, and gratify a refined taste.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 169)

Cassell & Co., Ltd. London, England. 1889

Chemistry relates to those operations by which the intimate nature of bodies is changed, or by which they acquire new properties.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 171)

Cassell & Co., Ltd. London, England. 1889

Chemistry relates to those operations by which the intimate nature of bodies is changed, or by which they acquire new properties. This definition will not only apply to the effects of mixture, but to the phenomena of electricity, and in short to all the changes which do not merely depend upon the motion or division of masses of matter.

*Consolations in Travel; or the Last Days of a Philosopher*

Dialogue V (pp. 247–248)

John Murray. London, England. 1830

It may be said of modern chemistry, that its beginning is pleasure, its progress knowledge and its object truth and utility.

*Consolations in Travel; or The Last Days of a Philosopher*

Dialogue V (p. 251)

John Murray. London, England. 1830

Chemistry is that part of Natural Philosophy which relates to those intimate actions of bodies upon each other, by which their appearances are altered, and their individuality destroyed.

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 5)

Press of the Royal Institution of Great Britain. London. 1802

...at no very distant period the whole science [chemistry] will be capable of elucidation by mathematical principles.

*Elements of Chemical Philosophy*

Part I, Volume I, Introduction (p. 60)

Printed for J. Johnson & Company, London, England. 1812

### **de Balzac, Honoré** 1799–1850

French novelist

You are dressed so coquettishly to talk about chemistry.

*The Quest of the Absolute* (p. 73)

The Macmillan Company, New York, New York, USA. 1901

Modern chemistry is...much, and yet little. Much has been accomplished, for chemistry has learned to shrink

before no difficulties; little, because what has been accomplished is as nothing compared with what remains to do.

*The Quest of the Absolute* (p. 76)

The Macmillan Company. New York, New York, USA. 1901

**de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

...chemistry ought to be not for chemists alone.

*The Tragic Sense of Life*

Chapter XII (p. 356)

Princeton University Press. Princeton, New Jersey, USA. 1972

**Dostoevsky, Fyodor Mikhailovich** 1821–81

Russian writer

It's chemistry, brother, chemistry. There's no help for it, your reverence, you must make way for chemistry.

In *Great Books of the Western World* (Volume 52)

*The Brothers Karamazov*

Part IV, Chapter XI (p. 312)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

A formidable array of bottles and test tubes, with the pungent cleanly smell of hydrochloric acid, told me that he had spent his day in the chemical work which was so dear to him. "Well, have you solved it?" I asked as I entered. "Yes. It was the bisulphate of baryta."

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Case of Identity* (p. 413)

Wings Books. New York, New York, USA. 1967

What horrible work this chemistry is! Look at my frock!

It is ruined. And this dreadful smell!

*The Great Shadow and Beyond the City*

Chapter IX (p. 213)

Bernhard Tauchnitz. Leipzig, Germany. 1893

**du Fresnoy, Nicholas Langlet** 1674–1755

French historian of alchemy

It is necessary to note that there are two kinds of chemistry; the one wise and reasonable, even necessary for the extraction of useful remedies from all things in nature...: the other is that foolish and senseless chemistry which is nevertheless the older of the two... The first has been given the name of Chemistry, and the second that of Alchemy.

In Allen G. Debus

*The French Paracelsians*

Chapter 6 (p. 203)

Cambridge University Press. Cambridge, England. 1991

**Duffy, Carol Ann** 1955–

Scottish poet, playwright, and writer

The words you spoke were frenzied prayers to chemistry...

*From the Other Country*

Dream of a Lost Friend, l. 9

Anvil Press Poetry. London, England. 1990

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

In chemistry, our theories are crutches; to show that they are valid, they must be used to walk... A theory established with the help of twenty facts must explain thirty, and lead to the discovery of ten more.

*Lecons de philosophie chimique* (p. 60)

Publisher data not available

**Duncan, Robert Kennedy** 1919–88

American poet

Chemistry having its equations beyond our range of inequation.

*Bending the Bow*

Orders Passage 24, l. 75–76

New Directions. New York, New York, USA. 1968

**Edgeworth, Maria** 1767–1849

English writer

...chemistry is a science particularly suited to women, suited to their talents and their situation. Chemistry is not a science of parade, it affords occupation and infinite variety; it demands no bodily strength, it can be pursued in retirement, it applies immediately to useful and domestic purposes; and whilst the ingenuity of the most intensive mind may be exercised, there is no danger of inflaming the imagination; the judgment is improved, the mind is intent upon realities, the knowledge that is acquired is exact, and the pleasure of the pursuit is a sufficient reward for the labour.

*Letters for Literary Ladies to Which Is Added an Essay on the Noble Science of Self-Justification*

Answer to the Preceding Letter (pp. 39–40)

Joseph Milligan. Georgetown, D.C. 1810

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

'Tis a short sight to limit our faith in laws to those of gravity, of chemistry, of botany, and so forth.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Worship (p. 1065)

The Library of America. New York, New York, USA. 1983

Chemistry takes to pieces, but it does not construct.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

*The Conduct of Life*

Chapter VII (p. 282)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Chemistry began by saying it would change the base metals into gold. By not doing that it has done much greater things.



*Journals of Ralph Waldo Emerson 1824–1832*

January 22, 1830 (p. 288)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Faraday, Michael** 1791–1867

English physicist and chemist

Chemistry is necessarily an experimental science: its conclusions are drawn from data, and its principles supported by evidence derived from facts.... Hence the importance of multiplying facts by every possible means, while engaged in such pursuits; and hence Chemistry is necessarily an experimental science.

*Chemical Manipulation*

Introduction

Printed and Published by W. Phillips. London, England. 1827

It is the great beauty of our science, CHEMISTRY, that advancement in it, whether in a degree great or small, instead of exhausting the subjects of research, opens the doors to further and more abundant knowledge, overflowing with beauty and utility, to those who will be at the easy personal pains of understanding its experimental investigations.

*Experimental Researches in Electricity* (Volume 1)

Seventh Series, 871 (p. 257)

Richard and John Edward Taylor. London, England. 1839–1855

**Farber, Eduard** 1892–1969

Galician chemist

The evolution of chemistry is a drama written and enacted by the great chemists.

*Great Chemists*

Preface (p. ix)

Interscience. New York, New York, USA. 1961

**Findlay, Alexander**

No biographical data available

...the end and aim of chemistry is not merely material. Chemistry offers its contribution also to the deeper interests of the human mind. Occupied as he is with the study of material substances and of the marvelous transformations which he is able to bring about in them, the thinking chemist is forced to look below the surface of things and to seek an answer to the fundamental questions relating to the ultimate constitution and structure of matter, and to the forces which govern the changes and transformations which he observes in his laboratory, or which are wrought out in the larger laboratory of Nature.

*Chemistry in the Service of Man*

Chapter I (p. 2)

Longmans, Green & Co. London, England. 1916

**Fischer, Emil Hermann** 1852–1919

German chemist

...the veil behind which Nature has so carefully concealed her secrets is being lifted where the carbohydrates are concerned. Nevertheless, the chemical enigma of Life

will not be solved until organic chemistry has mastered another, even more difficult subject, the proteins, in the same way as it has mastered the carbohydrates.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1902

Syntheses in the Purine and Sugar Group (p. 34)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

The circle within which the individual research worker, especially as an experimenter, can distinguish himself is continually shrinking in size. Consequently the progress of science today is not so much determined by brilliant achievements of individual workers, but rather by the planned collaboration of many observers.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1902

Syntheses in the Purine and Sugar Group (p. 35)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Flory, Paul J.** 1910–85

American physical chemist

...to hold that all chemistry follows deductively from physics and dismiss the matter therewith is to overlook the central role of science in erecting constructs for representation of physical reality in terms rational to the human mind...to present chemistry as a deductive science is to conceal the historical foundations and conceptual framework of the science of molecules and molecular behavior. This viewpoint could conceivably lead ultimately to denial of the rightful existence of chemistry as a separate discipline.

*The Science of Molecules*

*Chemical Engineering News*, Volume 52, Number 30, 1974 (p. 25)

**Fownes, George** 1815–49

English chemist

The Science of Chemistry has for its object the study of the nature and the properties of all the materials which enter into the composition or structure of the earth, the sea, and the air...The highest efforts of Chemistry are constantly directed to the discovery of the general laws or rules which regulate the formation of chemical compounds, and determine the action of one substance upon another. These laws are deduced from careful observation and comparison of the properties and relations of vast numbers of individual substances; – and by this method alone. The science is entirely experimental, and all its conclusions the result of skilful and systematic experimental investigations.

*A Manual of Elementary Chemistry, Theoretical and Practical*

Introduction (p. 37)

Henry C. Lea. Philadelphia, Pennsylvania, USA. 1870

**Glaser, Christophe** 1615–78

Swiss chemist

They that have any true knowledge of this Noble Art, are without doubt fully persuaded of the usefulness of it; for



it is the key which alone can unlock to all Naturalists the door of Nature's secrets...

*The Compleat Chymist; or a New Treatise of Chymistry*

Chapter II (p. 3)

Printed for John Starkey. London, England. 1677

### **Haber, Fritz** 1868–1934

German physical chemist

Nitrogen bacteria teach us that Nature, with her sophisticated forms of the chemistry of living matter, still understands and utilizes methods which we do not as yet know how to imitate. Let it suffice that in the meantime improved nitrogen fertilization of the soil brings new nutritive riches to mankind and that the chemical industry comes to the aid of the farmer who, in the good earth, changes stones into bread.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1918

The Synthesis of Ammonia from Its Elements (p. 339)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### **Halbach, Mary Jayne**

No biographical data available

I think that I shall never see

A study as muddled as chemistry,

A study hidden in ponderous books,

Where only a chemist ever looks!

A study written in secret code –

Just numerous equations by the load!

Chemistry was and is and will be –

But I'll never know what it means to me!

Sentiment of a Would-Be Chemistry Student

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 20, 20 October, 1932 (p. 257)

### **Haldane, John Burdon Sanderson** 1892–1964

English biologist

Chemistry is not haunted by the phlogiston theory as Christianity is haunted by the theory of a God with a craving for bloody sacrifices.

*Possible Worlds and Other Papers*

Chapter XXXI (p. 243)

Harper & Brothers Publishers. New York, New York, USA. 1928

### **Hamor, William Allan**

No biographical data available

To many intelligent and cultivated persons not specifically instructed in Chemistry, this word recalls confused memories of colored liquids, glistening crystals, dazzling flames, suffocating fumes, intolerable odors, startling explosions, and a chaos of mystifying experiments, the interest in which is proportional to the danger supposed to attend their exhibition.

*The Science-history of the Universe* (Volume 4)

Chapter I (p. 1)

The Current Literature Publishing Co. New York, New York, USA. 1909

### **Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Chemistry is, so far, eminently unmathematical (and therefore a suitable study for men of large capacity, who may be nearly destitute of mathematical talent – but this by the way), and it appears to communicate a part of its complexity and vagueness to electrical science whenever electrical phenomena which we can study are accompanied by chemical changes.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 12)

D. van Nostrand Co. New York, New York, USA. 1893

### **Hendrick, Ellwood**

American chemical engineer

Unless a man can have a good tune by himself, just wondering, and thinking about things, and guessing out, as best he can, how they happen, he can have no joy in chemistry.

*Opportunities in Chemistry*

Introduction (p. vii)

Harper & Brothers Publishers. New York, New York, USA. 1919

A knowledge of chemistry is something like a good wife.

It will help a man along in his work, but he must not count on it to support him.

*Opportunities in Chemistry*

Introduction (p. x)

Harper & Brothers Publishers. New York, New York, USA. 1919

There is a kind of cousinship between chemistry and astronomy, but their eyes are pointed in different directions – astronomy has to do with the ways of great masses of matter in their movements throughout illimitable space, while chemistry reasons about and tries out theories in regard to the ways of particles infinitely small.

*Everyman's Chemistry*

Chapter II (p. 16)

Harper & Brothers Publishers. New York, New York, USA. 1917

...chemistry is a study accompanied by constant surprises, and the only authority who "knows all about chemistry" is a poor creature, bereft of imagination.

*Everyman's Chemistry*

Chapter II

Harper & Brothers Publishers. New York, New York, USA. 1917

### **Hinshelwood, Sir Cyril** 1897–1967

English chemist

What the Society is and must continue above all else to be is a fellowship of those who share the love of chemistry, that most splendid child of intellect and art. Chemistry provides not only a mental discipline, but an adventure and an aesthetic experience. Its followers seek to know the hidden causes which underlie the transformations of our changing world, to learn the essence of the rose's colour, the lilac's fragrance, and the oak's tenacity, and

to understand the secret paths by which the sunlight and the air create these wonders.

Centenary Celebration of the Chemical Society  
*Journal of the Chemical Society of London*, 1947 (p. 1277)

### Hoblyn, Richard Dennis

No biographical data available

It will be found that there is no science so intimately connected with the arts of life, with the very life itself of man, as chemistry.

*A Manual of Chemistry* (p. 11)  
Printed for Scott, Webster & Geary  
London, England. 1841

### Hoffer, Eric 1902–83

American longshoreman and philosopher

The chemistry of dissatisfaction is as the chemistry of some marvelously potent tar. In it are the building stones of explosives, stimulants, poisons, opiates, perfumes, and stench.

*The Passionate State of Mind, and Other Aphorisms*  
No. 14  
Harper and Brothers. New York, New York, USA. 1955

### Hoffmann, Roald 1937–

Polish-born American chemist

These chemicals we desire and fear (chemists call them compounds or molecules, once they are reasonably pure) are not the largest (the realm of astronomy), nor the smallest (part of physics). They are squarely, nicely in the middle, on our human scale. Which is why we care about them, not as distanced, hypothetical constructs, but in this world. Those molecules, of pharmaceutical or pollutant, are of just the right size to interact, for better or for worse, with the molecules of our bodies.

*The Same and Not the Same*  
Preface (p. xiv)  
Columbia University Press. New York, New York, USA. 1995

Chemistry, the molecular way of knowing the natural and unnatural, is a remarkable science, prodigal in the way it has changed our world.

*The Same and Not the Same*  
Part One (p. 4)  
Columbia University Press. New York, New York, USA. 1995

Atoms are nice, atoms are fundamental, but they're not chemistry. Chemistry is about molecules, the fixed but transformable way in which atoms get together for a while.

*Chemistry Imagined: Reflections on Science*  
Smithsonian Institution Press. 1993

Chemistry is positioned between the simple world of atoms and the complex nature of biological molecules and real materials.

*Passionate Minds*  
Tapeworm Quadrilles (p. 20)  
Oxford University Press. Oxford, England. 1997

### Hofmann, A. W.

No biographical data available

Organic chemistry before Kekulé spread his wings was like a merrily splashing torrent; there were so many stones in the water that one could still cross it without getting wet. Today, the torrent has become a deep and massive stream; the eye can hardly see the opposite bank, and proud, richly loaded fleets rock gently on its broad surface.

In W.H. Brock, O.T. Benfey and S. Stark  
Hofmann's Benzene Tree at the Kekulé Festivities  
*Journal of Chemical Education*, Volume 68, 1991

### Holmes, Harry N.

No biographical data available

While you yawn comfortably in your easy chair, chemistry wages desperate battles on many fronts – against man's insect enemies, yet dominant on earth; against disease bacteria that have from time to time threatened to exterminate the race of men; against the frowns and mysteries of Nature.

*Out of the Test Tube*  
Preface (p. ix)  
Emerson Books, Inc. New York, New York, USA. 1941

### Horne, R. A.

No biographical data available

If you bemoan technological compartmentalization, take hope! Consider environmental chemistry. Man is a chemical mote aswim in a chemical soup. All the changes about him, all the changes within him are chemical. Everything he sees and touches, everything he does, and the effect of what he does are chemical. If there is anything in the real world that does not fit under the rubric of environmental chemistry, then I am at a loss to find it.

*The Chemistry of Our Environment*  
Preface (p. vii)  
John Wiley & Sons, Inc. New York, New York, USA. 1978

### Huxley, Thomas Henry 1825–95

English biologist

Looking back through the prodigious vista of the past, I find no record of the commencement of life, and therefore I am devoid of any means of forming a definite conclusion as to the conditions of its appearance. Belief, in the scientific sense of the word, is a serious matter, and needs strong foundations. To say, therefore, in the admitted absence of evidence, that I have any belief as to the mode in which existing forms of life originated, would be using words in a wrong sense. But expectation is permissible where belief is not; and if it were given to me to look beyond the abyss of geologically recorded time to the still more remote period when the Earth was passing through physical and chemical conditions which it can no more see again than a man can recall his infancy,

I should expect to be a witness of the evolution of living protoplasm from not-living matter.

*Collected Essays* (Volume 8)

Biogenesis and Abiogenesis (p. 256)

Macmillan & Company Ltd. London, England. 1904

Medicine was the foster-mother of Chemistry, because it has to do with the preparation of drugs and the detection of poisons; of Botany, because it enabled the physician to recognise medicinal herbs; of Comparative Anatomy and Physiology, because the man who studied Human Anatomy and Physiology for purely medical purposes was led to extend his studies to the rest of the animal world.

*Collected Essays* (Volume 3)

Science and Education

Universities: Actual and Ideal (p. 213)

Macmillan & Company Ltd. London, England. 1904

**Janssen, Johannes** 1829–81

Roman Catholic German historian

Chemistry is the true and living anatomy...

Translated by A.M. Christie

*History of the German People at the Close of the Middle Ages*

Volume XIV, Chapter VI (p. 5)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1909

...the doctor must be a chemist also, and medicine and chemistry cannot be separated from each other.

Translated by A.M. Christie

*History of the German People at the Close of the Middle Ages*

Volume XIV, Chapter VI (p. 7)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1909

**Jefferson, Thomas** 1743–1826

Third president of the USA

If you are obliged to neglect anything, let it be your chemistry. It is the least useful and the least amusing to a country gentleman of all the ordinary branches of science.

In E.M. Betts and J.A. Bear, Jr. (eds.)

*The Family Letters of Thomas Jefferson*

Letter

January 3, 1809, to Thomas Jefferson Randolph (p. 377)

**Kant, Immanuel** 1724–1804

German philosopher

...chemistry can become nothing more than a systematic art or experimental doctrine, but never a science proper...

Translated by James Ellington

*Metaphysical Foundations of Natural Science*

Preface (p. 7)

The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1970

**Keosian, J.**

No biographical data available

The materialist theory of the origin of life from inanimate beginnings recognizes the role of chance in the interactions of matter in the universe, but views the

overall developments as in no way accidental; on the contrary, it is looked upon as inevitable, almost inexorable, outcome of the emergence and operation of natural laws.

In D.J. Depew and B.H. Weaver (eds.)

*Molecular Evolution: Prebiological and Biological*

The Origin of Life Problem – A Brief Critique (p. 14)

Plenum Press. New York, New York, USA. 1972

**King George the Fifth** 1865–1936

First British monarch belonging to the House of Windsor

I fully appreciate the important part which chemistry plays in almost every branch of our modern industry. We all recognise that without a scientific foundation no permanent superstructure can be raised. Does not experience warn us that the rule of thumb is dead, and that the rule of science has taken its place, that today we cannot be satisfied with the crude methods which were sufficient for our forefathers, and that those great industries which do not keep abreast of the advance of science must surely and rapidly decline?

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter X (p. 283)

Macmillan & Co Ltd. London, England. 1916

**Klaproth, Martin Heinrich** 1743–1817

German chemist

No science has ever made more rapid progress in a shorter time than chemistry.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 316)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Knight, David**

No biographical data available

Chemistry can thus be seen as a kind of scientific cookery, its ideas only of interest to those involved in it and perhaps their wives, biographers or psychiatrists ...

*Ideas in Chemistry: A History of the Science*

Chapter 1 (p. 1)

Athlone. London, England. 1992

Now that God has given us chemistry let us enjoy it.

*Ideas in Chemistry: A History of the Science*

Chapter 1 (p. 12)

Athlone. London, England. 1992

Chemistry seems in our day more a business of questions difficult to answer than of questions difficult to ask.

*Ideas in Chemistry: A History of the Science*

Chapter 13 (p. 171)

Athlone. London, England. 1992

**Kornberg, Arthur** 1918–

American biochemist

Life, after all, is only chemistry, in fact, a small example of chemistry observed on a single, mundane planet.

*International Journal of Quantum Chemistry*, Volume 53, 1995

**Kremers, Edward**

Ni biographical data available

Chemistry is chemistry, whether general or applied. The dividing line between general and applied chemistry is an imaginary boundary that exists in some men's minds, but not in nature.

*Proceedings of the American Pharmaceutical Association at the Fortieth Annual Meeting*

The Study of Materia Medica (p. 314)

The American Pharmaceutical Association. Philadelphia, Pennsylvania, USA. 1892

**Kunckel, Johann** 1630–1703

German alchemist

Chemistry is without contradiction one of the most useful arts and it would be no exaggeration to call it the mother or the instructress of other arts; she alone can teach us to interpret the Sacred Scriptures; she alone teaches us the work of God; and it is thanks to her that we understand the Creation and the material world; Physics and medicine are her dependents; and again, she serves as the foundation for the science of animals and vegetables.

In Allen G. Debus

*The Chemical Philosophy* (Volume 2)

Chapter 7 (pp. 464, 467).

Science History Publications. New York, New York, USA. 1977

**Latham, Peter Mere** 1789–1875

English physician

Sagacious observers and experimenters have, in these later days, gone nigh to show that there is a chemistry within us which is cooperative with life; that making good its work, it gives to our bodies the materials of their health; and that doing its work faultily, it suffers noxious things to form, which become the elements of their diseases.

In William B. Bean

*Aphorisms from Latham* (p. 89)

Prairie Press. Iowa City, Iowa, USA. 1962

Let no man who is making his entrance into the medical profession henceforth ever neglect chemistry. Chemistry was once thought to be conversant only with the physiology of external nature; but every day is bringing us to look more and more to chemistry to explain the physiology of our own bodies.

In William B. Bean

*Aphorisms from Latham* (p. 89)

Prairie Press. Iowa City, Iowa, USA. 1962

Chemical experiment and clinical observation, leading each other by the hand, proceed together, and arrive at the seminal principal of the disease.

In William B. Bean

*Aphorisms from Latham* (p. 93)

Prairie Press. Iowa City, Iowa, USA. 1962

Chemistry was once thought to be conversant only with the physiology of external nature; but every day

is bringing us to look more and more to chemistry to explain the physiology of our own bodies.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture II (p. 33)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Lavoisier, Antoine Laurent** 1743–94

French chemist

I have been obliged to depart from the usual order of courses of lectures and of treatises upon chemistry, which always assume the first principles of the science, as known, when the pupil or the reader should never be supposed to know them till they have been explained in subsequent lessons. In almost every instance, these begin by treating of the elements of matter, and by explaining the table of affinities, without considering, that, in so doing, they must bring the principal phenomena of chemistry into view at the very outset: They make use of terms which have not been defined, and suppose the science to be understood by the very persons they are only beginning to teach.

*Elements of Chemistry*

Preface (pp. xvii–xviii)

Publisher undetermined

Edinburgh, Scotland. 1799

This science [chemistry] still has many chasms, which interrupt the series of facts, and often render it extremely difficult to reconcile them with each other: It has not, like the elements of geometry, the advantage of being a complete science, the parts of which are all closely connected together: Its present progress, however, is so rapid, and the facts, under the modern doctrine, have assumed so happy an arrangement, that we have ground to hope, even in our own times, to see it approach near to the highest state of perfection of which it is susceptible.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xx)

Printed for William Creech. Edinburgh, Scotland. 1790

I have been obliged to depart from the usual order of courses of lectures and of treatises upon chemistry, which always assume the first principles of the science, as known, when the pupil or the reader should never be supposed to know them till they have been explained in subsequent lessons. In almost every instance, these begin by treating of the elements of matter, and by explaining the table of affinities, without considering, that, in so doing, they must bring the principal phenomena of chemistry into view at the very outset: They make use of terms which have not been defined, and suppose the science to be understood by the very persons they are only beginning to teach. It ought likewise to be considered, that very little of chemistry can be learned in a first course, which is hardly sufficient to make the language of the science familiar to the ears, or the apparatus familiar to the eyes. It is almost impossible to become a chemist in less than three or four years of constant application.

Translated by Robert Kerr  
*Elements of Chemistry* (Volume 1) (5th edition)  
 Preface (pp. xxii–xxiii)  
 Printed for W. Creech. Edinburgh, Scotland. 1802

In submitting to experiments the different substances found in nature, chemistry seeks to decompose them, and to bring them into a condition such that their components can be examined separately.... Chemistry advances towards its goal, and towards its perfection, by dividing, subdividing, and again subdividing, and we do not know what will be the limit of its victories. We cannot be certain that what we think to-day to be simple is indeed simple; all we can say is, that such or such a substance is the actual term whereat chemical analysis has arrived, and that with our present knowledge we are unable to subdivide further.

Quoted in Matthew Moncrieff Pattison Muir  
*A History of Chemical Theories and Laws*  
 Part I, Chapter II (p. 69)  
 John Wiley & Sons. New York, New York, USA. 1907

...as chemistry advances towards perfection by dividing and subdividing, it is impossible to say where it will end; and these things we at present suppose simple may soon be found quite otherwise.

*Elements of Chemistry in a New Systematic Order*  
 Part II, Section I (p. 177)  
 W. Creech. Edinburgh, Scotland. 1790

### Le Févre, Nicholas

No biographical data available

Chymistry is the true Key of Nature.

In Allen G. Debus  
*The French Paracelsians*  
 Chapter 4 (p. 126)  
 Cambridge University Press. Cambridge, England. 1991

Chymistry is nothing else but the Art and Knowledge of Nature itself; that it is by her means we examine the Principles out of which natural bodies do consist and are compounded; and by her are discovered unto us the causes and sources of their generations and corruptions, and of all the changes and alterations to which they are liable:.... [Further] it is known, that the ancient Sages have taken from Chymistry, the occasions and true motives of reasoning upon natural things, and that their monuments and writings do testify this Art to be of no fresher date than Nature itself.

*A Compleat Body of Chymistry*  
 The Preface (p. 1)  
 Printed for O. Pully. London, England. 1640

### Le Noble, William J.

No biographical data available

It may sound like a lot of work to keep up with organic chemistry, and it is; however, those who haven't the time to do it become subject to decay in the ability to

teach and contribute to the Science – a sort of first-order process the half-life of which can't be much more than a year or so.

*Highlights of Organic Chemistry*  
 Chapter 3 (p. 112)  
 Marcel Dekker, Inc. New York, New York, USA. 1974

### Lederman, Leon 1922–

American high-energy physicist

I started out as a molecules kid. In high school and early college I loved chemistry, but I gradually shifted toward physics, which seemed cleaner – odorless, in fact.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
 Chapter 1 (p. 5)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### Lehn, Jean-Marie 1939–

French chemist

The essence of chemistry is not only to discover but to invent, and, above all, to create. The book of chemistry is not only to be read but to be written! The score of chemistry is not only to be played but to be composed!

In Ehud Keinan and Israel Schecheter (eds.)  
*Chemistry for the 21st Century*  
 Chapter 1, Section 1.3 (p. 7)  
 Wiley-VCH. Weinheim, Germany. 2001

### Lemaire, Eugene

No biographical data available

Chemistry respects nothing.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1906*  
 The Role of Chemistry in Painting (p. 453)  
 Government Printing Office. Washington, D.C. 1907

### Lemery, Nicolas 1645–1715

French chemist

Chymistry is an Art that teaches how to separate the different substances which are found in Mixt Bodies...

*A Course of Chemistry*  
 Of Chemistry in General (p. 1)  
 London, England. 1675

### Levi, Primo 1919–87

Italian writer and chemist

To botch an analysis was worse: perhaps because unconsciously one realized that the judgment of men (in this case the professors) is arbitrary and debatable, while the judgment of things is always inexorable and just: this law is the same for all.

*Other People's Trades*  
 The Mark of the Chemist (p. 99)  
 Summit Books. New York, New York, USA. 1989

It [the fact the fossils of wooden tools are rare] should remind us that wood, like all organic substances, is stable only in appearance. Its mechanical virtues go hand in



hand with an intrinsic chemical weakness. In our atmosphere rich in oxygen, wood is stable more or less like a billiard ball placed on a horizontal shelf edged by a border no thicker than a sheet of tissue paper. It can remain there for a long time, but the tiniest push, or even a faint breath of air, will be enough to make it go past the barrier and drop to the ground. In short, wood is anxious to oxidize, that is, to destroy itself.

*Other People's Trades*

Stable/Unstable

Summit Books. New York, New York, USA. 1989

...for me chemistry represented an indefinite cloud of future potentialities which enveloped my life to come in black volutes torn by fiery flashes, like those which had hidden Mount Sinai. Like Moses, from that cloud I expected my law, the principle of order in me, around me, and in the world...I would watch the buds swell in spring, the mica glint in the granite, my own hands, and I would say to myself:

Translated by Raymond Rosenthal

*The Periodic Table*

Hydrogen (pp. 22–23)

Schocken Books. New York, New York, USA. 1984

There was no need to get from Caselli the other raw material, the partner of zinc, that is, sulfuric acid: it was there in abundance in every corner. Concentrated, of course: and you had to dilute it with water; but watch out! it is written in all the treatises, one must operate in reverse, that is, pour the acid in the water and not the other way around, otherwise that innocuous-looking oil is prone to wild rages: this is known even to the kids in *liceo*.

Translated by Raymond Rosenthal

*The Periodic Table*

Zinc (p. 33)

Schocken Books. New York, New York, USA. 1984

In this place, too, nobody wasted many words teaching us how to protect ourselves from acids, caustics, fires, and explosions; it appeared that the Institute's rough and ready morality counted on the process of natural selection to pick out those among us most qualified for physical and professional survival. There were few ventilation hoods; each student, following his text's prescriptions, in the course of systematic analysis, conscientiously let loose into the air a good dose of hydrochloric acid and ammonia, so that a dense, hoary mist of ammonium chloride stagnated permanently in the lab, depositing minute scintillating crystals on the windowpanes.

Translated by Raymond Rosenthal

*The Periodic Table*

Iron (p. 39)

Schocken Books. New York, New York, USA. 1984

[The therapy] was found pretty soon, drawing on good inorganic chemistry, that distant Cartesian island, a lost paradise, for us organic chemists, bunglers, "students of gunk"...

Translated by Raymond Rosenthal

*The Periodic Table*

Chromium (p. 157)

Schocken Books. New York, New York, USA. 1984

This salt [stannous chloride], in itself, is odorless, but it reacts in some manner with the skin, perhaps reducing the keratin's disulfide bridges and giving off a persistent metallic stench that for several days announces to all that

you are a chemist.

Translated by Raymond Rosenthal

*The Periodic Table*

Tin (p. 188)

Schocken Books. New York, New York, USA. 1984

The lab is a place for the young, and returning there you feel young again: with the same longing for adventure, discovery, and the unexpected that you have at seventeen.

Translated by Raymond Rosenthal

*The Periodic Table*

Uranium (p. 198)

Schocken Books. New York, New York, USA. 1984

...all honor to the pickax and its modern equivalents; they are still the most important intermediaries in the millennial dialogue between the elements and man...

Translated by Raymond Rosenthal

*The Periodic Table*

Carbon (p. 226)

Schocken Books. New York, New York, USA. 1984

## Lewes, G. H.

No biographical data available

Physics treat of Masses acting at sensible distances. Chemistry treats of Molecules acting at insensible distances.

In G.H. Lewes

*Comte's Philosophy of the Sciences*

Section XI (p. 113)

Henry C. Bohn. London, England. 1853

## Lewis, Gilbert Newton 1875–1946

American chemist

The fact is that physical chemistry no longer exists. The men who have been called physical chemists have developed a large number of useful methods by which the concrete problems of inorganic chemistry, organic chemistry, biochemistry, and technical chemistry may be attacked, and as the applications of these methods grow more numerous, it becomes increasingly difficult to adhere to our older classification.

In J.W. Servos

*Physical Chemistry Ostwald to Pauling: The Making of Science in America*

Chapter 7 (p. 310)

Princeton University Press. Princeton, New Jersey, USA. 1990

I have attempted to give you a glimpse...of what there may be of soul in chemistry. But it may have been in vain. Perchance the chemist is already damned and the guardian the blackest. But if the chemist has lost his soul,



he will not have lost his courage and as he descends into the inferno, sees the rows of glowing furnaces and sniffs the homey fumes of brimstone, he will call out: "Asmodeus, hand me a test tube."

In Derek A. Davenport

Gilbert Newton Lewis: 1875–1946

*Journal of Chemical Education*, Volume 61, 1984 (p. 2)

**Lewis, Sinclair** 1885–1951

American novelist

Organic chemistry! Puzzle chemistry! Stink chemistry! Drug-store chemistry! Physical chemistry is power, it is exactness, it is life.

*Arrowsmith*

Chapter II, Section III (p. 14)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Libby, Willard F.**

No biographical data available

Chemistry is increasingly important to the peaceful atom. In fact, in the next few years, the chemist may be the most important contributor.

Address

Manufacturing Chemists' Association, Inc., November 25, 1998, New York

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

He who understands nothing but chemistry doesn't even understand chemistry.

In Philip Ball

*Designing the Molecular World: Chemistry at the Frontier*

Introduction (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1994

**Little, Arthur D.**

No biographical data available

Chemistry is a creative science...and the first chapter of its Book of Genesis is not yet written.

In David H. Killeffer

*Chemical Engineering*

Chapter 10 (p. 130)

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**Loos, Anita** 1889–1981

American screenwriter, playwright, and author

There's nothing colder than chemistry.

*Kiss Hollywood Good-by*

Chapter 21 (p. 193)

The Viking Press. New York, New York, USA. 1974

**Lubbock, John, First Baron Avebury** 1834–1919

English banker, politician, biologist, and archaeologist

...too many of us see nothing in the fields but sacks of wheat, in the meadows but trusses of hay, and in woods but planks for houses, or cover for game. Even from this mere prosaic point of view, how much there is to wonder at and admire, in the wonderful chemistry which changes

grass and leaves, flowers and seeds, into bread and milk, eggs and cream, butter and honey!

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter I (p. 13)

Macmillan & Company Ltd. London, England. 1903

**Mackenzie, Colin**

No biographical data available

The Science of Chemistry is the knowledge of the relations of those phenomena, or changes, which take place in the sensible qualities of bodies, as results of the action of one species of matter on another.

*One Thousand Experiments in Chemistry*

Introduction (p. v)

Printed for Sir Richard Phillips & Company. London, England. 1821

**Mann, Thomas** 1875–1955

German-born American novelist

Soon or late, division must yield "units" which, even though in composition, were not organized, and which mediated between life and absence of life; molecular groups, which represented the transition between vitalized organization and mere chemistry.

*The Magic Mountain*

Chapter V

Research (p. 283)

Alfred A. Knopf. New York, New York, USA. 1966

**Marcet, Mrs. (Jane Haldimand)** 1769–1858

English expository author in chemistry, botany, religion, and economics

...I am not disposed to form a very favorable idea of Chemistry, nor do I expect to derive much entertainment from it. I prefer the sciences which exhibit nature on a grand scale, to those that are confined to the minutiae of petty details.

*Conversations on Chemistry*

Conversation I (p. 9)

John Beach. Boston, Massachusetts, USA. 1836

...CHEMISTRY, which is so closely connected with Natural Philosophy...must be incomplete without some knowledge of the other; for, it is obvious that we can derive but a very imperfect idea of bodies from the study of the general laws by which they are governed, if we remain totally ignorant of their intimate nature.

*Conversations on Chemistry*

Conversation I (p. 9)

John Beach. Boston, Massachusetts, USA. 1836

...I am going to propose to you another branch of science to which I am particularly anxious that you should devote a share of your attention. This is Chemistry, which is so closely connected with Natural Philosophy, that the study of the one must be incomplete without some knowledge of the other; for, it is obvious that we can derive but a very imperfect idea of bodies from the study of the general laws by which they are governed, if we remain totally ignorant of their intimate nature.

*Conversations on Chemistry In Which the Elements of that Science Are Familiarly Explained and Illustrated by Experiments*  
 Conversation X (p. 159)  
 Oliver D. Cooke  
 Hartford, Connecticut, USA. 1822

### Martin, Geoffrey

Chemist

The endless circulation of matter in the universe is, perhaps, one of the most wonderful facts with which chemistry has to deal. It is this endless change which causes the history of the most common and insignificant objects about us to be more astonishing than any fairy tale.

*Triumphs & Wonders of Modern Chemistry*

Chapter I (p. 1)

D. van Nostrand Co. New York, New York, USA. 1911

### Mayo, William J. 1861–1939

American physician

Life is largely a matter of chemistry.

The Advancement of Learning in Medicine Through Biochemistry  
*Industrial and Engineering Chemistry: News Edition*, Volume 20, 1928

### Mellor, Joseph William 1863–1938

Chemist

The science of chemistry is man's attempt to classify his knowledge of all the different kinds of matter in the universe; of the ultimate constitution of matter; and of the phenomena which occur when the different kinds of matter react one with another.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 10)

Longman, Green, & Co. London, England. 1922

### Melville, Herman 1819–91

American novelist

In physical chemistry, as in other sciences, progress usually occurs by a series of rather discontinuous steps separated by periods of consolidation. Thus certain topics and branches of a subject become popular fields of activity once the pioneering work has defined the field of endeavor. Thereafter papers flow in ever-increasing numbers.

High Polymers

*Transactions of The Faraday Society*, Volume 49, 1953

### Mendeleev, Dmitry Ivanovich 1834–1907

Russian chemist

Sciences like chemistry, which deal with ideas as well as with material substances, and create a possibility of immediately verifying that which has been or may be discovered or assumed, demonstrate at every step that the work of the past has availed much, and that without it it would be impossible to advance into the ocean of the unknown.

Translated by George Kamensky  
 In Thomas Atkinson Lawson  
*The Principles of Chemistry* (Volume 1)  
 Author's Preface to the Fifth Edition (p. viii)  
 Longmans, Green & Co. London, England. 1891

Chemistry, like every other science, is at once a means and an end. It is a means of attaining certain practicable aspirations. Thus, by its assistance, the obtaining of matter in its various forms is facilitated: it shows new possibilities of availing ourselves of the forces of nature, indicates the methods of preparing many substances, points out their properties, etc. In this sense chemistry is closely connected with the work of the manufacturer and the artisan, its sphere is active, and is a means of promoting general welfare.

Translated by George Kamensky

In Thomas Atkinson Lawson

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. viii)

Longmans, Green & Co. London, England. 1891

By summoning adherents to the work of theoretical chemistry, I am confident that I call them to a most useful labour, to the habit of dealing correctly with nature and its laws, and to the possibility of becoming truly practical men.

Translated by George Kamensky

In Thomas Atkinson Lawson

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. ix)

Longmans, Green & Co. London, England. 1891

Chemistry is concerned with the study of the homogeneous substances or material of which all the objects of the universe are made up, with the transformations of these substances into each other, and with the phenomena which accompany such transformations.

Translated by George Kamensky

In Thomas Atkinson Lawson

*The Principles of Chemistry* (Volume 1)

Introduction (pp. 1–2)

Longmans, Green & Co. London, England. 1891

### Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton) 1831–91

English statesman and poet

“Friend, I believe in miracles?” said he,  
 “And I believe in chemistry as well...”

*Glenaveril; or, the Metamorphoses*

Volume II, Book The Fourth The Guardians, Canto ii. John Steel, I.

463–464

D. Appleton & Company. New York, New York, USA. 1885

Chemistry, Soldier, trust me, is a science  
 Which now-a-days we sceptred students need  
 To study more than your rough art of war.

*Chronicles and Characters* (Volume 2)

The Duke's Laboratory, I. 234–236

Chapman & Hall. London, England. 1868

**Mittasch, Alwin** 1869–1953  
German chemist

Chemistry without catalysis, would be a sword without a handle, a light without brilliance, a bell without sound.

In R.E. Oesper  
Alwin Mittasch

*Journal of Chemical Education*, Volume 25, 1948 (pp. 531–532)

**Muir, Matthew Moncrieff Pattison** 1848–1931  
English chemist

The more I try to understand chemistry, the more I am convinced that the methods, achievements, and aims of the science can be realized only by him who has followed the gradual development of chemical ideas.

*A History of Chemical Theories and Laws*

Preface (p. v)

John Wiley & Sons, Inc. New York, New York, USA. 1906

The purpose of chemistry seems to have changed much from time to time. At one time chemistry might have been called a theory of life, and at another time a department of metallurgy: at one time a study of combustion, and at another time an aid to medicine, at one time an attempt to define a single word, the word element, and at another time the quest for the unchanging basis of all phenomena. Chemistry has appeared to be sometimes a handicraft, sometimes a philosophy, sometimes a mystery, and sometimes a science.

*A History of Chemical Theories and Laws*

Introduction (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1906

Chemistry is a universal science: it was founded by many whose memories are forgotten. The foundations of chemistry are laid deep in the experiences, the hopes, the visions of mankind.

*A History of Chemical Theories and Laws*

Part I, Chapter I (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1906

**Nernst, Walther** 1864–1941  
German physicist and chemist

...generally speaking it is better, where possible in natural science, to study objects of research independently of the accidents of their historical development.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1920

Studies in Chemical Thermodynamics (p. 354)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Newman, Joseph S.** 1892–1960  
American poet

Thus man, in essence, seems to be

A problem based on chemistry.

*Poems for Penguins, and Other Lyrical Lapses*

Biochemistry

Greenburg. New York, New York, USA. 1941

**Olah, George A.** 1927–  
Hungarian chemist

Humanity's drive to uncover the secrets of life processes and to use this knowledge to improve human existence has led to spectacular advances in the biological and health sciences. Chemistry richly contributes to these advances by helping to increase our understanding of processes at the molecular level, and it provides many of the methods and techniques of biotechnology. However, chemistry is not just an adjunct of biology and biotechnology. It is and always will be a central science in its own right.

Editorial

*Science*, Volume 270, Number 5241, December 1, 1995 (p. 1417)

**Oparin, Alexander Ivanovich** 1894–1980  
Russian biochemist

It has now become quite clear that the origin of life was not the result of some "happy chance" as was thought till quite recently, but a necessary stage in the evolution of matter. The origin of life is an inalienable part of the general process of the development of the universe and, in particular, the development of the earth.

In R. Buvet and C. Ponnampuruma (eds.)

*Chemical Evolution and the Origin of Life*

Problem of the Origin of Life: Present State and Prospects (pp. 3–4)

North-Holland Publishing Company. Amsterdam, Netherlands. 1971

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

...the physician without physiology and chemistry flounders along in an aimless fashion, never able to gain any accurate conception of disease, practising a sort of pop-gun pharmacy, hitting now the malady and again the patient, he himself not knowing which.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Teaching and Thinking (p. 121)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

Professional chemists look askance at physiological chemistry, and physiological chemists criticize pretty sharply the work of some clinical chemists, but there can be no doubt of the value to the physicians of a very thorough training in methods and ways of organic chemistry.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Internal Medicine as a Vocation (p. 137)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Ostwald, Friedrich Wilhelm** 1853–1932  
Latvian-born German chemist

I have fortunately been proved wrong in that prediction demonstrates how far I underestimated that as science progressively developed and as its nature and attributes became more and more familiar, mankind's appreciation and acceptance of scientific progress has steadily accelerated.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1909

On Catalysis (p. 151)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Packe, Christopher** 1604–70

German-Dutch chemist

The Art of Chymistry, (Honoured Sir) although in its speculations most Noble and Delectable to a Philosophic Mind, and in its Practice highly Inservient, and Beneficial to Mankind; yet hath it not escaped Obloquies, the false Imputations of Detractors, and Calumniators, who either through Ignorance, Idleness, or Envoy (or all of the cojoined) have made a false Representation of this most Noble Art to the World, and endeavored to set Mankind at the greatest distance from that which is its highest interest to court.

In Johann Glauber

Translated by Christopher Packe

*The Works of the Highly Experienced and Famous Chymist, John Rudolph Glauber to The Honoured, and Truly Learned, Edmond Dickenson, M.D.* (p. 2)

Printed by Thomas Wilbourn. London, England. 1689

**Pallister, William Hales** 1877–1946

Canadian physician

This is the quest for you and me,  
Are men twigs on the chemis-tree?  
When X is life, and time is T,  
Sp is space, and vast force is E,  
When Y is thought, dimension D:  
Does  $X=C500H100O250N250S50+P?$

*Poems of Science*

Protoplasm (p. 75)

Playford Press. New York, New York, USA. 1931

**Pauling, Linus** 1901–94

American chemist

There is more to chemistry than an understanding of general principles. The chemist is also, perhaps even more, interested in the characteristics of individual substances – that is, of individual molecules.

In Mary Jo Nye

*Before Big Science*

Chapter 6 (p. 188)

Prentice-Hall International. London, England. 1996

Every aspect of the world today – even politics and international relations – is affected by chemistry.

*Chemical Engineering News*, April 16, 1984

Chemistry is wonderful! I feel sorry for people who don't know anything about chemistry. They are missing an important source of happiness.

In Barbara Marinacci (ed.)

*Linus Pauling in His Own Words*

Chapter 2 (p. 43)

Simon & Schuster. New York, New York, USA. 1985

**Percival, James Gates** 1795–1856

American poet

To tell you the truth, I hate chemistry, and the very thought of it gives me an ague. I have no notion of stifling myself with the stench and poison of a laboratory.

In Julius H. Ward

*The Life and Letters of James Gates Percival*

Chapter XI (p. 192)

Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Plath, Sylvia** 1932–63

American poet and novelist

I knew chemistry would be worse, because I'd seen a big chart of the ninety-odd elements hung up in the chemistry lab, and all the perfectly good words like gold and silver and cobalt and aluminum were shortened to ugly abbreviations with difficult decimal numbers after them. If I had to strain my brain with any more of that stuff I would go mad.

*The Bell Jar*

Chapter Three (p. 37)

Faber & Faber Ltd. London, England. 1966

**Plummer, Andrew**

Scottish chemist

Chemistry is an art that has furnished the world with a great number of useful facts, and has thereby contributed to the improvement of many arts; but these facts lie scattered in many different books, involved in obscure terms, mixed with many falsehoods, and joined to a great deal of false philosophy; so that it is no great wonder that chemistry has not been so much studied as might have been expected with regard to so useful a branch of knowledge, and that many professors are themselves but very superficially acquainted with.

In A.L. Donovan

*Philosophical Chemistry in the Scottish Enlightenment*

Chapter 3 (p. 39)

At The University Press. Edinburgh, Scotland. 1975

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Physics and chemistry are not very different, and there seems to be no great difference in the kind of things to which they apply, except that chemistry, as it is usually understood, becomes inapplicable, at very high temperatures and also, perhaps, at very low ones. It therefore would not be very surprising if the hopes, held for a long time, that chemistry can be reduced to physics, were to come true, as indeed they seem to be doing...by a reduction I mean, of course, that all the findings of chemistry can be fully explained by (that is to say, deduced from) the principles of physics.

*Objective Knowledge: An Evolutionary Approach*

Chapter 8 (p. 290)

Clarendon Press. Oxford, England. 1972

**Prelog, V.**

No biographical data available

Chemistry takes a unique position among the natural sciences for it deals not only with material from natural sources but creates the major parts of its objects by synthesis. In this respect, as stated many years ago by Macelin Bertholt, chemistry resembles the arts; the potential of creativity is terrifying.

Chirality in Chemistry

*Science*, Volume 193, Number 4247, 2 July, 1976 (p. 18)**Primas, Hans** 1928–

No biographical data available

The most important task of contemporary theoretical chemistry is to stimulate the mutual understanding of the various branches of chemistry and its neighboring sciences.

*Chemistry, Quantum Mechanics and Reductionism*

Chapter 1, Section 1.2 (p. 2)

Springer-Verlag, Berlin, Germany. 1983

**Protheroe, Chester F.**

No biographical data available

I sing to you of chemistry,  
Of test tubes and of stinks;  
Of things that burn and those that don't,  
And those that clog up sinks;  
Oh hydrogen and oxygen,  
The water that they make,  
And hydrogen peroxide –  
Unstable – do not shake;  
Of chemical equations,  
Of valence and other joys:  
How are your mathematics?  
Oh, bright-faced girls and boys!

Reader's Column

*Chemistry*, Volume 40, Number 3, March, 1967 (p. 42)**Prout, William** 1785–1850

English physician and chemist

Chemistry forms the connecting link between that kind of knowledge which is founded on quantity, and those kinds of knowledge which rest solely on experience. Now so far as the logic of quantity is applicable, so far are we certain of our conclusions. But when this logic cannot be applied, our conclusions are no longer such as must be, but are only for the most part such as may be.

In Ida Freund

*The Study of Chemical Composition*

Chapter XIX (p. 592)

At The University Press, Cambridge, England. 1904

**Raine, Kathleen Jessie** 1908–2003

English poet and critic

Chemistry dissolves the goddess in the alembic,  
Venus, the white queen, the universal matrix,  
Down to the molecular hexagons and carbon-chains.

*The Collected Poems of Kathleen Raine*

The Human Form Divine (p. 86)

Counterpoint. Washington, D.C. 2001

**Ramsay, Sir William** 1852–1916

English chemist

...I am leaving the regions of fact, which are difficult to penetrate, but which bring in their train rich rewards, and entering the regions of speculation, where many roads lie open, but where a few lead to a definite goal.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1904

The Rare Gases of the Atmosphere (p. 77)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Redgrove, H. Stanley** 1887–1943

No biographical data available

The science of chemistry has invaded almost every department of daily life, without the man in the street being at all cognizant of the debt he owes to it. Nor is it realized how many common domestic operations... really consist in causing a number of more or less complicated chemical reactions to take place in the materials employed. By the man in the street and the housewife in the kitchen, "chemicals" are thought to be substances of a nature quite distinct from the things they daily handle and to be chiefly characterized by the possession of a "nasty smell."

*Annual Report of the Board of Regents of the Smithsonian Institution (1929)*

Synthetic Perfumes (p. 253)

Government Printing Office. Washington, D.C. 1930

**Reis, Johann Philipp** 1834–74

German physicist

Chemistry is the dirty part of physics.

Quoted in R. Oesper

*The Human Side of Scientists* (p. 116)

University of Cincinnati. Cincinnati, Ohio, USA. 1975

**Richards, Ellen Henrietta Swallow** 1842–1911

American environmental chemist

...some sort of false logic has crept into our schools, for the people whom I have seen doing housework or cooking know nothing of botany or chemistry, and the people who know botany and chemistry do not cook or sweep. The conclusion seems to be, if one knows chemistry she must not cook or do housework.



In Caroline L. Hunt  
*The Life of Ellen H. Richards*  
 Chapter 10 (p. 179)  
 Whitcomb & Barrow. Boston, Massachusetts, USA. 1912

**Richards, Theodore William** 1868–1928  
 American chemist

The importance of accurate knowledge in a case of this sort was foreseen long ago by Plato, who perhaps drew his inspiration from yet more ancient knowledge, coming from wise men of the Far East. As I have often quoted, he said: "If from any art that which concerns weighing and measuring and arithmetic is taken away, how little is left of that art!" The implication of this wise saying as regards the study of atomic weights is clear; any increase in the accuracy of the determination of these quantities must of necessity add greatly to our insight into the profound mysteries with which chemistry has to deal.

*Nobel Lectures, Chemistry 1901–1921*  
 Nobel lecture for award received in 1914  
 Atomic Weights (p. 282)  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1966

Chemistry has not grown spontaneously to its present state; it is a product of human mentality. The science which we know today is but an echo of the eternal and incomprehensible "music of the spheres" as heard and recorded by the minds of individual men.

In Bernard Jaffe  
*New World of Chemistry*  
 Preface (p. vi)  
 Silver, Burdett & Company. New York, New York, USA. 1935

**Richet, Charles** 1850–1935  
 French physiologist

If the progress of chemistry consisted only in producing still more noxious gases capable of destroying a regiment in a few minutes, then chemistry would be an accursed science.

*The Natural History of a Savant*  
 Chapter II (p. 13)  
 J.M. Dent & Sons Ltd. London, England. 1927

**Roberts, Mary** 1788–1864  
 English botanist and author

...the operations of chemistry resemble the moving of a magic wand.

*The Sea-side Companion; or, Marine Natural History*  
 Letter II (p. 17)  
 Printed for Whittaker & Co. London, England. 1835

**Rush, Benjamin** 1746–1813  
 American physician, teacher, and man of affairs

Chemistry by unfolding to us the effects of heat and mixture, enlarges our acquaintance with the wonders of nature, and the mysteries of art hence it has become, in most of the universities of Europe, a necessary branch

of a gentleman's education. In a young country, where improvements in agriculture and manufactures are so much to be desired, the cultivation of this science, which explains the principles of both of them, should be considered as an object of the utmost importance.

*Essays, Literary, Moral and Philosophical*  
 On The Mode of Education Proper in a Republic (pp. 17–18)  
 Printed by Thomas & Wilford Bradford. Philadelphia, Pennsylvania, USA. 1806

**Sabatier, Paul** 1854–1941  
 French chemist

Theories cannot claim to be indestructible. They are only the plough which the ploughman uses to draw his furrow and which he has every right to discard for another one, of improved design, after the harvest.

*Nobel Lectures, Chemistry 1901–1921*  
 Nobel lecture for award received in 1912  
 The Method of Direct Hydrogenation by Catalysis (pp. 230–231)  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Sarton, George** 1884–1956  
 Belgian-born American scholar and writer

...any branch of science may be completely revolutionized at any time by a discovery necessitating a radically new approach to the subject. Chemistry today is essentially different from chemistry in the eighteenth century. The fundamental notions are different, the methods are different, the scope is indescribably larger, and the contents are infinitely more varied. We may safely assume that the chemistry of the twenty-fifth century will be as unlike that of the present as that, in turn, is unlike that of the fifteenth century.

*The Study of the History of Science* (pp. 7–8)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1936

**Scheele, Carl Wilhelm** 1742–1786  
 Swedish chemist

It is the object and chief business of chemistry to skillfully separate substances into their constituents, to discover their properties, and to compound them in different ways.

How difficult it is, however, to carry out such operations with the greatest accuracy, can only be unknown to one who either has never undertaken this occupation, or at least has not done so with sufficient attention.

*The Discovery of Oxygen*  
 Part II, Chemical Treatise on Air and Fire, Section 1  
 Oliver & Boyd. Edinburgh, Scotland. 1923

**Shaw, George Bernard** 1856–1950  
 Irish comic dramatist and literary critic

THE DEVIL: ...in the arts of life man invents nothing; but in the arts of death he outdoes Nature herself, and produces by chemistry and machinery all the slaughter of plague, pestilence and famine.



*Man and Superman: A Comedy and a Philosophy*

Act III (pp. 83–84)

The Heritage Press. New York, New York, USA. No date

Not love: we know better than that. Let's call it chemistry.... Well, you're attracting me irresistibly – chemically.

*You Never Can Tell*

Act II (p. 70)

University of Nebraska Press. Lincoln, Nebraska, USA. 1961

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

"I am happy," said M. Waldman, "to have gained a disciple; and if your application equals your ability, I have no doubt of your success. Chemistry is that branch of natural philosophy in which the greatest improvements have been and may be made: it is on that account that I have made it my peculiar study; but at the same time I have not neglected the other branches of science.

*Frankenstein: Or, The Modern Prometheus*

Chapter III (p. 66)

George Routledge & Sons. London, England. 1891

**Silver, Brian L.**

Israeli professor of physical chemistry

Chemistry handles the visible cloth from which the universe is made.

*The Ascent of Science*

Part Four, Chapter 13 (p. 166)

Solomon Press Book. New York, New York, USA. 1998

**Smith, Alexander** 1865–1922

American chemist and author

**Hall, Edwin H.**

No biographical data available

...there is only one science of chemistry, there are many opinions on the teaching of it.

*The Teaching of Chemistry and Physics in the Secondary School*

Prefatory Note (p. 3)

Longmans, Green & Co. London, England. 1902

**Smith, Betty** 1896–1972

American writer

Francie came away from her first chemistry lecture in a glow. In one hour she found out that everything was made up of atoms which were in continual motion. She grasped the idea that nothing was ever lost or destroyed. Even if something was burned up or rot away, it did not disappear from the face of the earth; it changed into something else – gases, liquids, and powders. Everything, decided Francie after that first lecture, was vibrant with life and there was no death in chemistry. She was puzzled as to why learned people didn't adopt chemistry as a religion.

*A Tree Grows in Brooklyn*

Chapter XLIX (p. 389)

Everybody's Vacation Publishing Company, Inc. New York, New York, USA. 1943 (Harper & Brothers)

**Smith, Walter Chalmers** 1824–1908

Scottish poet and preacher

But women who have lost their Faith  
Are angels who have lost their wings,  
And always have a nasty breath  
Of chemistry, and horrid things  
That go off when a lecturer rings  
His bell.

*Obrig Grange*

Book Third, Editorial, Loquitur Mater Domina, I. 185–190

James Maclehose. Glasgow, Scotland. 1933

**Snow, Charles Percy** 1905–80

English writer and government administrator

The future of chemistry rests and must rest, with physics.

In H. Wright

*University Studies* (p. 125)

I. Nicholson & Watson. London, England. 1933

**Teeple, John E.** 1874–1931

American chemist

Chemistry is a science, a branch of knowledge, and there is no law to prevent anyone who has the least bit of chemical information – such, for instance, as the chemical symbol for water – from calling himself a chemist.

*Journal of Industrial and Engineering Chemistry*, Volume 17, Number 7

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Chemistry is mainly the science of the different kinds of matter, their transformations, affinities, and interactions. It is par excellence the science of molecules and atoms.

*Introduction to Science*

Chapter IV (p. 106)

William & Norgate. London, England. 1916

**Thomson, Thomas**

No biographical data available

Chemistry, unlike other sciences, sprang originally from delusions and superstition, and was at its commencement exactly on a level with magic and astrology.

*The History of Chemistry*

Introduction (p. 1)

Henry Colburn & Richard Benrley. London, England. 1830

Chemistry is a science, the object of which is to ascertain the ingredients that enter into the composition of bodies, to examine the nature of these ingredients, the manner in which they combine, and the properties resulting from their combination.

*A New System of Chemistry*

Definition (p. 1)

Printed for Thomas Dobson. Philadelphia, Pennsylvania, USA. 1800

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Verily, chemistry is not a splitting of hairs when you have got half a dozen raw Irishmen in the laboratory.

*The Writings of Henry David Thoreau* (Volume 4)

Cape Cod

Chapter X (p. 264)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1893

**Townson, Robert** 1763–1827

Australian scholar and scientist

Chemistry of late years has made a most rapid progress and every branch of knowledge within its reach has been advanced by it. Mineralogy should be the first to speak its eulogium as the small tribute of gratitude for great favours.... Chemistry has done much for Mineralogy: it has raised it from a frivolous amusement to a sublime science; and still continuing its enlightening aid, will in time, with the progress of science, bring to light many things that now lie concealed, and unveil of the hidden mysteries of nature.

*Philosophy of Mineralogy*

Chapter IX (p. 114)

Printed for the author. London, England. 1798

**Trevor, J. E.**

No biographical data available

If chemistry be in its ultimate nature, an energy science, chemists obviously must study those energy transformations which constitute its phenomena.

*The Achievements and Aims of Physical Chemistry*, Volume XVI, Number 8, August, 1894 (p. 519)

**van Helmont, Jean-Baptista** 1579–1644

Flemish chemist

I praise my bountiful God, who hath called me into the Art of the fire, out of the dregs of other professions. For truly Chymistry...prepares the understanding to pierce the secrets of nature, and causeth a further searching out in nature, than all other Sciences being put together: and it pierceth even unto the utmost of real truth.

*Oriatrike or Physick Refined* (p. 462)

Printed for L. Loyd. London, England. 1662

**van't Hoff, Jacobus Henricus** 1852–1911

Dutch physical and organic chemist

This is physical chemistry, formerly a colony, now a great, free land.

In Diana Kormos Barkan

*Walther Nernst and the Transition to Modern Physical Science*

Chapter I (p. 1)

Cambridge University Press. Cambridge, England. 1999

**Venable, F. P.**

No biographical data available

The ovum from which chemistry has been slowly evolved seems to have been sorcery and magic.

*A Short History of Chemistry*

Part First (p. 2)

D.C. Heath & Co. Boston, Massachusetts, USA. 1894

**von Euler, Hans** 1873–1964

Swedish biochemist

Any scientific problem must be attacked by research into detail; the natural scientist did not win his victories until he left meditation on the great riddles of the world and began a careful study of special problems; our knowledge – of more general associations and of far-reaching laws – has grown out of the results of such research.

*Nobel Lectures, Chemistry 1922–1941*

Nobel lecture for award received in 1929

Fermentation of Sugars and Fermentative Enzymes (p. 144)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**von Liebig, Justus** 1803–73

German organic chemist

It is an indisputable requirement in organic chemistry that we refrain from stripping the phenomena, not yet clarified, of the charm that lies precisely in their obscurity.

In Rolf Huisgen

*The Adventure Playground of Mechanisms and Novel Reactions* (p. xx)

American Chemical Society, Washington, D.C. 1994

...Chemistry, as an independent science, offers one of the most powerful means towards the attainment of a higher mental cultivation; that the study of Chemistry is profitable, not only inasmuch as it promotes the material interests of mankind, but also because it furnishes us with insight into those wonders of creation which immediately surround us, and with which our existence, life, and development, are most closely connected.

In John Blyth

*Familiar Letters on Chemistry* (4th edition)

Letter I (p. 1)

Walton & Maberly. London, England. 1859

Chemistry is so often alluded to in modern writings, that it may perhaps be regarded as a problem of some importance to indicate more specially the influence of this science on the useful arts and on industry, as well as its relations to agriculture, physiology, and medicine.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter I (p. 1)

Walton & Maberly. London, England. 1859

Chemistry leads man into the domain of those latent forces, whose power controls the whole material world, and on whose operation is dependent the production of the most important necessities of life and of society.

In John Blyth

*Familiar Letters on Chemistry* (4th edition)

Letter I (p. 2)

Walton & Maberly. London, England. 1859

No science like Chemistry offers to man such a multitude of subjects for thought and reflection, and such stores of knowledge imbued with the charms of never-ending

freshness; none is more calculated to awaken the talent for observation, or to sharpen the intellect in the strict method of applying proof for the establishment of a truth, or in the inquiry into the cause and effect of a phenomenon.

In John Blyth

*Familiar Letters on Chemistry* (4th edition)

Letter I (p. 2)

Walton & Maberly. London, England. 1859

Many well-informed people still regard chemistry as the art of making experiments according to certain rules, very useful in the manufacture of soda and soap, in fixing good and permanent colours upon silk and cotton fabrics; but as an investigation of nature, or as an universal guide to its study, it is to most persons altogether unknown.

In John Gardner

*Familiar Letters on Chemistry* (2nd edition)

Letter I (p. 5)

Taylor & Walton. London, England. 1844

Chemistry, in its application to animals and vegetables, endeavors jointly with physiology to enlighten us respecting the mysterious processes and sources of organic life.

*Familiar Letters on Chemistry*

Letter IX (p. 128)

Walton & Maberly. London, England. 1859

### von Meyer, Ernst

German chemist

The main problem of chemistry, the investigation of the true composition of compounds, necessarily carries along with itself the constant endeavor to elaborate and perfect the means employed for arriving at this end.

*A History of Chemistry from Earliest Times to the Present Day*

Chapter VI (p. 358)

Macmillan & Company Ltd. London, England. 1891

### von Schelling, Friedrich Wilhelm

**Joseph** 1775–1854

German philosopher

Chemistry itself is a science which advances securely upon the beaten path of experience, even when it does not turn back to first principles. But a science which in itself is so rich, and which has lately made such great progress towards system, surely deserves to be led back to such principles.

Translated by Errol E. Harris and Peter Heath

*Ideas for a Philosophy of Nature as Introduction to the Study of this Science*

Chapter 8 (p. 237)

Cambridge University Press. Cambridge, England. 1988

### Webster, Jean

1876–1916

American writer

I am beginning chemistry, a most unusual study. I've never seen anything like it before. Molecules and Atoms are the material employed, but I'll be in a position to discuss them more definitely next month.

*Daddy-Long-Legs*

September 25th (p. 110)

The Century Co. New York, New York, USA. 1913

### Wells, H. G. (Herbert George)

1866–1946

English novelist, historian, and sociologist

He was a practical electrician but fond of whiskey, a heavy, red-haired brute with irregular teeth. He doubted the existence of the Deity but accepted Carnot's cycle, and he had read Shakespeare and found him weak in chemistry.

*The Door in the Wall, and Other Stories*

Lord of the Dynamos

Chapter 7

M. Kennerley. New York, New York, USA. 1911

### Werner, Alfred

1866–1919

German chemist

Chemistry must become the astronomy of the molecular world.

In George B. Kauffman

*Alfred Werner: Founder of Coordination Chemistry* (p. iii)

Springer-Verlag. Berlin, Germany. 1966

### Whewell, William

1794–1866

English philosopher and historian

The common operations of chemistry give rise in almost every instance to products which bear no resemblance to the materials employed. Nothing can be so false as to expect that the qualities of the elements shall be still discoverable in an unaltered form in the compound.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 1)

Part I, Book VI (p. 399)

John W. Parker. London, England. 1847

### Wieland, Heinrich O.

1877–1957

German chemist

The problem is not very attractive from the experimental viewpoint. There is no nitrogen, which adds interest and variety to the treatment of alkaloids. Only carbon, hydrogen and a little oxygen, all in the traditional combination, which does not lead us to expect any surprising results. The task would appear to be a long and unspeakably wearisome trek through an arid desert of structure. True, the wanderer in this apparently so unattractive region finds friendly landscapes at all stages of his journey, and the large quantity of substances bringing him nearer his goal accumulates around him like dear companions, although, clothed in the plain garment of colourlessness, they do not stand out either in their appearance or in their properties.

*Nobel Lectures, Chemistry 1922–1941*

Nobel lecture for award received in 1927

The Chemistry of the Bile Acids (p. 96)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### Wiley, Harvey W.

No biographical data available

There is no branch of our science which is to be crowned king and leader. Chemistry is a pure democracy, and all are equal therein.

Address of Welcome, World's Chemical Congress

*The Journal of the American Chemical Society*, Volume XV, Number 6, June, 1893 (p. 304)

**Wurtz, Charles Adolphe** 1817–84

French organic chemist

Chemistry is a French science; it was founded by Lavoisier of immortal memory.

Translated by Henry Watts

*History of Chemical Theory from the Age of Lavoisier to the Present*

Introduction (p. 1)

Macmillan & Company Ltd. London, England. 1869

## CHEMISTRY, HISTORY OF

**Bergman, Torbern Olaf** 1735–84

Swedish chemist and naturalist

The history of chemistry is properly divided into the mythological, the obscure, and the certain.

Quoted in Joseph William Mellor

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 1)

Longman, Green, & Co. London, England. 1922

## CHEMISTRY, INORGANIC

**Schulman, Max**

Screenwriter and humorist

Organic chemistry is the study of organs; inorganic chemistry is the study of the insides of organs.

*Barefoot Boy With Cheek* (p. 129)

Garden City Books. Garden City, New York, USA. 1943

## CHEMISTRY, INSTRUMENTATION

**Glaser, Christophe** 1615–78

Swiss chemist

To perform Chymical Operations, one must be very well provided with necessary Instruments and Vessels; for there being but few things that can be prepared in an open naked fire, one is obliged to put ones matter into some convenient Vessel, which is to be placed with dexterity upon the fire, and that is to be governed differently, according to the Artist's skill and intention.

*The Compleat Chymist; or a New Treatise of Chymistry*

Chapter VII (pp. 19–20)

Printed for John Starkey. London, England. 1677

## CHEMISTRY, ORGANIC

**Author undetermined**

Organic Chemistry: The practice of transmuting vile substances into publications.

Source undetermined

**Collie, John Norman** 1859–1942

English chemist

Deluged as we are with unnumbered facts that have often neither explanation nor obvious connection with one another, Organic Chemistry has become a vast rubbish heap of puzzling and bewildering compounds.

In Alfred Walter Stewart

*Recent Advances in Organic Chemistry*

Introduction (p. xiii)

Longmans, Green & Co. London, England. 1908

**Kekule, August** 1829–96

German organic chemist

We define, therefore, Organic Chemistry as the Chemistry of the Carbon Compounds. But this does not imply any real difference between inorganic and organic bodies. That part of our science to which the time-honoured name Organic Chemistry is given, and which we more conveniently call the Chemistry of the Carbon Compounds, is only a special part of pure chemistry treated separately, the large number and importance of the carbon compounds rendering such a special study of them necessary.

In Carl Schorlemmer

*The Rise and Development of Organic Chemistry* (pp. 84–85)

Macmillan & Co Ltd. London, England. 1894

**London, Jack** 1876–1916

American author

It was in their undergraduate days, however, in the midst of their profoundest plunges into the mysteries of organic chemistry, that Doris van Benschoten entered into their lives.

*Moon-face, and Other Stories*

The Shadow and the Flash (p. 121)

The Macmillan Co. New York, New York, USA. 1906

## CHEMISTRY, PHYSICAL

**Author undetermined**

Physics is the taking of very accurate measurements on impure and poorly defined materials. Chemistry is characterized by sloppy measurements on very pure

materials. Thus, Physical Chemistry is sloppy measurements on impure materials.

Source undetermined

## CHEMISTRY, STUDENT OF

**Tilden, Sir William Augustus** 1842–1926

English chemist

The study of nature requires the employment of two distinct processes: the first is the observation or discovery of facts, and the second is the deduction of inferences from those facts. It is of the utmost importance to the student of chemistry to keep these processes apart from each other in his mind, and endeavor clearly to apprehend the proper functions of observation and experiment on the one hand and those of hypothesis and theory on the other.

*Introduction to the Study of Chemical Philosophy*

10th Introduction (p. 3)

Longmans, Green & Co. London, England. 1901

## CHEMISTRY, STUDY OF

**von Liebig, Justus** 1803–73

German organic chemist

...the study of Chemistry is profitable, not only inasmuch as it promotes the material interests of mankind, but also because it furnishes us with insight into those wonders of creation which immediately surround us, and with which our existence, life, and development, are most closely connected.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter I (p. 1)

Walton & Maberly. London, England. 1859

## CHEMISTRY, SYSTEM OF

**Jones, Harry Clary** 1865–1916

American physical chemist and educator

It will, however, be easily recognized by any thinking man of science that a system of chemistry is one thing and a science of chemistry is another; just as the making of brick is one thing and the building of the brick into a piece of architecture is another. The making of the brick is, however, a necessary forerunner to the construction of the building.

*A New Era in Chemistry*

Chapter I (p. 17)

D. van Nostrand Co. New York, New York, USA. 1913

## CHEMISTRY, STUDY OF

**von Liebig, Justus** 1803–73

German organic chemist

...the study of Chemistry is profitable, not only inasmuch as it promotes the material interests of mankind, but also because it furnishes us with insight into those wonders of creation which immediately surround us, and with which our existence, life, and development, are most closely connected.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter I (p. 1)

Walton & Maberly. London, England. 1859

## CHEMOTHERAPY

**Domagk, Gerhard** 1895–1964

German bacteriologist and pathologist

I consider it my first duty in the development of chemotherapy to cure those diseases which have hitherto been incurable, so that in the first place those patients are helped who can be helped in no other way.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1939

Further Progress in Chemotherapy of Bacterial Infections (p. 525)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## CHEYNE–STOKES RESPIRATION

**Hippocrates** 460 BCE–377 BCE

Greek physician

Philiscus...too to bed on the first day of acute fever....

About the middle of the sixth day he died. The respiration throughout, like that of a person recollecting himself.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

Of the Epidemics

Fourteen Cases of Disease, Case I (p. 50)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CHILD

### Advertisement

A child is an island of curiosity surrounded by a sea of question marks.

Advertisement by Shell

*Scientific American*, Volume 2, Number 2, February, 1961 (p. 93)

## CHILDREN

**von Liebig, Justus** 1803–73

German organic chemist

Our children have more correct notions of nature and natural phenomena than had Plato! they may treat with ridicule the errors!

*Familiar Letters on Chemistry*

Letter I (p. 4)

Walton & Maberly. London, England. 1859

**CHILDBIRTH****Mitchell, Margaret** 1900–49

American author

Death and taxes and childbirth! There's never any convenient time for any of them!

*Gone With the Wind*

Part Four, Chapter XXXVIII (p. 668)

The Macmillan Company. New York, New York, USA. 1936

**CHIMERA****Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

The ambition of the inquirer seemed to limit itself to the annihilation of those visions on which my interest in science was chiefly founded. I was required to exchange chimeras of boundless grandeur for realities of little worth.

*Frankenstein: Or, The Modern Prometheus*

Chapter III (p. 63)

George Routledge &amp; Sons. London, England. 1888

**CHITIN****Peattie, Donald Culross** 1898–1964

American botanist, naturalist and author

Not blood nor flesh nor hair nor feathers, not the chlorophyll or cellulose of the plants, is stranger than the stuff called chitin.

*An Almanac for Moderns*

August 21 (p. 165)

G.P. Putnam's Sons. New York, New York, USA. 1935

**CHOICE****Huxley, Thomas Henry** 1825–95

English biologist

The choice lay between two absurdities and a middle condition of uneasy scepticism; which last, however unpleasant and unsatisfactory, was obviously the only justifiable state of mind under the circumstances.

*Lay Sermons, Addresses and Reviews*

Chapter XII (p. 291)

D. Appleton &amp; Co. New York, New York, USA. 1903

**Juster, Norton** 1929–

American architect and author

Just because you have a choice, it doesn't mean that any of them has to be right.

*The Phantom Tollbooth*

Chapter 14 (pp. 175–176)

Alfred A. Knopf. New York, New York, USA. 1989

**Poynting, John Henry** 1852–1914

English physicist

If our mental experience convinces us that we have freedom of choice, we are obliged to believe that in mind there is territory which the physicist can never annex. Some of his laws may still hold good, but somewhere or other his scheme must cease to give a true account.

*Collected Scientific Papers*

Physical Law and Life, 1903 (p. 698)

At The University Press. Cambridge. 1920

**CHRONOLOGY****Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

...we find that the difficulties of measuring time are as great as – if not greater than – the difficulties of measuring space; chronology, in the absolute sense of the word, is as difficult as geometry.

*Space and Time*

Introduction (p. 27)

Dover Publications. New York, New York, USA. 1960

**Lamb, Charles** 1775–1834

English essayist and critic

Your now is not my now; and again, your then is not my then; but my now may be your then, and vice versa.

Whose head is competent to these things?

In E.V. Lucas (ed.)

*The Works of Charles and Mary Lamb* (Volume 5)

Letter 236

To Barron Field, August 31, 1817

G.P. Putnam's Sons. New York, New York, USA. 1905

**CIRCLE****Browne, Sir Thomas** 1605–82

English author and physician

Circles and right lines limit and close all bodies, and the mortal right-lined circle must conclude and shut up all.

*Hydriotaphia*

Chapter V (p. 74)

Printed for Hen. Brome. London, England. 1658

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English writer

A small circle is quite as infinite as a large circle.

*Orthodoxy*

Chapter II (p. 33)

John Lane Company. New York, New York, USA. 1918

**Davis, John**

No biographical data available

The circle is one of the noblest representations of Deity, in his noble works of human nature. It bounds, determines, governs, and dictates space, bounds latitude and longitude, refers to the sun, moon, and all the planets,



in direction, brings to the mind thoughts of eternity, and concentrates the mind to imagine for itself the distance and space it comprehends. It rectifies all boundaries; it is the key to information of the knowledge of God ...

*The Measure of the Circle*

The Circle (p. 12)

Published for the Author

1854

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The eye is the first circle; the horizon which it forms is the second; and throughout nature this primary figure is repeated without end. It is the highest emblem in the cipher of the world.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

Circles (p. 403)

The Library of America. New York, New York, USA. 1983

**Frankland, William Barrett**

No biographical data available

To call the circle a beautiful curve would be an insipid commonplace, for from the dawn of geometry, ever since Thales and Pythagoras, mathematicians have been captivated by its absolute perfection of form.

*The Story of Euclid*

Chapter VII (p. 70)

George Newnes, Ltd. London, England. 1902

**Pope, Alexander** 1688–1744

English poet

As the small pebble stirs the peaceful lake;  
The centre mov'd, a circle straight succeeds,  
Another still, and still another spreads.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle IV, l. 364

Houghton Mifflin Company. New York, New York, USA. 1903

**Rablagiliati, Andrea Carlo Francisco**

No biographical data available

A circle has neither beginning nor end; or it is all beginning and all end.

*Aphorisms, Definitions, Reflections, and Paradoxes, Medical, Surgical and Dietetic*

Number 2 (p. 1)

William Wood & Co. New York, New York, USA. 1901

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

KNELLER: Just what such blockheads would believe. The circle is a dead thing like a straight line: no living hand can draw it: you make it by twirling a pair of dividers.

*The Complete Plays of Bernard Shaw*

In Good King Charles's Golden Days, Act I (p. 1358)

Odhams Press. London, England. 1950

**Soddy, Frederick** 1877–1956

English chemist

Four circles to the kissing come,  
The smaller are the benter.  
The bend is just the inverse of  
The distance from the centre.  
Though their intrigue left Euclid dumb  
There's now no need for rule of thumb.  
Since zero bend's a dead straight line  
And concave bends have minus sign,  
The sum of squares of all four bends  
Is half the square of their sum.

The Kiss Precise

*Nature*, Volume 137, Number 3477, June 20, 1936 (p. 1021)

**Swift, Jonathan** 1667–1745

Irish-born English writer

I'm up and down, and roundabout, Yet all the world can't  
find me out; Though hundreds have employ'd their lei-  
sure, They never yet could find my measure. I'm found  
almost in every garden, Nay, in the compass of a farthing.  
There's neither chariot, coach, nor mill, Can move an  
inch except I will.

*The Poetical Works of Jonathan Swift* (Volume 1)

On A Circle

Houghton, Osgood & Co. Boston, Massachusetts, USA. 1879

## CIRCULATION

**Harvey, William** 1578–1657

English physician

...I frequently and seriously bethought me, and long  
revolved in my mind, what might be the quantity of  
blood which was transmitted, in how short a time its  
passage might be effected, and the like; and not finding  
it possible that this could be supplied by the juices of  
the ingested aliment without the veins on the one hand  
becoming drained, and the arteries on the other getting  
ruptured through the excessive charge of blood, unless  
the blood should somehow find its way from the arteries  
into the veins, and so return to the right side of the heart;  
I began to think there might not be a MOTION, AS IT  
WERE, IN A CIRCLE.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Chapter 8 (p. 285)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...since all living things are warm, all dying things cold,  
there must be a...seat and fountain, a kind of home and  
hearth, where the cherisher of nature, the original of the  
native fire, is stored and preserved; whence heat and life  
are dispensed to all parts as from a fountain head; whence

sustenance may be derived; and upon which concoction and nutrition, and all vegetative energy may depend. Now, that the heart is this place, that the heart is the principle of life...I trust no one will deny.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Chapter 15 (p. 296)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CIRCUMCISION

### Freeland, E. Harding

No biographical data available

It has been urged as an argument against the universal adoption of circumcision that the removal of the protective covering of the glans tends to dull the sensitivity of that exquisitely sensitive structure and thereby diminishes sexual appetite and the pleasurable effects of coitus. Granted that this be true, my answer is that, whatever may have been the case in days gone by, sensuality in our time needs neither whip nor spur, but would be all the better for a little more judicious use of curb and bearing-rein.

Circumcision as a Preventative of Syphilis and Other Disorders

*The Lancet*, Volume 2, 29 December, 1900 (pp. 1869–1871)

### Johnson, Athol A. W.

No biographical data available

In cases of masturbation we must, I believe, break the habit by inducing such a condition of the parts as will cause too much local suffering to allow of the practice to be continued. For this purpose, if the prepuce is long, we may circumcise the male patient with present and probably with future advantages; the operation, too, should not be performed under chloroform, so that the pain experienced may be associated with the habit we wish to eradicate.

On an Injurious Habit Occasionally Met with in Infancy and Early Childhood

*The Lancet*, Volume 1, 7 April, 1860 (pp. 344–345)

### Sayer, Lewis L.

No biographical data available

Hip trouble is from falling down, an accident that children with tight foreskins are specially liable to, owing to the weakening of the muscles produced by the condition of the genitals.

Circumcision for the Cure of Enuresis

*Journal of the American Medical Association*, Volume 7, 1887 (pp. 631–633)

### Taylor, A. W.

No biographical data available

Not infrequently marital unhappiness would be better relieved by circumcising the husband than by suing for divorce.

Circumcision – Its Moral and Physical Necessities and Advantages

*Medical Record*, Volume 56, 1899 (p. 174)

## CIRCUMFERENCE

### de Morgan, Augustus 1806–71

English mathematician and logician

Let him also say what this mysterious 3.14159...really is, which comes in at every door and window, and down every chimney, calling itself the circumference to a unit of diameter.

*A Budget of Paradoxes* (Volume 2) (2nd edition) (p. 214)

The Open Court Publishing Co. Chicago, Illinois, USA. 1915

### Pascal, Blaise 1623–62

French mathematician and physicist

We...believe we are far more capable of reaching the center of things than of embracing their circumference.

*Pensees*

Transitions from the Knowledge of Man to that of God (p. 61)

Hackett. Indianapolis, Indiana, USA. 2004

## CIRCUMSTANCE

### Disraeli, Benjamin, First Earl

of Beaconsfield 1804–81

English prime minister, founder of Conservative Party, and novelist

Man is not the creature of circumstances. Circumstances are the creatures of men.

*Vivian Grey*

Chapter VII (p. 369)

Longmans, Green & Co. London, England. 1878

## CIRQUE

### Hobbs, William Herbert 1864–1952

American geologist

It is safe to say that no topographic feature is more characteristic of the mountains which have been occupied by glaciers than is the cirque. Approaching a range from a considerable distance, there is certainly no feature which so quickly forces itself upon the attention.

*Characteristics of Existing Glaciers*

Part I, Chapter 1 (p. 12)

The Macmillan Co. New York, New York, USA. 1911

## CITY

### Abbey, Edward 1927–89

American nature writer

We must save the city. It is essence and substance of us all—we cannot lose it without diminishing our stature as a nation, without a fatal wound.

*The Journey Home: Some Words in Defense of the American West*

Chapter 9 (p. 101)  
E.P. Dutton & Company. New York, New York, USA. 1977

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Stones make a wall, walls make a house, houses make streets, and streets make a city. A city is stones and a city is people; but it is not a heap of stones, and it is not a just a jostle of people.

*The Ascent of Man*  
The Grain in the Stone (p. 96)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

## CIVILIZATION

**Beston, Henry** 1888–1968  
American writer

Our fantastic civilization has fallen out of touch with many aspects of nature, and with none more completely than with night.

*The Outermost House*  
Chapter VIII (p. 168)  
Rinehart & Company. New York, New York, USA. 1928

**Connolly, Cyril** 1903–74  
English critic and editor

The civilization of one epoch becomes the manure of the next.

*The Unquiet Grave: A Word Cycle* (p. 50)  
H. Hamilton. London, England. 1961

**de La Beche, Henry Thomas** 1796–1855  
English geologist

Civilization advances science, viewed in all its strictness and height; and science, by its applications, advances civilization.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I  
Inaugural Discourse (pp. 21–22)  
Longman, Brown, Green & Longmans. London, England. 1852

**Fessenden, Reginald Aubrey** 1866–1932  
Canadian physicist and inventor

All our civilization is based on inventions; before invention, men lived on fruits and nuts and pine cones and slept in caves.

In Frederick Seitz  
*The Cosmic Inventor: Reginald Aubrey Fessenden*  
Aphorisms (p. 54)  
American Philosophical Society. Philadelphia, Pennsylvania, USA. 1999

**Hornaday, William Temple** 1854–1937  
American naturalist

We are weary of witnessing the greed, selfishness and cruelty of “civilized” man toward the wild creatures of the earth. We are sick of tales of slaughter and pictures of

carnage. It is time for a sweeping Reformation; and that is precisely what we now demand.

*Our Vanishing Wild Life: Its Extermination and Preservation*  
Preface (p. x)  
Charles Scribner’s Sons. New York, New York, USA. 1913

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

the only thing I wonder about  
is why the human species calls it a civilization  
human society has never been  
as well organized as a hill of ants  
or a hive of bees

*the lives and time of archy & mehitabel*  
prophecies (p. 279)  
Doubleday Doran & Co. Garden City, New York, USA. 1934

**Myers, Frederic William Henry** 1843–1901  
English poet and essayist

The transmutation of savage fear into scientific curiosity  
is of the essence of civilisation.

*Human Personality and Its Survival of Bodily Death*  
Chapter VII (p. 252)  
Longmans, Green & Co. New York, New York, USA. 1907

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Civilization is but a filmy fringe on the history of man.

*The Evolution of Modern Medicine*  
Chapter I (p. 2)  
Yale University Press. New Haven Connecticut, USA. 1921

**Page, David**  
No biographical data available

Man cannot make progress in civilisation without drawing from the mineral and metallic stores of the earth’s crust. He may lead a savage or a nomadic life, and subsist on roots and fruits, by hunting, by fishing, or on the produce of his herds and flocks; but he cannot settle down in civilised communities, or combat successfully with the forces of nature, till he has learned to arm himself with tools and implements.

*Economic Geology; Or, Geology in Its Relations to the Arts and Manufactures*  
Introduction (p. 2)  
William Blackwood & Sons. Edinburgh, Scotland. 1874

**Shklovskii, Josef Samuelovich** 1916–  
Russian astrophysicist

**Sagan, Carl** 1934–96  
American astronomer and author

The assumption that technical civilizations must *necessarily* make an appearance, even after many billions of years of biological evolution, implies that the ultimate purpose, or goal, in the formation of stars and planets is

the production of intelligent beings and technical civilizations – an idealistic and teleological view.

*Intelligent Life in the Universe* (p. 379)  
1966

## CLARITY

**Bronk, Detlev W.** 1897–1975

American biologist

Science, like art, music and poetry, tries to reduce chaos to the clarity and order of pure beauty.

In Max Levin

Our Debt to Hughlings Jackson

*Journal of the American Medical Association*, Volume 191, Number 12,  
March 22, 1965 (p. 996)

**Einstein, Albert** 1879–1955

German-born physicist

In the interest of clearness, it appeared to me inevitable that I should repeat myself frequently, without paying the slightest attention to the elegance of the presentation.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Preface (p. 3)

Pi Press. New York, New York, USA. 2005

**Sober, Elliott** 1948–

American philosopher of science and evolutionary theorist

A science may fall short of perfect clarity in different ways. One is relatively benign. A science may move forward, sideways, and backwards as if in a fog that sometimes lifts a little then resettles.... But a science enveloped by fog has at least one consolation. A fog does not foster the illusion of clarity; the lack of visibility is patent. More insidious than the fog is the mirage. Fogs are seen for what they are. Mirages are trickier, engendering the mistaken conviction that things are as they seem.

*The Nature of Selection: Evolutionary Theory in Philosophical Focus*

Introduction (p. 1)

The MIT Press. Cambridge, Massachusetts, USA. 1984

## CLASSIFICATION

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Are our systems the inventions of naturalists, or only their reading of the Book of Nature? and can that book have more than one reading? If these classifications are not mere inventions, if they are not an attempt to classify for our own convenience the objects we study, then they are thoughts which, whether we detect them or not, are expressed in Nature, – then Nature is the work of thought, the production of intelligence carried out according to plan, therefore premeditated, – and in our study of natural objects we are approaching the thoughts

of the Creator, reading His conceptions, interpreting a system that is His and not ours.

*Methods of Study in Natural History*

Chapter I (pp. 13–14)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

...believing, as I do, that classification, rightly understood, means simply the creative plan of God as expressed in organic forms, I feel the importance of attempting at least to present it in a popular guise, divested, as far as possible, of technicalities. I would therefore ask the indulgence of my readers for such scientific terms and details cannot well be dispensed with, begging them to remember that a long and tedious road may bring us suddenly upon a glorious prospect, and that a clearer mental atmosphere and a new intellectual sensation may well reward us for a little weariness in the outset.

*Methods of Study in Natural History*

Chapter IV (p. 42)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

Modern classifications of animals and plants are based upon the peculiarities of their structure; and this is generally considered as the most important, if not the only safe guide in our attempts to determine the natural relations which exist between animals. This view of the subject seems to me, however, to circumscribe the foundation of a natural system of Zoology and Botany within too narrow limits, to exclude from our consideration some of the most striking characteristics of the two organic kingdoms of nature, and to leave it doubtful how far the arrangement thus obtained is founded in reality ...

*An Essay on Classification*

Chapter First (p. viii)

Longman, Brown, Green, Longmans & Roberts. London, England. 1859

Are these divisions artificial or natural? Are they the devices of the human mind to classify and arrange our knowledge in such a manner as to bring it more readily within our grasp and facilitate further investigations, or have they been instituted by the Divine Intelligence as the categories of his mode of thinking?

*Essay on Classification*

Chapter I, Section I (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1962

**Aristotle** 384 BCE–322 BCE

Greek philosopher

Ought we, for instance (to give an illustration of what I mean), to begin by discussing each separate species – man, lion, ox, and the like – taking each kind in hand independently of the rest, or ought we rather to deal first with the attributes which they have in common in virtue of some common element of their nature, and proceed from this as a basis for the consideration of them separately?

In *Great Books of the Western World* (Volume 8)

*On the Parts of Animals*

Book I, Chapter 1 (p. 161)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bain, Alexander** 1818–1903

Scottish philosopher and psychologist

The number of trials necessary to arrive at a new construction, is commonly so great, that, without something of an affection, or fascination, for the subject, one grows weary of the task. The patient thought of the naturalist desirous of rising to new classifications, grows out of his liking for the subject, which makes it to him a sweet morsel rolled under the tongue, and gives an enjoyment even to fruitless endeavors.

*The Sense and the Intellect* (3rd edition) (p. 593)

D. Appleton & Company. New York, New York, USA. 1868

**Batten, Roger L.**

No biographical data available

One of mankind's earliest intellectual endeavors was the attempt to gather together the seemingly overwhelming variety presented by nature into an orderly pattern. The desire to classify – to impose order on chaos and then to form patterns out of this order on which to base ideas and conclusions – remains one of our strongest urges.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1959)

The Need to Classify (p. 509)

Government Printing Office. Washington, D.C. 1960

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

It is not obviously silly to classify flowers by their colors; after all, the blue flowers do tend to be associated with the colder climates and greater heights. There is nothing wrong with the system in advance. It simply does not work as conveniently and as instructively as Linnaeus's classification by family likenesses.

*The Common Sense of Science*

Chapter IV, Section 4 (p. 48)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Childe, V. Gordon** 1892–1957

Australian-English archaeologist

To interpret the objects he collects, to classify them and even to describe them correctly, an archaeologist ought ideally to be able to make them.

*A Short Introduction to Archaeology*

Chapter Five (p. 105)

Frederick Muller Ltd. London, England. 1956

**Darwin, Charles Robert** 1809–82

English naturalist

From the most remote period in the history of the world, organic beings have been found to resemble each other in descending degrees, so that they can be classed in groups under groups. This classification is not arbitrary like the grouping of the stars in constellations. The existence of groups would have been of simple significance, if one group had been exclusively fitted to inhabit the land, and

another the water; one to feed on flesh, another on vegetable matter, and so on; but the case is widely different, for it is notorious how commonly members of even the same subgroup have different habits.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XIV (p. 208)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

But what is classification but the perceiving that these objects are not chaotic, and are not foreign, but have a law which is also the law of the human mind?

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

The American Scholar (p. 56)

The Library of America. New York, New York, USA. 1983

**Gladilin, V. N.**

No biographical data available

There is no problem in archaeology today which is more important than the classification of archaeological materials.

*150 let Odesskomu arkheologicheskomu museju*

Printsipy Klassifikatsii Rannepaleoliticheskikh Izdelij Tezisy Dokladov

Konferentsii, Kiev, 1975 (p. 13)

**Graton, L. C.**

No biographical data available

The purpose of classification is not to set forth final and indisputable truths but rather to afford stepping stones towards better understanding.

In Fred M. Bullard

*Volcanoes of the Earth*

Chapter 4 (p. 30)

University Texas Press. Austin, Texas, USA. 1984

**Hopwood, Arthur Tindell** 1897–1969

English scientist

The urge to classify is a fundamental human instinct; like the predisposition to sin, it accompanies us into the world at birth and stays with us to the end.

The Development of Pre-Linnaean Taxonomy

*Proceedings of the Linnaean Society of London*, Volume 170, 1959 (p. 230)

**Hull, David L.**

No biographical data available

If contemporary philosophers of science agree on anything, it is that scientific classification cannot be theoretically neutral. Nor can there be any prescribed order in which theoretical combinations are introduced into a classification. One cannot begin by producing a theoretically neutral classification, and then only later add theoretical interpretations.

*Philosophy of Science Association 1978*

The Principles of Biological Classification: The Use and Abuse of Philosophy, Volume 2



**James, William** 1842–1910  
American philosopher and psychologist

The first steps in most of the sciences are purely classificatory. Where facts fall easily into rich and intricate series (as plants and animals and chemical compounds do), the mere sight of the series fill the mind with a satisfaction *sui generis*; and a world whose real materials naturally lend themselves to serial classification is *pro tanto* a more rational world, a world with which the mind will feel more intimate, than with a world in which they do not. By the pre-evolutionary naturalists, whose generation has hardly passed away, classifications were supposed to be ultimate insights into God's mind, filling us with adoration of his ways. The fact that Nature lets us make them was a proof of the presence of his Thought in her bosom.

*The Principles of Psychology* (Volume 2)  
Necessary Truths – Effects of Experience, Classificatory Series (p. 647)  
Harvard University Press. Cambridge, Massachusetts, US. 1981

### **Lamarck, Jean-Baptiste Pierre**

**Antoine** 1744–1829  
French biologist

Throughout nature, wherever man strives to acquire knowledge he finds himself under the necessity of using special methods, first, to bring order among the infinitely numerous and varied objects which he has before him; second, to distinguish, without danger of confusion, among this immense multitude of objects, either groups or those in which he is interested, or particular individuals among them; third, to pass on to his fellows all what he has learnt, seen and thought on the subject. Now the methods which he uses for this purpose are what I call the artificial devices in natural science, – devices which we must beware of confusing with the laws and acts of nature herself.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter I (p. 19)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

It was no doubt indispensable to break up the productions of nature into groups, and to establish different kinds of divisions among them such as classes, orders, families and genera. It was, moreover, necessary to fix what are called species, and to assign special names to these various sorts of objects. This is required on account of the limitations of our faculties; some such means are necessary for helping us to fix the knowledge which we gain from that prodigious multitude of natural bodies which we can observe in their infinite diversity.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter I (p. 20)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

Thus, among living bodies, nature, as I have already said, definitely contains nothing but individuals which succeed one another by reproduction and spring from one another; but the species among them have only a relative constancy and are only invariable temporarily.

Nevertheless, to facilitate the study and knowledge of so many different bodies it is useful to give the name of species to any collection of like individuals perpetuated by reproduction without change, so long as their environment does not alter enough to cause variations in their habits, character and shape.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter III (p. 44)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lankester, Edwin Ray** 1847–1929  
English zoologist

The fact that we are able to classify organisms at all in accordance with the structural characteristics which they present, is due to the fact of their being related by descent.

*American Museum of Natural History*, Volume XI, Number 4, 1873 (p. 321)

**Macculloch, John** 1800–50  
English historian and writer

...no arrangement can pretend to define and separate those objects which the hand of nature has neither defined nor separated.

*A Geological Classification of Rocks*  
Chapter XII (p. 180)  
Longman, Hurst, Reese, Orme & Brown. London, England. 1821

**Marshall, Charles E.**  
Microbiologist

Assignment to either animal or plant life is precarious and unnecessary, for in making such an attempt the scientist really does nothing more than prescribe for Nature restrictions rather than follow Nature as she exists.

In Charles E. Marshall  
*Microbiology: A Text-book of Microorganisms, General and Applied*  
(3rd edition)  
Part I (p. 12)  
P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1921

**Morris, Henry** 1918–2006  
American creationist

If an evolutionary continuum existed, as the evolution model should predict, there would be no gaps, and thus it would be impossible to demark specific categories of life. Classification requires not only similarities, but differences and gaps as well, and these are much more amenable to the creation model.

*Scientific Creationism*  
Chapter IV (p. 72)  
Creation-Life Publishers. San Diego, California, USA. 1974



**Olson, S. L.**

No biographical data available

...the present classification of birds amounts to little more than superstition and bears about as much relationship to a true phylogeny of the Class Aves as Greek mythology does to the theory of relativity.

The Museum Tradition in Ornithology – A Response to Ricklefs  
*The Auk*, Volume 98, January, 1981 (p. 193)

**Pearson, Karl** 1857–1936

English mathematician

*The classification of facts, the recognition of their sequence and relative significance is the function of science*, and the habit of forming a judgment upon these facts unbiased by personal feeling is characteristic of what may be termed the scientific frame of mind.

*The Grammar of Science* (2nd edition)

Chapter I (p. 6)

Adam &amp; Charles Black. London, England. 1900

**Rouse, Irving**

No biographical data available

Classification, like statistics, is not an end in itself but a technique by means of which to attain specific objectives, and so it must be varied with the objective.

The Classification of Artifacts in Archaeology

*American Antiquity*, Volume 25, January, 1960 (p. 313)

A good archaeologist is distinguished from a bad one by his ability to make valid classificatory judgments.

*Introduction to Prehistory: A Systematic Approach*

Chapter 2, Section 7 (p. 46)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Smiles, Samuel**

No biographical data available

A place for everything and everything in its place.

*Thrift*

Chapter 5 (p. 66)

John Murray. London, England. 1888)

**Tennyson, Alfred (Lord)** 1809–92

English poet

What is it? A learned man

Could give it a clumsy name.

Let him name it who can,

The beauty would be the same.

*Alfred Tennyson's Poetical Works*

Maude, Part II, Section II, Stanza II

Oxford University Press, Inc. London, England. 1953

**The Bible (King James Version)**

And Adam gave names to all cattle, and to the fowl of the air, and to every beast of the field...

Genesis 2:20

**Washington, Henry S.** 1867–1934

American petrologist, geologist, and geochemist

We can classify rocks, for petrological purposes, exactly, definitely, and strictly only by creating arbitrary divisions, cutting them up by sharp planes and putting them into man-devised pigeon-holes, as was done in the quantitative classification or as seems necessary in any modification of it. Such a classification is a pis-aller, a makeshift, a classification of convenience; it may or may not correspond to the evolution of igneous rocks as it really is.

Deccan Salts and Plateau Basalts

*Bulletin of Geological Society of America*, Volume 33, Number 4, November 2, 1922 (p. 801)

**CLASSIFY****Lardner, Dionysius** 1793–1859

British physicist and astronomer

To compare, to classify, to generalize, seem to be instinctive propensities peculiar to man. They separate him from inferior animals by a wide chasm.

*Popular Lectures on Science and Art* (Volume 2)

Matter & Its Physical Properties (p. 20)

Greeley & McElrath. New York, New York, USA. 1846

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

The art of classifying things into genera and species is of no little importance and of much use both to the judgment and the memory. You know how important this is in botany, not to speak of animals and other substances, and without mentioning also beings moral and notional, as some call them. Order largely depends upon it, and many good authors so write that their entire discourse can be reduced to divisions and subdivisions, according to a method which has some relation to genera and species, and is of use not only in retaining things, but also in finding them.

*New Essays Concerning Human Understanding*

Book III, Chapter III (p. 311)

The Open Court Publishing Co. Chicago, Illinois, USA. 1916

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Your mind will shortly be set aright,

When you have learned,

all things reducing,

To classify them for your using.

Translated by Bayard Taylor

*Faust*

IV (p. 66)

The Modern Publisher. New York, New York, USA. 1912

**CLEAR**

**Ramsey, Frank Plumpton** 1903–30  
English mathematician

...we are in the ordinary position of scientists of having to be content with piecemeal improvements: we can make several things clearer, but we cannot make anything clear.

*The Foundations of Mathematics: And Other Logical Essays*  
Chapter IX (p. 268)  
Routledge. London, England. 2001

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Your mind will shortly be set aright,  
When you have learned,  
all things reducing,  
To classify them for your using.

Translated by Bayard Taylor

*Faust*

IV (p. 66)

The Modern Publisher. New York, New York, USA. 1912

**CLINICAL TRIAL**

**Bartlett, Elisha** 1804–55  
American physician

The first condition, in the establishment of any therapeutical principle, or law, is this – that the facts, or phenomena, the relationships of which are to be investigated, shall be sufficiently fixed and definite to be comparable.... The subjects of the disease...ought to be taken from the same locality, and from the same classes of population.... [The disease, to be studied, should be susceptible of a clear and positive diagnosis.... [E]very case of the disease that presents itself, should be taken into account, whatever may be its stage, its degree of severity, or its complications. There should be no selection of case.

In William E. Stempsey

*Elisha Bartlett's Philosophy of Medicine*

Part II, Chapter XI (p. 128)

Springer-Verlag. Dordrecht, The Netherlands. 2005

**Cochrane, Archibald Leman**

No biographical data available

It appears in general it is Catholicism, Communism, and underdevelopment that appear to be against RCTs [randomized clinical trials]. In underdeveloped countries this can be understood, but what have Communism and Catholicism against RCTs?

*Effectiveness And Efficiency: Random Reflections on Health Services*

Evaluation of Evidence (p. 24)

Nuffield Provincial Hospitals Trust. London, England. 1972

An RCT [randomized clinical trials] is great fun for the co-ordinator but can be very boring for the scattered physicians filling in the forms.

*Effectiveness And Efficiency: Random Reflections on Health Services*  
Evaluation of Evidence (p. 24)  
Nuffield Provincial Hospitals Trust. London, England. 1972

**CLINICIAN**

**Addis, Thomas** 1881–1949  
English-born American physician

A clinician is complex. He is part craftsman, part practical scientist, and part historian; so his several classifications involve, in varying degree, all these elements. It is only if we look at him when he is working with his patients that we find him pragmatic and utilitarian. His only design is to bring relief, and he is not at all scrupulous about how he does it.

*Glomerular Nephritis: Diagnosis and Treatment*

Chapter 5 (p. 120)

The Macmillan Company. New York, New York, USA. 1948

**Feinstein, Alvin R.**

No biographical data available

Unlike other types of scientific equipment, a clinician is not easily tested, compared, or calibrated in the act of getting clinical evidence. He can markedly improve the scientific quality of his performance, however, if he is willing to recognize the importance of what he does, to acknowledge himself as the apparatus to be improved, and to revise many minor and some major aspects of the way he works.

*Clinical Judgment* (p. 308)

Williams & Wilkins. Baltimore. 1967

**Peabody, Francis Weld** 1881–1927

American physician

One of the essential qualities of the clinician is interest in humanity, for the secret of the care of the patient is in caring for the patient.

*The Care of the Patient*

The Care of the Patient (p. 48)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

**CLONE**

**Ehlers, Vernon** 1934–  
American politician

Human life is sacred. The good Lord ordained a time-honored method of creating human life, commensurate with substantial responsibility on the part of the parents, the responsibility to raise a child appropriately. Creating life in the laboratory is totally inappropriate and so far removed from the process of marriage and parenting that has been instituted upon this planet that we must rebel against the very concept of human cloning. It is simply wrong to experiment with the creation of human life in this way.

Human Cloning

*Congressional Record-House*, Volume 143, Number 26, 4 March, 1997 (p. H 713)

**Clifford, William Kingdon** 1845–79  
English mathematician

...how close, depends upon the circumstances.  
*Lectures and Essays, by the Late William Kingdon Clifford*  
On the Aims and Instruments of Scientific Thought (p. 93)  
Macmillan & Co Ltd. London, England. 1886

## COAL SACK

**de Vere Stacpoole, Henry** 1863–1951  
Irish author

In the Milky Way, near the Southern Cross, occurs a terrible circular abyss, the Coal Sack. So sharply defined is it, so suggestive of a void and bottomless cavern, that the contemplation of it afflicts the imaginative mind with vertigo. To the naked eye it is as black and as dismal as death, but the smallest telescope reveals it beautiful and populous with stars.

*The Blue Lagoon: A Romance*  
Book I, Part I, Chapter II (p. 12)  
Duffield. New York, New York, USA. 1910

## COD LIVER OIL

**Crichton-Browne, Sir James** 1840–1938  
English physician

Oleum Jecoris Aselli, or cod-liver oil... had long been used by the Laplanders as a delicacy, in the Shetland Islands in place of butter, and in Holland it had been recommended as a cure for gout and rheumatism, but its first employment as a medical agent amongst us followed on the publication of Dr. Bennett's treatise on the subject.

*From the Doctor's Notebook*  
Oleum Jecoris Aselli (p. 39)  
Duckworth. London, England. 1937

## COHERENCE

**Donne, John** 1572–1631  
English poet and divine

'Tis all in peeces, all cohaerence gone.  
*Anatomic of the World* (pp. 202–203)  
N. Douglas. London, England. 1926

## COINCIDENCE

**Brunstein, Karl A.**  
No biographical data available

Just as disease is the physician's realm, coincidence can be thought of as the foggy sphere in which the physicist performs.

*Beyond the Four Dimensions*  
Chapter Nine (p. 184)  
Walker & Co. New York, New York, USA. 1979

**Burger, Edward B.**  
American mathematician

**Starbird, Michael**  
American mathematician

Coincidence surprises us because our intuition about the likelihood of an event is often wildly inaccurate.

*Coincidences, Chaos, and All That Math Jazz*  
Chapter I (p. 5)  
W.W. Norton & Co. New York, New York, USA. 2005

**Gore, George** 1826–1909  
English electrochemist

Before we can completely explain a phenomenon we require not only to find its true cause, its chief relations to other causes, and all the conditions which determine how the cause operates, and what its effect and amount of effect are, but also all the coincidences.

*The Art of Scientific Discovery*  
Part IV, Chapter XLVIII (p. 444)  
Longmans, Green & Co. London, England. 1878

**Raymo, Chet** 1936–  
American physicist and science writer

Coincidence is the evidence of the True Believer.  
*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*  
Chapter Six (p. 107)  
Walker & Company. New York, New York, USA. 1998

## COLD

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...heat and cold are nature's two hands, whereby she chiefly worketh; and heat we have in readiness, in respect of the fire; but for cold we must stay till it cometh, or seek it in deep caves, or high mountains: and when all is done, we cannot obtain it in any great degree: for furnaces of fire are far hotter than a summer's sun; but vaults or hills are not much colder than a winter's frost.

*The Works of Francis Bacon* (Volume 1)  
*Sylva Sylvarum, Of Production of Cold* (p. 270)  
Reprinted for C. & J. Rivington. London, England. 1826

## COLD FUSION

**Beam, Alex**  
No biographical data available

Cold fusion, the most delectable scientific nonevent since Kohoutek's Comet, is fizzling fast. As reports debunking the improbable breakthrough pour in from labs around the country, "fusion in a jar" is looking like a latter-day Veg-O-Matic, the kitchen appliance that works when you see it on TV but not when you get it home.

Cold Fusion, We Hardly Knew Ye  
*The Boston Globe*, May 3, 1989 (p. 77)

## COLEOPTERIST

**Crowson, Roy Albert** 1914–99  
 English biologist

If and when the day comes when pure science is once again generally appreciated as a self-justifying intellectual adventure of mankind, then the coleopterists should be able to step forward and claim their share of its glory.

*The Biology of the Coleoptera*  
 Chapter 21 (p. 691)  
 Academic Press. London, England. 1981

## COLLAGEN

**Gross, Jerome**  
 American physician

Collagen is perhaps the most abundant protein in the animal kingdom. It is the major fibrous constituent of skin, tendon, ligament, cartilage and bone. Its properties are diverse and remarkable. In tendon it has a tensile strength equal to that of light steel wire; in the cornea it is as transparent as water. It accounts for the toughness of leather, the tenacity of glue and the viscousness of gelatin.

Collagen  
*Scientific American*, Volume 204, Number 5, May, 1961 (p. 121)

## COLLECTING

**Darwin, Charles Robert** 1809–82  
 English naturalist

The passion for collecting which leads a man to be a systematic naturalist, a virtuoso, or a miser, was very strong in me, and was clearly innate, as none of my sisters or brothers ever had this taste.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter II (p. 26)  
 D. Appleton & Company. New York, New York, USA. 1896

I was very fond of collecting eggs, but I never took more than a single egg out of a bird's nest, except on one single occasion, when I took all, not for their value, but from a sort of bravado.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter II (p. 28)  
 D. Appleton & Company. New York, New York, USA. 1896

**Durrell, Gerald M.** 1925–95  
 British naturalist, zookeeper, and author

One of the chief charms of collecting is its uncertainty. One day you will go out loaded down with nets and bags for the sole purpose of catching bats, and you will arrive back in camp with a python in the nets, your bags full of birds, and your pockets full of giant millipedes.

*The Overloaded Ark*  
 Chapter 5 (p. 92)  
 The Viking Press. New York, New York, USA. 1953

## COLONIZATION

**Bernal, John Desmond** 1901–71  
 Irish-born physicist and x-ray crystallographer

...once acclimatized to space living, it is unlikely that man will stop until he has roamed over and colonized most of the sidereal universe, or that even this will be the end. Man will not ultimately be content to be parasitic on the stars but will invade them and organize them for his own purposes.

*The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul*  
 Chapter II (pp. 27–28)  
 Indiana University Press. Bloomington, Indiana, USA. 1969

**Hoyle, Sir Fred** 1915–2001  
 English mathematician, astronomer, and writer

Colonization of the galaxy is impossible because it was deliberately arranged to be so.

*The Intelligent Universe*  
 Chapter 6 (p. 155)  
 Holt, Rinehart & Winston. New York, New York, USA. 1983

**Moore, Patrick** 1923–  
 English amateur astronomer

I cannot believe that it will ever be feasible to send a manned space-ship out beyond the Solar System; my lack of faith in space-warps, time-warps, freezing techniques, and cosmical Noah's Arks is profound, though I am well aware that others do not agree.

*The Next Fifty Years In Space*  
 Chapter 10 (p. 129)  
 William Luscombe Publisher Ltd. London, England. 1976

**Wiley, Jr., John P.**  
 No biographical data available

With the rest of our solar system inhospitable to life as we know it and with travel to the stars problematical, man must lie in the bed he is making on Earth for the foreseeable future.

Space: A Barrier to the Species  
*Natural History*, Volume 79, Number 1, January, 1970 (p. 73)

## COLOR

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

The world is not made up to the eye of figures, that is, only half; it is also made of color. How that element washes the universe with its enchanting waves!.... It is the last stroke of Nature; beyond color she cannot go.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

*Society and Solitude*

Success

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### Hunt, Leigh 1784–1859

English author, poet, and editor

Colors are the smiles of Nature. When they are extremely smiling, and break forth into other beauty besides, they are her laughs; as in the flowers.

*The Seer: Or, Common-places Refreshed* (Volume 1)

Color (pp. 36–37)

Roberts Brothers, Publishers. Boston, Massachusetts, USA. 1864

Nature at all events, humanly speaking, is manifestly very fond of color; for she has made nothing without it. Her skies are blue; her fields green; her waters vary with her skies; her animals, minerals, vegetables, are all colored. She paints a great many of them in apparently superfluous hues, as if to show the dullest eye how she loves colour.

*The Seer: Or, Common-places Refreshed* (Volume 1)

Color (p. 37)

Robert Brothers, Publishers. Boston, Massachusetts, USA. 1864

### Ruskin, John 1819–1900

English writer, art critic, and social reformer

What the colours of flowers, or of birds, or of precious stones, or of the sea and air, and the blue mountains, and the evening and the morning, and the clouds of Heaven, were given for – they only know who can see them and can feel, and who pray that the sight and the love of them may be prolonged, where cheeks will not fade, nor sunsets die.

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Part VII, Chapter I (p. 40)

George Allen. London, England. 1882

All good color is in some degree pensive, tho loveliest is melancholy, and the purest and most thoughtful minds are those which love color the most.

*The Stones of Venice*

Chapter 5 (p. 146)

John R. Alden, Publisher. New York, New York, USA. 1885

...of all God's gifts to the sight of man, color is the holiest, the most divine, the most solemn.

*The Stones of Venice*

Chapter 5 (p. 146)

John R. Alden, Publisher. New York, New York, USA. 1885

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

To understand the phenomena of colour nothing is required but unbiased observation and a sound head, but these are scarcer than folks imagine.

*Conversations of Goethe With Eckermann and Soret*

Wednesday, December 20 (p. 181)

George Bell & Sons. London, England. 1883

## COMBINATORICS

### Chadwick, John 1920–98

English linguist

This method of deduction...is often called “combinatory”. Its usefulness is not exhausted at this stage, but it does even at the outset lead to some valuable conclusions...

*The Decipherment of Linear B*

Cambridge University Press. Cambridge, England. 1958

### Dieudonné, Jean 1906–92

French mathematician and educator

We have not begun to understand the relationship between combinatorics and conceptual mathematics.

*A Panorama of Pure Mathematics: As Seen by N. Bourbaki*

Academic Press. New York, New York, USA. 1982

### Hoban, Russell

American fantasy writer

More and more I'm aware that the permutations are not unlimited.

*Turtle Diary*

Jonathan Cape. London, England. 1975

### Jones, Richard G.

No biographical data available

...Lord of sequence and design.

*The Hymn book of the Anglican Church of Canada and the United Church of Canada*

God of Concrete, God of Steel.

Anglican Church of Canada and the United Church of Canada. Toronto, Ontario, Canada. 1971

### Kanigel, Robert 1946–

Scientific journalist

...combinatorics, a sort of glorified dice-throwing...

*The Man Who Knew Infinity: A Life of the Genius Ramanujan*

Chapter Seven (p. 250)

Charles Scribner's Sons. New York, New York, USA. 1991

### Pinker, Steven 1954–

Canadian-born American cognitive scientist and author

Journalists say that when a dog bites a man, that is not news, but when a man bites a dog, that is news.... Thanks

to the mathematics of combinatorics, we will never run out of news.

*How the Mind Works*

Chapter 2 (p. 118)

W.W. Norton & Company, Inc. New York, New York, USA. 1997

**Segerstrale, Ullica** 1952–

Finish-born American sociologist and author

While [Maynard Smith] believed that a Marxist in science could take a lot of different positions, he saw the need for “some kind of substitute for Hegelian dialectics...some kind of concept that in dynamical systems there are going to be sudden breaks and thresholds and transformations, and so on”. He added that, in his opinion, “today we really do have a mathematics for thinking about complex systems and things which undergo transformations from quantity into quality”. Here he saw Hopf bifurcations and catastrophe theory as really nothing other than a change of quantity into quality in a dialectical sense.

*Defenders of the Truth: The Battle for Science in the Sociobiology Debate and Beyond*

Oxford University Press, Inc. Oxford 2000

**von Neumann, John** 1903–57

Hungarian-born mathematician

**Morgenstern, Oskar** 1902–77

German-born American economist

The emphasis on mathematical methods seems to be shifted more towards combinatorics and set theory – and away from the algorithm of differential equations which dominates mathematical physics.

*Theory of Games and Economic Behavior*

Chapter 4.8.3 (p. 45)

Princeton University Press. Princeton, New Jersey, USA. 1947

## COMET

### Author undetermined

...obviously, then, comet Kohoutek promises to be the celestial extravaganza of the century.

A Comet for Christmas

*Newsweek*, November 5, 1973 (p. 109)

We have reason to know that many weak people have been alarmed, and many still weaker people made positively ill, by an announcement which has appeared in almost all the newspapers, to the effect that Prof. Plan-tamour, of Geneva, has discovered a comet of immense size, which is to ‘collide,’ as our American friends would say, with our planet on the 12th of August next. We fear that there is no foundation whatever for the rumor. In the present state of science nothing could be more acceptable than the appearance of a good large comet, and the nearer it comes to us the better, for the spectroscope has

a long account to settle with the whole genus, which up to this present time has fairly eluded our grasp. But it is not too much to suppose that the laymen in these matters might imagine that discovery would be too dearly bought by the ruin of our planet. Doubtless, if such ruin were possible, or indeed probable – but let us discuss this point. Kepler, who was wont to say that there are as many comets in the sky as fishes in the ocean, has had his opinion endorsed in later times by Arago, who has estimated the number of these bodies which traverse the solar system as 17,500,000. But what follows from this? Surely that comets are very harmless bodies or the planetary system, the earth included, would have suffered from them long before this, even if we do not admit that the earth is as old as geologists would make it. But this is not all. It is well known that some among their number which have withal put on a very portentous appearance are merely the celestial equivalents of our terrestrial ‘wind-bags’...

Notes

*Nature*, Volume 5, February 15, 1872 (p. 310)

### Babylonian Inscription

A comet arose whose body was bright like the day, while from its luminous body a tail extended, like the sting of a scorpion.

In John Brandt and Robert Chapman

*Introduction to Comets*

Chapter 1 (p. 4)

Cambridge University Press. Cambridge, England. 1981

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

The angels all were singing out of tune,  
And hoarse with having little else to do,  
Excepting to wind up the sun and moon,  
Or curb a runaway young star or two,  
Or wild colt of a comet, which too soon  
Broke out of bounds o’er the ethereal blue,  
Splitting some planet with its beautiful tail,  
As boats are sometimes by a wanton whale.

*The Complete Poetical Works of Byron*

The Vision of Judgment

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Guardian and friend of the moon, O Earth, whom the comets forget not,

Yea, in the measureless distance wheel around and again they behold thee!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

Hymn to the Earth

The Clarendon Press. Oxford, England. 1912



**de Fontenelle, Bernard le Bovier** 1657–1757

French author

These foreign planets, with their tails and their beards, have a terrible menacing countenance, it may be they are sent to affront us...

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 173)

Printed for Peter Wilson. Dublin, Ireland. 1761

We think ourselves unhappy when a comet appears; but it is the comet itself which is unfortunate.

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 175)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Maupertuis, Pierre Louis Moreau** 1678–1759

French mathematician and astronomer

Kepler...thought it but reasonable, that as the sea has its whales and monsters, the air should have them likewise. These monsters are Comets ...

*An Essay Towards a History of the Principal Comets Since 1742*

A Letter Upon Comets (pp. 10–11)

Printed for T. Becket & P.A. de Hondt. London, England. 1769

...we have seen...how dangerous the shock of a Comet might prove, yet the mischief may be so inconsiderable, as to be fatal only to that part of the globe which receives the blow; we might perhaps escape with the crush only of one kingdom, while the rest of the earth would enjoy those rare productions with which so great a traveller would present them. We should be greatly surprised, perhaps, to find the fragments of these so much despised masses composed of gold and

*An Essay Towards a History of the Principal Comets Since 1742*

A Letter Upon Comets (p. 32)

Printed for T. Becket & P.A. de Hondt. London, England. 1769

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Whatever opinions we may adopt as to the physical constitution of comets, we must admit that they serve some grand and important purpose in the economy of the universe; for we cannot suppose that the Almighty has created such an immense number of bodies, and set them in rapid motion according to established laws, without an end worthy of his perfection, and, on the whole, beneficial to the inhabitants of the system through which they move.

*The Sidereal Heavens and Other Subjects Connected with Astronomy, as Illustrative of the Character of the Deity and of an Infinity of Worlds*

Chapter XX (p. 342)

Worthington. New York, New York, USA. 1884

...what I conceive to be one of the main designs of the Creator in the formation of such a vast number of splendid bodies is, that they may serve as habitations for myriads of intelligent beings.... If this position be admitted, then

we ought to contemplate the approach of a comet, not as an object of terror or harbinger of evil, but as a splendid world, of a different construction from ours, conveying millions of happy beings to survey a new region of the Divine empire...

*The Sidereal Heavens and Other Subjects Connected with Astronomy, as Illustrative of the Character of the Deity and of an Infinity of Worlds*

Chapter XX (p. 345)

Worthington. New York, New York, USA. 1884

**Donne, John** 1572–1631

English poet and divine

Who vagrant transitory comets sees,  
Wonders because they're rare; but a new star  
Whose motion with the firmament agrees,  
Is miracle; for there no new things are.

In A.J. Smith (ed.)

*The Complete English Poems*

To the Countess of Huntingdon (p. 169)

St. Martin's Press. New York, New York, USA. 1971

**Editor of the Louisville Journal**

That comet is a gay deceiver! He promised to jostle the earth, but has only jilted her. The rogue has told a tale instead of showing one.

*Prenticeana* (p. 213)

Derby & Jackson. New York, New York, USA. 1859

**Flammarion, Camille** 1842–1925

French astronomer and author

Between the solar world and the stars strange forms rush disheveled through celestial space, appearing to throw a bridge for our mind across the fathomless abyss, and to place us in communication with other universes. Let us observe these comets in passing, but let us take care not to be delayed too long by these fantastic creatures, the sirens of the sidereal ocean, whose revelations concerning immensity are full of charms, and whose hands, extended towards the inaccessible horizons, seem to show us from afar the mysterious dreams of Infinitude.

*Popular Astronomy: A General Description of the Heavens*

Book IV, Chapter IX (p. 474)

Chatto & Windus. London, England. 1894

It had been shown that if such a comet in its flight, instead of falling into the sun, should collide with...Jupiter it would raise the temperature of that globe to such a point as to restore to it its lost light, and to make it for a time a sun again, so that the earth would be lighted by two suns, Jupiter becoming a sort of minor night-sun, far brighter than the moon, and shining by its own light – of a ruby-red or garnet color, revolving about the earth in twelve years. A nocturnal sun!

*Omega: the Last Days of the World*

Chapter II (p. 37)

The Cosmopolitan Publishing Co. New York, New York, USA. 1894

**Fort, Charles** 1874–1932  
American writer

Throughout the history of astronomy, every comet that has come back upon predicted time – not that, essentially, there was anything more abstruse about it than is a prediction that you can make of a postman’s periodicities to-morrow – was advertised for all it was worth. It’s the way reputations are worked up for fortunetellers by the fortunetellers by the faithful.

*The Book of the Damned*

Chapter X (p. 133)

Boni & Liveright, New York, New York, USA. 1919

If a comet have not the orbit that astronomers have predicted – perturbed. If – like Halley’s comet – it be late – even a year late – perturbed. When a train is an hour late, we have small opinion of the predictions of time tables. When a comet’s a year late, all we ask is – that it be explained.

*The Book of the Damned*

Chapter X (p. 134)

Boni & Liveright, New York, New York, USA. 1919

...there never is a moment when there is not some comet in the sky. Virtually there is no year in which several new comets are not discovered, so plentiful are they. Luminous fleas on a vast black dog – in popular impressions, there is no realization of the extent to which this solar system is flea-bitten.

*The Book of the Damned*

Chapter X (p. 134)

Boni & Liveright, New York, New York, USA. 1919

**Guillemin, Amédée** 1826–93  
French journalist and scientific writer

In all countries and in all times, the apparition of a comet has been considered as a presage: a presage fortunate or unfortunate according to the circumstances, the popular state of mind, the prevailing degree of superstition, the imbecility of princes, or the calculation of courtiers.

Translated by James Glaisher

*The World of Comets*

Chapter I, Section I (p. 3)

Sampson Low, Marston, Searle & Rivington, London, England. 1877

**Grassi, Horatio** 1583–1654  
Jesuit astronomer

The vain comet which by its light has disturbed the earth and the heavens begins its harmless journey. With that light bestowed upon it by the creator it shrewdly propitiates the adverse celestial torches by its equal fire. May this comet which alters the heavens with its ready advantage teach me the nature of the stars.

*On the Three Comets of the Year MDCXVIII* (p. 2)

Rome. 1619

Have you seen the fleeting comet with its terrifying tail? Behold how with its fearsome beard it is carried

sky-high. But no longer need you fear that stellar body with its menacing rays, nor is there harm in those stars which delight us by their appearance. Tell me, does this phantom glitter as a better and more favorable omen and does its false light surpass that true fire of the stars?

*On the Three Comets of the Year MDCXVIII* (p. 2)

Rome. 1619

**Halley, Edmond** 1656–1742  
English astronomer and mathematician

We have reason to suspect that there are a great many more comets, which being at remote distances from the Sun, and being obscure and without a tail, may for that reason escape our observation.

*Transactions of the Royal Society of London*, Volume 24, 1706 (p. 882)

Now we know

The sharply veering ways of comets, once

A source of dread, no longer do we quail

Beneath appearances of bearded stars.

In Florian Cajori

*Sir Isaac Newton’s Mathematical Principles of Natural Philosophy and His System of the World* (p. xiv)

University of California Press, Berkeley, California, USA. 1934

Aristotle’s opinion...that comets were nothing else than sublunary vapors or airy meteors...prevailed so far amongst the Greeks, that this sublimest part of astronomy lay altogether neglected; since none could think it worthwhile to observe, and to give an account of the wandering and uncertain paths of vapours floating in the Aether.

In David Gregory

*The Elements of Astronomy, Physical and Geometrical*

A Synopsis of the Astronomy of Comets, Volume 2, 1715

Printed for John Morphew, London, England. 1715

Hitherto I have consider’d the Orbits of Comets as exactly Parabolic; upon which supposition it wou’d follow, that Comets being impell’d towards the Sun by Centripetal Force, would descend as from space infinitely distant, and by their so falling acquire such a Velocity, as that they may again fly off into the remotest parts of the Universe, moving upwards with a perpetual tendency, so as never to return again to the Sun. But since they appear frequently enough, and since some of them can be found to move in a Hyperbolic Motion, or a Motions swifter than what a Comet might acquire by its Gravity to the Sun, ‘tis highly probable they rather move in a very Excentric Elliptic Orbits, and make their returns after long periods of Time: For so their number will be determinate, and perhaps, not so very great.

In David Gregory

*The Elements of Astronomy, Physical and Geometrical*

A Synopsis of the Astronomy of Comets, Volume 2, 1715

Printed for John Morphew, London, England. 1715

...wherefore if according to what we have already said, it [the comet] should return again about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an Englishman.

In David Gregory  
*The Elements of Astronomy, Physical and Geometrical*  
 A Synopsis of the Astronomy of Comets, Volume 2, 1715  
 Printed for John Morphew. London, England. 1715

**Harris, John** 1666?–1719  
 English natural philosopher

The Affairs of Comets, Sir, with their grisly Beards and  
 Horrid Tails, fright me almost out of my Wits...  
*Astronomical Dialogues Between a Gentleman and a Lady* (p. 138)  
 Printed by T. Wood for Benj. Cowse. London, England. 1719

**Hellman, C. Doris** 1910–73  
 Translator and editor

I cannot think a comet is a sudden fire, but I rank it among  
 Nature's permanent creations.  
*The Comet of 1577: Its Place in the History of Astronomy* (p. 31)  
 Columbia University Press. New York, New York, USA. 1944

**Herschel, Sir John Frederick William** 1792–1871  
 English astronomer and chemist

There is, beyond question, some profound secret and  
 mystery of nature concerned in the phenomenon of their  
 [comets] tails. Perhaps it is not too much to hope that  
 future observation, borrowing every aid from rational  
 speculation, grounded on the progress of physical sci-  
 ence generally, (especially those branches of it which  
 relate to the aethereal or imponderable elements), may  
 ere long enable us to penetrate this mystery, and to  
 declare whether it is really matter, in the ordinary accep-  
 tation of the term, which is projected from their heads  
 with such extravagant velocity, and if not impelled, at  
 least directed in its course by a reference to the sun, as its  
 point of avoidance.

*Outlines of Astronomy*  
 Section 599 (p. 323)  
 Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1853

The great number of comets which appear to move in  
 parabolic orbits, or orbits at least undistinguishable from  
 parabolas during their description of that comparatively  
 small part within the range of their visibility to us, has  
 given rise to an impression that they are bodies extrane-  
 ous to our system, wandering through space, and merely  
 yielding a local and temporary obedience to its laws dur-  
 ing their sojourn. What truth there may be in this view,  
 we may never have satisfactory grounds for deciding.

*Outlines of Astronomy*  
 Section 600 (p. 324)  
 Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1853

It is for the most part after thus passing the sun that  
 they shine forth in all their splendor, and that their tails  
 acquire their greatest length and development, thus indi-  
 cating plainly the action of the sun's rays as the exciting  
 cause of that extraordinary emanation.

*Outlines of Astronomy*

Part I, Chapter XI (561) (p. 346)  
 Longman, Brown, Green & Longmans. London, England. 1849

There is beyond question some profound secret and mys-  
 tery of nature concerned in the phenomenon of their tails.  
 In no respect is the question as to the materiality of the  
 tail more forcibly pressed on us for consideration than  
 in that of the enormous sweep which it makes round the  
 sun in perihelion, in the manner of a straight and rigid  
 rod, in defiance of the law of gravitation, nay, even of the  
 received laws of motion...

*Outlines of Astronomy*  
 Part I, Chapter XI (599) (p. 375)  
 Longman, Brown, Green & Longmans. London, England. 1849

By far the most wonderful and mysterious bodies of our  
 system are the comets. Their number is immense, their  
 variety of aspect infinite, their magnitude astounding.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and  
 Other Pieces*  
 Humbolt's Kosmos (p. 298)  
 Longman, Brown, Green, Longmans & Roberts. London, England. 1857

Many of the operations of nature are carried on in her  
 great laboratory which we cannot comprehend, but now  
 and then we see some of the tools with which she is at  
 work. [The many telescopic comets may restore to the  
 sun what is lost by the emission of light.]

On the Nature and Contraction of the Sun and Fixed Stars  
*Philosophical Transactions of the Royal Society of London*, Volume 85  
 1795 (p. 60)

When we look through nature and observe the manifest  
 indications of design which every point of it exhibits, it  
 would be very presumptuous in us to assert that comets  
 are of no use, and serve no purpose in our system.

*Familiar Lectures on Scientific Subjects*  
 Lecture III  
 George Routledge & Sons. New York, New York, USA. 1871

### Hildebrand, Wolfgang

No biographical data available

When 'er a comet doth appear,  
 Come mishap, want, sorrow, and fear;  
 And never hath a comet's sheen  
 Without great evil yet been seen.

These dire ill-fortunes do ensue  
 When a comet appears to view –  
 In Bruno H. Burgel  
*Astronomy for All* (p. 257)  
 Cassell & Company Ltd. London, England. 1911

### Hirshfeld, Alan W.

No biographical data available

A comet is a wondrous thing: a cosmic interloper, whose  
 realm is neither of the stars nor of the Earth.

*Parallax: The Race to Measure the Cosmos*  
 Chapter 15 (p. 245)  
 W.H. Freeman & Co. New York, New York, USA. 2001

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The Comet! He is on his way,  
And singing as he flies;  
The whizzing planets shrinks before  
The specter of the skies.

*The Complete Poetical Works of Oliver Wendell Holmes*

The Comet, Stanza 1

Houghton Mifflin Company, Boston, Massachusetts, USA. 1899

**Hooke, Robert** 1635–1703

English physician

Tho' the Frequency of *Comets*, and some of them very considerable, has excited the Lovers of Astronomical Learning to search and find out what they are; yet I have not hitherto met with any (tho' I have seen and perused the *Theorys* published by very many Ingenious Men) that has given such an account of them, as to me seems natural and satisfactory. For tho' these Bodies seem very heterogeneous, singular, and of a distinct Nature from all the rest of the Celestial Bosies we contemplate; yet I am very apt to believe, that whenever we attain a true Knowledge of them, we shall find them to be the Product of the same regular Course of Nature.

In Harry Woolf (ed.)

*The Posthumous Works of Robert Hooke*

Comets (p. 150)

Johnson Reprint Corporation, New York, New York, USA. 1969

**Hopkins, Gerard Manley** 1844–89

English poet and Jesuit priest

I am like a slip of comet,  
Scarce worth discovery, in some corner seen  
Bridging the slender difference of two stars,  
Come out of space, or suddenly engender'd  
By heady elements, for no man knows:  
But there she sights the sun she grows and sizes  
And spins her skirts out, while her central star  
Shakes its cocooning mists; and so she comes  
To fields of light; millions of traveling rays  
Pierce her; she hangs upon the flame-cased sun,  
And sucks the light as full as Gideon's fleece:  
But then her tether calls her; she falls off,  
And as she dwindles shreds her smock of gold  
Amidst the sisting planets, till she comes  
To single Saturn, last and solitary;  
And then goes out into the cavernous dark.

In Norman H. MacKenzie (ed.)

*The Poetical Works of Gerard Manley Hopkins*

After Observing Tempel's Comet in 1864 (p. 40)

Clarendon Press, Oxford, England. 1990

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

But indeed all the whole story of Comets and Planets,  
and the Production of the World, is founded upon such

poor and trifling grounds, that I have often wonder'd how an ingenious man could spend all that pains in making such fancies hang together.

*The Celestial Worlds Discovered, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions* (p. 160)

Printed for Timothy Childe, London, England. 1698

**Joyce, James** 1882–1941

Irish-born author

Would the departed never nowhere nohow reappear? Ever he would wander, self-compelled, to the extreme limit of his cometary orbit, beyond the fixed stars and variable suns and telescopic planets, astronomical waifs and strays, to the extreme boundary of space, passing from land to land, among peoples, amid events. Somewhere imperceptibly he would hear and somehow reluctantly, uncompelled, obey the summons of recall. Whence, disappearing from the constellation of the Northern Crown he would somehow reappear reborn above delta in the constellation of Cassiopeia and after incalculable eons of peregrination return an estranged avenger, a wrecker of justice on malefactors, a dark crusader, a sleeper awakened, with financial resources (by supposition) surpassing those of Rothschild or the silver king.

*Ulysses* (p. 712)

Random House, Inc. New York, New York, USA. 1946

**Kepler, Johannes** 1571–1630

German astronomer

...there are as many comets in the sky as fishes in the ocean ...

Quote is attributed

Attributed

Notes

*Nature*, Volume 5, February 15, 1872 (p. 310)**Kraus, Karl** 1874–1936

Austrian essayist and poet

If the earth had any idea of how afraid the comet is of contact with it.

In Harry Zohn (ed.)

*Half-Truths & One-and-a-Half Truths*

Lord, Forgive Them (p. 109)

The University of Chicago Press, Chicago, Illinois, USA. 1990

**Lee, Oliver Justin** 1881–1964

American astronomer

Dynamically it is quite possible that great numbers of comets were once well-behaved members of the solar system and that they have been bullied and kicked around gravitationally by the great planets and by possible dark bodies in space that they have become the pariahs they are.

*Measuring Our Universe: From the Inner Atom to Outer Space*

Chapter 7 (p. 93)

Ronald Press Company, New York, New York, USA. 1950

**Levy, David H.** 1948–

Canadian astronomer and science writer

Comets are like cats: they have tails, and they do precisely what they want.

*Comets: Creators and Destroyers*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1998

**Lubbock, Sir John** 1834–1913

English banker, author, and scientist

Comets may almost be regarded as the ghosts of heavenly bodies.

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter X (p. 402)

The Macmillan Company. New York, New York, USA. 1893

**Maunder, Edward Walter** 1851–1928

English astronomer

Comets cannot be homes of life; they are not sufficiently condensed; indeed, they are probably but loose congeries of small stones. But even if comets were of planetary size it is clear that life could not be supported on them; water could not remain in the liquid state on a world that rushed from one such extreme of temperature to another.

*Are the Planets Inhabited?*

Chapter IX (pp. 119–120)

Harper & Brothers. London, England. 1913

**Milton, John** 1608–74

English poet

Satan stood

Unterrifi'd, and like a comet burn'd

That fires the length of Ophiuchus huge

In th' Arctick sky...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book II, l. 707–710

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## National Geographic Society

Comets are the nearest thing to nothing that anybody can be and still be something.

*National Geographic Society*

Concerning the comet of 31 March, 1955

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

So small is the earth in comparison with the celestial spaces, that if one should shut his eyes and fire a gun at random in the air, the chance of bringing down a bird would be better than that of a comet of any kind striking the earth.

*Popular Astronomy*

Part III, Chapter VI (p. 413)

Harper & Brothers Publishers. New York, New York, USA. 1879

**Nicholson, Norman** 1914–87

English poet

It's here at last. Eyes in the know

Had spotted it two years ago,

A microscopic smut on film.

...

Anxious astronomers protest:

Give them a month, and they'll know just what

The frozen core is made of, test

The fluorescence tailing from it,

Fanned out in the solar wind.

*Collected Poems*

Comet Come (p. 431)

Faber & Faber Ltd. London, England. 1994

**Noyes, Alfred** 1880–1958

English poet

It was a comet, made of mortal sins...

*The Torch Bearers: Watchers of the Sky*

Tycho Brahe, III (p. 61)

Frederick A. Stokes Company Publishers. New York, New York, USA. 1922

**Nye, Bill** 1850–96

American journalist

The comet is a kind of astronomical parody on the planet. Comets look some like planets, but they are thinner and do not hurt so hard when they hit anybody as a planet does. The comet was so called because it had hair on it, I believe, but late years the bald-headed comet is giving just as good satisfaction everywhere.

*Remarks*

Skimming the Milky Way (p. 125)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Paré, Ambroise** 1510–90

French surgeon

The comet was so horrible and frightful...that some [people] died of fear and others fell sick. It appeared as a star of excessive length and the color of blood; at its summit was seen the figure of a bent arm holding a great sword in its hand, as if about to strike. On both sides...were seen a great number of axes, knives and spaces colored with blood, among which were a great number of hideous human faces with beards and bristling hair.

In William H. Jefferys and R. Robert Robbins

*Discovering Astronomy*

Physician (p. 12)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Peltier, Leslie C.** 1900–80

American comet hunter

I had watched a dozen comets, hitherto unknown, slowly creep across the sky as each one signed its sweeping flourish in the guest book of the Sun.

*Starlight Nights*

Chapter 6 (p. 43)

Harper & Row, Publishers. New York, New York, USA. 1965



Time has not lessened the age-old allure of the comets. In some ways their mystery has only deepened with the years. At each return a comet brings with it the questions which were asked when it was here before, and as it rounds the sun and backs away toward the long, slow night of its aphelion, it leaves behind with us those questions, still unanswered.

To hunt a speck of moving haze may seem a strange pursuit, but even though we fail the search is still rewarding, for in no better way can we come face to face, night after night, with such a wealth of riches as old Croseus never dreamed of.

*Starlight Nights*

Chapter 27 (p. 231)

Harper & Row, Publishers. New York, New York, USA. 1965

**Pouchet, Félix Archimède** 1800–72

French biologist

Although the vulgar cannot fathom all the mysteries of the heavens, their imagination receives some compensation in the strange fancies which comets engender, as they have always enjoyed the privilege of creating ecstasy.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book I, Chapter IV

Blackie & Son. London, England. 1892

**Proctor, Richard Anthony** 1837–88

English astronomer

Although the astronomer has achieved many successes in studying comets, yet these objects still remain outside the surveyed fields of astronomy – now, as in the old days when men spoke of sun and moon, planet and stars, as including all the members of the heavenly host.

*The Twentieth Century*

Whence Came the Comets?

Volume 29, Number 111, May, 1886 (p. 692)

**Rexroth, Kenneth** 1905–82

American poet, translator, and critical essayist

When in your middle years  
The great comet comes again  
Remember me, a child,  
Awake in the summer night,  
Standing in my crib and  
Watching that long-haired star  
So many years ago.  
Go out in the dark and see  
Its plume over water  
Dribbling on the liquid night,  
And think that life and glory  
Flickered on the rushing  
Bloodstream for me once, and for  
All who have gone before me,  
Vessels of the billion-year-long  
River that flows now in your veins.

In Bradford Morrow

*Selected Poems*

Halley's Comet

New Directions Publishing Corporation. New York, New York, USA. 1984

**Sagan, Carl** 1934–96

American astronomer and science writer

These are the snows of yesteryear, the pristine remnants of the origin of the solar system, waiting frozen in the interstellar dark.

*Comet*

Chapter I (p. 4)

Random House, Inc. New York, New York, USA. 1985

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Some day there will arise a man who will demonstrate in what region of the heavens comets take their way.

In Michael Rowan-Robinson

*Our Universe: An Armchair Guide* (p. 1)

W.H. Freeman & Company. New York, New York, USA. 1990

If one of these fires of unusual shape have made its appearance, everybody is eager to know what it is. Blind to all other celestial bodies, each asks about the new-comer; one is not quite sure whether to admire or to fear it. Persons there are who seek to inspire terror by forecasting its grave import.

*Physical Science in the Time of Nero, Being a Translation of the Quæstiones Naturales of Seneca*

Book VII, Chapter I (p. 272)

Macmillan & Company Ltd. London, England. 1910

...how many other bodies besides [these comets] move in secret, never dawning upon human eyes? Nor is it for man that God has made all things.

*Physical Science in the Time of Nero, Being a Translation of the Quæstiones Naturales of Seneca*

Book VII, Chapter XXX (p. 305)

Macmillan & Company Ltd. London, England. 1910

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

When beggars die, there are no comets seen:  
The heavens themselves blaze forth the death of princes.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*Julius Caesar*

Act II, Scene ii, l. 30–31

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Hung by the heavens with black, yield day to night!  
Comets, importing change of time and states,  
Brandish your crystal tresses in the sky.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*The First Part of King Henry the Sixth*

Act I, Scene i, l. 1–3

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**Shelley, Percy Bysshe** 1792–1822  
English poet

Thou too, O Comet, beautiful and fierce,  
Who drew the heart of this frail Universe  
Towards thine own; till, wrecked in that convulsion,  
Alternating attraction and repulsion,  
Thine went astray, and that was rent in twain;  
Oh, float into our Azure heaven again!

*The Complete Poetical Works of Percy Bysshe Shelley*  
Epipsychidion, l. 367–372  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Swift, Jonathan** 1667–1745  
Irish-born English writer

...the earth very narrowly escaped a brush from the tail  
of the last comet, which would have infallibly reduced it  
to ashes...

In *Great Books of the Western World* (Volume 36)  
*Gulliver's Travels*  
Part III, Chapter II (p. 98)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

They have observed ninety-three different comets, and  
settled their periods with great exactness. If this be true  
(and they affirm it with great confidence), it is much  
to be wished that their observations were made public,  
whereby the theory of comets, which at present is very  
lame and defective, might be brought to the same perfec-  
tion with other parts of astronomy.

In *Great Books of the Western World* (Volume 36)  
*Gulliver's Travels*  
Chapter III (p. 102)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tasso, Torquato** 1544–95  
Italian poet

As shaking terrors from his blazing hair,  
A sanguine comet gleams through dusky air.

Translated by Edward Fairfax  
*Jerusalem Delivered*, l. 581  
The Colonial Press. New York, New York, USA. 1901

**Taylor, Bert Leston** 1866–1921  
American Poet

He can route the sun Arcturus,  
He can map Orion's bands;  
He can lure us and assure us,  
For we know he understands.  
Scarcely anything to speak of  
'Scapes his trusty spectroscope;  
But a hairy, scary streak of  
Gas defies his deepest dope. A comet always gets him,  
Always frets him and upsets him;  
For he can't make head or tail of it at all.

*A Penny Whistle*  
The Astronomer (p. 23)  
Alfred A. Knopf. New York, New York, USA. 1921

**Thomson, James** 1700–48  
Scottish poet

Lo! from the dread immensity of space  
Returning, with accelerated course,  
The rushing comet to the sun descends;  
And as he shrinks below the shading earth,  
With awful train projected o'er the heavens,  
The guilty nations tremble.

*Seasons*  
Summer, l. 1705–1710  
Printed by John Mycall. Newburyport, Massachusetts, USA. 1790

**Tolstoy, Leo** 1828–1910  
Russian writer

...this bright comet which, having traveled in its orbit  
with inconceivable velocity through immeasurable space,  
seemed suddenly – like an arrow piercing the earth – to  
remain fixed in a chosen spot, vigorously holding its tail  
erect, shining and displaying its white light amid count-  
less other scintillating stars.

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
Book VIII, Chapter XXII (p. 341)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Turner, H. H. (Herbert Hall)** 1861–1930  
English astronomer

Of all the meteors in the sky  
There's none like Comet Halley.  
We see it with the naked eye  
And periodically.

Halley's Comet  
*The Mathematical Gazette*, Volume VI, Number 91, March, 1911 (p. 53)

**Twain, Mark (Samuel Langhorne  
Clemens)** 1835–1910  
American author and humorist

I came in with Halley's Comet in 1835. It is coming  
again next year (1910), and I expect to go out with it. It  
will be the greatest disappointment of my life if I don't  
go out with Halley's Comet. The Almighty has said, no  
doubt: "Now here are these two unaccountable freaks;  
they came in together, they must go out together."

In Albert Bigelow Paine  
*Mark Twain: A Biography* (Volume 4)  
Chapter CCLXXXII (p. 1511)  
Harper & Brothers Publishers. New York, New York, USA. 1912

If you want to see comets that are comets, you've got to  
go outside of our solar system – where there's room for  
them, you understand.

*Extract from Captain Stormfield's Visit to Heaven* (p. 8)  
Harper & Brothers Publishers. New York, New York, USA. 1909

**Virgil** 70 BCE– 19 BCE  
Roman epic, didactic, and idyllic poet

Of, too, when wind is toward, the stars thou'lt see

From heaven shoot headlong, and through murky night  
Long trails of fire white-glistening in their wake...

In *Great Books of the Western World* (Volume 13)

*The Georgics*

Book I, l. 365–366

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Since scientific knowledge, although frequently blended with vague and superficial views, has been more extensively diffused through wider circles of social life, apprehensions of the possible evils threatened by comets have acquired more weight, as their direction has become more definite.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Aerolites (p. 110)

Harper & Brothers, Publishers. New York, New York, USA. 1869

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

That, science said, would be all. The green clouds would whirl and vanish, and there might be thunderstorms. But through the attenuated wisps of comet shine, the old sky, the old stars, would reappear, and all would be as it had been before.

*Seven Famous Novels by H.G. Wells*

In the Days of the Comet

Book I, Chapter 5 (pp. 774–775)

Alfred A. Knopf. New York, New York, USA. 1934

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Year of comets and meteors transient and strange – lo!  
even here one equally transient and strange!

As I flit through you hastily, soon to fall and be gone,  
what is this chant?

What am I but one of you meteors?

*Complete Poetry and Collected Prose*

Year of the Meteor

The Library of America. New York, New York, USA. 1982

**Winchell, Alexander** 1824–91

American geologist

Comets are facts of observation; there is no mistake as to the real existence of such bodies, whatever they may be. They always excite our admiration. They are full of wonder. They come from the unsearchable depths of space, and after shining in our heavens a few weeks, disappear in the unsearchable depths.

*Walks and Talks in the Geological Field*

Chapter XXXVI (p. 208)

Chautauqua Press. New York, New York, USA. 1890

**Winthrop, John** 1714–79

American educator and scientist

It may not seem unreasonable to remark, for a conclusion, that as, on the one hand, it argues a temerity unworthy a

philosophic mind, to explode every apprehension of danger from comets, as if it were impossible that any damage could ever be occasioned by any of them, because some idle and superstitious fancies have in times of ignorance prevailed concerning them; so on the other, to be thrown into a panic whenever a comet appears, on account of the ill effects which some few of these bodies might produce, if they were not under a proper direction, betrays a weakness equally unbecoming a reasonable being.

In William Jay Youmans

*Pioneers of Science in America: Sketches of their Lives and Scientific Work*

D. Appleton & Co. New York, New York, USA. 1896

**Young, Edward** 1683–1765

English poet and dramatist

Hast thou n'er seen the Comet's flaming Flight?

Th' illustrious Stranger passing, Terror sheds

On gazing Nations, from his fiery Train

Of length enormous; takes his ample Round

Thro' Depths of Ether; coasts unnumber'd Worlds,

Of more than solar Glory; doubles wide

Heavens's mighty Cape; and then revisits Earth,

From the long Travel of a thousand Years.

*Night Thoughts*

Night IV, l. 706–713

Printed by R. Nobels for R. Edwards. London, England. 1797

## COMMON SENSE

**Ackoff, Russell Lincoln** 1919–

American operations research and systems scientist

...common sense...has the very curious property of being more correct retrospectively than prospectively. It seems to me that one of the principal criteria to be applied to successful science is that its results are almost always obvious retrospectively; unfortunately they seldom are prospectively. Common sense provides a kind of ultimate validation after science has completed its work; it seldom anticipates what science is going to discover.

In Anthony de Reuck, Maurice Goldsmith and Julie Knight (eds.)

*Decision Making in National Science Policy*

Operational Research and National Science Policy, Discussion (p. 96)

**Arnould, Antoine** 1612–94

French philosopher, lawyer, and mathematician

Common sense is not really so common.

*The Art of Thinking: Port-Royal Logic*

First Discourse (p. 9)

The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1964

**Atkins, Peter William** 1940–

English physical chemist and writer

...common sense drives us to accept quantum theory in place of classical physics as more consistent with common sense.... When they are inspected, the explanations of classical physics fall apart, and they are seen to be mere superficial delusions, like film-sets.

*Creation Revisited: The Origin of Space, Time and the Universe*  
Chapter Three (p. 53)  
W.H. Freeman & Company. Oxford, England. 1992

**Barfield, Owen** 1898–1997  
British philosopher, critic, and anthroposophist

And common sense today assumes that it is the outer world that is real and permanent, while the inner experience we call consciousness, or subjectivity, or our own or our self, is a fleeting unreality to which it somehow gives birth from time to time.

*History, Guilt, and Habit*

Chapter 2 (p. 47)

Wesleyan University Press. Middletown, Connecticut, USA. 1979

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

This is precisely what common sense is for, to be jarred into uncommon sense. One of the chief services which mathematics has rendered the human race in the past century is to put “common sense” where it belongs, on the topmost shelf next to the dusty canister labeled “discarded nonsense.”

*Mathematics: Queen and Servant of Science*

Mathematical Truth (pp. 17–18)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

The double analysis kills the single analysis, and the treble kills the double, until at last a sufficiency of statistics comes very near to common sense.

*The Silence of the Sea*

On Statistics (p. 174)

Sheed & Ward. New York, New York, USA. 1940

**Bennett, Arnold** 1867–1931  
English novelist and playwright

And then he knew that something within him more powerful than his common-sense would force him to stake that five-franc piece. He glanced furtively at the crowd to see whether anyone was observing him. Number Well, it having been decided to bet, the next question was, how to bet? Now, Henry had read a magazine article concerning the tables at Monte Carlo, and, being of a mathematical turn, had clearly grasped the principles of the game. He said to himself, with his characteristic caution: “I’ll wait till red wins four times running, and then I’ll stake on the black.”

(“But surely,” remarked the logical superior person in him, “you don’t mean to argue that a spin of the ball is affected by the spins that have preceded it? You don’t mean to argue that, because red wins four times, or forty times, running, black is any the more likely to win at the next spin?”

“You shut up!” retorted the human side of him crossly....)

*A Great Man*

Chapter XXV (pp. 245–246)

George H. Doran Company. New York, New York, USA. 1911

**Bialac, Richard N.**

No biographical data available

Statistics are no substitute for common sense.

In Paul Dickson

*The Official Explanations* (p. B–14)

Delacorte Press. New York, New York, USA. 1980

**Bragdon, Claude Fayette** 1866–1945

American architect, writer, and stage designer

Common sense neither leads nor lags, but is ever limited to the passing moment: the common knowledge of to-day was the mystery and enchantment of the day before yesterday, and will be the mere commonplace of the day after to-morrow.

*Four Dimensional Vistas*

Chapter I (p. 18)

Alfred A. Knopf. New York, New York, USA. 1923

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

The world makes sense all right; it makes common sense.... But common sense is not what we put into the world. It is what we find there.

*The Common Sense of Science*

Chapter V, Section 7 (p. 78)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Chatfield, Christopher**

English statistician

“Common sense” is not common but needs to [be] learnt systematically.... A “simple analysis” can be harder than it looks.... All statistical techniques, however sophisticated, should be subordinate to subjective judgment.

The Initial Examination of Data

*Journal of The Royal Statistical Society*, Series A, Volume 148, 1985

**Compton, Karl Taylor** 1887–1954

American educator and physicist

We cannot get far by trying to impose an engineering education, however excellent it may be, on a young man of mediocre ability or one temperamentally unfitted for technical or administrative work. The idea reminds me of an experience which my sister had...in India. She had engaged a native electrician to install some new fixtures in her house, but he seemed particularly stupid and kept coming to her for instructions. Finally, in exasperation she said to him: “Why do you come asking questions all the time? Why don’t you use your common sense?” “Madam,” he replied gravely, “common sense is a rare

gift of God. I have only a technical education.”

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 51)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

### Crofton, M. W.

British mathematician

There is no more remarkable feature in the mathematical theory of probability than the manner in which it has been found to harmonize with, and justify, the conclusions to which mankind have been led, not by reasoning, but by instinct and experience, both of the individual and of the race. At the same time it has corrected, extended, and invested them with a definiteness and precision of which these crude, though sound, appreciations of common sense were till then devoid.

*Encyclopædia Britannica* (9th edition)

Probability

J.M. Stoddart & Co. Philadelphia, Pennsylvania, USA. 1911

### Cross, Hardy 1885–1959

American professor of civil and structural engineering

Common sense is only the application of theories which have grown and been formulated unconsciously as a result of experience.

*Engineers and Ivory Towers*

For Man's Use of God's Gifts (p. 107)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

### Dewey, John 1859–1952

American philosopher and educator

...unless the materials involved can be traced back to the material of common sense concern there is nothing whatever for scientific concern to be concerned with.

Common Sense and Science

*The Journal of Philosophy*, Volume XLV, Number 8, April 18, 1948 (p. 206)

### Dickens, Charles 1812–70

English novelist

I don't profess to be profound; but I do lay claim to common sense.

*David Copperfield*

Chapter VIII (p. 113)

Oxford University Press. Oxford, England. 1981

### Einstein, Albert 1879–1955

German-born physicist

...common sense is nothing more than a deposit of prejudices laid down in the mind before you reach eighteen.

In Eric T. Bell

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 42)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

### Galloway, Beverly T.

Former American Assistant Secretary of Agriculture

...to be a scientist is to be a man of affairs, a man gifted with that most uncommon of all things – common sense.

The Twentieth Century Botany

*Science*, N.S. Volume 19, January 1, 1904 (p. 13)

### Goldenweiser, Alexander 1880–1940

American anthropologist

...the physician would be even worse off than he is, if not for the occasional emergence of common sense which breaks through dogmas with intuitive freshness, or those flashes of insight for which talented diagnosticians are noted, or finally, an opportunity to make a biographical study of a patient, a luxury few physicians can enjoy and few patients can afford.

With the subject of the uniqueness of particulars, is ushered in intuitive mind as it functions in religion, art, and other forms of imaginative creativeness.

*Robots or Gods*

Chapter IV (p. 62)

Alfred A. Knopf. New York, New York, USA. 1931

### Gull, Sir William Withey 1816–90

English physician

Science and common sense differ as cultivated fruits differ from wild fruits.

Science sows its seeds of inquiry, and gathers the fruit. Common sense picks the fruit, such as it, is by the way-side. Common sense has no fields or orchards of knowledge.

*A Collection of the Published Writings of William Withey Gull* (Volume 2)

Notes and Aphorisms (p. lvi)

The New Sydenham Society. London, England. 1896

### Heinlein, Robert A. 1907–88

American science fiction writer

Son, that phrase is self-contradictory; “sense” is never “common”.

*Time Enough for Love*

Prelude, Chapter II (p. 47)

G.P. Putnam's Sons. New York, New York, USA. 1973

### Henderson, Lawrence 1878–1942

American biochemist

It is a strange irony that the principles of science should seem to deny the necessary conviction of common sense.

*The Order of Nature*

Chapter V (p. 92)

Harvard University Press. Cambridge, Massachusetts, USA. 1917

### Hofstadter, Douglas R. 1945–

American academic

...consider the very roots of our ability to discern truth. Above all (or perhaps I should say “underneath all”), common sense is what we depend on – that crazily elusive, ubiquitous faculty we all have, to some degree or other.... If we apply common sense to itself over and over again, we wind up building a skyscraper. The ground floor of this structure is the ordinary common sense we all have, and the rules for building new floors are implicit in the ground floor itself. However, working it all out is a gigantic task, and the result is a structure that transcends mere common sense.

Pretty soon, even though it has all been built up from common ingredients, the structure of this extended common sense is quite arcane and elusive. We might call the quality represented by the upper floors of this skyscraper “rare sense”; but it is usually called “science”. And some of the ideas and discoveries that have come out of this originally simple and everyday ability defy the ground floor totally.

*Metamagical Themas: Questing for the Essence of Mind and Pattern*

Section II, Chapter 5 (pp. 93, 94)

Basic Books, Inc. New York, New York, USA. 1985

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Science is a first-rate piece of furniture for a man’s upper chamber, if he has common sense on the ground-floor.

*The Poet at the Breakfast-Table*

Chapter V (p. 120)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Howe, E. W.** 1853–1937

American novelist and newspaper and magazine editor

What is common sense? That which attracts the least opposition: that which brings most agreeable and worthy results.

*Sinner Sermons: A Selection of the Best Paragraphs of E. W. Howe* (p. 7)

Girard, Kansas, USA. 1926

**Huxley, Thomas Henry** 1825–95

English biologist

Science is, I believe, nothing but trained and organized common sense, differing from the latter only as a veteran may differ from a raw recruit: and its methods differ from those of common sense only as far as the guardsman’s cut and thrust differ from the manner in which a savage wields a club.

*Collected Essays* (Volume 3)

*Science and Education*

On the Educational Value of the Natural History of Science (p. 45)

Macmillan & Company Ltd. London, England. 1904

Common sense is science exactly in so far as it fulfils the ideal of common sense; that is, sees facts as they are, or, at any rate, without the distortion of prejudice, and

reasons from them in accordance with the dictates of sound judgment. And science is simply common sense at its best; that is, rigidly accurate in observation, and merciless to fallacy in logic.

*The Crayfish: An Introduction to the Study of Zoology* (p. 2)

C. Kegan Paul & Co. London, England. 1880

Whoso will question the validity of the conclusions of sound science, must be prepared to carry his scepticism a long way; for it may be safely affirmed, that there is hardly any of those decisions of common sense on which men stake their all in practical life, which can justify itself so thoroughly on common sense principles, as the broad truths of science can be justified.

*The Crayfish: An Introduction to the Study of Zoology* (p. 2)

C. Kegan Paul & Co. London, England. 1880

No man...who is endowed with a fair share of common sense, and not more than a fair share of vanity, will identify either contemporary or posthumous fame with the highest good ...

*Science and Culture, and Other Essays*

Chapter I (p. 1)

Macmillan & Company Ltd. London, England. 1881

**James, William** 1842–1910

American philosopher and psychologist

Common-sense contents itself with the unreconciled contradiction, laughs when it can, and weeps when it must, and makes, in short, a practical compromise, without trying a theoretical solution.

*Collected Essays and Reviews*

German Pessimism (p. 17)

Longmans, Green & Company. New York, New York, USA. 1920

**Keynes, John Maynard** 1883–1946

British economist

We know that the probability of a well-established induction is great, but, when we are asked to name its degree, we cannot. Common sense tells us that some inductive arguments are stronger than others, and that some are very strong. But how much stronger or how strong we cannot express.

*A Treatise on Probability*

Chapter XXI (p. 259)

Harper & Row, Publishers. New York, New York, USA. 1962

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

One sees in this essay that the theory of probabilities is at bottom only common sense reduced to a calculus; it makes us appreciate with exactitude that which exact minds feel by a sort of instinct without being able oft-times to give a reason for it.

*A Philosophical Essay on Probabilities*

Chapter XVIII (p. 196)

Dover Publications, Inc. New York, New York, USA. 1951



**Latham, Peter Mere** 1789–1875  
English physician

A small overweight of knowledge is often a sore impediment to the movement of common sense.

In William B. Bean

*Aphorisms from Latham* (p. 37)

Prairie Press. Iowa City, Iowa, USA. 1962

**Lehrer, Keith** 1936–  
American philosopher

The overthrow of accepted opinion and the dictates of common sense are often essential to epistemic advance. Moreover, an epistemic adventurer may arrive at beliefs that are not only new and revelatory, but also better justified than those more comfortably held by others. The principle of the conservation of accepted opinion is a roadblock to inquiry, and, consequently, it must be removed.

*Knowledge*

Chapter 7 (p. 184)

Clarendon Press. Oxford, England. 1974

**Luria, Salvador Edward** 1912–91  
Italian-American microbiologist

Significant advances in science often have a peculiar quality: they contradict obvious, commonsense opinions.

*A Slot Machine, a Broken Test Tube: An Autobiography*

The Science Path: IV, Looking Back (p. 116)

Harper & Row, Publishers. New York, New York, USA. 1984

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Common sense is not wrong in the view that it is meaningful, appropriate and necessary to talk about the large objects of our daily experience.... Common sense is wrong only if it insists that what is familiar must reappear in what is unfamiliar.

*Science and the Common Understanding*

Chapter 5 (pp. 74–75)

Simon & Schuster. New York, New York, USA. 1953

...distrust all the philosophers who claim that by examining science they come to the results in contradiction with common sense. Science is based on common sense; it cannot contradict it.

In University of Denver

*Foundations for World Order*

The Scientific Foundations for World Order (p. 51)

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Common-sense nerve fibers are seldom medullated before forty – they are never seen even with a microscope before twenty.

*Sir William Osler: Aphorisms from His Bedside Teachings and Writings* (p. 283)

Charles C. Thomas. Springfield. 1961

**Pope, Alexander** 1688–1744  
English poet

Good sense, which only is the gift of Heaven,  
And through no science, fairly worth the seven.

*The Complete Poetical Works*

Moral Essays, Ep. IV, l. 43

Houghton Mifflin & Company. New York, New York, USA. 1903

**Roosevelt, Franklin Delano** 1882–1945  
32nd president of the USA

It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something.

Speech

Oglethorpe University, May 22, 1932

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Common sense starts with the notion that there is matter where we can get sensations of touch, but not elsewhere. Then it gets puzzled by wind, breath, clouds, etc., whence it is led to the conception of “spirit” – I speak etymologically. After “spirit” has been replaced by “gas,” there is a further stage, that of the aether.

*The Analysis of Matter*

Chapter XIII (p. 121)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

The supposition of common sense and naive realism, that we see the actual physical object, is very hard to reconcile with the scientific view that our perception occurs somewhat later than the emission of light by the object; and this difficulty is not overcome by the fact that the time involved, like the notorious baby, is a very little one.

*The Analysis of Matter*

Chapter XV (p. 155)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

Common sense, however it tries, cannot avoid being surprised from time to time. The aim of science is to save it from such surprises.

In Jean-Pierre Luminet

*Black Holes* (p. 182)

Cambridge University Press. New York, New York, USA. 1992

It used to be supposed by empiricists that the justification of such inference rests upon induction. Unfortunately, it can be proved that induction by simple enumeration, if conducted without regard to common sense, leads very much more often to error than the truth. And if a principle needs common sense before it can be safely used, it is not the sort of principle than can satisfy a logician. We must, therefore, look for a principle other than induction if we are to accept the broad outlines of science, and of common sense in so far as it is not refutable. This is a very large problem.



*My Philosophical Development*

Chapter 1 (p. 11)

George Allen & Unwin Ltd. London, England. 1975

### Stitt, Edward Rhodes

Physician

For the laboratory worker the most valuable asset is common sense and he must be able to bring to mind the possibilities of the production of various artifacts and results from trivial errors in technique.

*Practical Bacteriology, Blood Work and Animal Parasitology* (4th edition)

Preface to the First Edition (p. xi)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1916

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

...one of the most marked characteristics of science is its critical quality, which is just what common-sense lacks. By common-sense is usually meant either the consensus of public opinion, of unsystematic everyday thinking, the untrustworthiness of which is notorious, or the verdict of uncritical sensory experience, which has so often proved fallacious. It was “common-sense” that kept the planets circling around the earth; it was “common-sense” that refused to accept Harvey’s demonstration of the circulation of the blood.

*Introduction to Science*

Chapter II (p. 39)

Williams & Norgate Ltd. London, England. 1916

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

There is absolutely no common sense; it is common non-sense.

*The Writings of Henry David Thoreau* (Volume 4)

*Paradise (to Be) Regained* (p. 298)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Titchener, Edward Bradford 1867–1927

English-born American psychologist

...common sense is the very antipodes of science.

*Systematic Psychology: Prolegomena*

Chapter I (p. 48)

Cornell University Press. Ithaca, New York, USA. 1972

### Veblen, Thorstein 1857–1929

Norwegian-American sociologist and economist

...enlightened common-sense sticks by the opaque truth and refuses to go behind the returns given by the triangle of facts.

*The Place of Science in Modern Civilisation and Other Essays*

The Place of Science in Modern Civilisation (p. 4)

The Viking Press. New York, New York, USA. 1942

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

Man finds himself in the midst of a multitude of effects, and cannot refrain from searching out their causes. As an easy-going creature, he grasps at what is nearest to him, and rests satisfied with that. This procedure is that known in philosophical books as the common-sense method.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 154)

William Blackwood & Sons. Edinburgh, Scotland. 1883

### Whitehead, Alfred North 1861–1947

English mathematician and philosopher

...the anxious precision of modern mathematics is necessary for accuracy...it is necessary for research. It makes for clearness of thought and for fertility in trying new combinations of ideas. When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. Its sole criterion for judgment is that the new ideas shall look like the old ones, in other words it can only act by suppressing originality.

*An Introduction to Mathematics*

Chapter 11 (p. 116)

Oxford University Press, Inc. New York, New York, USA. 1958

### Wolpert, Lewis 1929–

American biologist

...one of the strongest arguments for the distance between common sense and science is that the whole of science is totally irrelevant to people’s day-to-day lives.

*The Unnatural Nature of Science*

Chapter I (p. 16)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

## COMMONPLACE

### Doyle, Sir Arthur Conan 1859–1930

Scottish writer

...there is nothing so unnatural as the commonplace.

*The Adventures of Sherlock Holmes*

*A Case of Identity* (p. 56)

Harper & Brothers Publishers. New York, New York, USA. 1892

## COMMUNICATE

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

If we are to explain the workings of an organization or a machine in a comprehensible way, we must speak to our listeners in a language they understand, and in terms of ideas with which they are familiar – otherwise our explanation will mean nothing to them. It is no, good telling a crowd of savages that the time-differential of

the electric displacement is the rotation of the magnetic force multiplied by the velocity of light.

*Physics and Philosophy*

Chapter I (p. 10)

Dover Publication. New York, New York, USA. 1981

**Lavoisier, Antoine Laurent** 1743–94

French chemist

However certain the facts of any science may be, and, however just the ideas we may have formed of these facts, we can only communicate false impressions to others, while we want words by which these may be properly expressed.

Translated by Robert Kerr

*Elements of Chemistry* (Volume 1) (5th edition)

Preface of the Author (p. xviii)

Printed for W. Creech. Edinburgh, Scotland. 1802

**Pascal, Blaise** 1623–62

French mathematician and physicist

I have spent much time in the study of the abstract sciences; but the paucity of persons with whom you can communicate on such subjects, disgusted me with them. When I began to study man, I saw that these abstract sciences are not suited to him, and that in diving into them, I wandered further from my real object, than those who knew them not, and I forgave them for not having attended to these things. I expected then, however, that I should find some companions in the study of man, since it was so specifically a duty. I was in error. There are fewer students of man, than of geometry.

*Thoughts on Religion, and Other Subjects*

Chapter XXVII (p. 269)

J.S. & C. Adams. Amherst, Massachusetts, USA. 1829

## COMMUNICATION

**Abbot, Charles Greeley** 1872–1973

American astrophysicist

Every large scientific institution or observatory has almost daily communications from persons of very moderate attainments who presume to question, nay rather to spurn, the most well-attested facts of human knowledge. Such persons seem to prefer especially to direct their attacks on the following facts: the Copernican system; the law of universal gravitation; the first and second laws of energy; and, finally, the high temperature of the sun. No argument can refute them, because they have not the requisite learning to comprehend it, which is no disgrace, but which should make men modest enough to have faith in those who excel them immeasurably. Hence it is the policy of most scientific institutions to avoid entirely discussions of these subjects with such correspondents.

*The Sun*

Chapter I (p. 8)

D. Appleton & Co. New York, New York, USA. 1911

**Babbage, Charles** 1792–1871

English mathematician

He who can see portions of matter beyond the ken of the rest of his species, confers an obligation on them, by recording what he sees; but their knowledge depends both on his testimony and on his judgment. He who contrives a method of rendering such atoms visible to ordinary observers, communicates to mankind an instrument of discovery, and stamps his own observations with a character, alike independent of testimony or of judgment.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter V (p. 169)

Printed for B. Fellowes. London, England. 1830

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

As the goal of science is to augment and order our experience, every analysis of the conditions of human knowledge must rest on considerations of the character and scope of our means of communication.

*Atomic Physics and Human Knowledge* (p. 88)

Wiley. New York, New York, USA. 1958

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

The following words are written over the signature of a man whose intelligence I respect, and I cannot make head or tail of them –

“When modern science declared that the cosmic process knew nothing of a historical event corresponding to a Fall, but told, on the contrary, the story of an incessant rise in the scale of being, it was quite plain that the Pauline scheme – I mean the argumentative processes of Paul’s scheme of salvation – had lost its very foundation; for was not that foundation the total depravity of the human race inherited from their first parents? ... But now there was no Fall; there was no total depravity, or imminent danger of endless doom; and, the basis gone, the superstructure followed.”

It is written with earnestness and in excellent English; it must mean something. But what can it mean?

*All Things Considered*

Science and Religion (p. 189)

John Lane Co. New York, New York, USA. 1910

**Feynman, Richard P.** 1918–88

American theoretical physicist

There is always another way to say the same thing that doesn’t look at all like the way you said it before.

*Nobel Lectures, Physics 1963–1970*

The Development of the Space-Time View of Quantum Electrodynamics  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1972

**Guyot, Arnold** 1807–84

Swiss-born American geologist, geographer, and educator

In the communion of mind with mind, in the mutual interchange of ideas, the first condition necessary for establishing between him who speaks and those that hear, the sympathetic harmony which makes its charm, is, that the word shall reach the understanding without obstacle and without effort.

*The Earth and Man*

Lecture I (p. 19)

Gould & Lincoln. Boston, Massachusetts, USA. 1860

**Herschel, Friedrich Wilhelm (Sir William)** 1738–1822

English astronomer

As an apology for this prematurity it may be said that the end of all discoveries being communication, we can never be too ready in giving facts and observations, whatever we may be, in reasoning upon them.

Account of Some Observations Tending to Investigate the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*, Volume 74, 1784 (p. 438)

...it may be said that, the end of all discoveries being communication, we can never be too ready in giving facts and observations, whatever we may be in reasoning upon them.

*Sir William Herschel*

Chapter III (p. 88)

Charles Scribner's Sons. New York, New York, USA. 1881

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The communication of knowledge and the necessity which everyone feels of managing his stock of experience with the least expenditure of thought, compel us to put our knowledge in economical forms.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On the Economical Nature of Physical Inquiry (p. 197)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Michaelson, Albert Abraham** 1852–1931

Prussian-born American physicist

Science when it has to communicate the results of its labor, is under the disadvantage that its language is but little understood. Hence it is that circumlocution is inevitable and repetitions are difficult to avoid.

*Light Waves and Their Uses* (Volume 3) (2nd series)

Lecture I (p. 1)

The University of Chicago Press. Cambridge, England. 1903

**Nichols, Ernest Fox** 1869–1924

American physicist

In the upbuilding of all the great and diverse departments of thought, characteristic methods have arisen which the human reason has found best suited to the pursuit of the many phases of truth which it seeks. In the perfection of methods and resourcefulness in applying them, no age

has been more fertile than our own. Yet one ever present danger to the orderly and symmetrical development of modern thought, is that those working in different fields for its advancement may lose touch with one another, and the interchange of methods and results so essential to balanced growth, be neglected.

*Physics*

Physics (p. 5)

The Columbia University Press. New York, New York, USA. 1907

**Scientist (Fictional character)**

If everything is ready on the dark side of the moon play the five tones...

*Close Encounters of the Third Kind*

Film (1977)

**Smith, George Otis** 1871–1944

American geologist

It takes years for some geologists to break the fetters of this scholastic habit of using big words for small ideas. Probably every one of us has been guilty of sentences like the following, which appeared in a Survey manuscript. "The argillaceous character of the formation is very prominent in some localities, although it is usually subsidiary to the arenaceous phase." On being translated this means: At some places the formation includes considerable clay, but generally it is made up chiefly of sand.

Paper presented to the Society of Economic Geologists at the Amherst Meeting

December 28, 1921

**COMMUNITY**

**Greenspoon, David Harry**

No biographical data available

We are community, within and without – that is, our bodies are, in a sense, communities of microorganisms, and our biosphere is an intricate mesh of interacting communities. It's only natural to want to extend this and create an interplanetary community. There is beauty and inspiration in the vision of humanity's spreading into the galaxy, leaving the cradle, becoming who-knows-what.

*Venus Revealed*

Chapter 6 (p. 337)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

**COMPARISON**

**Bramah, Ernest** 1869–1942

English author

How is it possible to suspend topaz in one cup of the balance and weigh it against amethyst in the other; or who in a single language can compare the tranquilizing grace

of a maiden with the invigorating pleasure of witnessing a well-contested rat-fight.

*Kai Lung's Golden Hours*  
258

G.H. Doran Company. New York, New York, USA. 1923

**Levy, Matthys**

No biographical data available

**Salvadori, Mario**

No biographical data available

When we compare our tiny corner of the universe to the infinite majesty of the whole, our innate, unjustified pride should naturally vanish. Yet, if we realize that, small as we are, we have been able to penetrate the mystery of the universe, establish its history, analyze its composition and draw its map; and that, moreover, we might even soon be able to predict its behavior to the end of time; and finally that, unfazed by our smallness, we have explored our little home, discovering in the process the origin of earthquakes and volcanoes, we are entitled to a complacent smile, a smile wisely tempered by the comparison of our mortality to the apparent never-ending life of the universe.

*Why the Earth Quakes*

Chapter 15 (pp. 191–192)

W.W. Norton & Company, Inc. New York, New York, USA. 1995

**COMPETITION**

**Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

Don't compete! – competition is always injurious to the species, and you have plenty of resources to avoid it! That is the *tendency* of nature, not always realised in full, but always present. That is the watchword which comes to us from the bush, the forest, the river, the ocean. Therefore combine – practice mutual aid! That is the surest means of giving to each and to all the greatest safety, the best guarantee of existence and progress, bodily, intellectual, and moral.

Mutual Aid Among Animals

*The Eclectic Magazine of Foreign Literature, Science, and Art*, Volume LII, Number 6, December, 1890 (p. 848)

**COMPLEX**

**Perry, J.**

No biographical data available

I am afraid that what seem to you simple is to him [the average school boy] complex, and what seems to you complex is to him quite simple.

The Correlation of Teaching Mathematics and Science

*The School World*, Number 120, December, 1908 (p. 461)

**COMPLEXITY**

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

The physicist's problem is the problem of ultimate origins and ultimate natural laws. The biologist's problem is the problem of complexity.

*The Blind Watchmaker*

Chapter I (p. 15)

W.W. Norton & Co. New York, New York, USA. 1986

**Forrester, Jay Wright** 1918–

American computer engineer and systems theorist

...complex systems are counterintuitive. That is, they give indications that suggest corrective action which will often be ineffective or even adverse in its results.

*Urban Dynamics*

Chapter I (p. 9)

MIT Press. Cambridge, Massachusetts, USA. 1969

**Pagels, Heinz R.** 1939–88

American physicist and science writer

Science has explored the microcosmos and the macrocosmos; we have a good sense of the lay of the land. The great unexplored frontier is complexity.

*The Dreams of Reason*

Preface (p. 12) S

Simon & Schuster. New York, New York, USA. 1988

**Ptolemy** 85–165

Greek astronomer

We must not be repelled...by the complexity of the hypotheses, but explain the phenomena as well as we can. If the hypotheses satisfy each apparent inequality separately, the combination of them will represent the truth; and why should it appear wonderful to any that such a complexity should exist in the heavens, when we know nothing of their nature which entitles us to suppose that any inconsistency will result?

Quoted in William Whewell

*History of the Inductive Sciences from the Earliest to the Present Time*

Book III, Chapter III (p. 142)

John W. Parker & Son. London, England. 1857

**Reeves, Hubert** 1932–

Canadian astrophysicist

But shouldn't the simple have already potentially encompassed the complex? Where were the seeds of complexity during the first three minutes of the universe?

*Atoms of Silence*

Chapter 4 (p. 46)

The MIT Press. Cambridge, Massachusetts. USA. 1984

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

A more complete study of the movements of the world will oblige us, little by little, to turn it upside down; in other words, to discover that if things hold and hold together, it is only by reason of complexity, from above.

*The Phenomenon of Man*

Book One, Chapter I, Section 1 (p. 43)

Harper & Brothers Publishers. New York, New York, USA. 1959

**Watts, Alan Wilson** 1915–73

American philosopher

The natural world seems a marvel of complexity, requiring a vastly intricate intelligence to create and govern it, just because we have represented it to ourselves in the clumsy “notation” of thought.

*Nature, Man, and Woman*

Part I, Chapter 2 (p. 62)

Vintage Books. New York, New York, USA. 1970

## COMPOST

**Burroughs, John** 1837–1921

American naturalist and essayist

Nature does not care whether the hunter slay the beast or the beast the hunter; she will make good compost of them both, and her ends are prospered whichever succeed.

*Birds and Poets With Other Papers*

Touches of Nature (p. 62)

David Douglas Edinburgh, Scotland. 1884

## COMPOUND

**Baeyer, Adolf von** 1835–1917

German research chemist

I have never stuck stubbornly to a particular point of view if it could no longer be reconciled with the facts.... I went for a ride, so to speak, through a pleasant countryside among the compounds and enjoyed the view. One day it looked this way, and perhaps the next day it looked different. So why should one stick stubbornly to one particular point of view.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 141)

W.A. Benjamin. New York, New York, USA. 1965

**Fittag, R.**

No biographical data available

We are now forced to increase the number of compounds, not merely in order to prepare new substances, but to discover natural laws.

In W. Mansfield Clark

*The Determination of Hydrogen Ions*

Chapter IV (p. 67)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1928

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932

Latvian-born German chemist

...the only difference between elements and compounds consists in the supposed impossibility of proving the so-called elements to be compounds.

Faraday Lecture: Elements and Compounds

*Journal of the Chemical Society*, Volume 85 1904 (p. 520)

**Pirsig, Robert M.** 1928–

American writer

Why, for example, should a group of simple, stable compounds of carbon, hydrogen, oxygen and nitrogen struggle for billions of years to organize themselves into a professor of chemistry?

*Lila: An Inquiry into Morals*

Chapter 11 (p. 140)

Bantam Books. New York, New York, USA. 1991

**Proust, J. L.** 1755–1826

French chemist

We must recognize an invisible hand which holds the balance in the formation of compounds. A compound is a substance to which Nature assigns fixed ratios, it is, in short, a being which Nature never creates other than balance in hand, *pondere et mensurd.*

*Annales of Chimie*, Volume 32, 1799 (p. 26)

## COMPREHEND

**Weyl, Hermann** 1885–1955

German mathematician

Beyond the knowledge gained from the individual sciences, there remains the task of comprehending. In spite of the fact that the views of philosophy sway from one system to another, we cannot dispense with it unless we are to convert knowledge into a meaningless chaos.

*Space – Time – Matter*

Introduction (p. 10)

Dover Publications. 1922

**Wedgwood, Josiah**

I have got beyond my depth – These wonderful works of Nature are too vast for my narrow microscopic comprehension.

In Eliza Meteyard

*The Life of Josiah Wedgwood* (Volume 1)

Chapter XII (p. 502)

Hurst & Blackett. London, England. 1865

## COMPREHENSION

**Atkins, Peter William** 1940–

English physical chemist and writer

Comprehension is moving across the face of the Earth, like the sunrise.



*Creation Revisited: The Origin of Space, Time and the Universe*  
Chapter Seven (p. 157)  
W.H. Freeman & Company. Oxford, England. 1992

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

...for objective description and harmonious comprehension it is necessary in almost every field of knowledge to pay attention to the circumstances under which evidence is obtained.

*Atomic Physics and Human Knowledge*  
Introduction (p. 2)  
John Wiley & Sons. New York, New York, USA. 1958

**D'Alembert, Jean Le Rond** 1717–83  
French mathematician

To someone who could grasp the universe from one unified viewpoint, the entire creation would appear as a unique fact and a great truth.

In Cornelius Lanczos  
*Albert Einstein and the Cosmic World Order*  
Chapter 6 (p. 107)  
Interscience Publishers. New York, New York, USA. 1965

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In the end what we comprehend about the universe is precisely that which we put into the universe to make it comprehensible.

*The Relativity Theory of Protons and Electrons* (p. 328)  
Cambridge University Press. Cambridge, England. 1936

**Einstein, Albert** 1879–1955  
German-born physicist

There exists a passion for comprehension, just as there exists a passion for music.

On the Generalized Theory of Gravitation  
*Scientific American*, Volume 182, Number 4, April, 1950 (p. 13)

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

A strong sense of unease and dissatisfaction always goes with lack of comprehension. Laymen feel it too; how can we otherwise account for the relief they feel when they learn that some odd and disturbing phenomenon can be explained? It cannot be the explanation itself that brings relief, for it may easily be too technical to be widely understood. It is not the knowledge itself, but the satisfaction of knowing that something is known.

*Advice to a Young Scientist*  
Chapter 2 (p. 7)  
Basic Books, Inc. New York, New York, USA. 1979

## COMPUTATION

**Peirce, Benjamin** 1809–80  
American mathematician

Computation is not barren when it supplies subsistence; it ceases to be an unmitigated evil when it is dignified by ministering to the necessities of material life and comfort. But the computation of the geometer, however tedious it may be, has a loftier aspiration. It provides spiritual nourishment: hence it is life itself, and is the worthy occupation of an immortal soul.

*Ideality in the Physical Sciences*  
Lecture I (p. 10)  
Little, Brown & Co. Boston, Massachusetts, USA. 1881

## COMPUTER

**Babbage, Charles** 1792–1871  
English mathematician

The whole of the developments and operations of analysis are now capable of being executed by machinery.... As soon as an Analytical Engine exists, it will necessarily guide the future course of science.

*Passages from the Life of a Philosopher*  
Chapter VIII (pp. 136, 137)  
Longman, Green, Longman, Roberts & Green. London, England 1864

**Crichton, Michael** 1942–  
American novelist

This fascination with computer models is something I understand very well. Richard Feynman called it a disease. I fear he is right.

Lecture  
Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

**Hawking, Stephen William** 1942–  
English theoretical physicist

At present, computers are a useful aid in research, but they have to be directed by human minds. If one extrapolates their recent rapid rate of development, however, it would seem quite possible that they will take over altogether in theoretical physics. So maybe the end is in sight for theoretical physicists, if not for theoretical physics.

*Black Holes and Baby Universes and Other Essays*  
Chapter Seven (p. 68)  
Bantam Books. New York, New York, USA. 1987

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

What a satire, by the way, is that machine [Babbage's engine] on the mere mathematician! A Frankenstein-monster, a thing without brains and without heart, too stupid to make a blunder; that turns out results like a corn-sheller, and never grows any wiser or better, though it grind a thousand bushels of them!

*The Autocrat of the Breakfast-Table*  
Chapter I (p. 9)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891



**Klein, Felix** 1849–1925  
German mathematician

If the activity of a science can be supplied by a machine, that science cannot amount to much, so it is said; and hence it deserves a subordinate place. The answer to such arguments, however, is that the mathematician, even when he is himself operating with numbers and formulas, is by no means an inferior counterpart of the errorless machine...

Translated by E.R. Hedrick and C.A. Noble  
*Elementary Mathematics from an Advanced Standpoint*  
Part First, Chapter II (p. 22)  
Dover Publications. New York, New York, USA. 1939

### Mathematical Sciences Education Board

Calculators and computers should be used in ways that anticipate continuing rapid change due to technological developments. Technology should be used not because it is seductive, but because it can enhance mathematical learning by extending each student's mathematical power.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*  
Change (p. 84)  
National Academy Press. Washington, D.C. 1989

### COMPUTER SCIENCE

**Kac, Mark** 1914–84  
Polish mathematician

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

**Schwartz, Jacob T.** 1930–  
American mathematician

Computer science, a new addition to the fraternity of sciences, confronts its older brothers, mathematics and engineering, with an adolescent brashness born of rapid, confident growth and perhaps also of enthusiastic inexperience.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*  
Chapter Seven (p. 63)  
Springer-Verlag. New York, New York, USA. 1992

### COMPUTING

**Hamming, Wesley Richard** 1915–98  
American mathematician

The purpose of computing is insight, not numbers.  
*Numerical Methods for Scientists and Engineers* (p. v)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1962

### CONCEPT

**Adair, Robert K.**  
American physicist

...basic concepts [in physics] are almost never – perhaps never – overturned, although grand designs take different courses. It is rather as if physicists are laborers building a cathedral, who have constructed the foundation and many rows of stone. As common workers, masons, and carpenters, they never see the architect's design, but during lunch hour they talk about their conception of the design on the basis of the work they have done. As time goes on and a buttress grows here, a nave takes form there, they change our idea of the final building. But the foundation they have dug and the stones they have placed remain unchanged.

*The Great Design: Particles, Fields, and Creation*  
Chapter I (p. 8)  
Oxford University Press. Oxford, England. 1989

### Advertisement

A mind is filled and enriched by a new concept only if the concept is fully understood.

Advertisement by Great Books of the Western World  
*Scientific American*, Volume 204, Number 1, January, 1961 (p. 157)

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

It is more important to have a clear understanding of general principles, without, however, thinking of them as fixed laws, than to load the mind with a mass of detailed technical information which can readily be found in reference books or card indexes.

*The Art of Scientific Investigation*  
Chapter One (p. 4)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Due to the contrast between the principles underlying the ordinary description of natural phenomena and the element of discontinuity characteristic for the quantum theory, we must be prepared that every concept used in accounting for the experimental evidence will have only restricted validity when dealing with atomic phenomena. In E. Rudinger (ed.)

*Niels Bohr: Collected Works* (Volume 6) (p. 69)  
North-Holland. Amsterdam, Netherlands. 1985

**Bridgman, Percy Williams** 1882–1961  
American physicist

...the concept is synonymous with the corresponding set of operations.

*The Logic of Modern Physics*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1928

**Cassirer, Ernst** 1874–1945

German philosopher

But what are concepts save formulation and creations of thought, which, instead of giving us the true forms of objects, show us rather the forms of thought itself? Consequently all schemata which science evolves in order to classify, organize and summarize phenomena of the real world turn out to be nothing but arbitrary schemes – dry fabrics of the mind, which express not the nature of things, but the nature of mind.

Translated by Susanne K. Langer

*Language and Myth*

Chapter 1 (p. 7)

Harper & Brothers Publishers. New York, New York, USA. 1946

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The initial incommunicability of truth, scientific or otherwise, shows that we think in grooves, and that it is painful for us to be torn away from the womblike security of accepted concepts.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part II

The Exquisiteness of Minute Differences (p. 86)

Rockefeller University Press. New York, New York, USA. 1978

Great concepts require great names.

*Essays on Nucleic Acids*

Chapter 11 (p. 183)

Elsevier Publishing Company. Amsterdam, Netherlands. 1963

**Conant, James Bryant** 1893–1978

American educator and scientist

...a useful concept may be a barrier to the acceptance of a better one if long-entrenched in the minds of scientists.

*On Understanding Science*

Chapter III (p. 74)

Yale University Press. New Haven, Connecticut, USA. 1947

**Egler, Frank E.** 1911–96

American botanist and ecologist

A concept is nothing more than an idea, a mental creation, which makes comprehensible a certain group of facts.

*The Way of Science*

Science Concepts (p. 21)

Hafner Publishing Company. New York, New York, USA. 1970

**Einstein, Albert** 1879–1955

German-born physicist

In the attempt to achieve a conceptual formulation of the confusingly immense body of observational data, the scientist makes use of a whole arsenal of concepts

which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts.

*Concepts of Space: The History of Theories of Space in Physics*

Preface (p. xi)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Physical concepts are free creations of the human mind, and are not, however it may seem, uniquely determined by the external world.

*The Evolution of Physics*

One Clew Remains (p. 31)

Simon & Schuster. New York, New York, USA. 1961

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Even if we realize that the meaning of a concept is never defined with absolute precision, some concepts form an integral part of scientific methods, since they represent for the time being the final result of the development of human thought in the past, even in a very remote past; they may even be inherited and are in any case the indispensable tools for doing scientific work in our time.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter V (p. 92)

Harper & Row, Publishers. New York, New York, USA. 1958

...words are not so clearly defined as they seem to be at first sight and...they have only a limited range of applicability.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter X (p. 168)

Harper & Row, Publishers. New York, New York, USA. 1958

**Hertzberger, Herman** 1932–

Dutch architect

To find new concepts as an answer to new challenges you first have to unmask the existing clichés.

*Space and the Architect: Lessons in Architecture 2*

Chapter 2 (p. 30)

Publishers. Rotterdam, The Netherlands. 2000

**Hoffmann, Roald** 1927–

Polish-born American chemist

...even in two “hard natural science” fields as close to each other as chemistry and physics, even *there* there are concepts in chemistry which are not reducible to physics. Or if they are reduced they lose much that is interesting in them.

*The Same and Not the Same*

Part One (p. 20)

Columbia University Press. New York, New York, USA. 1995

**Kierkegaard, Søren Aabye** 1813–1855  
Danish philosopher and theologian

Concepts, like individuals, have their histories and are just as incapable of withstanding the ravages of time as are individuals. But in and through all this they retain a kind of homesickness for the scenes of their childhood.

Translated by Lee M. Capel

*The Concept of Irony, With Constant Reference to Socrates* (p. 47)  
Indiana State University Press. Bloomington, Indiana, USA. 1965

**Riemann, Bernhard** 1826–66  
German mathematician

Science is the attempt to comprehend nature by means of concepts.

In C.J. Keyser

*The Hibbert Journal*, Volume 3, 1904–1905 (pp. 312–313)

**Talbot, Michael** 1953–92  
American physicist

We have dreamed the world. Our concepts of time and space, the very structure of the universe, are more intimately related to the problems and phenomenon of consciousness than we have seriously suspected.

*Mysticism and the New Physics* (p. 2)

Routledge & Kegan Paul. London, England & Henley. 1981

**Taylor, E. S.** 1903–91  
American aircraft engine pioneer

It is necessary to have a concept before it can be analyzed.

Report on Engineering Design

*Journal of Engineering Education*, Volume 51, Number 8, April, 1961 (p. 649)

**von Bertalanffy, Ludwig** 1901–72  
Austrian biologist

Behind the logical thesis that all concepts in science are reducible to physical concepts, there lies a metaphysical motive, although this would be sternly denied by the representatives of logical positivism. This motive is that the world, as pictured in physics, is the ultimate reality. The world consists of those elementary particles called atoms, electrons, protons, neutrons, and the like; and the things observed, whether stars and crystals, plants and animals, or brains and mental life, are aggregates or the outcome of those ultimate realities.

*The Scientific Monthly*, November, 1953 (p. 236)

**Wheeler, John Archibald** 1911–  
American theoretical physicist and educator

I have great hesitation in trying to formulate some unifying concepts out of my own field, and still more reluctance in speaking about their application to other fields of human knowledge.

*At Home in the Universe*

A Septet of Sibyls: Aids in the Search for Truth (p. 3)

The American Institute of Physics. Woodbury, New York, USA. 1994

## CONCEPTION

**Merz, John Theodore** 1840–1922  
German-born British chemist, historian, and industrialist

The introduction...into geometrical work of conceptions such as the infinite, the imaginary, and the relations of hyperspace, none of which can be directly imagined, has a psychological significance well worthy of examination. It gives a deep insight into the resources and working of the human mind. We arrive at the borderland of mathematics and psychology.

*A History of European Thought in the Nineteenth Century* (Volume 2)

Chapter XIII (p. 716)

William Blackwood & Sons. Edinburgh, Scotland. 1903

**Millikan, Robert Andrews** 1868–1953  
American physicist

We can still look with a sense of wonder and mystery and reverence upon the fundamental elements of the physical world as they have been partially revealed to us in this century. The childish mechanical conceptions of the nineteenth century are now grotesquely inadequate.

*Evolution in Science and Religion*

Chapter I (p. 27)

Yale University Press. New Haven, Connecticut, USA. 1927

**Richards, Herbert Maul** 1871–1928  
No biographical data available

The conception formed in ignorance is continued in ignorance.

Lecture delivered at Columbia University, December 4, 1907

*Botany* (p. 4)

The Columbia University Press. New York, New York, USA. 1908

**Whewell, William** 1794–1866  
English philosopher and historian

When men merely repeat the terms of science, without attaching to them any clear conceptions; – when their apprehensions become vague and dim; – when they assent to scientific doctrines as a matter of tradition, rather than of conviction, on trust rather than on sight; – when science is considered as a collection of opinions, rather than a record of laws by which the universe is really governed; – it must inevitably happen, that men will lose their hold on the knowledge which the great discoverers who preceded them have brought to light.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book IV, Chapter I (pp. 183–184)

John W. Parker & Son. London, England. 1857

To discover a Conception of the mind which will justly represent a train of observed facts is, in some measure, a

process of conjecture, as I have stated already; and as I then observed, the business of conjecture is commonly conducted by calling up before our minds several suppositions, and selecting that one which most agrees with what we know of the observed facts.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 54)

John W. Parker. London, England. 1867

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

It is the large generalisation, limited by a happy particularity, which is the fruitful conception.

*Science and the Modern World*

Chapter II (p. 30)

Simon and Schuster. New York, New York, USA. 1997

## CONCHOLOGY

**Garstang, Walter** 1868–1949

English embryologist and amateur poet

Echinospira sets this riddle to the students of Conchology  
To make them pay attention to the doctrines of Morphology:  
And this is how he poses it: “The Ammonite’s old shell  
From time to time was portioned off, to make it fit him  
well.

“The smaller shell around his hump was “visceral,” like mine;

His outer shell also agrees: it’s “pallial” in fine.

We differ in this: his inner shell was fixed by suture,

While mine is truly portable, and useful for the future!

So let us sing in fitting terms an entente cordiale,

Observing in its proper place the torsion viscerales:

My outer shell’s a “relic” of my Ammonitic traits,

My inner is a tribute to my clever modern ways!

*Larval Forms, and Other Zoological Verses*

Echinospira’s Double Shell, Stanzas 2–4 (p. 42)

The University of Chicago Press. Chicago, Illinois, USA. 1985

**Warren, John**

No biographical data available

Conchology, indeed is a study peculiarly adapted to  
recreate the senses, and insensibly to lead us to the con-  
templation of the glory and order of the great God, in  
creation.

*The Conchologist*

Introduction (p. 3)

Russell, Odiorn & Metcalf. Boston, Massachusetts, USA. 1834

## CONCISE

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Conciseness may produce aridity, whilst too great a multiplicity of objects kept in view at the same time leads to a want of clearness and precision in the sequence of ideas.

*Cosmos: A Sketch of a Physical Description of the Universe*

Introduction (p. 3)

Longman, Brown, Green & Longmans. London, England. 1849

## CONCLUSION

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

These practical results – for so we venture to call the general conclusions last presented – although they are purely scientific deductions from general principles, may satisfy the most obstinate supporters of the matter-of-fact side of all questions, of the advantages of scientific illustrations in the daily walks of life, and also justify the course which has been followed with so much success by the Coast Survey, in combining the strictest scientific methods with its practical operation.

*Annual Report of the Superintendent of the Coast Survey, Showing the Progress of that Work During the Year Ending November, 1851*

Extracts from the Report of Professor Agassiz to the Superintendent of the Coast Survey, on the Examination of the Florida Reefs, Keys, and Coast (pp. 159–160)

Printed by Robert Armstrong. Washington, D.C. 1852

**Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

It may seem rash indeed to draw conclusions valid for the whole universe from what we can see from the small corner to which we are confined. Who knows that the whole visible universe is not like a drop of water at the surface of the earth? Inhabitants of that drop of water, as small relative to it as we are relative to the Milky Way, could not possibly imagine that beside the drop of water there might be a piece of iron or a living tissue, in which the properties of matter are entirely different.

*Space and Time*

Note IV (p. 227)

Dover Publications, Inc. New York, New York, USA. 1960

## Charlie Chan (Fictional character)

Hasty conclusion like gunpowder. Easy to explode.

*Charlie Chan in Paris*

Film (1935)

Hasty conclusion easy to make, like hole in water.

*Charlie Chan in Egypt*

Film (1935)

Hasty conclusion like toy balloon. Easy to blow up, easy to pop.

*Charlie Chan at the Race Track*

Film (1936)

**de Luc, Jean André** 1773–1817

Swiss naturalist

The mind is at all times so eager to draw inferences, that it will not stop to collect all the data necessary for deducing legitimate conclusions, respecting the objects on which it is employed, but is not unfrequently rash in proportion to the importance of the subject, while this very circumstance ought to preclude all precipitate decisions.

Translated by Henry de La Fite

*An Elementary Treatise on Geology*

Preliminary Discourse on Geology (p. 1)

F.C. &amp; J. Rivington. London, England. 1809

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

However experienced the observer, I do not think we ought to put implicit trust in a result which strains his skill to the utmost until it has been verified by others working independently. Therefore you should for the present make the usual reservations in accepting these conclusions. But science is not just a catalogue of ascertained facts about the universe; it is a mode of progress, sometimes tortuous, sometimes uncertain. And our interest in science is not merely a desire to hear the latest facts added to the collection; we like to discuss our hopes and fears, probabilities and expectations.

*Stars and Atoms*

Lecture II (p. 53)

Yale University Press. London, England. 1927

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

He that will not verify his conclusions as far as possible by mathematics, as it were bringing the ingots of common sense to be assayed and coined at the mint of sovereign science, will hardly realize the full value of what he holds, will want a measure of what it will be worth in however slightly altered circumstances, a means of conveying and making it current.

*Mathematical Psychics*

Part I (p. 3)

C. Kegan Paul &amp; Company. London, England. 1881

**Faraday, Michael** 1791–1867

English physicist and chemist

It may be very distasteful, and great fatigue, to suspend a conclusion; but as we are not infallible, so we ought to be cautious; we shall eventually find our advantage, for the man who rests in his position is not so far from right as he who, proceeding in a wrong direction, is ever increasing his distance.

*Experimental Researches in Chemistry and Physics*

Lecture on Mental Education (p. 483)

Richard Taylor &amp; William Francis. London, England. 1859

**Gregory, Sir Richard Arman** 1864–1952

Scientific writer and journalist

There is a common impression that the conclusions arrived at by men of science are of the nature of beliefs, and have, therefore, no firmer basis than that of conviction. Nothing could be farther from the truth.

*Discovery: The Spirit and Service of Science*

Chapter V (p. 92)

Macmillan &amp; Company Ltd. London, England. 1918

**Hooke, Robert** 1635–1703

English physician

For as in pure Geometry nothing is let pass for a Truth, whose Cause and Principles are not clearly shown by the Progress of Reasoning, and the Process of Demonstration: So in Physicks Geometrically handled, nothing is to be taken for granted, nor any thing admitted for a true Conclusion, that is not plainly deduced from self-evident Principles, and those founded upon the immediate Objects of Sense disintangled from all the Fallacies of the Medium and Organ.

In Harry Woolf (ed.)

*The Posthumous Works of Robert Hooke*

Lectures of Light, Section I (p. 73)

Johnson Reprint Corporation. New York, New York, USA. 1969

**Hume, David** 1711–76

Scottish philosopher and historian

The principal difficulty in the mathematics is the length of inferences and compass of thought, requisite to the forming of any conclusion.

In *Great Books of the Western World* (Volume 35)*An Enquiry Concerning Human Understanding*

Section VII, Part I (p. 471)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

Scientific men should not rush to conclusions, but keep their minds open for such time as may be necessary.

In Eric Temple Bell

*The Search for Truth*

Chapter XVIII (p. 277)

George Allen &amp; Unwin Ltd. London, England. 1935

**Somerville, Mary** 1780–1872

English mathematician

Great discoveries generally lead to a variety of conclusions...

*The Connexion of the Physical Sciences* (9th edition)

Section IV (p. 32)

John Murray. London, England. 1858

English poet

A large number of incorrect conclusions are drawn because the possibility of chance occurrences is not fully considered. This usually arises through lack of proper controls and insufficient repetitions. There is the story of the research worker in nutrition who had published a rather surprising conclusion concerning rats. A visitor asked



him if he could see more of the evidence. The researcher replied, "Sure, there's the rat."

*An Introduction to Scientific Research*

Chapter 3 (p. 34)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Conclusions based upon analogies may fill up a portion of the vast chasm which separates the certain results of a mathematical natural philosophy from conjectures verging on the extreme, and therefore obscure and barren confines of all scientific development of mind.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 3)

Special Results of OBSERVATION IN THE DOMAIN OF COSMICAL PHENOMENA (p. 29)

Harper & Brothers Publishers. New York, New York, USA. 1851

## CONDUCTION

**Faraday, Michael** 1791–1867

English physicist and chemist

All these considerations impress my mind strongly with the conviction, that insulation and ordinary conduction cannot be properly separated when we are examining into their nature; that is, into the general law or laws under which their phenomena are produced.

*Experimental Researches in Electricity* (Volume 3)

On electric induction (p. 513, fn 1)

Bernard Quaritch. London, England. 1855

Everybody appears to discharge; but the possession of this capability in a greater or smaller degree in different bodies, makes them better or worse conductors, worse or better insulators: and both induction and conduction appear to be the same in their principle and action, except that in the latter, an effect common to both is raised to the higher degree, whereas in the former it occur, in the best cases, in only an almost insensible quantity.

*Experimental Researches in Electricity* (Volume 3)

On Electric Induction (p. 513, fn 1)

Bernard Quaritch. London, England. 1855

## CONDUCTOR

**Rudberg, Eric Gustaf**

Swedish physicist

If the Easter pilgrims in Piazza San Pietro were to represent the carriers in a metal, then an insulator would resemble the Antarctic with one solitary traveler. In the abundance of carriers there is an enormous gap between conductors and insulators.

*Nobel Lectures, Physics 1942–1962*

Presentation speech for Nobel Prize for physics in 1956

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## CONFIDENCE

**Burroughs, Edgar Rice** 1875–1950

American writer

I do not think that I am ever overconfident. I am merely wholly confident, and I maintain that there is all the difference in the world there.

*Llana of Gathol*

Book IV, Chapter 9

Ballantine Books. Tarzana, California, USA. 1948

**Curie, Marie Skłodowska** 1867–1934

Polish-born French physicist and chemist

Life is not easy for any of us. But what of that? We must have perseverance and above all confidence in ourselves.

We must believe that we are gifted for something and that this thing, at whatever cost, must be attained.

In *Eve Curie*

*Madame Curie*

Chapter XII (p. 158)

The Literary Guild of America, Inc. New York, New York, USA. 1937

## CONFUSION

**Darwin, Charles Robert** 1809–82

English naturalist

I am in thick mud; the orthodox would say in fetid abominable mud. I believe I am in much the same frame of mind as an old gorilla would be in if set to learn the first book of Euclid...yet I cannot keep out of the question.

*The Correspondence of Charles Darwin*

Letter to Asa Grey (p. 369)

Cambridge University Press. Cambridge, England. 1994

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

At times also I have been put to confusion and driven to despair of ever explaining something for which I could not account, but which my senses told me to be true.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 131)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hammer, P. C.**

American science editor

...the filling of minds with technical concepts without establishing their relationships is a form of pollution.

*Mind Pollution*

*Cybernetics*, Volume 14, 1971

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Chaos and confusion are not to be introduced into the order of nature, because certain things appear to our



partial views as being in some disorder. Nor are we to proceed in feigning causes when those seem insufficient which occur in our experience.

*The Theory of the Earth* (Volume 2)

Part II, Chapter XIV (p. 547)

Messrs. Cadwell, Junior, and Davies. London, England. 1795

### Marriott, R. A. (Reginald Adams)

No biographical data available

...in...sailing without a chronometer Science cannot fix her [pre-glacial] position, and is obliged to allow great freedom of speculation, and to give equal weight to very diverse opinions on the subject, thus creating a confusion of tongues very detrimental to progress.

*The Change in the Climate and Its Cause, Giving the Date of the Last Ice Age Based on a Recent Astronomical Discovery and Geological Research*

Introduction (p. 9)

E. Marlborough & Co. London, England. 1914

### Miller, Henry 1891–1980

American writer

Confusion is a word we have invented for an order which is not understood.

*Tropic of Capricorn*

An Interlude (p. 176)

Grove Press. New York, New York, USA. 1961

### Moore, Marianne 1887–1972

American poet

Unconfusion submits

its confusion to proof; it's

not a Herod's oath that cannot change.

*Collected Poems*

The Mind Is an Enchanting Thing (p. 134)

The Macmillan Company. New York, New York, USA. 1967

### Oppenheimer, James Robert 1904–67

American theoretical physicist

This is a world in which each of us, knowing his limitations, knowing the evils of superficiality and the terrors of fatigue, will have to cling to what is close to him, to what he knows, to what he can do, to his friends and his tradition and his love, lest he be dissolved in a universal confusion and know nothing and love nothing.

*The Open Mind*

Prospects in the Arts and Sciences (p. 144)

Simon & Schuster. New York, New York, USA. 1955

### Ritchie, Arthur David 1891–1967

Scottish history of science author

If you are in the very thickest fog you are not confused because you see nothing to confuse you. But as the fog gradually disperses you catch sight indistinctly of a bit of something here and other bit of something there; you are not quite sure what each is or how it fits in with the rest. Then you are confused until it is clear enough to see everything.

The Atomic Theory

*Memoirs and Proceedings of the Manchester Literary & Philosophical Society*, Volume 86, 1944 (p. 180)

### Townson, Robert 1763–1827

Australian scholar and scientist

When science has not connected the different parts of the great plan of Nature; whilst the various concurring means to one great end, are difficult and insulated; great disorder and want of contrivance may appear, where nothing but order really prevails; and what may be the result of infinite wisdom, will be considered as the effect of chance, and the consequence of confusion.

*Philosophy of Mineralogy*

Chapter VI (p. 76)

Printed for the author. London, England. 1798

### Whitehead, Alfred North 1861–1947

English mathematician and philosopher

...leaving the vast darkness of the subject unobscured.

In J. Robert Oppenheimer

*The Open Mind*

Chapter V (p. 102)

Simon & Schuster. New York, New York, USA. 1955

## CONIC SECTION

### Fabre, Jean-Henri 1823–1915

French entomologist and author

Take this or that term, place the + sign before it and forthwith you have the ellipse, the trajectory of the planets, with its two friendly foci, transmitting pairs of vectors whose sum is constant; substitute the – sign and you have the hyperbola with the antagonistic foci, the desperate curve that dives into space with infinite tentacles, approaching nearer and nearer to straight lines, the asymptotes, but never succeeding in meeting them. Suppress that term and you have the parabola, which vainly seeks in infinity its lost second focus; you have the trajectory of the bombshell; you have the path of certain comets which come one day to visit our sun and then flee to depths whence they never return. Is it not wonderful thus to formulate the orbit of the worlds?

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 303)

Dodd, Mead & Co. New York, New York, USA. 1925

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

The history of science abundantly proves that a body of abstract propositions – even if, as in the case of conic sections, it remains two thousand years without effect upon daily life – may yet, at any moment, be used to cause a revolution in the habitual thoughts and occupations of every citizen.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 72)

Longmans, Green & Co. London, England. 1919

**Sylvester, James Joseph** 1814–97

English mathematician

The discovery of the conic sections, attributed to Plato, first threw open the higher species of form to the contemplation of geometers. But for this discovery, which was probably regarded in Plato's time and long after him, as the unprofitable amusement of a speculative brain, the whole course of practical philosophy of the present day, of the science of astronomy, of the theory of projectiles, of the art of navigation, might have run a different channel; and the greatest discovery that has ever been made in the history of the world, the law of universal gravitation, with its innumerable direct and indirect consequences and applications to every department of human research and industry, might never to this hour have been elicited.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry

Gresham Committee and the Members of the Common Council of the City of London

4 December, 1854 (p. 7)

University Press. Cambridge, England. 1904–1912

**Whewell, William** 1794–1866

English philosopher and historian

If the Greeks had not cultivated Conic Sections, Kepler could not have superseded Ptolemy; if the Greeks had cultivated Dynamics, Kepler might have anticipated Newton.

*History of the Inductive Sciences, from the Earliest to the Present Time*

(Volume 2)

Book VI, Introduction (p. 7)

John W. Parker. London, England. 1837

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

No more impressive warning can be given to those who would confine knowledge and research to what is apparently useful, than the reflection that conic sections were studied for eighteen hundred years merely as an abstract science, without regard to any utility other than to satisfy the craving for knowledge.

*An Introduction to Mathematics*

Chapter 10 (p. 100)

Oxford University Press, Inc. New York, New York, USA. 1958

## CONJECTURE

**Adams, George** 1750–95

English instrument maker

Conjecture may lead you to form opinions, but it cannot produce knowledge. Natural philosophy must be built upon the phenomena of nature discovered by observation and experiment.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 59)

Printed by R. Hindmarsh. London, England. 1794

Conjectures in philosophy are termed hypotheses or theories; and the investigation of an hypothesis founded on some slight probability, which accounts for many appearances in nature, has too often been considered as the highest attainment of a philosopher. If the hypothesis (sic) hangs well together, is embellished with a lively imagination, and serves to account for common appearances – it is considered by many, as having all the qualities that should recommend it to our belief, and all that ought to be required in a philosophical system.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 59)

Printed by R. Hindmarsh. London, England. 1794

**Aeschylus** 525 BCE–456 BCE

Greek playwright

To know and to conjecture differ widely.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 23)

Edward Howell. Liverpool, England. 1864

**Darwin, Charles Robert** 1809–82

English naturalist

If we choose to let conjecture run wild, then animals, our fellow brethren in pain, disease, suffering and famine – our slaves in the most laborious works, our companions in our amusements – they may partake of our origin in one common ancestor – we may be all melted together.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Note-Book of 1837 (p. 368)

D. Appleton & Company. New York, New York, USA. 1896

**Davy, Sir Humphry** 1778–1829

English chemist

Upon all occasions, when I venture upon a conjecture, you will, I trust, have the goodness to consider it has brought forward, not as an opinion which it would be painful to relinquish, but as a hint which may lead to inquiry.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 216)

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**Holbach, Paul Henri Thiry** 1723–89

French philosopher

Man unfortunately for himself, wishes to exceed the limits of his sphere, and to transport himself beyond the visible world. He neglects experience, and feeds himself with conjectures.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*

(Volume 1)

*The True Meaning of the System of Nature*

Introduction (p. 339)

J.P. Mendum. Boston, Massachusetts, USA. 1889

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

An ancient philosopher once remarked that people who cudged their brains about the nature of the moon reminded him of men who discussed the laws and institutions of a distant city of which they had heard no more than the name.

*Popular Scientific Lectures*

On Symmetry (p. 89)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Quinton, Anthony M.**

No biographical data available

The conjectures of the scientific intelligence are genuine creative novelties, inherently unpredictable and not determined by the character of the scientist's physical environment. The thinking mind is not a causal mechanism.

In D.J. O'Connor (ed.)

*A Critical History of Western Philosophy* (p. 551)

The Free Press of Glencoe. London, England. 1964

**Shelah, Saharon** 1945–

Israeli mathematician

Given a conjecture, the best thing is to prove it. The second best thing is to disprove it. The third best thing is to prove that it is not possible to disprove it, since it will tell you not to waste your time trying to disprove it. That's what Gödel did for the Continuum Hypothesis.

Rutgers University Colloquium, October 26, 2001

## CONNECTIONS

**de Maupertuis, Pierre Louis Moreau** 1678–1759

French mathematician and astronomer

To endeavor at discovering the connections that subsist in nature, is no way inconsistent with prudence; but it is downright folly to push these researches too far; as it is the lot only of superior Beings to see the dependence of events, from one end to the other, of the chain which supports them.

*An Essay Towards a History of the Principal Comets Since 1742*

A Letter Upon Comets (p. 10)

Printed for T. Becket & P.A. de Hondt. London, England. 1769

## CONQUEST

**Massey, Raymond**

American actor

Rest enough for the individual man. Too much and too soon and we call it death. But for Man no rest and no

ending. He must go on, conquest beyond conquest. First, this little planet and its winds and ways. And then all laws of mind and matter that restrain him. Then the planets about him. And at last, out across immensity to the stars. And when he has conquered all the deeps of space and all the mysteries of time, still he will be beginning.... Little animals. And if we're no more than animals we must snatch each little scrap of happiness, and live and suffer and pass, mattering no more than all the other animals do or have done. It is this, or that. All the universe or nothing. Which shall it be, Passworthy? Which shall it be?

*Things to Come*

Film (1936)

**Slossin, Edwin Emery** 1865–1919

Chemist and author

The conquest of nature, not the imitation of nature, is the whole duty of man.

*Creative Chemistry*

Chapter I (pp. 9–10)

The Century Co. New York, New York, USA. 1919

## CONSCIOUSNESS

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

...nowadays most people identify themselves almost exclusively with their consciousness, and imagine that they are only what they know about themselves.

*Memories, Dreams, Reflections*

Chapter XI (p. 300)

Vintage Books. New York, New York, USA. 1970

**Shaw, James Byrnie**

American mathematician

After the unconscious power has led us to our eldorado, it has done all it can. The deductions, the demonstrations, the applications, must be carried out at the expense of prolonged effort again. The intuition cannot do this kind of work. Its region is the nebulous part of thought where the mental ions unite, dissolve, and whirl away, – or we may say that it is found where the breakers surge against the shores of the unknown. But in the consciousness, the stable, the crystallized, the permanent combinations are formed; the new world is organized, surveyed, mapped, and the frontier is widened. Here everything proceeds under hard supervision.

Henri Poincare as An Investigator

*Popular Science Monthly*, March, 1913 (pp. 223–224)

**Tyndall, John** 1820–93

Irish-born English physicist

Between molecular mechanics and consciousness is interposed a fissure over which the ladder of physical reasoning is incompetent to carry us.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 2)  
Chapter 15 (p. 388)  
D. Appleton & Co. New York, New York, USA. 1896

**Watts, Alan Wilson** 1915–73  
American philosopher

Consciousness recurs in every newborn creature, and wherever it recurs it is “I.” And in so far as it is only this “I,” it struggles again and again in hundreds of millions of beings against the dissolution which would set it free. To see this is to feel the most peculiar solidarity – almost identity – with other creatures, and to begin to understand the meaning of compassion.

*Nature, Man, and Woman*  
Part I, Chapter 4 (p. 117)  
Vintage Books. New York, New York, USA. 1970

In this light it will be clear that consciousness is no mere phosphorescent scum upon the foundations of fire and rock – a late addition to a world which is essentially unfeeling and mineral. Consciousness is rather the unfolding, the “evolution,” of what has always been hidden in the heart of the primordial universe of stars.

*Nature, Man, and Woman*  
Part II, Chapter 8 (p. 186)  
Vintage Books. New York, New York, USA. 1970

## CONSEQUENCE

**Huxley, Thomas Henry** 1825–95  
English biologist

...logical consequences are the scarecrows of fools and the beacons of wise men.

*Science and Culture and Other Essays*  
Chapter IX (p. 240)  
Macmillan & Company Ltd. London, England. 1881

**Ingersoll, Robert Green** 1833–99  
American lawyer, public official, and orator

We must remember that in nature there are neither rewards nor punishments – there are consequences.

*The Works of Robert G. Ingersoll* (Volume 2)  
Some Reasons Why (p. 315)  
The Dresden Publishing Co. New York, New York, USA. 1915

**Stallo, John Bernhard** 1823–1900  
German-American academic, jurist, philosopher, and ambassador

The blindness of eminent physicists to some of the most obvious consequences of their own theories is marvellous.

*The Concepts and Theories of Modern Physics*  
Introduction to the Second Edition (p. xxxiii)  
D. Appleton & Co. New York, New York, USA. 1885

## CONSERVATION

**Arrhenius, Svante August** 1859–1927  
Swedish scientist

Humanity stands... before a great problem of finding new raw materials and new sources of energy that shall never become exhausted. In the meantime we must not waste what we have, but must leave as much as possible for coming generations.

Translated by Clifford Shattuck Leonard  
*Chemistry in Modern Life* (p. vii)  
D. van Nostrand Co. Princeton, New Jersey, USA. 1925

**Bates, Marston** 1906–74  
American zoologist

We remain important, you and I and all mankind. But so is the butterfly – not because it is good for food or good for making medicine or bad because it eats our orange trees. It is important in itself, as a part of the economy of nature.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
Chapter 1 (p. 5)  
Random House, Inc. New York, New York, USA. 1960

In defying nature, in destroying nature, in building an arrogantly selfish, man-centered, artificial world, I do not see how man can gain peace or freedom or joy.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
Chapter 16 (p. 262)  
Random House, Inc. New York, New York, USA. 1960

**Bergman, Charles**  
No biographical data available

I have a fantasy: I imagine myself sitting in my living room, on my sofa. Outside my house – outside our house – animals are gathering. Lost animals, endangered animals. Peering in the windows, with strange expressions on their gaunt faces. Murmuring indistinctly of Something Else. Murmuring in wild echoes.

*Wild Echoes: Encounters with the Most Endangered Animals in North America*  
Introduction (p. 1)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1990

We have inherited, and created, impoverished seas. The spouting is more sporadic, gone totally from some areas of the oceans, and the whales that remain are mere relics of the swarms our ancestors wrote off with such awe.

*Wild Echoes: Encounters with the Most Endangered Animals in North America*  
Chapter IV (p. 201)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1990

**Berry, Wendell** 1934–

American essayist, poet, critic, and farmer

Man...is the center of the universe only in the sense that wherever he is it seems to him that he is at the center of his own horizon; the truth is that he is only a part of a vast complex of life, on the totality and the order of which he is blandly dependent.

*The Hudson Review*, Autumn, 1970

**Brower, David** 1912–2000

American environmentalist

Let us begin. Let us restore the Earth. Let the mountains talk, and the rivers run.

*Let the Mountains Talk, Let the Rivers Run*

Chapter 24 (p. 196)

HarperCollins Publishers. New York, New York, USA. 1995

I started out as a boy bent over a spring. Then I climbed mountains. I became a conservationist. Then I saw what we all were doing, and I wanted to stop us from doing worse. Now I want to restore what once was, not for an old man's memories, but for a baby's smile.

*Let the Mountains Talk, Let the Rivers Run*

Chapter 11 (p. 98)

HarperCollins Publishers. New York, New York, USA. 1995

When you understand how recent an arrival we are, in comparison with a forest or a mountain, and you begin to understand how much wildness contributed to making us as a successful evolutionary project, you acquire some humility.

*Let the Mountains Talk, Let the Rivers Run*

Chapter 16 (pp. 131–132)

HarperCollins Publishers. New York, New York, USA. 1995

Nature recycles everything.

*Let the Mountains Talk, Let the Rivers Run*

Chapter 19 (p. 149)

HarperCollins Publishers. New York, New York, USA. 1995

Although Thomas Jefferson argued that no one generation has a right to encroach upon another generation's freedom, the future's right to know the freedom of wilderness is going fast.

*This Is the American Earth*

Foreword

Sierra Club. San Francisco, California, USA. 1968

**Carson, Rachel** 1907–64

American marine biologist and author

Our attitudes toward plants is a singularly narrow one. If we see any immediate utility in a plant we foster it. If for any reason we find its presence undesirable or merely a matter of indifference, we may condemn it to destruction forthwith.

*Silent Spring*

Chapter 6 (p. 63)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

**Hudson, William Henry**

Argentinean/English ornithologist, naturalist, and author

And above all others, we should protect and hold sacred those types, Nature's masterpieces, which were first singled out for destruction on account of their size, or splendor, or rarity, and that false detestable glory which is accorded to their most successful slayers. In ancient times the spirit of life shone brightest in these; and when others that shared the earth with them were taken by death they were left, being more worthy of perpetuation. Like immortal flowers they have drifted down to us on the ocean of time, and their strangeness and beauty bring to our imagination a dream and a picture of that unknown world, immeasurable far removed, where man was not: and when they perish, something of gladness goes out from nature, and the sunshine loses something of its brightness.

*The Naturalist in La Plata*

Chapter I (p. 29)

Chapman & Hall, Ltd. London, England. 1892

**Leopold, Aldo** 1886–1948

American naturalist

Conservation is getting nowhere because it is incompatible with our Abrahamic concept of land. We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.

*A Sand County Almanac, with Essays on Conservation from Round River*

Foreword (p. xix)

Sierra Club. San Francisco, California, USA. 1970

To keep every cog and wheel is the first precaution of intelligent tinkering.

*A Sand County Almanac, with Essays on Conservation from Round River*

Part III, Round River (p. 190)

Sierra Club. San Francisco, California, USA. 1970

Conservation is a state of harmony between men and land.

*A Sand County Almanac, with Essays on Conservation from Round River*

Part IV, The Land Ethic (p. 243)

Sierra Club. San Francisco, California, USA. 1970

Need we always await the willy nilly pressure of wrecked resources before professional cooperation begins?

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

Engineering and Conservation (p. 253)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**Lovejoy, Thomas E.** 1941–

American tropical biologist

In the last analysis, even when we have learned to manage other aspects of the global environment, even if population reaches a stable level, even if we reach a time when environmental crises have become history, even if most



wastes have gone except the most long lived, even if global cycles have settled back into more normal modes, then the best measurement of how we have managed the global environment will be how much biological diversity has survived.

In D.B. Botkin, M.F. Caswell, J.E. Estes, and A.A. Orio (eds.)  
*Changing the Global Environment: Perspectives on Human Involvement*  
Deforestation and Extinction of Species (p. 97)  
Academic Press. Boston, Massachusetts, USA. 1989

Conservation is sometimes perceived as stopping everything cold, as holding whooping cranes in higher esteem than people. It is up to science to spread the understanding that the choice is not between wild places or people. Rather, it is between a rich or an impoverished existence for Man.

In Yvonne Baskin  
*The Work of Nature: How the Diversity of Life Sustains Us* (p. ii)  
Island Press. Washington, D.C. 1997

**Osborn, Henry Fairfield** 1857–1935  
American paleontologist and geologist

[The] great battle for preservation and conservation cannot be won by gentle tones, nor by appeals to the aesthetic instincts of those who have no sense of beauty, or enjoyment of Nature.

In William T. Hornaday  
*Our Vanishing Wild Life*  
Preface (p. vii)  
Charles Scribner's Sons. New York, New York, USA. 1913

**Pinchot, Gifford** 1865–1946  
American forester

The vast possibilities of our great future will become realities only if we make ourselves responsible for that future.

In James Rudolph Garfield  
*Public Service* (Volume 6)  
The Conservation of Natural Resources (p. 177)  
Hall & Locke Co. Boston, Massachusetts, USA. 1911

**Roosevelt, Franklin Delano** 1882–1945  
32nd president of the USA

During the three or four centuries of white men on the American continent, we find a continuous striving of civilization against Nature. It is only in recent years that we have learned how greatly by these processes we have harmed Nature and Nature in turn has harmed us.

*A Message to the Congress on the Use of Our National Resources*  
January 25, 1935

Men and Nature must work hand in hand. The throwing out of balance of the resources of Nature throws out of balance also the lives of men.

*A Message to the Congress on the Use of Our National Resources*  
January 25, 1935

**Sheldrick, Daphne** 1934–  
Kenyan-born wildlife expert

With amazing arrogance we presume omniscience and an understanding of the complexities of Nature, and with amazing impertinence we firmly believe that we can better it.... [W]e have forgotten that we, ourselves, are just a part of nature, an animal which seems to have taken the wrong turning bent on total destruction.

*The Tsavo Story*  
Chapter 15 (p. 190)  
Collins & Harvill Press. London, England. 1973

### The Bible (King James Version)

... Hurt not the earth, neither the sea, nor the trees...  
Revelation 7:3

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Can he who has discovered only some of the values of whale-bone and whale oil be said to have discovered the true use of the whale? Can he who slays the elephant for his ivory be said to have "seen the elephant"? These are pretty and accidental uses; just as if a stronger race were to kill us in order to make buttons and flageolets of our bones.

*The Maine Woods* (pp. 158–159)  
Thomas Y. Crowell & Co. New York, New York, USA. 1909

**Wilson, Edward O.** 1929–  
American biologist and author

A civilization able to envision God and to embark on the colonization of space will surely find the way to save the integrity of this planet and the magnificent life it harbors.

*The Future of Life*  
Chapter 7 (p. 189)  
Alfred A. Knopf. New York, New York, USA. 2002

## CONSERVATIONIST

**Leopold, Aldo** 1886–1948  
American naturalist

A conservationist is one who is humbly aware that with each stroke he is writing his signature on the face of his land. Signatures of course differ, whether written with axe or pen, and this is as it should be.

*A Sand County Almanac, with Essays on Conservation from Round River*  
Part I, November (p. 73)  
Sierra Club. San Francisco, California, USA. 1970

## CONSERVATION, LAW OF

**Tyndall, John** 1820–93  
Irish-born English physicist

The law of conservation rigidly excludes both creation and annihilation. Waves may change to ripples, and



ripples to waves – magnitude may be substituted for number, and number for magnitude – asteroids may aggregate to suns, suns may invest their energy in floras and faunas, and flora and faunas may melt in air – the flux of power is eternally the same. It rolls in music through the ages, while the manifestations of physical life as well as the display of physical phenomena are but the modulations of its rhythm.

*Heat Considered as a Mode of Motion*

Chapter XIV (p. 467)

D. Appleton & Company. New York, New York, USA. 1875

## CONSERVATION OF ENERGY

**Joule, James Prescott** 1818–89

English physicist

...the most convincing proof of the conversion of heat into living force [*vis viva*] has been derived from my experiments with the electro-magnetic engine, a machine composed of magnets and bars of iron set in motion by an electrical battery. I have proved by actual experiment that, in exact proportion to the force with which this machine works, heat is abstracted from the electrical battery. You see, therefore, that living force may be converted into heat, and that heat may be converted into living force, or its equivalent attraction through space.

*Scientific Papers* (Volume 1)

On Matter, Living Force, and Heat (pp. 270–271)

Dawsons of Pall Mall. London, England. 1963

**Levi, Primo** 1919–87

Italian writer and chemist

It is the destiny of wine to be drunk, and it is the destiny of glucose to be oxidized. But it was not oxidized immediately: its drinker kept it in his liver for more than a week, well curled up and tranquil, as a reserve aliment for a sudden effort; an effort that he was forced to make the following Sunday, pursuing a bolting horse. Farewell to the hexagonal structure: in the space of a few instants the skein was unwound and became glucose again, and this was dragged by the bloodstream all the way to a minute muscle fiber in the thigh, and here brutally split into two molecules of lactic acid, the grim harbinger of fatigue: only later, some minutes after, the panting of the lungs was able to supply the oxygen necessary to quietly oxidize the latter. So a new molecule of carbon dioxide returned to the atmosphere, and a parcel of the energy that the sun had handed to the vine-shoot passed from the state of chemical energy to that of mechanical energy, and thereafter settled down in the slothful condition of heat, warming up imperceptibly the air moved by the running and the blood of the runner. "Such is life," although rarely is it described in this manner: an inserting itself, a drawing off to its advantage, a parasitizing of the

downward course of energy, from its noble solar form to the degraded one of low-temperature heat. In this downward course, which leads to equilibrium and thus death, life draws a bend and nests in it.

Translated by Raymond Rosenthal

*The Periodic Table*

Carbon (pp. 229–230)

Shocken Books. New York, New York, USA. 1984

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

...Nature as a whole possesses a store of energy 1 that cannot be in any way either increased or diminished...

The quantity of energy in nature is eternal and unalterable... I have named this general law "The Principle of the Conservation of Energy.

Translated by Edmund Atkinson

*Popular Lectures on Scientific Subjects*

On the Interaction of Natural Forces p. 170)

D. Appleton & Co. New York, New York, USA. 1883

## CONSISTENCY

**Davy, Sir Humphry** 1778–1829

English chemist

Consistency in regard to opinions is the slow poison of the intellectual life, the destroyer of its vividness and its energy.

In Sir Richard Arman Gregory

*Discovery: The Spirit and Service of Science*

Chapter VII (p. 165)

Macmillan & Company Ltd. London, England. 1918

## CONSTELLATION

**Aeschylus** 525 BCE–456 BCE

Greek playwright

I know the nightly concourse of the stars  
And which of the sky's bright regents brings us storm,  
Which summer; when they set, and their uprisings.

In *Great Books of the Western World* (Volume 5)

*The Plays of Aeschylus*

Agamemnon, l. 4–6

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Aratus** 271 BCE–213 BCE

Greek statesman

So thought he good to make the stellar groups,  
That each by other lying orderly,  
They might display their forms.

And thus the stars

At once took names and rise familiar now.

In William Tyler Olcott

*Star Lore of All Ages* (p. 3)

G.P. Putnam's Sons. New York, New York, USA. 1911

Some man of ages past  
 Observed their goings; and devised their titles,  
 Forming the constellations. For the name  
 Of each star singly none could tell or learn; –  
 So numerous are they everywhere, and many  
 Of the same size and color, as they roll.  
 Thus he bethought him to combine them so,  
 That, ranged in neighborhood, they might present  
 Images, – each taking his proper name,  
 And henceforth none rising to doubt or guess at.

In N.L. Frothing

*Metrical Pieces*

The Appearances of the Stars (pp. 39–40)

Crosby, Nichols. Boston, Massachusetts, USA. 1855

Below Orion's feet the Hare  
 Is chased eternally; behind him  
 Sirius ever speeds as in pursuit,  
 And rises after, and eyes him as he sets.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter III (p. 40)

Harper & Brothers Publishers. New York, New York, USA. 1908

The tiny Dolphin floats o'er Capricorn,  
 His middle dusky, but he has four eyes,  
 Two parallel to two.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter X (p. 125)

Harper & Brothers Publishers. New York, New York, USA. 1908

### Babylonian Sun-God Marduk

Then Marduk created places for the great gods.  
 He set up their likeness in the constellations.  
 He fixed the year and defined its divisions;  
 Setting up three constellations for each of the twelve  
 months.  
 When he had defined the days of the year by the constel-  
 lations,  
 He set up the station of the zodiac band as a measure of  
 them all,  
 That none might be too long or too short.

In John D. Barrow

*The World Within the World* (p. 34)

Clarendon Press. Oxford, England. 1988

### Barton, Samuel G.

No biographical data available

A constellation is an area on the sky. Somewhat as the  
 USA is divided into forty-eight states with irregular  
 boundaries, varying greatly in shape, size, and impor-  
 tance, so the whole expanse of the sky is divided into  
 constellations of varied shape, size, and importance ...

*A Guide to the Constellations*

Part I (p. 4)

Whittlesey House. New York, New York, USA. 1935

### Brainard, John 1796–1828

American poet

O! How calm and how beautiful – look at the night!  
 The planets are wheeling in pathways of light;  
 And the lover, or poet, with heart, or with eye,  
 Sends his gaze with a tear, or his soul with a sigh.  
 But from Fesole's summit the Tuscan looked forth,  
 To eastward and westward, to south and to north;  
 Neither planet nor star could his vision delight,  
 'Till his own bright Pleiades should rise to his sight.  
 They rose, and he numbered their glittering train –  
 They shone bright as he counted them over again;  
 But the star of his love, the bright gem of the cluster,  
 Arose not to lend the Pleiades its lustre.

*Occasional Pieces of Poetry*

The Lost Pleiad

E. Bliss and E. White. New York, New York, USA. 1825

### Bryant, William Cullen 1794–1878

American poet

The sad and solemn night Hath yet her multitude of  
 cheerful fires;  
 The glorious host of light Walk the dark hemisphere till  
 she retires;  
 All through her silent watches, gliding slow, Her constel-  
 lations come, and climb the heavens, and go.

*Thanatopsis and Other Poems*

Hymn to the North Star

Clark & Maynard. New York, New York, USA. 1884

### Burns, Robert 1759–96

Scottish poet

...O, had I power like inclination,  
 I'd heeze thee up a constellation!  
 To canter with the Sagitarre,  
 Or loop the Ecliptic like a bar,  
 Or turn the Pole like any arrow...

*The Complete Poetical Works of Robert Burns*

Epistle to Hugh Parker

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

### Carlyle, Thomas 1795–1881

English historian and essayist

Why did not somebody teach me the constellations, and  
 make me at home in the starry heavens, which are always  
 overhead, and which I don't half know to this day?

In Richard Hinckley Allen

*Star Names* (p. v)

G.E. Stechert. New York, New York, USA. 1899

### de Cervantes, Miguel 1547–1616

Spanish novelist, playwright, and poet

...the lore I learned when I was a shepherd tells me it  
 cannot want three hours of dawn now, because the mouth

of the Horn is overhead and makes midnight in the line of the left arm.

In *Great Books of the Western World* (Volume 29)  
*The History of Don Quixote de la Mancha*  
Part I, Chapter 20 (p. 58)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Donne, John** 1572–1631

English poet and divine

And in these Constellations then arise  
New Starres, and old doe vanish from our eyes.

*The Complete Poetry and Selected Prose of John Donne*  
First Anniversary  
Random House, Inc. New York, New York, USA. 1941

**Enoch**

When I saw them [the constellations], I praised, every time I praised the Lord of glory, who had made these great and splendid signs, that they might display the magnificence of his works to angels and to the souls of men, that they may glorify all his works and deeds, might see the working of his power, might glorify the great labour of his hands, and praise him forever.

Translated by Andrew Gotlieb Hoffmann  
*The Book of Enoch the Prophet*  
Chapter XI (p. 24)  
Hathard & Son. London, England. 1839

**Escher, M. C.** 1898–1972

Dutch graphic artist

It has always irked me as improper that there are still so many people for whom the sky is no more than a mass of random points of light. I do not see why we should recognize a house, a tree, or a flower here below and not, for example, the red Arcturus up there in the heavens as it hangs from its constellation Bootes, like a basket hanging from a balloon.

*M.C. Escher, His Life and Complete Graphic Work* (Volume 1982) Part I (p. 113)  
H.N. Abrahams. 1982

**Frost, Robert** 1874–1963

American poet

You know Orion always comes up sideways.

*Complete Poems of Robert Frost*  
The Star Splitter  
Henry Holt & Company. New York, New York, USA. 1949

You'll wait a long, long time for anything much  
To happen in heaven.

*Complete Poems of Robert Frost*  
On Looking Up by Chance at the Constellations  
Henry Holt & Company. New York, New York, USA. 1949

**Glasgow, Ellen** 1874–1945

American writer

Last night the stars were magnificent – Pegasus and Andromeda faced me brilliantly when I lifted my shade,

so I went down and had a friendly reunion with the constellations –

*Letters of Ellen Glasgow*  
Letter to Mary Johnson, August 15, 1906 (pp. 53–54)  
Harcourt Brace & Company. New York, New York, USA. 1958

**Guion, Haywood Williams**

No biographical data available

The astronomer's map presents us with a motley group of bulls and bears and lions, harmoniously dwelling with kids and goats and little twins.

*The Comet* (p. 122)  
E.J. Hale & Son. New York, New York, USA. 1869

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

The constellations seem to have been almost purposely named and delineated to cause as much confusion and inconvenience as possible. Innumerable snakes twine through long and contorted areas of the heavens, where no memory can follow them; bears, lions and fishes, large and small, northern and southern, confuse all nomenclature.

*Outlines of Astronomy: By Sir John F. W. Herschel*  
Part I, Chapter V (p. 253, fn 2)  
American Home Library Co. New York, New York, USA. 1901

**Homer (Smyrns of Chios)** fl. 750 BCE

Greek poet

He wrought the earth, the heavens, and the sea; the moon also at her full and the untiring sun, with all the signs that glorify the face of heaven – the Pleiades, the Hyads, huge Orion, and the Bear, which men also call the Wain and which turns around ever in one place, facing Orion, and alone never dips into the stream of Oceanus.

In *Great Books of the Western World* (Volume 4)  
*The Iliad of Homer*  
Book XVIII, l. 483–489 (p. 135)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He never closed his eyes, but kept them fixed on the Pleiades, on late-setting Bootes, and on the Bear – which men also call the wain, and which turns round and round where it is, facing Orion, and alone never dipping into the stream of Oceanus – for Calypso had told him to keep this to his left.

In *Great Books of the Western World* (Volume 4)  
*The Odyssey*  
Book V, l. 271–276  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hopkins, Frederick Gowland** 1844–89

English biochemist

Now Time's Andromeda on this rock rude,  
With not her either beauty's equal or  
Her injury's, looks of by both horns of shore  
Her flower, her piece of being, doomed dragon's food.

In Norman H. MacKenzie (ed.)  
*The Poetical Works of Gerard Manley Hopkins*  
 Andromeda, l. 1–4  
 Clarendon Press. Oxford, England. 1990

**Jacoby, Harold** 1865–1932  
 American astronomer

The stars are here marshalled before us in a new and engaging manner; not as austere unchanging beacons of the universe; not as mere material for vivifying the results of profound mathematical analysis; but rather as they must have seemed to the herdsmen of old, and as they should appear to all who love the open air – rising constellation after constellation, nature’s kindly reminders of the seasons as they come and go.

In Martha Evans Martin  
*The Friendly Stars*  
 Introductory Note  
 Harper & Brothers Publishers. New York, New York, USA. 1907

**Jeans, Sir James Hopwood** 1877–1946  
 English physicist and mathematician

The division of the stars into constellations tells us very little about the stars, but a great deal about the minds of the earliest civilizations and of the mediaeval astronomers.

*Physics and Philosophy*  
 Chapter II (p. 54)  
 Dover Publications. Mineola, New York, USA. 1981

### The Bible (King James Version)

Canst thou bind the sweet influences of the Pleiades, or loose the bands of Orion ?

*Job 38:31*

**Joyce, James** 1882–1941  
 Expatriate Irish writer and poet

...the appearance of a star (first magnitude) of exceeding brilliancy dominating by night and day (a new luminous sun generated by the collision and amalgamation in incandescence of two nonluminous exsuns) about the period of the birth of William Shakespeare over delta in the recumbent never setting constellation of Cassiopeia and of a star (second magnitude) of similar origin but of lesser brilliancy which had appeared in and disappeared from the constellation of the Corona Septentrionalis about the period of the birth of Leopold Bloom and of other stars of (presumably) similar origin which had (effectively or presumably) appeared in and disappeared from the constellation of Andromeda about the period of the birth of Stephen Dedalus, and in and from the constellation of Auriga some years after the birth and death of Rudolph Bloom, junior, and in and from other constellations some years before or after the birth or death of other persons...

*Ulysses* (p. 685)  
 Random House, Inc. New York, New York, USA. 1946

**Kirkup, James** 1923–  
 Poet and journalist

Slung between the homely poplars at the end of the familiar avenue, the Great Bear in its lighted hammock swings, like a neglected gate that neither bars admission nor invites, hangs on the sagging pole its seven-pointed shape.

*Omens of Disaster*  
 Collected Shorter Poems, Volume I, Ursa Major  
 University of Salzburg. Salzburg, Austria. 1996

**Longfellow, Henry Wadsworth** 1807–82  
 American poet

Begirt with many a blazing star,  
 Stood the great giant Algebar,  
 Orion, the hunter of the beast!

*The Poetical Works of Henry Wadsworth Longfellow*  
 The Occultation of Orion  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Manilius, Marcus** fl. 10 AD  
 Roman poet

First next the Twins, see great Orion rise,  
 His arms extended stretch o’er half the skies;  
 His stride as large, and with a steady pace  
 He marches on, and measures a vast space;  
 On each broad shoulder a bright star display’d,  
 And three obliquely grace his hanging blade.

In Elijah H. Burritt  
*The Geography of the Heavens*  
 Chapter III, Orion (p. 56)  
 Huntington & Savage, Mason & Law. New York, New York, USA. 1850

Near to Bootes the bright Crown is view’d  
 And shines with stars of different magnitude:  
 Or placed in front above the rest displays  
 A vigorous light, and dwarfs surprising rays.  
 This shone, since Theseus first his faith betray’d,  
 The monument of the forsaken maid.

In Elijah H. Burritt  
*The Geography of the Heavens* (p. 95)  
 Sheldon & Company. New York, New York, USA. 1873

And next Bootes comes, whose order’d beams  
 Present a figure driving of his teams.  
 Below his girdle, near his knees, he bears  
 The bright Arcturus, fairest of the stars.  
 In Elijah H. Burritt  
*The Geography of the Heavens*  
 Chapter VIII, Bootes (p. 97)  
 Huntington and Savage, Mason and Law. New York, New York, USA. 1850

First Aries, glorious in his golden wool,  
 Looks back and wonders at the mighty Bull.  
 In Mrs. Jesse B. Holman  
*The Zodiac, the Constellations and the Heavens* (p. 11)  
 Printed by E. L. Steck Co. Austin, Texas. 1924

Close by the Kneeling Bull behold  
 The Charioteer, who gained by skill of old

His name and heaven, as first his steeds he drove  
With flying wheels, seen and installed by Jove.

In Garrett P. Serviss  
*Astronomy with the Naked Eye*  
Chapter II (p. 20)  
Harper & Brothers Publishers. New York, New York, USA. 1908

Bright Scorpio, armed with poisonous tail, prepares  
Men's martial minds for violence and wars.  
His venom heats and boils their blood to rage  
And rapine spreads o'er the unlucky age.

In Garrett P. Serviss  
*Astronomy with the Naked Eye*  
Chapter VIII (p. 103)  
Harper & Brothers Publishers. New York, New York, USA. 1908

### Maunder, Walter Edward

No biographical data available

We stand out under the stars on some clear moonless  
night, and looking upward, though no forms are visible,  
though it is only here and there that the natural grouping  
can by the utmost legitimate effort of fancy be made to  
fit some preconceived shape, yet we still seem to see the  
whole vast dome covered with mysterious frescoes.

The Oldest Picture-Book of All  
*The Twentieth Century*, Volume XLVIII, September, 1900 (p. 451)

### Melville, Herman 1819–91

American novelist

Wondrous worlds on worlds! Lo, round and round me,  
awful spells: all glorious, vivid constellations, God's  
diadem ye are! To you, ye stars, man owes his subtlest  
raptures, thoughts unspeakable, yet full of faith.

*Mardi*  
Chapter LVIII  
The St. Botolph Society. Boston, Massachusetts, USA. 1923

### Noyes, Alfred 1880–1958

English poet

Night after night, among the gabled roofs,  
Climbing and creeping through a world unknown  
Save to the roosting stork, he learned to find  
The constellations, Cassiopeia's throne,  
The Plough still pointing to the Pole star,  
The Sword-belt of Orion. There he watched  
The movement of the planets, hours and hours,  
And wondered at the mystery of it all.

*The Torch-Bearers: Watchers of the Sky* (Volume 1)  
Tycho Brahe, I (p. 40)  
Frederick A. Stokes Company Publishers. New York, New York, USA.  
1922

### Ovid 43 BCE–17 AD

Roman poet

There is a place above, where Scorpio bent,  
In tail and arms surrounds a vast extent;  
In a wide circuit of the heavens he shines,

And fills the place of two celestial signs.

In Elijah H. Burritt  
*The Geography of the Heavens*  
Chapter IX, (p. 102)  
Sheldon & Company. New York, New York, USA. 1874

Midst golden stars he stands resplendent now,  
And thrusts the Scorpion with his bended bow.

In Garrett P. Serviss  
*Astronomy with the Naked Eye*  
Chapter IX (p. 113)  
Harper & Brothers Publishers. New York, New York, USA. 1908

### Payne-Gaposchkin, Cecilia 1900–79

British-American astronomer

The constellations carry us back to the dawn of astron-  
omy. They have been called the fossil remains of primi-  
tive stellar religion, and as such they have extraordinary  
interest.

*Introduction to Astronomy*  
Chapter I, Section 1 (p. 3)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

### Peltier, Leslie C. 1900–80

American comet hunter

No true star-gazer will fail to become familiar with the  
constellations and fortunate is he whose introduction to  
the skies comes to him through nature's eyes alone and  
not through any telescope.

*Starlight Nights*  
Chapter 6 (p. 39)  
Harper & Row, Publishers. New York, New York, USA. 1965

### Rilke, Ranier Maria 1875–1926

Czech-born German language poet and novelist

...who sets him in a constellation and puts the measur-  
ing-stick of distance in his hands?

*The Duino Elegies* (p. 25)  
Peter Pauper Press. Mount Vernon Press, New York, USA. 1957

### Sagan, Carl 1934–96

American astronomer and science writer

In the night sky, when the air is clear, there is a cosmic  
Rorschach test awaiting us. Thousands of stars, bright  
and faint, near and far, in a glittering variety of colors, are  
peppered across the canopy of night. The eye, irritated  
by randomness, seeking order, tends to organize into pat-  
terns these separate and distinct points of light.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 2 (p. 9)  
Dell Publishing, Inc. New York, New York, USA. 1975

### Smyth, William Henry 1788–1865

English admiral and scientific writer

...in fabricating new constellations, puerility and mean-  
ness aided blind zeal in ransacking the heavens for



*amorphotae*, or unformed stars, wherewith to wheedle accidental rulers of the hour, by exalting them and a heterogeneous assemblage of modern implements, among the heroes and classical symbols of remote ages.

*A Cycle of Celestial Objects* (Volume 1)  
Chapter V (p. 436)  
John W. Parker. London, England. 1844

...the recent consecrations of flattery, as *Scutum Sobieskii*, *Honores Frederici*, *Taurus Poniatowski*, *Cor Caroli*, *Robur Caroli*, *Sceptrum Brandenburgicum*, *Harpa Georgii*, and the like, together with every political, national, and worldly interested allusion, should be at once swept away. So also should be treated the *Sextant*, the *Printing press*, the *Painters easel*, the *Sculptor's apparatus*, the, the *Log and line* and other unnatural intrusions into the starry heavens, which, with all the pretensions of the moderns, are just as inapplicable as the grotesque chimeras of the ancients. Indeed, "it is to mythology," says Sir John Herschel, "and to classic antiquity that I should be disposed to retreat, as to a neutral ground, on which to escape from vexatious and interminable discussions on this head." The view is correct: those who would sweep away the constellations altogether as incongruous absurdities, or wicked pagan allusions, seem rather reckless about the consequences of such a measure on astronomical history, chronology, and extra-observatorial practice.

*A Cycle of Celestial Objects*  
Chapter V (p. 437)  
John W. Parker. London, England. 1844

**Statius, Publius** ca. 45–96  
Roman poet

Vast as the starry Serpent, that on high  
Tracks the clear ether, and divides the sky,  
And southward winding from the Northern Wain,  
Shoots to remoter spheres its glittering train.

In Elijah H. Burritt  
*The Geography of the Heavens*  
Chapter VIII, Serpens (p. 93)  
Huntington & Savage, Mason & Law. New York, New York, USA. 1850

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Many a night from yonder ivied casement, ere I went to rest,

Did I look on great Orion, sloping slowly to the west.  
*Alfred Tennyson's Poetical Works*  
Locksley Hall, Stanza 4  
Oxford University Press, Inc. London, England. 1953

**Thomson, James** 1700–48  
Scottish poet

And fierce Aquarius stains th' inverted year...  
*The Complete Poetical Works of James Thomson*  
Seasons, Winter  
H. Frowde. London, England. 1908

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Constellations have always been troublesome things to name. If you give one of them a fanciful name, it will always persist in not resembling the thing it has been named for.

*Following the Equator* (Volume 1)  
Chapter V (p. 75)  
Harper & Brothers Publishers. New York, New York, USA. 1899

**Watts, Isaac** 1674–1748  
English poet, theologian, and hymn writer

The Ram, the Bull, the Heavenly Twins,  
And next the Crab, the Lion shines,  
The Virgin and the Scales;  
The Scorpion, Archer, and Sea-goat,  
The Damsel with the Watering-pot,  
The Fish with glittering tails.

In Cecilia Payne-Gaposchkin  
*Introduction to Astronomy*  
Mnemonic for the zodiacal constellations (p. 74)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

All the old constellations had gone from the sky, however: that slow movement which is imperceptible in a hundred human lifetimes, had long since rearranged them in unfamiliar groupings.

*The Time Machine*  
Chapter VII (p. 94)  
Berkeley Publishing Corporation. New York, New York, USA. n.d.

**White, Henry Kirke** 1785–1806  
English poet

Orion in his Arctic tower...  
*The Poetical Works of Gray, Blair, Beattie, Collins, Thomson and Kirke*  
*White*  
Time  
Carey & Lea. Philadelphia, Pennsylvania, USA. 1830

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

The earth, that is sufficient,  
I do not want the constellations any nearer,  
I know they are very well where they are,  
I know they suffice for those who belong to them.

*Complete Poetry and Collected Prose*  
Song of the Open Road  
The Library of America. New York, New York, USA. 1982

**Young, Edward** 1683–1765  
English poet and dramatist

A Star His Dwelling pointed out below:  
Ye Pleiades! Arcturus! Mazaroth!  
And thou, Orion! of still keener Eye!



Say, ye, who guide the Wilder'd in the Waves,  
And bring them out of Tempest into Port!

*Night Thoughts*

Night IX, l. 1702–1706

Printed by R. Nobels for R. Edwards. London, England. 1797

## ANDROMEDA

**Keats, John** 1795–1821

English Romantic lyric poet

Andromeda! Sweet woman! Why delaying  
So timidly among the stars: come hither!  
Join this bright throng, and nimbly follow whither  
They all are going.

*The Complete Poetical Works and Letters of John Keats*

Endymion

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Kingsley, Charles** 1819–75

English clergyman and author

High for a star in the heavens, a sign and a hope for the  
seamen,

Spreading thy long white arms all night in the heights of  
the aether,

Hard by thy sire and the hero, thy spouse, while near thee  
thy mother

Sits in her ivory chair, as she plaits ambrosial tresses;

All night long thou wilt shine.

*Poems*

Andromeda

Ticknor & Fields. Boston, Massachusetts, USA. 1856

## ARCTURUS

**Teasdale, Sara** 1884–1933

American lyrical poet

When, in the gold October dusk, I saw you near to set-  
ting,

Arcturus, bringer of spring,

Lord of the summer nights, leaving us now in autumn,

Having no pity on our withering...

*The Collected Poems of Sara Teasdale*

Arcturus in Autumn (p. 87)

Collier Books. New York, New York, USA. 1966

## ARIES

**Longfellow, Henry Wadsworth** 1807–82

American poet

Now the zephyrs diminish the cold, and the year being  
ended,

Winter Maeotian seems longer than ever before;

And the Ram that bore unsafely the burden of Helle,

Now makes the hours of the day equal with those of the  
night.

*The Poetical Works of Henry Wadsworth Longfellow*

Ovid in Exile Tristia, Book III, Elegy XII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Spencer, Lilian White** 1876–1953

American poet and playwright

The Ram was once the golden fleece  
That bore Nephele's babes from Greece.

He died to honor Zeus. Then, he

Shone brighter than the brightest star

In Jason's dream: who wandered far

To bring his pelt to Thessaly.

Aries

*Popular Astronomy*, Volume 37, Number 4, April, 1929 (p. 209)

## BIG DIPPER

**Burroughs, John** 1837–1921

American naturalist and essayist

...if we could grasp the handle of the Big Dipper, we  
could dip up the heavens and all their shinning pebbles.

*The Heart of Burroughs's Journals*

Jan. 30, 1858 (p. 10)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

## CANCER

**Spencer, Lilian White** 1876–1953

American poet and playwright

This is the sky-crab, named of old,

Because here, so Chaldeans told,

The sun seemed to move backward. These

And other tales about him teem

Of mangers, hives, and gods. If dream

They are delightful fantasies.

Cancer

*Popular Astronomy*, Volume 37, Number 9, November, 1929 (p. 513)

## CANIS MAJOR

**Frost, Robert** 1874–1963

American poet

The great Overdog,

That heavenly beast

With a star in one eye,

Gives a leap in the east.

He dances upright

All the way to the west

And never once drops

On his forefeet to rest.

I'm a poor underdog,

But tonight I will bark

With the great Overdog

That romps through the dark.

*Complete Poems of Robert Frost*

Canis Major

Henry Holt & Company. New York, New York, USA. 1949

**CAPRICORNUS**

**Aratus** 271 BCE–213 BCE  
Greek statesman

Then blow the fearful south-winds, when the Goat  
With the sun rises; and then Jove's sharp cold,  
Still worse, besets the stiffening mariner.

In N.L. Frothingham

*Metrical Pieces*

The Appearances of the Stars (p. 33)

Crosby, Nichols. Boston, Massachusetts, USA. 1855

**Spencer, Lilian White** 1876–1953  
American poet and playwright

Once, as the gods were feasting while  
Sojourning by the river Nile  
Huge Typhon scared them. Off they ran  
And one dived eastward to escape:  
Since then he wears a sea-goat's shape  
Who really is the great go, Pan.

Capricornus

*Popular Astronomy*, Volume 37, Number 5, May, 1929 (p. 261)

**DRACO**

**Darwin, Erasmus** 1731–1802  
English physician and poet

With vast convolutions Draco holds  
Th' ecliptic axis in his scaly folds.  
O'er half the skies his neck enormous rears,  
And with immense meanders parts the Bears.

*The Botanic Garden*

Part I, Canto I, XI, l. 517

Jones & Company. London, England. 1825

**LIBRA**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

I hear the Scales, where hang in equipoise  
The night and day.

*The Poetical Works of Henry Wadsworth Longfellow*

The Poet's Calendar, September

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**LOST PLEIAD**

**Hemans, Felicia D.** 1793–1835  
English poet

And is there glory from the heavens departed?  
Oh! Void unmarked! –  
Thy sisters of the sky  
Still hold their place on high,

Though from its rank thine orb so long hath started,  
Thou, that no more art seen of mortal eye.

*The Complete Works of Mrs. Hemans* (Volume 1)

The Lost Pleiad

D. Appleton & Company. New York, New York, USA. 1868

**PLEIADES**

**Peirce, Benjamin** 1809–80  
American mathematician

The sweet influence of the Pleiades may be rejected as  
a baseless poetic myth, their supposed position at the  
centre of the stellar world may be a scientific error, the  
beauty of the constellation may be set aside as having  
slight intellectual significance; but the reality of the com-  
bination of at least five hundred stars into one close fam-  
ily is indisputable and absolutely independent of human  
recognition.

*Ideality in the Physical Sciences*

Lecture I (p. 24)

Little, Brown & Co. Boston, Massachusetts, USA. 1881

**ORION**

**Dickinson, Emily** 1830–86  
American lyric poet

Follow wise Orion  
Till you waste your eye –  
Dazzlingly decamping  
He is just as high –

*The Complete Poems of Emily Dickinson*

No. 1538 (p. 642)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Tennyson, Alfred (Lord)** 1809–92  
English poet

...those three stars of the airy Giants' zone  
That glitter burnished by the frosty dark.

*Alfred Tennyson's Poetical Works*

The Princess, V

Oxford University Press, Inc. London, England. 1953

**PISCES**

**Spencer, Lilian White** 1876–1953  
Poet and playwright

Two Fishes in the sky-deeps swim,  
Both elongated but quite dim  
Which seems to be a paradox:  
Because they lead the Zodiac,  
Are Famous in the almanac,  
And own the vernal equinox.

Pisces

*Popular Astronomy*, Volume 37, Number 4, April, 1929 (p. 198)

## PLEIADES

**Tabb, John Banister** 1845–1909  
American poet

“Who are ye with clustered light,  
Little Sisters seven?”  
“Crickets, chirping all the night  
On the hearth of heaven.”

In Francis A. Litz (ed.)  
*The Poetry of Father Tabb*  
Humorous Verse, The Pleiads  
Dodd, Mead. New York, New York, USA. 1928

## SAGITTARIUS

**Longfellow, Henry Wadsworth** 1807–82  
American poet

The Centaur, Sagittarius, am I,  
Born of Ixion and the cloud’s embrace:  
With sounding hoofs across the earth I fly,  
A steed Thessalian with a human face.

*The Poetical Works of Henry Wadsworth Longfellow*  
Poet’s Calendar, November  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

## SCORPIO

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Though on the frigid scorpion I ride,  
The dreamy air is full, and overflows  
With tender memories of the summer-tide  
And mingled voices of the doves and crows.

*The Poetical Works of Henry Wadsworth Longfellow*  
Poet’s Calendar, October  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Spencer, Lilian White** 1876–1953  
Poet and playwright

On summer’s south horizon, he  
Crawls in bright, baleful majesty:  
Antares is his old read heart,  
He slew Orion with his sting  
And since he did that horrid thing  
They circle heaven far apart.

Scorpio  
*Popular Astronomy*, Volume 37, Number 5, May, 1929 (p. 274)

## SOUTHERN CROSS

**Meredith, Owen (Edward Robert  
Bulwer-Lytton, First Earl Lytton)** 1831–91  
English statesman and poet

Then did I feel as one who, much perplexed,  
Led by strange legends and the light of stars

Over long regions of the midnight sand  
Beyond the red tract of the Pyramids,  
Is suddenly drawn to look upon the sky,  
From sense of unfamiliar light, and sees,  
Reveal’d against the constellated cope,  
The great cross of the South.

*The Poetical Works of Owen Meredith*  
Queen Guenevere  
American News Co. New York, New York, USA. 1905

**Twain, Mark (Samuel Langhorne  
Clemens)** 1835–1910  
American author and humorist

We saw the Cross tonight, and it is not large. Not large,  
and not strikingly bright. But it was low down toward  
the horizon, and it may improve when it gets up higher  
in the sky. It is ingeniously named, for it looks just as a  
cross would look if it looked like something else. But that  
description does not describe; it is too vague, too general,  
too indefinite. It does after a fashion suggest a cross – a  
cross that is out of repair – or out of drawing; not cor-  
rectly shaped. It is long, with a short cross-bar, and the  
cross-bar is canted out of the straight line.

It consists of four large stars and one little one. The little  
one is out of line and further damages the shape. It should  
have been placed at the intersection of the stem and the  
cross-bar. If you do not draw an imaginary line from star  
to star it does not suggest a cross – nor anything in par-  
ticular.

One must ignore the little star, and leave it out of the  
combination – it confuses everything. If you leave it out,  
then you can make out of the four stars a sort of cross –  
out of true; or a sort of kite – out of true; or a sort of  
coffin – out of true.

*Following the Equator* (Volume 1)  
Chapter V (p. 75)  
Harper & Brothers Publishers. New York, New York, USA. 1899

## VIRGO

**Longfellow, Henry Wadsworth** 1807–82  
American poet

I am the Virgin, and my vestal flame  
Burns less intensely than the Lion’s rage;  
Sheaves are my only garments, and I claim  
A golden harvest as my heritage.

*The Poetical Works of Henry Wadsworth Longfellow*  
Poet’s Calendar, August  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

## CONSTRUCT

**Feuer, Michael J.**  
No biographical data available

**Towne, Lisa**  
No biographical data available

The development of common constructs can also contribute to a cohesive knowledge core and further enhance theoretical understanding.

Scientific Culture and Educational Research  
*Educational Researcher*, Volume 31, 2002 (p. 11)

## CONSTRUCTION

**Kipling, Rudyard** 1865–1936

British writer and poet

After me cometh a Builder. Tell him, I too have known.  
When I was King and a Mason - a Master proven and skilled -

I cleared me ground for a Palace such as a King should build.

I decreed and dug down to my levels. Presently, under the silt,

I came on the wreck of a Palace such as a King had built...

...

Swift to my use in my trenches, where my well-planned ground-works grew,

I tumbled his quoins and his ashlar, and cut and reset them anew.

Lime I milled of his marbles; burned it, slacked it, and spread;

Taking and leaving at pleasure the gifts of the humble dead.

Yet I despised not nor gloried; yet as we wrenched them apart,

I read in the razed foundation the heart of that builder's heart.

As he had risen and pleaded, so did I understand

The form of the dream he had followed in the face of the thing he had planned.

*Collected Verse of Rudyard Kipling*

The Palace (pp. 257–258)

Doubleday, Page & Company. Garden City, New York, USA. 1915

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The pleasure in planned construction is one of the most powerful motives in men who combine intelligence with energy; whatever can be constructed according to a plan, such men will endeavor to construct.

*The Scientific Outlook*

Chapter XII (p. 211)

George Allen & Unwin. London, England. 1931

## CONSULTANT

**Grindal, Bruce** 1940–

American anthropologist

**Salamone, Frank**

American anthropologist

In the past twenty years, “doing” anthropology has become more and more complex. In the days when we traveled long distances to far-off places, our fieldwork stayed in the field. Now, the distances have been narrowed. Informants have become consultants. Consultants are our friends. As such, they can board a plane in their land and come to visit, spending long nights in earnest conversation about truth and meaning and enlightenment and expectations. In the days when we wrote only inscrutable manuscripts circulated among colleagues, there was no one to dispute the validity of our work except another “expert” in the area. Now, our consultant-friends are critics, editors of our written words, commentators of their lives, and ours.

*Bridges to Humanity: Narrative on Anthropology and Friendship*

The Reflecting Pool (p. 193)

Waveland Press, Inc. Prospect Heights, Illinois, USA. 1995

## CONSULTATION

**Halle, John**

No biographical data available

When thou arte callde at anye time,  
A patient to see;

And doste perceave the cure too grate,  
And ponderous for thee:

See that thou laye disdeyne aside,  
And pride of thyne owne skyll:

And thinke no shame counsell to take,  
But rather wyth good wyll.

Gette one or two of experte men,  
To helpe thee in that nede;

And make them partakers wyth thee,  
In that worke to procede.

In Mary Lou McDonough

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*

Goodly Doctrine and Instruction (p. 11)

C.C. Thomas. Springfield, Illinois, USA. 1945

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Now when a doctor's patients are perplexed,

A Consultation comes in order next –

You know what that is? In certain a certain place

Meet certain doctors to discuss a case

And other matters, such as weather, crops,

Potatoes, Pumpkins, lager-beer, and hops.

For what's the use! – there's little to be said,

Nine times in ten your man's as good as dead;

At best a talk (the secret to disclose)

Where three men guess and sometimes one man knows.

*The Complete Poetical Works of Oliver Wendell Holmes*

Rip van Winkle, M.D., Canto Second

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

## CONTAGION

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Will he steal out of his wholesome bed,

To dare the vile contagion of the night?

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*Julius Caesar*  
Act II, Scene i, l. 264–265  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CONTEMPLATION

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

In reflecting upon the different degrees of enjoyment presented to us in the contemplation of Nature, we find that the first place must be assigned to a sensation which is wholly independent of an intimate acquaintance with the physical phenomena presented to our view, or of the peculiar character of the region surrounding us. In the uniform plain bounded only by a distant horizon, where the lowly heather, the cistus, or waving grasses deck the soil; on the ocean shore, where the waves, softly rippling over the beach, leave a track, green with the weeds of the sea; everywhere, the mind is penetrated by the same sense of the grandeur and vast expanse of Nature, revealing to the soul, by a mysterious inspiration, the existence of laws that regulate the forces of the universe.

Translated by E.C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 25)  
D. Appleton & Co. New York, New York, USA. 1850

The mere accumulation of unconnected observations of details, devoid of generalization of ideas, may doubtlessly have tended to create and foster the deeply rooted prejudice, that the study of the exact sciences must necessarily chill the feelings, and diminish the nobler enjoyments attendant upon a contemplation of nature.

Translated by E. C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 40)  
Harper & Brothers Publishers. New York, New York, USA. 1858

## CONTINENT

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

First-born among the Continents, though so much later in culture and civilization than some of more recent birth, America, so far as her physical history is concerned, has been falsely denominated the New World. Hers was the first dry land lifted out of the waters, hers the first shore

washed by the ocean that enveloped all the earth beside; and while Europe was represented only by islands rising here and there above the sea, America already stretched an unbroken line of land from Nova Scotia to the Far West.

*Geological Structures*  
Chapter I (p. 1)  
Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Ewing, Maurice** 1906–74  
American geophysicist and oceanographer

**Landisman, Mark**  
No biographical data available

We shall take as a starting point the familiar idea that the continents are blocks of low-density sialic rock, remarkably uniform in thickness and other properties, which are in isostatic or floating equilibrium on a heavier substratum, the sima.

In Mary Sears  
*Oceanography; Invited Lectures Presented at the International Oceanographic Congress Held in New York, 31 August-12 September, 1959*  
Shape and Structure of Ocean Basins (p. 3)  
American Association for the Advancement of Science. Washington, D.C. 1961

**Geikie, Sir Archibald** 1835–1924  
English geologist

It is the fate of continents, no less than of the human communities that inhabit them, to have their first origin shrouded in obscurity.

*Geological Sketches at Home and Abroad*  
Chapter XIII (p. 295)  
The Macmillan Co. New York, New York, USA. 1892

**Huntington, Ellsworth** 1876–1947  
American explorer and geographer

America forms the longest and straightest bone in the earth's skeleton.

*The Red Man's Continent Chronicle of Aboriginal America*  
Chapter II (p. 36)  
Yale University Press. New Haven, Connecticut, USA. 1920

**Keith, Arthur**  
Geologist

...I can see only an individuality of the continent, its unity, and also its permanence of environment, and I see nothing of the haphazard arrangement which must have followed the random course of a continent floating like a waif on a sea of sial.

Structural Symmetry in North America  
*Bulletin of the Geological Society of America*, Volume 39 1928 (p. 372)

**Suess, Eduard** 1831–1914  
Austrian geologist

If we imagine an observer to approach our planet from outer space, and, pushing aside the belts of red-brown clouds which obscure our atmosphere, to gaze for a

whole day on the surface of the earth as it rotates beneath him, the feature beyond all others most likely to arrest his attention would be the wedge-like outlines of the continents as they narrow away to the South.

This is indeed the most striking character presented by our map of the world, and has been so regarded ever since the chief features of our planet have become known to us.

*The Face of the Earth* (Volume 2)

Introduction (p. 1)

At The Clarendon Press. Oxford, England. 1906

**Willis, Bailey** 1857–1949

American geologist

Once a continent, always a continent; once an ocean, always an ocean.

In Naomi Oreskes

*The Rejection of Continental Drift: Theory and Method in American Earth Science*

Chapter 2 (p. 48)

Oxford University Press, Inc. New York, New York, USA. 1999

## CONTINENTAL DRIFT

**Chamberlain, Rollin T.**

American geologist

Can we call geology a science when there exists such a difference of opinion on fundamental matters as to make it possible for such a theory as this to run wild.

In W.A.J.M. Waterschoot van der Gracht et al.(eds.)

*Theory of Continental Drift: A Symposium on the Origin and Movement of Land Masses...*

Some of the Objections to Wegener's Theory (p. 83)

The American Association of Petroleum Geologists, Tulsa, Oklahoma, USA. 1928

**du Toit, Alex L.** 1878–1948

South African geologist

[The geologist] will have to leave behind him – perhaps reluctantly – the dumbfounding spectacle of the present continental masses, firmly anchored to a plastic foundation yet remaining fixed in space; set thousands of kilometers apart, it may be, yet behaving in almost identical fashion from epoch to epoch and stage to stage like soldiers at drill; widely stretched in some quarters at various times and astoundingly compressed in others, yet retaining their general shapes, positions and orientations; remote from one another throughout history, yet showing in their fossil remains common or allied forms of terrestrial life; possessed during certain epochs of climates that may have ranged from glacial to torrid or pluvial to arid, though contrary to meteorological principles when their existing geographic positions are considered – to mention but a few such paradoxes.

*Our Wandering Continents: An Hypothesis of Continental Drift*

Chapter I (p. 3)

Hafner Publishing Company. New York, New York, USA. 1957

**King, Lester C.**

No biographical data available

The driftist is no more obligated to adduce a mechanism to prove the fact of drift than the user of an electric appliance is obligated to define the nature and mechanism of electricity.

*Proceedings of the Geological Society of London*, 1957 (p. 79)

**Lake, Philip**

No biographical data available

A moving continent is as strange to us as a moving earth was to our ancestors, and we may be as prejudiced as they were. On the other hand, if continents have moved many former difficulties disappear, and we may be tempted to forget the difficulties of the theory itself and the imperfection of the evidence.

Wagner's Displacement Theory

*Geological Magazine*, Volume 59, Number 8, August, 1922 (p. 338)

**Termier, Pierre** 1859–1930

French geologist

A sound almost imperceptible, so slight, so little different from silence itself, of continents *en marche*, which slowly, oh very slowly, as great pontoons floating on the calm waters of a port, or as great icebergs borne by the polar currents, are drifting towards the equator.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1924

The Drifting of the Continents (p. 219)

Government Printing Office. Washington, D.C. 1925

The theory of [Alfred] Wegener is to me a beautiful dream, the dream of a great poet. One tries to embrace it and finds that he has in his arms but a little vapor or smoke; it is at the same time alluring and intangible.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1924

The Drifting of the Continents (p. 236)

Government Printing Office. Washington, D.C. 1925

**Wegener, Alfred** 1880–1930

German climatologist and geophysicist

The first concept of continental drift first came to me as far back as 1910, when considering the map of the world, under the direct impression produced by the congruence of the coastlines on either side of the Atlantic. At first I did not pay attention to the idea because I regarded it as improbable.

Translated by John Biram

*The Origin of Continents and Oceans*

Chapter 1 (p. 1)

Dover Publications, Inc. New York, New York, USA. 1966

We shall refrain here from citing the literature in support of our statements. The obvious needs no backing by outside opinion, and the willfully blind cannot be helped by any means. As far as we are concerned, it is not now a question of whether the continental blocks have moved; doubt is no longer possible.



Translated by John Biram  
*The Origin of Continents and Oceans*  
 Chapter 7 (p. 133)  
 Dover Publications, Inc. New York, New York, USA. 1966

**Wilson, John Tuzo** 1908–93  
 Canadian geologist and geophysicist

If the continents have moved, then they have drifted like rafts and formed the ocean floors in their wake. It is to this wake that we should look first.

In P. M.S. Blackett, E.C. Bullard and S.K. Runcorn  
 A Symposium on Continental Drift  
*Philosophical Transactions of the Royal Society of London, Series A,*  
 Volume 258, 1964

## CONTINUITY

**Fort, Charles** 1874–1932  
 American writer

In Continuity, it is impossible to distinguish phenomena at their merging-points, so we look for them at their extremes. Impossible to distinguish between animal and vegetable in some infusoria – but hippopotamus and violet. For all practical purposes they're distinguishable enough.

*The Book of the Damned*  
 Chapter III (p. 30)  
 Boni & Liveright. New York, New York, USA. 1919

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

Calculus required continuity, and continuity was supposed to require the infinitely little; but nobody could discover what the infinitely little might be.

*Mysticism and Logic: And Other Essays*  
 Chapter V (p. 82)  
 Longmans, Green & Co. London, England. 1919

**Sylvester, James Joseph** 1814–97  
 English mathematician

Geometry formerly was the chief borrower from arithmetic and algebra, but it has since repaid its obligation with abundant usury; and if I were asked to name, in one word, the pole-star round which the mathematical firmament revolves, the central idea which pervades as a hidden spirit the whole corpus of mathematical doctrine, I should point to Continuity as contained in our notions of space, and say, it is this, it is this!

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
 Presidential Address to the British Association (p. 659)  
 University Press. Cambridge, England. 1904–1912

## CONTINUUM

**Wheeler, John Archibald** 1911–  
 American theoretical physicist and educator

For the advancing army of physics, battling for many a decade with heat and sound, fields and particles, gravitation and spacetime geometry, the cavalry of mathematics, galloping out ahead, provided what it thought to be the rationale for the natural number system. Encounter with the quantum has taught us, however, that we acquire our knowledge in bits; that the continuum is forever beyond our reach. Yet for daily work the concept of the continuum has been and will continue to be as indispensable for physics as it is for mathematics.

Hermann Weyl and the Unity of Knowledge  
*American Scientist*, Volume 74, July–August, 1986 (p. 374)

## CONTRACEPTIVE

**Allen, Woody** 1935–  
 American film director and actor

A fast word about oral contraception. I asked a girl to go to bed with me and she said “no.”

*Woody Allen Volume Two*  
 Colpix Cp. 488 (side 4, band 6)

**Chatton, Milton J.**  
 No biographical data available

Jack told Jill to take her pill  
 With a glass of water.

Jill forgot, and Jack begot  
 A bouncing baby daughter.

A bouncing baby daughter  
*Quotable Quotes*, March 13, 1966 (p. 16)

**Glasser, Allen**  
 No biographical data available

When a patient asked which sulfa compounds make the safest contraceptives, his doctor replied: “Sulfa-denial and sulfa-control!”

*Quote, the Weekly Digest*, May 7, 1967 (p. 377)

**Sharpe, Tom** 1928–  
 English satirical author

Skullion had little use for contraceptives at the best of times. Unnatural, he called them, and placed them in the lower social category of things along with elastic-sided boots and made-up bow-ties. Not the sort of attire for a gentleman.

*Porterhouse Blue*  
 Chapter 9 (p. 96)  
 Secker & Warburg. London, England. 1974

## CONTRACTION

**Fowler, Richard** 1765–1863  
 Physician

He one day observed, that some frogs, hooked by the spine of the back, and suspended from the iron palisades,

which surrounded his garden, contracted frequently and involuntarily. Examining minutely into the cause of these contractions, he found that he could produce them at pleasure, by touching the animals with two different metals, at the same time in contact with each other.

*Experiments and Observations Relative to the Influence Lately Discovered by M. Galvani*

Section I (p. 3)

Printed for T. Duncan, P. Hill, Robertson & Berry, and G. Murdie. Edinburgh, Scotland. 1793

## CONTRADICT

### Herschel, Friedrich Wilhelm

**(Sir William)** 1738–1822

English astronomer

As observations, carefully made, should always take the load of theories, I shall not be concerned if what I have to say contradicts what has been said in my last paper.

On the Satellites of the Planet Saturn and the Rotation of its Ring on an Axis  
*Philosophical Transactions of the Royal Society of London*,  
Volume 80, 1790 (p. 479)

## CONTRADICTION

### Hofstadter, Douglas R.

1945–

American academic

...to confront the apparent contradiction head-on, to savor it, to turn it over, to take it apart, to wallow in it, so that in the end the reader may gain new insights into the seemingly unbridgeable gulf between the formal and the informal, the animate and the inanimate, the flexible and the inflexible.

*Gödel, Escher, Bach: an Eternal Golden Braid* (p. 26)

Basic Books, Inc. New York, New York, USA. 1979

### Schrödinger, Erwin

1887–1961

Austrian theoretical physicist

Like Cervantes' tale of Sancho Panza, who loses his donkey in one chapter but a few chapters later, thanks to the forgetfulness of the author, is riding the dear little animal again, our story has contradictions.

What is Matter?

*Scientific American*, Volume 189, Number 3, September, 1953 (p. 52)

## CONTROL

### Nabokov, Vladimir Vladimirovich

1899–1977

Russian-born American novelist

What can be controlled is never completely real; what is real can never be completely controlled.

In Ilya Prigogine

*The End of Certainty: Time, Chaos, and the New Laws of Nature* (p. 154)  
The Free Press. New York, New York, USA. 1997

## CONTROVERSY

### Huxley, Thomas Henry

1825–95

English biologist

It is an evil, in so far as controversy always tends to degenerate into quarrelling, to swerve from the great issue of what is right and what is wrong to the very small question of who is right and who is wrong.

*Collected Essays*

Prologue (p. 2)

D. Appleton & Co. New York, New York, USA. 1900

...few literary dishes are less appetising than cold controversy; moreover, there is an air of unfairness about the presentation of only one side of a discussion, and a flavour of unkindness in the reproduction of "winged words," which, however appropriate at the time of their utterance, would find a still more appropriate place in oblivion.

*Collected Essays*

Prologue (p. 2)

D. Appleton & Co. New York, New York, USA. 1900

## CONUNDRUM

### Ramsay, Sir William

1852–1916

English chemist

The solving of conundrums has for many people a great attraction: Nature surrounds us with conundrums, and it is one of the greatest pleasures in life to attempt their solution.

*Essays Biographical and Chemical*

Chemical Essays

The Aurora Borealis (p. 225)

Archibald Constable & Company Ltd. London, England. 1908

## CONVALESCENCE

### Lamb, Charles

1775–1834

English essayist and critic

How convalescence shrinks a man back to his pristine stature! where is now the space, which he occupied so lately, in his own, in the family's eye?

*Essays of Elia*

The Last Essays of Elia, The Convalescent (pp. 332–333)

Henry Altemus. Philadelphia, Pennsylvania, USA. 1893

### Shaw, George Bernard

1856–1950

Irish comic dramatist and literary critic

I enjoy convalescence. It is the part that makes the illness worthwhile.

*Back to Methuselah*

Part II, XXXIII (p. 59)

Constable & Company Ltd. London, England. 1921

## CONVERSATION

**Broderip, William John** 1789–1859  
English naturalist

...his sparkling conversation flowed continually, and without effort, like an exuberant Artesian well. There was no straining for effect: all was easy ...

*Zoological Recreations*

Preface (p. 9)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1849

## CONVICTION

**Darwin, Charles Robert** 1809–82  
English naturalist

I could not employ my life better than in adding a little to Natural Science. This I have done to the best of my abilities, and critics may say what they like, but they cannot destroy this conviction.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 73)

D. Appleton & Company. New York, New York, USA. 1896

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

I cannot give any scientist of any age better advice than this: the intensity of the conviction that a hypothesis is true has no bearing on whether it is true or not. The importance of the strength of our conviction is only to provide a proportionately strong incentive to find out if the hypothesis will stand up to critical evaluation.

*Advice to a Young Scientist*

Chapter 6 (p. 39)

Basic Books, Inc. New York, New York, USA. 1979

**Robinson, James Harvey** 1863–1936  
American historian and educator

Few of us take the pains to study the origins of cherished convictions.... We like to continue to believe what we have been accustomed to accept as true, and the resentment aroused when doubt is cast upon any of our assumptions leads us to seek every manner of excuse for clinging to them.

*The Mind in the Making*

Chapter II (p. 41)

Harper & Brothers Publishers. New York, New York, USA. 1921

## COORDINATE AXES

**Berlinski, David** 1942–  
American mathematician

Like two lost and lonely railroad tracks, the coordinate axes stretch to the north and to the south and to the past and to the future.

*A Tour of the Calculus*

Chapter 10 (p. 61)

Pantheon Books. New York, New York, USA. 1995

## COPERNICAN DOCTRINE

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

In order to suppress the Copernican doctrine, it would be necessary not only to prohibit the book of Copernicus and the writings of authors who agree with him, but to interdict the whole science of astronomy, and even to forbid men to look at the sky lest they might see Mars and Venus at very varying distances from the earth, and discover Venus at one time crescent, at another time round, or make other observations irreconcilable with the Ptolemaic system.

In Arthur Mee and J.A. Hammerton (Eds.)

*The World's Greatest Books* (Volume 13)

*The Authority of Scripture in Philosophical Controversies*

Section II

Scripture and Experimental Truth (p. 134)

W.H. Wise. New York, New York, USA. 1910

## COPERNICAN SYSTEM

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

I have known, too, for a long time, that we have no arguments for the Copernican system, but I shall never dare to be the first to attack it. Don't rush into the wasps' nest. You will but bring upon yourself the scorn of the thoughtless multitude. If once a famous astronomer arises against the present conception, I will communicate, too, my observations, but to come forth as the first against opinions, which the world has become fond of, I don't feel the courage.

Quoted in August Tischner

*The Fixed Idea of Astronomical Theory* (p. 33)

Gustav Fock. Leipzig, Germany. 1885

## COPERNICUS

**Bürigel, Bruno Hans** 1875–1948  
German astronomer

...Nicholas Copernicus...cast the earth from its central pivot and reduced it to but a star among stars, to an infinitesimal drop in the ocean of the worlds, whose glistening waves play on the shoreless infinite.

Translated by Stella Bloch

*Astronomy for All*

Chapter I (p. 2)

Cassell & Co., Ltd. London, England. 1911

## CORAL GARDEN

**Maury, Matthew Fontaine** 1806–73  
American astronomer, astrophysicist, historian, and oceanographer

To look down upon such a scene [a coral garden] in the great bosom of the ocean is like gazing upon the splendors of fairyland itself.

*Physical Geography*  
Part II, Section IV (p. 41)  
University Publishing Co. New York, New York, USA. 1894

## CORONA

**Newcomb, Simon** 1835–1909  
Canadian-American astronomer

...the corona is not a mass of foggy or milky light... but has a hairy structure, like long tufts of flax.... Of this appendage we may say with entire confidence that it cannot be an atmosphere...that is, a continuous mass of elastic gas held up by its own elasticity.... What, then, is the corona? Probably detached particles partially or wholly vaporized by the intense heat to which they are exposed.... The difficult question which we meet is, How are these particles held up? To this question only conjectural replies can be given.

*Popular Astronomy*  
Part III, Chapter II (pp. 263, 265, 266)  
Harper & Brothers Publishers. New York, New York, USA. 1884

**Young, Charles Augustus** 1834–1908  
American astronomer

I do not know what to make of the corona.... [B]y what forces the peculiar radiated structure of the corona is determined, I have no definite idea. The analogies of comets' tails and auroral streamers both appear suggestive; but, on the other hand, the spectra of the corona, the aurora borealis, the comets, and the nebulae are all different – no two in the least alike.

In Simon Newcomb  
*Popular Astronomy*  
Part III, Chapter II (p. 284)  
Harper & Brothers Publishers. New York, New York, USA. 1884

## CORRELATION

**Aron, Raymond** 1905–83  
French sociologist and historian

There is no correlation between the cause and the effect. The events reveal only an aleatory determination, connected not so much with the imperfection of our knowledge as with the structure of the human world.

*The Opium of the Intellectuals*  
Chapter VI (p. 163)  
Secker & Warburg. London, England. 1957

## Author undetermined

The quantity of the correlation is inversely proportional to the density of the control (the fewer the facts, the smoother the curves).

Source undetermined

**Balchin, Nigel** 1908–70  
English novelist

“You know those penetration figures?”  
“Mm.”

“Well, there’s a positive correlation between penetration and the height of the man firing.”

“Easy,” I said. “The taller the man, the more rarefied the atmosphere and the less the air resistance.”

*The Small Back Room* (p. 8)  
Collins. London, England. 1943

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“Very true,” said the Duchess: “flamingos and mustard both bite. And the moral of that “Birds of a feather flock together.”

“Only mustard isn’t a bird.” Alice remarked.

“Right as usual,” said the Duchess: “what a clear way you have of putting things!”

*The Complete Works of Lewis Carroll*  
*Alice’s Adventures in Wonderland*  
Chapter IX (p. 97)  
The Modern Library. New York, New York, USA. 1936

**Cook, Robin**  
American author

Reading the twenty-sixth chart, one correlation suddenly occurred to Jason. Although the patients did not share physical symptoms, their charts showed a predominance of high-risk social habits. They were overweight, smoked heavily, used drugs, drank too much, and failed to exercise, or combined any and all of these unhealthy practices; they were men and women who were eventually destined to have severe medical problems. The shaking fact was that they deteriorated so quickly. And why the sudden upswing in deaths. People weren’t indulging in vices more than they were a year ago. Maybe it was a kind of statistical equalizing. They’d been lucky and now the numbers were catching up to them.

*Mortal Fear*  
Chapter 11 (p. 220)  
G.P. Putnam’s Sons. New York, New York, USA. 1988

**Cronbach, L. J.** 1916–2001  
American educational psychologist

The well-known virtue of the experimental method is that it brings situational variables under tight control. It thus permits rigorous tests of hypotheses and confidential

statements about causation. The correlational method, for its part, can study what man has not learned to control. Nature has been experimenting since the beginning of time, with a boldness and complexity far beyond the resources of science. The correlator's mission is to observe and organize the data of nature's experiments.

The Two Disciplines of Scientific Psychology

*The American Psychologist*, Volume 12, November, 1957 (p. 672)

### Dickson, Paul

American freelance writer

Hall's Law. There is a statistical correlation between the number of initials in an Englishman's name and his social class (the upper class having significantly more than three names, while members of the lower class average 2.6).

*The Official Rules* (p. H-80)

Delacorte Press. New York, New York, USA. 1978

### Pearson, Karl 1857–1936

English mathematician

Biological phenomena in their numerous phases, economic and social, were seen to be only differentiated from the physical by the intensity of their correlations. The idea Galton placed before himself was to represent by a single quantity the degree of relationships, or of partial causality between the different variables of our ever-changing universe.

*The Life, Letters, and Labours of Francis Galton* (Volume 3a)

Chapter XIV (p. 2)

Cambridge University Press. Cambridge, England. 1914–1930

### Soddy, Frederick 1877–1956

English chemist

One of the main duties of science is the correlation of phenomena, apparently disconnected and even contradictory.

*The Interpretation of Radium and the Structure of the Atom* (4th edition)

Part I, Chapter I (p. 1)

G.P. Putnam's Sons. New York, New York, USA. 1920

## COSMIC BALANCE

### Tesla, Nikola 1856–1943

Austrian-born Serbian American physicist and inventor

Every living being is an engine geared to the wheelwork of the universe. Though seemingly affected only by its immediate surroundings, the sphere of external influence extends to infinite distance. There is no constellation or nebula, no sun or planet, in all the depths of limitless space, no passing wander of the starry heavens, that does not exercise some control over its destiny – not in the vague and delusive sense of astrology, but in the rigid and positive meaning of physical science. More than this can be said. There is nothing endowed with life – from man,

who is enslaving the elements, to the humblest creature – in all this world that does not sway it in turn. Whenever action is born from force, though it be infinitesimal, the cosmic balance is upset and universal motion results.

How Cosmic Forces Shape Our Destiny

*New York American*, February 7, 1915

## COSMIC EVOLUTION

### Chaisson, Eric J. 1946–

American astrophysicist

Put bluntly yet magnanimously, the scenario of cosmic evolution grants us unparalleled “big thinking,” from which may well emerge the global ethics and planetary citizenship likely needed if our species is to remain part of that same cosmic evolutionary scenario.

*Cosmic Evolution: The Rise of Complexity in Nature*

Epilogue (p. 224)

Harvard University Press. Cambridge, Massachusetts, USA. 2001

## COSMIC RAY

### Hess, Viktor 1887–1961

German physicist

The results of my observations are best explained by the assumption that a radiation of very great penetrating power enters our atmosphere from above...

In Walter J. Moore

*Schrodinger: Life and Thought*

Chapter 2 (p. 67)

Cambridge University Press. Cambridge, England. 1989

### Lund, Niels 1938–

Danish physicist

Most of this [cosmic ray] landscape is still hidden from our view by heavy clouds, but even so, simple physical arguments can help us to draw the boundaries around what may ultimately be the full extent of the region.

In Maurice Mandel Shapiro

*Cosmic Radiation in Contemporary Astrophysics*

*Cosmic Ray Abundances, Elemental and Isotopic* (p. 1)

Proceedings of the NATO Advanced Study Institute on Cosmic Radiation in Contemporary Astrophysics

Sicily, Italy. 1984

### Powell, Cecil 1903–69

English physicist

Coming out of space and incident on the high atmosphere, there is a thin rain of charged particles known as the primary cosmic radiation.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1950

The Cosmic Radiation (p. 144)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

### Rossi, Bruno 1905–93

Italian-American experimental physicist

The earth is under a ceaseless rain of particles from space. These cosmic rays, our only material contact with the vast universe outside our planetary system, have excited wonder and eager study ...

Where Do Cosmic Rays Come From?

*Scientific American*, Volume 189, Number 3, September, 1953 (p. 64)

**Shapley, Harlow** 1885–1972

American astronomer

It is high time that astronomers do something about cosmic rays. The physicist now do practically all of the observing and thinking in this area ...

Astronomy

*Scientific American*, Volume 183, Number 3, September, 1950 (p. 25)

## COSMIC VAPOR

**Huxley, Thomas Henry** 1825–95

English biologist

That proposition is, that the whole world, living and not living, is the result of the mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed. If this be true, it is no less certain that the existing world lay, potentially, in the cosmic vapour; and that a sufficient intelligence could, from a knowledge of the properties of the molecules of that vapour, have predicted, say the state of the Fauna of Britain in 1869, with as much certainty as one can say what will happen to the vapour of the breath in a cold winter's day.

*Critiques and Addresses*

The Geanology of Animals (pp. 305–306)

Macmillan & Company Ltd. London, England. 1873

## COSMOCHEMISTRY

**Fuller, R. Buckminster** 1895–1983

American engineer and architect

Universe has no pollution.

All the chemistries of the Universe are essential

To its comprehensive self regulation.

In John S. Lewis

*Physics and Chemistry of the Solar System*

Chapter II (p. 43)

Academic Press. San Diego, California, USA. 1995

**Marcet, Mrs. (Jane Haldimand)** 1769–1858

English expository author in chemistry, botany, religion, and economics

Nature also has her laboratory, which is the universe, and there she is incessantly employed in chemical operations.

*Conversations on Chemistry, in Which the Elements of that Science Are Familiarly Explained and Illustrated by Experiments* (Volume 1)

Conversation I (p. 2)

Sidney's Press for Cooke. New Haven, Connecticut, USA. 1809

## COSMOGONIST

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The cosmogonist has finished his task when he has described to the best of his ability the inevitable sequence of changes which constitute the history of the material universe. But the picture which he draws opens questions of the widest interest not only to science, but also to humanity. What is the significance of the vast processes it portrays? What is the meaning, if any there be which is intelligible to us, of the vast accumulations of matter which appear, on our present interpretations of space and time, to have been created only in order that they may destroy themselves?

*Astronomy and Cosmogony*

Chapter XVII (p. 422)

Dover Publications, Inc. New York, New York, USA. 1961

## COSMOGONY

**Bridgman, Percy Williams** 1882–1961

American physicist

...the most striking thing about cosmogony is the perfectly hair raising extrapolations which it is necessary to make. We have to extend the times of the order of 1013 years and distances of the order of 109 light years [regarding] laws which have been checked in a range of not more than  $3 \times 10^2$  years, and certainly in distances not greater than the distance which the solar system has traveled in that time, or about  $4 \times 10^{-2}$  light years. It seems to me that one cannot take such extrapolations seriously unless one subscribes to a metaphysics that claims that laws of the necessary mathematical precision *really* control the actual physical universe.

*The Nature of Physical Theory*

Chapter VIII (p. 109)

Princeton University Press. Princeton, New Jersey, USA. 1936

**Kant, Immanuel** 1724–1804

German philosopher

I have chosen a subject which is capable of exciting an unfavorable prejudice in a great number of my readers at the very outset, both on account of its own intrinsic difficulty, and also from the way they may regard it from the point of view of religion. To discover the system which binds together the great members of the creation in the whole extent of infinitude, and to derive the formation of the heavenly bodies themselves, and the origin of their movements, from the primitive state of nature by mechanical laws, seems to go far beyond the power of human reason.

Translated by W. Hastie

*Kant's Cosmogony*



Preface (p. 17)

James Maclehose & Sons. Glasgow, Scotland. 1900

**Lemaître, Abbé Georges** 1894–1966  
Belgian astronomer and cosmologist

Cosmogony is atomic physics on a large scale – large scale of space and time – why not large scale of atomic weight?

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 705)

The purpose of any cosmogonic theory is to seek out ideally simple conditions which could have initiated the world from which, by the play of recognized physical forces, that world, in all its complexity, may have resulted.

*The Primeval Atom*

Chapter V (p. 162)

D. van Nostrand Company, Inc. New York, New York, USA. 1950

**Peirce, Benjamin** 1809–80  
American mathematician

So long as a scientific doubt remains, the story of cosmogony is partially untold.

*Ideality in the Physical Sciences*

Lecture II (p. 38)

Little, Brown & Co. Boston, Massachusetts, USA. 1881

**Weyl, Hermann** 1885–1955  
German mathematician

Only on the basis of the spectroscopic investigation of stars and the modern atomic physics, and only after well-founded opinions about spatial order of the stellar universe had been derived by analysis of vast observational material, could the astronomers undertake to draw a picture, first of the inner constitution and then also of the temporal development, of stars. Cosmogony still remains a rather problematic enterprise.

*Philosophy of Mathematics and Natural Science*

Appendix F (p. 286)

Princeton University Press. Princeton, New Jersey, USA. 1949

## COSMOLOGICAL

**Guth, Alan** 1947–  
American physicist

...I believe that soon any cosmological theory that does not lead to the eternal reproduction of universes will be considered as unimaginable as a species of bacteria that cannot reproduce.

*The Inflationary Universe: The Quest For a New Theory of Cosmic Origins*

Chapter 15 (p. 252)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

## COSMOLOGIST

**Chaisson, Eric J.** 1946–  
American astrophysicist

To the cosmologist, planets are hardly relevant, stars only point sources of hydrogen consumption, and galaxies mere details in the much broader context of all space.

*Epic of Evolution: Seven Ages of the Cosmos*

Prologue (p. 1)

Columbia University Press

New York, New York, USA. 2006

**Darling, David** 1953–  
British astronomer and science writer

What is a big deal – the biggest deal of all – is how you get something out of nothing. Don't let the cosmologists try to kid you on this one. They have not got a clue either – despite the fact that they are doing a pretty good job of convincing themselves and others that this is really not a problem. "In the beginning," they will say, "there was nothing – no time, space, matter, or energy. Then there was a quantum fluctuation from which...." Whoa! Stop right there. You see what I mean? First there is nothing, then there is something. And the cosmologists try to bridge the two with a quantum flutter, a tremor of uncertainty that sparks it all off. Then they are away and before you know it, they have pulled a hundred billion galaxies out of their quantum hats.

*On Creating Something from Nothing*

*New Scientist*, Volume 151, Number 2047, 1996 (p. 49)

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The cosmologist, accepting the universe for what it is, must try to discover why it is thus and not otherwise.

*Annual Report of the Board of Regents of the Smithsonian Institution (1926)*

Cosmogony (p. 155)

Government Printing Office. Washington, D.C. 1927

...the astronomer is satisfied if he can see the universe as it is, the cosmologist must ever strive to see it as it has been and as it will be.

*Annual Report of the Board of Regents of the Smithsonian Institution (1926)*

Cosmogony (p. 155)

Government Printing Office. Washington, D.C. 1927

**Zeldovich, Yakov Borisovich** 1914–87  
Russian physicist

Cosmologists are often in error, but never in doubt.

In Rudolf Kippenhahn

Translated by Storm Dunlop

*Light from the Depths of Time*

Introduction (p. 1)

Springer-Verlag. Berlin, Germany. 1987

## COSMOLOGY

### Author undetermined

An elementary particle that does not exist in particle theory should also not exist in cosmology.

Source undetermined

**Bondi, Sir Hermann** 1919–2005

English mathematician and cosmologist

There are probably few features of theoretical cosmology that could not be completely upset and rendered useless by new observational discoveries.

In G. Borner

*The Early Universe*

Chapter 2 (p. 26)

Springer-Verlag, Berlin, Germany. 1988

**Chaisson, Eric J.** 1946–

American astrophysicist

Exploring the whole universe requires large thoughts. There are no larger thoughts than cosmological ones.

*Cosmic Dawn: The Origins of Matter and Life*

Prologue (p. 3)

Little, Brown & Company. Boston, Massachusetts, USA. 1981

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

Cosmology is the elder sister of cosmogony.

*Modern Cosmogonies*

Chapter 1 (p. 15)

Adam & Charles Black. London, England. 1905

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

The character of the emotion with which men contemplate the world, the temper in which they stand in the presence of the immensities and the eternities, must depend first of all on what they think the world is.

In L. Stephen and F. Pollock (eds.)

*Lectures and Essays*

Cosmic Emotion (p. 395)

Macmillan & Company Ltd. London, England. 1879

**Ferris, Timothy** 1944–

American science writer

When it comes to a frontier science like cosmology, where the scope of inquiry stretches out to the distant galaxies and down to the subatomic jitterbug from which they emerged, conservatism is not decidedly a virtue nor imagination a vice.

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 12)

Simon & Schuster. New York, New York, USA. 1997

So it seems reasonable to ask what cosmology, now that it is a science, can tell us about God.

Sadly, but in all earnestness, I must report that the answer as I see it is: Nothing. Cosmology presents us neither the face of God, nor the handwriting of God, nor such thoughts as may occupy the mind of God. This does not mean that God does not exist, or that he did not create the universe, or universes. It means that cosmology offers no resolution to such questions.

*The Whole Shebang: A State-of-the Universe's Report*

Contrarian Theological Afterword (pp. 303–304)

Simon & Schuster. New York, New York, USA. 1996

**Görtnitz, Thomas**

No biographical data available

Modern cosmology is myth which does not know itself to be myth.

Connections between Abstract Quantum Theory and Space-Time Structure II, A Model of Cosmological Evolution

*International Journal of Theoretical Physics*, Volume 27, Number 6, June, 1988 (p. 659)

**Hawking, Stephen William** 1942–

English theoretical physicist

Cosmology used to be considered a pseudoscience and the preserve of physicists who might have done some useful work in their earlier years but who had gone mystic in their dotage.

*The Nature of Space and Time*

Chapter Five (p. 75)

Princeton University Press. Princeton, New Jersey, USA. 1996

**Holz, Daniel E.**

American astrophysicist

Over 2,000 years ago, the Greeks thought they had it all worked out. In their cosmology, the entire Universe was composed of four elements: earth, wind, fire and water. Now, despite several millennia of effort, modern cosmologists are significantly worse off. We have no idea what the bulk of the Universe is composed of.

Shedding Light on Dark Matter

*Nature*, Volume 400, Number 6746, 26 August, 1999 (p. 819)

**McCrea, William Hunter** 1904–98

Irish theoretical astrophysicist and mathematician

I am always surprised when a young man tells me he wants to work at cosmology; I think of cosmology as something that happens to one, not something one can choose.

Presidential Address

Royal Astronomical Society, February, 1963

**Peebles, Phillip James Edwin** 1935–

Canadian-American theoretical cosmologist

In cosmology the reliance on physical simplicity, pure thought and revealed knowledge is carried well beyond the fringe because we have so little else to go on. By this desperate course we have arrived at a few simple

pictures of what the Universe may be like. The great goal is now to become more familiar with the Universe, to learn whether any of these pictures may be a reasonable approximation, and if so how the approximation may be improved. The great excitement in cosmology is that the prospects for doing this seem to be excellent.

*Physical Cosmology* (p. vii)

Princeton University Press. Princeton, New Jersey, USA. 1971

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

All science is cosmology, I believe ...

*The Logic of Scientific Discovery*

Preface to the First English Edition (p. xviii)

Routledge. London, England. 2002

I, however, believe that there is at least one philosophical problem in which all thinking men are interested. It is the problem of cosmology: the problem of understanding the world – including ourselves and our knowledge, as part of the world. All science is cosmology, I believe, and for me the interest of philosophy lies solely in the contributions which it has made to it.

*The Logic of Scientific Discovery*

Preface to English Edition (p. 15)

Basic Books, Inc. New York, New York, USA. 1959

**Rucker, Rudy (Rudolph von Bitter**

**Rucker)** 1946–

American scientist, writer, and editor

I love cosmology: there's something uplifting about viewing the entire universe as a single object with a certain shape. What entity, short of God, could be nobler or worthier of man's attention than the cosmos itself? Forget about interest rates, forget about war and murder, let's talk about space.

*The Fourth Dimension: Toward a Geometry of Higher Reality*

Chapter 7 (p. 91)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1984

**Tolman, R. C.**

No biographical data available

It is appropriate to approach the problems of cosmology with feelings of respect for their importance, of awe for their vastness, and of exultation for the temerity of the human mind in attempting to solve them. They must be treated, however, by the detailed, critical, and dispassionate methods of the scientist.

*Relativity, Thermodynamics and Cosmology*

Part IV, Section 187 (p. 488)

At The Clarendon Press. Oxford, England. 1934

**Turok, Neil G.**

South African mathematical physicist

Maybe the problems cosmology has set for itself will turn out to be just too difficult to solve scientifically. After all,

we've got a lot of gall to suppose that the universe can be described by some simple theory.

In John Hogan

Universal Truths

*Scientific American*, Volume 263, Number 4, October, 1990 (p. 117)

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Cosmology...restrains the aberrations of the mere undisciplined imagination.

*The Function of Reason*

Chapter III (p. 76)

Beacon Press. Boston, Massachusetts, USA. 1929

**COSMOS**

**Alfvén, Hannes** 1908–95

Swedish physicist

To try to write a grand cosmical drama leads necessarily to myth. To try to let knowledge substitute ignorance in increasingly larger regions of space and time is science.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 6 (p. 214)

Random House, Inc. New York, New York, USA. 1991

**Blavatsky, Helena Petrovna** 1831–91

Founder of the Theosophical Society

By the radiant light of the universal magnetic ocean... electric waves bind the cosmos together ...

*Isis Unveiled*

Section I, Chapter VIII (p. 282)

The Aryan Theosophical Press. Point Loma, California, USA. 1919

**Chaisson, Eric J.** 1946–

American astrophysicist

If we are examples of anything in the cosmos, it is probably of magnificent mediocrity.

*Cosmic Dawn: The Origins of Matter and Life*

Epoch Seven (p. 291)

Little, Brown & Company. Boston, Massachusetts, USA. 1981

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

For the universe is a single jewel, and while it is a natural cant to talk of a jewel as peerless and priceless, of this jewel it is literally true. This cosmos is indeed without peer and without price: for there cannot be another one.

*Orthodoxy*

Chapter IV (pp. 116–117)

John Lane Company. New York, New York, USA. 1918

The Cosmos is about the smallest hole that a man can hide his head in.

*Orthodoxy*

Chapter II (p. 39)

John Lane Company. New York, New York, USA. 1918

A cosmic philosophy is not constructed to fit a man; a cosmic philosophy is constructed to fit a cosmos.

*The Book of Job*

Introduction

London, England. 1916

In the fairy tales the cosmos goes mad, but the hero does not go mad. In the modern novels the hero is mad before the book begins, and suffers from the harsh steadiness and cruel sanity of the cosmos.

In John D. Barrow

*The World Within the World* (p. 271)

Clarendon Press. Oxford, England. 1988

**Donne, John** 1572–1631

English poet and divine

The Sun is lost, and the earth, and no man's wit  
Can well direct him where to looke for it.

And freely men confesse that this world's spent,

When in the Planets, and the Firmament

They seeke so many new; then see that this

Is crumbled out againe to his Atomies.

'Tis all in peeces, all cohaerence gone;

All just supply, and all Relation.

In A.J. Smith (ed.)

*The Complete English Poems*

An Anatomie of the World, First Anniversary, l. 207–214

St. Martin's Press. New York, New York, USA. 1971

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

And we, inhabitants of the great coral of the Cosmos, believe the atom (which still we cannot see) to be full matter, whereas, it too, like everything else, is but an embroidery of voids in the Void, and we give the name of being, dense and even eternal, to that dance of inconsistencies, that infinite extension that is identified with absolute Nothingness and that spins from its own non-being the illusion of everything.

*The Island of the Day Before*

Chapter 37 (p. 473)

Penguin Group Inc. New York, New York, USA. 1996

**Ferris, Timothy** 1944–

American science writer

The history of the cosmos is arrayed in the sky for those who care to read it.

*Galaxies*

Chapter VI (p. 161)

Sierra Club Books. San Francisco, California, USA. No date

**Jastrow, Robert** 1925–

American space scientist

According to the astronomical evidence, the elements that make up the body of the earth are found in abundance throughout the Cosmos. Innumerable earth-like planets must exist in other solar systems.

*Until the Sun Dies*

Chapter 18 (p. 165)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

We and the cosmos are one. The cosmos is a vast body, of which we are still parts. The sun is a great heart whose tremors run through our smallest veins. The moon is a great gleaming nerve-centre from which we quiver forever. Who knows the power that Saturn has over us or Venus? But it is a vital power, rippling exquisitely through us all the time.... Now all this is literally true, as men knew in the great past and as they will know again.

*Apocalypse*

Five (p. 45)

The Viking Press. New York, New York, USA. 1932

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

1. The cosmos is a gigantic fly wheel making 10,000 revolutions a minute.
2. Man is a sick fly taking a dizzy ride on it.
3. Religion is the theory that the wheel was designed and set spinning to give him the ride.

*Prejudices: Third Series*

Chapter V, Section 5 (p. 132)

Alfred A. Knopf. New York, New York, USA. 1922

**Plato** 428 BCE–347 BCE

Greek philosopher

...this universe is called Cosmos, or order, not disorder or misrule.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 508 (p. 284)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Reeves, Hubert** 1932–

Canadian astrophysicist

Knowledge of the cosmos is much more than a luxury for cultivated souls. It is the foundation of a cosmic consciousness. It casts light on the heavy responsibilities that have fallen upon us.

*Atoms of Silence*

Chapter 13 (p. 146)

The MIT Press. Cambridge, Massachusetts, USA. 1984

**Sagan, Carl** 1934–96

American astronomer and science writer

Our feeblest contemplations of the Cosmos stir us – there is a tingling in the spine, a catch in the voice, a faint sensation, as if a distant memory, of falling from a height. We know we are approaching the greatest of mysteries.

*Cosmos*

Chapter I (p. 1)

Ballentine Books. New York, New York, USA. 1985

The cosmos is all there ever was and all there ever will be.

*Cosmos*

Chapter I (p. 1)

Random House, Inc. New York, New York, USA. 1980

The size and age of the Cosmos are beyond ordinary human understanding. Lost somewhere between immensity and eternity is our tiny planetary home.

*Cosmos*

Chapter I (p. 4)

Random House, Inc. New York, New York, USA. 1980

It is too late to be shy and hesitant. We have announced our presence to the cosmos – in a backward and groping and unrepresentative manner, to be sure – but here we are!

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 30 (p. 216)

Dell Publishing, Inc. New York, New York, USA. 1975

...in the last tenth of a percent of the lifetime of our species, in the instant between Aristarchus and ourselves, we reluctantly noticed that we were not the center and purpose of the Universe, but rather lived on a tiny and fragile world lost in immensity and eternity, drifting in a great cosmic ocean dotted here and there with a hundred billion galaxies and a billion trillion stars. We have bravely tested the waters and have found the ocean to our liking, resonant with our nature. Something in us recognizes the Cosmos as home. We are made of stellar ash. Our origin and evolution have been tied to distant cosmic events. The exploration of the Cosmos is a voyage of self-discovery. As the ancient mythmakers knew, we are the children equally of the sky and the Earth.

*Cosmos*

Chapter XIII (p. 318)

Random House, Inc. New York, New York, USA. 1980

...we are the local embodiment of a Cosmos grown to self-awareness. We have begun to contemplate our origins: starstuff pondering the stars; organized assemblages of ten billion billion billion atoms considering the evolution of atoms; tracing the long journey by which, here at least, consciousness arose.

*Cosmos*

Chapter XIII (p. 345)

Random House, Inc. New York, New York, USA. 1980

### **Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

...the cosmos has its own way of doing things, not wholly rational nor ideally best, but patient, fatal, and fruitful. Great is this organism of mud and fire, terrible this vast, painful glorious experiment.

In Logan Pearsall Smith

*Little Essays Drawn from the Writings of George Santayana*

Piety (p. 86)

Charles Scribner's Sons. New York, New York, USA. 1920

### **Shapley, Harlow** 1885–1972

American astronomer

Cosmography is to the Cosmos what geography is to the earth.

*Of Stars and Men: Human Response to an Expanding Universe*

Introduction (fn, p. 4)

Beacon Press. Boston, Massachusetts, USA. 1958

### **Slossin, Edwin Emery** 1865–1919

Chemist and author

Chaos is the “natural” state of the universe. Cosmos is the rare and temporary exception.

*Creative Chemistry*

Chapter I (p. 11)

The Century Co. New York, New York, USA. 1919

### **Tomlinson, C.**

No biographical data available

He sees in Nature's laws a code divine,  
A living Presence he must first adore,  
Ere he the sacred mysteries explore,  
Where Cosmos is his temple, Earth his shrine.

Michael Faraday

*The Graphic*, Volume XX, Number 508, 23 August, 1879 (p. 183)

## COUNT

### **Author undetermined**

The King was in his counting house

Counting out his money.

In J. F. Goodridge

*Mother Goose Rhymes* (p. 50)

Lee & Sheperd. Boston, Massachusetts, USA. 1880

### **Brautigan, Richard** 1935–85

American writer

“I count a lot of things that there's no need to count,” Cameron said. “Just because that's the way I am. But I count all the things that need to be counted.”

*The Hawkline Monster* (p. 154)

Somon & Schuster. New York, New York, USA. 1974

### **Hoban, Russell** 1925–

American writer of fantasy, science fiction and mainstream fiction

Them as counts counts moren them as dont count.

*Riddley Walker* (p. 19)

Summit Books. New York, New York, USA. 1980

### **Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

To count is a modern practice, the ancient method was to guess ...

*A Journey to the Western Islands of Scotland* (p. 150)

Printed at the Stanhope Press. Glasgow, Scotland. 1817

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

There is no problem in all mathematics that cannot be solved by direct counting.

Translated by Thomas Joseph McCormack

*Popular Scientific Lectures* (3rd edition)

On the Economical Nature of Physics (p. 197)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

**van Leeuwenhoek, Antony** 1632–1723

Dutch pioneer of microscopic research

My counting is always as uncertain as that of folks who, when they see a big flock of sheep being driven, say, by merely casting their eye upon them, how many sheep there be in the whole flock.

Translated by Clifford Dobell

*Antony van Leeuwenhoek and His "Little Animals"*

Part II, Chapter II (p. 170)

John Bale, Sons, & Danielsson. London, England. 1932

## COUNTING

### Author undetermined

Why do Computer Scientists confuse Halloween and Christmas?

Because Oct. 31 = Dec. 25.

Source undetermined

**Brautigan, Richard** 1935–84

American writer

I count a lot of things that there's no need to count, Cameron said. Just because that's the way I am. But I count all the things that need to be counted.

*The Hawkline Monster: A Gothic Western*

Picador. London, England. 1976

**Feynman, Richard P.** 1918–88

American theoretical physicist

You see, the chemists have a complicated way of counting: instead of saying "one, two, three, four, five protons", they say, "hydrogen, helium, lithium, beryllium, boron."

*QED: The Strange Theory of Light and Matter*

Chapter 3 (p. 113)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Park, Ruth** 1922–

New Zealand writer

"You know, Mouse," [Tabby] said, "a brilliant cat like me should have smart friends; people who can count to more than four."

"I can count to more than four," answered Mouse, very offended. "And I can do hard sums, and I know geography and history, and I can knit and..."

*The Muddle-Headed Wombat at School*

Educational Press. Sydney, Australia. 1966

**Sampson, R. A.**

Astronomer

Counting correctly is very difficult, because, so to put it, it requires from the mind a simultaneous hold upon the past, present, and future. Counting, on the other hand, done carefully is the only region of knowledge, even of mathematics, in which we can be perfectly sure we are not talking nonsense.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1916)

A Census of the Sky (p. 186)

Government Printing Office. Washington, D.C. 1917

**Seares, Frederick H.**

No biographical data available

Counting the stars is not unlike counting people or sheep or pebbles on the seashore. The astronomer's difficulties are not in the counting, but rather in knowing when the counting must start and stop.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1929

Counting the Stars and Some Conclusions (p. 183)

Government Printing Office. Washington, D.C. 1930

## COURAGE

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Have the courage to say: "I do not know."

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907

## CRATER

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

...I distinguish two parts of it, which I call respectively the brighter and the darker. The brighter seems to surround and pervade the whole hemisphere; but the darker part, like a sort of cloud, discolours the Moon's surface and makes it appear covered with spots. Now these spots, as they are somewhat dark and of considerable size, are plain to everyone and every age has seen them, wherefore I will call them great or ancient spots, to distinguish them from other spots, smaller in size, but so thickly scattered that they sprinkle the whole surface of the Moon, but especially the brighter portion of it. These spots have never been observed by anyone before me; and from my observations of them, often repeated, I have been led to the opinion which I have expressed, namely, that I feel sure that the surface of the Moon is not perfectly smooth, free from inequalities and exactly spherical...but that, on



the contrary, it is full of inequalities, uneven, full of hollows and protuberances, just like the surface of the Earth itself, which is varied everywhere by lofty mountains and deep valleys.

*The Sidereal Messenger of Galileo Galilei, and a Part of the Preface to Kepler's Dioptrics*

The Astronomical Messenger (p. 15)  
Rivingtons. London, England. 1880

## CRAZY

**Heinlein, Robert A.** 1907–88

American science–fiction writer

...crazy – a nonscientific term meaning that the person to whom one applies that label has a world picture differing from the accepted one.

*Time Enough for Love*

Da Capo, Chapter II (p. 480)

G.P. Putnam's Sons. New York, New York, USA. 1973

## CREATE

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

You imagine what you desire; you will what you imagine; and you create what you will.

*Back to Methuselah*

Part I, Act I (p. 8)

Constable & Company Ltd. London, England. 1921

## CREATION

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

With all our wide vision we may be looking at only a small part of a grand creation. Our universe with its billions of galaxies may be only one among many.

*Science Is Not Enough*

Chapter IX (p. 168)

William Morrow & Company, Inc. New York, New York, USA. 1967

**Conduitt, John** 1688–1737

English politician

When I asked him [Newton] how this earth could have been repopled if ever it had undergone the same it was threatened with hereafter by the comet of 1680? He answered, that required the power of a Creator.

Article XI

*The Monthly Review*, Volume 11, 1829 (p. 596)

**Dewar, Redcote**

No biographical data available

Now, "creation" was a word invented by the most learned men of a bygone age, to express the notion that something may be created out of nothing. This was a

simple matter to them, for the ignorant man's imagination is illimitable, and vacuities naturally beget vacuities.

*From Matter to Man: A New Theory of the Universe*

Chapter I (p. 2)

Chapman & Hall, Ltd. London, England. 1898

**Dobzhansky, Theodosius** 1900–75

Russian American scientist

The creation...is not an event which happened in the remote past but is rather a living reality of the present. Creation is a process of evolution of which man is not merely a witness but a participant and a partner as well.

*The Biological Basis of Human Freedom*

Man's Kinship with Nature, Creation by Evolution (p. 5)

Columbia University Press. New York, New York, USA. 1956

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

Creation, strictly speaking, is inconceivable to us. And yet creation is a fact. The system of visible things in which we live was certainly not the author of itself.

Professor Huxley on the War-path

*The Popular Science Monthly*, Volume 38 1891 (p. 777)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I do not think that the whole purpose of the Creation has been staked on the one planet where we live; and in the long run we cannot deem ourselves the only race that has been or will be gifted with the mystery of consciousness.

Man's Place in the Universe

*Harper's Magazine*, October, 1928 (p. 574)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

We have theories of races and of functions, but scarcely yet a remote approach to an idea of creation. We are now so far from the road to truth, that religious teachers dispute and hate each other, and speculative men are esteemed unsound and frivolous.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

*Nature: Addresses and Lectures*

Introduction (p. 4)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Flaubert, Gustave** 1821–90

French novelist

How vast is creation! I see the planets rise and the stars hurry by, carried along with their light! What, then, is this hand which propels them? The sky broadens the more I ascend. Worlds revolve around me. And I am the center of this restless creation.

Oh, how great is my spirit! I feel superior to that miserable world lost in the immeasurable distance beneath me; planets frolic about me – comets pass by casting forth

their fiery tails, and centuries hence they will return, still running like horses on the field of space. How I am soothed by this immensity! Yes, this is indeed made for me; the infinite surrounds me on all sides. I am devouring it with ease.

*Smarh*

Librairie de France. Paris, France. 1922

**Haeckel, Ernst Heinrich Philipp August** 1834–1919  
German biologist and philosopher

The struggle for life in natural selection acts with as much selective power as does the will of man in artificial selection. The latter, however, acts according to a plan and consciously, the former without a plan and unconsciously.

Translated by Edwin Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)  
Chapter XI (p. 283)

D. Appleton & Co. New York, New York, USA. 1892

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

The assumption of a special act of creation, either now or at any time, is merely a confession of ignorance.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 11)

D. van Nostrand Co. New York, New York, USA. 1893

**Hopkins, Gerard Manley** 1844–89

English poet and Jesuit priest

To know what creation is look at the size of the world. Speed of light: it would fly six or seven times around the world while the clock ticks once. Yet it takes thousands of years to reach us from the Milky Way.

In Christopher Devlin, S.J.

*The Sermons and Devotional Writings of Gerard Manley Hopkins* (p. 238)  
Oxford University Press, Inc. London, England. 1959

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

There is no interruption in creation; no broken arch, no lapse; an action and its consequences embrace all nature; the chain may be longer or shorter, but never breaks. Climb this immense knotted cord, take one fact after another, and you will progress from the vibrio to the constellation. The immanent marvel has its own cohesion. Nothing is wasted; no effort is lost. The useless does not exist. The universe has what is necessary and only what is necessary.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 409)

The Heritage Press. New York, New York, USA. 1961

... who among us knows whether the creation of worlds is not determined by the fall of grains of sand?

*Les Misérables*

Volume IV, Book III, Chapter 3 (p. 67)

The Heritage Press. New York, New York, USA. 1938

**Huxley, Thomas Henry** 1825–95

English biologist

...the hypothesis of special creation is not only a mere specious mask for our ignorance; its existence in Biology marks the youth and imperfection of the science. For what is the history of every science but the history of the elimination of the notion of creative, of other interferences, with the natural order of the phenomena which are the subject-matter of that science?

*Lay Sermons, Addresses and Reviews*

Chapter XII (pp. 282–283)

D. Appleton & Co. New York, New York, USA. 1903

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...so little do we understand time that perhaps we ought to compare the whole of time to the act of creation...

*The Mysterious Universe*

Chapter V (p. 148)

The Macmillan Company. New York, New York, USA. 1932

**Kett, Henry** 1761–1825

English college teacher and writer

That which is first to nature in the order of creation, is not first to man in the order of philosophical inquiries; or, in other words, the progress of the Creator is different from that of the creature.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 91)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Creation cannot take place without miracle; but it would be a strange reversal of all our previous conclusions on the subject, should we have to hold that the dead, dark blank out of which creation arose was miraculous also.

*The Testimony of the Rocks; or, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Third (p. 156)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

Who shall declare what, throughout these long ages, the history of creation has been? We see at wide intervals the mere fragments of successive floras; but know not how what seem the blank interspaces were filled, or how, as extinction overtook in succession one tribe of existences after another, and species, like individuals, yielded to the great law of death, yet other species were brought to the birth and ushered upon the scene, and the chain of being was maintained unbroken. We see only detached bits of that green web which has covered our earth ever since the dry land first appeared; but the web itself seems to have been continuous throughout all time; though ever, as breadth after breadth issued from the creative loom, the pattern has altered, and the sculpturesque and graceful forms that illustrated its first beginnings and its middle

spaces have yielded to flowers of richer colour and blow, and fruits of fairer shade and outline; and for gigantic club-mosses stretching forth their hirsute arms, goodly trees of the Lord have expanded their great boughs; and for the barren fern and the calamite, clustering in thickets beside the waters, or spreading on flowerless hill-slopes, luxuriant orchards have yielded their ruddy flush, and rich harvests their golden gleam.

*The Testimony of the Rocks; or, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Twelfth (pp. 501–502)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

### **Parker, Barry**

Canadian physicist

Creation depends on the basic laws of nature – without them it would not be possible. Who creates these laws? There is no question but that a God will always be needed.

*Creation: The Story of the Origin and Evolution of the Universe*  
Chapter 17 (p. 282)  
Plenum Press. New York, New York, USA. 1998

### **Peacock, R.**

No biographical data available

We have used his law (the Second law of thermodynamics) in determining that the universe had a beginning, creation. Even though the tools of the physicist are unable to break into the secrets of the first moment, we can conclude that it initiated a period of low, but increasing entropy.

*A Brief History of Eternity*  
Chapter Eight (p. 114)  
Monarch Publications Ltd. E. Sussex, Great Britain. 1989

### **Wright, Thomas** 1711–86

English cosmologist

... we cannot long observe the beautiful Parts of the visible Creation, not only those of this World on which we live, but also the Myriads of bright Bodies round us, with any Attention, without being convinced, that a Power supreme, and of a Nature unknown to us, presides in, and governs it...

*An Original Theory or New Hypothesis of the Universe*  
Letter the Seventh (p. 58)  
Printed for the Author. London, England. 1750

### **Pouchet, Félix Archimède** 1800–72

French biologist

It [creation] stands revealed in the azure dome of heaven, where glows a perfect dust of stars, and in the living atom which hides from us the marvels of its organization.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book I (p. 3)  
Blackie & Son. London, England. 1870

... the phenomena of creation astound us, whether uplifting our look we scrutinize the mechanism of the heavens,

or cast our eyes upon the tiniest creatures of this lower realm.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book I (p. 3)  
Blackie & Son. London, England. 1870

### **Ruskin, John** 1819–1900

English writer, art critic, and social reformer

God has lent us the earth for our life; it is a great entail. It belongs as much to those who are to come after us, and whose names are already written in the book of creation, as to us; and we have no right, by anything that we do or neglect, to involve them in unnecessary penalties, or deprive them of benefits which it was in our power to bequeath.

*The Seven Lamps of Architecture*  
Chapter 6 (p. 154)  
John Wiley & Son. New York, New York, USA. 1865

### **Titcomb, Timothy** 1819–81

American writer and editor

God only opened his hand to give flight to a thought [creation] that He had held imprisoned from eternity!

*Gold-foil*  
17th Chapter III (p. 32)  
Charles Scribner's Sons. New York, New York, USA. 1863

### **Warren, Henry White** 1831–1912

American Methodist Episcopal bishop and author

Creation is a necessity of mind – even of the Divine mind.

*Recreations in Astronomy*  
Chapter I (p. 5)  
Harper & Brothers Publishers. New York, New York, USA. 1895

### **Wilson, Edward O.** 1929–

American biologist and author

Who are we to destroy the planet's creation?

*The Diversity of Life*  
Foreword (p. xxiii)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

## **CREATIONISM**

### **Berra, Tim M.** 1943–

Professor Emeritus of evolution, ecology, and organismal biology

The proper place for the study of religious beliefs is in a church or temple, at home, or in a course on comparative religions, but not in a biology class. There is no place in our world for an ideology that seeks to close minds, force obedience, and return the world to a paradise that never was. Students should learn that the universe can be confronted and understood, that ideas and authority should be questioned, that an open mind is a good thing. *Education does not exist to confirm people's superstitions, and children do not learn to think when they are fed only dogma.*

*Evolution and the Myth of Creationism*

Chapter 5 (p. 139)

Stanford University Press. Stanford, California, USA. 1990

**Cloud, Preston Ercelle** 1912–91

American biogeologist, paleontologist, and humanist

Fundamentalist creationism is not a science but a form of antisense, where more vocal practitioners, despite their master's and doctoral degrees in the sciences, play fast and loose with the facts of geology and biology.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

"Scientific Creationism" – A New Inquisition Brewing? (p. 134)

Oryx Press, Phoenix, Arizona, USA. 1983

**Darwin, Charles Robert** 1809–82

English naturalist

Do they really believe that at innumerable periods in the earth's history certain elemental atoms have been commanded suddenly to flash into living tissues? Do they believe that at each supposed act of creation one individual or many were produced? Were all the infinitely numerous kinds of animals and plants created as eggs or seed, or as full grown?

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XV (p. 240)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The argument that the literal story of Genesis can qualify as science collapses on three major grounds: the creationists' need to invoke miracles in order to compress the events of the earth's history into the biblical span of a few thousand years; their unwillingness to abandon claims clearly disproved, including the assertion that all fossils are products of Noah's flood; and their reliance upon distortion, misquote, half-quote, and citation out of context to characterize the ideas of their opponents.

The Verdict on Creationism

*The Skeptical Inquirer*, Volume 12, Winter, 87/88 (p. 186)

Creation science has not entered the curriculum for a reason so simple and so basic that we often forget to mention it: because it is false, and because good teachers understand exactly why it is false. What could be more destructive of that most fragile yet most precious commodity in our entire intellectual heritage – good teaching – than a bill forcing honorable teachers to sully their sacred trust by granting equal treatment to a doctrine not only known to be false, but calculated to undermine any general understanding of science as an enterprise?

The Verdict on Creationism

*The Skeptical Inquirer*, Volume 12, Winter, 87/88 (p. 186)

**Laudan, Larry** 1945–

American philosopher of science

Rather than taking on the creationists obliquely and in wholesale fashion by suggesting that what they are doing is "unscientific" tout court (which is doubly silly because few authors can even agree on what makes an activity scientific), we should confront their claims directly and in piecemeal fashion by asking what evidence and arguments can be marshaled for and against each of them. The core issue is not whether Creationism satisfies some undemanding and highly controversial definition of what is scientific; the real question is whether the existing evidence provides stronger arguments for evolutionary theory than for Creationism.

Commentary: Science at the Bar – Cause for Concern

*Science, Technology & Human Values*, Volume 7, Number 41, Fall 1982 (p. 18)

**Lyell, Sir Charles** 1797–1875

English geologist

Whatever be the power which has for hundreds of times re-peopled the Earth with tribes of plants & animals as fast as they became extinct, that power I have always held is still in full & unabated action as is its antagonist or destructive power.

In Leonard G. Wilson (ed.)

*Sir Charles Lyell's Scientific Journals on the Species Question*

Journal II, July 10, 1856 (p. 124)

Yale University Press. New Haven, Connecticut, USA. 1970

**Moore, John A.**

American writer and professor of genetics and biology

It becomes evermore important to understand what is science and what is not. Somehow we have failed to let our students in on that secret. We find as a consequence, that we have a large and effective group of creationists who seek to scuttle the basic concept of the science of biology – the science that is essential for medicine, agriculture, and life itself; a huge majority of citizens who, in "fairness," opt for presenting as equals the "science" of creation and the science of evolutionary biology; and a president who is so poorly informed that he believes that scientists are questioning that evolution ever occurred. It is hard to think of a more terrible indictment of the way we have taught science.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

Evolution, Education, and the Nature of Science and Scientific Inquiry (p. 3)

Oryx Press. Phoenix, Arizona, USA. 1983

**Morris, Henry** 1918–2006

American creationist

Creationism is consistent with the innate thoughts and daily experiences of the child and thus is conducive to his

mental health. He knows, as part of his own experience of reality, that a house implies a builder and a watch a watchmaker. As he studies the still more intricately complex nature of, say, the human body, or the ecology of a forest, it is highly unnatural for him to be told to think of these systems as chance products of irrational processes.

*Scientific Creationism*

Chapter I (p. 14)

Creation-Life Publishers. San Diego, California, USA. 1974

It seems beyond all question that such complex systems as the DNA molecule could never arise by chance, no matter how big the universe or how long the time. The creation model faces this fact realistically and postulates a great Creator, by whom came life.

*Scientific Creationism*

Chapter IV (p. 62)

Creation-Life Publishers. San Diego, California, USA. 1974

**Nelkin, Dorothy** 1933–2003

American sociologist

Creationism is a “gross perversion of scientific theory.” Scientific theory is derived from a vast mass of data and hypotheses, consistently analysed; creation theory is “God given and unquestioned”, based on an a priori commitment to a six-day creation. Creationists ignore the interplay between fact and theory, eagerly searching for facts to buttress their beliefs. Creationism cannot be submitted to independent testing and has no predictive value, for it is a belief system that must be accepted on faith.

*Science Textbook Controversies and the Politics of Equal Time*

Chapter 6 (p. 89)

The MIT Press. Cambridge, Massachusetts, USA. 1977

**Patterson, John W.**

No biographical data available

There are many facets to “scientific creationism” and the movement can be discussed in any of several ways. However, it is best viewed as a loosely connected group of fundamentalist ministries led largely by scientifically incompetent engineers.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

An Engineer Looks at the Creationist Movement (p. 151)

Oryx Press, Phoenix, Arizona, USA. 1983

## CREATIONIST

**Albritton, Jr., Claude** 1913–

No biographical data available

One can only conclude that some creationists, recoiling from the fearsome prospect of time’s abyss, have toppled backward into the abyss of ignorance.

*The Abyss of Time: Changing Conceptions of the Earth’s Antiquity after the Sixteenth Century*

Chapter Seventeen (pp. 218–219)

Freeman, Cooper & Company. San Francisco, California, USA. 1980

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

According to the idealized principles of scientific discourse, the arousal of dormant issues should reflect fresh data that give renewed life to abandoned notions. Those outside the current debate may therefore be excused for suspecting that creationists have come up with something new, or that evolutionists have generated some serious internal trouble. But nothing has changed; the creationists have presented not a single new fact or argument. Darrow and Bryan were at least more entertaining than we lesser antagonists today. The rise of creationism is politics, pure and simple; it represents one issue (and by no means the major concern) of the resurgent evangelical right. Arguments that seemed kooky just a decade ago have reentered the mainstream.

*Hen’s Teeth and Horses Toes*

Evolution as Fact and Theory (p. 253)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

The basic attack of modern creationists falls apart on two general counts before we even reach the supposed factual details of their assault against evolution. First, they play upon a vernacular misunderstanding of the word “theory” to convey the false impression that we evolutionists are covering up the rotten core of our edifice. Second, they misuse a popular philosophy of science to argue that they are behaving scientifically in attacking evolution. Yet the same philosophy demonstrates that their own belief is not science, and that “scientific creationism” is a meaningless and self-contradictory phrase, an example of what Orwell called “newspeak.”

*Hen’s Teeth and Horses Toes*

Evolution as Fact and Theory (p. 254)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

Creationist critics often charge that evolution cannot be tested, and therefore cannot be viewed as a properly scientific subject at all. This claim is rhetorical nonsense.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Seven, Chapter 30 (p. 397)

Random House, Inc. New York, New York, USA. 1995

Our creationist detractors charge that evolution is an unproved and unprovable charade – a secular religion masquerading as science. They claim, above all, that evolution generates no predictions, never exposes itself to test, and therefore stands as dogma rather than disprovable science. This claim is nonsense. We make and test risky predictions all the time; our success is not dogma, but a highly probable indication of evolution’s basic truth.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Seven, Chapter 31 (p. 409)

Random House, Inc. New York, New York, USA. 1995

**Miller, Hugh** 1802–56

Scottish geologist and theologian

There is no progression. If fish rose into reptiles, it must have been by sudden transformation.... There is no



getting rid of miracle in the case, – there is no alternative between creation and metamorphosis. The infidel substitutes progression for Deity; Geology robs him of his god.

*The Old Red Sandstone*

Chapter III (pp. 65–66)

J.M. Dent & Sons Ltd. London, England. 1922

## CREATIVE

### Advertisement

The creative thinker today still need not have a specific use in mind when, by equation or formula, he branches off from the accepted to the hitherto unknown.

Bell Telephone Laboratories advertisement

*Scientific American*, Volume 200, Number 1, January, 1959 (p. 21)

### Author undetermined

If you are going to be creative, you are going to be wrong a lot.

Source undetermined

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

To be creative, scientists need libraries and laboratories and the company of other scientists; certainly a quiet and untroubled life is a help. A scientist's work is in no way deepened or made more cogent by privation, anxiety, distress, or emotional harassment. To be sure, the private lives of scientists may be strangely and even comically mixed up, but not in ways that have any special bearing on the nature and quality of their work. If a scientist were to cut off an ear, no one would interpret such an action as evidence of an unhappy torment of creativity; nor will a scientist be excused any bizzarerie, however extravagant, on the grounds that he is a scientist, however brilliant.

*Advice to a Young Scientist*

Chapter 6 (p. 40)

Basic Books, Inc. New York, New York, USA. 1979

## CREATIVITY

### Adler, Alfred 1870–1937

Austrian psychiatrist

The essential feature of mathematical creativity is the exploration, under the pressure of powerful implosive forces, of difficult problems for whose validity and importance the explorer is eventually held accountable by reality.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 9)

Wadsworth, Inc. Belmont, California, USA. 1984

### Arieti, Silvano 1914–81

Italian-American psychologist

However, creativity is not simply originality and unlimited freedom. There is much more to it than that. Creativity also imposes restrictions. While it uses methods other than those of ordinary thinking, it must not be in disagreement with ordinary thinking – or rather, it must be something that, sooner or later, ordinary thinking will understand, accept, and appreciate. Otherwise the result would be bizarre, not creative.

*Creativity: The Magic Synthesis*

Chapter 1 (p. 4)

Basic Books, Inc. New York, New York, USA. 1976

Indeed, it is the perennial (and almost always unverbalized) premise of creativity, to show that the tangible, visible, and audible universe is infinitesimal in comparison to the one that awaits discovery through exploration of the external world and of the human psyche.

*Creativity: The Magic Synthesis*

Chapter 1 (p. 5)

Basic Books, Inc. New York, New York, USA. 1976

### Birch, Arthur J. 1915–95

Australian chemist

...creativity is the ability to see the obvious over the long term, and not to be restrained by short-term conventional wisdom.

*To See the Obvious*

Random Conversations with the Editor (p. 196)

American Chemical Society, Washington, D.C. 1995

### Bolz, Ray E.

No biographical data available

### Dean, Jr., Robert C.

No biographical data available

What the educational experience almost completely excludes is the exercise and development of the students' creativity – even though creativity is probably the single most important characteristic demanded of a modern, practicing engineer.

In Daniel V. DeSimone

*Education for Innovation*

Strategies and Teaching Methods, Chapter 11 (p. 128)

Pergamon Press. New York, New York, USA. 1968

### Calvin, Melvin 1911–97

American biochemist

There is no such thing as pure science. By this I mean that physics impinges on astronomy on the one hand, and chemistry and biology on the other. The synthesis of a really new concept requires some sort of union in one mind of the pertinent aspects of several disciplines.... It's no trick to get the right answer when you have all the data. The real creative trick is to get the right answer when you have only half of the data in hand and half of it is wrong and you don't know which half is wrong. When you get the right answer under these circumstances, you are doing something creative.



*Following the Trail of Light: A Scientific Odyssey*  
Bringing It Together (p. 134)  
American Chemical Society. Washington, D.C. 1992

### Duren, Peter L.

No biographical data available

A lot of mathematicians are a little bit strange in one way or another. It goes with creativity.

*New York Times*, May 26, 1996 (p. 23)

### Eiseley, Loren C. 1907–77

American anthropologist, educator, and author

The creative element in the mind of man...emerges in as mysterious a fashion as those elementary particles which leap into momentary existence in great cyclotrons, only to vanish again like infinitesimal ghosts.

*The Night Country*

Chapter 13 (p. 212)

Charles Scribner's Sons. New York, New York, USA. 1971

### Freund, C. J.

No biographical data available

For one thing, engineering creativity is much more like inventiveness than like research. The creative engineer is a cousin to Edison and Marconi; he is no relation at all to Einstein or Enrico Fermi.

Creativity Is a Task, Not a Trait

*Machine Design*, May 25, 1967 (p. 161)

### Gilmer, Ben S.

No biographical data available

We need men who have been schooled in the principles of creativity and who dare to court the ridicule of the masses for the sake of improving the lot of mankind.

Times Demand as Goal: Education for Creativity

*Auburn Alumnews*, July, 1961 (p. 7)

### Glegg, Gordon L.

American engineer

Disciplined thinking focuses inspiration rather than blinkers it.

*The Design of Design*

Introduction (p. 1)

Cambridge University Press. Cambridge, England. 1979

### Gould, Stephen Jay 1941–2002

American paleontologist and evolutionary biologist

Creative work, in geology and anywhere else, is interaction and synthesis; half-baked ideas from a bar room, rocks in the field, chains of thought from lonely walks, numbers squeezed from rocks in a laboratory, numbers from a calculator riveted to a desk, fancy equipment usually malfunctioning on expensive ships, cheap equipment in the human cranium, arguments before a road cut.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 6 (p. 98)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

### Hertzberger, Herman 1932–

Dutch architect

Creativity in that respect is the capacity to see 'things' differently by lifting them from their present context so that they lose their original meaning and, seen in a new context, evoke another and so become something else.

*Space and the Architect: Lessons in Architecture 2*

Chapter 2 (p. 37)

Publishers. Rotterdam, The Netherlands. 2000

### Hoyle, Sir Fred 1915–2001

English mathematician, astronomer, and writer

The nation that neglects creative thought today will assuredly have its nose ground into the dust of tomorrow.

In Sidney J. Parnes and Harold F. Harding

*A Source Book for Creative Thinking*

Creativity: Education's Stepchild (p. 17)

Charles Scribner's Sons. New York, New York, USA. 1962

It is a mistake to imagine that potentially great men are rare. It is the conditions that permit the promise of greatness to be fulfilled that are rare. What is so difficult to achieve is the cultural background that permits potential greatness to be converted into actual greatness.

*Of Men and Galaxies*

Motives and Aims of the Scientist (p. 21)

University of Washington Press. Seattle, Washington, USA. 1964

### Jung, Carl G. 1875–1961

Swiss psychologist and psychiatrist

A creative person has little power over his own life. He is not free. He is captive and driven by his daemon.

*Memories, Dreams, Reflections*

Retrospect (p. 357)

Vintage Books. New York, New York, USA. 1963

### King, Blake

No biographical data available

Creativity bothers engineers.

Object: Creativity

*Mechanical Engineering*, November, 1963 (p. 38)

### Koestler, Arthur 1905–83

Hungarian-born English writer

Creativity in science could be described as the art of putting two and two together to make five. In other words, it consists in combining previously unrelated mental structures in such a way that you get more out of the emergent whole than you have put in.

*Janus: A Summing Up*

Chapter VII (p. 131)

Random House, Inc. New York, New York, USA. 1978

**Kuhn, Thomas S.** 1922–96  
American historian of science

Let us assume that crises are a necessary precondition for the emergence of novel theories and ask next how scientists respond to their existence. Part of the answer, as obvious as it is important, can be discovered by noting first what scientists never do when confronted by even severe and prolonged anomalies. Though they may begin to lose faith and then to consider alternatives, they do not renounce the paradigm that has led them into crisis. They do not, that is, treat anomalies as counterinstances, though in the vocabulary of philosophy of science that is what they are.

*The Structure of Scientific Revolutions*

Chapter VIII (p. 77)

The University of Chicago Press. Chicago, Illinois, USA. 1970

The transition from a paradigm to a new one from which a new tradition of normal science can emerge is far from a cumulative process, one achieved by an articulation or extension of the old paradigm. Rather it is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications.

*The Structure of Scientific Revolutions*

Chapter VIII (pp. 84–85)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Lipscombe, William N.** 1919–  
American chemist

For me, the creative process, first of all, requires a good nine hours of sleep a night. Second, it must not be pushed by the need to produce practical applications.

*New York Times*, 7 December, 1977

**Lowell, James Russell** 1819–91  
American poet, critic, and editor

In creating, the only hard thing's to begin....

*A Fable for Critics*

A Fabler for the Critics (p. 28)

G.P. Putnam. New York, New York, USA. 1848

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

The romantic view of the creative process of science as something cognate with poetic invention is often sneered at by people who pride themselves as shrewd, practical-minded men of the world with a sound sense of the value of money. But they don't do any better than the rest of us, and it is they, indeed – people who believe that there is a cut and dried scientific method and that they can buy scientific results by paying for them – who are the incurable daydreamers with their heads in the clouds and no real understanding of the way the mind works.

*The Strange Case of the Spotted Mice and Other Classic Essays on Science* New York Review of Books, 15 April, 1976

**Moore, A. D.**  
No biographical data available

Throughout the long history of the human race, we find that creativity has nearly always had to struggle against anything from discouragement to violent rejection.

*Invention, Discovery, and Creativity* (p. 140)

Doubleday & Company, Inc. Garden City, New York, USA. 1969

**Morton, Jack A.**  
No biographical data available

Creativity is involved in research, discovery of new knowledge, in its application, in development engineering, in the manufacture of the hardware, in marketing and sales, in the raising of capital, and in the supplying of services.

In Daniel V. DeSimone

*Education for Innovation*

Innovation and Entrepreneurship, Discussion (p. 105)

Pergamon Press. New York, New York, USA. 1968

**Sagan, Carl** 1934–96  
American astronomer and science writer

I know of no significant advance in science that did not require major inputs from both cerebral hemispheres. This is not true for art, where apparently there are no experiments by which capable, dedicated and unbiased observers can determine to their mutual satisfaction which works are great. As one of hundreds of examples, I might note that the principal French art critics, journals and museums of the late nineteenth and early twentieth centuries rejected French Impressionism in toto; today the same artists are widely held by the same institutions to have produced masterpieces. Perhaps a century hence the pendulum will reverse direction again.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 184)

Random House, Inc. New York, New York, USA. 1977

I think the most significant creative activities of our or any other human culture – legal and ethical systems, art and music, science and technology – were made possible only through the collaborative work of the left and right cerebral hemispheres.... We might say that human culture is the function of *corpus callosum*.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 185)

Random House, Inc. New York, New York, USA. 1977

**Salzberg, Paul**  
No biographical data available

There is no magic formula for achieving creativity – it is simply a way of life in a laboratory dedicated to discovery and invention.

*Think*, November–December, 1962

**Selye, Hans** 1907–82

Austrian endocrinologist

It is often cited as an argument against teamwork that every great new concept originates in one brain. This is true, but tossing an idea around in a group discussion helps to formulate it clearly in the brain of one participant or the other. Some of my best ideas came when I was trying to explain to my students and associates something that I myself only sensed but did not yet fully understand.

*From Dream to Discovery: On Being a Scientist*

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Tumin, Melvin**

No biographical data available

Let us not kid ourselves. The way to the creative life for the average man is difficult in the extreme.

In Sidney J. Parnes and Harold F. Harding

*A Source Book for Creative Thinking*

Obstacles to Creativity (p. 113)

Charles Scribner's Sons. New York, New York, USA. 1962

**Weisburd, Stefi**

American poet

Creativity is at once both an intensely individual act of expression and a bridge that links us to the rest of the universe. It can be a personal joy, a chance at immortality or a tool for humanity's survival. Yet, in spite of its importance to individuals and societies, creativity is not something that is freely and intensely exuded by everyone.

The Spark: Personal Testimonies of Creativity

*Science News*, November 7, 1987

**Wilson, Robert Q.**

No biographical data available

He who is truly creative can distinguish between those matters worthy of change and those that are not worth the effort.

*Battelle Technical Review*, Volume 11, Number 4, April, 1962 (p. 12)

**CREATURE****Samuelson, John Braxton**

No biographical data available

**James, Hicks**

No biographical data available

...no creature has been formed without its special ends, and that the humblest are frequently selected to carry out the most gigantic natural operations.

*Humble Creatures*

Letter III (p. 24)

John van Voorst. London, England. 1868

**CREDESCENCE****Heyl, Paul R.**

American scientist

...beware lest, flushed with success and intoxicated with power, you attempt too much and achieve your own downfall. What you tell me now goes beyond all bounds or credence.

*Annual Report of the Board of Regents of the Smithsonian Institution (1929)*

The Lingerer Dryad (p. 214)

Government Printing Office. Washington, D.C. 1930

**CREDIBLE****Ciardi, John** 1916–86

American poet, translator, and etymologist

Who could believe an ant in theory?

a giraffe in blueprint?

Ten thousand doctors of what's possible

could reason half the jungle out of being.

*Selected Poems*

Credibility (p. 54)

University of Arkansas Press. Fayetteville, Arkansas, USA. 1984

**CREDIT****Forbes, Edward** 1815–54

English naturalist

As to giving credit to whom credit is due, rest assured the best way to do good to one's-self is to do justice to others. There is plenty for everybody in science, and more than can be consumed in our time.

In George Wilson and Archibald Geikie

*Memoir of Edward Forbes, F.R.S.*

Chapter XI (p. 366)

Macmillan & Company Ltd. Cambridge, England. 1861

**CREDULITY****Stewart, Dugald** 1753–1828

Scottish philosopher

In the course of my own experience, I have never met with a mere mathematician who was not credulous to a fault: credulous not only with respect to human testimony, but credulous also in matters of opinion; and prone, on all subjects which he had not carefully studied, to repose too much faith in illustrious and consecrated names.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 294)

Harper & Brothers Publishers. New York, New York, USA. 1861

**CREED****Bourne, Gilbert Charles** 1861–1933

British naturalist

It is necessary, even in the study of Natural Science, to have something of the nature of a creed, an abiding belief

in some fixed principle, which may regulate and give coherence to the mass of information and ideas which we accumulate in the course of our studies. Without such a belief to guide us we embark on our journey of investigation without rudder, compass, or pilot.

*An Introduction to the Study of the Comparative Anatomy of Animals* (Volume 1)

Introduction (p. 1)

George Bell & Sons. London, England. 1900

**Lewes, George Henry** 1817–78  
English philosopher

No one meditating on the present condition of the intellectual world can fail to be arrested by the evidences of its deep-seated unrest. Yeast is working everywhere. Ancient formulas and time-honoured creeds are yielding as much to internal pressure as to external assault. The expansion of knowledge is loosening the very earth clutched by the roots of creeds and churches.

*Problems of Life and Mind* (Volume 1)

Part I, Chapter I (p. 1)

Trubner & Co

London, England. 1874–1875

**Lewis, Sinclair** 1885–1951  
American novelist

God give me unclouded eyes and freedom from haste.  
God give me quiet and relentless anger against all pretense and all pretentious work and all work left slack and unfinished. God give me a restlessness whereby I may neither sleep nor accept praise until my observed results equal my calculated results, or, in pious glee, I discover and assault my error. God give me strength not to trust to God.

*Arrowsmith*

Chapter XXVI, Section II (p. 292)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

### National Society of Professional Engineers

As a Professional Engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I Pledge:

To give the utmost of performance;

To participate in none but honest enterprise;

To live and work according to the laws of man and the highest standards of professional conduct.

To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

In humility and with need for Divine Guidance, I make this pledge.

*Engineers' Creed*

Adopted June, 1954

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

As soon as any one swears to a certain narrow creed in science, every unprejudiced and true perception is gone.

The decided Vulcanist always sees through the spectacles of a Vulcanist; and every Neptunist, and every professor of the newest elevation theory, through his own. The contemplation of the world, with all these theorists who are devoted to an exclusive view, has lost its innocence, and the objects no longer appear in their natural purity.

In John Stuart Blackie

*The Wisdom of Goethe*

Nature – Natural History (p. 187)

William Blackwood & Sons. Edinburgh, Scotland. 1883

## CRIME

**Plato** 428 BCE–347 BCE  
Greek philosopher

Do not great crimes and the spirit of pure evil spring out of a fullness of nature ruined by education rather than from any inferiority, whereas weak natures are scarcely capable of any very great good or very great evil?

Translated by B. Jowett

*The Republic of Plato* (2nd edition) (p. 184)

At The Clarendon Press. Oxford, England. 1881

**Wilson, Andrew** 1852–1912  
No biographical data available

...only when aided by the skilled expert – the chemist, surgeon, physiologist, or engraver – and by the deductions and inductions science is able or prepared to draw from any given set of circumstances, is justice enabled to enter upon the pursuit of crime, and to make her name a terror to evildoers.

*Leaves from a Naturalist's Note-book*

Science and Crime (p. 1)

Chatto & Windus. London, England. 1882

## CRITIC

**Pearson, Karl** 1857–1936  
English mathematician

If I have not paid greater attention to my numerous critics, it is not that I have failed to study them; it is simply that I have remained – obstinately it may be – convinced that the views expressed are, relatively to our present state of knowledge, substantially correct.

*The Grammar of Science* (2nd edition)

Preface to the Second Edition (p. ix)

Adam & Charles Black. London, England. 1900

## CRITICAL

**Newcomb, Simon** 1835–1909  
Canadian-American astronomer

All scientific conclusions drawn from statistical data require a critical investigation of the basis on which they rest.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*  
Chapter XIX (p. 303)  
Harper & Brothers Publishers. New York, New York, USA. 1906

## CRITICISM

**Cram, Donald J.** 1919–2001  
American chemist

Anyone who wishes to grow over their lifetime needs criticism.

*From Design to Discovery*  
Carbanion Stereochemistry and Mechanisms (1955–1972) (p. 45)  
American Chemical Society. Washington, D.C. 1990

**Darwin, Charles Robert** 1809–82  
English naturalist

Whenever I have found out that I have blundered, or that my work has been imperfect, and when I have been contemptuously criticized, and even when I have been overpraised, so that I have felt mortified, it has been my greatest comfort to say hundreds of time to myself that “I have worked as hard and as well as I could, and no man can do more than this.”

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II, Autobiography (p. 72)  
D. Appleton & Company. New York, New York, USA. 1887

Pray do not suppose that I expect to convert or pervert you; if I could stagger you in ever so slight a degree I should be satisfied; nor fear to annoy me by severe criticisms, for I have had some hearty kicks from some of my best friends.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
Letter to J. Prestwich, March 12, 1860 (p. 89)  
D. Appleton & Company. New York, New York, USA. 1896

**Pasteur, Louis** 1822–95  
French chemist

Little tolerant of frivolous or prejudiced contradiction, contemptuous of that ignorant criticism which doubts on principle, I welcome with open arms the militant attack which has a method in doubting and whose rule of conduct has the motto “More light.”

*The Harvard Classics* (Volume 38)  
*On the Extension of the Germ Theory to the Etiology of Certain Common Diseases* (p. 382)  
P.F. Collier & Son. New York, New York, USA. 1938

**Sagan, Carl** 1934–96  
American astronomer and science writer

Valid criticism does you a favor.  
*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 132)  
Random House, Inc. New York, New York, USA. 1995

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The criticism of knowledge is the criticism of the past.  
*Essays in Science and Philosophy*  
Education (p. 202)  
Philosophical Library. New York, New York, USA. 1947

## CRUST

**Darwin, Charles Robert** 1809–82  
English naturalist

The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its imbedded remains must not be looked at as a well filled museum, but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognized as having depended on an unusual occurrence of favorable circumstances, and the blank intervals between the successive stages as having been of vast duration.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter XV (p. 242)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gutenberg, Beno** 1889–1960  
German American seismologist

The books and papers dealing with hypotheses on the development of the earth’s crust are as the sands of the seas.

*Physics of the Earth* (Volume 7)  
Chapter IX (p. 177)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1939

## CRYSTALLOGRAPHY

**Lonsdale, Dame Kathleen** 1903–71  
English crystallographer

...a crystal is like a class of children arranged for drill, but standing at ease, so that while the class as a whole has regularity both in time and space, each individual child is a little fidgety!

*Crystals and X-Rays*  
Chapter I  
D. van Nostrand Company. New York, New York, USA. 1949

**Pauling, Linus** 1901–94  
American chemist

I miss the old days, when nearly every problem in X-ray crystallography was a puzzle that could be solved only by much thinking.

In Philip Ball  
*Designing the Molecular World: Chemistry at the Frontier* (p. 111)  
Princeton University Press. Princeton, New Jersey, USA. 1994

**CUBE**

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Can a cube that does not last for any time at all, have a real existence?

*The Great Ideas Toda*, 1971

*The Time Machine*

Chapter I (p. 449)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1971

**CULTURE**

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

Culture is not inherited through the genes. It is acquired, by every person for himself, through contacts with other people, who may or may not be biological relatives.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas Toda*, 1974

*Advancement and Obsolescence in Science* (p. 60)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1975

**Hart, Charles William**

Cultural anthropologist

...every culture in the world has had its own unique history and we cannot therefore say that any culture observable in the present day world is an earlier form of any other.

In H.A. Innis

*Essays in Political Economy*

Social Evolution and Modern Anthropology (p. 114)

University of Toronto Press. Toronto, Ontario, Canada. No date

**Libby, Walter** 1867–1955  
American science historian

Very little advance in culture could be made even by the greatest man of genius if he were dependent, for what knowledge he might acquire, merely on his own personal observation. Indeed, it might be said that exceptional mental ability involves a power to absorb the ideas of others, and even that the most original people are those who are able to borrow the most freely.

*An Introduction to the History of Science*

Chapter IV (p. 43)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1917

**Midgley, Mary** 1919–  
English philosopher

Man is innately programmed in such a way that he needs a culture to complete him. Culture is not an alternative or replacement for instinct, but its outgrowth and supplement.

*Beast and Man: The Roots of Human Nature*

Chapter 12 (p. 274)

Routledge. New York, New York, USA 2002

**CURE****Advertisement**

I have discovered the natural system of cure for all diseases, habits, defects, failings, etc., without the use of deleterious and pernicious drugs or medicines. Being Scientific, it is absolutely safe, simple, painless, pleasant, rapid, and infallible. Diseases like hysteria, epilepsy, rheumatism, loss of memory, paralysis, insanity and mania; addiction to smoking, opium, drink, etc.; impotence, sterility, adultery, and the like can be radically cured duly by My System.

In Aldous Huxley

*Jesting Pilate*

India & Burma (p. 119)

Chatto & Windus. London, England. 1926

**Alexander, Franz** 1891–1964

Hungarian-born physician and psychoanalysis pioneer

We now feel we can cure the patient without his fully understanding what made him sick. We are no longer so interested in peeling the onion as in changing it.

Psychoanalysis Then and Now

*Time*, May 19, 1961 (p. 68)

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

There is no curing a sick man who believes himself in health.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

February, 1877 (p. 305)

A.L. Burt Company, Publishers. New York, New York, USA. 189?

**Author undetermined**

One physician cures you of the colic; two physicians cure you of the medicine.

The Fixed Eruption

*Journal of the American Medical Association*, Volume 190, 1964 (p. 765)

**Baruch, Bernard M.** 1870–1965

American presidential advisor

There are no such things as incurables, there are only things for which man has not found a cure.

Address to the President's Committee on Employment of the Physically

Handicapped

News report of May 1, 1954

**Beaumont, Francis** 1584–1616

English playwright and dramatic poet

**Fletcher, John**

No biographical data available

THIERRY: We study satisfaction; must the cure Be worse than the disease?

*Beaumont and Fletcher*



*Thierry and Theodore*

Act IV, Scene ii

Charles Scribner's Sons. New York, New York, USA. 1904

**Born-Volber, A. J.**

No biographical data available

The farther the physician and the patient drift from nature, the more difficult it is to cure.

In Albert Abrams

*Man and His Poisons*

Chapter X (p. 220)

E.B. Treat & Co. New York, New York, USA. 1906

**Browne, Sir Thomas** 1605–82

English author and physician

...we all labour against our owne cure, for death is the cure of all diseases.

*Religio Medici*

Part II, Section 9 (p. 93)

Elliot Stock. London, England. 1883

**Burton, Robert** 1577–1640

English clergyman and scholar

It is in vain to speak of cures, or think of remedies, until such time as

we have considered of the causes...

*The Anatomy of Melancholy* (Volume 1)

Part I, Section II, Memb. I, Subsection 1 (p. 202)

AMS Press, Inc. New York, New York, USA. 1973

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Tis not amiss, ere ye're giv'no'er,  
To try one desp'rate med'cine more;  
For where your case can be no worse,  
The desp'rat is the wisest course.

*The Poetical Works of Samuel Butler* (Volume 1)

Epistle of Hudibras to Sidrophe

I, l. 5–8

Bell & Daldy. London, England. 1835

Diseases of their own accord,  
But cures come difficult and hard.

*The Poetical Works of Samuel Butler* (Volume 2)

The Weakness and Misery of Man, l. 82–83

Bell & Daldy. London, England. 1835

**Crabbe, George** 1754–1832

English poet

Man yields to custom, as he bows to fate,  
In all things rul'd – mind, body, and estate:  
In pain, in sickness, we for cure apply  
To them we know not, and we know not why...

*Tales*

Tale III (p. 46)

Printed for J. Hatchard. London, England. 1813

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

In truth, the most important thing for curing illnesses and maintaining health is good humor and joy.

In René Dubos & Jean-Paul Escande

Translated by Patricia Ranum

*Quest: Reflections on Medicine, Science, and Humanity*

Chapter III (p. 59)

Harcourt Brace Jovanovich. New York, New York, USA. 1979

**Hardy, Thomas** 1840–1928

English poet and regional novelist

And ill it therefore suits

The mood of one of my high temperature

To pause inactive while await me means  
of desperate cure for these so desperate ills!

*The Dynasts*

Part First, Act IV, Scene III

Warrington & Company. London, England. 1914

**Herrick, Robert** 1591–1674

English poet

To an old soare a long cure must goe on...

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

Great Maladies, Long Medicine (p. 50)

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Hitchcock, Alfred** 1899–1980

English-born American filmmaker

I have a perfect cure for a sore throat – cut it.

In Evan Esar

*20,000 Quips and Quotes* (p. 199)

Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

When desp'rate Ills demand a Speedy Cure,  
Distrust is Cowardice, and Prudence Folly.

*Irene*

Act IV, Scene I

Scolar Press Ltd. Menston, England. 1973

**Kipling, Rudyard** 1865–1936

British writer and poet

The cure for this ill is not to sit still,  
Or frost with a book by the fire;  
But to take a large hoe and a shovel also,  
And dig till you gently perspire.

*Just So Stories*

How the Camel Got His Hump (p. 27)

Doubleday & Company, Inc. Garden City, New York, USA. 1952

**Latham, Peter Mere** 1789–1875

English physician

Let cure be looked upon as concerned with the disease as such, and having little or no regard to the individual patient whom it befalls.

In William B. Bean

*Aphorisms from Latham* (p. 60)

Prairie Press. Iowa City, Iowa, USA. 1962

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Forth then issued Hiawatha,  
Wandered eastward, wandered westward,  
Teaching men the use of simples  
And the antidotes for poisons,  
And the cure of all diseases.  
Thus was first made known to mortals  
All the mystery of Medamin,  
All the sacred art of healing.

*The Song of Hiawatha*

Hiawatha's Lamentation (pp. 208–209)

A.L. Burt. New York, New York, USA. 1900

**Ray, John** 1627–1705  
English naturalist

What cannot be cured must be endured.

*A Complete Collection of English Proverbs* (p. 97)

Printed for G. Cowie. London, England. 1813

A disease known, is half cured.

*A Complete Collection of English Proverbs* (p. 100)

Printed for G. Cowie. London, England. 1813

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

It is human nature to think that if a small dose helps, a  
double dose will cure.

*Encyclopædia of Thoughts*

Aphorisms 329

Ithaca Heritage Books. Ithaca, New York, USA. 1975

One's desire to live is the best cure for many illnesses.

*Encyclopedia of Thoughts*

Aphorisms 370

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Activity is the best cure for many ills of body and mind.

*Encyclopedia of Thoughts*

Aphorisms 2252

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Shadwell, Thomas** 1642?–92  
English dramatist and poet

RAYMUND: Well a desperate disease must have a des-  
perate Cure...

*The Complete Works of Thomas Shadwell* (Volume 1)

*The Humorists*, Act IV (p. 237)

The Fortune Press. London, England. 1927

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Care is no cure, but rather corrosive  
For things that are not to be remedied.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The First Part of King Henry the Sixth*

Act III, Scene iii, l. 3

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Szasz, Thomas** 1920–  
Hungarian-born American psychiatrist

Masturbation: the primary sexual activity of mankind. In  
the nineteenth century it was a disease; in the twentieth,  
it's a cure.

*The Second Sin*

Sex (p. 12)

Anchor Press/Doubleday. Garden City, New Jersey, USA. 1974

**Tolstoy, Leo** 1828–1910  
Russian writer

What can doctors cure?

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Book Ten, Chapter XXIX (p. 449)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Trudeau, Edward**

No biographical data available

*Guérir quelquefois, soulager souvent, consoler toujours.*

To sometimes cure, often help, always console.

In René Dubos & Jean-Paul Escande

Translated by Patricia Ranum

*Quest: Reflections on Medicine, Science, and Humanity*

Chapter III (p. 56)

Harcourt Brace Jovanovich. New York, New York, USA. 1979

## CURIOSITY

**Amaldi, Ginestra Giovene**

No biographical data available

Man in his universe is like a baby in a strange room. Just  
as a baby reaches out to finger or taste all the mysteri-  
ous objects in the room, so man's curiosity is excited by  
the wonderful sights, sounds, and smells that greet him  
whichever way he turns.

*Our World and the Universe Around Us* (Volume 1)

Introduction (p. ix)

Abradale Press. New York, New York, USA. 1966

**Asimov, Isaac** 1920–92  
American author and biochemist

Curiosity, the overwhelming desire to know, is not char-  
acteristic of dead matter. Nor does it seem to be charac-  
teristic of some forms of living organism, which, for that  
very reason, we can scarcely bring ourselves to consider  
alive.

*Asimov's New Guide to Science*

Chapter 1 (p. 3)

Basic Books, Inc. New York, New York, USA. 1984

**Author undetermined**

Curiosity, curiosity, is an imperious tyrant, and it will be  
obeyed.

*The Fruitless Repentance*, Volumes 1–2

Volume 86 of the Flowering of the Novel  
*The Fruitless Repentance*  
 Chapter I  
 Garland Publications. 1974

**Bates, Marston** 1906–74  
 American zoologist

All children are curious and I wonder by what process this trait becomes developed in some and suppressed in others. I suspect again that schools and colleges help in the suppression insofar as they meet curiosity by giving the answers, rather than by some method that leads from narrower questions to broader questions. It is hard to satisfy the curiosity of a child, and even harder to satisfy the curiosity of a scientist, and methods that meet curiosity with satisfaction are thus not apt to foster the development of the child into the scientist. I don't advocate turning all children into professional scientists, although I think there would be advantages if all adults retained something of the questioning attitude, if their curiosity were less easily satisfied by dogma, of whatever variety.

*The Nature of Natural History*  
 Chapter 1 (p. 4)  
 1950

**Bauer, Henry H.** 1931–  
 American chemist

One can fool all the people some of the time, and some of the people all the time, but one cannot fool all the people all the time when the evidence is as clear as it can be in natural science. Nothing, by contrast, can force one person to agree with another about which approach to literary criticism is the best, right, or most fruitful; and we simply do not know what makes some children grow up curious and others uninterested; and we can and do argue and disagree over such matters without end.

*Scientific Literacy and the Myth of the Scientific Method*  
 Chapter 7 (p. 143)  
 University of Illinois Press. Urbana, Illinois, USA. 1992

**Born, Max** 1882–1970  
 German-born English physicist

The collective enterprise of practical science consists in the end of individuals and cannot thrive without their devotion. But devotion does not suffice; nothing great can be achieved without the elementary curiosity of the philosopher.

*Natural Philosophy of Cause and Chance*  
 Chapter X (p. 128)  
 At The Clarendon Press. Oxford, England. 1949

**Bostwick, Arthur Elmore** 1860–1942  
 No biographical data available

The lives of the great scientific men show that they all have something in common – a passion for truth, a

lifelong effort to get at new facts and to explain the old ones, a “divine curiosity,” pursued for its own sake and not for that of any personal advantage.

In Frederick Houk Law  
*Science in Literature*  
 Pivotal Figures of Science (p. 350)  
 Harper & Brothers Publishers. New York, New York, USA. 1929

**Brunstein, Karl A.**  
 No biographical data available

Curiosity is one of our more primal appetites. It may at time go out of fashion, but it always commands respect. Timeless as well as artless in its enticement, it has stirred men since mankind's more hirsute, sniffingly inquisitive days. Certainly it is the prerequisite of knowledge, if not that rarer quality of wisdom itself.

*Beyond The Four Dimensions*  
 Chapter One (p. 1)  
 Walker & Co. New York, New York, USA. 1979

**Burton, Robert** 1577–1640  
 English scholar

...curious wits, not be a slave of one science, or dwell altogether in one subject as most do, but [should] rove abroad, to have an oar in every mans boat, to taste of every dish, and sip of every cup,

*The Anatomy of Melancholy*  
 Democritus to the Reader (p. 14)  
 George Bell & Sons. London, England. 1896

### Charlie Chan (Fictional character)

Curiosity responsible for cat needing nine lives.  
*Charlie Chan at the Circus*  
 Film (1936)

Knowledge only gained through curiosity.  
*Charlie Chan at the Wax Museum*  
 Film (1940)

**Clarke, Arthur C.** 1917–  
 English science and science fiction writer

Perhaps one day men will no longer be interested in the unknown, no longer tantalized by mystery. This is possible, but when Man loses his curiosity one feels he will have lost most of the other things that make him human.

*The Exploration of Space*  
 Chapter 18 (p. 187)  
 Harper & Brothers Publishers. New York, New York, USA. 1951

**Coman, Dale Rex** 1906–  
 American research physician and wildlife writer

Youth's insatiable curiosity is soon squelched and its breadth of view quickly forced into the furrow cut by the plow of convention.

*The Endless Adventure*  
 The Swamp Pink and Long-Eared Owls (p. 139)  
 Henry Regnery Company. Chicago, Illinois, USA. 1972

**Day, Clarence S.** 1874–1935  
American writer

Creatures whose mainspring is curiosity will enjoy the accumulating of facts, far more than pausing at times to reflect on those facts.

*This Simian World*

Chapter Nine (p. 51)

Alfred A. Knopf. New York, New York, USA. 1941

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

So blind is the curiosity by which mortals are possessed, that they often conduct their minds along unexplored routes, having no reason to hope for success, but merely being willing to risk the experiment of finding whether the truth they seek lies there.

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule IV (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Douglas, A. Vibert** 1894–1988

Canadian astronomer

To every investigator there come moments when his thought is baffled, when the limits of experimental possibility seem to have been reached and he faces a barrier which defies his curiosity. Then it is that imagination, like a glorious greyhound, comes bounding along, leaps the barrier, and a vision is flashed before the mind – a vision no doubt that is partly false, but a vision that may be partly true. It stirs up new ideas in the thoughts of the investigator, it fires him with a fresh enthusiasm and his curiosity spurs him on to further endeavors.

From *Atoms to Stars*

*The Atlantic Monthly*, Volume 144, August, 1929 (p. 158)

**Einstein, Albert** 1879–1955

German-born physicist

The important thing is not to stop questioning. Curiosity has its own reason for existence. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery each day. Never lose a holy curiosity.

Old Man's Advice to Youth: "Never Lose a Holy Curiosity"

*Life*, May 2, 1955 (p. 64)

It is, in fact, nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry; for this delicate little plant, aside from stimulation, stands mainly in need of freedom; without this the plant goes to wreck and ruin without fail.

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 17)

Open Court. La Salle, Illinois, USA. 1979

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Curiosity is lying in wait for every secret.

*Letters and Social Aims*

*Progress of Culture* (p. 215)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1884

**Feynman, Richard P.** 1918–88

American theoretical physicist

...I stand at the seashore, alone, and start to think: There are the rushing waves...mountains of molecules each stupidly minding its own business...trillions apart...yet forming white surf in unison.

Ages on ages...before any eyes could see...year after year...thunderously pounding the shore as now. For whom, for what? ...On a dead planet with no life to entertain.

Never at rest tortured by energy...wasted prodigiously by the sun...poured into space. A mite makes the sea roar.

Deep in the sea, all molecules repeat the patterns of one another till complex new ones are formed. They make others like themselves...and a new dance starts.

Growing in size and complexity...living things, masses of atoms, DNA, protein...dancing a pattern ever more intricate.

Out of the cradle, onto dry land...here it is standing...atoms with consciousness...matter with curiosity.

Stands at the sea...wonders at wondering...I...a universe of atoms...an atom in the universe.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 6 (p. 144)

Perseus Books. Cambridge, Massachusetts, USA. 1999

**Frisch, Otto Robert** 1904–79

Austrian-born English physicist

...I think scientists have one thing in common with children: curiosity. To be a good scientist you must have kept this trait of childhood, and perhaps it is not easy to keep just this one trait. A scientist has to be curious like a child; perhaps one can understand that there are other childish features he hasn't grown out of.

*What Little I Remember*

Denmark 1934–1939: I (p. 86)

Cambridge University Press. Cambridge, England. 1979

**Gamow, George** 1904–68

Russian-born American physicist

They say "curiosity kills the cat"; I say "Curiosity makes a scientist."

*Mr. Tompkins in Paperback*

Chapter 15 (p. 186)

At The University Press. Cambridge, England. 1965

**Goldsmith, Oliver** 1728–74

Anglo-Irish writer, poet, and physician

...human curiosity, though at first slowly excited, being at last possessed of leisure for indulging its propensity, becomes one of the greatest amusements of life, and gives higher satisfactions than what even the senses can afford.

*A History of the Earth and Animated Nature* (Volume 1)

Chapter I (p. 9)

Claxton, Remson & Haffelfinger. Philadelphia, Pennsylvania, USA. 1875

**Haber, Heinz** 1913–90

German physicist

The curiosity of man must forever find its greatest challenge in the magnificent riddle of the universe.

*Stars, Men and Atoms*

Chapter 11 (p. 188)

Golden Press. New York, New York, USA. 1962

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...the laws of nature are not only permanent, but consistent, intelligible, and discoverable with such a moderate degree of research, as is calculated rather to stimulate than to weary curiosity.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter III, Section 33 (pp. 42–43)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Jevons, William**

English astronomer

Dull indeed must that mind be, and dead to all the charms of knowledge, which does not burn with eager curiosity to learn whatever may be known respecting these great [nocturnal heavenly] objects.

*Elements of Astronomy*

Introduction (p. 2)

Longman, Rees, Orme & Co. London, England. 1828

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

He that enlarges his curiosity after the works of nature, demonstrably multiplies the inlets to happiness.

*The Rambler* (Volume 1)

No. 5, April 3, 1750 (p. 75)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Johnstone, Charles**

No biographical data available

...under the direction of reason, its [curiosity] impulse is the strongest and most extensive cause of human knowledge.

*The Reverie* (Volume I)

Chapter I (p. 3)

Printed for T. Beckett. London, England. 1767

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Next to the peaceful pleasure of meeting genuine curiosity, half-way, upon its own ground, comes the joy of

combat when an attack upon some valued right or precious interest of the human spirit requires to be repelled.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter I (p. 1)

Columbia University Press. New York, New York, USA. 1916

Curiosity is the aspect of the universe seeking to realise itself, and the fruit of such activity is new reality, stimulating to new research.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter VI (p. 128)

Columbia University Press. New York, New York, USA. 1916

**Lauden, Larry** 1945–

American philosopher of science

If a sound justification for most scientific activity is going to be found, it will eventually come perhaps from a recognition that man's sense of curiosity about the world and himself is every bit as compelling as his need for clothing and food.... Making sense of the world and one's place in that world has roots deep within the human psyche.... We can drop the dangerous pretense that science is legitimate only in so far as it contributes to our material well-being or to our store of perennial truths. Viewed in this light, the repudiation of theoretical scientific inquiry is tantamount to a denial of what may be our most characteristically human trait.

*Progress and Its Problems: Toward a Theory of Scientific Growth*

Epilogue (p. 225)

University of California Press. Berkeley, California, USA. 1977

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The value the world sets upon [scientists'] motives is often grossly unjust and inaccurate. Consider, for example, two of them: mere insatiable curiosity and the desire to do good. The latter is put high above the former, and yet it is the former that moves some of the greater men the human race has yet produced: the scientific investigators. What actually urges him on is not some brummagem idea of Service, but a boundless, almost pathological thirst to penetrate the unknown, to uncover the secret, to find out what has not been found out before. His prototype is not the liberator releasing slaves, the good Samaritan lifting up the fallen, but a dog sniffing tremendously at an infinite series of rat-holes.

*Prejudices: Third Series*

Chapter XIV, Section 6 (pp. 269–270)

Alfred A. Knopf. New York, New York, USA. 1922

**Munroe, J.**

No biographical data available

Our scientific curiosity is excited, and we find ourselves trying to explain the physical causes of the effect of the impression produced on us. We are like the geologist who was insensible to the beauty of the Apollo Belvedere, because he was examining the texture of the marble.



Science and the Sense of Beauty  
*The Journal of Science, and Annals of Astronomy, Biology, Geology,*  
 Volume IV, (Third series), April, 1882 (p. 204)

**Newman, Paul** 1925–  
 American actor

I'm depending upon his curiosity. It's a pretty strong instinct among most people, but among scientists it's a bloody obsession.

*Torn Curtain*  
 Film (1966)

**Pittendreigh, Jr., W. Maynard**  
 No biographical data available

I burn with curiosity about what lies beyond the sky.  
 Pittendreigh's Law of Planetary Motion  
*Sky & Telescope*, Volume 87, Number 2, February, 1994 (p. 6)

**Professor Barnhardt (Fictional character)**

It isn't faith that makes good science Mr. Klaatu, it's curiosity.

*The Day the Earth Stood Still*  
 Film (1951)

**Roberts, Mary** 1788–1864  
 English botanist and author

The curiosity of the human mind is insatiable. It looks abroad into the fair creation, and sees unnumbered instances of grandeur and munificence.

*The Sea-side Companion; or, Marine Natural History*  
 Letter 1 (p. 10)  
 Printed for Whittaker & Co. London, England. 1835

**Ruelle, David** 1935–  
 Belgian-French mathematical physicist

What is the origin of the urge, the fascination that drives physicists, mathematicians, and presumably other scientists as well? Psychoanalysis suggests that it is sexual curiosity. You start by asking where little babies come from, one thing leads to another, and you find yourself preparing nitroglycerine or solving differential equations. This explanation is somewhat irritating, and therefore probably basically correct.

*Chance and Chaos*  
 Chapter 26 (p. 164)  
 Princeton University Press. Princeton, New Jersey, USA. 1991

**Selye, Hans** 1907–82  
 Austrian endocrinologist

The true scientist thrives on curiosity...  
*From Dream to Discovery: On Being a Scientist*  
 Chapter 1 (p. 10)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

Scientific curiosity can be satisfied much more easily by reading the publications of others than by working in the lab. It may take years to prove by experimentation

what we can learn in the few minutes needed to read the published end result. So let us not fool ourselves; the driving force is hardly sheer curiosity.

*From Dream to Discovery: On Being a Scientist*  
 Chapter 1 (p. 15)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shelley, Mary Wollstonecraft** 1797–1851  
 English Romantic writer

Curiosity, earnest research to learn the hidden laws of nature, gladness akin to rapture, as they were unfolded to me, are among the earliest sensations I can remember.

*Frankenstein: Or, The Modern Prometheus*  
 Chapter 2 (p. 48)  
 George Routledge & Sons. London, England. 1888

**Stein, Sherman K.**  
 No biographical data available

...the power of curiosity...makes men explore the unknown to find the truth whether it be of stars, continents or mathematics.

The Mathematician as an Explorer  
*Scientific American*, Volume 204, Number 5, May, 1961 (p. 158)

**Stetson, Harlan True** 1885–1964  
 American astronomer and physicist

That which arouses the greatest curiosity is the first to be intelligently investigated.

*Man and the Stars*  
 Chapter I (p. 4)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1930

**von Ebner-Eschenbach, Marie** 1830–1916  
 Austrian novelist

When curiosity is felt about serious things we call it thirst for knowledge.

Translated by Annis Lee Wister  
*Aphorisms*  
 Number 73  
 J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

**von Goethe, Johann Wolfgang** 1749–1832  
 German poet, novelist, playwright, and natural philosopher

The desire of knowledge is first stimulated in us when remarkable phenomena attract our attention. In order that this attention be continued it is necessary that we should feel some interest in exercising it, and thus by degrees we become better acquainted with the object of our curiosity.

Translated by Charles Lock Eastlake  
*Goethe's Theory of Colour*  
 Introduction (p. li)  
 The MIT Press. Cambridge, Massachusetts, USA. 1970

**Weisskopf, Victor Frederick** 1908–2002  
 Austrian-American physicist

Curiosity without compassion is inhuman; compassion without curiosity is ineffectual.



*The Development of Science during this Century*

Talk presented at the Conference on Disarmament and Arms Limitation Obligations: Problems of Compliance and Enforcement, Geneva, Switzerland, 5–6 Aug. 1993

Science is an important part of the humanities because it is based on an essential human trait: curiosity about how and why of our environment. We must foster wonder, joy of insight.

*The Privilege of Being a Physicist*

Chapter 4 (p. 33)

W.H. Freeman & Company. New York, New York, USA. 1989

**Whately, Richard** 1787–1863

English theologian

Curiosity is the desire of knowing what is unknown, for that reason alone.

*Miscellaneous Remains from the Commonplace Book of Richard*

*Whately, D.D.*

Apothegms (p. 6)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

...the valuable attributes of research men are conscious ignorance and active curiosity.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry

*Science*, Volume 65, Number 1862, March 25, 1927 (p. 285)

**Wright, Helen**

No biographical data available

The curiosity of Alice to see what lives behind the looking glass may be likened to the desire of the astronomer to see beyond the range of his vision. By each addition to the light-gathering power of his instrument he soon yearns for a glimpse of things farther away and plans for a larger telescope.

*Palomar: The World's Largest Telescope*

A 200 Inch Mirror (p. 91)

The Macmillan Company. New York, New York, USA. 1952

## CURVE

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...I shall have given here a sufficient introduction to the study of curves when I have given a general method of drawing a straight line making right angles with a curve at an arbitrarily chosen point upon it. And I dare say that this is not only the most useful and most general problem in geometry that I know, but even that I have ever desired to know.

In *Great Books of the Western World* (Volume 31)

*Geometry*

Second Book (p. 317)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Johnson, George** 1952–

American science writer

A theory can be thought of as the fitting of a curve to a spray of data. One can always simply go from point to point, connecting the dots like those of a child's coloring book. But all that is left is a meandering line with little explanatory power; there is no way to predict how future points are likely to fall. Science is the search for neat, predictable curves, compact ways of summarizing the data. But there is always the danger that the curves we see are illusory, like pictures of animals in clouds.

*Fire in the Mind: Science, Faith, and the Search for Order*

Introduction (p. 4)

Vintage Books. New York, New York, USA. 1995

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

The curves treated by the calculus are normal and healthy; they possess no idiosyncrasies. But mathematicians would not be happy merely with simple, lusty configurations. Beyond these their curiosity extends to psychopathic patients, each of whom has an individual case history resembling no other; these are the pathological curves in mathematics.

*Mathematics and the Imagination*

Chance and Chanceability – The Calculus (p. 343)

Simon & Schuster. New York, New York, USA. 1940

**Klein, Felix** 1849–1925

German mathematician

Everyone knows what a curve is, until he has studied enough mathematics to become confused through the countless number of possible exceptions.

In Carl B. Boyer

The Invention of Analytic Geometry

*Scientific American*, Volume 180, Number 1, January, 1949 (p. 41)

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The curve described by a simple molecule of air or vapor is regulated in a manner just as certain as the planetary orbits; the only difference between them is that which comes from our ignorance.

*A Philosophical Essay on Probabilities*

Chapter II (p. 6)

John Wiley & Sons. London, England. 1902

**West, Mae** 1893–1980  
American film actress

A figure with curves always offers a lot of interesting angles.

*The Wit and Wisdom of Mae West* (p. 35)  
G.P. Putnam's Sons. New York, New York, USA. 1967

## CYNIC

**Gibson, William Hamilton**  
No biographical data available

My butterfly net and pocket magnifying-glass are rare companions for a walk in the country.

*Sharp Eyes: A Rambler's Calendar*

The Sweep-Nest Harvest  
July 21st (p. 117)  
Harper & Brothers Publishers. New York, New York, USA. 1900

**Huxley, Thomas Henry** 1825–95  
English biologist

I wish not to be in any way confounded with the cynics who delight in degrading man, or with the common run of materialists, who think mind is any the lower for being a function of matter. I dislike them even more than I do the pietists.

In Leonard Huxley  
*Life and Letters of Thomas Henry Huxley* (Volume 1)  
Chapter XVI  
Letter to Hooker, January 6, 1861 (p. 241)  
D. Appleton & Company. New York, New York, USA. 1901

## D

### DANGEROUS

#### Henry Frankenstein (Fictional character)

Dangerous? Poor old Waldman. Have you never wanted to do anything that was dangerous? Where should we be if no one tried to find out what lies beyond? Have your never wanted to look beyond the clouds and the stars, or to know what causes the trees to bud? And what changes the darkness into light? But if you talk like that, people call you crazy. Well, if I could discover just one of these things, what eternity is, for example, I wouldn't care if they did think I was crazy.

Frankenstein

### DARK AGE

#### London, Jack 1876–1916

American author

...the Dark Ages. A period wherein science was raped by the metaphysicians, wherein physics became a search for the Philosopher's Stone, wherein chemistry became alchemy, and astronomy became astrology.

*The Iron Heel*

Chapter I (p. 13)

The Review of Review's Co. New York, New York, USA. 1917

### DARK ENERGY

#### Kirshner, Robert P.

American astronomer

We are not made of the type of particles that make up most of the matter in the universe, and we have no idea yet how to sense directly the dark energy that determines the fate of the universe.

In John Noble Wilford

From Distant Galaxies, News of a "Stop-and-Go Universe"

*New York Times*, June 3, 2003

### DARK MATTER

#### Belkora, Leila

No biographical data available

Considering that more than 90% of the universe consists of unknown dark matter, we may have to admit that the stellar system we have studied so long, and with so much success since the middle of the twentieth century, may add up to only a tiny part of the galaxy – as though we

had been studying the foam on a breaking wave, and thought we understood the ocean.

*Minding the Heavens: The Story of Our Discovery of the Milky Way*

Chapter 10 (p. 369)

Institute of Physics Publishing, Bristol, England. 2003

#### Browning, Robert 1812–89

English poet

Greet the unseen with a cheer!

*The Poems and Plays of Robert Browning*

Asolando

Epilogue

The Modern Library, New York, New York, USA. 1934

#### de Saint-Exupéry, Antoine 1900–44

French aviator and writer

What is most essential is invisible to the eye.

Translated by Katherine Woods

*The Little Prince*

Chapter XXI (p. 70)

Harcourt, Brace & Company, New York, New York, USA. 1943

#### Herschel, Friedrich Wilhelm

(Sir William) 1738–1822

English astronomer

*Hier ist wahrhaftig ein Loch im Himmel!*

Here, truly, is a hole in the heavens!

In Hector Macpherson

*A Century's Progress in Astronomy*

Chapter II (p. 32)

William Blackwood & Sons, Edinburgh, Scotland. 1909

#### Kolb, Edward W. (Rocky) 1951–

American cosmologist

It's like Elvis. There are sightings [of dark matter] every so often that are never confirmed.

Quoted in Usha Lee McFarling

Darkest Puzzle of the Cosmos

*LA Times*, March 20, 2000

#### Milgrom, Mordehai

Israeli physicist

If we accept a departure from the standard laws of physics, we might do away with dark matter.

Does Dark Matter Really Exist?

*Scientific American*, Volume 287, Number 2, August, 2002. (p. 44)

#### Riordan, Michael

No biographical data available

#### Schramm, David N.

No biographical data available

Modern science is based on observation and measurement, and cosmology is no exception. The mysteries of dark matter and the structure of the universe will resolve

not just by thinking and calculating, but also by watching and probing.

*The Shadows of Creation*

Chapter 11 (p. 255)

H.W. Freeman & Company. New York, New York, USA. 1991

## DARKNESS

**Morley, Christopher** 1890–1957

American writer

Of all gifts to earth, the first and greatest was darkness. Darkness preceded light, you will remember, in Genesis. Perhaps that is why darkness seems to man natural and universal. It requires no explanation and no cause. We postulate it. Whereas light, being to our minds merely the cleansing vibration that dispels the black, requires some origin, some lamp whence to shine. From the appalling torch of the sun down to the pale belly of the glowworm we deem light a derivative miracle, proceeding from some conceivable source. We can conceive darkness without thought of light; but we cannot conceive light without darkness.

*Travels in Philadelphia*

Darkness Visible (p. 108)

Wm. F. Fell Company. Philadelphia, Pennsylvania, USA. 1920

## DARWIN, CHARLES

**Huxley, Thomas Henry** 1825–95

English biologist

To the present generation, that is to say, the people a few years on the hither and thither side of thirty, the name of Charles Darwin stands alongside of those of Isaac Newton and Michael Faraday; and, like them, calls up the grand ideal of a searcher after truth and interpreter of Nature.

In Francis Darwin

*The Life and Letters of Charles Darwin* (Volume 1)

On the Reception of the Origin of Species (p. 533)

D. Appleton & Co. New York, New York, USA. 1904

## DARWINISM

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

I confess that I was not prepared to see this theory [Darwinism] received as it has been by the best intellects of our time. Its success is greater than I could have thought possible.

In John Tyndall

*Fragments of Science: A Series of Detached Essays, Addresses, and*

*Reviews* (5th edition) (p. 514)

D. Appleton & Co. New York, New York, USA. 1884

**Butler, Samuel** 1835–1902

British writer

Darwinism tries to explain how I am here by showing how my uncles, cousins, and aunts have gone away.

J. Arthur Thomson

*The System of Animate Nature: The Gifford Lectures Delivered in the*

*University of St. Andrews in the Years 1915 and 1916*

Lecture XIV (p. 441)

Henry Holt & Co. New York, New York, USA. 1920

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

It is almost as if the human brain were specifically designed to misunderstand Darwinism, and to find it hard to believe.

*The Blind Watchmaker*

Preface (p. xi)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

The kindly God who lovingly fashioned each and every-one of us (all creatures great and small) and sprinkled the sky with shining stars for our delight – that God is, like Santa Claus, a myth of childhood, not anything a sane, undeluded adult could literally believe in. That God must either be turned into a symbol for something less concrete or abandoned altogether.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 18)

Simon & Schuster. New York, New York, USA. 1995

Almost no one is indifferent to Darwin, and no one should be. The Darwinian theory is a scientific theory, and a great one, but that is not all it is. The creationists who oppose it so bitterly are right about one thing: Darwin's dangerous idea cuts much deeper into the fabric of our most fundamental beliefs than many of its sophisticated apologists have yet admitted, even to themselves.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 18)

Simon & Schuster. New York, New York, USA. 1995

Let me lay my cards on the table. If I were to give an award for the single best idea anyone ever had, I'd give it to Darwin, ahead of even Newton or Einstein and everyone else. In a single stroke, the idea of evolution by natural selection unifies the realm of life, meaning and purpose with the realm of space and time, cause and effect, mechanism and physical law.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 21)

Simon & Schuster. New York, New York, USA. 1995

Do you believe, literally, in an anthropomorphic God? If not, then you must agree with me that the song is a beautiful, comforting falsehood. Is that simple song nevertheless a valuable meme? I certainly think it is. It is a

modest but beautiful part of our heritage, a treasure to be preserved. But we must face the fact that, just as there were times when tigers would not have been viable, times are coming when they will no longer be viable, except in zoos and other preserves, and the same is true of many of the treasures in our cultural heritage.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 514)

Simon & Schuster. New York, New York, USA. 1995

We cannot preserve all the features of the cultural world in which these treasures flourished. We wouldn't want to.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 514)

Simon & Schuster. New York, New York, USA. 1995

But hasn't there been a tremendous rebirth of fundamentalist faith in all these creeds? Yes, unfortunately, there has been, and I think that there are no forces on this planet more dangerous to us all than the fanaticisms of fundamentalism, of all the species: Protestantism, Catholicism, Judaism, Islam, Hinduism, and Buddhism, as well as countless smaller infections. Is there a conflict between science and religion here? There most certainly is.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 515)

Simon & Schuster. New York, New York, USA. 1995

I know, I know, the lion is beautiful but dangerous; if you let the lion roam free, it would kill me; safety demands that it be put in a cage. Safety demands that religions be put in cages, too – when absolutely necessary.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 515)

Simon & Schuster. New York, New York, USA. 1995

Save the Baptists! Yes, of course, but not by all means. Not if it means tolerating the deliberate misinforming of children about the natural world. According to a recent poll, 48% of the people in the USA today believe that the book of Genesis is literally true. And 70% believe that "creation science" should be taught in school alongside evolution. Some recent writers recommend a policy in which parents would be able to "opt out" of materials they didn't want their children taught. Should evolution be taught in the schools? Should arithmetic be taught? Should history? Misinforming a child is a terrible offense.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 516)

Simon & Schuster. New York, New York, USA. 1995

The message is clear: those who will not accommodate, who will not temper, who insist on keeping only the purest and wildest strain of their heritage alive, we will be obliged, reluctantly, to cage or disarm, and we will do our best to disable the memes they fight for.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 516)

Simon & Schuster. New York, New York, USA. 1995

If you insist on teaching your children falsehoods – that the Earth is flat, that "Man" is not a product of evolution by natural selection – then you must expect, at the very least, that those of us who have freedom of speech will feel free to describe your teaching as the spreading of falsehoods, and will attempt to demonstrate this to your children at our earliest opportunity. Our future well-being – the well-being of all of us on the planet – depends on the education of our descendants.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 519)

Simon & Schuster. New York, New York, USA. 1995

### **Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

The Darwinian revolution knocked out the back wall, revealing eerie lighted landscapes as far back as we can see. Almost at once, Albert Einstein and astronomers with reflector telescopes and radio telescopes knocked out the other walls and ceilings leaving us sunlit, exposed and drifting – leaving us puckers, albeit evolving puckers, on the inbound curve of space.

*Teaching a Stone to Talk*

Life on the Rocks (p. 121)

Harper & Row Publishers. New York, New York, USA. 1982

### **Haeckel, Ernst Heinrich Philipp**

**August** 1834–1919

German biologist and philosopher

...Darwinism is (like Hegel's philosophy) the delusion of a generation.

Translated by Joseph McCabe

*The Wonders of Life: A Popular Study of Biological Philosophy*

Harper & Brothers Publishers. New York, New York, USA. 1904

### **Jones, F. Wood** 1879–1954

English naturalist and anthropologist

Only a fool could deny the revolutionary impact of Darwinism on the outlook of the nineteenth century, when – as one biologist put it – the educated public was faced with the alternative "for Darwin or against evolution." But the narrow sectarianism of the neo-Darwinists of our own age is an altogether different matter; and in the not-too-distant future biologists may well wonder what kind of benightedness it was that held their elders in thrall.

In Arthur Koestler

*Janus: A Stumming Up*

Chapter X, Section 5 (p. 204)

Random House, Inc. New York, New York, USA. 1978

### **Kitcher, Philip**

No biographical data available

Darwin is the Newton of Biology.

*Abusing Science: The Case Against Creationism*

Chapter 2 Believing What We Cannot Prove (p. 54)

The MIT Press. Cambridge, Massachusetts, USA. 1982

**Marett, Robert Randolph** 1866–1943  
Social anthropologist

[Darwinism] means that man must, for certain purposes of science, toe the line with the rest of living things. And at first, naturally enough, man did not like it. He was too lordly. For a long time, therefore, he pretended to be fighting for the Bible, when he was really fighting for his own dignity. This was rather hard on the Bible, which has nothing to do with the Aristotelian theory of the fixity of species; though it might seem possible to read back something of the kind into the primitive creation-stories preserved in Genesis. Now-a-days, however, we have mostly got over the first shock to our family pride. We are all Darwinians in a passive kind of way.

*Anthropology*

Chapter I (p. 9)

Henry Holt & Co. New York, New York, USA. 1912

**McKibben, Bill** 1960–  
American freelance writer

“Science,” of course, replaced “God” as a guiding concept for many people after Darwin. Or, really, the two were rolled up into a sticky ball. To some degree this was mindless worship of a miracle future, the pursuit of which has landed us in the fix we now inhabit.

*The End of Nature*

The End of Nature (pp. 80–81)

Random House, Inc. New York, New York, USA. 1989

**Newman, Joseph S.** 1892–1960  
American poet

What countless procreative mates  
Brought plasmic cells to vertebrates  
And blazed the long ancestral trails  
That substituted brains for tails!  
For when the human kind began  
It did not spring full-blown to man;  
It started from the very seed  
That branched to snail and centipede,  
And which, by devious ways Darwinian,  
Made oyster, lobster, and Virginian.

*Poems for Penguins and Other Lyrical Lapses*

Anthropology

Greenburg. New York, New York, USA. 1941

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

...as compared to the open-eyed intelligent wanting and trying of Lamarck, the Darwinian process may be described as a chapter of accidents. As such, it seems simple, because you do not at first realise all that it involves. But when its whole significance dawns on you, your heart sinks into a heap of sand within you. There is a hideous fatalism about it, a ghastly and damnable reduction of beauty and intelligence, of strength and purpose,

of honour and aspirations, to such casually picturesque changes as an avalanche may make in a mountain landscape, or a railway accident in a human figure.

*Back to Methuselah*

Preface (p. xl)

Constable & Company Ltd. London, England. 1921

**Wilson, Edward O.** 1929–  
American biologist and author

Like the old god Proteus it [Darwinism] is endless in the form it takes and is therefore filled with the information of realized Nature.

*The Diversity of Life*

Chapter Six (p. 80)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

The rise of Darwinism reminds us that a great scientific theory is like a sunrise. It illuminates the steeples of the unknown and then their dark hollows.

The Linnaean Enterprise: Past, Present, and Future

*Proceedings, American Philosophical Society*, Volume 149, Number 3, 2005 (p. 346)

## DATA

### Author undetermined

Sint ut sunt aut non sint.

Accept them as they are or deny their existence.

Source undetermined

### Bartel, N., et al

No biographical data available

No data were taken at station D during the period 0830 to 1630 GST due to the presence of a red racer snake (*Coluber constrictor*) draped across the high-tension wires (33,000 V) serving the station. However, even though this snake, or rather a three-foot section of its remains, was caught in the act of causing an arc between the transmission lines, we do not consider it responsible for the loss of data. Rather we blame the incompetence of a red-tailed hawk (*Buteo borealis*) who had apparently built a defective nest that fell off the top of the nearby transmission tower, casting her nestlings to the ground, along with their entire food reserve consisting of a pack rat, a kangaroo rat, and several snakes, with the exception of the above-mentioned snake who had a somewhat higher destiny. No comparable loss of data occurred at the other antenna sites.

VLBI Observations of 23 Hot Spots in the Starburst Galaxy M82

*Astrophysical Journal, Part 1*, Volume 323, December 15, 1987 (p. 507)

**Berkeley, Edmund C.** 1909–88  
American computer theoretician

There is no substitute for honest, thorough, scientific effort to get correct data (no matter how much of it clashes with preconceived ideas). There is no substitute



for actually reaching a correct claim of reasoning. Poor data and good reasoning give poor results. Good data and poor reasoning give poor results. Poor data and poor reasoning give rotten results.

Right Answers – A Short Guide for Obtaining Them  
*Computers and Automation*, Volume 18, Number 10, September, 1969 (p. 20)

Lots of people bring you false information.

Right Answers – A Short Guide for Obtaining Them  
*Computers and Automation*, Volume 18, Number 10, September, 1969 (p. 20)

**Binford, Lewis R.** 1930–

American archaeologist

...data relevant to most, if not all, of the components of past sociocultural systems are preserved in the archaeological record.... Our task, then, is to devise means for extracting this information from the data.

*An Archaeological Perspective*  
Archaeological Perspectives (p. 95)  
Seminar Press. New York, New York, USA. 1972

**Brinton, Willard Cope**

No biographical data available

After a person has collected data and studied a proposition with great care so that his own mind is made up as to the best solution for the problem, he is apt to feel that his work is about completed. Usually, however, when his own mind is made up, his task is only half done. The larger and more difficult part of the work is – to convince the minds of others that the proposed solution is the best one ...

*Graphic Methods for Presenting Facts*  
Chapter I (p. 1)  
The Engineering Magazine Co. New York, New York, USA. 1914

**Burger, Edward B.**

American mathematician

**Starbird, Michael**

American mathematician

With our heads spinning in the world of coincidence and chaos, we nevertheless must make decisions and take steps into the minefield of our future. To avoid explosive missteps, we rely on data and statistical reasoning to inform our thinking.

*Coincidences, Chaos, and All That Math Jazz*  
Understanding Uncertainty (p. 2)  
W.W. Norton & Co. New York, New York, USA. 2005

**Captain Kirk (Fictional character)**

Insufficient data is not sufficient, Mr. Spock. You're the Science Officer, you're supposed to have sufficient data all the time.

*STAR TREK: The Original Series*  
The Immunity Syndrome  
Television program  
Season 2, 1968

**Chatfield, Christopher**

English statistician

More fundamentally students should be taught that instead of asking "What techniques shall I use here?," they should ask "How can I summarize and understand the main features of this set of data?"

The Initial Examination of Data  
*Journal of the Royal Statistical Society, Series A*, Volume 148, 1985

**Childe, V. Gordon** 1892–1957

Australian-English archaeologist

All archaeological data are expressions of human thoughts and purposes and are valued only as revelations thereof.

*A Short Introduction to Archaeology*  
Chapter One (p. 11)  
Frederick Muller LTD. London, England. 1956

**Cousins, Norman** 1912–90

American editor and author

There is a tendency to mistake data for wisdom, just as there has always been a tendency to confuse logic with values, intelligence with insight. Unobstructed access to facts can produce unlimited good only if it is matched by the desire and ability to find out what they mean and where they lead. Facts are terrible things if left sprawling and unattended. They are too easily regarded as evaluated certainties rather than as the rawest of raw materials crying to be processed into the texture of logic.

*Human Options: An Autobiographical Notebook*  
Freedom as Teacher (p. 104)  
W.W. Norton & Company, Inc. New York, New York, USA. 1981

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

There is only one kind of whiskey, but two broad classes of data, good and bad.

On the Classification of Statistics  
*The American Statistician*, Volume 2, Number 2, April, 1948 (p. 16)

Scientific data are not taken for museum purposes; they are taken as a basis for doing something. If nothing is to be done with the data, then there is no use in collecting any. The ultimate purpose of taking data is to provide a basis for action or a recommendation for action. The step intermediate between the collection of data and the action is prediction.

On a Classification of the Problems of Statistical Inference  
*Journal of the American Statistical Association*, Volume 37, Number 218, June, 1942 (p. 173)

Anyone can easily misuse good data.

*Some Theory of Sampling* (p. 18)  
John Wiley & Sons, Inc. New York, New York, USA. 1950

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“No data yet,” he answered. “It is a capital mistake to theorize before you have all of the evidence. It biases the judgment.”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 3 (p. 166)  
Wings Books. New York, New York, USA. 1967

Still, it is an error to argue in front of your data. You find yourself insensibly twisting them around to fit your theories.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of Wisteria Lodge* (p. 246)  
Wings Books. New York, New York, USA. 1967

“Data! Data! Data!” he cried impatiently. “I can’t make bricks without clay.”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of the Copper Beeches* (p. 120)  
Wings Books. New York, New York, USA. 1967

I have no data yet. It is a capital mistake to theorize before one has data. Insensibly, one begins to twist facts to suit theories, instead of theories to suit facts.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Scandal in Bohemia* (pp. 349–350)  
Wings Books. New York, New York, USA. 1967

### **Ehrenberg, A. S. C.**

No biographical data available

Data are often presented in a form that is not immediately clear. The reader can then either ignore the data, analyze them himself, or return them to the author for him to analyze.

*Data Reduction*  
Part I (p. 1)  
John Wiley & Sons Ltd. London, England. 1975

### **Enarson, Harold L.** 1819–2006

American educator

It does not follow that because something can be counted it therefore should be counted.

Speech  
To Society for College & University Planning, September, 1975

### **Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

No human mind is capable of grasping in its entirety the meaning of any considerable quantity of numerical data.

*Statistical Methods for Research Workers*  
Chapter I (p. 6)  
Oliver & Boyd. Edinburgh, Scotland. 1938

### **Fort, Charles** 1874–1932

American writer

The interpretations will be mine, but the data will be for anybody to form his own opinions on.

In Damon Knight

*Charles Fort: Prophet of the Unexplained*  
A Charles Fort Sampler (p. vii)  
Gollancz. London, England. 1971

A procession of the damned. By the damned, I mean the excluded.

We shall have a procession of data that Science has excluded.

Battalions of the accursed, captained by pallid data that I have exhumed, will march. You’ll read them – or they’ll march. Some of them livid and some of them fiery and some of them rotten.

Some of them are corpses, skeletons, mummies, twitching, tottering, animated by companions that have been damned alive. There are giants that will walk by, though sound asleep. There are things that are theorems and things that are rags: they’ll go by like Euclid arm in arm with the spirit of anarchy. Here and there will flit little harlots. Many are clowns. But many are of the highest respectability. Some are assassins. There are pale stenchers and gaunt superstitions and mere shadows and lively malices: whims and amiabilities. The naive and the pedantic and the bizarre and the grotesque and the sincere and the insincere, the profound and the puerile.

*The Book of the Damned*  
Chapter I (p. 7)  
Boni & Liveright. New York, New York, USA. 1919

I have gone into the outer darkness of scientific and philosophical transactions and proceedings, ultra-respectable, but covered with the dust of disregard. I have descended into journalism. I have come back with the quasi-souls of lost data.

*The Book of the Damned*  
Chapter I (p. 15)  
Boni & Liveright. New York, New York, USA. 1919

### **Fox, Russell**

No biographical data available

### **Gorbunov, Max**

No biographical data available

It has been said that data collection is like garbage collection: before you collect it you should have in mind what you are going to do with it.

*The Science of Science: Methods of Interpreting Physical Phenomena*  
Chapter 6 (p. 51)  
Walker. New York, New York, USA. 1964

### **Freeman, R. Austin** 1862–1943

British physician and mystery novelist

I can only suggest that, as we are practically without data, we should endeavor to obtain some.

*A Certain Dr. Thorndyke*  
Thorndyke Takes Up the Inquiry (p. 186)  
Dodd, Mead & Company. New York, New York, USA. 1928

**Greenstein, George** 1940–  
American astronomer

Data in isolation are meaningless, a collection of numbers. Only in context of a theory do they assume significance...

*Frozen Star*

Chapter 1 (pp. 3–4)

Freundlich Books. New York, New York, USA. 1983

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

By any process of reasoning whatever (not fancy) you cannot get any results that are not implicitly contained in the material with which you work, the fundamental data and their connections, which form the basis of your inquiry.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 9)

D. van Nostrand Co. New York, New York, USA. 1893

**Hodnett, Edward** 1901–84

Illustration historian

When you learn how to mobilize your data and bring them to bear on your problems, you are no longer a rank amateur.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 42)

Harper & Brothers. New York, New York, USA. 1955

**Hooke, Robert** 1635–1703

English physicist

If you can't have an experiment, do the best you can with whatever data you can gather, but do be very skeptical of historical data and subject them to all the logical tests you can think of.

In J.M. Tanur

*Statistics: A Guide to the Unknown*

Statistics, Sports, and Some Other Things (p. 195)

Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

To the optical astronomer, radio data serves like a good dog on a hunt.

*Galaxies, Nuclei and Quasars* (p. 43)

Harper & Row, Publishers. New York, New York, USA. 1965

**Hull, David L.** 1935–

American philosopher of biology

Although data about science are to some extent malleable, they are not totally plastic.

*Science As Process*

Chapter One (p. 17)

The University of Chicago Press. Chicago, Illinois, USA. 1988

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

In examining things present, we have data from which to reason with regard to what has been; and, from what has actually been, we have data for concluding with regard to that which is to happen hereafter.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section I (p. 19)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Inose, Hiroshi**

No biographical data available

**Pierce, J. R.**

No biographical data available

Where is the information we have lost in data?

*Information Technology and Civilization*

Chapter 7–4 (p. 210)

W.H. Freeman. New York, New York, USA. 1984

**James, William** 1842–1910

American philosopher and psychologist

The ignoring of data is, in fact, the easiest and most popular mode of obtaining unity in one's thought.

*The Sentiment of Rationality*

*Mind*, Series 1, Volume 4, 1879 (p. 320)

**Jennings, Herbert Spencer** 1868–1947

American zoologist

...the biologist has a more intimate access [than other scientists] to a certain sample of his material, for he is himself that sample. Through this fact he discovers certain things about the materials of biological science that he cannot discover by the other method [hypothesizing] alone...he finds that the thing to be studied by the biologist include[s] emotions, sensations, impulses, desires.... Thus the biologist has two sets of data, discovered in somewhat different ways, one set being discoverable only through the fact that the biologist is himself a biological specimen.

*The Universe and Life*

Chapter I (pp. 9, 10)

Yale University Press. New Haven, Connecticut, USA. 1941

**Katsaros, Kristina**

Ocean and atmosphere researcher

Sometimes there are heated arguments at meetings about how to interpret data. When you have very few facts, fully interpreting them can give rise to three or four interpretations – within the error bars, the uncertainties in the measurements. You get people adhering to one or the other interpretation for a while, and that's not based on fact because there are not enough facts. Eventually more facts are gathered and it becomes clear what the answer is, and everybody agrees. In the end you have a new result. That's the wonderful thing about science, that you can only find in science. There is a point when there is no doubt anymore. There is usually a lot of emotional stress before you get rid of some former idea. There may

be a few crackpots who fight it, but if the evidence is good, eventually all accept it. I think that's wonderful. One of the best things about science is that there are some objective answers.

In Linda Jean Shepherd

*Lifting the Veil: The Feminine Face of Science*

Receptivity (pp. 99–100)

Shambhala. Boston, Massachusetts, USA. 1993

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Without the hard little bits of marble which are called “facts” or “data” one cannot compose a mosaic; what matters, however, are not so much the individual bits, but the successive patterns into which you arrange them, then break them up and rearrange them.

*The Act of Creation*

Book One, Part Two, Chapter X (p. 235)

The Macmillan Company. New York, New York, USA. 1964

**Krumbein, W. C.**

No biographical data available

...numerous samples collected without a clear idea of what is to be done with the data are commonly less useful than a moderate number of samples collected in accordance with a specific design.

In B. Kummel and D. Raup (eds.)

*Handbook of Paleontological Techniques*

Sampling in Paleontology (p. 147)

W.H. Freeman. San Francisco, California, USA. 1965

**Lowell, Percival** 1855–1916

American astronomer

All deduction rests ultimately upon the data derived from experience. This is the tortoise that supports our conception of the cosmos.

*Mars*

Chapter I (p. 6)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Margenau, Henry** 1901–97

German-born American physicist

Data have an ephemerality, a rhapsodic spontaneity, a nakedness so utterly at variance with the orderly instincts that pervade our being and with the given unity of our own experience as to be unfit for use in the building of reality. The constructs, on the other hand, are foot-loose, subjective, and altogether too fertile with logical implications to serve in their indiscriminate totality as material for the real world. They do, however, contain the solid logical substance which a stable reality must contain.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 21 (pp. 448–449)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Mellor, Joseph William** 1863–1938

Chemist

By no process of sound reasoning can a conclusion drawn from limited data have more than a limited application.

*Higher Mathematics for Students of Chemistry and Physics* (p. 4)

Dover Publications. New York, New York, USA. 1955

**Morris, Henry** 1918–2006

American creationist

The data must be explained by the evolutionist, but they are predicted by the creationist.

*Scientific Creationism*

Chapter I (p. 13)

Creation-Life Publishers. San Diego, California, USA. 1974

**Pirsig, Robert M.** 1928–

American writer

Data without generalization is just gossip.

*Lila: An Inquiry into Morals*

Chapter 9 (p. 55)

Bantam Books. New York, New York, USA. 1991

**Rittmann, Alfred** 1893–1980

Volcanologist

However important the quantitative treatment of a problem may be, the quality of the initial data remains solely decisive for the validity of the results, and these data must never be at variance with the facts observed in Nature.

Translated by E. A. Vincent

*Volcanoes and Their Activity*

Conclusion (p. 290)

John Wiley & Sons. New York, New York, USA. 1962

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

When a man of science speaks of his “data,” he knows very well in practice what he means. Certain experiments have been conducted, and have yielded certain observed results, which have been recorded. But when we try to define a “datum” theoretically, the task is not altogether easy. A datum, obviously, must be a fact known by perception. But it is very difficult to arrive at a fact in which there is no element of inference, and yet it would seem improper to call something a “datum” if it involved inferences as well as observation. This constitutes a problem...

*The Analysis of Matter*

Chapter XIX (p. 187)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

...there is more difficulty in stating our principle so as to be applicable when our data are confined to a finite part of the universe. Things from outside may always crash in and have unexpected effects.

*Religion and Science*

Determinism (p. 149)

Henry Holt & Company. New York, New York, USA. 1935

**Schramm, David N.** 1945–97

American astrophysicist

**McKee, Christopher F.** 1942–  
American astrophysicist

When datataking yields huge archives without understanding, a field goes through intellectual stagnation. Astronomy in the Mind and the Lab  
*Sky and Telescope*, Volume 82, Number 4, October, 1991 (p. 352)

**Sidman, Murray**  
American behavioral analyst

When evaluating the reliability and generality of data, it is often important to know the aims of the experimenter. When evaluating the importance of experimental results, however, science has a trick of disregarding the experimenter's rationale and finding a more appropriate context for the data than the one he proposed.  
*Tactics of Scientific Research*  
Chapter I (p. 3)  
Basic Books, Inc. New York, New York, USA. 1960

**Simpson, George Gaylord** 1902–84  
American paleontologist

For almost every topic discussed in the following pages the data are insufficient.  
*Tempo and Mode in Evolution*  
Introduction (p. xxx)  
Columbia University Press. New York, New York, USA. 1944

**Stamp, Josiah** 1880–1941  
English economist and financier

The individual source of the statistics may easily be the weakest link. Harold Cox tells a story of his life as a young man in India. He quoted some statistics to a Judge .... His friend said, "Cox, when you are a bit older, you will not quote Indian statistics with that assurance. The Government are very keen on amassing statistics – they collect them, and they raise them to the *n*th power, take the cube root and prepare wonderful diagrams. But what you must never forget is that everyone of those figures come in the first instance from the *chowty dar* (village watchman), who just puts down what he damn pleases."  
*Some Economic Factors in Modern Life*  
Chapter VII (p. 258)  
P.S. King & Son Ltd. London, England. 1929

**Stigler, Stephen M.** 1941–  
American historian and statistician

Beware of the problem of testing too many hypotheses; the more you torture the data, the more likely they are to confess, but confessions obtained under duress may not be admissible in the court of scientific opinion.  
In Matthew H. Niteckl and Antoni Hoffman (eds.)  
*Neutral Models in Biology*  
Testing Hypotheses or Fitting Models? Another Look at Mass Extinctions (p. 148)  
Oxford University Press. New York, New York, USA. 1987

**Stoppard, Tom** 1937–  
Czech-born English playwright

Real data is messy.  
*Arcadia*  
Act I, Scene Four (p. 46)  
Faber & Faber Limited. London, England. 1993

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

The first step in beginning the scientific study of a problem is to collect the data, which are or ought to be "facts."  
*Introduction to Science*  
Chapter III (p. 63)  
Henry Holt & Co. New York, New York, USA. 1911

**Thurber, James** 1894–1961  
American writer and cartoonist

We have no scientific data whatever on clock-eating and hence no controlled observation.  
*Lanterns and Lances*  
The Last Clock (p. 43)  
Time-Life Books, Inc. Alexandria, Virginia, USA. 1980

**Tippett, L. C.**  
No biographical data available

In general, it is necessary to have some data on which to calculate probabilities.... Statisticians do not evolve probabilities out of their inner consciousness, they merely calculate them.  
In James R. Newman  
*The World of Mathematics* (Volume 3)  
Sampling and Standard Error (p. 1486)  
Simon & Schuster. New York, New York, USA. 1956

**Veblen, Thorstein** 1857–1929  
Economist, social critic, and author

...the data with which any scientific inquiry has to do are trivialities in some other bearing than that one in which they are of account.  
*The Place of Science in Modern Civilisation and Other Essays*  
The Point of View (p. 42)  
The Viking Press, Inc. New York, New York, USA. 1942

**Weaver, Jefferson Hane**  
American science author

Data are to statistics what gasoline is to engines.  
*Conquering Statistics*  
Chapter 2 (p. 28)  
Plenum Trade. New York, New York, USA. 1977

**Woodger, Joseph Henry** 1894–1981  
English biologist

We are, therefore, in danger of being overwhelmed by our data and of being unable to deal with the simpler problems



first and understand their connection. The continual heaping up of data is worse than useless if interpretation does not keep pace with it. In biology this is all the more deplorable because it leads us to slur over what is characteristically biological in order to reach hypothetical “causes.”

*Biological Principles: A Critical Study*

Part II, Chapter VI, B, 13 (p. 318)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1929

## DATING

**Eldredge, Niles** 1943–

American paleontologist

And this poses something of a problem: if we date the rocks by their fossils, how can we then turn around and talk about patterns of evolutionary change through time in the fossil record? We need an independent time frame to know that a trilobite in Ohio is roughly the same age as one in New York before we can talk about geographic variation; otherwise, their differences might as well be ascribed to the sort of process of gradual change that Darwin thought was inevitable with the simple passage of time.

*Time Frames: The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria*

Chapter 2 (p. 52)

Simon & Schuster. New York, New York, USA. 1985

## DAWN

**Ackerman, Diane** 1948–

American writer

We say dawn breaks, as if something were shattering, but what we mean is that waves of light crest over the earth.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 4 (p. 170)

Random House, Inc. New York, New York, USA. 1991

## DAY

**Lubbock, John, First Baron Avebury** 1834–1919

English banker, politician, biologist, and archaeologist

If we could imagine a day prolonged for a lifetime, or nearly so, and that sunrise and sunset were rare events which happened but a few times to each of us, we should certainly be entranced by the beauty of the morning and evening tints.

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter I (p. 8)

Macmillan & Company Ltd. London, England. 1903

## DEATH

**Allen, Durward L.** 1910–87

Wildlife biologist

Probably most of us are at least vaguely aware of a universal reality in the natural world. All living things are destined to die and be recycled as part of the flow of energy through the life community. Which is to say, a creature must feed, and sooner or later it will be fed upon.

*Wolves of Minong: Their Vital Role in a Wild Community*

Chapter 6 (p. 113)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1979

**Allen, James Lane** 1849–1925

American novelist and short story writer

Death, lover of the peerless.

*Kentucky Cardinal*

Chapter II (p. 18)

Harper & Brothers Publishers. New York, New York, USA. 1898

**Allman, David**

American physician

Life is precious to the old person. He is not interested merely in thoughts of yesterday’s good life and tomorrow’s path to the grave. He does not want his later years to be a sentence of solitary confinement in society. Nor does he want them to be a death watch.

Address to National Conference of Christian and Jews

*The Brotherhood of Healing*, 1 February, 1958

**Annesley, Richard** 1745–1824

2nd Earl Annesley

The dread of death seems implanted in the nature of human kind as a peculiar curse, since no other species of created beings are capable of it.

*Memoirs of an Unfortunate Young Nobleman*

Chapter I

1747

The light is come upon the dark benighted way. Dead!

*Memoirs of an Unfortunate Young Nobleman*

Chapter XLVII

1747

**Amory, Thomas** 1691–1788

English author

Wise is the man who prepares both for his own death and the death of his friends; who makes use of the foresight of troubles so as to abate the uneasiness of them ...

*The Life of John Buncke, Esq* (Volume 3) (p. 183)

Septimus Prowett. London, England. 1825

**Asimov, Isaac** 1920–92

American author and biochemist



[Death] is an essential part of the successful functioning of life...new organisms cannot perform their role properly unless the old ones are removed from the scene after they have performed their function in producing the new. In short, the death of the individual is essential to the life of the species.

*A Choice of Catastrophes*

Chapter 12 (p. 239)

Simon & Schuster. New York, New York, USA. 1979

**Auerbach, Berthold** 1812–82

German novelist

To a father, when his child dies, the future dies; to a child, when his parents die, the past dies.

Translated by Fanny Elizabeth Bennett

*On the Heights* (p. 449)

Roberts Brothers. Boston, Massachusetts, USA. 1868

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Death is something like the birth of man, equally a mystery of nature.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 36)

Edward Howell. Liverpool, England. 1864

O death! mayest thou approach quickly, lest at any time I should forget myself.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 38)

Edward Howell. Liverpool, England. 1864

**Author undetermined**

Support your local medical examiner – die strangely.

Source undetermined

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Death is a friend of ours; and he that is not ready to entertain him is not at home.

*Essays*

Of Death (p. 318)

R.H. Woodward & Co. Baltimore, Maryland, USA. 1893

**Bassler, Thomas J.** 1932–

American science fiction writer

Two out of every three deaths are premature; they are related to loafer's heart, smoker's lungs and drinker's liver.

In James Fixx

*The Complete Book of Running*

Chapter 1 (p. 4)

Random House, Inc. New York, New York, USA. 1977

**Bates, Marston** 1906–74

American zoologist

We think of death from old age as “natural death” and we thus come across the paradox that natural death is uncommon in nature, unnatural.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*

Chapter 11 (p. 164)

Random House, Inc. New York, New York, USA. 1960

**Brackenridge, Hugh Henry** 1748–1816

American author and jurist

When the patient is dead, it was the disease killed him, not the Doctor. Dead men tell no tales.

*Modern Chivalry*

Part II, Volume I, Chapter X (p. 378)

American Book Company. New York, New York, USA. 1937

**Browne, Sir Thomas** 1605–82

English author and physician

Men that looke no further than their outsides, thinke health an appertinance unto life, and quarrell with their constitutions for being sick; but I that have examined the parts of man, and know upon what tender filaments that Fabrik hangs, doe wonder that we are not always so; and considering the thousand dores that lead to death, doe thank my God that we can die but once.

*Religio Medici*

Part I, Section 44 (p. 57)

Elliot Stock. London, England. 1883

**Burroughs, John** 1837–1921

American naturalist and essayist

The marble face of Death! What unspeakable repose and silence there is in it!

*The Heart of Burroughs's Journals*

January 21, 1884 (p. 106)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Carlyle, Thomas** 1795–1881

English historian and essayist

*Death*, that is the utmost the crash of the whole solar and stellar system could bring on us.

*New Letters of Thomas Carlyle* (Volume 1)

Letter 31 (p. 97)

John Lane. London, England. 1904

**Chamfort, Nicolas** 1741–94

French ironist and maker of maxims

Living is an illness to which sleep provides relief every sixteen hours. It's a palliative. The remedy is death.

*Maximes et Pensées*

Chapter 2

A. Silvaire. Paris, France. 1999

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

When there is someone in a family who has long been ill, and hopelessly ill, there come terrible moments when all those close to him timidly, secretly, at the bottom of their hearts wish for his death...

*The Portable Chekhov*

Peasants (p. 296)

Penguin Books. New York, New York, USA. 1977

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

Death is the liberator of him whom freedom cannot release, the physician of him whom medicine cannot cure, and the comforter of him whom time cannot console.

*Lacon: or, Many Things in Few Words*

Death (p. 64)

William Tegg. London, England. 1866

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

...however many ways there may be of being alive, it is certain that there are vastly more ways of being dead, or rather not alive.

*The Blind Watchmaker*

Chapter 1 (p. 9)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Dickens, Charles** 1812–70

English novelist

Death is Nature's remedy for all things ...

*A Tale of Two Cities*

Book II, Chapter I (p. 73)

At the Riverside Press. Cambridge, England. 1869

There are three hundred sixty-five days in the year – three hundred and sixty-six in a leap year – and he may die on anyone of 'em.

*Martin Chuzzlewit* (Volume 4)

Chapter XLVI (p. 131)

At the Riverside Press. Cambridge, England. 1868

**Donnan, F. G.**

No biographical data available

The harpies of death sleep in every unit of our living bodies, but as long as life is there their wings are bound and their devouring mouths are closed.

*Annual Report of the Board of Regents of the Smithsonian Institution (1929)*

The Mystery of Life (p. 316)

Government Printing Office. Washington, D.C. 1830

**Fechner, Gustav** 1801–87

German experimental psychologist

[At death] we step into a still more free, quite new empire, that is not detached from the former one, but rather encloses it...

*Life After Death*

Continued Existence of Ideas (p. 123)

Pantheon Books, Inc. New York, New York, USA. 1943

**Fielding, Henry** 1707–54

English novelist, playwright, and barrister

Death, that inexorable judge, had passed sentence on him, and refused to grant him a reprieve, though two doctors who arrived, and were fee'd at one and the same instant, were his counsel.

*The History of Tom Jones: A Foundling* (Volume 1)

Book II, Chapter 9 (p. 85)

P.F. Collier & Son Company. New York, New York, USA. 1917

There is nothing more unjust than the vulgar opinion, by which physicians are misrepresented as friends to death. On the contrary, if the number of those who recover by physic could be opposed to that of the martyrs to it, the former would rather exceed the latter. Nay, some are so cautious on this head, that, to avoid a possibility of killing the patient, they abstain from all method of curing, and prescribe nothing but what can neither do good nor harm. I have heard some of these, with great gravity, deliver it as a maxim that Nature should be left to do her own work, while the physician stands by as it were to clap her on the back and encourage her when she doth well.

*The History of Tom Jones: A Foundling* (Volume 1)

Book II, Chapter 9 (p. 86)

P.F. Collier & Son Company. New York, New York, USA. 1917

**Fuller, Thomas** 1608–61

English clergyman and author

[The physician]...when he can keep life no longer in, he makes a fair and easy passage for it to go out.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 2) (p. 299)

Clarendon Press. Oxford, England. 1925

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

For life and death are one, even as the river and the sea are one.

*The Prophet*

Death (p. 87)

Alfred A. Knopf. New York, New York, USA. 1969

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Old age leaps upon [the nose] as his saddle, and rides triumphant, unchallenged, until the darkness comes which no glasses can penetrate. Nature is pitiless in carrying out the universal sentence, but very pitiful in her mode of dealing with the condemned on his way to the final scene.

*Over the Teacups*

Chapter XII (p. 295)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

How much better for us if all humans died in costly nursing homes amid doctors who lie, nurses who lie, friends who lie...

*The Screwtape Letters*

Chapter V (p. 32)

Geoffrey Bles. London, England. 1942

**Lincoln, Abraham** 1809–65

16th president of the USA

...we here highly resolved that these dead shall not have died in vain.

*Gettysburg Address*

**Lovelock, James Ephraim** 1919–

English scientist

...the unending death-roll of all creatures, including ourselves, is the essential complement to the unceasing renewal of life.

*Gaia: A New Look at Life on Earth*

Chapter 8 (p. 117)

Oxford University Press, Inc. Oxford, England. 2000

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

...in his unceasing desire to diminish the boundaries of the incomprehensible, man has always been engaged in attempts to understand death by life and life by death.

Translated by Thomas Joseph McCormack

*Popular Scientific Lectures* (3rd edition)

On the Economical Nature of Physics (p. 186)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

**Mann, Thomas** 1875–1955

German-born American novelist

A man's dying is more the survivor's affair than his own.

*The Magic Mountain*

Chapter VI

Alfred A. Knopf. New York, New York, USA. 1966

**McCullers, Carson** 1917–67

American writer

Death is always the same, but each man dies in his own way.

*Clock Without Hands*

Chapter 1 (p. 1)

Houghton Mifflin & Company. New York, New York, USA. 1961

**Muir, John** 1838–1914

American naturalist

Leaves have their time to fall, and though indeed there is a kind of melancholy present when they, withered and dead, are plucked from their places and made the sport of the gloomy autumn wind, yet we hardly deplore their fate, because there is nothing unnatural in it. They have done all that their Creator wished them to do, and they should not remain longer in their green vigor.

In Sally M. Miller (ed.)

*John Muir: Life and Work*

Part I, Chapter 1 (p. 28)

University of New Mexico Press. Albuquerque, New Mexico, USA. 1993

**Nashe, Thomas**

No biographical data available

Adieu! farewell earth's bliss!

This world uncertain is:

Fond are life's lustful joys,

Death proves them all but toys.

None from his darts can fly:

I am sick, I must die –

Lord, have mercy on us!

In Robert Coope

*The Quiet Art* (p. 155)

E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

We speak of death as the King of Terrors, yet how rarely does the act of dying appear to be painful, how rarely do we witness AGONY in the last few hours. Strict, indeed, is the fell sergeant in his arrest, but few feel the iron grip; the hard process of nature's law is for the most of us mercifully effected, and death, like birth, is "but a sleep and a forgetting."

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Captor XII (p. 294)

Clarendon Press. Oxford, England. 1925

**Pope, Alexander** 1688–1744

English poet

But just disease to luxury succeeds,

And ev'ry death its own avenger breeds.

*The Complete Poetical Works* (Volume 3)

Essay on Man, Epis. Iii, l. 165–166

Houghton Mifflin & Company. New York, New York, USA. 1903

**Proverb, Scottish**

Death defies the doctor.

*A Complete Collection of English Proverbs* (p. 283)

Printed for G. Cowie. London, England. 1813

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

In a philosophical sense, "life" and "death" are but conventional terms, meaning nothing more than a change of matter from one form of existence to another.

*Nature and Culture*

Chapter 1 (p. 9)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**Rothman, Tony** 1953–

American cosmologist

The Graveyard Principle: To be behind one's time is permanent death. To be ahead of one's time may be temporary death. But Confucius say: dead is dead.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 2 (p. 56)

Ballantine Books. New York, New York, USA. 1995

**Rous, Francis**

English puritan

Now Death his servant Sickness forth hath sent...

*Thule; or, Vertues historie*

The Second Book, Canto 4 (p. 103)

B. Franklin. New York, New York, USA. 1967

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins...

*Mysticism and Logic: And Other Essays*

Chapter III (pp. 47–48)

Longmans, Green & Co. London, England. 1919

**Sakaki, Nanao**

Japanese poet

At a department store in Kyoto  
One of my friends bought a beetle  
For his son, seven years old.  
A few hours later  
The boy brought his dead bug  
To a hardware store, asking  
“Change battery please.”

*Break the Mirror*

Future Knows (p. 27)

North Point Press. San Francisco, California, USA. 1987

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

No cataplasm so rare,  
Collected from all simples that have virtue  
Under the moon, can save the thing from death.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*

Act IV, Scene vii, l. 144–146

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The patient dies while the physician sleeps.

*The Complete Works of William Shakespeare*

*The Rape of Lucrece*, l. 909

Oxford University Press. London, England. 1954

By medicine life may be prolonged, yet death  
Will seize the doctor too.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Cymbeline*

Act V, Scene v, l. 29–30

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He had rather

Groan so in perpetuity, than be cured  
By the sure physician, death.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Cymbeline*

Act V, Scene iv, l. 4–6

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is silliness to live when to live is torment; and then have  
we a prescription to die when death is our physician.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Othello, The Moor of Venice*

Act I, Scene iii, l. 307–309

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Strehler, Bernard** 1925–2001

American biochemist and gerontologist

Aging and death do seem to be what Nature has planned  
for us. But what if we have other plans?

In J. Lyon and P. Gorner

*Altered Fates*

Part II (p. 295)

W.W. Norton & Company, Inc. New York, New York, USA. 1995

**Teale, Edwin Way** 1899–1980

American naturalist

In nature, there is less death and destruction than death  
and transmutation.

*Circle of the Seasons*

July 5 (p. 143)

Dodd, Mead & Company. New York, New York, USA. 1953

**Thomas, Lewis** 1913–93

American physician and biologist

We continue to share with our remotest ancestors the  
most tangled and evasive attitudes about death, despite  
the great distance we have come in understanding some  
of the profound aspects of biology. We have as much  
distaste for talking about personal death as for thinking  
about it; it is an indelicacy, like talking in mixed company  
about venereal disease or abortion in the old days.

*The Lives of a Cell: Notes of a Biology Watcher*

The Long Habit (p. 47)

The Viking Press. New York, New York, USA. 1974

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Every part of nature teaches that the passing away of one  
life is the making room for another. The oak dies down  
to the ground, leaving within its rind a rich virgin mold,  
which will impart a vigorous life to an infant forest.

*Journal (Volume 1): 1837–1844*

October 24, 1837 (p. 5)

Princeton University Press. Princeton, New Jersey, USA. 1981

**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

Whoever has lived long enough to find out what life is,  
knows how deep a debt of gratitude we owe to Adam,

the first great benefactor of our race. He brought death into the world.

*The Tragedy of Pudd'nhead Wilson*

Chapter III (p. 33)

New American Library. New York, New York, USA. 1980

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Death is Nature's expert advice to get plenty of life.

In J. Arthur Thomson

*The Outline of Science* (Volume 1)

Chapter VI (p. 200)

G.P. Putnam's Sons. New York, New York, USA. 1937

**Watts, Alan Wilson** 1915–73

American philosopher

Life and death are not two opposed forces; they are simply two ways of looking at the same force, for the movement of change is as much the builder as the destroyer.

*The Wisdom of Insecurity*

Chapter III (p. 41)

Pantheon. New York, New York, USA. 1951

**Wheeler, John Archibald** 1911–

American theoretical physicist and educator

As we make our way into the world of tomorrow, with its endless frontiers and its opportunities for a deeper and richer civilization than ever before, we will meet and overcome many a new risk. But we know that the greatest risk of all is what it always has been – to be born – for then we are sure to die.

*At Home in the Universe*

Dealing with Risk (p. 221)

The American Institute of Physics. Woodbury, New York, USA. 1994

## DECAY

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

We are thus led to see a circulation of the matter of this globe, and a system of beautiful economy in the works of nature. This earth, like the body of an animal, is wasted at the same time that it is repaired. It has a state of growth and augmentation; it has another state, which is that of diminution and decay. This world is thus destroyed in one part, but it is renewed in another; and the operations by which this world is thus constantly renewed are as evident to the scientific eye, as are those in which it is necessarily destroyed.

*The Theory of the Earth* (Volume 2)

Part II, Chapter XIV (p. 562)

Messrs. Cadwell, Junior, and Davies. London, England. 1795

...the surface of this land...is made by nature to decay...

*The Theory of the Earth* (Volume 1)

Part I, Chapter I, Section I (p. 13)

Messrs. Cadwell, Junior & Davies. London, England. 1795

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

Again, see you not that even stones are conquered by time, that high towers fall and rocks moulder away, that shrines and idols of gods are worn out with decay, and that the holy divinity cannot prolong the bounds of fate or struggle against the fixed laws of nature? In *Great Books of the Western World* (Volume 12)

*On the Nature of Things*

Book V, 306 (p. 65)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

Everything cosmical must be gradually decaying.

In Alexander Winchell

*World-Life or Comparative Geology*

Part II, Chapter IV (p. 451)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**Tennyson, Alfred (Lord)** 1809–92

English poet

The hills are shadows, and they flow  
From form to form and nothing stands;  
They melt like mists the solid lands,  
Like clouds they form themselves and go.

*Alfred Tennyson's Poetical Works*

In Memoriam A.H.H., Part CXXIII, Stanza II

Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

How much beauty in decay! I pick up a white oak leaf, dry and stiff, but yet mingled red and green, October-like, whose pulpy part some insect has eaten beneath, exposing the delicate network of its veins. It is very beautiful held up to the light, such work as only an insect eye could perform.... To rebuild the tortoise-shell is a far finer game than any geographical or other puzzle, for the pieces do not merely make part of a plane surface, but you have got to build a roof and a floor and the connecting walls. These are not only thus dovetailed and braced and knitted and bound together, but also held together by the skin and within. It is a band-box.

In Bradford Torrey and Francis H. Allen (eds.)

*The Journal of Henry D. Thoreau* (Volume 7)

October 18, 1855 (pp. 495, 496–497)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1949

## DECIMAL

**Churchill, Lord Randolph** 1849–95

English politician

...I could never make out what those damned dots meant.

In Winston S. Churchill  
*Lord Randolph Churchill* (Volume 2)  
 Chapter XV (p. 184)  
 The Macmillan Company. New York, USA. 1906

**Gauss, Johann Carl Friedrich** 1777–1855  
 German mathematician, physicist, and astronomer

Referring to the decimal system of numeration or its equivalent (with some base other than 10): To what heights would science now be raised if Archimedes had made that discovery!

Quoted by Eric Temple Bell  
 In James Roy Newman  
*The World of Mathematics* (Volume I)  
 The Prince of Mathematicians (p. 328)  
 Simon & Schuster. New York, New York, USA. 1956

## DECISION

### Author undetermined

It is better to be inconsistent but sometimes right, than to be consistently wrong.  
 Source undetermined

### British Admiralty

It is necessary for technical reasons that these warheads be stored upside down, that is, with the top at the bottom and the bottom at the top. In order that there may be no doubt as to which is the bottom and which is the top, it will be seen to it that the bottom of each warhead immediately be labeled with the word TOP.

Of Optics and Opticists  
*Applied Optics*, Volume 7, Number 1, January, 1968 (p. 19)

**Carroll, Lewis (Charles Dodgson)** 1832–98  
 English writer and mathematician

It may be right to go ahead, I guess;  
 It may be right to stop, I do confess;  
 Also, it may be right to retrogress.

*The Complete Works of Lewis Carroll*  
*The Elections to the Hebdomadal Council* (p. 910)  
 The Modern Library. New York, New York, USA. 1936

### Charlie Chan (Fictional character)

Expert is merely man who make quick decision – and is sometimes right.

*The Chinese Cat*  
 Film (1944)

**Doyle, Sir Arthur Conan** 1859–1930  
 Scottish writer

Take time to consider. The smallest point may be the most essential.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of the Red Circle* (p. 692)  
 Wings Books. New York, New York, USA. 1967

**Huxley, Thomas Henry** 1825–95  
 English biologist

And when you cannot prove that people are wrong, but only that they are absurd, the best course is to let them alone.

*Collected Essays*  
*On the Method of Zadig* (p. 13)  
 D. Appleton & Company. New York, New York, USA. 1898

**Shaw, George Bernard** 1856–1950  
 Irish playwright

You are asking me to kill another man for his sake; for as surely as I undertake another case, I shall have to hand back one of the old ones to the ordinary treatment. Well, I don't shrink from that. I have had to do it before; and I will do it again if you can convince me that his life is more important than the worst life I am now saving. But you must convince me first.

*The Doctor's Dilemma*  
 Act I (p. 122)  
 Penguin Books. Baltimore, Maryland, USA. 1954

**Simon, Herbert Alexander** 1916–2001  
 American social scientist

Decisions are something more than factual propositions. To be sure, they are descriptive of a future state of affairs, and this description can be true or false in a strictly empirical sense; but they possess, in addition, an imperative quality – they select one future state of affairs in preference to another and direct behavior toward the chosen alternative. In short, they have an ethical as well as factual content.

*Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization*  
 Chapter III (p. 46)  
 Free Press. New York, New York, USA. 1965

**Taylor, E. S.**  
 American aircraft engine pioneer

...the most important decisions in a design problem must often be made without assistance from higher mathematics.

Report on Engineering Design  
*Journal of Engineering Education*, Volume 51, Number 8, April, 1961 (p. 649)

## DEDICATION

**Fiske, John** 1842–1901  
 American philosopher and historian

It has long been my wish to make you the patron saint or tutelary divinity of some book of mine, and it has lately



occurred to me that it ought to be a book of the desultory and chatty sort that would remind you, in your present exile at the world's eastern rim, of the many quiet evenings of old, when, over a tankard of mellow October and pipe of fragrant Virginia, while Yule logs crackled blithely and the music of pattering sleet was upon the window-pane, we used to roam in fancy through the universe and give free utterance to such thoughts, sedate or frivolous, as seemed to us good.

*A Century of Science and Other Essays*

Dedicatory Epistle to Thomas Sergeant Perry (p. iii)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1900

## DEDUCTION

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...the two operations of our understanding...[are] intuition and deduction, on which alone we have said we must rely in the acquisition of knowledge.

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule IX (p. 14)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Like all other arts, the Science of Deduction and Analysis is one which can only be acquired by long and patient study, nor is life long enough to allow any mortal to attain the highest possible perfection in it. Before turning to those moral and mental aspects of the matter which present the greatest difficulties, let the inquirer begin by mastering more elementary problems.

*The Works of A. Conan Doyle*

*A Study in Scarlet* (p. 26)

D. Appleton & Co. New York, New York, USA. 1902

**Everett, Charles Carroll** 1829–1900

American theologian

To give rules for deduction is like giving rules for firing a gun. You teach how to load the gun, and how to aim it when firing. These two points are like the premises, and their combination in deduction. In firing, the ball will take care of itself. If the charge and the aim be right, it will hit the mark. This is like the conclusion of a deductive syllogism. Take care of the premises, and the conclusion will take care of itself.

*The Science of Thought*

Second Book (p. 171)

De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

**Hickok, Laurens Perseus** 1798–1888

No biographical data available

To know that a fact is, and to be competent to deduce a logical conclusion that because such fact is, other

dependent facts must have been, or must now or in future be, is doubtless in various ways of great importance.

*Rational Cosmology: Or, The Eternal Principles and the Necessary Laws of the Universe*

Introduction (p. 14)

D. Appleton & Co. New York, New York, USA. 1858

**Jevons, William Stanley** 1835–82

English economist and logician

Deduction is certain and infallible, in the sense that each step in deductive reasoning will lead us to some result, as certain as the law itself. But it does not follow that deduction will lead the reasoner to every result of a law or combination of laws.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XXIV (p. 534)

Macmillan & Company Ltd. London, England. 1887

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

...philosophers and logicians since the days of Bacon have been entirely clear on this point: deduction merely makes explicit information that is already there. It is not a procedure by which new information can be brought into being.

*The Limits of Science*

Chapter 3 (p. 80)

Harper & Row, Publishers. New York, New York, USA. 1984

**Ritchie, Arthur David** 1891–1967

Scottish philosopher and science history writer

The question whether any branch of science can ever become purely deductive is easily answered. It cannot. If science deals with the external world, as we believe it does, and not merely with the relations of propositions then no branch of science can ever be purely deductive. Deductive reasoning by itself can never tell us about facts. The use of deduction in science is to serve as a calculus to make our observations go further, not to take the place of observation.

*Scientific Method: An Inquiry into the Character and Validity of Natural Laws*

Chapter I (p. 12)

Kegan Paul, Trench, Trubner & Company., Ltd. London, England. 1923

**Whewell, William** 1794–1866

English philosopher and historian

These sciences have no principles besides definitions and axioms, and no process of proof but deduction; this process, however, assuming a most remarkable character; and exhibiting a combination of simplicity and complexity, of rigor and generality, quite unparalleled in other subjects.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 1)

Part 1, Book 2, Chapter 1, Section 2 (p. 83)

John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Mathematical reasoning is deductive in the sense that it is based upon definitions which, as far as the validity of the reasoning is concerned (apart from any existential import) needs only the test of self-consistency. Thus no external verification of definitions is required in mathematics, as long as it is considered merely as mathematics.

*A Treatise on Universal Algebra, with Applications*

Preface (p. vi)

Hafner Publishing Company. New York, New York, USA. 1960

**DEDUCTIVE PROCESS****Author undetermined**

Deductive Process

Formulate hypothesis

Apply for grant

Perform experiments or gather data to test hypothesis

Revise hypothesis to fit data

Backdate revised hypothesis

Publish.

Source undetermined

**DEEDS****Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

“Deeds” were never invented, they were done; thoughts, on the other hand, are a relatively late discovery of man. First he was moved to deeds by unconscious factors; it was only a long time afterward that he began to reflect upon the causes that had moved him; and it took him a very long time indeed to arrive at the preposterous idea that he must have moved himself – his mind being unable to identify any other motivating force than his own.

*Man and His Symbols*

Part I, The Archetype in Dream Symbolism (p. 81)

Doubleday & Company Inc. Garden City, New York, USA. 1964

**Roosevelt, Theodore** 1858–1919

26th president of the USA

It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall

never be with those cold and timid souls who neither know victory nor defeat.

*Citizenship in a Republic*

Speech at the Sorbonne, 23 April, 1910

**DEFICIENCY****Lewes, George Henry** 1817–78

English philosopher

To note a deficiency is one thing, another to remedy that deficiency.

*Problems of Life and Mind* (Volume 1)

Preface (p. vii)

Trubner & Co

London, England. 1874–75

**DEFINE****Kac, Mark** 1914–84

Polish mathematician

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Schwartz, Jacob T.** 1930–

American mathematician

Give a mathematician a situation which is the least bit ill-defined – he will first of all make it well defined. Perhaps appropriately, but perhaps also inappropriately.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

Chapter Three (p. 20)

Springer-Verlag. New York, New York, USA. 1992

**DEFINITION****Adams, Joh** 1735–1826

26th president of the USA

The reasoning of mathematicians is founded on certain and infallible principles. Every word they use, conveys a determinate idea, and by accurate definitions they excite the same ideas in the mind of the reader that were in the mind of the writer. When they have defined the terms they intend to make use of, they premise a few axioms, or self evident principles, that every man must assent to as soon as proposed. They then take for granted certain postulates, that no one can deny them, such as, that a right line may be drawn from one given point to another, and from these plain simple principles, they have raised most astonishing speculations, and proved the extent of the human mind to be more spacious and capable than any other science.

In Charles Francis Adams

*The Works of John Adams, Second President of the United States*

(Volume 2)

June 1 (p. 21)

Little, Brown & Co. Boston, Massachusetts, USA. 1865

**Anscombe, Francis John** 1918–2001  
English-born American statistician

An observation with an abnormally large residual will be referred to as an outlier. Other terms in English are “wild”, “straggler”, “sport” and “maverick”; one may also speak of a “discordant”, “anomalous” or “aberrant” observation.

Rejection of Outliers  
*Technometrics*, Volume 2, 1960

**Arnold, Thurman** 1891–1961  
American lawyer and author

Definition is ordinarily supposed to produce clarity in thinking. It is not generally recognized that the more we define our terms the less descriptive they become and the more difficulty we have in using them.

*The Folklore of Capitalism*  
Chapter VII (p. 180)  
Yale University Press. New Haven, Connecticut, USA. 1937

**Bornstein, Kate** 1948–  
American author

Definitions have their uses in much the same way that road signs make it easy to travel: they point out the directions. But you don't get where you're going when you just stand underneath some sign, waiting for it to tell you what to do.

*Gender Outlaw: On Men, Women, and the Rest of Us* (p. 21)  
Vintage Books. New York, New York, USA. 1994

**Boutroux, Émile** 1845–1921  
French philosopher

There can be nothing clearer or more convenient for the purpose of setting one's ideas in order and for conducting an abstract discussion, than precise definitions and inviolable lines of demarcation.

*Science & Religion in Contemporary Philosophy*  
Chapter I (p. 39)  
Duckworth & Company. London, England. 1909

**Campanella, Tommaso** 1568–1639  
Italian philosopher, theologian, astrologer, and poet

We begin to reason from sensible objects, and definition is the end and epilogue of science. It is not the beginning of our knowing, but only of our teaching.

In William Whewell  
*The Philosophy of the Inductive Sciences: Founded Upon Their History*  
(Volume 2)  
Book VII, Chapter IX (pp. 196–197)  
John W. Parker. London, England. 1847

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

...it is the essence of a scientific definition to be causative, not by introduction of imaginary somewhats, natural or supernatural, under the name of causes, but by

announcing the law of action in the particular case, in subordination to the common law of which all the phenomena are modifications or results.

*Hints Towards the Formation of a More Comprehensive Theory of Life*  
The Nature of Life (p. 25)  
John Churchill. London, England. 1847

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

The beginner has in his head a definition of the science; a childish definition, perhaps, but still a definition; on the science's subject-matter he has no definition at all.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*  
Part I, Chapter I, aphorism I. 43 (p. 3)  
At The Clarendon Press. Oxford, England. 1942

**Davies, Charles** 1798–1876  
American mathematician

Definition is a metaphorical word, which literally signifies “laying down a boundary.” All definitions are of names, and of names only; but in some definitions, it is clearly apparent, that nothing is intended except to explain the meaning of the word; while in others, besides explaining the meaning of the word, it is also implied that there exists, or may exist, a *thing* corresponding to the word.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*  
Book I, Chapter I (p. 27)  
A.S. Barnes & Burr Co. New York, New York, USA. 1860

**Davy, Sir Humphry** 1778–1829  
English chemist

There is nothing more difficult than a good definition, for it is scarcely possible to express, in a few words, the abstracted view of an infinite variety of facts.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (p. 247)  
J. Murray. London, England. 1830

**de Morgan, Augustus** 1806–71  
English mathematician and logician

...there are terms which cannot be defined, such as number and quantity. Any attempt at a definition would only throw difficulty in the student's way, which is already done in geometry by the attempts at an explanation of the terms point, straight line, and others, which are to be found in treatise on that subject. A point is defined to be that “which has no parts and which has no magnitude”; a straight line is that which “lies evenly between its extreme points...” In this case the explanation is a great deal harder than the term to be explained, which must always happen when we are guilty of the absurdity of attempting to make the simplest ideas yet more simple.

*On the Study and Difficulties of Mathematics*  
Chapter II (pp. 12–13)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1943

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

A chunk is a convenient slice of a population.

*Some Theory of Sampling* (p. 14)

John Wiley & Sons, Inc. New York, New York, USA. 1950

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

Questions of Definition are of the very highest importance in Philosophy, and they need to be watched accordingly.

A Fourth State of Matter

*Nature*, June 24, 1880 (p. 168)

**Durand, David**

No biographical data available

Degrees of freedom. The number of fetters on the statistician. The number of d.f. is usually considered self-evident – except for the analysis of data that have not appeared in a textbook.

A Dictionary for Statismagicians

*The American Statistician*, Volume 24, Number 3, June, 1970 (p. 21)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I admit I am hazy about strict definitions. There is not time for everything; and there are so many interesting things to find out in physics, which take up my attention.

*Space, Time and Gravitation*

Prologue (p. 4)

At the University Press. Cambridge, England. 1921

**Einstein, Albert** 1879–1955

German-born physicist

Every physical concept must be given a definition such that one can in principle describe, in virtue of this definition, whether or not it applies in each particular case.

In Maurice Solovine

*Letters to Maurice Solovine* (p. 20)

Gauthier-Villars. Paris, France. 1956

The strangest thing in all this medieval literature is the conviction that if there is a word there must also be a clear meaning behind it, and the only problem is to find out that meaning.

In James T. Cushing, C.F. Delaney and Gary M. Gutting

*Science and Reality*

Letter to Rabbi P.D. Bookstaber, August 24, 1951 (p. 108)

University of Notre Dame Press. Notre Dame, Indiana, USA. 1984

**Fischer, Martin H.** 1879–1962

German-American physician

When there is no explanation, they give it a name, which immediately explains everything.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 4)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Frege, Friedrich Ludwig Gottlob** 1848–1925

German logician

One cannot require that everything shall be defined, any more than one can require that a chemist shall decompose every substance.

In Peter Geach and Max Black

*Translations from the Philosophical Writings of Gottlob Frege*

On Concept and Object (p. 42)

Basil Blackwell. Oxford, England. 1952

**Freudenthal, Hans** 1905–80

Dutch mathematician

Fundamental definitions do not arise at the start but at the end of the exploration, because in order to define a thing you must know what it is and what it is good for.

In A.G. Howson (ed.)

*Developments in Mathematical Education*

What Groups Mean in Mathematics and What They Should Mean in

Mathematical Education (p. 107)

At the University Press. Cambridge, England. 1973

**Green, Celia** 1935–

English philosopher and psychologist

Thinking in words, consciousness is behavior, experiment is measurement.

*The Decline and Fall of Science*

Aphorisms (p. 172)

Hamilton. London, England. 1976

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

...a man that seeketh precise truth, had need to remember what every name he uses stands for; and to place it accordingly; or else he will find himselfe entangled in words, as a bird in lime-twigs; the more he struggles, the more belimed.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 4 (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huff, Darrell** 1913–2001

American writer

Misinforming people by use of statistical material might be called statistical manipulation; in a word (though not a very good one), statistication.

*How to Lie with Statistics*

Chapter 9 (p. 100)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

**Huxley, Aldous** 1894–1963

English writer and critic

In the scientist verbal caution ranks among the highest of virtues. His words must have a one-to-one relationship with

some specific class of data or sequence of ideas. By the rules of the scientific game he is forbidden to say more than one thing at a time, to attach more than one meaning to a given word, to stray outside the bounds of logical discourse, or to talk about his private experiences in relation to his work in the domains of public observation and public reasoning...

*Literature and Science*

Chapter 14 (p. 36)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Margenau, Henry** 1901–97

American physicist

The scientist prides himself on the clarity and precision of the concepts he employs. Many minds see in accurate thought and speech the prime characteristic of every science, and it is the professional creed of the physicist and his interpreters that terms must not be used unless they are clearly defined. Like most creeds, however, this utterance has become hollow by reason of its being at times thoughtlessly proclaimed.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 12 (p. 220)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1950

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

#### **J. S. Medawar**

No biographical data available

In certain formal contexts – mathematical logic, for example, in which a definition is a rule for substituting one symbol for one or more others – definition are crucial important, but in everyday life and in sciences such as biology their importance is highly exaggerated. It is simply not true that no discourse is possible unless all technical terms are precisely defined; if that were so, there would be no biology.

*Aristotle to Zoos: A Philosophical Dictionary of Biology*

Definition of Life and Other Terms (p. 66)

Harvard University Press. Cambridge, Massachusetts, USA. 1983

### **Moment, Gairdner B.**

No biographical data available

Any science should define its basic concepts. Yet life is almost as difficult to define as the redness of red.

*General Zoology*

Chapter 3 (p. 23)

Houghton Mifflin Company. New York, New York, USA. 1958

### **Moroney, Michael Joseph** 1918–90

English statistician

The words figure and fictitious both derive from the same Latin root, *figere*. Beware!

*Facts from Figures*

Scatter (p. 56)

Penguin Books Ltd., Harmondsworth, England. 1951

### **Newton, Sir Isaac** 1642–1727

English physicist and mathematician

My Design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove by Reason and Experiments: In order to which I shall premise the following Definitions and Axioms.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book One, Part I (p. 379)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Paulos, John Allen** 1945–

American mathematician

Innumeracy, an inability to deal comfortably with the fundamental notions of numbers and chance, plagues far too many otherwise knowledgeable citizens.

*Innumeracy*

Introduction (p. 3)

Hill & Wang. New York, New York, USA. 1988

### **Rousseau, Jean-Jacques** 1712–78

Swiss-French philosopher

...definitions might be good if we did not employ words in making them.

Translated by William Harold Payne

*Rousseau's Émile, or, Treatise on Education*

Book Second (p. 72 fn)

D. Appleton & Co. New York, New York, USA. 1895

### **Ruse, Michael** 1940–

English historian and philosopher of science

It is simply not possible to give a neat definition – specifying necessary and sufficient characteristics – which separates all and only those things that have ever been called “science.”

Response to the Commentary: Pro Justice

*Science, Technology & Human Values*, Volume 7, Number 41, Fall 1982 (p. 72)

### **Szyborska, Wislawa** 1923–

Polish poet, essayist, and translator

Don't bear me ill will, speech, that I borrow weighty words, then labor heavily so that they may seem light.

*View With a Grain of Sand*

Under One Small Star (p. 92)

Harcourt Brace & Co. New York, New York, USA. 1995

### **Thompson, Joseph Parrish**

No biographical data available

A definition should be framed with reference to the thing defined, and not to any use to which either the term or the definition may be applied in some wider statement or system of thought. It should include everything that is essential, and exclude everything that is not essential, to a conception of the thing defined. In other words, the thing should be defined as it is – an “und fur sich” – “in itself, by itself, for its own sake.”



*American Comments on European Questions, International and Religious*  
Chapter IX (p. 186)  
Houghton Mifflin & Co. New York, New York, USA. 1884

**Toulmin, Stephen** 1922–  
Anglo-American philosopher

It is just because the terms of science are so well defined, and defined in a way which is closely tied down to the phenomena, that questions in science can be settled; only because this is so can scientists hope to answer definitely the questions that arise for them, by looking to see whether things actually happen in nature in the manner the theory suggests...

*The Return to Cosmology: Postmodern Science and the Theology of Nature*  
Scientific Theories and Scientific Myths (p. 28)  
University of California Press. Berkeley, California, USA. 1985

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

Define your terms, you will permit me again to say, or we shall never understand one another.

*The Portable Voltaire*  
Philosophical Dictionary, Miscellany (p. 225)  
The Viking Press. New York, New York, USA. 1959

**Walsh, John E.** 1919–72  
Statistician

A precise and universally acceptable definition of the term “nonparametric” is not presently available.

*Handbook of Nonparametric Statistics* (Volume 1)  
Chapter 1 (p. 2)  
van Nostrand Company, Inc. Princeton, New Jersey, USA. 1962–1968

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...think of arm chairs and reading chairs and dining-room chairs, and kitchen chairs, chairs that pass into benches, chairs that cross the boundary and become settees, dentists chairs, thrones, opera stalls, seats of all sorts, those miraculous fungoid growths that cumber the floor of arts and crafts exhibitions, and you will perceive what a lax bundle in fact is this simple straightforward term. In cooperation with an intelligent joiner I would undertake to defeat any definition of chair or chairishness that you gave me.

*First and Last Things: A Confession of Faith and a Rule of Life*  
Book the First (p. 26)  
G.P. Putnam’s Sons. New York, New York, USA. 1908

## DEGREE OF FREEDOM

**Durand, David** 1912–96  
American educator

Degrees of freedom. The number of fetters on the statistician. The number of d.f. is usually considered self-evident – except for the analysis of data that have not appeared in a textbook.

A Dictionary for Statisticians  
*The American Statistician*, Volume 24, Number 3, June, 1970 (p. 21)

## DEHYDRATION

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

If the plant, from lack of water, should be allowed to perish, one may watch its dance of death, as it twists in the throes of dehydration, droops its heavy head, and falls.

*Flowering Earth*  
Chapter 4 (p. 42)  
G.P. Putnam’s Sons. New York, New York, USA. 1939

## DEITY

**Dewar, Redcote**  
No biographical data available

...if men fashion their own deities – their invariable practice to-day as hitherto – it follows that they also construct their own universes.

*From Matter to Man: A New Theory of the Universe*  
Chapter II (p. 12)  
Chapman & Hall, Ltd. London, England. 1898

It...never seems to strike theologians and metaphysicians how absurd it is for them to be forever trying to prove the existence of a Deity by longwinded and hair-splitting arguments; for if He were as omniscient, omnipotent, and omnipresent as He is said to be, the terror of the universe, there would be no necessity for such proof; He would be superabundantly obvious.

*From Matter to Man: A New Theory of the Universe*  
Chapter II (p. 26)  
Chapman & Hall, Ltd. London, England. 1898

## DELIRIUM

**Hippocrates** 460 BCE–377 BCE  
Greek physician

When in acute fevers, pneumonia, phrenitis, or headache, the hands are waved before the face, hunting through empty space, as if gathering bits of straw, picking the nap from the coverlet, or tearing chaff from the wall – all such symptoms are bad and deadly.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
The Book of Prognostics, 4 (p. 20)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**DELUGE**

**Lyell, Sir Charles** 1797–1875  
English geologist

Notwithstanding, therefore, that we have not witnessed within the last three thousand years the devastation by deluge of a large continent, yet, as we may predict the future occurrence of such catastrophes, we are authorized to regard them as part of the present order of Nature ...

*Principles of Geology* (3rd edition)

Book I, Chapter V (pp. 129–139)

John Murray. London, England. 1834

**DELUSION**

**Holbach, Paul Henri Thiry** 1723–89  
French philosopher

The most important of our duties, then, is to seek means by which we may destroy delusions that can never do more than mislead us. The remedies for these evils must be sought for in Nature herself; it is only in the abundance of her resources, that we can rationally expect to find antidotes to the mischiefs brought upon us by an ill-directed, by an overpowering enthusiasm.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*  
(Volume 1)

Author's Preface (p. 3)

J.P. Mendum

Boston, Massachusetts, USA. 1889

**Huxley, Thomas Henry** 1825–95  
English biologist

No delusion is greater than the notion that method and industry can make up for lack of motherwit, either in science or in practical life ...

*Method and Results: Essays*

Chapter II (p. 46)

D. Appleton & Co. New York, New York, USA. 1898

**Sagan, Carl** 1934–96  
American astronomer and author

If we long to believe that the stars rise and set for us, that we are the reason there is a Universe, does science do us a disservice in deflating our conceits?...[I]t is far better to grasp the Universe as it really is than to persist in delusion, however satisfying and reassuring.

*Demon-Haunted World: Science As a Candle in the Dark*

Chapter 1 (p. 12)

Random House, Inc. New York, New York, USA. 1995

**DEMONSTRATE**

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Thus, be it understood, to demonstrate a theorem, it is neither necessary nor even advantageous to know what it means. The geometer might be replaced by the logic piano imagined by Stanley Jevons; or, if you choose, a machine might be imagined where the assumptions were put in at one end, while the theorems came out at the other, like the legendary Chicago machine where the pigs go in alive and come out transformed into hams and sausages. No more than these machines need the mathematician know what he does.

Translated by George Bruce Halsted

*The Foundations of Science  
Science and Method*

Book II, Chapter III (p. 451)

The Science Press. New York, New York, USA. 1921

**DEMONSTRATION**

**Fejer, M. M.**

No biographical data available

Franken's first demonstration of nonlinear optical frequency conversion in 1961 employed a quartz crystal to double the frequency of 694-nm light from a ruby laser. Because that interaction was not phase matched, the ultraviolet output power was so small that the editors at Physical Review Letters mistook for a blemish the spot on Franken's spectrograph plate that demonstrated the new effect. They airbrushed it out of the published version, rendering the first evidence of nonlinear frequency conversion truly invisible.

Nonlinear Optical Frequency Conversion

*Physics Today*, Volume 47, Number 5, May, 1994 (p. 27)

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

...no isolated experiment, however significant in itself, can suffice for the experimental demonstration of any natural phenomenon; for the "one chance in a million" will undoubtedly occur, with no less and no more than its appropriate frequency, however surprised we may be that it should occur to us.

*The Design of Experiments*

II, 7 (pp. 13–14)

Hafner Publishing Company. New York, New York, USA. 1971

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Nothing ever satisfies her [Eve] but demonstration; untested theories are not in her line, and she won't have them.

*Eve's Diary*

Friday (p. 75)

Harper & Brothers Publishers. New York, New York, USA. 1906

**DENSITY****Brown, E. Parmly**

No biographical data

We [dentistry] are not a part of anything, but a something complete within itself; closely allied to medicine and surgery, but principally what they are not – operative and artistic dentists – and until the dental art, as now taught to the dental students, is taught to all medical students (which will never come to pass), dentistry will never be a specialty of medicine. The dentist is like the oculist and optician combined. His oculistic part (oral surgery) is medicine's specialty, his optician part (dental art) is not in the M. D. curriculum.

The Past, Present, and Future of Dentistry

*The Practical Dentist*, Volume 1, Number 1, April, 1888 (p. 1)**Brown, Gerald**

American physicist

**Bethe, Hans** 1906–2005

German-born American physicist

... $2.7 \times 10^{14}$  grams per cubic centimeter. This is the density of matter inside a large atomic nucleus, and in effect the nucleons in the core [of a star] merge to form a single gigantic nucleus. A teaspoonful of such matter has about the same mass as all the buildings in Manhattan combined.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*

How a Supernova Explodes (p. 285)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1991

**DENTIST****Author undetermined**

Nitrous oxide is called laughing gas because it is used by dentists.

Class-Room Chemical Emanations

*Journal of Chemical Education*, Volume 3, Number 1, 1926

Members of the seventh grade class (in Louisville) were instructed to write an essay on what they wanted to be when they grew older. One youngster wrote: "I want to be a dentist, like my father because I figure by the time I grow up, he will have all of his equipment paid for."

*Quote, the Weekly Digest*, October 27, 1968 (p. 334)

Drill, fill and bill.

A Free Bike with Your Braces

*Newsweek*, May 5, 1986 (p. 82)

A dentist named Archibald Moss

Fell in love with the dainty Miss Ross,

But he held in abhorrence

Her Christian name, Florence,

So he renamed her his Dental Floss.

In William S. Baring-Gould (ed.)

*The Lure of the Limerick* (p. 102)

Clarkson N. Potter, Inc. New York, New York, USA. 1967

**Benjamin, Arthur**

No biographical data available

We all basically go back to being a child when we're in a dentist's chair.

A Free Bike with Your Braces

*Newsweek*, May 5, 1986 (p. 82)**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

DENTIST, n. A prestidigitator who puts metal into your mouth, pulls coins out of your pocket.

*The Enlarged Devil's Dictionary* (p. 62)

Doubleday. Garden City, New York, USA. 1967

**Davies, Robertson** 1913–95

Canadian novelist

In odd corners of the world strange dentists still lurk; an Irish friend of mine told me recently of visiting a dentist on the West Coast of Ireland who had no running water, and bade his patients spit into a potted fern which was conveniently placed by the chair...

*The Table Talk of Samuel Marchbanks* (p. 178)

Clarke, Irwin. Toronto, Ontario, Canada. 1949

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

His neighbor is a tooth-drawer. That bag at his girdle is full of the teeth that he drew at Winchester fair. I warrant that there are more sound ones than sorry, for he is quick at his work and a trifle dim in the eye.

*The White Company*

Chapter V (p. 55)

John Murray. London, England. 1975

**Fillery, Frank**

No biographical data available

Dentists' precept: The tooth, the holed tooth, and nothing but the tooth.

*Quote, the Weekly Digest*, November 12, 1967 (p. 397)**Flaubert, Gustave** 1821–90

French novelist

Dentists. All untruthful. They use steel balm: are said to be also chiropodists. Pretend to be surgeons, just as opticians pretend to be physicists.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Gilman, Charlotte Perkins** 1860–1935  
American writer and feminist

“You told us about your dentists,” she said, at length, “those quaintly specialized persons who spend their lives filling little holes in other persons’ teeth – even in children’s teeth sometimes.”

*Herland*

Chapter 7 (p. 83)

Pantheon Books. New York, New York, USA. 1979

**Hale, Susan** 1833–1910  
American artist and art teacher

He got into my mouth along with a pickaxe and telescope, battering-ram and other instruments, and drove a lawn-cutting machine up and down my jaws for a couple of hours. When he came out he said he meant wonderful improvements, and it seems I’m going to have a bridge and mill-wheel and summit and crown of gold, and harps, and Lord knows what.

In Caroline P. Atkinson (ed.)

*Letters of Susan Hale*

Chapter X, To Mrs. William G. Weld, September 19, 1897 (p. 327)

**Hood, Thomas** 1582–98  
English poet and editor

Of all our pains, since man was curst,  
I mean of body, not the mental,  
To name the worst, among the worst,  
The dental sure is transcendental;  
Some bit of masticating bone,  
That ought to help to clear a shelf:  
But lets its proper work alone,  
And only seems to gnaw itself.

*The Complete Poetical Works of Thomas Hood*

A True Story

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

... a dentist and the wheel

Of Fortune are a kindred cast,  
For after all is drawn, you feel  
It’s paying for a blank at last.

*The Complete Poetical Works of Thomas Hood*

A True Story, l. 43–46

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**London, Jack** 1876–1916  
American author

In my jaw are cunning artifices of the dentists which replace the parts of me already gone.

*John Barleycorn*

Chapter XXXVI (pp. 278–279)

Mills & Boon. London, England. 1914

**Lower, Lennie** 1903–47  
Australian humorist

I’ve often wondered how people become dentists. Probably some sadistic urge due to ill-treatment in early youth.

In Cyril Pearl

*The Best of Lennie Lower*

Charge Your Hypodermics! (p. 211)

Lansdowne Press. Melbourne, Australia. 1963

**Morley, Christopher** 1890–1957  
American writer

The only previous time he had taken gas was in a dentist’s office in the Flatiron Building. Whenever he visited that dentist he was always thrilled by the view from the chair, which included the ornate balconies of the old Madison Square Garden and the silhouette of Diana tiptoe in the sky.

*Human Being*

Pathology (p. 205)

Doubleday, Doran & Company, Inc. New York, New York, USA. 1932

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Some tortures are physical and some are mental.

But one that’s both is dental.

Have You a Pash for Ogden Nash

*The Reader’s Digest*, July 1952 (p. 10)

**Perelman, Sidney Joseph** 1904–79  
American comic writer

I had always thought of dentists as of the phlegmatic type – square-jawed sadists in white aprons who found release in trying out new kinds of burs on my shaky little incisors.

*Crazy Like a Fox*

Nothing But the Tooth (p. 69)

Random House, Inc. New York, New York, USA. 1944

For years I have let dentists ride roughshod over my teeth; I have been sawed, hacked, chopped, whittled, bewitched, bewildered, tattooed, and signed on again; but this is cuspid’s last stand.

*Crazy Like a Fox*

Nothing But the Tooth (p. 72)

Random House, Inc. New York, New York, USA. 1944

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

When teeth became touched with decay or were otherwise ailing, the doctor knew of but one thing to do – he fetched his tongs and dragged them out. If the jaw remained, it was not his fault.

*Mark Twain’s Autobiography* (Volume 1)

Chapters Begun in Vienna (p. 107)

Harper & Brothers Publishers. New York, New York, USA. 1924

Some people who can skirt precipices without a tremor have a strong dread of the dentist’s chair...

*Europe and Elsewhere*

Down the Rhone (p. 161)

Harper & Brothers Publishers. New York, New York, USA. 1932

All dentists talk while they work. They have inherited this from their professional ancestors, the barbers.

*Europe and Elsewhere*

Down the Rhone (p. 162)

Harper & Brothers Publishers. New York, New York, USA. 1932

It reminds a person of those dentists who secure your instant and breathless interest in a tooth by taking a grip on it with the forceps, and then stand there and drawl through a tedious anecdote before they give the dreaded jerk.

*A Tramp Abroad*

Appendix D (p. 270)

Harper & Brothers Publishers. New York, New York, USA. 1921

Most cursed of all are the dentists who made too many parenthetical remarks – dentists who secure your instant and breathless interest in a tooth by taking a grip on it, and then stand there and drawl through a tedious anecdote before they give the dreaded jerk. Parentheses in literature and dentistry are in bad taste.

*A Tramp Abroad*

Appendix D, The Awful German Language (p. 392)

Penguin Books. New York, New York, USA. 1997

### **Wagh, Evelyn** 1903–66

English author of satirical novels

All this fuss about sleeping together. For physical pleasure I'd sooner go to my dentist any day.

*Vile Bodies*

Chapter VI (p. 122)

Jonathan Cape. New York, New York, USA. 1930

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

...he had one peculiar weakness; he had faced death in many forms but he had never faced a dentist. The thought of dentists gave him just the same sick horror as the thought of invasion.

*Bealby*

Part VIII, How Bealby Explained (p. 264)

The Macmillan Company. New York, USA. 1915

### **Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

**JACK:** It is very vulgar to talk like a dentist when one isn't a dentist. It produces a false impression.

*The Importance of Being Earnest: A Trivial Comedy for Serious People*  
Act I (p. 11)

Walter H. Baker Company. Boston, Massachusetts, USA. 19 –

### **Woolf, Virginia** 1882–1941

English novelist and essayist

...when we have a tooth out and come to the surface in the dentist's arm-chair ...[we] confuse his "Rinse the mouth – rinse the mouth" with the greeting of the Deity stooping from the floor of Heaven to welcome us...

*The Moment*

On Being Ill (p. 9)

Harcourt, Brace & Company, New York, New York, USA, 1948

## DENTOPEDALOGY

### **Prince Philip (Phillip Mountbatten), Duke of Edinburgh** 1921–

British naturalist

Dentopedalogy is the science of opening your mouth and putting your foot in it. I've been practicing it for years.

*Time*, November 21, 1960

## DENUATION

### **Muir, John** 1838–1914

American naturalist

When Nature lifted the ice-sheet from the mountains she may well be said not to have turned a new leaf, but to have made a new one of the old. Throughout the unnumbered seasons of the glacial epoch the range lay buried, crushed, and sunless. In the stupendous denudation to which it was then subjected, all its pre-glacial features disappeared. Plants, animals, and landscapes were wiped from its flanks like drawings from a blackboard, and the vast page left smooth and clean, to be repictured with young life and the varied and beautiful inscriptions of water, snow, and the atmosphere.

*Studies in the Sierra*

Chapter V (p. 62)

Sierra Club. San Francisco, California, USA. 1960

## DEPLETION

### **Jenkins, Edward B.**

American astronomer

Figuratively, when we study depletions, it is as if we were looking at the crumbs left on the plate after the grains have eaten their dinner.

In L.J. Allamandola and A.G.G.M. Tielens (eds.)

*Interstellar Dust*

Proceedings of the 135th Symposium of the International Astronomical Union, Insights on Dust Grain Formation and Destruction Provided by Gas-Phase Element Abundances, Section 2 (p. 24)

## DERIVATIVE

### **Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

And what are these Fluxions? The Velocities of evanescent Increments. And what are these same evanescent Increments? They are neither finite Quantities, nor Quantities infinitely small, nor yet nothing. May we not call them Ghosts of departed Quantities?

*The Analyst*

Section 35

Kluwer Academic Publishers. Dordrecht, Netherlands. 1992

**Lehrer, Tom** 1928–  
American singer-songwriter and mathematician

You take a function of  $x$  and you call it  $y$ ,  
Take any  $x$ -nought that you care to try,  
You make a little change and call it delta  $x$ ,  
The corresponding change in  $y$  is what you find next,  
And then you take the quotient and now carefully  
Send delta  $x$  to zero, and I think you'll see  
That what the limit gives us, if our work all checks,  
Is what we call  $dy/dx$ ,  
It's just  $dy/dx$ .  
The Derivative Song  
*The American Mathematical Monthly*, Volume 81, Number 5, May,  
1974 (p. 490)

**Rossi, Hugo** 1935–  
American mathematician

In the fall of 1972 President Nixon announced that the rate of increase of inflation was decreasing. This was the first time a sitting president used the third derivative to advance his case for reelection.  
Mathematics Is an Edifice, Not a Toolbox  
*Notices of the American Mathematical Society*, Volume 43, Number 10, October, 1996

## DERMATOLOGIST

**Frank, Julia Bess**  
No biographical data available

I wish the dermatologist  
Were less a firm apologist  
For all the terminology  
That's used in dermatology.  
Dermatology  
*The New England Journal of Medicine*, Volume 297, Number 12, 1977  
(p. 660)

**McLaughlin, Mignon** 1915–  
American journalist and author

Psychiatrists are terrible ads for themselves, like a dermatologist with acne.  
*The Neurotic's Notebook* (p. 73)  
The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1963

## DERMATOLOGY

### Author undetermined

Dermatology is the only specialty in medicine where there are 200 diseases and only three types of cream to treat them.  
Source undetermined

## DESCENDANT

**Darwin, Charles Galton** 1809–82  
English naturalist

He who wishes to decide whether man is the modified descendant of some pre-existing form, would probably first enquire whether man varies, however slightly, in bodily structure and in mental faculties; and if so, whether the variations are transmitted to his offspring in accordance with the laws which prevail with the lower animals.  
*The Descent of Man and Selection in Relation to Sex*  
Chapter I (p. 5)  
D. Appleton & Co. New York, New York, USA. 1909

## DESCRIBE

**Chapman, Frank M.** 1864–1945  
American ornithologist

Not only do our memories sometimes deceive us, but we really see nothing with exactness until we attempt to describe it.  
In William H. Carr  
*The Stir of Nature*  
Chapter Nine (p. 117)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Guyot, Arnold** 1807–84  
Swiss-born American geologist, geographer, and educator

To describe, without rising to the causes, or descending to the consequences, is no more science, than merely and simply to relate a fact of which one has been a witness.  
*The Earth and Man*  
Lecture I (p. 20)  
Gould & Lincoln. Boston, Massachusetts, USA. 1860

**Huxley, Thomas Henry** 1825–95  
English biologist

There is not one person in a hundred who can describe the commonest occurrence with even an approach to accuracy.  
*Introductory*  
Article 11 (pp. 16–17)  
Macmillan & Company Ltd. London, England. 1907

**Poynting, John Henry** 1852–1914  
English physicist

We are no longer content to describe what we actually see or feel, but we describe what we imagine we should see or feel if our senses were on quite another scale of magnitude and sensibility. We cease to be physicists of the real and become physicists of the ideal.

Address to the Mathematical and Physical Section of the British Association

*The Chemical News and Journal of Industrial Science*, Volume 80, Number 2079, September 29, 1899 (p. 155)

## DESCRIPTION

**Barrow, John D.** 1952–

English theoretical physicist

Just as our picture of the most elementary particles of matter as little billiard balls, or atoms as mini solar systems, breaks down if pushed far enough, so our most sophisticated scientific description in terms of particles, fields, or strings may well break down as well if pushed too far. Mathematics is also seen by many as an analogy. But, it is implicitly assumed to be the analogy that never breaks down. Our experience of the world has failed to reveal any physical phenomenon that cannot be described mathematically. That is not to say there are not things for which a description is wholly inappropriate or pointless. Rather, there has yet to be found any system in Nature so unusual that it cannot be fitted into one of the strait-jackets that mathematics provides.

*Pi in the Sky*

Chapter 1 (p. 21)

Back Bay Books. 1993

**Timiriacheff, C. A.**

Russian botanist

The fragmentary description of remarkable plants and animals arouses but little interest, being too hackneyed, and suitable only for children's books, or for occasional illustrated publications for grown-up people.

Translated by Anna Sheremeteva

*Die Sinne der Pflanzen*

Chapter I (p. 3)

Longmans, Green & Co. London, England. 1912

**Walker, Kenneth** 1882–1966

Physician

We first described billiard balls in terms of atoms and then described atoms in terms of billiard balls, a description that brought us no nearer to a true understanding of the ultimate nature of either billiard balls or atoms.

*Meaning and Purpose*

Chapter XIV (p. 153)

Jonathan Cape. London, England. 1944

**Whately, Richard** 1787–1863

English theologian

Trite descriptions lose most of their force because they remind us, not of the reality, but of some other description.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D.*

Apothegm 47 (p. 5)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Wilder, Burt Green** 1841–1925

American zoologist, neurologist, and composer

The test of the accuracy and completeness of a description is, not that it may assist, but that it cannot mislead.

A Partial Revision of Anatomical Nomenclature

*Science*, March 29, 1881 (p. 123)

## DESERT

**Abbey, Edward** 1927–89

American environmentalist and nature writer

To the east, under the spreading sunrise, are more mesas, more canyons, league on league of red cliff and arid tablelands, extending through purple haze over the bulging curve of the planet to the ranges of Colorado – a sea of desert.

*Desert Solitaire*

The First Morning (p. 5)

Ballantine Books. New York, New York, USA. 1968

[After supper] I put on hat and coat and go outside again, sit on the table, and watch the sky and the desert dissolve slowly into mystery under the chemistry of twilight.

*Desert Solitaire*

Solitaire (p. 13)

Ballantine Books. New York, New York, USA. 1968

Under the desert sun, in that dogmatic clarity, the fables of theology and the myths of classical philosophy dissolve like mist.

*Desert Solitaire*

Down the River (p. 219)

Ballantine Books. New York, New York, USA. 1968

The sun is touching the fretted tablelands on the west. It seems to bulge a little, to expand for a moment, and then it drops – abruptly – over the edge. I listen for a long time.

*Desert Solitaire*

Down the River (p. 219)

Ballantine Books. New York, New York, USA. 1968

The restless sea, the towering mountains, the silent desert – what do they have in common? and what are the essential differences? Grandeur, color, spaciousness, the power of the ancient and elemental, that which lies beyond the ability of man to wholly grasp or utilize, these qualities all three share. In each there is the sense of something ultimate, with mountains exemplifying the brute force of natural processes, the sea concealing the richness, complexity and fecundity of life beneath a surface of huge monotony, and the desert – what does the desert say? The desert says nothing. Completely passive, acted upon but never acting, the desert lies there like the bare skeleton of Being, spare, sparse, austere, utterly worthless,



inviting not love but contemplation. In its simplicity and order it suggests the classical, except that the desert is a realm beyond the human and in the classicist view only the human is regarded as significant or even recognized as real.

*Desert Solitaire*

Episodes and Visions (p. 270)

Ballantine Books. New York, New York, USA. 1968

The finest quality of this stone, these plants and animals, this desert landscape is the indifference to our presence, our absence, our coming, our staying or our going. Whether we live or die is a matter of absolutely no concern to the desert.

*Desert Solitaire*

Bedrock and Paradox (pp. 300–301)

Ballantine Books. New York, New York, USA. 1968

It has been said, and truly, that everything in the desert either stings, stabs, stinks, or sticks. You will find the flora here as venomous, hooked, barbed, thorny, prickly, needled, saw-toothed, hairy, stickered, mean, bitter, sharp, wiry, and fierce as the animals.

*The Journey Home: Some Words in Defense of the American West*

Chapter 2 (p. 14)

E.P. Dutton. New York, New York, USA. 1977

**Austin, Mary Hunter** 1868–1934

American novelist and essayist

...the true desert breeds its own kind, each in its particular habitat. The angle of the slope, the frontage of a hill, the structure of the soil determines the plant.

*The Land of Little Rain*

The Land of Little Rain (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

Go as far as you dare in the heart of a lonely land, you cannot go so far that life and death are not before you.

*The Land of Little Rain*

The Land of Little Rain (p. 13)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

None other than this long brown land lays such a hold on the affections. The rainbow hills, the tender bluish mists, the luminous radiance of the spring, have the lotus charm. They trick the sense of time, so that once inhabiting there you always mean to go away without quite realizing that you have not done it.

*The Land of Little Rain*

The Land of Little Rain (p. 16)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

For all the toll the desert takes of a man it gives compensations, deep breaths, deep sleep, and the communion of the stars.

*The Land of Little Rain*

The Land of Little Rain (p. 21)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

What makes the desert beautiful is that somewhere it hides a well.

Translated by Katherine Woods

*The Little Prince*

Chapter XXIV (p. 75)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Charlie Chan (Fictional character)**

Desert present many mysteries.

*The Golden Eye*

Film (1948)

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

I shall never be able to express clearly whence comes this pleasure men take from aridity, but always and everywhere I have seen men attach themselves more stubbornly to barren lands than to any other. Men will die for a calcined, leafless, stony mountain. The nomads will defend to the death their great store of sand as if it were a treasure of gold dust. And we, my comrades and I, we too have loved the desert to the point of feeling that it was there we had lived the best years of our lives.

*Wind, Sand, and Stars*

Chapter 7 (p. 127)

Reynal & Hitchcock. New York, New York, USA. 1939

**L'Amour, Louis** 1872–1970

American author

The desert was a school, a school where each day, each hour, a final examination was offered, where failure meant death and the buzzards landed to correct the papers.

*Shalako*

Chapter One

Bantam Books. New York, New York, USA. 1985

**Pattison, Eliot**

American writer and journalist

Deserts are where mountains go when they die.

*Water Touching Stone*

Chapter Eighteen (p. 456)

St. Martin's Press. New York, New York, USA. 2001

**Strobridge, Idah Meacham** 1855–1932

American writer

When your eye is so trained that it may discover the beauty that dwells in that vast, still corner of the world, and your ear is attuned to catch the music of the plains or the anthems sun in deep canons by the winds; when your heart finds comradeship in the mountains and the great sand-seas, the sun and the stars, and the huge cloud-drifts that the Desert winds set a rolling round the world—when all these reach your heart by way of your eye and your ear, then you shall find one of the alluring ways that belongs to the Desert.

*In Miners' Mirage-land*

The Lure of the Desert (pp. 68–69)  
Baumgardt Publishing Co. Los Angeles, California, USA. 1904

The Desert calls to him who has once felt its strange attraction, calls and compels him to return, as the sea compels the sailor to forsake the land. He who has once felt its power can never free himself from the haunting charm of the Desert.

*In Miners' Mirage-land*

The Lure of the Desert (p. 69)  
Baumgardt Publishing Co. Los Angeles, California, USA. 1904

If you go to the Desert, and live there, you learn to love it. If you go away, you will never forget it for one instant in after life; it will be with you in memory forever and forever. And always will you hear the still voice that lures one, calling – and

*In Miners' Mirage-land*

The Lure of the Desert (p. 69)  
Baumgardt Publishing Co. Los Angeles, California, USA. 1904

Do you seek for the marvelous? Or do you go a-quest for riches? Or simply desire to wander away into little known rifts in the wilderness? By these lures and a hundred others will the Desert draw you there. And once there, unprejudiced, the voice by and by will make itself heard as it whispers at your ear. And when you can lay your head on its breast, and hear its heart-beats, you will know a rest that is absolute and infinite.

*In Miners' Mirage-land*

The Lure of the Desert (p. 69)  
Baumgardt Publishing Co. Los Angeles, California, USA. 1904

**van Dyke, John Charles** 1856–1932  
American art historian and critic

How silently, even swiftly, the days glide by out in the desert, in the waste, in the wilderness!

*The Desert*

Chapter VI (p. 95)  
Charles Scribner's Sons. New York, New York, USA. 1930

**Walther, Johannes** 1860–1937  
German geologist

The desert, however, which once had drastically influenced the course of earthly life and caused its most important progress, today is only the symbol of unlimited desolation and rigid negation of life to mankind. Only a few guess the wealth of scientific problems hidden in the diverse desert, its strong influence on our thoughts and observations, its colorful beauty which enralls our senses, its infinite loneliness which deepens our thoughts, and how we have to regard the kingdom of the colorful life from the lifeless desert if we want to understand its oldest and last secrets.

In Eberhard Gischler and Kenneth W. Glennie (eds.)

*Johannes Walther: The Law of Desert Formations – Present and Past*  
Chapter 37 (p. 263)  
University of Miami. Miami, Florida, USA. 1997

## DESERT, LIFE OF

**van Dyke, John Charles** 1856–1932  
American art historian and critic

The life of the desert lives only by virtue of adapting itself to the conditions of the desert. Nature does not bend the elements to favor the plants and the animals; she makes the plants and the animals do the bending.

*The Desert*

Chapter IX (p. 150)  
Charles Scribner's Sons. New York, New York, USA. 1930

## DESIGN

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

A common mistake that people make when trying to design something completely foolproof is to underestimate the ingenuity of complete fools.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Mostly Harmless  
Chapter 12 (p. 719)  
The Ballantine Book Company. New York, New York, USA. 2002

**Dewar, Redcote**  
No biographical data available

Nature does not intentionally produce designs for her own delectation, or for man's admiration, as some child-like theologians assert. The object of nature, indeed, is not to produce a design, but a "something" whether it be a design or not. The design is a very secondary consideration to the "something." It is the "something" alone which is of importance.

*From Matter to Man: A New Theory of the Universe*

Chapter X (p. 121)  
Chapman & Hall, Ltd. London, England. 1898

**Ferguson, Eugene S.**  
Technological historian

No matter how vigorously a "science" of design may be pushed, the successful design of real things in a contingent world will always be based more on art than on science. Unquantifiable judgments and choices are the elements that determine the way a design comes together. Engineering design is simply that kind of process. It always has been; it always will be.

*Engineering and the Mind's Eye*

Chapter 7 (p. 194)  
The MIT Press. Cambridge, Massachusetts, USA. 1992

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

If you are in a shipwreck and all the boats are gone, a piano top buoyant enough to keep you afloat that comes

along makes a fortuitous life preserver. But this is not to say that the best way to design a life preserver is in the form of a piano top. I think that we are clinging to a great many piano tops in accepting yesterday's fortuitous contrivings as constituting the only means for solving a given problem.

*Operating Manual for Spaceship Earth*

Chapter 1 (p. 9)

Simon & Schuster. New York, New York, USA. 1969

### Layton, Jr., Edwin T.

Historian of technology

From the point of view of modern science, design is nothing, but from the point of view of engineering, design is everything. It represents the purposive adaptation of means to reach a preconceived end, the very essence of engineering.

American Ideologies of Science and Engineering

*Technology and Culture*, Number 4, October, 1976 (p. 696)

### Mailer, Norman 1923–

American author

Indeed the early history of rocket design could be read as the simple desire to get the rocket to function long enough to give an opportunity to discover where the failure occurred. Most early debacles were so benighted that rocket engineers could have been forgiven for daubing the blood of a virgin goat on the orifice of the firing chamber.

*Of a Fire on the Moon*

Part II, Chapter I, Section iv (p. 168)

Little, Brown & Company. Boston, Massachusetts, USA. 1969

### Reswick, J. B.

No biographical data available

Design is the essential purpose of engineering.

In Morris Asimow

*Introduction to Design*

Forward (p. iii)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

### Vincenti, Walter G. 1917–

American aeronautical engineer

Engineering knowledge reflects the fact that design does not take place for its own sake and in isolation. Artificial design is a social activity directed at a practical set of goals intended to serve human beings in some direct way. As such, it is intimately bound up with economic, military, social, personal, and environmental needs and constraints.

*What Engineers Know and How They Know It*

Chapter 1 (p. 11)

The Johns Hopkins University Press. Baltimore. 1990

## DESTINATION

### Bester, Alfred 1913–87

American science fiction author

Gully Foyle is my name

And Terra is my nation.

Deep space is my dwelling place

And death's my destination.

Gully Foyle is my name

And Terra is my nation.

Deep space is my dwelling place,

The stars my destination.

*The Stars My Destination* (pp. 17–18)

Vintage Books. New York, New York, USA. 1996

## DESPOTISM

### Leslie, Sir John 1766–1832

Scottish physicist and mathematician

Science first dawned in the genial climes of the East; but its warming rays were soon absorbed in the cheerless fog of despotism. The body of knowledge which had been created by the efforts of unfettered genius, became the exclusive property of the order of priesthood, who rendered it an engine of power, subservient to the purposes of a gloomy and debasing superstition. The discoveries of happier times were entombed in silence and darkness.

*Elements of Natural Philosophy: Including Mechanics and Hydrostatics* (Volume 1)

Introduction (pp. xvi–xvii)

Oliber & Boyd. Edinburgh, Scotland. 1829

## DESTINY

### Gray, George W.

Freelance science writer

Within the limits of nature's law, a man is free to mold his future. By design he may increase the probability of a desired outcome. And so we say that destiny is a choice, a selection among alternative destinies. But the selection cannot be left to accident; it is not fortuitous, automatic, foolproof. Man himself must choose.

*The Advancing Front of Science*

Epilogue (p. 353)

Whittlesey House. New York, New York, USA. 1937

## DESTRUCTION

### Abbey, Edward 1927–89

American environmentalist and nature writer

The philosophers and the theologians have agreed, for three thousand years, that the perfect is immutable – that

which cannot alter and cannot ever be altered. They were wrong. We were wrong. Glen Canyon was destroyed. Everything changes, and nothing is more vulnerable than the beautiful.

*Down the River*

Part IV, Chapter 19 (p. 231)

E.P. Dutton. New York, New York, USA. 1982

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

If we are still here to witness the destruction of our planet some five billion years or more hence, then we will have achieved something so unprecedented in the history of life that we should be willing to sing our swansong with joy – *Sic Transit Gloria Mundi*.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 12 (p. 142)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

### **Huxley, Thomas Henry** 1825–95

English biologist

Rain and river, frost and thaw, wind and wave, however much they may differ among themselves, agree in this – that they are, upon the whole, slow and certain agents of destruction.

In *George Isles*

*The Skies and the Earth*

Earthquakes and Volcanoes (p. 171)

Doubleday, Page & Co. New York, New York, USA. 1902

### **Taylor, Walter W.** 1913–97

American archaeologist

The archivist and the experimental scientist may with impunity select from their sources those facts which have for them a personal and immediate significance in terms of some special problem. Their libraries and experimental facilities may be expected to endure, so that in the future there may be access to the same or a similar body of data. If, however, it were certain that, after the archivist's first perusal, each document would be utterly and forever destroyed it would undoubtedly be required of him that he transcribe the entire record rather than just that portion which at the moment interests him. He would have difficulty in justifying his research if, knowingly, he caused the destruction of a unique record for the sake of abstracting only a narrowly selected part.

The gathering of data from archeological sites, in nearly every instance, involves the destruction of the original record.

*A Study of Archaeology*

Part II, Chapter 6 (p. 152)

Southern Illinois University Press, Carbondale, Illinois, USA. 1967

## DETAIL

### **da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

If you wish to gain knowledge of the forms of things, begin with the detail and only move from one detail to another when you have fixed the first firmly in your memory and become well acquainted with it.

In Michael White

*Leonardo: The First Scientist*

Chapter 2 (p. 30)

Little, Brown & Company. London, England. 2000

### **Garwin, R. L.**

No biographical data available

Polaroid photography itself was initiated during that time, too: In December 1943, on a family vacation in Santa Fe, Land's three-year-old daughter asked why she couldn't see instantly the picture Land took of her. Within the hour, he had thought through the camera, the film and the physical chemistry that could do the job. Instant photography had been perfected "except for those few details that took from 1943 to 1973," as he recalled later.

Book review

Insisting on the Impossible: The Life of Edwin Land

*Physics Today*, Volume 52, Number 2, February, 1999 (p. 65)

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Details are all that matters: God dwells there, and you never get to see Him if you don't struggle to get them right.

*Eight Little Piggies: Reflections in Natural History*

A Reflective Prologue (p. 14, fn)

W.W. Norton & Co. New York, New York, USA. 1993

### **Rowling, J. K.** 1965–

English fiction writer

...but it was like trying to keep water in his cupped hands; the details were now trickling away as fast as he tried to hold on to them...

*Harry Potter and the Goblet of Fire* (p. 17)

Arthur A. Levine Books. New York, New York, USA. 2000

### **Tucker, Wallace**

No biographical data available

### **Tucker, Karen**

No biographical data available

If you study anything in detail, no matter how prosaic it may appear, you will frequently uncover a gem of breathtaking beauty and value.

*The Dark Matter*

Chapter 7 (p. 87)

William Morrow & Co. New York, New York, USA. 1988

## DETECTION

### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Detection is, or ought to be, an exact science, and should be treated in the same cold and unemotional manner. You have attempted to tinge it with romanticism, which produces much the same effect as if you worked a love-story or an elopement into the fifth proposition of Euclid.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Sign of the Four*, Chapter 1 (p. 611)

Wings Books. New York, New York, USA. 1967

## DETECTIVE

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

The temptation to form premature theories upon insufficient data is the bane of this profession.

*Sherlock Holmes, The Complete Novels and Stories* (Volume 2)

*The Valley of Fear* (p. 179)

Barnes & Noble. New York, New York, USA.

## DETECTOR

**Glashow, Sheldon L.** 1932–

American physicist

The detector is like the journalist who must determine what, where, when, which, and how? What is the identity of the particle? Exactly where is it when it is observed? When does the particle get to the detector? Which way is it going? How fast is it moving?

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 4 (p. 101)

Warner Books. New York, New York, USA. 1988

**Rubbia, Carlo** 1934–

Italian physicist

Detectors...are really the way you express yourself. To say somehow what you have in your guts. In the case of painters, it's painting. In the case of sculptures, it's sculpture. In the case of experimental physicists, it's detectors. The detector is the image of the guy who designed it.

In Gary Taubes

*Nobel Dreams*

Chapter 4 (p. 44)

Random House, Inc. New York, New York, USA. 1986

If it turns out that the magnet does not work, or the detector does not track, we cannot blame anybody but ourselves. You have to understand every part in your detector. You have to know what makes it run, how it works.

In Gary Taubes

*Nobel Dreams*

Chapter 4 (p. 47)

Random House, Inc. New York, New York, USA. 1986

## DETERMINANT

**Sylvester, James Joseph** 1814–97

English mathematician

For what is the theory of determinants? It is an algebra upon algebra; a calculus which enables us to combine and foretell the results of algebraical operations, in the same way as algebra itself enable us to dispense with the performance of the special operations of arithmetic. All analysis must ultimately clothe itself under this form.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 1)

On the Relation Between the Minor Determinants of Linearly Equivalent Quadratic Functions (pp. 246–247)

University Press. Cambridge, England. 1904–1912

## DETERMINISM

**Einstein, Albert** 1879–1955

German-born physicist

Everything is determined, the beginning as well as the end, by forces over which we have no control. It is determined for the insect as well as the star. Human beings, vegetables, or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible piper.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 17)

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The intuitive idea of determinism may be summed up by saying that the world is like a motion-picture film: the picture or still which is just being projected is the present. Those parts of the film which have already been shown constitute the past. And those which have not yet been shown constitute the future.

In the film, the future co-exists with the past; and the future is fixed, in exactly the same sense as the past. Though the spectator may not know the future, every future event, without exception, might in principle be known with certainty, exactly like the past, since it exists in the same sense in which the past exists. In fact, the future will be known to the producer of the film – to the Creator of the world.

*The Open Universe*

Chapter I (p. 5)

Rowman & Littlefield. Totowa, New Jersey, USA.

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

The basis of the vision of classical physics was the conviction that the future is determined by the present, and therefore a careful study of the present permits an



unveiling of the future. At no time, however, was this more than a theoretical possibility. Yet in some sense this unlimited predictability was an essential element to the scientific picture of the physical world. We may perhaps even call it the founding myth of classical science. The situation is greatly changed today...

*From Being to Becoming*

Chapter 9 (p. 214)

W.H. Freeman & Company. San Francisco, California, USA. 1980

**Stewart, Ian** 1945–

English mathematician

**Cohen, Jack**

Biologist

Neutrons paired incestuously with their proton offspring to form creation's first atoms – heavy hydrogen, otherwise known as deuterium.

*Fragments of Reality*

Prologue (pp. 1–2)

Cambridge University Press. Cambridge, England. 1997

## DEVELOPMENT

**Compton, Karl Taylor** 1887–1954

American educator and physicist

In science, as in human affairs, great events do not occur without a background of development.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1937*

The Electron: Its Intellectual and Social Significances (p. 206)

Government Printing Office. Washington, D.C. 1938

**Disraeli, Benjamin, 1st Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Development is the discovery of utility.

*Vivian Grey*

Popanilla (p. 377)

Longmans, Green & Co. London, England. 1878

**Feynman, Richard P.** 1918–88

American theoretical physicist

When the scientist tells you he does not know the answer, he is an ignorant man. When he tells you he has a hunch about how it is going to work, he is uncertain about it. When he is pretty sure of how it is going to work, and he tells you, "This is the way it is going to work, I'll bet," he still is in some doubt. And it is of paramount importance, in order to make progress, that we recognize this ignorance and this doubt. Because we have the doubt, we then propose looking in new directions for new ideas. The rate of development in science is not the rate at which you make observations alone but, much more important, the rate at which you create new things to test.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 27)

Perseus Books. Reading, Massachusetts, USA. 1998

## DEVELOPMENT HYPOTHESIS

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Every individual, whatever its species or order, begins and increases until it attains to its state of fullest development, under certain fixed laws, and in *consequence* of their operation.

*The Foot-prints of the Creator: Or, The Asterolepis of Stromness*

The Development Hypothesis, and Its Consequences (p. 37)

Gould & Lincoln. Boston, Massachusetts, USA. 1868

## DEVELOPMENT, SCALE OF

**Anderson, James H.**

No biographical data available

There is nothing but has its relative position in the scale of development, not a blade of grass nor a grain of sand but bears mute testimony to some wonderworking force. Each individual man has his place and is necessary to a complete harmony of things. Nature waves her magic wand, and the small brown seed bursts forth in tender green, the silken petaled blossoms that erstwhile swayed in the western breeze falls off and leaves the young fruit on her stem, the ripened fruit is at heart a seed. Minute life forms have built up lofty mountains, and tiny, pattering raindrops have leveled rocky headlands.

*Riddles of Prehistoric Times*

Chapter I (p. 8)

Broadway Publishing Co. New York, New York, USA. 1911

## DIAGNOSIS

**Bigelow, Jacob** 1787–1879

American Physician

*He is a great physician who, above other men, understands diagnosis.* It is not he who promises to cure all maladies, who has a remedy ready for every symptom, or one remedy for all symptoms; who boasts that success never fails him, when his daily history gives the lie to such assertion. It is rather he, who, with just discrimination, looks at a case in all its difficulties; who to habits of correct reasoning, adds the acquirements obtained from study and observation; who is trustworthy in common things for his common sense, and in professional things for his judgment, learning, and experience; who forms his opinion positive or approximate, according to the evidence; who looks at the necessary results of inevitable causes; who promptly does what man may do of good, and carefully avoids what he may do of evil.

*Nature in Disease, Illustrated in Various Discourses and Essays*

(pp. 67–68)

Ticknor & Fields. Boston, Massachusetts, USA. 1854



**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

The best physician must fail if his treatment is based on a wrong diagnosis.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Ten (p. 119)  
Duell, Sloan & Pearce. New York, New York, USA. 1947

**Field, Eugene** 1850–95  
American poet and journalist

Upon an average, twice a week,  
When anguish clouds my brow,  
My good physician and friend I seek  
To know “what ails me now.”  
He taps me on my back and chest,  
And scans my tongue for bile,  
And lays an ear against my breast  
And listens there awhile;  
Then is he ready to admit  
That all he can observe  
Is something wrong inside, to wit:  
My pneumogastric nerve!

*The Poems of Eugene Field*  
The Pneumogastric Nerve  
Charles Scribner’s Sons. New York, New York, USA. 1910

**Hoffmann, Friedrich** 1660–1742  
German physician

When investigating the nature of disease, we should attend to all the signs and symptoms. They should not be considered in isolation but rather in combination with each other.

*Fundamenta Medicinæ*  
Semiotics, Chapter I, 6 (p. 83)  
American Elsevier. New York, New York, USA. 1971

Who identifies well, treats well; hence the diagnosis of disease is in the highest degree necessary for a physician.

*Fundamenta Medicinæ*  
Semiotics, Chapter I, 2 (p. 83)  
American Elsevier. New York, New York, USA. 1971

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Young doctors are particularly strong, as I understand, on what they call diagnosis – an excellent branch of the healing art, full of satisfaction to the curious practitioner who likes to give the right Latin name to one’s complaints; not quite so satisfactory to the patient, as it is not so very much pleasanter to be bitten by a dog with a collar round his neck telling you that he is called Snap or Teaser, than by a dog without a collar. Sometimes, in fact, one would a little rather not know the exact name of his complaint, as if he does he is pretty sure to look it out in a medical dictionary, and then if he reads, “This terrible disease is

attended with vast suffering and is inevitably mortal,” or any such statement, it is apt to affect him unpleasantly.

*The Poet at the Breakfast-Table*  
Chapter III (p. 65)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Kraus, Karl** 1874–1936  
Austrian essayist and poet

One of the most widespread diseases is diagnosis.

In Harry Zohn (ed.)  
*Half-Truths & One-and-a-Half Truths*  
In Hollow Heads (p. 77)  
The University of Chicago Press. Chicago, Illinois, USA. 1990

**Latham, Peter Mere** 1789–1875  
English physician

The diagnosis of disease is often easy, often difficult, and often impossible.

In William B. Bean  
*Aphorisms from Latham* (p. 56)  
Prairie Press. Iowa City, Iowa, USA. 1962

Ordinary diseases will sometimes occur under extraordinary circumstances, or in unusual situations; and then we are apt to be thrown out in our diagnosis, as the pilot is in his course upon any unexpected alteration of lights and signals on the coast. He makes false points, and so do we.

In William B. Bean  
*Aphorisms from Latham* (p. 57)  
Prairie Press. Iowa City, Iowa, USA. 1962

You may listen to the chest forever and be no wiser, if you do not previously know what it is you are to hear. You may beat the chest forever, and all in vain, unless you know what it is that is capable of rendering it now dull and now resonant.

In William B. Bean  
*Aphorisms from Latham* (p. 58)  
Prairie Press. Iowa City, Iowa, USA. 1962

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

If necessary, be cruel; use the knife and the cautery to cure the intumescence and moral necrosis which you will feel in the posterior parietal region, in Gall and Spurzheim’s center of self-esteem, where you will find a sore spot after you have made a mistake in diagnosis.

In Harvey Cushing  
*The Life of Sir William Osler* (Volume 1)  
Chapter XIII (p. 329)  
Clarendon Press. Oxford, England. 1925

**Tolstoy, Leo** 1828–1910  
Russian writer

The doctor said : “So and so and so and so proves that so and so and so and so is the matter with your inside, but if this is not confirmed by the examination of so and so and

so, then it is necessary to assume so and so and so and so. If, then, we assume so and so and so and so, then of course” – and so on and so on. So far as Ivan Il’ich was concerned, only a single question was of any importance: “Is my condition dangerous or not?”

Translated by R. Nisbit Banes

*More Tales from Tolstoi*

The Death of Ivan Il’ich (p. 197)

Brentano’s. New York, New York, USA. 1903

## DIAGNOSTICIAN

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

One finger in the throat and one in the rectum makes a good diagnostician.

In William Bennett Bean (ed.)

*Aphorisms from His Bedside Teachings* (p. 104)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1968

## DIALECTIC

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

As there is a science of stars, called astronomy; a science of quantities, called mathematics; a science of qualities, called chemistry; so there is a science of sciences – I call it Dialectic – which is the Intellect discriminating the false and the true.

*Representative Men*

Plato; or, The Philosopher (p. 62)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1883

## DICE

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

Four dice are cast and a Venus throw results – that is chance; but do you think it would be chance, too, if in one hundred casts you made one hundred Venus throws? It is possible for paints flung at random on a canvas to form the outline of a face; but do you imagine that an accidental scattering of pigments could produce the beautiful portrait of Venus of Cos? Suppose that a hog should form a letter “A” on the ground with its snout; is that a reason for believing that it could write out Ennius’s poem *The Andromache*?

Translated by William Armistead Falconer

*Cicero: De Senectute, De Amicitia, De Divinatione*

De Divinatione, I. XIII (pp. 249–250)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Tis fate that flings the dice,  
and as she flings  
of Kings makes peasants,  
and of peasants Kings.

*The Works of John Dryden*

Volume XV, 1821 Edition (p. 103)

Hurst, Robinson & Company. London, England. 1821

**Einstein, Albert** 1879–1955

German-born physicist

I can, if the worst comes to worst, still realize that God may have created a world in which there are no natural laws. In short, a chaos. But that there should be statistical laws with definite solutions, i.e., laws which compel God to throw the dice in each individual case, I find highly disagreeable.

In Ronald W. Clark

*Einstein: The Life and Times*

Part Four, Chapter 12 (p. 340)

The World Publishing Company. New York, New York, USA. 1971

**Eldridge, Paul** 1888–1982

American educator

Acorns may be food for hogs or rise into magnificent oaks, as the dice of chance decree.

*Maxims for a Modern Man*

1849

T. Yoseloff. New York, New York, USA. 1965

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The dice of God are always loaded.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

Compensation (p. 289)

The Library of America. New York, New York, USA. 1983

**Hawking, Stephen William** 1942–

English theoretical physicist

It therefore seems that Einstein was doubly wrong when he said that God does not play dice. Consideration of particle emission from black holes suggests that God not only plays with dice but that he sometimes throws them where they cannot be seen.

The Breakdown of Physics

*Nature*, Volume 257, Number 5525, October 2, 1975 (p. 362)

**Hood, Thomas** 1582–98

English poet and editor

For dice will run the contrary way  
As well is known to all who play...

*The Complete Poetical Works of Thomas Hood*

Miss Kilmansegg and Her Precious Leg

Her Misery

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Lang, Andrew** 1844–1912  
Scottish scholar and man of letters

They need only adapt to the circumstances that old Lydian tradition which says that games of chance were invented during great famine. Men permitted themselves to eat only every second day, and tried to forget their hunger by playing at draughts and dice.

*Lost Leaders*

Winter Sports

Longman, Green & Company. New York, New York, USA. 1889

**Lubbock, John William** 1774–1820  
English banker

**Bethune, John Elliot Drinkwater** 1801–1851  
English barrister

...the anonymous writer, who, in 1692, published the first English essay “Of the Laws of Chance,” thought it necessary to protest in his preface that the design of his book was “not to teach the art of playing at dice, but to deal with them as with other epidemic distempers, and perhaps persuade a raw squire to keep his money in his pocket.”

*On Probability* (p. 43)

Baldwin & Cradock. London, England. 1830

**Mallarme, Stephane**  
Poet

*Coup de des jamais n’abolira le hasard*

A Cast of Dice Never Can Annul Chance

Translated by Neil Crawford

*A Cast of Dice Never Can Annul Chance*

Tetred. London, England. 1985

**Plutarch** 46–119  
Greek biographer and author

*Jacta alea est.*

The die is cast.

*Plutarch’s Lives*

Caesar

Harvard University Press. Cambridge, Massachusetts, USA. 1914

**Pólya, George** 1887–1985  
Hungarian mathematician

One day in Naples the reverend Galiana saw a man from the Basilicata who, shaking three dice in a cup, wagered to throw three sixes; and, in fact, he got three sixes right away. Such luck is possible, you say. Yet the man succeeded a second time, and the bet was repeated. He put back the dice in the cup, three, four, five times, and each time he produced three sixes. “*Sangue di Bacco*,” exclaimed the reverend, “the dice are loaded!” And they were.

*Mathematoics and Plausable Reasoning, Volume 2: Patterns of Plausible Inference* (p. 74)

Princeton University Press. Princeton, New Jersey, USA. 1968

**Ritsos, Yannis** 1909–90  
Greek poet

I hear the clack – who cast the dice on the bathroom tiles?

Translated by Kimon Friar

*Erotica*

Small Suite in Red Major

Sachem Press. Old Chatham, New York, USA. 1982

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

And by the hazard of the spotted die

Let die the spotted.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Timon of Athens*

Act V, Scene iv, l. 34–35

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Suidas**

No biographical data available

*Midas in tesseris consultor optimus.*

Midas on the dice gives the best advice.

*Collected Works of Erasmus*

Adages II vii 1 to III iii 100 (p. 124)

University of Toronto Press. Toronto, Ontario, Canada. 1974

**Wilder, Thornton** 1897–1975  
American playwright and novelist

We were shaken into existence, like dice from a box.

*The Eighth Day*

II, Illinois to Chile (p. 107)

Harper & Row, Publishers, New York, New York, USA, 1967

## DICTIONARY

**Valéry, Paul** 1871–1945  
French poet and critic

Leaf through a dictionary or try to make one, and you will find that every word covers and masks a well so bottomless that the questions you toss into it arouse no more than an echo.

*Aesthetics*

Man and the Sea Shell (pp. 3–4)

Pantheon Books. New York, New York, USA. 1964

## DIET

**Arnoldus** 1510–82  
Dutch philosopher and poet

A wise physician will not give physic, but upon necessity, and first try medicinal diet, before he proceed to medicinal cure.

In Robert Burton

*The Anatomy of Melancholy* (Volume 2)  
Part 2, Sect. I, Memb. IV, subsect. 1 (p. 18)  
AMS Press, Inc. New York, New York, USA. 1973

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Beware of sudden changes in any great point of diet, and, if necessity enforce it, fit the rest to it.

*Essays, Advancement of Learning, New Atlantis, and Other Pieces*  
The Essays or Counsels, Civil and Moral, XXX, Of Regiment of Health (p. 93)  
Odyssey Press. New York, New York, USA. 1937

**Davis, Adelle** 1904–74

American nutritionist

When the blood sugar is extremely low, the resulting irritability, nervous tension, and mental depression are such that a person can easily go berserk.... Add a few guns, gas jets, or razor blades, and you have the stuff murders and suicides are made of. The American diet has become dangerous in many more ways than one.

*Let's Eat Right to Keep Fit*  
Chapter 2 (p. 19)  
New American Library. New York, New York, USA. 1970

**Editor of the Louisville Journal**

What some call health, if purchased by perpetual anxiety about diet, isn't much better than tedious disease.

In George Denison Prentice  
*Prenticeana* (p. 302)  
Derby & Jackson. New York, New York, USA. 1859

**Grant, Claud**

No biographical data available

Diets are for people who are thick and tired of it.

*Quote, the Weekly Digest*, June 2, 1968 (p. 437)

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

It is probably true quite generally that in the history of human thinking the most fruitful development frequently takes place at those points where two different lines of thought meet. These lines may have roots in quite different parts of human culture, in different times or different cultural environments or different religious traditions: hence if they actually meet, that is, if they are at least so much related to each other that a real interaction can take place, then one may hope that new and interesting developments may follow.

*Physics and Philosophy*  
Chapter XI (p. 187)  
Harper & Row, Publishers. New York, New York, USA. 1962

**Simmons, Charles** 1798–1856

American clergyman and litterateur

He who eats of but one dish, never wants a physician.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 234)  
Robert Dick. Toronto, Ontario, Canada. 1853

When I behold a fashionable table, set out in all its magnificence, I fancy that I see gout and dropsies, fevers and lethargies, with innumerable distempers, lying in ambuscade among the dishes. Nature delights in the most plain and simple diet. Every animal, but man, keeps to one dish. Herbs are the food of this species, fish of that, and flesh of a third. Man falls upon everything that comes his way; not the smallest fruit or excrescence of the earth, scarce a berry or mushroom can escape him.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 486)  
Robert Dick. Toronto, Ontario, Canada. 1853

**DIETY**

**Sagan, Carl** 1934–96

American astronomer and author

We are, almost all of us, descended from people who responded to the dangers of existence by inventing stories about unpredictable or disgruntled deities.

*Cosmos*  
Chapter VII (p. 173)  
Random House, Inc. New York, New York, USA. 1980

**DIFFERENCE**

**Foster, Sir Michael** 1836–1907

English physiologist and educator

Man, unscientific man...is often content with "the nearly" and "the almost." Nature never is. It is not her way to call the same things which differ, though the difference may be measured by less than the thousandth of a milligramme or of a millimetre, or by any other like standard of minuteness. And the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature's differences in any other way than she treats them herself, will find that she resents his conduct; if he in carelessness or in disdain overlooks the minute difference which she holds out to him as a signal to guide him in his search, the projecting tip, as it were, of some buried treasure, he is bound to go astray, and, the more strenuously he struggles on, the farther will he find himself from his true goal.

In J.A. Thomson  
*Introduction to Science*  
Chapter I (p. 18)  
Williams & Norgate Ltd. London, England. 1916

**Heinlein, Robert A.** 1907–88

American science fiction writer

It has long been known that one horse can run faster than another – but which one? Differences are crucial!

*The Notebooks of Lazarus Long* (p. 1)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Huff, Darrell** 1913–2001

American writer

...a difference is a difference only if it makes a difference.

*How to Lie with Statistics*  
Chapter 4 (p. 58)  
W.W. Norton & Company, Inc. New York, New York, USA. 1954

## DIFFERENTIAL

**Zamyatin, Yevgeny** 1884–1937

Russian novelist, playwright, and satirist

The works of the highest faculty of man, judgment, is always directed toward the constant limiting of the infinite, toward the breaking up of the infinite into comfortably digestible portions, differentials.

Translated by Gregory Zilboorg  
*We*  
Record Twelve (p. 62)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1952

## DIFFERENTIAL CALCULUS

**Levi, Primo** 1919–87

Italian writer and chemist

Alongside the liberating relief of the veteran who tells his story, I now felt in the writing a complex, intense, and new pleasure, similar to that I felt as a student when penetrating the solemn order of differential calculus.

Translated by Raymond Rosenthal  
*The Periodic Table*  
Chromium (p. 153)  
Schocken Books. New York, New York, USA. 1984

## DIFFERENTIAL EQUATION

### Author undetermined

A man had a certain evasion  
For solving all difference equations.  
He used random numbers  
To cover his blunders,  
And answers caused quite a sensation!  
Source undetermined

Trying to solve differential equations is a youthful activity that you will soon grow tired of.  
Source undetermined

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

Since in the differential equations of mechanics themselves there is absolutely nothing analogous to the second law of thermodynamics the latter can be mechanically represented only by means of assumptions regarding initial conditions.

In B. McGuinness (ed.)  
*Theoretical Physics and Philosophical Problems. Selected Writings On Statistical Mechanics* (pp. 170–171)  
Reidel Publishing Company. Boston, Massachusetts, USA. 1974

**Born, Max** 1882–1970

German-born English physicist

The difficulty involved is that the proper and adequate means of describing changes in continuous deformable bodies is the method of differential equations.... They express mathematically the physical concept of contiguous action.

*Einstein's Theory of Relativity*  
Chapter IV, Section 6 (pp. 109, 111)  
Dover Publications. New York, New York, USA. 1962

**Fourier, (Jean Baptiste-) Joseph** 1768–1830

French mathematician and physicist

The differential equations of the propagation of heat express the most general conditions, and reduce the physical questions to problems of pure analysis, and this is the proper object of theory.

In *Great Books of the Western World* (Volume 43)  
*The Analytical Theory of Heat*  
Preliminary Discourse (p. 172)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

Men have fallen in love with status and pictures. I find it easier to imagine a man falling in love with a differential equation, and I am inclined to think that some mathematicians have done so. Even in a nonmathematician like myself, some differential equations evoke fairly violent physical sensations to those described by Sappho and Catallus when viewing their mistresses. Personally, I obtain an even greater “kick” from finite difference equations, which are perhaps more like those which an up-to-date materialist would use to describe human behavior.

*The Inequality of Man and Other Essays*  
Scientific Calvinism (p. 39)  
Penguin Books Ltd., Harmondsworth, England. 1937

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

If one looks at the different problems of the integral calculus which arise naturally when he wishes to go deep into the different parts of physics, it is impossible not to be struck by the analogies existing. Whether it be electrostatics or electrodynamics, the propagation of heat, optics, elasticity, or hydrodynamics, we are led always to differential equations of the same family.

Sur les Equations aux Dérivées Partielles de la Physique Mathématique  
*American Journal of Mathematics*, Volume 12, 1890 (p. 211)

**Pólya, George** 1887–1985  
Hungarian mathematician

In order to solve a differential equation you look at it till a solution occurs to you.

*How to Solve It: A New Aspect of Mathematical Method*  
Part III, The traditional mathematics professor (p. 208)  
Princeton University Press. Princeton, New Jersey, USA. 1973

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

Once you learn the concept of a differential equation, you see differential equations all over, no matter what you do.

*Indiscrete Thoughts* (p. 213)

**Sholander, Marlow**  
Mathematician

If the finding is essential  
Of a singular solution  
For equations differential,  
Let me sketch its execution.  
First obtain some ordinary  
Members of the family  
Of solutions – oh, not very  
Many, maybe twenty three.  
Find their curves by carefully plotting.  
Ink them quickly and you ought,  
From the points requiring blotting,  
To obtain the locus sought.

Envelopes and Nodes  
*Mathematics Magazine*, Volume 34, Number 2, Nov–Dec 1960 (p. 108)

**Temple, George Frederick James** 1901–92  
English mathematician

The group of problems which I propose to describe belong to that Cinderella of pure mathematics – the study of differential equations.

*Proceedings of the International Mathematical Congress (1958)* (p. 233)

An inviting flora of rare [differential] equations and exotic problems lies before a botanical excursion into the non-linear field.

*Proceedings of the International Mathematical Congress (1958)* (p. 233)

**Turing, Alan** 1912–54  
English mathematician

Science is a differential equation. Religion is a boundary condition.

In John D. Barrow  
*Theories of Everything: The Quest for Ultimate Explanation*  
Chapter Three (p. 31)  
Clarendon Press. Oxford, England. 1991

**Webster, Arthur Gordon** 1864–1923  
American mathematician and experimental physicist

It seems to be the impression among students that mathematical physics consists in deriving a large number of partial differential equations and then solving them, individually, by an assortment of special mutually unrelated devices. It has not been made clear that there is any underlying unity of method and one has often been left entirely in the dark as to what first suggested a particular device to the mind of its inventor.

*Partial Differential Equations of Mathematical Physics*  
Note by the Editor (p. v)  
Dover Publications, Inc. New York, New York, USA. 1955

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Matter-of-fact is an abstraction, arrived at by confining thought to purely formal relations which then masquerade as the final reality. This is why science, in its perfection, relapses into the study of differential equations. The concrete world has slipped through the meshes of the scientific net.

*Modes of Thought*  
Chapter I, Lecture One (p. 25)  
The Macmillan Company. New York, New York, USA. 1938

## DIFFERENTIATION

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Common integration is only the *memory of differentiation* ...

*Transactions of the Cambridge Philosophical Society* (Volume 8)  
On Divergent Series, and Various Points of Analysis Connected with Them (p. 188)  
At the University Press. Cambridge, England. 1849

## DIFFICULTY

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...man always believes more readily that which he prefers. He, therefore, rejects difficulties for want of patience in investigation...

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 49 (p. 111)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lamb, Sir Horace** 1848–1934  
English applied mathematician

It remains to call attention to the chief outstanding difficulty of our subject [turbulent motion].

*Hydrodynamics* (4th edition)  
Chapter XI (p. 651)  
At the University Press. Cambridge, England. 1916

**Parkhurst, Charles Henry** 1842–1933  
American clergyman and reformer



Science has not solved difficulties, only shifted the points of difficulty.

*The Pattern in the Mount*

Walking by Faith (p. 52)

Anson D.F. Randolph & Co. New York, New York, USA. 1885

**Schuster, Arthur** 1851–1934

German-born English physicist

Difficulties cease to trouble us either when they are surmounted, or when we have become accustomed to them.

*The Progress of Physics During 33 Years (1875–1908)*

Lecture IV (p. 118)

At the University Press. Cambridge, England. 1911

**Simmons, Charles** 1798–1856

American clergy and litterateur

If you find a hill in the path of science, climb over it, and not run round it.

*A Laconic Manual and Brief Remarker* (p. 141)

Charles Simmons. North Wrentham, Massachusetts, USA. 1852

## DIFFUSION

**Barcroft, Joseph** 1872–1947

Irish physiologist

A number of tests were made for the purpose of discovering whether the pressure of oxygen in the blood was or was not higher than that in the alveolar air. In all cases they were so nearly the same that we attribute the passage of gas through the pulmonary epithelium to diffusion.

Observations Upon the Effect of High Altitude on the Physiological Processes of the Human Body, Carried Out in the Peruvian Andes, Chiefly at Cerro de Pasc

*Philosophical Transactions of the Royal Society of London, B*, Volume 211, 1923

**Goldsmith, Oliver** 1730?–74

Anglo-Irish author

As aromatic plants bestow

No spicy fragrance while they grow;

But crushed or trodden to the ground

Diffuse their balmy sweets around.

In Roger Lonsdale (ed.)

*The Poems of Thomas Gray, William Collins, Oliver Goldsmith*

*The Captivity*

Act I

Longmans, Green & Company. New York, New York, USA. 1969

## DIG

**Bibby, Geoffrey** 1917–2001

English archaeologist

...every archaeologist knows in his heart why he digs. He digs, in pity and humility, that the dead may live again, that what is past may not be forever lost, that something may be salvaged from the wreck of ages.

*The Testimony of the Spade*

Book Four, Chapter 28 (p. 411)

Alfred A. Knopf. New York, New York, USA. 1956

**Leakey, Mary** 1913–96

English archaeologist

Fortunately, there is so much underground still. It is a vast place, and there is plenty more under the surface for future generations that are better educated.

Marguerite Holloway

*Scientific American*, October, 1994

You know, you only find what you are looking for, really, if the truth be known.

Marguerite Holloway

*Scientific American*, October, 1994

**Wheeler, Sir Mortimer** 1890–1976

English archaeologist

There is no right way of digging but there are many wrong ways.

*Archaeology from the Earth*

Introduction (p. 1)

At The Clarendon Press. Oxford, England. 1954

...there must always be an element of chance and of opportunism in an excavation, however carefully planned.

But scientific digging is not on that account a gamble.

*Archaeology from the Earth*

Chapter V (pp. 62–63)

At The Clarendon Press. Oxford, England. 1954

**Wodehouse, Sir Pelham Grenville** 1881–1975

English writer

A mere hole in the ground, which of all sights is perhaps the least vivid and dramatic, is enough to grip their [archaeologists] attention for hours at a time.

*A Damsel in Distress*

Chapter 3 (p. 31)

Herbert Jenkins. London, England. 1919

**Woolley, Sir Charles Leonard** 1880–1960

English archaeologist

...the digger who will best observe and record his discoveries is precisely he who sees them as historical material and rightly appraises them: if he has not the power of synthesis and interpretation he has mistaken his calling.

*Digging Up the Past*

Chapter V (p. 135)

Charles Scribner's Sons. New York, New York, USA. 1931

## DILEMMA

**Compton, Arthur H.** 1892–1962

American physicist

We are thus faced with the fact that the fundamental things in nature, matter, and radiation, present to us a

dual aspect. In certain ways they act like particles, in others like waves. The experiments tell us that we must seize both horns of the dilemma.

*Annual Report of the Board of Regents of the Smithsonian Institution (1929)*

What is Light? (p. 226)

Government Printing Office. Washington, D.C. 1930

## DIMENSION

**Abbott, Edwin A.** 1838–1926

English schoolmaster and theologian

Yet I exist in the hope that these memoirs...may find their way to the minds of humanity in *Some Dimension*, and may stir up a race of rebels who shall refuse to be confined to limited Dimensionality.

*Flatland: A Romance of Many Dimensions*

Part II, Section 22 (p. 107)

Barnes & Noble, Inc. New York, New York, USA. 1963

To

The Inhabitants of SPACE IN GENERAL

And H. C. IN PARTICULAR

This Work is Dedicated

By a Humble Native of Flatland

In the Hope that

Even as he was Initiated into the Mysteries

Of THREE Dimensions

Having been previously conversant

With ONLY Two

So the Citizens of that Celestial Region

May aspire yet higher and higher

To the Secrets of FOUR FIVE OR EVEN SIX Dimensions

Thereby contributing

To the Enlargement of THE IMAGINATION

And the possible Development

Of that most rare and excellent Gift of MODESTY

Among the Superior Races

Of SOLID HUMANITY

*Flatland: A Romance of Many Dimensions*

Dedication (p. 5)

Little, Brown & Co. Boston, Massachusetts, USA. 1899

“Look yonder,” said my Guide, “in Flatland thou hast lived; of Lineland thou hast received a vision; thou hast soared with me to the heights of Spaceland; now, in order to complete the range of thy experience, I conduct thee downward to the lowest depth of existence, even to the realm of Pointland, the Abyss of No dimensions.”

*Flatland*

Section 20

**Baker, W. R.**

No biographical data available

Length, breadth, and depth are said to be  
The limits of man’s comprehension,

But when I see the pile of junk

That she can get into a trunk

The mystery convinces me

That woman knows a fourth dimension.

The Magic Box

*Harper’s Magazine*, Volume CLVI, December 1927–May 1928 (p. 649)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The quest of the absolute leads into the four-dimensional world.

*The Nature of the Physical World*

Chapter II (p. 26)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

Imagine a bedbug completely flattened out, living on the surface of a globe. This bedbug may be gifted with analysis, he may study physics, he may even write a book. His universe will be two-dimensional. He may even intellectually or mathematically conceive of a third dimension, but he cannot visualize it. Man is in the same position as the unfortunate bedbug, except that he is three-dimensional. Man can imagine a fourth dimension mathematically, but he cannot see it, he cannot visualize it, he cannot represent it physically. It exists only mathematically for him. The mind cannot grasp it.

*Cosmic Religion, with Other Opinions and Aphorisms*

On Science (pp. 102–103)

Covici-Fiede. New York, New York, USA. 1931

**Fock, Vladimir Alexandrovich** 1898–1974

Russian theoretical physicist

Though we may weigh it as we will,

Exhausted and delirious,

One-hundred-thirty-seven still

Remains for us mysterious.

But Eddington, he, sees it clear,

Denouncing those who tend to jeer;

It is the number of (says he)

The world’s dimensions. Can it?! be?! –

In George Gamow

*Biography of Physics* (p. 327)

Harper & Row, Publishers. New York, New York, USA. 1951

**Hamilton, Sir William Rowan** 1805–65

Irish mathematician

Time is said to have only one dimension, and space to have three dimensions.... The mathematical quaternion partakes of both these elements; in technical language it may be said to be “time plus space,” or “space plus time”: and in this sense it has, or at least involves a reference to, four dimensions...

And how the One of Time, of Space the Three,  
Might in the Chain of Symbols girdled be.

In Robert Percival Graves  
*Life of Sir William Rowan Hamilton* (Volume 3) (p. 635)  
 Hodges, Figgis & Company. Dublin, Ireland. 1882–1889

**Keyser, Cassius Jackson** 1862–1947  
 American mathematician

Among the splendid generalizations effected by modern mathematics, there is none more brilliant or more inspiring or more fruitful, and none more nearly commensurate with the limitless immensity of being itself, than that which produced the great concept variously designated by such equivalent terms as hyperspace, multidimensional space,  $n$ -space,  $n$ -fold or  $n$ -dimensional space, and space of  $n$  dimensions.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
 Chapter V (p. 101)  
 Columbia University Press. New York, New York, USA. 1916

**Maxwell, James Clerk** 1831–79  
 Scottish physicist

My soul is an entangled knot,  
 Upon a liquid vortex wrought  
 By Intellect in the Unseen residing,  
 And thine doth like a convict sit,  
 With marlinespike untwisting it,  
 Only to find its knottiness abiding;  
 Since all the tools for its untying  
 In four-dimensional space are lying,  
 Wherein thy fancy intersperses  
 Long avenues of universes,  
 While Klein and Clifford fill the void  
 With one finite, unbounded homoloid,  
 And think the Infinite is now at last destroyed.

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*  
 A Paradoxical Ode (p. 649)  
 Macmillan & Company Ltd. London, England. 1882

### Ray Stantz (Fictional character)

As a duly designated representative of the City, County and State of New York, I order you to cease any and all supernatural activities and return forthwith to your place of origin or to the nearest convenient parallel dimension.  
*Ghostbusters*  
 Film (1984)

**Reichenbach, Hans** 1891–1953  
 German philosopher of science

Let us assume that the three dimensions of space are visualized in the customary fashion, and let us substitute a color for the fourth dimension. Every physical object is liable to changes in color as well as in position. An object might, for example, be capable of going through all shades from red through violet to blue. A physical interaction between any two bodies is possible only if they are close to each other in space as well as in color. Bodies of

different colors would penetrate each other without interference.... If we lock a number of flies into a red glass globe, they may yet escape: they may change their color to blue and then able to penetrate the red globe.

Translated by Maria Reichenbach and John Freund  
*The Philosophy of Space & Time*  
 Section 44 (pp. 281, 282)  
 Dover Publications, Inc. New York, New York, USA. 1958

**Stewart, Ian** 1945–  
 English mathematician

Well, Diary Dear, eventually the Space Hopper managed to explain in what sense the Planiturthian People's Bicircle is Seven Dimensional. It's all to do with variables – quantities that can change. 'Dimension' is a geometric way of referring to a variable. Time is a nonspatial variable, so it provides a fourth dimension, but the same goes for temperature, wind-speed, or the number of termites in Tangentia. The position of a point in three: dimensional space depends on three variables – its distances East, North, and Upwards relative to some reference point. By analogy, anything that depends on four variables lives in a four dimensional space, and anything that depends on variables lives in a 101-dimensional space.

*Flatterland*  
 A Hundred and One Dimensions (pp. 46–47)  
 Perseus Publishing. Cambridge, Massachusetts, USA. 2001

**Thorne, Kip S.** 1940–  
 American theoretical physicist

Hyperspaces' third dimension has nothing whatsoever to do with any of the dimensions of our own Universe. It is a dimension into which we can never go and never see, and from which we can never get information; it is purely hypothetical.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*  
 Chapter 3 (p. 130)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Updike, John** 1932–  
 American novelist, short story writer, and poet

...you need no more or less than three dimensions to make a knot, a knot that tightens on itself and won't pull apart, and that's what the ultimate particles are – knots in space-time. You can't make a knot in two dimensions because there's no over or under...

*Roger's Version*  
 Chapter V (p. 302)  
 Alfred A. Knopf. New York, New York, USA. 1986

Imagine nothing, a total vacuum. But wait! There's something in it! Points, potential geometry. A kind of dust of structurless points. Or, if that's too woolly for you, try "a Borel set of points not yet assembled into a manifold of any particular dimensionality."

*Roger's Version*  
 Chapter V (p. 303)  
 Alfred A. Knopf. New York, New York, USA. 1986

**Uspenskii, Petr Demianovich** 1878–1947

Russian author, thinker, and mystic

And when we shall see or feel ourselves in the world of four dimensions we shall see that the world of three dimensions does not really exist and has never existed: that it was the creation of our own fantasy, a phantom host, an optical illusion, a delusion – anything one pleases excepting only reality.

Translated by Nicholas Bessaraboff and Claude Bragdon

*Tertium Organum: The Third Canon of Thought*

Chapter IX (p. 98)

Vintage Books. New York, New York, USA. 1970

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Mathematical theorists tell us that the only way in which the right and left sides of a solid body can be changed is by taking that body clean out of space as we know it – taking it out of ordinary existence, that is and turning it somewhere outside space.... To put the thing in technical language, the curious inversion of Plattner's right and left sides is proof that he has moved out of our space into what is called the Fourth Dimension, and that he has returned again to our world.

*The Short Stories of H.G. Wells*

The Plattner Story (p. 329)

E. Benn Limited. London, England. 1927

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

I regret that it has been necessary for me in this lecture to administer a large dose of four-dimensional geometry. I do not apologise, because I am really not responsible for the fact the nature in its most fundamental aspect is four-dimensional. Things are what they are....

*The Concept of Nature*

Chapter V (p. 119)

At The University Press. Cambridge, England. 1920

**Williams, W. H.**

No biographical data available

And space, it has dimensions four,

Instead of only three.

The square of the hypotenuse

Ain't what it used to be.

In Fred Alan Wolf

*Parallel Universes*

Part Three (p. 105)

Simon &amp; Schuster. New York, New York, USA. 1988

**TWO DIMENSION****King, Stephen** 1947–

American author and screenwriter

She looked at Kevin with narrow suspicion as they drew closer together. At the moment when they passed each

other on the sidewalk, she disappeared. Her *shadow* was still there and he could still hear that rhythmic squeaking, but she was no longer there. Then she reappeared, looking back at him from her fat flat suspicious face, and Kevin understood the reason why she had disappeared for a moment. It was because the concept of 'a side view' didn't exist, *couldn't* exist, in a world where everything was perfectly flat.

*Four Past Midnight*

Chapter 7 (p. 654)

Viking Publisher. New York, New York, USA. 1990

**THREE DIMENSION****Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Threefold is the form of space: *Length*, with ever restless motion,

Seeks eternity's wide ocean; –

*Breadth* with boundless sway extends; *Depth* to unknown realms descends.*Poems*

The Proverbs of Confucius Stanza II

Harvard Publishing Co. New York, New York, USA. 1895

**FOUR DIMENSION****Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Time is not the fourth dimension, for the sufficient reason that 'the fourth dimension' is a collection of three words without meaning.

*The Handmaiden of the Sciences*

Chapter 6 (p. 95)

Williams &amp; Wilkins Co. Baltimore, Maryland, USA. 1937

**Bragdon, Claude Fayette** 1866–1945

American architect, writer, and stage designer

To the question, where and what is the fourth dimension, the answer must be, it is here – in us, and all about us – in a direction toward which we can never point because at right angles to all the directions that we know. Our space cannot contain it, because it contains our space. No walls separate us from this demesne, not even the walls of our fleshly prison; yet we may not enter, even though we are already "there." It is the place of dreams, of living dead men: it is *At the Back of the North Wind* and *Behind the Looking Glass*.

*Four Dimensional Vistas*

Chapter I (pp. 15–16)

Alfred A. Knopf. New York, New York, USA. 1923

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

However successful the theory of a four-dimensional world may be, it is difficult to ignore a voice inside us

which whispers “At the back of your mind, you know that a fourth dimension is all nonsense.” I fancy that that voice must often have had a busy time in the past history of physics.... Let us not be beguiled by this voice. It is discredited.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 56)

At the University Press. Cambridge, England. 1921

The material structure of the four-dimensional world is fibrous, with the threads all running along time – like tracks; it is a tangled warp without a woof.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 60)

At The University Press. Cambridge, England. 1921

### Ionides, Stephen A.

No biographical data available

The brains of mathematicians must contain some very curious sights; not only do they claim to know what tesseracts look like, but they also tell us that the fourth dimension must be multiplied by the square root of minus one before it will fit into equations, and that it then fits perfectly.

*Stars and Men*

Chapter XVII (p. 405)

Bobbs-Merrill. Indianapolis, Indiana, USA. 1939

### Sleator, William 1945–

American science fiction writer

The Fourth Dimension is just a hypothetical math concept. Or else it's time, or something. Just a lot of sci-fi crud.

*The Boy Who Reversed Himself*

Chapter 4 (p. 16)

E.P. Dutton. New York, New York, USA. 1986

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

There are really four dimensions, three of which we call the three planes of Space, and a fourth, Time. There is, however, a tendency to draw an unreal distinction between the former three dimensions and the latter, because it happens that our consciousness moves intermittently in one direction along the latter from the beginning to the end of our lives.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

Here is a portrait of a man at eight years old, another at fifteen, another at seventeen, another at twenty-three, and so on. All these are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensional being, which is a fixed and unalterable thing.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine

Chapter One (p. 450)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

## FIVE DIMENSION

### Abbott, Edwin A. 1838–1926

English schoolmaster and theologian

In that blessed region of Four Dimensions, shall we linger on the threshold of the Fifth, and not enter therein? Ah, no! Let us rather resolve that our ambition shall soar with our corporal ascent.

*Flatland*

Part II, section 19 (p. 90)

Seeley & Co. London, England. 1884

### L'Engle, Madeleine 1918–2007

American writer

Well, the fifth dimension's a tesseract. You add that to the other four dimensions and you can travel through space without having to go the long way round.

*A Wrinkle in Time*

Chapter 5 (p. 78)

Dell Publishing Co. New York, New York, USA. 1962

## DIMENSIONS

### Fisher, J. B.

No biographical data available

### Tully, R. B.

No biographical data available

We will now go on to justify the system of dimensions that has been chosen. Readers with weak stomachs may wish to pass to the next subsection.

Neutral Hydrogen Observations of a Large Sample of Galaxies

*Astrophysical Journal Supplement Series*, Volume 47 October, 1981 (p. 185)

### Newcomb, Simon 1835–1909

Canadian-American astronomer

If the material bodies which surround us were placed in a space of more than three dimensions, their kinematic susceptibilities would be increased in a manner which, at first sight, would seem very extraordinary.

Note on a Class of Transformations Which Surfaces May Undergo in Space of More Than Three Dimensions

*American Journal of mathematics*, Volume 1, Number 1, 1878 (p. 1)

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

There may be other universes and dimensions galore. There may be a fourth dimension, for example, and, if you like, a fifth dimension and a sixth dimension and any number of other dimensions. They don't concern me. I live in this universe and in three dimensions, and I have



no more interest in all these other universes and dimensions than a bug under the wallpaper has in the deep, deep sea.

*The Undying Fire*

Chapter 5 (p. 138)

The Macmillan Co. New York, New York, USA. 1919

“Could I but rotate my arm out of the limits set to it,” one of the Utopians had said to him, “I could thrust it into a thousand dimensions.”

*Men Like Gods*

Book the Third, Chapter IV, Section 6 (p. 322)

The Macmillan Company. New York, New York, USA. 1923

## DIRT

**Warner, Charles Dudley** 1829–1900

American editor and author

The love of dirt is among the earliest of passions, as it is the latest. Mud-pies gratify one of our first and best instincts. So long as we are dirty, we are pure.

*My Summer in a Garden*

Preliminary (p. 13)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1897

## DISCHARGE

**Flaubert, Gustave** 1821–90

French novelist

Discharge. Rejoice when it leaves any affected part, and express astonishment that the human body can contain so much matter.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

## DISCONTINUITY

**Landé, Alfred** 1888–1976

German-born American physicist

...if our world is not “the best of all possible worlds” it certainly is the only one in which it is possible to avoid the dilemma of discontinuity.

Quantum Mechanics, A Thermodynamic Approach

*American Scientist*, Volume 41, Number 3, July 1953 (p. 448)

## DISCOVER

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

We do not yet pretend to have discovered all things, or that what we have discovered can receive no addition; and therefore, pray let us agree, there are yet many things to be done in the ages to come.

*Conversations on the Plurality of Worlds*

The Second Evening (p. 66)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Edison, Thomas** 1847–1931

American inventor

When I want to discover something, I begin by reading up everything that has been done along that line in the past – that’s what all these books in the library are for. I see what has been accomplished at great labor and expense in the past. I gather the data of many thousands of experiments as a starting point, and then I make a thousand more.

In Dogbert D. Runes (ed.)

*The Diary and Sundry Observations of Thomas Alva Edison*

Chapter XXVII (pp. 161–162)

Philosophical Library. New York, New York, USA. 1948

**Hadamard, Jacques** 1865–1963

French mathematician

It is important for him who wants to discover not to confine himself to one chapter of science, but to keep in touch with various others.

In Freeman Dyson

Missed Opportunities

*Bulletin of the American Mathematical Society*, New Series, Volume 78, Number 5, 1972

**Half, Robert**

No biographical data available

The first step to finding something is knowing where to look.

*Robert Half on Hiring*

Chapter 3 (p. 31)

Crown Publishers Inc. New York, New York, USA. 1985

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

...it is the individual man who thinks and who discovers; not any aggregate or mass of men.

*Report of the Fifth Meeting of the British Association for the Advancement of Science*

Address by Sir William Hamilton (p. xliii)

John Murray. London, England. 1836

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

To discover the real nature of things, we must discard all prejudices, all purely instinctive ways of thinking, and labour along the stony but sure path of reason and verification.

In J. Arthur Thomson

*The Outline of Science* (Volume 3)

Chapter XIX (p. 673)

G.P. Putnam’s Sons. New York, New York, USA. 1937

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The sailor in whose phantasy objects swept up on the coast vividly provoke the picture of a far-off land will go to look for it. Whether he finds it or not, whether its location and character correspond with his idea or



not, if instead of the surmised Indian or Chinese coast he discovers a new one, in any case he has widened his experience.

*Knowledge and Error: Sketches on the Psychology of Enquiry*  
Chapter XIV (p. 172)  
D. Reidel Publishing Company. Dordrecht, Netherlands. 1976

**Planck, Max** 1858–1947  
German physicist

We cannot hope to find what is assumed not to be existent.

Translated by W.H. Johnston  
*The Philosophy of Physics*  
Chapter I (p. 28)  
W.W. Norton & Co. New York, New York, USA. 1936

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

...in repeating an argument that I have learned, I could readily have discovered it myself: or rather, even if this is an illusion, if I were not clever enough to have created it myself, I rediscover it myself, to the extent that I repeat it.

In Raymond George Ayoub  
*Musings of the Masters: An Anthology of Mathematical Reflections*  
Mathematical Invention (p. 22)  
Mathematical Association of America. Washington, D.C. 2004

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

It behooves us always to remember that in physics it has taken great men to discover simple things.

*On Growth and Form* (Volume 1)  
Chapter I (p. 13)  
At The University Press. Cambridge, England. 1951

**Wilson, Edward O.** 1929–  
American biologist and author

In our hearts we hope we will never discover everything. We pray there will always be a world like this one at whose edge I sat in darkness.

*The Diversity of Life*  
Chapter One (p. 7)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Wren, Sir Christopher** 1632–1723  
English mathematician architect

But then I only begin to value the Advantage of this Age in Learning before the former, when I fancy him (Seneca) continuing his Prophecy (of a new world), and imagine how much the ancient laborious Enquirers would envy us, should he have sung to them, that a Time would come, when Men should be able to stretch out their Eyes, as Snails do, and extend them to fifty feet in length; by which means, they should be able to discover Two Thousand Times as many Stars as we can; and find this Galaxy to be Myriads of them; and every nebulous

Star appearing as if it were the Firmament of some other World, at an incomprehensible Distance, buried in the vast Abyss of intermundious vacuum. ([O]r, in the original Latin “*si nebulosam quam stellam Potius Firmamentum esse, non nostrum portasse sed Remotissimi cujus da Mundi quam vastis Intermundiis dissiti.*”)

Inaugural Address, Gresham College, 1657  
Quoted by G.J. Whitrow, *The Quarterly Journal of the Royal Astronomical Society*, Volume 8, 1967 (p. 55)

**Wright, Thomas** 1711–86  
English cosmologist

Time and Observation will undoubtedly, at last, discover everything to us necessary to our Natures, and proper for us to know.

*An Original Theory or New Hypothesis of the Universe*  
Letter the Second (p. 9)  
Printed for the Author. London, England. 1750

## DISCOVERER

**Gore, George** 1826–1909  
English electrochemist

A discoverer is a tester of scientific ideas; he must not only be able to imagine likely hypotheses, and to select suitable ones for investigation, but, as hypotheses may be true or untrue, he must also be competent to invent appropriate experiments for testing them, and to devise the requisite apparatus and arrangements.

*The Art of Scientific Discovery*  
Part III, Chapter XXXII (p. 306)  
Longmans, Green & Co. London, England. 1878

**Owen, Richard** 1804–92  
English biologist, comparative anatomist, and paleontologist

He...becomes the true discoverer who establishes the truth: and the sign of the proof is the general acceptance. Whoever, therefore, resumes the investigation of a neglected or repudiated doctrine, elicits its true demonstrations, and discovers and explains the nature of the errors that have led to its tacit or declared rejection, may calmly and confidently await the acknowledgments of his rights in the discovery.

*On the Archetype and Homologies of the Vertebrate Skeleton* (pp. 76–77)  
John van Noorst. London, England. 1848

**Playfair, Lyon** 1818–98  
Scottish scientist and Parliamentarian

Man gets so accustomed to luxurious applications of science, that he often forgets the searcher of abstract truth whose discoveries led to them.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I  
he Study of Abstract Science (p. 41)  
Longman, Brown, Green & Longmans. London, England. 1852

## DISCOVERY

**Atkins, Peter William** 1940–  
English theoretical chemist

Many chemists, physicists, and artisans have contributed to the discovery of the regions of the kingdom [periodic table]. Some have stumbled on a new element unexpectedly; others have planned their journeys of exploration, in the expectation of discovering an element whose existence they already suspect. Some of this exploration is the equivalent of land reclamation, for it is along the southern shore of the mainland that there is every expectation of creating new land.

*The Periodic Kingdom*

Chapter 4 (p. 47)

BasicBooks. New York, New York, USA. 1995

**Ansted, David Thomas** 1814–80  
English geologist

Every year something is discovered that was not before known; but there remains so vast an amount of material yet unknown and unrecorded, that we may be quite sure it will never be exhausted, however long the human race may remain on the earth, or however highly the faculties of man may be developed.

*The Great Stone Book of Nature*

The Book of Nature (p. 3)

Macmillan & Co Ltd. London, England. 1864

**Auerbach, Berthold** 1812–82  
German novelist

We make nothing; we only form and discover what is already there, but which without our assistance cannot release itself from formless chaos.

Translated by Fanny Elizabeth Bennett

*On the Heights* (p. 466)

Roberts Brothers. Boston, Massachusetts, USA. 1868

### Author undetermined

Discoveries are like fruits.... [W]e must give them time to blossom, to form, and to ripen. When a man applies his whole mind to a research – takes advantage of all indications, all chances – when he makes, in a word, the idea he is pursuing the center of all his activity, there infallibly comes an hour of illumination, which reveals to him suddenly the so long-sought secret.

Heads and Hands

*To-day: A Boston Literary Journal*, Volume II, Number 9, August 28,

1852 (p. 130)

All scientific discoveries are first recorded on napkins or tablecloths. Keep supplies of them handy at all times.

Source undetermined

Nothing can be more puerile than the complaints sometimes made by certain cultivators of a science, that it is very difficult to make discoveries now that the soil has been exhausted, whereas they were so easily made when the ground was first broken. It is an error begotten by ignorance out of indolence. The first discovery did not drop upon the expectant idler who, with placid equanimity waited for the goods the gods might send, but was heavily obtained by patient, systematic, and intelligent labour; and, beyond all question, the same labour of the same mind which made the first discoveries in the new science, would now succeed in making many more, trampled though the field may be by the restless feet of those unmethodical inquirers who, running to and fro, anxiously exclaim, “Who will show us any good thing?”

Psychological Inquiries

*Journal of Mental Science*, 1862 (p. 212)

Pioneers occupy new land. Only later, one comes to understand that the cabins they built were really cathedrals.

In Jeremy Bernstein

*Experiencing Science*

Part 1. Two Faces of Physics

Chapter I. Kepler: Harmony of the World (p. 3)

Basic Books, Inc., Publishers. New York, New York, USA. 1978

Show me the scientific man who never made a mistake, and I will show you one who never made a discovery.

In J.A. Thomson

*Introduction to Science*

Chapter III (p. 73)

Williams & Norgate Ltd. London, England. 1916

**Babbage, Charles** 1792–1871  
English mathematician

The first steps in the path of discovery, and the first approximate measures, are those which add most to the existing knowledge of mankind.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter V (p. 167)

Printed for B. Fellowes. London, England. 1830

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

For no perfect discovery can be made upon a flat or a level; neither is it possible to discover the more remote and deeper parts of any science, if you stand but upon the level of the same science, and ascend not to a higher science.

*The Works of Francis Bacon* (Volume 1)

*The Advancement of Learning*

Disease of Learning (p. 36)

Printed for C. & J. Rivington. London, England. 1826

They are ill discoverers that think there is no land, when they can see nothing but the sea.

In *Great Books of the Western World* (Volume 30)  
*The Advancement of Learning*  
 Second Book, Chapter VII, Section 5 (p. 44)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...brutes by their natural instinct made many discoveries, whilst men derived but few from discussion and the conclusions of reason.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 73 (p. 118)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barth, John** 1930–  
 American writer

“My project,” he told us, “is to learn where to go by discovering where I am by reviewing where I’ve been – where we’ve all been...”

*Chimera*  
 Dunyazadiad (p. 10)  
 Fawcett. Greenwich, Connecticut, USA. 1972

**Becker, Carl Lotus** 1873–1945  
 American historian

Fresh discoveries and new inventions are no longer the result of fortunate accidents which we are expected to note with awe. They are all a part of the day’s work, anticipated, deliberately intended and brought to pass on schedule. We should be amazed indeed if tomorrow and tomorrow and tomorrow failed to offer something new to challenge our capacity for readjustment.

*The Heavenly City of the Eighteenth-century Philosophers* (p. 23)  
 Yale University Press. New Haven, Connecticut, USA. 2003

**Bernard, Claude** 1813–78  
 French physiologist

A great discovery is a fact whose appearance in science gives rise to shining ideas, whose light dispels many obscurities and shows us new paths.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II, Section II (p. 34)  
 Henry Schuman, Inc. New York, New York, USA. 1927

It has often been said that, to make discoveries, one must be ignorant. This opinion, mistaken in itself, nevertheless conceals a truth. It means that it is better to know nothing than to keep in mind fixed ideas based on theories whose confirmation we constantly seek, neglecting meanwhile everything that fails to agree with them.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II, Section iii (p. 37)  
 Henry Schuman, Inc. New York, New York, USA. 1927

Men who have excessive faith in their theories or ideas are not only ill prepared for making discoveries; they also make very poor observations.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section iii (p. 38)  
 Henry Schuman, Inc. New York, New York, USA. 1927

...a discovery is generally an unforeseen relation not included in theory, for otherwise it would be foreseen.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II, Section iii (p. 38)  
 Henry Schuman, Inc. New York, New York, USA. 1927

Ardent desire for knowledge, in fact, is the one motive attracting and supporting investigators in their efforts; and just this knowledge, really grasped and yet always flying away before them, becomes at once their sole torment and sole happiness. Those who do not know the torment of the unknown cannot have the joy of discovery, which is certainly the liveliest that the mind of man can ever feel.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part Three, Chapter IV, Section iv (pp. 221–222)  
 Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–  
 Australian zoologist

Probably the majority of discoveries in biology and medicine have been come upon unexpectedly, or at least had an element of chance in them, especially the most important and revolutionary ones.

*The Art of Scientific Investigation*  
 Chapter Three (p. 31)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1957

Often the original discovery, like the crude ore from the mine, is of little value until it has been refined and fully developed...

*The Art of Scientific Investigation*  
 Chapter Seven (p. 91)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bolyai, János** 1802–60  
 Hungarian mathematician

Mathematical discoveries, like springtime violets in the woods, have their season which no human can hasten or retard.

Quoted in Israel Kleiner  
*Thinking the Unthinkable: The Story of Complex Numbers* (with a Moral)  
*Mathematics Teacher*, Volume 81, Number 7, October, 1988 (p. 590)

**Bolyai, Wolfgang** 1775–1856  
 Hungarian mathematician

...it seems to be true that many things have as it were, an epoch in which they are discovered in several places simultaneously, just as the violets appear on all sides in springtime.

In Harold Wolfe  
*Introduction to Non-Euclidean Geometry* (p. 45)  
 Dryden Press. New York, New York, USA. 1945

**Born, Max** 1882–1970  
German-born English physicist

This pleasure [of discovery] is a little like that known to anyone who solves crossword puzzles. Yet it is much more than that, perhaps even more than the joy of doing creative work in other professions except art. It consists in the feeling of penetrating the mystery of nature, discovering a secret of creation, and bringing some sense and order into a part of the chaotic world. It is a philosophical satisfaction.

*My Life and Views* (p. 47f)

Charles Scribner's Sons. New York, New York, USA. 1968

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

In my laboratory I find that water of Lethe which causes that I forget everything but the joy of making experiments.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter I (p. 18)

Macmillan & Co Ltd. London, England. 1916

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Discovery is a double relation of analysis and synthesis together. As an analysis, it probes for what is there; but then, as a synthesis, it puts the parts together in a form by which the creative mind transcends the bare limits, the bare skeleton, that nature provides.

*The Ascent of Man*

Chapter III (p. 115)

Little, Brown & Co. Boston, Massachusetts, USA. 1975

**Brougham, Henry** 1778–1868  
English statesman

A discovery in mathematics, or a successful induction of facts, when once completed, cannot be too soon given to the world. But...an hypothesis is a work of fancy, useless in science, and fit only for the amusement of a vacant hour...

*Edinburgh Review*, 1, 1803 (p. 451)

**Bruner, Jerome Seymour** 1915–  
American psychologist

First, I should be clear about what the act of discovery entails. It is rarely, on the frontier of knowledge or elsewhere, that new facts are “discovered” in the sense of being encountered, as Newton suggested, in the form of islands of truth in an uncharted sea of ignorance. Or if they appear to be discovered in this way, it is almost always thanks to some happy hypothesis about where to navigate. Discovery, like surprise, favors the well-prepared mind.

*On Knowing: Essays for the Left Hand*

Part I, The Quest for Clarity (p. 82)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Buckle, Henry Thomas** 1821–62  
English historian

...the discoveries of great men never leave us; they are immortal, they contain those eternal truths which survive the shock of empires, outlive the struggles of rival creeds, and witness the decay of successive religions.

*History of Civilization in England* (Volume 1), Part I

Chapter IV (p. 163)

Hearst's International Library. New York, New York, USA. 1913

**Bulwer Lytton, Edward** 1831–91  
English statesman and poet

*What Will He Do With It?* Volume 2

Book VIII, Chapter 1 (p. 173)

George Routledge & Sons. London, England. 1898

**Calder, Peter Ritchie** 1906–82  
Scottish journalist and author

The genealogy of scientific discovery is important because every scientist inherits so much from his predecessors. Science is evolutionary, depending upon the inter-marriage of ideas. The family tree of a major scientific discovery is usually more impressively international than that of the most august royal house.

*Profile of Science*

Chapter 2 (p. 32)

George Allen & Unwin Ltd. London, England. 1951

**Camras, Marvin** 1916–95  
American inventor

A scientific discovery...doesn't have to please anybody. It just has to be in accordance with nature, and it has to work.

In Kenneth A Brown

*Inventors at Work: Interviews with 16 Notable American Inventors*

Marvin Camras (p. 75)

Tempus Books of Microsoft Press, Redmond, Washington, USA. 1988

**Cannon, Walter Bradford** 1871–1945  
American neurologist and physiologist

Investigators do not march straight to their goal with ease and directness.

*The Way of an Investigator: A Scientist's Experiences in Medical Research*

Chapter II (p. 22)

W.W. Norton & Company, Inc. New York, New York, USA. 1945

**Cardano, Girolamo** 1501–76  
Italian physician, mathematician, and astrologer

I swear to you by the Sacred Gospel, and on my faith as a gentleman, not only never to publish your discoveries, if you tell them to me, but I also promise and pledge my faith as a true Christian to put them down in cipher so that after my death no one shall be able to understand them.

In Øystein Ore

*Cardano: The Gambling Scholar*

Chapter 3 (p. 77)

Dover Publications, Inc. New York, New York, USA. 1953

**Carey, Sam Warren** 1911–2002  
Australian geologist

...do not expect to be hailed as a hero when you make your great discovery. More likely you will be a ratbag – maybe failed by your examiners. Your statistics, or your observations, or your literature study, or your something else will be patently deficient. Do not doubt that in our enlightened age the really important advances are and will be rejected more often than acclaimed. Nor should we doubt that in our own professional lifetime we too will repudiate with like pontifical finality the most significant insight ever to reach our desk.

*Theories of the Earth and Universe*  
Epilogue (p. 365)  
Stanford University Press. 1988

**Chapin, Edwin Hubbell** 1840–80  
Universalist minister, author lecturer, and social reformer

Through every rift of discovery some seeming anomaly drops out of the darkness, and falls as a golden link in the great chain of order.

*Living Words*  
Universalist Publishing Co. Boston, Massachusetts, USA. 1883

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

My life has been marked by two immense and fateful scientific discoveries: the splitting of the atom, [and] the recognition of the chemistry of heredity and its subsequent manipulation. It is the mistreatment of nucleus that, in both instances, lies at the basis: the nucleus of the atom, the nucleus of the cell. In both instances do I have the feeling that science has transgressed a barrier that should have remained inviolate. As happens often in science, the first discoveries were made by thoroughly admirable men, but the crowd that came right after had a more mephitic smell.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Rockefeller University Press. New York, New York, USA. 1978

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

VERSHININ: Take Copernicus or Columbus, for instance – didn't their discoveries seem useless or ridiculous at first, and some fool's empty nonsense seem the truth?

Translated by Randall Jarrell  
*The Three Sisters*  
Act I (p. 14)

Collier-Macmillan Canada, Ltd. Toronto, Ontario, Canada. 1969

**Chernyshevsky, Nikolai Gavrilovich** 1828–89  
Russian socialist reformer

Our time is a time of great discoveries and firm scientific convictions.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneiersson  
Progress Publishers. Moscow, Russia. 1979

**Chittenden, Newton W.**  
Mineral surveyor

Step by step the untreden path was measured, till, at length, the entrance seemed disclosed, and the tireless explorer to stand amid the first opening wonders of the universe.

Translated by Andrew Motte  
In Isaac Newton  
*Newton's Principia: The Mathematical Principles of Natural Philosophy*  
Life of Sir Isaac Newton (p. 16)  
Daniel Adee. New York, New York, USA. 1848

**Chomsky, Noam** 1928–  
American linguist

Discovery is the ability to be puzzled by simple things.

In Ron Grossman  
Strong Words, Asking the Questions  
*Chicago Tribune*, 1:5, Section 5, January 1, 1993

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

It is impossible to follow with intelligent interest the course of astronomical discovery without feeling some curiosity as to the means by which such surpassing results have been secured. Indeed, the bare acquaintance with what has been achieved, without any corresponding knowledge of how it has been achieved, supplies food for barren wonder rather than for fruitful and profitable thought.

*A Popular History of Astronomy During the Nineteenth Century*  
Part I, Chapter VI (p. 108)  
A. & C. Black. London, England. 1908

**Clifford, William Kingdon** 1845–79  
English mathematician

We know, of course, that the great discoveries – the true and noble paradoxes – have always come from men who by long prenticeship have so far mastered the tools forged by their fathers that they were not tied down to one particular way of using them; we know that Jove's head cannot crack with Minerva unless he have previously swallowed Metis.

*Mathematical Papers*  
Review of *A Budget of Paradoxes* (p. 560)  
Macmillan & Company Ltd. London, England. 1882

**Coleridge, Stephen** 1854–1936  
English author, barrister, and opponent of vivisection

The knowledge of past discoveries in the physical world and the hope of discovering new ones, the results of which, with hardly an exception, are to make the face of the earth hideous and disgusting, to aggravate in an appalling crescendo men's means of slaughtering one another, to increase everywhere facilities for bodily self-indulgence, and forcibly to concentrate the mind of man on things physical instead of things spiritual.

*The Idolatry of Science*  
Chapter II (p. 8)  
John Lane Co. London, England. 1920



**Conant, James Bryant** 1893–1978  
American educator and scientist

...experimental discoveries must fit the time; facts may be at hand for years without their significance being realized; the total scientific situation must be favorable for the acceptance of new views.

*On Understanding Science*

Chapter III (p. 74)

Yale University Press. New Haven, Connecticut, USA. 1947

**Cooke, Josiah Parsons** 1827–94  
American chemist

Great discoveries are not Achieved in an hour or a day. Nature has so concealed her truths, and surrounded them by so many adventitious circumstances, that they can be disclosed to the world only after long and careful study.

*Religion and Chemistry: A Re-statement of an Old Argument*

Chapter VIII (p. 240)

Charles Scribner's Sons. New York, New York, USA. 1891

**Crichton, Michael** 1942–  
American novelist

Discovery is always a rape of the natural world. Always.

*Jurassic Park*

Aviary (p. 284)

Alfred A. Knopf. New York, New York, USA. 1990

**Cronenberg, David** 1943–  
Canadian director

The way a child discovers the world constantly replicates the way science began. You start to notice what's around you, and you get very curious about how things work. How things interrelate. It's as simple as seeing a bug that intrigues you. You want to know where it goes at night; who its friends are; what it eats.

*Cronenberg on Cronenberg*

Chapter 1 (p. 5)

Faber & Faber. London, England. 1992

**Curie, Marie Skłodowska** 1867–1934  
Polish-born French physicist and chemist

"The moment of discovery" does not always exist: the scientist's work is too tenuous, too divided, for the certainty of success to crackle out suddenly in the midst of his laborious toil like a stroke of lightning, dazzling him by its fire.

In Eve Curie

*Madame Curie*

Chapter XII (p. 158)

The Literary Guild of America, Inc. New York, New York, USA. 1937

A great discovery does not leap completely achieved from the brain of the scientist, as Minerva sprang, all panoplied, from the head of Jupiter; it is the fruit of accumulated preliminary work.

*Pierre Curie*

Chapter VII (p. 144)

The Macmillan Company. New York, New York, USA. 1926

**Darwin, Charles Galton** 1809–82  
English naturalist

Every *new* body of discovery is mathematical in form, because there is no other guidance we can have.

*The New Conceptions of Matter*

Introduction (p. 3)

The Macmillan Co. New York, New York, USA. 1931

**Davisson, Clinton J.** 1881–1958  
American physicist

Discoveries in physics are made when the time for making them is ripe, and not before; the stage is set, the time is ripe, and the event occurs – more often than not at widely separated places at almost the same moment.

*Nobel Lectures, Physics 1922–1941*

The Discovery of Electron Waves (p. 387)

Elsevier Publishing Co. Amsterdam, The Netherlands. 1965

**Davy, Sir Humphry** 1778–1829  
English chemist

The greatest use of practical science is discovery.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter III (p. 154)

Smith, Elder & Company. London, England. 1839–1849

Imagination, as well as reason, is necessary to perfection in the philosophical mind. A rapidity of combination, a power of perceiving analogies, and of comparing them by facts, is the creative source of discovery.

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* (Volume 8)

Parallels Between Art and Science (p. 308)

Smith, Elder & Company. London, England. 1839–1840

In this advanced age of the world there ought to be no question concerning the importance of natural knowledge, of discoveries of the powers of nature, and of the wise laws by which they are governed.

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 58)

John Churchill. London, England. 1858

...discoveries are like blessings of heaven, permanent and universal, applying to all ages and all conditions of society.

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 59)

John Churchill. London, England. 1858

In announcing even the greatest and most important discoveries, the true philosopher will communicate his details with modesty and reserve; he will rather be a useful servant of the public, bringing forth a light from under his cloak when it is needed in darkness, than a charlatan exhibiting fireworks and having a trumpeter to announce their magnificence.



*Consolations in Travel: Or, The Last Days of a Philosopher*  
Dialogue the Fifth (p. 175)  
Cassell & Co., Ltd. London, England. 1889

**de Broglie, Louis** 1892–1987  
French physicist

The great epoch-making discoveries in the history of science (think, for example, of that of universal gravitation) have been like sudden lightning flashes, making us perceive in one single glance a harmony up till then unsuspected, and it is to have, from time to time, the divine joy of discovering such harmonies that pure science works without sparing its toil or seeking for profit.

Translated by M. Davidson  
*Physics and Microphysics* (p. 208)  
Grosset & Dunlap. New York, New York, USA. 1966

**de Castro, Adolphe** 1890–1937  
Supernatural fiction and fantasy writer

What a grown man worships is truth – knowledge – science – light – the rending of the veil and the pushing back of the shadow. Knowledge, the juggernaut! There is death in our own ritual. We must kill – dissect – destroy – and all for the sake of discovery – the worship of the ineffable light. The goddess Science demands it. We test a doubtful poison by killing. How else? No thought for self – just knowledge – the effect must be known.

In H.P. Lovecraft (ed.)  
*The Horror in the Museum and Other Revisions*  
The Last Test (p. 215)  
Arkham House: Publishers. Sauk City, Wisconsin, USA. 1970

**de Maistre, J.**  
No biographical data available

Those who have made the most discoveries in science are those who knew Bacon least, while those who have read and pondered him, like Bacon himself, have not succeeded well.

In Hans Selye  
*From Dream to Discovery: On Being a Scientist* (p. 263)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Modern discoveries have not been made by large collections of facts, with subsequent discussion, separation, and resulting deduction of a truth thus rendered perceptible. A few facts have suggested an hypothesis which means a supposition proper to explain them. The necessary results of this supposition are worked out, and then, and not till then, other facts are examined to see if their ulterior results are found in nature.

*A Budget of Paradoxes*  
Francis Bacon (p. 55)  
Longmans, Green. London, England. 1872

Great discoveries are always laughed at: but it is very often not the laugh of incredulity; it is a mode

of distorting the sense of inferiority into a sense of superiority, or a mimicry of superiority interposed between the laughter and his feeling of inferiority.

*A Budget of Paradoxes*  
Milner's Lamp (p. 149)  
Longmans, Green. London, England. 1872

**Dickens, Charles** 1812–70  
English novelist

The discoveries of modern science lead us to infer that there is a great resemblance, in many particulars, between the greatest and the smallest bodies in creation; that atoms, like suns, are separated from each other by distances which are enormous when compared with their actual size; that the molecules composing a bar of iron waltz round and round in circlets or ovals, exactly as Mars, Jupiter, and the rest of us, whirl round Phoebus, and Phoebus himself and his fellow-stars revolve round some unknown central point.

In Charles Dickens  
Periodical Comets  
*All the Year Round: A Weekly Journal*, Volume 7 March 23, 1872 (p. 388)

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

A discovery made today may not be significant or even comprehensible by itself, but it will make sense in conjunction with what was known before.

In Robert M. Hutchins and Mortimer J. Adler  
*The Great Ideas Today*, 1974  
*Advancement and Obsolescence in Science* (p. 52)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1975

**Dock, William** 1898–1990  
American physicist

The most remarkable fact about the Korotkoff sound is that it was discovered. Its observation confirmed Pasteur's thesis that "chance favors the prepared mind" – meaning that chances are innumerable or infrequent but prepared minds are very rare.

Korotkoff's Sounds  
*New England Journal of Medicine*, Volume 302, 1980

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

Truth is beautiful enough in itself to merit a homage abstract and pure; the role of science noble enough to satisfy the aspirations of the most exalted intellects; its field vast enough to offer a harvest to every worker. Some cut down rich crops, others are content to glean; but that which each gathers or discovers all enjoy; among men of science goods are in common; and the torch, kindled by genius, is not extinguished, even when it has communicated, from place to place, its quickening flame to the entire world.

*Essays in Historical Chemistry*  
Chapter XI (p. 362)  
Macmillan & Co Ltd. London, England. 1902

...if I call on memory to picture to me how the type of true happiness is realised on earth, I do not see it under the form of the powerful man clothed in high authority, nor under that of the rich man to whom the splendours of luxury and the delicacies of well-being are granted, but under that of the man of science, who consecrates his life to penetrating the secrets of nature and to the discovery of new truths.

*Essays in Historical Chemistry*

Chapter XI (p. 362)

Macmillan & Co Ltd. London, England. 1902

**Duncan, Robert Kennedy** 1919–88

American poet

It often happens in science that when a new Alaska is discovered there is a rush of “tenderfeet” to the district and it becomes difficult to extract from the mass of material presented the pure metal from the “fools gold.”

*The New Knowledge: A Popular Account of the New Physics and the New Chemistry in Their Relation to the New Theory of Matter*

Preface (p. vii)

A.S. Barnes & Co. New York, New York, USA. 1908

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...we have not to discover the properties of a thing which we have recognized in nature, but to discover how to recognize in nature a thing whose properties we have assigned.

*The Mathematical Theory of Relativity*

Introduction (p. 6)

At The University Press. Cambridge, England. 1930

...the knowledge that has been attained [of the universe] shows only the more plainly how much there is to learn. The perplexities of to-day foreshadow the discoveries of the future.

*Stellar Movements and the Structure of the Universe*

Chapter XII (p. 261)

Macmillan & Co Ltd. London, England. 1914

**Eden, Sir Anthony** 1897–1977

British politician and statesman

Every succeeding scientific discovery makes greater nonsense of old-time conceptions of sovereignty.

Speech

House of Commons, November 22, 1945

**Edison, Thomas** 1847–1931

American inventor

Many great discoveries remain to be made. We must start anew in many things, rejecting the old theories as Einstein did, building along new lines as Einstein did, fearing nothing any more than Einstein did.

In Dogbert D. Runes (ed.)

*The Diary and Sundry Observations of Thomas Alva Edison*

Chapter XXXXI (p. 227)

Philosophical Library. New York, New York, USA. 1948

**Einstein, Albert** 1879–1955

German-born physicist

In the light of knowledge attained, the happy achievement seems almost a matter of course, and any intelligent student can grasp it without too much trouble. But the years of anxious searching in the dark, with their intense longing, their alternations of confidence and exhaustion, and the final emergence into the light; – only those who have experienced it can understand that.

Translated by Alan Harris

*Essays in Science*

The General Theory of Relativity (p. 84)

Philosophical Library. New York, New York, USA. 1934

The history of scientific and technical discovery teaches us that the human race is poor in independent thinking and creative imagination.

Translated by Alan Harris

*Essays In Science*

The Flettner Ship (p. 92)

Philosophical Library. New York, New York, USA. 1934

The use of the word “Discovery” in itself is to be deprecated. For discovery is equivalent to becoming aware of a thing which is already formed; this links up with proof, which no longer bears the character of “discovery” but, in the last instance, of the means that leads to discovery.... Discovery is really not a creative act!

In Alexander Moszkowski

*Conversations with Einstein*

Chapter V (pp. 94, 95)

Horizon Press. New York, New York, USA. 1970

...the scientist finds his reward in what Henri Poincaré calls the joy of comprehension, and not in the possibilities of application to which any discovery of his may lead.

In Max Planck

*Where Is Science Going?*

Epilogue (p. 211)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Every man contains within himself a ghost continent – a place circled as warily as Antarctica was circled two hundred years ago by Captain James Cook. If, in addition, the man is a scientist, he will see strange shapes amidst his interior ice floes and be fearful of exposing to the ridicule of his fellows what he has seen.

*The Unexpected Universe*

Chapter One (p. 3)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Epps, John** 1805–69

Physician

Let it be remembered that there are, in every discovery, two accidents; the accident of meeting with the fact connected with the discovery, and the accident of possessing

an ingenious, and, in most cases, a great mind to take advantage of the fact.

*Life of John Walker, M.D.*

Chapter XII (p. 295)

Whittaker, Treacher & Company. London, England. 1831

**Faraday, Michael** 1791–1867

English physicist and chemist

I have rather, however, been desirous of discovering new facts and new relations dependent on magneto-electric induction, than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter.

*Experimental Researches in Electricity* (Volume 1) (p. 47)

Bernard Quaritch. London, England. 1939

To discover a new element is a very fine thing, but if you could decompose an element and tell us what it is made of – that would be a discovery indeed worth making.

Quoted in William Crookes

*Report of the Fifty-sixth Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 55)

John Murray. London, England. 1887

**Ferris, Timothy** 1944–

American science writer

...more discoveries have been made by scientists burning to prove a cherished theory than by disinterested observers who sat back and asked of the universe, “OK, so what can you show me?”

*Seeing in the Dark*

Chapter 10 (p. 126)

Simon & Schuster. New York, New York, USA. 2002

**Feynman, Richard P.** 1918–88

American theoretical physicist

We are very lucky to be living in an age in which we are still making discoveries.... The age in which we live is the age in which we are discovering the fundamental laws of nature, and that day will never come again. It is very exciting, it is marvelous, but this excitement will have to go.

*The Character of Physical Law*

Chapter 7 (p. 172)

British Broadcasting Company. London, England. 1965

The prize is the pleasure of finding the thing out, the kick in the discovery, the observation that other people use it [my work] – those are the real things, the honors are unreal to me.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 1 (p. 12)

Perseus Books. Cambridge, Massachusetts, USA. 1999

I think the problem is not to find the best or most efficient method to proceed to a discovery, but to find any method at all.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1965

The Development of the Space-Time View of Quantum Electrodynamics  
Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Fischer, Martin H.** 1879–1962

German-American physician

Every discovery in science is a tacit criticism of things as they are. That is why the wise man is invariably called a fool.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

**Fleming, Sir Alexander** 1881–1955

Scottish bacteriologist

We all know that chance, fortune, fate or destiny – call it what you will – has played a considerable part in many of the great discoveries in science. We do not know how many, for all scientists who have hit on something new have not disclosed exactly how it happened.

*Les Prix Nobel. The Nobel Prizes in 1945*

Nobel banquet speech for award received in 1945

Nobel Foundation. Stockholm, Sweden. 1946

It may be that while we think we are masters of the situation we are merely pawns being moved about on the board of life by some superior power.

*Les Prix Nobel. The Nobel Prizes in 1945*

Nobel banquet speech for award received in 1945

Nobel Foundation. Stockholm, Sweden. 1946

**Forbes, George** 1849–1936

Physician

As each new discovery opens up, it may be, boundless oceans for investigation, for wonder, and for admiration, the great astronomers, refusing to accept mere hypotheses as true, have founded upon these discoveries a science as exact in its observation of facts as in theories.

*History of Astronomy*

Preface (p. v)

G.P. Putnam's Sons. New York, New York, USA. 1909

**Fourier, (Jean Baptiste-) Joseph** 1768–1830

French mathematician and physicist

Profound study of nature is the most fertile source of mathematical discovery.

In *Great Books of the Western World* (Volume 43)

*The Analytical Theory of Heat*

Preliminary Discourse (pp. 172–173)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Frost, Edwin B.** 1866–1935

American astrophysicist

Scientific discoveries seldom come singly. The mastering of one problem of nature commonly suggests new modes of attacking other problems, and often contains in itself the key to their solution. Perhaps it is quite

as frequently the case that new discoveries follow incidentally, it may be, in the researches for completing the original discovery, or in the revived interest in subjects previously supposed to be exhausted for research with known methods.

Helium Astronomically Considered

*Publications of the Astronomical Society of the Pacific*, Volume VII, February, 1896 (p. 317)

**Fuller, R. Buckminster** 1895–1983

American engineer and architect

Scientific discovery is invention, and vice versa.

*Nine Chains to the Moon*

Chapter 22 (p. 169)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

A discovery is the product of a previous discovery and in its turn it will give rise to a further discovery.

In Maurice Crosland

*Gay-Lussac: Scientist and bourgeois*

Chapter 4 (p. 71)

Cambridge University Press. Cambridge, England. 1978

**Gies, William J.** 1872–1956

US biochemist and dentist

The youthful mind inclines to dissent and to discovery.

Research in Dentistry

*Journal of Dental Research*, Volume 3, Number 3, September, 1921

(p. xciv)

**Gilbert, William** 1544–1603

English scientist and physician

Since in the discovery of secret things and in the investigation of hidden causes, stronger reasons are obtained from sure experiments and demonstrated arguments than from probable conjectures and the opinions of philosophical speculators of the common sort...

In *Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Preface (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Glass, H. Bentley** 1906–2005

American geneticist

We are like the explorers of a great continent who have penetrated to its margins in most points of the compass and have mapped the major mountain chains and rivers. There are still innumerable details to fill in, but the endless horizons no longer exist.

Science: Endless Horizons or Golden Age?

*Science*, Volume 171, 1971 (p. 24)

**Gore, George** 1826–1909

English electrochemist

One of the most important qualifications of a scientific discoverer, viz., rapid scientific insight, depends essentially upon the possession of extensive knowledge, and especially upon a knowledge of great scientific principles and their relations to each other. Every fact and every discovery casts a light beyond itself, and the extent to which this light is perceived depends upon the man.

*The Art of Scientific Discovery*

Part III, Chapter XXX (p. 294)

Longmans, Green & Co. London, England. 1878

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

What could be more democratic than the principle that nuggets of real discovery abound in primary sources, located in such accessible places as major university and city libraries, for those willing to do the work and develop the skills.

*Leonardo's Mountain of Clams and the Diet of Worms*

Introduction (p. 5)

Harmon Brown, New York, New York, USA. 1998

Since all discovery emerges from an interaction of mind and nature, thoughtful scientists must scrutinize the main biases that record our socialization, our moment in political and geographical history, even the limitations (if we hope to comprehend them from within) imposed by a mental machinery jury-rigged in the immensity of evolution.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Seven, Chapter 27 (p. 345)

Random House, Inc. New York, New York, USA. 1995

The pleasure of discovery in science derives not only from the satisfaction of new explanations, but also, if not more so, in fresh (and often more difficult) puzzles that the novel solutions generate.

*Eight Little Piggies: Reflections in Natural History*

Chapter 4 (p. 73)

W.W. Norton & Co. New York, New York, USA. 1993

**Granick, Samuel**

No biographical data available

There is a constant urge in man to seek beginnings.

Speculations on the Origins and Evolution of Photosynthesis

*Annals of the New York Academy of Science*, Volume 69, 1957

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

Most men of science are neither suppliants at the feet of Nature nor fiery advocates of truths wrested from her, but

by critical inquiry into the origin of her strength and weakness they hope to discover the means of subduing her.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 4)

Macmillan & Company Ltd. London, England. 1918

The pleasure derived from the discovery of some secret of Nature unknown before except to the architect of the universe surpasses all the rewards the world can give.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 17)

Macmillan & Company Ltd. London, England. 1918

The discovery of a law of Nature is always of great advantage to scientific progress. By the warp and woof of experiment, the man of science weaves a pattern from the threads of evidence, and presents the result to the world for anyone to use or improve.

*Discovery, Or, The Spirit and Service of Science*

Chapter VII (p. 183)

Macmillan & Co Ltd. London, England. 1916

Every addition to knowledge is a stepping-stone by which the human race can pass to new regions of discovery. Science asks not for words, but work; for the patient study of the things before us rather than for dreams and vague speculations. Listen to the trumpet-call of a naturalist and philosopher, whose labours for many years "to search out the secrets of nature by the way of experiment" have made life happier and surer in many parts of the world.

*Discovery, Or, The Spirit and Service of Science*

Chapter VIII (p. 233)

Macmillan & Co Ltd. London, England. 1916

### **Gumpert, Martin**

Physician

Great discoveries are like catastrophes of nature, a mixture of destruction and beneficence. After the misery of the overthrow comes the glory of building up.

*Trail Blazers of Science*

Jerome Cardan (p. 4)

Funk & Wagnalls. New York, New York, USA. 1936

### **Hale, George Ellery** 1868–1938

American astronomer

The joys of the pioneer, the excitement that comes to him who looks for the first time upon an unknown land, the intense satisfaction of discovery, all belong to the successful investigator.

*The Study of Stellar Evolution: An Account of Some Recent Methods of Astrophysical Research*

Chapter 2 (p. 9)

The University of Chicago Press. Chicago, Illinois, USA. 1908

### **Hamilton, Sir William Rowan** 1805–65

Irish mathematician

In physical sciences the discovery of new facts is open to any blockhead with patience and manual dexterity and acute senses.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eleven (p. 144)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Harwit, Martin**

American astronomer

The history of most efforts at discovery follows a common pattern, whether we consider the discovery of varieties of insects, the exploration of the oceans for continents and islands, or the search for oil reserves in the ground. There is an initial accelerating rise in the discovery rate as increasing numbers of explorers become attracted. New ideas and tools are brought to bear on the search, and the pace of discovery quickens. Soon, however, the number of discoveries remaining to be made dwindles, and the rate of discovery declines despite the high efficiency of the methods developed. The search is approaching an end. An occasional, previously overlooked feature can be found or a particular rare species encountered; but the rate of discovery begins to decline quickly and then diminishes to a trickle. Interest drops, researchers leave the field, and there is virtually no further activity.

*Cosmic Discovery*

Chapter I (pp. 42–43)

Basic Books, Inc. New York, New York, USA. 1981

### **Henry, Joseph**

No biographical data available

The seeds of great discoveries are everywhere present and floating around us, but they fall in vain upon the unprepared mind, and germinate only where previous inquiry has elaborated the soil for their reception, and awakened the attention to a perception of their value.

Quoted in A.D.G.

Scientia Miscellanea

*Southern Literary Messenger*, Volume IV, Number 6, June, 1838 (p. 359)

### **Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

He who has seen obscurities which appeared impenetrable in physical and mathematical science suddenly dispelled, and the most barren and unpromising fields of enquiry converted, as if by inspiration, into rich and inexhaustible springs of knowledge and power on a simple change of our point of view, or by merely bringing to bear on them some principle which it never occurred before to try, will surely be the very last to acquiesce in any dispiriting prospects of either the present or future destinies of mankind ...

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (p. 8)

Longman, Orme, Brown, Green & Longmans. London, England. 1840

...we stand on the verge of a vast cosmological discovery such as nothing hitherto imagined can compare with.

In Frank A. J. L. James



*The Correspondence of Michael Faraday: January 1849–October 1855*  
Letter to Michael Faraday, 10 November, 1852 (p. 433)  
Institute of Electrical Engineers

**Hertwig, Oscar** 1849–1922  
German embryologist

From unpromising chemical and physical discoveries have arisen numerous giant industries, the basis of a commerce on an even more magnificent scale, and various technical contrivances by which men have more and more subjected space and time to their will, flitting by the force of steam, without fatigue, over wide stretches of land, or interchanging their ideas with the speed of lightning over the ocean.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
The Growth of Biology in the Nineteenth Century (p. 461)  
Government Printing Office. Washington, D.C. 1901

**Hertzberger, Herman** 1932–  
Dutch architect

...the difficulty of finding the new is mainly that of shaking off the old.

*Space and the Architect: Lessons in Architecture 2*  
Chapter 2 (p. 30)  
010 Publishers. Rotterdam, The Netherlands. 2000

**Hill, Archibald V.** 1886–1977  
English physiologist

Those whose lives are so filled with the romance of discovery, whose years are a holiday of exploration, do not need, do not deserve, payment for their toil. Their work itself is adequate reward, they have more happiness already than their share...

*Les Prix Nobel. The Nobel Prizes in 1922*  
Nobel banquet speech for award received in 1922  
Nobel Foundation. Stockholm, Sweden. 1923

**Hitching, Francis** 1933–  
English author

Science is a voyage of discovery, and beyond each horizon there is another.

*The Neck of the Giraffe: Where Darwin Went Wrong*  
Part Three, Chapter 9 (p. 263)  
Ticknor & Fields. New Haven, Connecticut, USA. 1982

**Holland, Josiah Gilbert** 1819–81  
American novelist and poet

Who never walks save where he sees men's tracks,  
Makes no discoveries ...

*Garnered Sheaves*  
*Katrina*  
Part II, Labor (p. 220)  
Scribner, Armstrong & Co. New York, New York, USA. 1873

**Holton, Gerald** 1922–  
Research professor of physics and science history

...it is precisely because the drive toward discovery is in a sense irrational that it is so powerful.

*Thematic Origins of Scientific Thought: Kepler to Einstein*  
Chapter 11 (p. 390)  
Harvard University Press. Cambridge, Massachusetts, USA. 1973

**Hooke, Robert** 1635–1703  
English physician

He...that would make thorough Discovery, must begin from the most sensible, obvious and plain Effects of Nature; of these he must make a diligent Inquiry, first what is done, and then as near as may be how 'tis done.

In Harry Woolf (ed.)  
*The Posthumous Works of Robert Hooke*  
Lectures of Light, Section II (p. 84)  
Johnson Reprint Corporation. New York, New York, USA. 1969

**Hoyle, Sir Fred** 1915–2001  
English mathematician, astronomer, and writer

Great credit accrues to those who make a scientific discovery when the world is already teetering on the edge of it, whereas the discoverer who is markedly too early scarcely earns a footnote in scientific history.

Final Remarks  
*Observational Cosmology*, ASP Conference Series, Volume 51, 1993 (p. 695)

**Hubbs, Carl L.** 1894–1979  
Oceanographer

Nearly all of the grand, fundamental discoveries and inventions by which man has lifted himself out of his dark animal past were but repetitions of discoveries and inventions which nature had made eras before our anthropoid ancestor first stood erect and looked up into the sky.

*Annual Report of the Board of Regents of the Smithsonian Institution (1933)*  
Nature's Own Seaplanes (p. 333)  
Government Printing Office. Washington, D.C. 1934

**Huggins, Sir William** 1824–1910  
English astronomer

From individual minds are born all great discoveries and revolutions of thought. New ideas may be in the air, and more or less present in many minds, but it is always an individual who at the last takes the creative step and enriches mankind with the living germ – thought of a new era of opinion.

Presidential Address  
Royal Society Anniversary Meeting, November 30, 1905  
In William H. George  
*The Scientist in Action: A Scientific Study of His Methods*  
Some Problems in Theorizing (p. 265)  
William & Norgate. London, England. 1936

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author



The man who is content to make records or to collect skins and eggs will, unless he spends years of his life in a systematic analysis of his own and others' facts, not get anything from his labours – save the very real pleasure of making the observations. But he who takes the trouble to think out new problems and new lines of attack upon the old will have the same pleasure, and in addition the joy of intellectual discovery.

*Essays in Popular Science*

Birds and the Territorial System (p. 170)  
Chatto & Windus. London, England. 1926

**Joly, John** 1857–1933

Irish physicist and geologist

In our day but little time elapses between the discovery and its application.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

Uranium and Geology (p. 355)  
Government Printing Office. Washington, D.C. 1909

**Jevons, Frank Byron** 1858–1936

No biographical data available

To the discoveries of science it is felt that no bounds can be set; what a day may bring forth in the way of the extension of man's control over the forces of Nature, what secrets of Nature the chemist in his laboratory may light upon at any moment, no man can surmise, but everyone is confident that things will be discovered as marvellous to us now as the telegraph and telephone to our predecessors of the pre-scientific age.

*Evolution*

Chapter 1 (p. 2)  
Methuen & Co. London, England. 1900

**Jevons, William Stanley** 1835–82

English economist and logician

Fertility of imagination and abundance of guesses at truth are among the first requisites of discovery; but the erroneous guesses must be many times as numerous as those which prove well founded. The weakest analogies, the most whimsical notions, the most apparently absurd theories, may pass through the teeming brain, and no record remain of more than the hundredth part. There is nothing really absurd except that which proves contrary to logic and experience. The truest theories involve suppositions which are most inconceivable, and no limit can really be placed to the freedom of hypothesis.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Chapter XXVI (p. 577)

Macmillan & Co Ltd. London, England. 1887

**Kasner, Edward** 1878–1955

American mathematician

The great mathematicians have acted on the principle “Devinez avant de démontrer,” and it is certainly true

that almost all important discoveries are made in this fashion.

The Present Problems of Geometry

*Bulletin of the American Mathematical Society*, Volume XI, Number 6,  
March, 1905 (p. 285)

**Kekulé, Friedrich August** 1829–96

German chemist

I fell into a reverie, and lo, the atoms were gamboling before my eyes! Whenever, hitherto, these diminutive beings had appeared to me, they had always been in motion; but up to that time I had never been able to discern the nature of their motion. Now, however, I saw how, frequently, two smaller atoms united to form a pair; how a larger one embraced the two smaller ones; how still larger ones kept hold of three or even four of the smaller; whilst the whole kept whirling in a giddy dance. I saw how the larger ones formed a chain, dragging the smaller ones after them but only at the ends of the chain.

In O. Theodor Benfey

*From Vital Force to Structural Formulas*

Chapter 9 (p. 77)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, the truth of which is emphasised by every advance in science, that “Great are the Works of the Lord.”

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter I (p. 21)

Macmillan & Co Ltd. London, England. 1916

**Kepler, Johannes** 1571–1630

German astronomer

Here it is a question not only of leading the reader to an understanding of the subject matter in the easiest way, but also, chiefly, of the arguments, meanderings, or even chance occurrences by which I the author first came upon that understanding. Thus, in telling of Christopher Columbus, Magellan, and of the Portuguese, we do not simply ignore the errors by which the first opened up America, the second, the China Sea, and the last, the coast of Africa; rather, we would not wish them omitted, which would indeed be to deprive ourselves of an enormous pleasure in reading.

*New Astronomy*

Summaries of the individual chapters (p. 78)

At The University Press. Cambridge, England. 1992

**Kett, Henry** 1761–1825

English college teacher and writer

The different theories of the earth, the generation of animals, the first population of the world, the perceptive power of vegetables, and the internal structure of the globe, are subjects respectively supported by arguments, which may rather invite assent by their plausibility, than produce conviction by their evidence; and may perplex our minds without satisfying our judgment: but no one can survey the common phenomena of nature, the wonders of the heavenly bodies, and the productions of the earth and the ocean, without arriving at some accurate conclusions as to their origin and design, and without increasing pleasure at every new discovery.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 90)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

### **Kingsley, Charles** 1819–75

English clergyman and author

The truth is, the pleasure of finding new species is too great; it is morally dangerous; for it brings with it the temptation to look on the thing found as your own possession, all but your own creation; to pride yourself on it, as if God had not known it for ages since; even to squabble jealously for the right of having it named after you, and of being recorded in the Transactions of I-know-not-what Society as its first discoverer: – as if all the angels in heaven had not been admiring it, long before you were born or thought of.

*Glaucus; Or, The Wonders of the Shore* (p. 31)

Macmillan & Co Ltd. London, England. 1890

### **Körner, T. W.**

No biographical data available

It is sometimes said that the great discovery of the nineteenth century was that the equations of nature were linear, and the great discovery of the twentieth century is that they are not.

*Fourier Analysis*

Chapter 24 (p. 99)

Cambridge University Press. Cambridge England. 1988

### **Krauss, Lawrence M.** 1954–

American physicist

Popular wisdom might have you believe that new discoveries in science always center on radically new ideas. In fact, most often the opposite is true. The old ideas not only survive but almost always remain seminal. While the universe is infinitely diverse in phenomena, it seems to be rather limited in principles. As a result, in physics there isn't as much premium on new ideas as there is on ideas that work.

*Fear of Physics*

Chapter 3 (p. 57)

BasicBooks. New York, New York, USA. 1993

### **Kuhn, Thomas S.** 1922–96

American historian of science

Discovery commences with the awareness of anomaly, i.e., with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. It then continues with a more or less extended exploration of the area of anomaly. And it closes only when the paradigm theory has been adjusted so that the anomalous has become the expected.... Until he has learned to see nature in a different way – the new fact is not quite a scientific fact at all.

*The Structure of Scientific Revolutions*

Chapter VI (pp. 52–53)

The University of Chicago Press. Chicago, Illinois, USA. 1970

### **Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

...the most important discoveries of the laws, methods and progress of nature have nearly always sprung from the examination of the smallest objects which she contains...

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Preliminary Discourse (pp. 9–10)

The University of Chicago Press. Chicago, Illinois, USA. 1984

### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

One of the strongest passions in a man of genius, is the love of truth. Full of the enthusiasm which a great discovery inspires, he burns with ardor to disseminate it, and the obstacles which ignorance and superstition, armed with power, oppose to it, only stimulate and increase his energy...

*System of the World* (Volume 2)

Book V, Chapter IV (p. 266)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

### **Lavrentjev, Mikhail Alexeevich**

Russian mathematician

There are no useless discoveries! You must not tell a scientist to discontinue his research because it is unneeded today.... By scornfully discharging research that now may be abstract, but is actually leveled at unraveling the mysteries of nature and reproducing its phenomena, we run the risk of losing too much, because knowledge of the unknown forces of nature is always followed by the mastery of these forces.

Translated by Nicholas Weinstein

In Roman Podolny

*Something Called Nothing. Physical Vacuum: What Is it?*

To the Reader (p. 11)

MIR Publishers. Moscow, Russia. 1986

**Lehmann, Karl Gotthelf**

No biological data available

In order to make great discoveries it is not necessary to know what one is going to discover.

*Physiological Chemistry*

Chapter VII (p. 1010)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1855

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

The art of discovering the causes of phenomena, or true hypothesis, is like the art of deciphering, in which an ingenious conjecture often greatly shortens the road.

*New Essays Concerning Human Understanding*

Book IV, Chapter XII (p. 526)

The Open Court Publishing Company. La Salle, Illinois, USA. 1916

It is an extremely useful thing to have knowledge of the true origins of memorable discoveries, especially those that have been found not by accident but by dint of meditation. It is not so much that thereby history may be attributed to each man his own discoveries and others should be encouraged to earn like commendation, as that the art of making discoveries should be extended by considering noteworthy examples of it.

*The Early Mathematical Manuscripts of Leibniz*

Historia et Origo Calculi Differentialis

Chapter III (p. 22)

The Open Court Publishing Company. La Salle, Illinois, USA. 1920

**Lonergan, Bernard J. F.** 1904–84

Canadian philosopher, theologian, and educator

Discovery is new beginning. It is the origin of new rules that supplement, or even supplant, the old. Genius is creative. It is genius precisely because it disregards established routines, because it originates the novelties that will be the routines of the future. Were there rules for discovery, then discoveries would be mere conclusions.

*Insight*

Chapter I (p. 4)

Harper & Row, Publishers. San Francisco, California, USA. 1978

**Lowell, Percival** 1855–1916

American astronomer

The road to discovery is not an easy one to travel.... There is to add to its forbiddingness no warm compensating reception at its end, except in one's own glow of attainment. For progress is first obstructed by the reticence of nature and then opposed by the denunciation of man. Nature does not help and humanity hinders. If nature abhors a vacuum, mankind abhors filling it. A really new idea is a foundling without friends. Indeed a doorstep acquisition is welcome compared with the gift of a brand new upsetting thought. The undesired outsider is ignored, pooh-poohed, denounced, or all three according to circumstances. A generation or more is needed to secure it a hearing and more time still before its worth is recognized.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 299)

University of Arizona Press. Tucson, Arizona, USA. 1976

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

WHEN a criminal judge has a right crafty knave before him, one well versed in the arts of prevarication, his main object is to wring a confession from the culprit by a few skilful questions. In almost a similar position the natural philosopher seems to be placed with respect to nature. True, his functions here are more those of the spy than the judge; but his object remains pretty much the same. Her hidden motives and laws of action is what nature must be made to confess. Whether a confession will be extracted depends upon the shrewdness of the inquirer.

*Popular Scientific Lectures* (2nd edition)

The Velocity of Light (p. 48)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Maddox, John Royden** 1925–

Welsh chemist and physicist

The river of discovery will continue to flow without cessation, deepening our understanding of the world and enhancing our capacity to forefend calamity and live congenial lives.

*What Remains to Be Discovered*

Introduction (p. 21)

The Free Press. New York, New York, USA. 1998

**March, Fredric** 1897–1975

American actor

I have found that certain agents, certain chemicals have the power to disturb the trembling immateriality of the seemingly solid body in which we walk.

*Dr. Jekyll and Mr. Hyde*

Film (1932)

**Mayo, William J.** 1861–1939

American physician

It is a great thing to make scientific discoveries of rare value, but it is even greater to be willing to share these discoveries and to encourage other workers in the same field of scientific research.

Remarks on the Romance of Medicine

*Proceedings of Staff Meetings, Mayo Clinic*, Volume 10, June 19, 1935

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Deductivism in mathematical literature and inductivism in scientific papers are simply the postures we choose to be seen in when the curtain goes up and the public sees us. The theatrical illusion is shattered if we ask what goes on behind the scenes. In real life discovery and justification are almost always different processes.

*Induction and Intuition in Scientific Thought*

Chapter II, Section 2 (p. 26)  
American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

It can be said with complete confidence that any scientist of any age who wants to make important discoveries must study important problems. Dull or piffling problems yield dull or piffling answers. It is not enough that a problem should be “interesting” – almost any problem is interesting if it is studied in sufficient depth.... No, the problem must be such that it matters what the answer is – whether to science generally or to mankind.

*Advice to a Young Scientist*

Chapter 3 (p. 13)

Basic Books, Inc., Publishers. New York, New York, USA. 1979

**Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

Scientific discoveries are rarely made overnight, for usually the heralds do not at once manage to convince the world in the verity of the discovered; but we must not forget that discoveries result from the work of many and from the accumulated aggregate of facts.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Merton, Robert King** 1910–2003

American sociologist

The discovery is not true

If true, it is not new

If both new and true, it is not significant.

*On Theoretical Sociology. Five Essays, Old and New*

Chapter I (p. 21)

The Free Press. New York, New York, USA. 1967

**Millikan, Robert Andrews** 1868–1953

American physicist

The foregoing discoveries of our generation have taught us a wholesome lesson of humility, wonder, and joy in the face of an as yet incomprehensible physical universe. We have learned not to take ourselves as seriously as the nineteenth century physics took themselves. We have learned to work with new satisfaction, new hope, and new enthusiasm because there is still so much that we do not understand, and because, instead of having to it all pigeonholed as they thought they had, we have found in our lifetime more new relations in physics than had come to light in all preceding ages put together, and because the stream of discovery as yet shows no sign of abatement.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1927*

The Evolution of Twentieth Century Physics (p. 199)

Government Printing Office. Washington, D.C. 1928

**Milne, A. A. (Alan Alexander)** 1882–1956

English playwright, poet, and story writer

“Oh!” said Pooh again. “What is the North Pole?” he asked.

“It’s just a thing you discover,” said Christopher Robin carelessly, not being quite sure himself.

*The Complete Tales & Poems of Winnie-the-Pooh*

Winnie-the-Pooh, Christopher Robin Leads an Expedition to the North Pole (p. 111)

Dutton Children’s Books. New York, New York, USA. 2001

**Mitchel, Ormsby MacKnight** 1805–62

American astronomer

...the mind is long left to struggle with difficulties which it seemed that no ingenuity or skill could remove. But its efforts do not go unrewarded. If it fails in the accomplishment of its grand object, it is rewarded by the most brilliant discoveries.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great*

*Discoveries and Theories of Modern Astronomy*

Lecture I (p. 34)

Baker & Scribner. New York, New York, USA. 1848

**Mitchell, Silas Weir** 1829–1914

American physician and author

The success of a discovery depends upon the time of its appearance.

In F.H. Garrison

*Bulletin of the New York Academy of Medicine*, Volume 4, 1928 (p. 1002)

**Morris, George Sylvester** 1840–89

American educator and philosophical writer

Scientific discovery is like poetic creation, and creates and follows its own laws before they are technically drawn up, formulated, tabulated. It anticipates, often half unconsciously, its own conclusions.

*British Thought and Thinkers*

Chapter IV (pp. 138–139)

S.C. Griggs & Co. Chicago, Illinois, USA. 1880

**Morse, Harold Marston** 1892–1977

American mathematician

...discovery in mathematics is not a matter of logic. It is rather the result of mysterious powers which no one understands, and in which the unconscious recognition of beauty must play an important part. Out of an infinity of designs a mathematician chooses one pattern for beauty’s sake, and pulls it down to earth, no one knows how. Afterwards the logic of words and of forms sets the pattern right. Only then can one tell someone else. The first pattern remains in the shadows of the mind.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematics and the Arts (p. 88)

Mathematical Association of America. Washington, D.C. 2004

**Moynihan, Sir Berkeley** 1865–1936  
English surgeon

A discovery is rarely, if ever, a sudden achievement, nor is it the work of one man; a long series of observations, each in turn received in doubt and discussed in hostility, are familiarized by time, and lead at last to the gradual disclosure of truth.

*Surgery, Gynecology & Obstetrics*, Volume 31, 1920 (p. 549)

**Newcomb, Simon** 1835–1909  
Canadian-American astronomer

As frequently happens in history of science, the first discoverer of a new field has himself to be discovered by antiquarian research.

In David Eugene Smith and Jekuthiel Ginsburg

*A History of Mathematics before 1900*

The Open Court Publishing Co. Chicago, Illinois, USA. 1934

**Newlands, John A. R.** 1837–98  
English chemist

As a matter of simple justice, and in the interest of all true workers in science, both theoretical and practical, it is right that the originator of any proposal or discovery should have the credit of his labour.

*On the Discovery of the Periodic Law And On Relations Among The Atomic Weights*

Preface (p. v)

E, & F.N. Spon. London, England. 1884

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

No great discovery was ever made without a bold guess.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eleven (p. 145)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

I keep the subject constantly before me, and wait till the first dawns open slowly by little and little into a full and clear light.

In Robert Grant

*History of Physical Astronomy, From the Earliest Ages to the Middle of the Nineteenth Century*

Chapter II (p. 40)

Robert Baldwin. London, England. 1852

**Niebuhr, Barthold Georg** 1776–1831  
German historian

...he who calls what has vanished back again into being, enjoys a bliss like that of creating.

*The History of Rome* (Volume 1)

The History of Rome (p. 4)

Taylor, Walton & Maberly. London, England. 1851

**Nobel, Alfred** 1833–96  
Swedish chemist, engineer, inventor, and industrialist

Each new discovery leaves in the brains of men seeds which make it possible for an ever-increasing number of minds of new generations to embrace even greater scientific concepts.

Quoted in Camillo Golgi

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1906

The Neuron Doctrine – Theory and Facts (p. 217)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Noyes, Alfred** 1889–1958  
English poet

At first, we bask contented in our sun And take what daylight shows us for the truth. Then we discover ...

*Watchers of the Sky*

Copernicus (p. 24)

Frederick A. Stokes Co. New York, New York, USA. 1922

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

A discovery in science, or a new theory, even where it appears most unitary and most all-embracing, deals with some immediate element of novelty or paradox within the framework of far vaster, unanalyzed, unarticulated reserves of knowledge, experience, faith, and presupposition. Our progress is narrow: it takes a vast world unchallenged and for granted.

*Atom and Void*

Chapter Three (pp. 38–39)

Princeton University Press, Princeton, New Jersey, USA. 1989

It is almost as hard to tell a man what it is like to find out something new about the world as it is to describe a mystical experience to a chap who has never had any hint of such an experience.

*The Open Mind*

The Scientist in Society (pp. 126–127)

Simon & Schuster. New York, New York, USA. 1955

**Parkhurst, Charles Henry** 1842–1933  
American clergyman and reformer

All great discoveries are made by men whose feelings run ahead of their thoughts.

*The Pattern in The Mount*

Coming to the Truth (p. 38)

Anson D.F. Randolph & Co. New York, New York, USA. 1885

**Parsons, Talcott** 1902–79  
American sociologist

A scientifically unimportant discovery is one which, however true and however interesting for other reasons, has no consequences for a system of theory with which scientists in the field are concerned.

*The Structure of Social Action*

Part I, Chapter 1 (p. 7)

The Free Press. Glencoe, Illinois, USA. 1949



**Pasteur, Louis** 1822–95  
French chemist

To him who devotes his life to science nothing can give more happiness than increasing the number of discoveries, but his cup of joy is full when the results of his studies immediately find practical applications.

In René Dubos

*The Dreams of Reason*

Chapter 6 (p. 141)

Columbia University Press. New York, New York, USA. 1961

When I am in my laboratory I begin by shutting the door on materialism and on spiritualism; I observe facts alone; I seek but the scientific conditions under which life manifests itself.

In Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter I (p. 11)

Macmillan & Co Ltd. London, England. 1916

### **Peebles, Curtis**

American aerospace historian

Before a discovery can be made, human imagination must be opened to new possibilities.

*Asteroids*

Chapter 1 (p. 3)

Smithsonian Institution Press. Washington, D.C. 2000

### **Piccard, Auguste** 1884–1962

Swiss physicist, inventor, and explorer

...to climb the highest peaks, to travel through new area of celestial space, to turn our searchlights upon domains of eternal darkness, that is what makes life worth living.

Translated by Christina Stead

*Earth, Sky and Sea*

Introduction (p. xii)

Oxford University Press. New York, New York, USA. 1956

...discovery, even the most apparently insignificant, will end by being of use to man.

Translated by Christina Stead

*Earth, Sky and Sea*

Introduction (p. xii)

Oxford University Press. New York, New York, USA. 1956

### **Planck, Max** 1858–1947

German physicist

Scientific discovery and scientific knowledge have been achieved only by those who have gone in pursuit of it without any practical purpose whatsoever in view.

*Where Is Science Going?*

Chapter IV (p. 138)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

### **Playfair, Lyon** 1818–98

Scottish scientist and Parliamentarian

There are very few instances in the history of science of a sudden development of great discoveries, either illumined from darkness by a flood of light from genius, or betrayed through some accidental and straggling ray. The growth of scientific discovery is slow; it does not, like the prophet's gourd, spring into full development in a single night.

*Records of the School of Mines and of Science Applied to the Arts*

(Volume 1), Part I

The Study of Abstract Science (p. 29)

Longman, Brown, Green & Longmans. London, England. 1852

The great discoveries of science leave behind them no boundary line of demarcation from those which have preceded, but, like the full day succeeding the dawning of the sun, follow that which fully foretold their approach.

*Records of the School of Mines and of Science Applied to the Arts*

(Volume 1), Part I

The Study of Abstract Science (pp. 29–30)

Longman, Brown, Green & Longmans. London, England. 1852

### **Poincaré, Lucien** 1862–1920

French physicist

The now numerous public which tries with some success to keep abreast of the movement in science, from seeing its mental habits every day upset, and from occasionally witnessing unexpected discoveries that produce a more lively sensation from their reaction on social life, is led to suppose that we live in a really exceptional epoch, scored by profound crises and illustrated by extraordinary discoveries, whose singularity surpasses everything known in the past.

*The New Physics and Its Evolution*

Chapter I (p. 1)

Kegan Paul, Trench, Triibner, & Co., Ltd. London, England. 1907

### **Polanyi, Michael** 1891–1976

Hungarian-born English scientist philosopher and social scientist

Discoveries made by the surprising configuration of existing theories might in fact be likened to the feat of a Columbus whose genius lay in taking literally and as a guide to action that the earth was round, which his contemporaries held vaguely and as a mere matter for speculation.

In A.C. Crombie (ed.)

*Scientific Change*

Commentaries (p. 379)

Basic Books Inc., Publishers. New York, New York, USA. 1961

### **Pólya, George** 1887–1985

Hungarian mathematician

A great discovery solves a great problem but there is a grain of discovery in the solution of any problem.

*How to Solve It: A New Aspect of Mathematical Method*

From the Preface to the First Printing (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1973



The first rule of discovery is to have brains and good luck. The second rule of discovery is to sit tight and wait till you get a bright idea.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, Rules of discovery (p. 172)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Pope, Alexander** 1688–1744

English poet

By mutual confidence, and mutual aid,

Great deeds are done, and great discoveries made ...

*The Poetical Works of Alexander Pope*

*The Iliad*

Book X

Crissy & Markley. Philadelphia, Pennsylvania, USA. 1853

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...I am inclined to think that scientific discovery is impossible without faith in ideas which are of a purely speculative kind, and sometimes even quite hazy; a faith which is completely unwarranted from the point of view of science...

*The Logic of Scientific Discovery*

Part I, Chapter I, Section 4 (p. 38)

Basic Books, Inc. New York, New York, USA. 1959

**Priestley, Joseph** 1733–1804

English theologian and scientist

In completing one discovery, we never fail to get an imperfect knowledge of others, of which we could have had no idea before; so that we cannot solve one doubt without creating several new ones.

*Experiments and Observations on Different Kinds of Air* (Volume 1)

The Preface (p. xviii)

Thomas Pearson. Birmingham, England. 1790

**Racker, Efraim** 1913–91

Polish-born American biochemist

Rejoice when other scientists do not believe what you know to be true. It will give you extra time to work on it in peace. When they start claiming that they have discovered it before you, look for a new project.

Resolution and Reconstitution of Biological Pathways from 1919 to 1984

*Federation Proceedings*, Volume 12, 1983 (p. 2902)

**Ramsay, Sir William** 1852–1916

English chemist

There is a difference between discovery and invention. A discovery brings to light what existed before, but what was not known; an invention is the contrivance of something that did not exist before.

*Essays Biographical and Chemical*

Chemical Essays

How Discoveries Are Made (p. 115)

Archibald Constable & Company Ltd. London, England. 1908

**Reichenbach, Hans** 1891–1953

German philosopher of science

The scientist who discovers a theory is usually guided to his discovery by guesses; he cannot name a method by means of which he found the theory and can only say that it appeared plausible to him, that he had the right hunch or that he saw intuitively which assumption would fit the facts.

*The Rise of Scientific Philosophy*

Chapter 14 (p. 230)

University of California Press. Berkeley, California, USA. 1951

**Reynolds, Osborne** 1842–1912

Engineer, physicist, and educator

The discoverer of a law is he who first generalizes whether he has or has not taken part in the discovery of the facts on which the generalization is made.

*Memoir of James Prescott Joule*

Introduction (p. 1)

Manchester Literary and Philosophical Society. Manchester, England. 1892

**Richtmyer, Floyd Karker** 1881–1939

American physicist

...the whole history of physics proves that a new discovery is quite likely lurking in the next decimal place.

The Romance of the Next Decimal Place

*Science*, Volume 75, Number 1931, January 1, 1932 (p. 3)

**Rivers, Pitt**

No biographical data available

A discovery dates only from the time of the record of it, and not from the time of its being found in the soil.

Address To the Archaeological Institute of Great Britain and Ireland

Dorchester, August 3, 1887

**Roscoe, Henry E.** 1833–1915

English chemist

As in common life he who best knows how to meet the many difficulties and to utilise the various opportunities which life presents is the successful man, so in scientific discovery he is successful who is able to seize upon and rightly understand the meaning of the phenomena which all eyes witness but only those of the seer can interpret.

*Essays and Addresses*

Lecture II (p. 34)

Macmillan & Co Ltd. London, England. 1874

**Rowland, Henry Augustus** 1848–1901

American physicist

Discoveries...have their origin not only in the presence of men of exceptional genius in the world, but in a true and overwhelming progress of science which marches forward to the understanding of the universe, irrespective of the efforts of any single individual to promote or retard it.

*The Physical Papers of Henry Augustus Rowland*  
The Electrical and Magnetic Discoveries of Faraday (p. 638)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Rubbia, Carlo** 1934–  
Italian physicist

...science discovery is an irrational act. It's an intuition which turns out to be reality at the end of it – and. I see no difference between a scientist developing a marvellous discovery and an artist making a painting

In Lewis Wolpert and Alison Richards

*Passionate Minds: The Inner World of Scientists*

Chapter 21 (p. 197)

Oxford University Press. New York, New York, USA. 1997

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

No transcendent ability is required in order to make useful discoveries in science; the edifice of science needs its masons, bricklayers, and common labourers as well as its foremen, master-builders, and architects.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 41)

Longmans, Green & Co. London, England. 1919

**Rutherford, Ernest** 1871–1937  
English physicist

The march of discovery has been so rapid that it has been difficult even for those directly engaged in the investigations to grasp at once the full significance of the facts that have been brought to light.

*Radioactive Transformations*

Chapter I (p. 1)

Archibald Constable & Company Ltd. London, England. 1906

It is not in the nature of things for anyone man to make a sudden, violent discovery; science goes step by step and every man depends on the work of his predecessors. When you hear of a sudden unexpected discovery – a bolt from the blue, as it were – you can always be sure that it has grown up by the influence of one man or another, and it is the mutual influence which makes the enormous possibility of scientific advance. Scientists are not dependent on the ideas of a single man, but on the combined wisdom of thousands of men, all thinking of the same problem and each doing his little bit to add to the great structure of knowledge which is gradually being erected.

In Robert B. Heywood

*The Works of the Mind*

The Scientist (p. 178)

The University of Chicago Press. Chicago, Illinois, USA. 1947

**Safonov, V.**  
No biographical data available

There are scientists who make their chief discovery at the threshold of their scientific career, and spend the rest of their lives substantiating and elaborating it, mapping out the details of their discovery, as it were. There are other

scientists who have to tread a long, difficult and often tortuous path to its end before they succeed in crowning their efforts with a discovery.

*Courage*

Chapter 10 (p. 40)

Foreign Languages Pub. House. Moscow, Russia. 1953

**Samuelsson, Bengt I.** 1934–  
Swedish physician

There are almost unlimited possibilities for making discoveries and to uncover the unknown. It is in the nature of the discovery that it cannot be planned or programmed. On the contrary it consists of surprises and appears many times in the most unexpected places. However, the basis of the discovery is imagination, careful reasoning and experimentation where the use of knowledge created by those who came before is an important component.

*Les Prix Nobel. The Nobel Prizes in 1982*

Nobel banquet speech for award received in 1982

Nobel Foundation. Stockholm, Sweden. 1983

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

When one investigates carefully the genesis of any discovery, one finds that it was gradually prepared by a number of smaller ones, and the deeper one's investigation, the more intermediary stages are found. Our first impression of scientific progress is like that of gigantic stairs, each enormous step representing one of those essential discoveries which brought mankind almost suddenly up to a higher level, but that impression is imperceptibly obliterated as we pursue our analysis. The big steps are broken into smaller ones, and these into others still smaller, until finally the steps seem to vanish altogether – yet they never vanish.

*The History of Science and the New Humanism*

Chapter I (p. 36)

H. Holt & Co. New York, New York, USA. 1931

**Schiller, Ferdinand Canning Scott** 1864–1937  
English philosopher

One curious result of this inertia [regarding acceptance of an idea], which deserves to rank among the fundamental "laws" of nature, is that when a discovery has finally won tardy recognition it is usually found to have been anticipated, often with cogent reason and in great detail.

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (pp. 256–257)

At The Clarendon Press. Oxford, England. 1917

**Schwartz, John**  
No biographical data available

...scientific discovery moves less as the crow flies than as a sailboat tacks, first this way, then that, but edging ever forward.

If You Seek the Truth, Don't Trash the Science

*Washington Post*, 21 February, 1999 (p. B-1)

**Selye, Hans** 1907–82  
Austrian-American endocrinologist

It is not to see something first, but to establish solid connections between the previously known and the hitherto unknown that constitutes the essence of scientific discovery.

*From Dream to Discovery: On Being a Scientist*  
What Should Be Done (p. 89)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

...any fool can make a discovery. Every baby has to discover more in the first years of its life than Roger Bacon ever discovered in his laboratory.

*Back to Methuselah*  
Part IV, Act I, XXXV (p. 160)  
Constable & Company Ltd. London, England. 1921

**Sigerist, Henry E.** 1891–1957  
Medical historian

We must also keep in mind that discoveries are usually not made by one man alone, but that many brains and many hands are needed before a discovery is made for which one man receives the credit.

*A History of Medicine* (Volume 1)  
Introduction (p. 13)  
Oxford University Press, Inc. New York, New York, USA. 1961

**Sime, James** 1843–95  
No biographical data available

Boldly and with all reverence, he [Herschel] set himself to open the closed hand of Almighty Wisdom, and find what that Power had kept hid.

*William Herschel and His Work*  
Chapter VIII (p. 129)  
T.&T. Clark. Edinburgh, Scotland. 1900

**Simon, Herbert Alexander** 1916–2001  
American social scientist

...scientific discovery, when viewed in detail, is an excruciatingly slow and painful process.

In Robert G. Colodny (ed.)  
*Mind and Cosmos*  
Scientific Discovery and the Psychology of Problem Solving (p. 24)  
University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1966

**Smith, James Leonard Brierley** 1897–1968  
South African ichthyologist

Scientific discovery rarely follows a smooth and orderly course. Like most natural processes it proceeds spasmodically, and important results frequently come only after long-drawn-out, exhausting, and apparently fruitless endeavor, sometimes even almost by what appears to be a lucky chance.

*Annual Report of the Board of Regents of the Smithsonian Institution (1940)*  
A Living Fossil (p. 321)  
Government Printing Office  
Washington, D.C. 1941

**Smith, Theobald** 1859–1934  
American pathologist

Discovery should come as an adventure rather than as the result of a logical process of thought. Sharp, prolonged thinking is necessary that we may keep on the chosen road, but it does not necessarily lead to discovery.

In W.I.B. Beveridge  
*The Art of Scientific Investigation*  
Chapter Seven (p. 81)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

Great discoveries which give a new direction to currents of thoughts and research are not, as a rule, gained by the accumulation of vast quantities of figures and statistics. These are apt to stifle and asphyxiate and they usually follow rather than precede discovery. The great discoveries are due to the eruption of genius into a closely related field, and the transfer of the precious knowledge there found to his own domain.

*Boston Medical and Surgical Journal*, Volume 172, 1915 (p. 121)

**Soddy, Frederick** 1877–1956  
English chemist

Man may and often does create great works of art, literature, or music in a garret, but when it comes to making great discoveries in electricity or in radioactivity, in addition to the ability of the investigator there is the almost equally important consideration of laboratory facilities, of materials and of the means of mastery over the properties of materials, the lack of which not even the genius of a Faraday could entirely overcome.

*The Interpretation of Radium and the Structure of the Atom*  
A forward (p. x)  
J. Murray. London, England. 1909

**Spencer, Herbert** 1829–1903  
English social philosopher

Positive knowledge does not, and never can, fill the whole region of possible thought. At the uttermost reach of discovery there arises, and must ever arise, the question – What lies beyond?

*First Principles of a New System of Philosophy*  
Part I, Chapter I, section 4 (p. 16)  
D. Appleton & Co. New York, New York, USA. 1892

**Strauss, Maurice B.** 1904–74  
American physician

Discoveries do not arise de novo, like Athena from the brow of Zeus, but are more akin to the living layers

of a coral reef built on the past labors of countless predecessors.

*Medicine*, Volume 43, 1964 (p. 619)

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Discovery consists of seeing what everybody has seen and thinking what nobody has thought.

In Irving John Good (ed.)

*The Scientist Speculates: An Anthology of Partly-Baked Ideas*

Chapter I, 6 (p. 15)

Basic Books, Inc. New York, New York, USA. 1963

**Taton, René** 1915–2004

No biographical data available

Every great discovery has produced some sort of intellectual scandal, has been opposed by current, and always badly informed, opinions on the basic nature of scientific problems, and also by the majority of scientists of the time holding outdated theories, and incapable of renouncing some of their most solidly ingrained ideas.

*Reason and Chance in Scientific Discovery*

Chapter XI (p. 147)

Philosophical Library. New York, New York, USA. 1957

**Taylor, Angus E.**

American mathematician

The process of discovery in mathematics is one in which we are concerned with both the particular and the general. Induction and imagination are as important as purely deductive reasoning. Very often it is some simple insight into a particular fact at a particular level of abstraction that provides the illumination for an important advance. Later, from the heights newly won, the practiced eye may see the opportunity to broaden the advance all along a higher level of abstraction.

Some Aspects of Mathematical Research

*American Scientist*, Volume 35, Number 2, April, 1947 (p. 223)

**Thomson, Sir Joseph John** 1856–1940

English physicist

As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon: in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasized by every advance in science, that “Great are the Works of the Lord.”

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

Progress in Physics (p. 205)

Government Printing Office. Washington, D.C. 1910

A great discovery is not a terminus, but an avenue leading to regions hitherto unknown. We climb to the top of the peak and find that it reveals to us another higher than any we have yet seen, and so it goes on. The additions to

our knowledge of physics made in a generation do not get smaller or less fundamental or less revolutionary, as one generation succeeds another. The sum of our knowledge is not like what mathematicians call a convergent series... where the study of a few terms may give the general properties of the whole.

In Sir George Thomson

*The Inspiration of Science*

Some Conclusions (p. 138)

Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Do not engage to find things as you think they are.

*Familiar Letters of Henry David Thoreau* (Volume 11)

Letter, August 9, 1850 to Harrison Blake (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1894

**Todhunter, Isaac** 1820–84

English mathematician

It would be rash to say that nothing remains for discovery or improvement even in the elements of mathematics; but it may be safely asserted that the ground has been so long and so thoroughly explored as to hold out little hope of profitable return for a casual adventurer.

*The Conflict of Studies, and Other Essays on Subjects Connected With Education*

Chapter III (p. 73)

Macmillan & Co Ltd. London, England. 1873

**Trousseau, Armand** 1801–67

French internist

The man who is convinced that there is something to be gained, will always gain something; and in the most beaten paths something new can always be found, provided it be sought for with ardour and intelligence.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)

Introduction (p. 29)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

**Turner, H. H. (Herbert Hall)** 1861–1930

English astronomer

Discovery is expected from an astronomer. The Popular lay mind scarcely thinks of a naturalist nowadays discovery, discovering new animals, or of a chemist as finding new elements save on rare occasions; but it does think of the astronomer as making discoveries.

*Astronomical Discovery*

Chapter I (p. 1)

Edward Arnold. London, England. 1904

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

What is there that confers the noblest delight? What is that which swells a man's breast with pride above that

which any other experience can bring to him? Discovery! To know that you are walking where none others have walked; that you are beholding what human eye has not seen before; that you are breathing a virgin atmosphere. To give birth to an idea, to discover a great thought – an intellectual nugget, right under the dust of a field that many a brain-plough had gone over before. To find a new planet, to invent a new hinge, to find a way to make the lightnings carry your message. To be the first – that is the idea.

*The Innocents Abroad* (Volume 1)  
Chapter XXVI (p. 338)  
Harper & Brothers Publishers. New York, New York, USA. 1904

If there wasn't anything to find out, it would be dull. Even trying to find out and not finding out is just as interesting as trying to find out and finding out; and I don't know but more so.

*Eve's Diary*  
Friday (p. 87)  
Harper & Brothers Publishers. New York, New York, USA. 1906

**Tyndall, John** 1820–93  
Irish-born English physicist

A modern discovery illustrates the manner in which our present mastery over nature has been obtained.

*Heat A Mode of Motion* (6th edition)  
Lecture I (p. 1)  
D. Appleton & Co. New York, New York, USA. 1915

There is no discovery so limited as not to illustrate something beyond itself.

*Fragments of Science for Unscientific People*  
Chapter VI (p. 110)  
D. Appleton & Co. New York, New York, USA. 1875

**Valentine, Alan**  
No biographical data available

Whenever science makes a discovery, the devil grabs it while the angels are debating the best way to use it.

*Reader's Digest*, April, 1962 (p. 70)

**Vernadskii, Vladimir Ivanovich** 1863–1945  
Russian mineralogist

Scientific discoveries are never readymade or complete. The process of scientific discovery, illuminated by the intellect of great human personalities, is at the same time a slow process of universal human development stretching over the ages.

Compiled by V.V. Vorontsov  
*Words of The Wise: A Book of Russian Quotations*  
Translated by Vic Schneiersson  
Moscow, Russia. 1979

**Verne, Jules** 1828–1905  
French novelist

In the first place...you must keep the whole affair a profound secret. There is no more envious race of men than

scientific discoverers. Many would start on the same journey. At all events, we will be the first in the field.

*A Journey to the Center of The Earth*  
Chapter 3 (p. 22)  
The Limited Editions Club. New York, New York, USA. 1966

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

No one can take from us the joy of the first becoming aware of something, the so-called discovery. But if we also demand the honor, it can be utterly spoiled for us, for we are usually not the first. What does discovery mean, and who can say that he has discovered this or that? After all it's pure idiocy to brag about priority; for it's simply unconscious conceit, not to admit frankly that one is a plagiarist.

In Lancelot Law Whyte  
*The Unconscious Before Freud*  
Epigraph to Lancelot Law Whyte (p. 1)  
Julian Friedmann Publishers. London, England. 1978

In science everything depends on what one calls an aperçu – the discovery of something that is at the bottom of phenomena. Such a discovery is infinitely fruitful.

Translated by Charles Lock Eastlake  
*Theory of Colors*  
Historical Part, Fifth Division, Galileo Galilei (p. 204)  
The MIT Press. Cambridge, Massachusetts, USA. 1970

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

A single remarkable discovery may, of course, be the result of a happy accident and may not indicate the possession of any special gift on the part of the discoverer...

*The Modern Development of Faraday's Conception of Electricity*  
Faraday Lecture  
Delivered before the Fellows of the Chemical Society in London on April 5, 1881

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

As men contemplate the riches of nature, and see the mass of observations incessantly increasing before them, they become impressed with the intimate conviction that the surface and the interior of the earth, the depths of the ocean, and the regions of air will still, when thousands and thousands of years have passed away, open to the scientific observer untrodden paths of discovery.

*Cosmos* (Volume I)  
Introduction (p. 21)  
Henry G. Bohn. London, England. 1849

This active striving, which has existed in all ages, must frequently, and under various forms, have deluded men into the idea that they had reached the goal, and discovered the principle which could explain all that is variable in the organic world, and all the phenomena revealed to us by sensuous perception.

Translated by E.C. Otte



*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 3)  
Introduction (p. 8)  
D. Appleton & Co. New York, New York, USA. 1850

**von Lenard, Philipp E. A.** 1862–1947  
Physicist

...I have by no means always been numbered among those who pluck the fruit; I have been repeatedly only one of those who planted or cared for the trees...

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1905

On Cathode Rays (p. 105)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**von Liebig, Justus** 1803–73  
German organic chemist

Theories lead to experiments and investigations and he who investigates will scarcely ever fail of being rewarded by discoveries. It may be, indeed, the theory sought to be established is entirely unfounded in nature, but while searching in a right spirit for one thing, the inquirer may be rewarded by finding others far more valuable than those which he sought.

*Familiar Letters on Chemistry*

Letter IV (pp. 33–34)

Taylor & Walton. London, England. 1843

Every new discovery opens up wider and richer fields to our researches; and in the laws of nature we are still ever seeking the “virgin earth” of the alchemist, a search which can never have an end.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter III (p. 57)

Walton & Maberly. London, England. 1859

**von Siemens, Werner** 1816–1892  
German inventor and entrepreneur

If some phenomenon that has been shrouded in obscurity suddenly emerges into the light of knowledge, if the key of a long sought mechanical combination has been found, if the missing link of a chain of thought is fortuitously supplied, this then gives the discoverer the exultant feeling that comes with a victory of the mind, which alone can compensate him for all the struggle and effort and lift him to a higher plane of existence.

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter VI (p. 77)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

**Weinberg, Steven** 1933–  
American nuclear physicist

Scientists have discovered many peculiar things, and many beautiful things. But perhaps the most beautiful and the most peculiar thing that they have discovered is the pattern of science itself. Our scientific discoveries are not

independent isolated facts; one scientific generalization finds its explanation in another, which is itself explained by yet another. By tracing these arrows of explanation back toward their source we have discovered a striking convergent pattern – perhaps the deepest thing we have yet learned about the universe.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Chapter II (p. 19)

Pantheon Books. New York, New York, USA. 1992

I have difficulty in understanding the philosophical content that many people seem to find in discoveries in physics. It is true, of course, that many of the subjects of physics – space and time, causality, ultimate particles – have been the concern of philosophers since the earliest times. But in my view, when physicists make discoveries in these areas, they do not so much confirm or refute the speculation of philosophers as show that philosophers were out of their jurisdiction in speculating about these phenomena.

The Forces of Nature

*American Scientist*, Volume 65, March–April, 1977 (p. 175)

**Whately, Richard** 1787–1863  
English theologian

The diligence, candour, and judgment requisite to make a full use of this discoveries of others, are perhaps as rare, and quite as useful, as originality. The flint and steel would be of little use without the tinder and match.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard*

*Whately, D.D.*

Apothegm 19

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Whewell, William** 1794–1866  
English philosopher and historian

...advances in knowledge are not commonly made without the previous exercise of some boldness and license in guessing. The discovery of new truths requires, undoubtedly, minds careful and fertile in examining what is suggested; but it requires, no less, such as are quick and fertile in suggesting.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 1)

Book V, Chapter IV, Section 1 (p. 411)

John W. Parker. London, England. 1837

No *scientific discovery* can, with any justice, be considered *due to accident*. In whatever manner facts may be presented to the notice of a discoverer, they can never become the materials of exact knowledge, except they find his mind already provided with precise and suitable conceptions by which they may be analyzed and connected.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2)



Book XI, Chapter II (p. 23)  
John W. Parker. London, England. 1847

The process of scientific discovery is cautious and rigorous, not by abstaining from hypothesis, but by rigorously comparing hypotheses with facts, and by resolutely rejecting all which the comparison does not confirm.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, X (p. 468)  
John W. Parker. London, England. 1847

...Newton could not admit that there was any difference between him and other men, except in the possession of such habits as...perseverance and vigilance. When he was asked how he made his discoveries, he answered, "by always thinking about them;" and at another tune he declared that if he had done anything, it was due to nothing but industry and patient thought: "I keep the subject of my inquiry constantly before me, and wait till the first dawning opens gradually, by little and little, into a full and clear light."

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book VII, Chapter II (p. 140)  
John W. Parker & Son. London, England. 1857

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

What Bacon omitted was the play of free imagination, controlled by the requirements of coherence and logic. The true method of discovery is like the flight of an aeroplane. It starts from the ground of particular observation; it makes a flight in the thin air of imaginative generalization; and it again lands for renewed observation rendered acute by rational interpretation.

*Process and Reality: An Essay in Cosmology*

Part I, Chapter I, Section II (p. 7)  
The Macmillan Company. New York, New York, USA. 1929

**Wigglesworth, Sir Vincent B.** 1899–1994  
English entomologist

New discoveries in science are not made by plunge into the unknown. They are made on the misty fringes of "the known" by observers whose eyes can pierce the fog more deeply than others.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Control of Form in the Living Body (p. 252)  
Pergamon Press. Oxford, England. 1977

**Wilford, John Noble** 1933–  
American science writer

Finding something is not the same as discovering what is found. The more astronomers study the growing evidence of extra-solar planets, the less the planets resemble anything in the one planetary system they had known and had based their theories on: the Sun's family of planets.

Search for New Planets Yields Confusion  
*The New York Times*, 2 March, 1999

**Wilks, Samuel** 1824–1911  
British physician and biographer

...discoveries are made by the age, and not by the individual.

*The Harveian Oration* (p. 36)

J.&A. Churchill. London, England. 1879

**Williams, Frederick Smeeton**  
No biographical data available

...we are standing on the shore of a mighty river of discovery, which has been becoming broader and deeper as successive centuries have rolled away, and now its mighty volume sweeps onward with surpassing majesty. It devolves upon us to trace backward its course, and with eagle-eye to gaze from the vantage-ground which we enjoy on its onward course, till we see it gradually contracting towards its source, and lose its silver thread in the clouds and mists of a hoary antiquity.

*The Wonders of the Heavens* (pp. 11–12)

Printed by John Cassell. London, England. 1852

**Willstätter, Richard** 1872–1942  
German chemist

Whether we deal with such tentative explanations, or with the controversial protein nature of enzymes, I feel that it is not important for the scientist whether his own theory proves the right one in the end. Our experiments are not carried out to decide whether we are right, but to gain new knowledge. It is for knowledge's sake that we plow and sow. It is not inglorious at all to have erred in theories and hypotheses. Our hypotheses are intended for the present rather than for the future. They are indispensable to us in the explanation of the secured facts, to enliven and mobilize them and above all to blaze a trail into unknown regions toward new discoveries.

*From My Life: The Memoirs of Richard Willstätter*

Chapter 12, Willard Gibbs Medal address, American Chemical Society, Chicago, September 14, 1933 (p. 385)

W.A. Benjamin. New York, New York, USA. 1965

**Wilson, Daniel**  
No biographical data available

The discovery of America at the close of the fifteenth century wrought a marvellous change in the ideas and opinions of mankind relative to the planet they occupy, and prepared the way for many subsequent revolutions in thought, as well as in action.

*Prehistoric Man: Researches Into the Origin of Civilisation in the Old and the New World* (2nd edition)

Chapter I (p. 1)

Macmillan & Co Ltd. London, England. 1865

**Wilson, Edmund Beecher** 1856–1939  
American zoologist

...each forward step on the highway of discovery will bring to view a new horizon of regions still unknown. It will be an ill day for science when it can find no more fields to conquer.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Biology (p. 24)  
The Columbia University Press. New York, New York, USA. 1908

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

What a Copernicus or a Darwin really achieved was not the discovery of a new true theory but a fertile point of view.

Translated by Peter Winch  
*Culture and Value* (p. 18e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wright, Orville** 1871–1948  
American aeronautical engineer

Isn't it astonishing that all these secrets have been preserved for so many years just so that we could discover them!

In Fred C. Kelly (ed.)  
*Miracle at Kitty Hawk*  
Chapter III, Letter to George A. Spratt, June 7, 1903 (p. 91)  
Farrar, Straus & Young. New York, New York, USA. 1951

**Wright, Thomas** 1711–86  
English cosmologist

...how difficult a Talk it is to advance any new Doctrine with Success, those who have hitherto attempted to propagate astronomical Discoveries in all Ages, have been but ill rewarded for their Labours, tho' finally they have proved of the greatest Benefit and Advantage to Mankind.

*An Original Theory or New Hypothesis of the Universe*  
Preface (p. iii)  
Printed for the Author. London, England. 1750

**Young, Thomas** 1773–1829  
English polymath

No discovery, however remote in its nature from the subjects of daily observation, can with reason be declared wholly inapplicable to the benefit of mankind.

*A Course of Lectures on Natural Philosophy and the Mechanical Arts*  
Lecture I (p. 2)  
Taylor & Walton. London, England. 1845

**Zewail, Ahmed H.** 1946–  
Egyptian American scientist

In our science endeavor, the thrill of discovery is the real fuel for taking off but the flight becomes satisfactory and enjoyable when recognition by peers, perhaps the most significant reward, becomes evident.

*Voyage Through Time: Walks of Life to the Nobel Prize*  
Chapter 8 (p. 167)  
The American University in Cairo Press. Cairo, Egypt. 2002

## DISCOVERY, MARCH OF

**Rutherford, Ernest** 1871–1937  
English philosopher, logician, and social reformer

The march of discovery has been so rapid that it has been difficult even for those directly engaged in the investigations to grasp at once the full significance of the facts that have been brought to light.

*Radioactive Transformations*  
Chapter I (p. 1)  
Charles Scribner's Sons. New York, New York, USA. 1906

## DISCUSSION

**Poynting, John Henry** 1852–1914  
English physicist

While the investigation of Nature is ever increasing our knowledge, and while each new discovery is a positive addition never again to be lost, the range of the investigation and the nature of the knowledge gained from the theme of endless discussion.

Address to the British Association  
*Chemical News and Journal of Industrial Science*, Volume 80, Number 2079, September 29, 1899 (p. 154)

**Ruelle, David** 1935–  
Belgian-French mathematical physicist

A meaningful physical discussion always requires an operational background. Either this is provided by an existing theory, or you have to give it yourself by the sufficiently explicit description of an experiment that can, at least in principle, be performed.

*Chance and Chaos*  
Chapter 2 (p. 13)  
Princeton University Press. Princeton, New Jersey, USA. 1991

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...the best that we can hope to achieve by philosophical discussion is to lead people to see that philosophical discussion is a mistake.

In Ludwig Wittgenstein  
*Tractatus Logico-Philosophicus*  
Introduction (p. 11)  
Harcourt, Brace & Co. New York, New York, USA. 1922

## DISEASE

**Abrams, Albert** 1863–1924  
American physician

Hope in all diseases is the most valuable adjunct of the physician.

*Man and His Poisons*  
Chapter X (p. 222)  
E.B. Treat & Co. New York, New York, USA. 1906

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...cure the disease and kill the patient.

*Bacon's Essays*  
Of Friendship (p. 129)  
Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

...diseases of the body may have appropriate exercises; bowling is good for the stone and veins, shooting for the lungs and breast, gentle walking for the stomach, riding for the head and the like...

*Bacon's Essays*  
Of Studies (p. 211)  
Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

**Baring, Maurice** 1874–1945  
English author

Pale disease

Shall linger by thy side, and thou shalt know  
Eternal autumn to thy day of death.

*The Black Prince and Other Poems*  
The Black Prince and the Astrologer (p. 59)  
John Lane. London, England. 1903

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

Physicians of the Utmost Fame

Were called at once;

but when they came

They answered, as they took their Fees,

“There is no Cure for this Disease.”

*Cautionary Tales for Children, Designed for the Admonition of Children Between the Ages of Eight and Fourteen Years*  
Henry King (pp. 18–19)  
Duckworth & Company. London, England. 1918

**Born-Volber, A. J.**  
No biographical data available

Everything that promotes the general health promotes  
recovery from the particular disease.

In Albert Abrams  
*Man and His Poisons*  
Chapter X (p. 220)  
E.B. Treat & Co. New York, New York, USA. 1906

**Browne, Sir Thomas** 1605–82  
English author and physician

Some will allow no Disease to be new, others think  
that many old ones are ceased; and that such which are  
esteemed new, will have but their time.

*The Works of Sir Thomas Browne* (Volume One)  
A Letter to a Friend (pp. 172–173)  
John Grant. Edinburgh, Scotland. 1927

...medical Predictions fail not, as sometimes in acute  
Diseases, and wherein 'tis as dangerous to be sentenced  
by a Physician as a Judge.

*The Works of Sir Thomas Browne* (Volume Three)  
A Letter to a Friend (p. 370)  
John Grant. Edinburgh, Scotland. 1927

**Burton, Robert** 1577–1640  
English clergyman and scholar

[Diseases] crucify the soul of man, attenuate our bodies,  
dry them, wither them, shrivel them up like old apples,  
make them as so many anatomies.

*Anatomy of Melancholy*  
Part I, Sc. 2, Memb. 3, Subsect. 10

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

When slow Disease, with all her host of pains.  
Chills the warm tide which flows along the veins;  
When Health, affrighted, spreads her rosy wing,  
And flies with every changing gale of spring...

*The Complete Poetical Works of Byron*  
Childish Recollections (p. 550)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Self-contemplation...is infallibly the symptom of dis-  
ease...

*Characteristics, by Thomas Carlyle; Favorite Poems, by Percy Bysshe Shelley; the Eve of St. Agnes, and Other Poems, by John Keats*  
Paragraph 9 (p. 17)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1882

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

People love talking of their diseases, although they are  
the most uninteresting things in their lives.

*Note-Book of Anton Chekhov* (p. 28)  
B.W. Huebsch, Inc. New York, New York, USA. 1921

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

The discoveries of healing science must be the inheritance  
of all. That is clear. Disease must be attacked, whether it  
occurs in the poorest or the richest man or woman, sim-  
ply on the ground that it is the enemy; and it must be  
attacked just in the same way as the fire brigade will give  
its full assistance to the humblest cottage as readily as to  
the most important mansion.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Royal College of Physicians, London, March 2, 1944 (p. 171)  
George Allen & Unwin Ltd. London, England. 1956

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

...philosophers apply the term disease to all disorders of  
the soul, and they say that no foolish person is free from  
such diseases; sufferers from disease however, are not

sound, and the souls of all unwise persons are diseased.

Translated by J.E. King

*Cicero in Twenty Eight-Volumes* (Volume 18)

Tusculanarum Disputationum

III, iv, 9 (p. 235)

Harvard University Press. Cambridge, Massachusetts, USA. 1921

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

It is with diseases of the mind as with those of the body:  
.we are half dead before we understand our disorder, and  
half cured when we do.

*Lacon: or, Many Things in Few Words*

Disease (p. 73)

William Tegg. London, England. 1866

**de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

There are no diseases, but only persons who are diseased,  
some doctors say, and I say that there are no opinions, but  
only opining persons.

*Essays and Soliloquies*

My Religion (pp. 156–157)

Alfred A. Knopf. New York, New York, USA. 1925

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

No Sickness known before, no slow Disease,  
To soften Grief by Just Degrees.

*The Poetical Works of Dryden*

Threnodia Augustalis, Stanza 1 (p. 442)

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The difficulty of defining disease is implied in the very  
structure of the word: “dis-ease.” So many different  
kinds of disturbances can make a person feel not at ease  
and lead him to seek the aid of a physician that the word  
ought to encompass most of the difficulties inherent in  
the human condition.

*Man, Medicine, and Environment* (p. 67)

Frederick A. Praeger. New York, New York, USA. 1968

Eradication of microbial disease is a will-o’ – the-wisp;  
pursuing it leads into a morass of hazy biological con-  
cepts and half truths.

*Man Adapting*

Chapter XIV (p. 381)

Yale University Press. New Haven, Connecticut, USA. 1965

Complete and lasting freedom from disease is but a  
dream remembered from imaginings of a Garden of Eden  
designed for the welfare of man.

*Mirage of Health*

Chapter I (p. 2)

Harper & Brothers Publishers. New York, New York, USA. 1959

It is seldom recognized that each type of society has dis-  
eases peculiar to itself – indeed, that each civilization  
creates its own diseases.

*The Dreams of Reason: Science and Utopia*

Chapter 4 (p. 71)

Columbia University Press. New York, New York, USA. 1961

**Eddy, Mary Baker** 1821–1910

Religious writer

...disease...can carry its ill-effects no farther than mortal  
mind maps out the way.

*Science and Health with Key to the Scriptures*

Chapter VII (p. 176)

Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Einthoven, Willem** 1860–1927

Dutch physiologist

A new chapter has been opened in the study of heart dis-  
eases, not by the work of a single investigator, but by that  
of many talented men, who have not been influenced in  
their work by political boundaries and, distributed over  
the whole surface of the earth, have devoted their powers  
to an ideal purpose, the advance of knowledge by which,  
finally, suffering mankind is helped.

*Nobel Lectures, Physiology or Medicine 1922–1941*

The string galvanometer and the measurement

of the action currents of the heart

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Fuller, Thomas** 1608–61

English clergyman and author

Diseases are the price of ill pleasures.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings.*

*Ancient and Modern, Foreign and British*

No. 1297

Printed for Thomas & Joseph Allman. London, England. 1816

**Gregg, Alan** 1890–1957

American medical educator and philosopher

The perpetual enemies of the human race, apart from  
man’s own nature, are ignorance and disease.

In J. Bordley and A.M. Harvey

*Two Centuries of American Medicine* (p. 751)

W.B. Saunders. Philadelphia, Pennsylvania, USA. 1976

**Harrison, Jane** 1850–1920

English classical scholar

If I think of Death at all it is merely as a negation of life, a  
close, a last and necessary chord. What I dread is disease,  
that is, bad, disordered life, not Death, and disease, so far,  
I have escaped.

*Reminiscences of a Student’s Life*

Conclusion

L. & V. Woolf. London, England. 1925

**Heller, Joseph** 1923–99

American writer

Hungry Joe collected lists of fatal diseases and arranged them in alphabetical order so that he could put his finger without delay on anyone he wanted to worry about.

*Catch-22*

Chapter Seventeen (p. 177)

Dell Publishing Company, Inc. New York, New York, USA. 1985

How do you expect anyone to believe you have a liver condition if you keep squeezing the nurses' tits every time you get a chance? You're going to have to give up sex if you want to convince people you've got an ailing liver.

*Catch-22*

Chapter Eighteen (p. 187)

Dell Publishing Company, Inc. New York, New York, USA. 1985

### **Hershko, Avram** 1937–

Hungarian-born Israeli biochemist

...the boundaries between chemistry, biology, physics and medicine are rapidly disappearing. Only a comprehensive understanding of the chemical and physical processes in our cells and organ systems will yield the insights needed to develop rational approaches to the prevention and treatment of disease.

Nobel Banquet Speech (Chemistry)

December 10, 2004

The Nobel Foundation. 2004

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

If it is true that we understand ourselves but imperfectly in health, this truth is more signally manifested in disease, where natural actions imperfectly understood, disturbed in an obscure way by half-seen causes, are creeping and winding along in the dark toward their destined issue, sometimes using our remedies as safe stepping-stones, occasionally, it may be, stumbling over them as obstacles.

*The Writings of Oliver Wendell Holmes* (Volume 9)

*Medical Essays: 1842–1882*

Chapter IV (pp. 211–212)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

### **Hudson, Robert P.**

No biographical data available

If a medical and social consensus defined freckles as a disease, this benign and often winsome skin condition would become a disease. Patients would consult physicians complaining of freckles, physicians would diagnose and treat freckles, and presumably, in time, we would have a National Institute of Freckle Research.

*Disease and Its Control: The Shaping of Modern Thought* (p. x)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1983

### **Huxley, Thomas Henry** 1825–95

English biologist

A scornor of physic once said that nature and disease may be compared to two men fighting, the doctor to a blind

man with a club, who strikes into the *melee*, sometimes hitting the disease, and sometimes hitting nature.

*Select Works of Thomas H. Huxley*

Technical Education, II (p. 12)

John B. Alden, Publisher. New York, New York, USA. 1886

### **James, Henry** 1843–1916

American-born English author and literary critic

...even medical families cannot escape the more insidious forms of disease...

*Washington Square*

Chapter I (p. 8)

The Modern Library. New York, New York, USA. 1950

### **Jerome, Jerome K.** 1859–1927

English author

I remember going to the British Museum one day to read up the treatment for some slight ailment of which I had touch. I got down the book, and read all I came to read; and then, in an unthinking moment, I idly turned the leaves, and began to indolently study diseases. Bright's disease, I was relieved to find, I had only in a modified form, and so far as that was concerned, I might live for years. Cholera I had, with severe complications; and diphtheria I seemed to have been born with. I plodded conscientiously through the twenty-six letters, and the only malady I could conclude I had not got was housemaid's knee.

*Three Men In a Boat, to Say Nothing of The Dog!*

Chapter 1 (p. 2)

Time Incorporated. New York, New York, USA. 1964

### **Jhabvala, Ruth Praver** 1927–

German-born novelist and short story writer

Doctors don't know a thing. These diseases that people [who travel there] get in India, they're not physical, they're purely psychic. We only get them because we try to resist India – because we shut ourselves up in our little Western egos and don't want to give ourselves.

*Travelers* (p. 166)

Harper & Row, Publishers. New York, New York, USA. 1973

### **Latham, Peter Mere** 1789–1875

English physician

Disease is a series of new and extraordinary actions. Each link in the series is essentially to the integrity of the whole. Let one link be fairly broken, and this integrity is spoiled; and there is an end of the disease; and then the constitution is left to resume its old and accustomed actions, which are the actions of health.

In William B. Bean

*Aphorisms from Latham* (p. 71)

Prairie Press. Iowa City, Iowa, USA. 1962

Diseases are not abstractions; they are modes of acting, different from the natural and healthy modes – modes of disorganizing, modes of suffering, and modes of dying;



and there must be a living, moving, sentient body for all this.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture II (p. 37)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

Beware of mistaking the nature of the disease, and then believing that the remedy has cured what in fact never existed.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture V (p. 129)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Mann, Thomas** 1875–1955  
German-born American novelist

Disease has nothing refined about it, nothing dignified.

*The Magic Mountain*  
Chapter IV (p. 98)  
Alfred A. Knopf. New York, New York, USA. 1949

**Mather, Cotton** 1663–1728  
American minister and religious writer

*Ingluvies omnium morborum mortisque Causa.*  
Gluttony is the cause of all diseases and of death.

*The Angel of Bethesda*  
Capsula II, Appendix (p. 15)  
American Antiquarian Society & Barre Publishers. Barre, Massachusetts, USA. 1972

**Nuland, Sherwin B.** 1930–  
American surgeon and teacher of bioethics and medicine

The quest to achieve true dignity fails when our bodies fail.

*How We Die: Reflections on Life's Final Chapter* (p. xvii)  
Alfred A. Knopf. New York, New York, USA. 1994

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

From Hippocrates to Hunter, the treatment of disease was one long traffic in hypotheses.

In R. Kagan (ed.)  
*Leaders of Medicine*  
Chapter X (p. 100)  
The Medico-Historical Press. Boston, Massachusetts, USA. 1941

It cannot be denied that we have learned more rapidly how to prevent than how to cure diseases, but with a definite outline of our ignorance we no longer live now in a fool's Paradise, and fondly imagine that in all cases we control the issues of life and death with our pills and potions.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
Chapter VII (p. 129)  
P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

Let not your conceptions of the manifestations of disease come from words heard in the lecture room or read from the book.

In W.S. Thayer

*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*

Osler, The Teacher (p. 51)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Parr, William**  
No biographical data available

The infectious diseases replace each other, and when one is rooted out it is apt to be replaced by others which ravage the human race indifferently whenever the conditions of health are wanting. They have this property in common with weeds and other forms of life, as one species recedes another advances.

In Rene Dubos  
*The Dreams of Reason: Science and Utopias*  
Chapter 4 (p. 67)  
Columbia University Press. New York, New York, USA. 1961

**Peabody, Francis Weld** 1881–1927  
American physician

Disease in man is never exactly the same disease in an experimental animal, for in man the disease at once affects and is affected by what we call the emotional life.

*The Care of the Patient*  
The Care of the Patient (p. 48)  
Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Persius** 32–64  
Roman poet

...check the ailment before it's got to you...

*The Satires of Persius*  
Satire Three, l. 67  
Anvil Press Poetry. London, England. 1981

**Plato** 428 BCE–347 BCE  
Greek philosopher

...to require the help of medicine, not when a wound has to be cured, or on occasion of an epidemic, but just because, by indolence and habit of life such as we have been describing, men fill themselves with waters and winds, as if their bodies were a marsh, compelling the ingenious sons of Asclepius to find more names for diseases, such as flatulence and catarrh; is not this, too, a disgrace? "Yes, he said, they do certainly give very strange and new-fangled names to diseases." Yes, I said, and I do not believe there were any such diseases in the days of Asclepius.

In *Great Books of the Western World* (Volume 7)  
*The Republic*  
Book III, Section 405 (p. 335)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ray, John** 1627–1705  
English naturalist

Diseases are the interests of pleasure.  
*A Complete Collection of English Proverbs* (p. 6)  
Printed for G. Cowie. London, England. 1813



**Rogers, Will** 1879–1935  
American actor and humorist

We were primitive people when I was a kid. There were only a mighty few known diseases. Gunshot wounds, broken legs, toothache, fits, and anything that hurt you from the lower end of your neck down was known as a bellyache.

*The Autobiography of Will Rogers*  
Chapter Twelve (p. 151)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

**Sacks, Oliver W.** 1933–  
American neurologist and author

Diseases have a character of their own, but they also partake of our character; we have a character of our own, but we also partake of the world's character...

*Awakenings*

Perspectives (p. 229)

Vintage Books. New York, New York, USA. 1990

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

...a disease also is farther on the road to being cured when it breaks forth from concealment and manifests its power.

Translated by Richard M. Gummere

*Ad Lucilium Epistulae Morales* (Volume 1)

Epistle Ivi, Section 10 (p. 379)

Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shadwell, Thomas** 1642?–92  
English dramatist and poet

Physicians tell us, that in every Age  
Some one particular Disease does rage,  
The Scurvy once, and what you call the Gout,  
But Heaven be prais'd their Reign is almost out...

*The Complete Works of Thomas Shadwell* (Volume 1)

The Sullen Lovers, Epilogue (p. 92)

The Fortune Press. London, England. 1927

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

O, he's a limb, that has but a disease;  
Mortal, to cut it off; to cure it easy.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Coriolanus*

Act III, Scene i, l. 296–297

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Diseases desperate grown  
By desperate appliance are relieved,  
Or not at all.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*

Act IV, Scene iii, l. 9–11

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I'll sweat and seek about for eases,  
And at that time bequeath you my diseases.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Troilus and Cressida*

Act V, Scene x, l. 56–57

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

There is at bottom only one genuinely scientific treatment for all diseases, and that is to stimulate the phagocytes.

*The Doctor's Dilemma*

Act I (p. 28)

Brentano's. New York, New York, USA. 1920

**Simmons, Charles** 1798–1856  
American clergyman and litterateur

The diseases and "evils which flesh is heir to," are all the messengers of God, to rebuke us for our sins, and ought so to be regarded.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 148)

Robert Dick. Toronto, Ontario, Canada. 1853

**Smyth, Francis Scott** 1895–1972  
American pediatrician

To know what kind of a person has a disease is as essential as to know what kind of disease a person has.

*Journal of Medical Education*, Volume 37, 1962

**Sonneberg, Walter**  
No biographical data available

Each new disease improves our claim to civilization.

*Social Eccentricities*

*Social Eccentricities* (p. 39)

Broadway Publishing Co. New York, New York, USA. 1906

**Straus, Bernard**

No biographical data available

Almost as fast as one disease is conquered new ones are discovered and sometimes created. We exchange new ones for old. The balance is clearly on the credit side and it is a fact that many of the old scourges, real or imaginary, are gone or are vanishing.

*Disappearing Diseases*

*Medical Counterpoint*, Volume 2, 1970

**Sydenham, Thomas** 1624–89  
English physician

...all this is mighty fine! but it won't do – Anatomy – botany – nonsense! Sir, I know an old woman in Covent Garden, who understands botany better; and as for anatomy, my butcher can dissect a joint full and well: – no, young man, all this is stuff; you must go to the bedside, it is there you alone can learn disease!

*Mems. Maxims, and Memoirs*

Sir Hans Slone (p. 231)  
Printed for Gallow & Wilson. London, England. 1827

**Thurber, James** 1894–1961  
American writer and cartoonist

If you don't pay no mind to diseases, they will go away.  
*The Thurber Carnival*  
Recollections of the Gas Buggy (p. 36)  
The Modern Library. New York, New York, USA. 1957

**Tolstoy, Leo** 1828–1910  
Russian writer

Doctors came to see her singly and in consultation, talked much in French, German, and Latin, blamed one another, and prescribed a great variety of medicines for all the diseases known to them, but the simple idea never occurred to any of them that they could not know the disease Natasha was suffering from, as no disease suffered by a live man can be known, for every living person has his own peculiarities and always has his own peculiar, personal, novel, complicated disease, unknown to medicine – not a disease of the lungs, liver, skin, heart, nerves, and so on mentioned in medical books, but a disease consisting of one of the innumerable combinations of the maladies of those organs.

*Great Books of the Western World*  
*War and Peace*  
Book 9, Chapter XVI (p. 373)  
Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Trousseau, Armand** 1801–67  
French internist

To know the natural progress of diseases is to know more than half of medicine.... Observe the practice of many physicians; do not implicitly believe the mere assertion of your master; be something better than servile learner; go forth yourselves to see and compare...knowing, henceforth, the physiognomy of the disease when allowed to run its own course, you can, without risk of error, estimate the value of the different medications which have been employed. You will discover which remedies have done no harm, and which have notably curtailed the duration of the disease; and thus for the future you will have a standard by which to measure the value of the medicine which you see employed to counteract the malady in question. What you have done in respect of one disease, you will be able to do in respect of many; and by proceeding in this way you will be able, on sure data, to pass judgment on the treatment pursued by your masters.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)  
Introduction (pp. 14–15)  
Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Man seems to be a rickety poor sort of a thing, any way you take him; a kind of British Museum of infirmities and inferiorities. He is always undergoing repairs. A machine that was as unreliable as he is would have no market.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*  
Man's Place in the Animal World (p. 213)  
The Library of America. New York, New York, USA. 1992

...man starts in as a child and lives on diseases to the end as a regular diet.

In Albert Bigelow Paine  
*Mark Twain: A Biography* (Volume 4)  
Chapter CCLII (p. 1362)  
Harper & Brothers Publishers. New York, New York, USA. 1912

**Viereck, George S.** 1884–1962  
No biographical data available

**Eldridge, Paul**  
No biographical data available

All diseases are curable, provided the patient lives long enough to overcome the initial cause of the complaint.

*My First Two Thousand Years: The Autobiography of the Wandering Jew*  
Chapter VII (p. 56)  
Sheridan House. New York, New York, USA. 1963

**Virchow, Rudolf Ludwig Karl** 1821–1902  
German pathologist and archaeologist

Ever since we recognized that diseases are neither self-subsistent, circumscribed, autonomous organisms, nor entities which have forced their way into the body, nor parasites rooted on it, but...the course of physiological phenomena under altered conditions...the goal of therapy has had to be the maintenance or the reestablishment of normal physiological conditions.

Translated by Lelland J. Rafter  
*Disease, Life, and Man*  
Standpoints in Scientific Medicine (p. 26)  
Stanford University Press. Stanford, California, USA. 1958

**Young, Arthur** 1741–1820  
English traveler

Catch the disease, that we may show our skill in curing it!

*The Adventures of Emmera* (Volume 2)  
Letter 26 (p. 115)  
Printed for W. Nicoll. London, England. 1768

**Zinsser, Hans** 1878–1940  
American bacteriologist

Infectious disease is one of the greatest tragedies of living things – the struggle for existence between different forms of life.

*Rats, Lice and History*  
Chapter I (p. 7)  
Little, Brown & Co. Boston, Massachusetts, USA. 1963

Infectious disease is one of the few genuine adventures left in the world.

*Rats, Lice and History* (p. 13)

Little, Brown & Company. Boston, Massachusetts, USA. 1935

## CANCER

**Fibiger, Johannes Andreas Grib** 1867–1928

Danish pathologist

The study of the manifold problems presented by cancer has, in recent years, seemed to offer many more riddles than were previously thought to exist; but the history of medicine has never known a period in which problems could be attacked in so many different ways as those made accessible today by the working methods now at our command.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1926

Investigations on Spiroptera Carcinoma and the Experimental Induction of Cancer (p. 148)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

I wish I had the voice of Homer

To sing of rectal Carcinoma,

Which kills a lot more chaps, in fact,

Than were bumped off when Troy was sacked.

I noticed I was passing blood

(Only a few drops, not a flood).

So passing on my way homeward way

From Tallahassee to Bombay

I asked a doctor, now my friend,

To peer into my hinder end,

To prove or to disprove the rumor

That I had a malignant tumor.

Cancer's a Funny Thing

*New Statesman*, 21 February, 1964 (p. 298)

**Hippocrates** 460 BCE–377 BCE

Greek physician

It is better not to apply any treatment in cases of occult cancer; for, if treated, the patient dies quickly; but if not treated, they hold out for a long time.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

Aphorisms, Section VI, 38 (p. 141)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mayo, Charles Horace** 1865–1939

American physician

While there are several chronic diseases more destructive to life than cancer none is more feared.

Carcinoma of the Right Segment of the Colon

*Annals of Surgery*, Volume 83, March, 1926

**Shimkin, Michael B.** 1913–89

American physician

Virology, immunology and chemotherapy may well stand for the first three letters that will spell victory over cancer. The day is not yet here, and we shall experience many disappointments before it dawns. But it is clearer than ever that cancer is a solvable problem, solvable by a human thought-and-action process that we call scientific research, and within the capabilities of human intelligence with which man was endowed by his creator.

*Science and Cancer* (p. 136)

US DHEW Publication No. (NIH) 74–568

Washington, D.C. 1973

**Smithers, Sir David** 1908–95

British cancer physician, writer, and research scientist

Cancer is no more a disease of cells than a traffic jam is a disease of cars. A lifetime of study of the internal combustion engine would not help anyone to understand our traffic problems. A traffic jam is due to a failure in normal relationships between driven cars and their environment.

In Gothard Booth

*The Cancer Epidemic: Shadow of the Conquest of Nature* (p. 20)

Mellen Press. New York, New York, USA. 1979

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

...the motive that will conquer cancer will not be pity nor horror; it will be curiosity to know how and why.

And the desire for service, said Lord Tamar.

As the justification of that curiosity, said Mr. Sempack, but not as a motive. Pity never made a good doctor, love never made a good poet. Desire for service never made a discovery.

*Meanwhile*

Chapter 5 (p. 44)

George H. Doran. New York, New York, USA. 1927

## CHOLERA

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

He died from fear of cholera.

*Note-Book of Anton Chekhov* (p. 68)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Flaubert, Gustave** 1821–90

French novelist

Cholera: You catch it from eating melons. The cure is lots of tea with rum in it.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Inge, William Ralph** 1860–1954  
English religious leader and author

If...an outbreak of cholera might be caused either by an infected water supply or by the blasphemies of an infidel mayor, medical research would be in confusion.

*Outspoken Essays (Second Series)*

Confessio Fidei (p. 3)

Longmans, Green & Company. New York, New York, USA. 1922

**Kipling, Rudyard** 1865–1936  
British writer and poet

When the cholera comes – as it will past a doubt –  
Keep out of the wet and don't go on the shout,  
For the sickness gets in as the liquor dies out,  
An' it crumples the young British soldier.  
Crum-, crum-, crumples the soldier...

*Collected Verse of Rudyard Kipling*

The Young British Soldier

Doubleday, Page & Company. Garden City, New York, USA. 1915

**Melville, Herman** 1819–91  
American novelist

Nature is good Queen Bess; but who's responsible for the cholera?

*Confidence-Man*

Chapter XXI (p. 99)

Airmont Publishing Co. New York, New York, USA. 1966

## EPILEPSY

**Hippocrates** 460 BCE–377 BCE  
Greek physician

The disease called Sacred...appears to me to be nowise more divine nor more sacred than other diseases, but has the natural cause from which it originates like other affections. Men regard its nature and cause as divine from ignorance and wonder, because it is not at all like to other disease.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On the Sacred Disease (p. 154)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## GOUT

**Ray, John** 1627–1705  
English naturalist

With respect to gout, the physician is a lout.

*A Complete Collection of English Proverbs* (p. 35)

Printed for G. Cowie. London, England. 1813

## HERPES

**Nahmias, André**  
Virologist and animal researcher

Herpes is from the Greek word for serpent, and herpes viruses really are creeps.

*Medical World News*, May 12, 1980

## LEPROSY

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Her skin was as white as leprosy  
The nightmare life-in-death was she.

*The Rime of the Ancient Mariner and Other Poems*

Rime of the Ancient Mariner, Part III, I. 189

Little Leather Library Corporation. New York, New York, USA. 1915

## MALARIA

**Laveran, Alphonse** 1845–1922  
French physician, pathologist, and parasitologist

Many observers before me had sought without success to discover the cause of malaria and I should also have failed if I had been content merely to examine the air, water, or the soil in malarial localities as had been done up till then, but I had taken as the basis of my investigations the pathological anatomy and the study in vivo of malarial blood and this is how I was able to reach my goal.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Protozoa as Causes of Diseases

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Ross, Sir Ronald** 1857–1932  
English bacteriologist

I was tired, and what was the use? I must have examined the stomachs of a thousand mosquitoes by this time. But the Angel of Fate fortunately laid his hand on my head [when he discovered that parasites carrying malaria lived in mosquitoes].

*Memoirs: With a full Account of the Great Malaria Problem and Its Solution*

Chapter 13

E.P. Dutton & Company, Inc. New York, New York, USA. 1923

I cannot help remembering the dingy little military hospital, the old cracked microscope, and the medicine bottles which constituted all the laboratory and apparatus which I possessed for the purpose of attacking one of the most redoubtable of scientific problems.

*Les Prix Nobel. The Nobel Prizes in 1902*

Nobel banquet speech for award received in 1902

Nobel Foundation. Stockholm, Sweden. 1903

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

He is so shak'd of a burning quotidian tertian that it is most lamentable to behold.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Life of King Henry the Fifth*  
 Act I, Scene ii, l. 123  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## MEASLES

**Ward, Artemus (Charles Farrar Browne)** 1834–67  
 American humorist

Did you ever have the measles, and if so, how many?  
*The Complete Works of Artemus Ward*  
 The Census (p. 69)  
 G. W. Dillingham. New York, New York, USA. 1898

## PARKINSON'S DISEASE

**Parkinson, James** 1755–1824  
 English physician and paleontologist

The disease, respecting which the present inquiry is made, is of a nature highly afflictive.... The unhappy sufferer has considered it as an evil, from the domination of which he had not prospect of escape.  
 An Essay on the Shaking Palsy  
*Medical Classics*, Volume 2, Number 10, June, 1938

So slight nearly imperceptible are the first inroads of this malady, and so extremely slow its progress, that it rarely happens, that the patient can form any recollection of the precise period of its commencement. The first symptoms perceived are, a slight sense of weakness, with a proneness to trembling in some particular part, sometimes in the head, but most commonly in one of the hands and arms.  
 An Essay on the Shaking Palsy  
*Medical Classics*, Volume 2, Number 10, June, 1938

## SMALLPOX

**Macaulay, Thomas Babington** 1800–50  
 English historian and writer

That disease over which science has since achieved a succession of glorious and beneficial victories was then the most terrible of all the ministers of death. The havoc of the plague had been far more rapid; but plague had visited our shores only once or twice within living memory, and the smallpox was always present, filling the churchyards with corpses, tormenting with constant fears all whom it had not yet stricken, leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden objects of horror to the lover.  
*The History of England, from the Accession of James the Second* (Volume 2) (p. 498)  
 Longmans, Green & Co. London, England. 1886

## TUBERCULOSIS

**Bunyan, John** 1628–88  
 English Christian writer and preacher

... Captain Consumption, with all his men of death ...  
*The Whole Works of John Bunyan* (Volume 1)  
 Memoir of John Bunyan (p. xxxiv)  
 Blackie & Son. London, England. 1862

**Koch, Robert** 1843–1910  
 German physician

The struggle against tuberculosis is not dictated from above, and has not always developed in harmony with the rules of science, but it has originated in the people itself, which has finally correctly recognized its mortal enemy. It surges forward with elemental power, sometimes in a rather wild and disorganized fashion, but gradually more and more finding the right paths.  
*Nobel Lectures, Physiology or Medicine 1901–1921*  
 The Current State of the Struggle against Tuberculosis  
 Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

## TYPHUS

**Butler, Samuel** 1612–80  
 English novelist, essayist, and critic

They made a clean sweep of all machinery that had not been in use for more than two hundred and seventy-one years (which period was arrived at after a series of compromises), and strictly forbade all further improvements and inventions under pain of being considered in the eye of the law to be labouring under typhus fever, which they regard as one of the worst of all crimes.  
*Erewhon and Erewhon Revisited*  
 Chapter IX (pp. 81–82)  
 The Modern Library. New York, New York, USA. 1955

**Nicolle, Charles** 1866–1936  
 French bacteriologist

And this is the ultimate lesson that our knowledge of the mode of transmission of typhus has taught us: Man carries on his skin a parasite, the louse. Civilization rids him of it. Should man regress, should he allow himself to resemble a primitive beast, the louse begins to multiply again and treats man as he deserves, as a brute beast.  
*Nobel Lectures, Physiology or Medicine 1922–1941*  
 Nobel lecture for award received in 1928  
 Investigations on Typhus (p. 187)  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1965

I asked myself what happened between the entrance to the hospital and the wards. This is what happened: the typhus patient was stripped of his clothes and linen, shaved and washed. The contagious agent was therefore something attached to his skin and clothing, something which soap and water could remove. It could only be the



louse. It was the louse.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Investigations on Typhus

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Zinsser, Hans** 1878–1940

US bacteriologist

Typhus is not dead. It will live on for centuries, and it will continue to break into the open whenever human-stupidity and brutality give it a chance, as most likely they occasionally will. But its freedom of action is being restricted, and more and more it will be confined, like other savage creatures, in the zoological gardens of controlled diseases.

*Rats, Lice and History*

Chapter XVI (p. 301)

Little, Brown & Co. Boston, Massachusetts, USA. 1963

## YELLOW FEVER

**Theiler, Max** 1899–1972

South African-born American microbiologist

By the intelligent application of antimosquito measures combined with vaccination, public-health officials have now the means available to render what was once a prevalent epidemic disease to one which is now a comparatively rare infection of man.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1951

The Development of Vaccines Against Yellow Fever (p. 359)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## DISINFECT

**Cambridge, P. J.**

No biographical data available

Disinfection and isolation on general principles may do a certain amount of good, but their routine practice unguided by scientific knowledge is rather like firing a blunderbuss into a thicket, in the hope that some of the shots may find a mark in the bodies of the animals hiding therein.

The Scope and Limitations of Bacteriology in the Local Investigation of Infectious Diseases

*Journal of the Sanitary Institute*, Volume XXIV, 1903 (p. 411)

## DISINFECTANT

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Soap and water and common sense are the best disinfectants.

In Evan Esar

*20,000 Quips and Quotes*

Doubleday. Garden City, New York, USA. 1968

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

But if men cannot live on bread alone, still less can they do so on disinfectants.

*Science and the Modern World*

Chapter IV (p. 87)

The Macmillan Company. New York, New York, USA. 1929

## DISK FLEX

**Hatchett, Stephen P.**

Astronomer

**Begelman, Mitchell Craig**

Astronomer

**Sarazin, Craig L.**

Astronomer

Old equations describing disk flex would many a reader perplex, but we've fixed up some errors and banished the terrors: our equation is *linear* (complex). For a number of torque contributions this allows analytic solutions. With equal facility we've shown the stability resulting from viscous diffusion.

*Astrophysical Journal, Part 1*, Volume 247 July 15, 1981 (p. 684)

## DISORDER

**Dürrenmatt, Friedrich** 1921–90

Swiss playwright and novelist

I simply can't stand disorder. Really it was my love of order that made me become a physicist...

Translated by James Kirkup

*The Physicists*

Act One (p. 18)

Grove Press, Inc. New York, New York, USA. 1964

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

So we now have to talk about what we mean by disorder and what we mean by order.... Suppose we divide the space into little volume elements. If we have black and white molecules, how many ways could we distribute them among the volume elements so that white is on one side and black is on the other? On the other hand, how many ways could we distribute them with no restriction on which goes where? Clearly, there are many more ways to arrange them in the latter case. We measure "disorder" by the number of ways that the insides can be arranged,



so that from the outside it looks the same. The logarithm of that number of ways is the entropy. The number of ways in the separated case is less, so the entropy is less, or the “disorder” is less.

*Feynman Lectures on Physics* (Volume 1) 46–5  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA.  
1963

**McCabe, Joseph** 1867–1955  
English rationalist writer and ex-Franciscan priest

Today we know not only that there is a terrible amount of disorder in the heavens – great catastrophes or conflagrations occur frequently – but evolution gives us a perfectly natural explanation of such order as there is. No distinguished astronomer now traces “the finger of God” in the heavens; and astronomers ought to know best.

*The Story of Religious Controversy*  
Chapter V (p. 86)  
Publisher undetermined

**Melville, Herman** 1819–91  
American novelist

There are some enterprises in which a careful disorderliness is the true method.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 82 (p. 267)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ziman, John M.** 1925–2005  
English Physicist

“Disorder” is not mere chaos; it implies defective order...

*Models of Disorder*  
Chapter 1 (p. 1)  
Cambridge University Press. Cambridge England. 1979

## DISPERSAL

**Zimmerman, E. C.** 1932–  
No biographical data available

We must recognize that it is abnormal conditions that account for much overseas dispersal. It is not the soft, gentle trade wind – it is the irresistible hurricane that is the key.

In J. Linsley Gressitt (ed.)  
*Pacific Basin Biogeography*  
*Pacific Basin Biogeography: A Summary Discussion* (p. 478)  
Bishop Museum Press. Honolulu, Hawaii, USA. 1963

So many continents and land bridges have been built in and across the Pacific by biologists that, were they all plotted on a map, there would be little space left for water. Whenever a particularly puzzling problem arises, the simplest thing seems to be to build a continent or bridge, rather than to admit defeat at the hands of nature, or to consider the data at hand inadequate for solving the

problem. Most of the land bridges suggested to account for the distribution of certain plants and animals in the Pacific create more problems than they solve. If the central and eastern Pacific ever included large land areas and land bridges, there should be some indication of the consequent peculiar development of the fauna and floras, but there is no such evidence.

Distribution and Origin of Some Eastern Oceanic Insects  
*American Naturalist*, Volume LXXVI, Number 764, 1942 (p. 282)

## DISSECT

**Morgagni, GiovanniBattista** 1682–1771  
Italian anatomist and pathologist

Those who have dissected or inspected many bodies have at least learnt to doubt; while others who are ignorant of anatomy and do not take the trouble to attend it are in no doubt at all.

Quoted in Margaret Cox and Simon Mays  
*Human Osteology in Archaeology and Forensic Science* (p. 493)  
Cambridge University Press. Cambridge, England. 2000

## DISSECTION

**Barbellion, Wilhelm Nero Pilate** 1889–1919  
English author

Dissected the Sea Urchin (*Echinus esculentus*). Very excited over my first view of Aristotle’s Lantern. These complicated pieces of animal mechanism never smell of musty age – after aeons of evolution. When I open a Sea Urchin and see the Lantern, or dissect a Lamprey and cast eyes on the branchial basket, such structures strike me as being as finished and exquisite as if they had just a moment before [they had] been tossed me fresh from the hands of the Creator. They are fresh, young, they smell new.

*The Journal of a Disappointed Man*  
November 3, 1908 (p. 19)  
George H. Doran Company. New York, New York, USA. 1919

**Brinton, William**  
English physician

Awful as it is to stand day after day in the presence of the dead, and watch the repulsive and unwholesome process by which the human body returns to earth again, the necessity of dissection is no longer questioned by any civilized nation.! Every sane person must acknowledge that an artisan cannot be expected to correct the derangements of a machine if ignorant of its structure; and that our limited knowledge of the human frame, and still more limited power over its derangements, do not prevent the application of this common-sense rule.

Introductory Lecture  
*The London Lancet*, Volume 2, Number 6, December, 1857 (p. 435)

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

As if a man should be dissected,  
To see what part is disaffected.  
*The Poetical Works of Samuel Butler* (Volume 1)  
Part II, Canto I (pp. 1. 505–506)  
Bell & Daldy. London, England. 1835

**Flaubert, Gustave** 1821–90  
French novelist

Dissection. An outrage upon the majesty of death.  
*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

**Pope, Alexander** 1688–1744  
English poet

Life following life through creatures you dissect,  
You lose it in the moment you detect.  
*The Complete Poetical Works*  
Moral Essays, Epistle I (pp. 1. 29–30)  
Houghton Mifflin Company. New York, New York, USA. 1903

**Wordsworth, William** 1770–1850  
English poet

Sweet is the lore which Nature brings;  
Our meddling intellect  
Mis-shapes the beauteous form of things: –  
We murder to dissect.  
*The Complete Poetical Works of William Wordsworth*  
The Tables Turned, The Thorn  
Crowell. New York, New York, USA. 1888

## DISTANCE

**Berlinski, David** 1942–  
American mathematician

Distance is a concept with a thousand florid faces – there is emotional distance, intellectual distance, biological distance, psychological distance, geographical distance, moral distance, aesthetic distance, sociological distance – but in mathematics distance is defined by a reference to a space of some sort and is thus a concept that requires, among other things, a fixed point, the question *how far?* Prompting in turn the inevitable further question *from where?*  
*A Tour of the Calculus*  
Chapter 3 (p. 18)  
Pantheon Books. New York, New York, USA. 1995

**Braithwaite, William Stanley** 1878–1962  
Editor and literary critic

Just where that star above  
Shines with a cold, dispassionate smile –  
If in the flesh I'd travel there,

How many, many a mile!  
*Lyrics of Life and Love*  
Distances  
H. B. Turner. Boston, Massachusetts, USA. 1904

**Coblentz, Stanton**  
No biographical data available

Our race has want of sages such as these,  
Whose measuring-rods are light-years, and who say  
That points a million trillion leagues away  
Are only as our next-door galaxies.  
Astronomers  
*Sky & Telescope*, Volume III, Number 10, August, 1940 (p. 12)

**Fowles, John** 1926–2005  
English novelist

I looked round the trees. The thin net of reality. These trees, this sun. I was infinitely far from home. The profoundest distances are never geographical.  
*The Magus* (p. 460)  
Little, Brown and company  
New York, New York, USA. 2001

**Heidmann, Jean** 1923–2000  
French-born astronomer

The distances we are going to embrace are so enormous that galaxies will appear as tiny toys, infinitesimal as the dust-specks dancing in the sunbeam in the crack of the curtain.  
Translated by Maureen Schaeffer and Ann Boesgaard  
*Extragalactic Adventure: Our Strange Universe*  
Chapter 2 (p. 20)  
Cambridge University Press. Cambridge, England. 1982

**Jeffers, Robinson** 1887–1962  
American poet

I strain the mind to imagine distances  
That are not in man's mind...  
In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 3)  
Pleasures (p. 473)  
Stanford University Press. Stanford, California, USA. 1988

## DISTILL

**Levi, Primo** 1919–87  
Italian writer and chemist

Distilling is beautiful. First of all, because it is a slow, philosophic, and silent occupation, which keeps you busy but gives you time to think of other things, somewhat like riding a bike. Then, because it involves a metamorphosis from liquid to vapor (invisible), and from this once again to liquid; but in this double journey, up and down, purity is attained, an ambiguous and fascinating

condition, which starts with chemistry and goes very far. And finally, when you set about distilling, you acquire the consciousness of repeating a ritual consecrated by the centuries, almost a religious act, in which from imperfect material you obtain the essence, the usia, the spirit, and in the first place alcohol, which gladdens the spirit and warms the heart.

Translated by Raymond Rosenthal

*The Periodic Table*

Potassium (pp. 57–58)

Schocken Books. New York, New York, USA. 1984

### Sedwizoj, Michal

No biographical data available

Such therefore is the Distiller, the Maker of all things, in whose hands is this Distillatory, according to the example of which all Distillations have been invented by Philosophers; which thing the most High God himself out of pity, without doubt, hath inspired into the Sons of Men: and he can, when it is his Holy Will, either extinguish the Central Fire, or break the Vessel, and then there will be an end of all.

*A New Light of Alchymy* (pp. 94–95)

Printed by A. Clark. London, England. 1674

### Shakespeare, William 1564–1616

English poet, playwright, and actor

Hast thou not learned me how to make perfumes? Distil? Preserve?

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Cymbeline*

Act I, Scene v, l. 13

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## DISTORTION

### Mellor, Joseph William 1863–1938

Chemist

What we wish, said Demosthenes, that we believe; what we expect, said Aristotle that we find.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 6)

Longman, Green & Co. London, England. 1922

## DISTRIBUTION

### Author undetermined

An exterminator made this contribution On rats arriving in random profusion “I know nothing of math, Probability of stats, But I handle ‘em with Poisson distributions.”

In Arnold O. Allen

*Probability, Statistics, and Queueing Theory with Computer Science Applications* (p. 86)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

### Author undetermined

You have two chances –

One of getting the germ

And one of not.

And if you get the germ

You have two chances –

One of getting the disease

And one of not.

And if you get the disease

You have two chances –

One of dying....

Source undetermined

When you get an 8 on the midterm, there ain’t a curve in the world that can save you.

Source undetermined

### Galton, Sir Francis 1822–1911

English anthropologist, explorer, and statistician

The primary objects of the Gaussian Law of Error were exactly opposed, in one sense, to those to which I applied them. They were to get rid of, or to provide a just allowance for errors. But these errors or deviations were the very thing I wanted to preserve and to know about.

*Memories of My Life*

Chapter XX (p. 305)

Methuen & Company Ltd. London, England. 1908

It has been objected...that I pushed the application of the Law of Frequency of Error somewhat too far. I may have done so...; but I am sure that, with the evidence before me, the applicability of that law is more than justified within...reasonable limits.

*Natural Inheritance*

Schemes of Distribution and of Frequency (p. 44)

Macmillan & Company Ltd. London, England. 1889

### Geary, R. C.

No biographical data available

Normality is a myth; there never has, and never will be, a normal distribution.

Testing for Normality

*Biometrika*, Volume 34, 1947 (p. 241)

### Hamming, Wesley Richard 1915–98

American mathematician

If the prior distribution, at which I am frankly guessing, has little or no effect on the result, then why bother; and if it has a large effect, then since I do not know what I am doing how would I dare act on the conclusions drawn?

*The Art of Probability for Scientists and Engineers*

Chapter 8 (p. 298)

Westview Press. Boulder, Colorado, USA. 1991

### Harris, Sidney

No biographical data available

Which Bernoulli do you wish to see – “Hydrodynamics” Bernoulli, “Calculus” Bernoulli. “Geodesic” Bernoulli. “Large Numbers” Bernoulli or “Probability” Bernoulli?  
*What’s So Funny About Science*  
Caption to Cartoon

### Kneale, W.

No biographical data available

A misunderstanding of Bernoulli’s theorem is responsible for one of the commonest fallacies in the estimation of probabilities, the fallacy of the maturity of chances. When a coin has come down heads twice in succession, gamblers sometimes say that it is more likely to come down tails next time because “by the law of averages” (whatever that may mean) the proportion of tails must be brought right some time.

*Probability and Induction*

Part III, subsection 29 (p. 140)

At The Clarendon Press. Oxford, England. 1949

### Lewis, Don

No biographical data available

### Burke, C. J.

No biographical data available

It has become increasingly apparent over a period of several years that psychologists, taken in the aggregate, employ the chi-square test incorrectly.

The Use and Misuse of the Chi-Square Test

*Psychological Bulletin*, Volume 46, Number 6, November, 1949 (p. 433)

### May, Robert M.

No biographical data available

I would therefore urge that people be introduced to [the logistic equation] early in their mathematical education. This equation can be studied phenomenologically by iterating it on a calculator, or even by hand. Its study does not involve as much conceptual sophistication as does elementary calculus. Such study would greatly enrich the student’s intuition about nonlinear systems. Not only in research but also in the everyday world of politics and economics, we would all be better off if more people realized that simple nonlinear systems do not necessarily possess simple dynamical properties.

Simple Mathematical Models with very Complicated Dynamics

*Nature*, Volume 261, Number 5560, June 10, 1976 (p. 467)

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

We know not to what are due the accidental errors, and precisely because we do not know, we are aware they obey the law of Gauss. Such is the paradox.

*The Foundations of Science*

*Science and Method*, Book I

Chapter IV, Section VI (p. 406)

The Science Press. New York, New York, USA. 1913

### Pynchon, Thomas 1937–

American novelist

She’s almost got it; nearly understands his Poisson equation...

*Gravity’s Rainbow*

Part I (p. 54)

The Viking Press. New York, New York, USA. 1973

But a hard-on, that’s either there, or it isn’t. Binary, elegant. The job of observing it can even be done by a student.

*Gravity’s Rainbow*

Part I (p. 84)

The Viking Press. New York, New York, USA. 1973

## DIVERGENCE

### Lillich, Robert

No biographical data available

Divergence B, it’s plain to see, is zero.

I think they’ve got it, I think they’ve got it!

And del dot D is always rho, you know.

I think they’ve got it, I think they’ve got it!

My Fair Physicist, I Think They’ve Got It

*The Physics Teacher*, Volume 6, Number 9, December, 1968 (p. 490)

## DIVERGENT SERIES

### Abel, Niels Henrik 1802–29

Norwegian mathematician

The divergent series are the invention of the devil, and it is a shame to base on them any demonstrations whatsoever.

In Morris Kline

*Mathematics: The Loss of Certainty*

Chapter VII (p. 170)

Oxford University Press, Inc. New York, New York, USA. 1980

## DIVERSITY

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

The smallest sheet of fresh water, every point upon the sea-shore, every acre of dry land teems with a variety of animals and plants. The narrower the boundaries which are assigned as the primitive home of all these beings, the more uniform must be the conditions under which they must be assumed to have originated; so uniform, indeed, that in the end the inference would be, that the same physical causes can produce the most diversified effects.

*An Essay on Classification*

Chapter First (p. 15)

Longman, Brown, Green, Longmans & Roberts. London, England. 1859

**Minelli, A.**

No biographical data available

Despite the vagaries of systematists, there are, in a taxonomic sense, many dense clusters of biotic diversity.

*Biological Systematics: The State of the Art* (p. 185)  
Chapman & Hall. London, England. 1993

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

...species is but the ideal form; within this idea, within each species, is a diversity of individuality to make the stars look monotonous.

*Flowering Earth*

Chapter 4 (p. 47)

G.P. Putnam's Sons. New York, New York, USA. 1939

**DIVING****Author undetermined**

The charm of terror hangs around it [the sea], and the interminable succession of exciting events renders it dear to its professor; not to the common diver...who can remain but for a fraction of time beneath the wave, and grope fearfully among rugged ocean-mounds, but to the adept in the civilized mode of diving, who, in his protective armor, may remain submerged for hours, and wander with impunity for miles along those unknown regions far below the sea.

*Putnam's Monthly*

The Ocean Depths

Volume VII April, 1856 (p. 386)

**DIVINE INTELLIGENCE****Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

No rational order of divine intelligence unites species. The natural ties are genealogical along contingent pathways of history.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Eight, Chapter 32 (p. 424)

Random House, Inc. New York, New York, USA. 1995

**DNA****Baum, Harold**

No biographical data available

The primary sequence of proteins

Is coded with DNA

One sense strand of the double helix

Coiled antiparallel way.

(Introns and exons, changes post-transcriptional, and all Glycosylations, don't alter such basics at all.)

*The Biochemists' Handbook*

Protein Biosynthesis (Tune: My Bonnie Lies Over the Ocean)

van Nostrand Company, Inc. Princeton, New Jersey, USA. 1961

**Boulding, Kenneth E.** 1910–93

English economist and social scientist

DNA was the first three-dimensional Xerox machine.

In Richard P. Beilock (ed.)

*Beasts, Ballads, and Bouldingisms: A Collection of Writings*

Evolution, Ecology, and Spaceship Earth (p. 160)

Transaction Books. New Brunswick, New Jersey, USA. 1980

**Crick, Francis Harry Compton** 1916–2004

English molecular biologist, physicist, and neuroscientist

Nowadays most people know what DNA is, or if they don't know it must be a dirty word, like "chemical" or "synthetic."

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 6 (p. 63)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

We are digital archives of the African Pliocene, even of Devonian seas; walking repositories of wisdom out of the old days. You could spend a lifetime reading in this ancient library and die unseated by the wonder of it.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter 10 (p. 256)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

The potentiality of mind must be present in the egg and the sperm and in the DNA molecules. But it does not follow that eggs and sperms themselves have minds. A stone has in it a potentiality to become a statue, but it does not follow that every stone has a statue concealed in it.

*The Biology of Ultimate Concern*

Chapter 2 (p. 30)

The New American Library, Inc. New York, New York, USA. 1967

**Dulbecco, Renato** 1914–

Italian-born American virologist

In the evolution of life DNA created the brain because devices were needed for sensing the environment: prey had to be identified, predators avoided, a mate located.

*The Design of Life*

Chapter 17 (p. 339)

Yale University Press. New Haven, Connecticut, USA. 1987

**Dunne, Dominick** 1925–

American writer

The fact is, although DNA testing may be as foolproof as fingerprinting, it doesn't cause excitement. It's difficult to respond to. It's like advanced math, brilliant but boring, astonishing but passionless. It made everyone eager to move on to the next phase of the trial, which consisted of autopsy pictures...

*If the Glove Fits*

*Vanity Fair*, August, 1995

**Jukes, Thomas Hughes** 1906–99  
American molecular biologist

Slowly the molecules enmeshed in ordered asymmetry.  
A billion years passed, aeons of trial and error.  
The life message took form, a spiral,  
a helix, repeating itself endlessly,  
Swathed in protein, nurtured by  
enzymes, sheltered in membranes,  
laved by salt water, armored with lime.

*Molecules and Evolution* (p. iii)  
Columbia University Press, New York, New York, USA. 1966

### **Lisa Simpson (Fictional character)**

Isn't there any way I can change my DNA, like – sitting  
on the microwave?

The Simpsons: Lisa  
The Simpson (Television program 1998)

**Skinner, Burrhus Frederic** 1904–90  
American psychologist

A person is not an originating agent; he is a locus, a point  
at which many genetic and environmental conditions  
come together in a joint effect.

*About Behaviorism* (p. 172)  
Knopf. New York, New York, USA. 1974

**Thomas, Lewis** 1913–93  
American physician and biologist

The greatest single achievement of nature to date was  
surely the invention of DNA. We have had it from the  
very beginning, built into the first cell to emerge, mem-  
branes and all, somewhere in the soupy waters of the  
cooling planet.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
The Wonderful Mistake (p. 27)  
The Viking Press. New York, New York, USA. 1979

The capacity to blunder slightly is the real marvel of  
DNA. Without this special attribute, we would still be  
anaerobic bacteria and there would be no music.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
The Wonderful Mistake (p. 28)  
The Viking Press. New York, New York, USA. 1979

## **DOCTOR**

### **Author undetermined**

You go to the Doctor,  
you feel mighty ill  
The Doctor looks you over,  
he gives you a pill  
Then if you die,  
they break out the band  
The Doctor's done his duty  
and he doesn't give a damn.

*The Book of Navy Songs*  
Collected by the Trident Society, 1943 Home, Boys, Home

Three doctors are in the duck blind and a bird flies over-  
head.

The general practitioner looks at it and says, "Looks  
like a duck, flies like a duck...it's probably a duck," and  
shoots at it but misses and the bird flies away.

The next bird flies overhead, and the pathologist looks  
at it, then looks through the pages of a bird manual, and  
says, 'Hmmm...green wings, yellow bill, quacking  
sound...might be a duck.' He raises his gun to shoot it,  
but the bird is long gone.

A third bird flies over. The surgeon raises his gun and  
shoots almost without looking, brings the bird down, and  
turns to the pathologist and says, 'Go see if that was a  
duck.'

Source undetermined

Some doctors seem to think that M.D. actually stands for  
Minor Deity.

Source undetermined

Fifty years ago the successful doctor was said to need  
three things; a top hat to give him Authority, a paunch  
to give him Dignity, and piles to give him an Anxious  
Expression.

In England Now  
*The Lancet*, Volume 260 January 20, 1951 (p. 169)

## **DOCTRINE**

**Huxley, Thomas Henry** 1825–95  
English biologist

...there are three great products of our time which justify  
the assertion. One of these is that doctrine concerning the  
constitution of matter which, for want of a better name,  
I will call "molecular;" the second is the doctrine of the  
conservation of energy; the third is the doctrine of evolu-  
tion.

*Method and Results: Essays*  
The Progress of Science (p. 66)  
D. Appleton & Co. New York, New York, USA. 1898

## **DOGMA**

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Science is properly more scrupulous than dogma. Dogma  
gives a charter to mistake, but the very breath of science  
is a contest with mistake, and must keep the conscience  
alive.

*Middlemarch: A Study in Provincial Life*  
Book VII, Chapter LXXIII (p. 673)  
John B. Alden, Publisher. New York, New York, USA. 1883



**Flexner, Abraham** 1866–1959  
American educator

...men possessed of vague preconceived ideas are strongly disposed to force facts to fit, defend, or explain them. And this tendency both interferes with the free search for truth and limits the good which can be extracted from such truth as is in its despite attained.

*Medical Education in the United States and Canada*  
Chapter X (p. 156)  
The Carnegie Foundation. New York, New York, USA. 1910

**Pearson, Karl** 1857–1936  
English mathematician

If the reader questions whether there is still war between science and dogma, I must reply that there always will be as long as knowledge is opposed to ignorance. To know requires exertion, and it is intellectually easiest to shirk effort altogether by accepting phrases which cloak the unknown in the undefinable.

*The Grammar of Science* (2nd edition)  
Preface to the Second Edition (p. viii)  
Adam & Charles Black. London, England. 1900

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

This assemblage of imperfect dogmas bequeathed by one age to another – this physical philosophy, which is composed of popular prejudices – is not only injurious because it perpetuates error with the obstinacy engendered by the evidence of ill observed facts, but also because it hinders the mind from attaining to higher views of nature.

*Cosmos* (Volume I)  
Introduction (p. 17)  
Henry G. Bohn. London, England. 1849

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

...in science nothing is absolutely permanent. We have no dogma.

In Denis Brian  
*The Voice of Genius*  
Chapter Four (p. 99)  
Perseus Publishing. Cambridge, Massachusetts, USA. 1995

## DOGMATISM

**Burroughs, John** 1837–1921  
American naturalist and essayist

Dogmatism about nature, or about anything else, very often turns out to be an ungrateful cur that bites the hand that reared it.

*Signs and Seasons*  
Chapter I (p. 31)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Herrick, Charles Judson** 1868–1960  
American neurologist

Dogmatism has no place in science, and dogmatism about the unknown is especially reprehensible. We live by, faith, faith in the order of nature, faith in ourselves, and faith in our fellow men. This faith is our most prevalent motivation, and it is a reliable guide for behavior just in so far as it is founded on knowledge. Where knowledge is lacking we may extrapolate with due regard for the uncertainties arising from the incompleteness of our knowledge.

*The Evolution of Human Nature*  
Epilogue: The Unknown God (p. 465)  
University of Texas Press. Austin, Texas, USA. 1956

**Hoefler, F.**  
Chemist

The systems which confront the intelligence remain basically unchanged through the ages, although they assume different forms...there is nothing so disastrous in science as the arrogant dogmatism which despises the past and admires nothing but the present.

*Histoire de la Chimie*  
Paris, France. 1866

## DOPPLER EFFECT

### Author undetermined

The easiest way to observe Doppler's effect optically (not acoustically) in one's everyday life is to go out in the evening and look at the cars. They lights are white or yellow when they approach, but they are red when they are moving away of you.

Source undetermined

## DOUBLE STARS

**Tennyson, Alfred (Lord)** 1809–92  
English poet

She saw the snowy poles and moons of Mars, That mystic field of drifted light

In mid Orion and the married stars.  
*The Works of Tennyson*  
Notes (p. 697)  
The Macmillan Co. New York, New York, USA. 1913

## DOUBT

**Dana, James Dwight** 1813–95  
American geologist, mineralogist, and naturalist

I think it better to doubt until you know. Too many people assert and then let others doubt.

In Oliver C. Farrington

James D. Dana as a Teacher of Geology

*The Journal of Geology*, Volume III, Number 3, 1895 (p. 336)

### Davis, Andrew Jackson

No biographical data available

Doubt is the beginning of wisdom. Doubt is the precursor of inquiry; inquiry leads to Evidence; Evidence is the foundation of *Knowledge*; and Knowledge is the parent of Liberty and Power.

*The Present Age and Inner Life* (3rd edition)

A Survey of Human Needs (p. 8)

W. White & Co. Boston, Massachusetts, USA. 1873

### Davy, Sir Humphry 1778–1829

English chemist

Doubt in physical research is highly salutary, and is always the parent of inquiry, and often of truth.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 218)

Longman, Rees, Orme, Brown, Green & Longman London, England.

1836

### Enriques, Federigo 1871–1946

Italian mathematician

How can we doubt that of which every man is most certain even from his earliest infancy?

Translated by Katharine Head Royce

*Problems of Science*

Chapter I (p. 10)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

### Feynman, Richard P. 1918–88

American theoretical physicist

Our freedom to doubt was born out of a struggle against authority in the early days of science. It was a very deep and strong struggle.... It is our responsibility as scientists...to proclaim the value of this freedom; to teach how doubt is not to be feared but welcomed and discussed; and to demand this freedom as our duty to all coming generations.

*What Do You Care What Other People Think?*

The Value of Science (pp. 245, 248)

W.W. Norton & Co. New York, New York, USA. 1988

When the scientist tells you he does not know the answer, his is an ignorant man. When he tells you he has a hunch about how it is going to work, he is uncertain about it. When he is pretty sure of how it is going to work, and he tells you, "This is the way it's going to work, I'll bet," he is still in some doubt.

*The Meaning of It All*

Chapter 1 (p. 27)

Addison-Wesley, Reading, Massachusetts, USA. 1998

### Herschel, Friedrich Wilhelm

(Sir William) 1738–1822

English astronomer

It is sometimes of great use in natural philosophy to doubt of things that are commonly taken for granted; especially as the means of resolving any doubt, when once it is entertained, are often within our reach.

Investigation of the Powers the Prismatic Colours to Heat and Illuminate Objects

*Philosophical Transactions of the Royal Society of London*,

Volume 90, 1800 (p. 255)

### Rothman, Tony 1932–99

Italian-born American mathematician

### Sudarshan, George 1931–

Indian American physicist

When the unknown vanishes, doubt remains.

*Doubt and Certainty*

Preface (p. xi)

Perseus Books. Cambridge, Massachusetts, USA. 1998

### Thorpe, Sir Thomas Edward 1845–1925

English chemist

...when men began to use their hands and eyes as well as their reason in attempting to get at nature's secrets, doubts arose whether the explanations and hypotheses of the gown-men were not rather strained, and for the most part unsatisfactory.

*Essays in Historical Chemistry*

Robert Boyle (p. 8)

Macmillan & Co Ltd. London, England. 1902

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

*Mit dem Wissen wächst der Zweifel.*

Doubt ever grows alongside of knowledge.

*Sprüche in Prosa*

Maximen und Reflexionen, III

Undetermined

Those only who know little, can be said to know anything. The greater the knowledge the greater the doubt.

Translated by Otto Wenckstern

*Goethe's Opinions on the World, Mankind, Literature, Science, and Art*

(p. 24)

John W. Parker & Son. London, England. 1853

### Wittgenstein, Ludwig Josef Johann 1889–1951

Austrian-born English philosopher

...doubt can only exist where there is a question; a question only where there is an answer, and this only where something *can be said*.

*Tractatus Logico-Philosophicus*

6.51 (p. 187)

Harcourt, Brace & Co. New York, New York, USA. 1922

**DREAM**

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Why does the eye see a thing more clearly in dreams than the imagination when awake?

Translated by Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I (p. 49)

Duckworth & Co. London, England. 1906

**Kekule, August** 1829–96  
German organic chemist

Gentlemen, if we learn to dream we may find out the truth; but let us avoid publishing our dreams before they have been tested by the wide-awake intelligence.

In Harry Clary Jones

*A New Era in Chemistry*

Chapter I (p. 15)

D. van Nostrand Co. New York, New York, USA. 1913

Let us learn to dream, gentlemen then perhaps we shall find the truth... but let us beware of publishing our dreams before they have been put to the proof by the waking understanding.

Quoted by Francis R. Japp

*Memorial Lectures Delivered before the Chemical Society*

Kekule Memorial Lecture (p. 100)

Gurney & Jackson. London, England. 1901

**DRUG**

**Abrams, Albert** 1863–1924  
American physician

Drugs have been invented for the patient and the physician: to relieve the former of obeying the laws of hygiene and the latter of inculcating them.

*Man and His Poisons*

Chapter X (p. 222)

E.B. Treat & Co. New York, New York, USA. 1906

Cheer is a powerful drug, for a merry heart, doeth good like a medicine.

*Man and His Poisons*

Chapter X (p. 222)

E.B. Treat & Co. New York, New York, USA. 1906

**Bartlett, Elisha** 1804–55  
American physician

The natural history of cinchona, its botanical character and relations, its geographical distribution, its anatomy and physiology, its chemical constitution, do not involve in any way its therapeutical properties; they do not even indicate them, or throw any light upon them.

In William E. Stempsey

*Elisha Bartlett's Philosophy of Medicine*

Part II, Chapter XVI (p. 198)

Springer-Verlag. Dordrecht, The Netherlands. 2005

**COCAINE**

**Bankhead, Tallulah** 1903–68  
American actress

Cocaine habit-forming? Of course not. I ought to know. I've been using it for years.

*Tallulah*

Chapter 4 (p. 101)

Harper and Brothers, Publishers. New York, New York, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

...whether it was the Beaune which I had taken with my lunch, or the additional exasperation produced by the extreme deliberation of his manner, I suddenly felt that I could hold out no longer.

“Which is it to-day,” I asked, “morphine or cocaine?”

He raised his eyes languidly from the old black-letter volume which he had opened.

“It is cocaine,” he said, “a seven-per-cent solution. Would you care to try it?”

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Sign of the Four*

Chapter 1 (p. 610)

Wings Books. New York, New York, USA. 1967

**HEROIN****Author undetermined**

King Heroin is my shepherd, I shall always want. He maketh me to lie down in the gutters. He leadeth me beside the troubled waters. He destroyeth my soul. He leadeth me in the paths of wickedness for the effort's sake. Yea, I shall walk through the valley of poverty and will fear all evil for thou, Heroin, art with me. Thy Needle and capsule try to comfort me. Thou strippest the table of groceries in the presence of my family. Thou robbest my head of reason. My cup of sorrow runneth over. Surely heroin addiction shall stalk me all the days of my life and I will dwell in the House of the Damned forever.

The Psalm of the Addict

*Congressional Record*, Volume 117, July 31, 1971 (p. 28511)

**OPIUM**

**de Quincey, Thomas** 1785–1859  
English essayist

Oh! just, subtle, and mighty opium! that to the hearts of poor and rich alike, for the wounds that will never heal, and for “the pangs that tempt the spirit to rebel,” bringest an assuaging balm; eloquent opium!

*The Collected Writings of Thomas de Quincey* (Volume 3)

*Confessions of an English Opium Eater*

Part II (p. 396)

A. & C. Black. London, England. 1897

**Dickens, Charles** 1812–70  
English novelist

[Opium] is so far like a human creature so far, that you always hear what can be said against it, but seldom what can be said in its praise.

*The Complete Mystery of Edwin Drood*  
Chapter XXIII (p. 197)  
Chapman & Hall. London, England. 1912

**Melville, Herman** 1819–91  
American novelist

... whenever my hypos get such an upper hand of me, that it requires a strong moral principle to prevent me from deliberately stepping into the street, and methodically knocking people's hats off – then, I account it high time to get to sea as soon as I can.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 1 (p. 2)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Scott, Sir Walter** 1771–1832  
Scottish novelist and poet

When applied to the purposes of indulgence and debauchery, opium rends the nerves, destroys the strength, weakens the intellect, and undermines life. But fear not to use the virtues in the time of need, for the wise man warms him by the same firebrand with which the madman burneth the tent.

*The Talisman*  
Chapter XXII (p. 226)  
White, Stokes & Allen. New York, New York, USA. 1885

## DRY ROT

**Dickens, Charles** 1812–70  
English novelist

...dry rot and wet rot and all the silent rots that rot in neglected roof and cellar...addressed themselves faintly to my sense of smell...

*Great Expectations*  
Chapter XXI (p. 198)  
Estes & Lauriat. Boston, Massachusetts, USA. 1884

## DUALITY

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Duality may be a conceptual prison, but if we must live with such a mental strategy, we might maximize our opportunity to grasp some of nature's complexity by hitching our star to the dyad of change and constancy. Slow and steady does not always win the race.

*Dinosaur in a Haystack*  
Chapter 11 (p. 144)  
Harmony Books. New York, New York, USA. 1995

## DUST

**Culverwel, Nathanael** 1618–51  
English empiricist philosopher

The sun discovers atoms, though they be invisible by candle-light, yet that makes them dance naked in his beams.

*Of the Light of Nature: A Discourse*  
Discourse of the Light of Nature (p. 174)  
Thomas Constable & Co. Edinburgh, Scotland. 1857

**Playfair, Lyon** 1818–98  
Scottish scientist and Parliamentarian

Isolated facts may be viewed as the dust of science.  
Inaugural Address  
*Nature*, Volume 32, September 10, 1885 (p. 443)

**Preston, Richard** 1954–  
American writer

The earth suffered the same late heavy bombardment [by planetesimals], but weather erased the scars long ago. The bombardment has dwindled to almost nothing today. Almost. The planets have never quite left off growing. The earth is now gaining about twenty tons a day through perpetual rain of dust from space. Every once in a while, it gains two billion tons in one second.

In Edmund Blair Bolles  
*Galileo's Commandment: An Anthology of Great Science Writing*  
Chapter Ten, Dark Time (p. 463)  
W.H. Freeman & Co. New York, New York, USA. 1997

**Stapledon, Olaf** 1886–1950  
English author

Presently nothing was left in the whole cosmos but darkness and the dark whiffs of dust that once were galaxies.  
*Last and First Men and Star Maker* (p. 411)  
Dover Publications. New York, New York, USA. 1968

## COSMIC DUST

**Winchell, Alexander** 1824–91  
American geologist

Out from the depths of space – beyond the clouds – beyond the atmosphere – from a granary of material germs which stock the empire of the blue sky, comes a perpetual but invisible rain of material atoms – like the evening dew, emerging from the transparency of space into a state of growing visibility.

*World-life; Or, Comparative Geology* (3rd edition)  
Part I, Chapter I (p. 4)  
S.C. Griggs & Co. Chicago, Illinois, USA. 1889

## METEORIC DUST

**Geikie, Sir Archibald** 1835–1924  
English geologist

In tracts where the growth of silt upon the sea-floor is excessively tardy, the fine particles, scattered by the dissipation of these meteorites, may remain in appreciable quantity. In this case, again, it is not needful to suppose that meteorites have disappeared over these ocean depths more numerous than over other parts of the earth's surface. The iron granules have no doubt been as plentifully showered down elsewhere, though they cannot be so readily detected in accumulating sediment. I know no recent observation in physical geography more calculated to impress deeply the imagination than the testimony of this presumably meteoric iron from the most distant abysses of the ocean. To be told that mud gathers on the floor of these abysses at an extremely slow rate conveys but a

vague notion of the tardiness of the process. But to learn that it gathers so slowly, that the very star-dust which falls from outer space forms an appreciable part of it, brings home to us, as hardly anything else could do, the idea of undisturbed and excessively slow accumulation.

*Geological Sketches at Home and Abroad*  
Chapter XIII (pp. 281–282)  
The Macmillan Co. New York, New York, USA. 1892

## DYNAMICS

**Stewart, Ian** 1945–  
English mathematician

“So what does the Mandelblot tell us, then?”  
“That a very simple mathematical rule can lead to incredibly complicated behaviour,” replied the Space Hopper.  
“Isn't that amazing?”

“I guess... But doesn't that mean that trying to understand dynamics in terms of rules is a waste of time?”

*Flutterland*  
One and a Quarter Dimensions (p. 87)  
Perseus Publishing. Cambridge, Massachusetts, USA. 2001

## E

## E

### Berrett, Wayne

No biographical data available

It had to be e,  
nonintegral e,  
I looked around  
Until I found  
A base that would do.  
To differentiate  
or to integrate,  
One that would not  
Carry along  
Some ugly weight.  
Some bases I know  
Are simpler to state,  
A snap to invert,  
Exponentiate,  
But they wouldn't do.  
For no other base can fit math so well,  
With all its digits I love it still!  
It had to be e,  
Irrational e,  
It had to be e!  
It Had to Be e  
*Mathematics Magazine*, Volume 68, Number 1, February, 1995 (p. 15)

### Brewster, G. W.

$$2^{(5/2)^{2/5}} = e$$

*The Mathematical Gazette*, Volume 25, Number 263, February, 1941 (p. 49)

### Klein, Felix 1849–1925

German mathematician

The definition of  $e$  is usually, in imitation of the French models, placed at the very beginning of the great text books of analysis, and entirely unmotivated, whereby the really valuable element is missed, the one which mediates the understanding, namely, an explanation of why precisely this remarkable limit is used as base and why the resulting logarithms are called natural.

Translated by E.R. Hedrick and C.A. Noble  
*Elementary Mathematics from an Advanced Standpoint*  
Part Third, Chapter I, Section 3 (p. 146)  
Dover Publications. New York, New York, USA. 1939

### Teller, Edward 1908–2003

Hungarian-born American nuclear physicist

### Teller, Wendy

No biographical data available

...the first nine digits after the decimal can be remembered by  $e = 2.7$ (Andrew Jackson)<sup>2</sup>, or  $e = 2.718281828...$  because Andrew Jackson was elected President of the USA in 1828. For those good in mathematics on the other hand, this is a good way to remember their American History.

*Conversations on the Dark Secrets of Physics*  
Chapter 6 (p. 87, fn)  
Plenum Press. New York, New York, USA. 1991

## E = MC<sup>2</sup>

### Author undetermined

Energy = milk chocolate square.  
Source undetermined

### Chase, Stuart 1888–1985

American economist and engineer

The Atomic Age is built on Einstein's equation  $E = mc^2$ , where  $m$  is the mass of the atom, and  $c$  is the speed of light (186,000 miles per second). You square that, and out of the atom comes quite a bit of energy.

New Energy for a New Age  
*Saturday Review*, January 22, 1955 (p. 14)

## EAR WAX

### Flaubert, Gustave 1821–90

French novelist

Cerumen. Human wax. Should not be removed: it keeps insects from entering the ears.

*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

## EARLY MAN

### Lapworth, Charles 1842–1920

English Geologist

The world over which early man wandered was to him the theatre of a never-ending conflict, in which were arrayed against him impassable seas, unscalable mountains, gloomy forests peopled by deadly beasts of prey, raging streams and foaming torrents, each and all the haunts of spirits luring him to doom.

The Relations of Geology  
*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1902 (pp. 395–396)



## EARTH

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

It is not possible for a...man to walk across so much as a rood of the natural earth, with mind unagitated and rightly poised, without receiving strength and hope from some stone, flower, leaf, or sound, nor without a sense of a dew falling upon him out of the sky.

*The True and the Beautiful in Nature, Art, Morals and Religion*  
Part VII, Duty and Delight (p. 402)  
Wiley & Halsted. New York, New York, USA. 1859

## EARTH FORCES

**Morton, Ron L.**  
No biographical data available

Deep in the earth, hundreds of miles from the madding crowd, great forces toil and struggle, making the music of the spheres. These forces drive Arthur Holmes' conveyor belts – hot magma rising, spreading laterally, and slowly cooling to sink back into the bowels of the earth to start the whole process over again. The rigid crust, our lithosphere – our towns, our houses, ourselves – dragged and pulled over the earth's surface from here to eternity.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*  
Chapter I (p. 29)  
Plenum Press. New York, New York, USA. 1996

## EARTH MUSIC

**Morton, Ron L.**  
No biographical data available

A distant morning, desolate and steamy (horns and oboes, low and melodic). Sunrise over an empty ocean. The earth stretches; it wiggles and breathes. Ocean floors begin to move and continents start to wander (woodwinds and trumpets have found their voices). Migrating continents and sliding oceans cause volcanic eruptions and earthquakes (hear the power of the pipe organ and the low, steady moan of the double basses). Volcanoes give birth to hot springs, geysers, and mineral waters (a lull for clarinets and flutes). These dynamics contribute to and help drive the earth's atmosphere, producing climatic change and ice ages (an interlude for French horns and cellos). This is earth music: earth rhythms from earth processes.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*  
Introduction (p. 2)  
Plenum Press. New York, New York, USA. 1996

## EARTH SCIENCE

**Carson, Rachel** 1907–64  
American marine biologist and author

There is one quality that characterizes all of us who deal with the sciences of the earth and its life – we are never bored.

In Linda Leer (ed.)  
*Lost Woods: The Discovered Writings of Rachel Carson*  
The Real World Around Us (p. 148)  
Beacon Press. Boston Massachusetts, USA. 1998

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

That which passes under the name earth-science is not all science in the strict sense of the term. Not a little consists of generalizations from incomplete data, of inferences hung on chains of uncertain logic, of interpretations not beyond question, of hypotheses not fully verified, and of speculation none too substantial.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 4  
The Methods of the Earth-Sciences (p. 477)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

A part of the mass [earth science] is true science, a part is philosophy, as I would use the term, a part is speculation, and a part is yet unorganized material. However, I like to think of the aggregate, not as an amorphous mixture of science, philosophy, and speculation, but as a rather definite aggregation of these, not wholly unlike that of the earth itself.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 4  
The Methods of the Earth-Sciences (p. 477)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**Wegener, Alfred** 1880–1930  
German climatologist and geophysicist

Scientists still do not appear to understand sufficiently that all earth sciences must contribute evidence toward unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combing all this evidence.... It is only by combing the information furnished by all the earth sciences that we can hope to determine 'truth' here, that is to say, to find the picture that sets out all the known facts in the best arrangement and that therefore has the highest degree of probability. Further, we have to be prepared always for the possibility that each new discovery, no matter what science furnishes it, may modify the conclusions we draw.

*The Origins of Continents and Oceans*

**EARTH, AGE OF**

**Holmes, Arthur** 1890–1965  
English geologist

It is perhaps a little indelicate to ask of our Mother Earth her age, but Science acknowledges no shame and from time to time has boldly attempted to wrest from her a secret which is proverbially well guarded.

*The Age of the Earth: An Introduction to Geological Ideas*  
Preface (p. ix)  
T. Fisher Unwin. London, England. 1905

There are few problems more fascinating than those that are bound up with the bold question: How old is the Earth? With insatiable curiosity men have been trying for thousands of years to penetrate the carefully guarded secret.

*The Age of the Earth: An Introduction to Geological Ideas*  
Chapter I (p. 5)  
T. Fisher Unwin. London, England. 1905

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The poor world is almost six thousand years old.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*As You Like It*  
Act IV, Scene i  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A great while ago the world began.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Twelfth Night*  
Act V, Scene i, l. 413  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**EARTH, CRUST OF**

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The crust of our earth is a great cemetery, where the rocks are tombstones on which the buried dead have written their own epitaphs. They tell us not only who they were and when and where they lived, but much also of the circumstances under which they lived.

*Geological Sketches*  
Chapter II (p. 31)  
Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Darwin, Charles Galton** 1809–82  
English naturalist

Daily it is forced home on the mind of the geologist, that nothing, not even the wind that blows, is so unstable as the crust of this earth.

Quoted in William Samuel Symonds  
*Old Stones*  
Chapter I (p. 7)  
Simpkin, Marshall & Co. London, England. 1884

**EARTH, DEATH OF**

**Cheever, George Barrell** 1802–71  
English naturalist and publisher

The crust of the earth tells not with more certainty how old it is, than its two hundred volcanoes, those vast safety valves, which prevent the foundations of the great central deep of fire from breaking up, and the crust from bursting, do tell, with the all surrounding inflammable atmosphere of our globe, that this planet is one day to be enveloped in a sea and sheet of fire arid flame.

In Robert Chambers  
*Vestiges of the Natural History of Creation* (2nd edition)  
Introduction (p. viii)  
Wiley & Putnam. New York, New York, USA. 1845

**Darwin, Charles Robert** 1809–82  
English naturalist

[Consider] the view now held by most physicists, namely, that the sun with all the planets will in time grow too cold for life, unless indeed some great body dashes into the sun, and thus gives it fresh life. Believing as I do that man in the distant future will be a far more perfect creature than he now is, it is an intolerable thought that he and all other sentient beings are doomed to complete annihilation after such long-continued slow progress.

*The Autobiography of Charles Darwin, 1809–1882: With Original Omissions Restored*  
Religious Beliefs (p. 92)  
Harcourt, Brace. New York, New York, USA. 1959

**EARTH, HISTORY OF**

**Barrell, Joseph** 1869–1919  
American geologist

The history of the earth is read in the rocks which have been thrust up by internal forces and beveled across by erosion. The nearer events are clearly recorded in the sequence and nature of the sedimentary rocks and their fossils.

In Joseph Barrell and Charles Schuchert  
*The Evolution of the Earth and Its Inhabitants*  
Introduction (p. 1)  
Yale University Press. New Haven, Connecticut, USA. 1919

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

Genius and science have burst the limits of space; and observations, explained by just reasoning, have unveiled the mechanism of the universe. “Would it not also be glorious for man to burst the limits of time, and, by means of observations, to ascertain the history of this world, and the succession of events which preceded the birth of the human race?”

*Essay on the Theory of the Earth* (5th edition)  
Preliminary Observations (p. 3)  
William Blackwood. Edinburgh, Scotland. 1827

It is my object, in the following work, to travel over ground which has as yet been little explored, and to make my reader acquainted with a species of Remains, which, though absolutely necessary for understanding the history of the globe, have been hitherto almost uniformly neglected.

*Essay on the Theory of the Earth*

Section 1 (p. 25)

Kirk & Mercein. New York, New York, USA. 1818

The ancient history of the globe, which is the ultimate object of all these researches, is also of itself one of the most curious subjects that can engage the attention of enlightened men; and if they take any interest in examining, in the infancy of our species, the almost obliterated traces of so many nations that have become extinct, they will doubtless take a similar interest in collecting, amidst the darkness which covers the infancy of the globe, the traces of those revolutions which took place anterior to the existence of all nations.

*Essay on the Theory of the Earth*

Section 1 (p. 27)

Kirk & Mercein. New York, New York, USA. 1818

We admire the power by which the human mind has measured the motions of globes which nature seemed to have concealed forever from our view: Genius and science have burst the limits of space, and a few observations, explained by just reasoning, have unveiled the mechanism of the universe. Would it not also be glorious for man to burst the limits of time, and, by a few observations, to ascertain the history of this world, and the series of events which preceded the birth of the human race?

*Essay on the Theory of the Earth*

Section 1 (p. 27)

Kirk & Mercein. New York, New York, USA. 1818

We now propose to examine those changes which still take place on our globe, investigating the causes which continue to operate on its surface.... This portion of the history of the earth is so much the more important, as it has been long considered possible to explain the more ancient revolutions on its surface by means of these still existing causes.... But we shall presently see that unfortunately this is not the case in physical history; the thread of operations is here broken, the march of nature is changed, and none of the agents that she now employs were sufficient for the production of her ancient works.

*Essay on the Theory of the Earth*

Section 8 (p. 44)

Kirk & Mercein. New York, New York, USA. 1818

## EARTH, MOBILITY OF

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

I began to consider the mobility of the Earth; and although the idea seemed absurd, yet because I knew that the liberty had been granted to others before me to postulate all sorts of little circles for explaining the phenomena of the stars, I thought I also might easily be permitted to try whether by postulating some motion of the Earth, more reliable conclusions could be reached regarding the revolution of the heavenly bodies, than those of my predecessors.

Translated by John Allen

*The Harvard Classics*

*Prefaces and Prologues to Famous Books*

Dedication of the *Revolutions of the Heavenly Bodies* (pp. 58–59)

P.F. Collier & Son. New York, New York, USA. 1909

## EARTH, MODEL OF

**Bullen, K. E.**

Seismologist

The nether regions of the Earth are inaccessible in the ordinary sense. Before the time of Newton, when evidence about them was nearly totally lacking, it was not necessarily unreasonable to describe the Earth in terms of models involving say a Hell, or a subterranean monster shaking itself to cause earthquakes. The subsequent growth of evidence has lowered the plausibility of such models.

*The Earth's Density* (p. 61)

## EARTH, ORIGIN OF

**Smart, W. M.**

To many it may seem presumptuous of anyone to attempt to unravel the mysteries surrounding the origin of the Earth and, in a wider sense, of the Universe itself; to others it may even seem irreverent that the great act of Creation should be regarded as a field for scientific speculation. In his pursuit of knowledge of the external world the scientist, however, is not held within precise limits of time, past or future; for example, the measure of progress in astronomy through the ages can be expressed, in some respects at least, in terms of the increasing capacity of man to see still further into the future and to peer still more deeply into the mists of the past.

*The Origin of the Earth*

Chapter I (p. 1)

Cambridge University Press. Cambridge, England. 1953

**EARTH, SYSTEM OF****Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

The system of this earth appears to comprehend many different operations; and it exhibits various powers co-operating for the production of those effects which we perceive. Of this we are informed by studying natural appearances; and in this manner we are led to understand the nature of things, in knowing causes.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter XIV (p. 540)

H.R. Engelmann &amp; Weldon &amp; Wesley. Weinheim, Germany. 1959

**EARTH, THEORY OF****Geikie, Sir Archibald** 1835–1924

English geologist

It was a long time before men came to understand that any true theory of the earth must rest upon evidence furnished by the globe itself, and that no such theory could properly be framed until a large body of evidence had been gathered together.

*The Founders of Geology* (2nd edition)

Chapter II (p. 66)

Macmillan &amp; Company Ltd. London, England. 1905

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

A theory is nothing but the generalization of particular facts; and, in a theory of the earth, those facts must be taken from the observations of natural history.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter III (p. 297)

H.R. Engelmann &amp; Weldon &amp; Wesley. Weinheim, Germany. 1959

**EARTHQUAKE****Addison, Joseph** 1672–1719

English essayist, poet, and statesman

I remember when (Britain) was shaken with an earthquake some years ago, there was an impudent mountebank who sold pills which (as he told the country people) were very good against an earthquake.

*The Works of the Right Honourable Joseph Addison, A New Edition, with Notes* (Volume 2)*The Tatler*

Number 243 (p. 418)

Printed for T. Cadell and W. Davies. London, England. 1811

**Ager, Derek Victor** 1923–98

Geologist

The [tectonic] history of anyone part of the earth, like the life of a soldier, consists of long periods of boredom and short periods of terror.

In Stephen Gould

*The Panda's Thumb: More Reflections in natural History*

Chapter 17 (p. 185)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1980

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

...like every other person, I knew of earthquakes by description. But what is description compared with the reality?

*Ornithological Biography* (Volume 1)

The Earthquake (p. 239)

Adam Black. Edinburgh, Scotland. 1831

**Author undetermined**

What powerful hand with force unknown,  
Can these repeated tremblings make?  
Or do the imprison'd vapours groan?  
Or do the shores with fabled Tridents shake?  
Ah no! the tread of impious feet,  
The conscious earth impatient bears;  
And shudd'ring with the guilty weight,  
One common grave for her bad race prepares.

In Bruce A Bolt

*Earthquakes: A Primer*

Chapter 4 (p. 53)

W. H. Freeman. San Francisco, California, USA. 1978

**Blount, Sir Thomas Pope** 1649–97

English author

Earthquakes are too evident Demonstrations of the Holowness of the Earth, being the dreadful Effects or Consequences of it; for if the Body of the Earth was sound and compact, there would be no such thing in Nature as an Earthquake.

*A Natural History*

Observations Concerning Earthquakes (p. 403)

Printed for R. Bentley. London, England. 1693

**Boscowitz, Arnold**

French writer

No evil is without its remedy, but against the earthquake there is no protection.

*Earthquakes*

Earthquakes (p. 5)

G. Routledge. London, England. 1890

Other calamities give some warning note: the volcano roars before its lava flood begins to flow; the waters of a river rise gradually before they overflow; the hurricane gathers and drives the black clouds in front of it before bursting in full fury upon us; but there is nothing to tell of the coming of an earthquake, neither in the heaven above, nor on the earth beneath, nor in the waters under the earth.

*Earthquakes*

The Forewarnings (p. 17)

G. Routledge &amp; Sons. London, England. 1890

Earthquakes are events simply fearful; there is nothing about them which is not appalling in its nature. They come without warning, and leave nothing but dismay and ruin behind. Even the minor shocks are terrible, and more alarming in proportion to the number of times they have been experienced. It is only in California that an attempt has been made to pooh-pooh an earthquake ...

*Earthquakes* (p. 34)

G. Routledge & Sons. London, England. 1890

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

When Poseidon shakes his finger, waves quiver through the rocks in all directions from the point of origin.

*Parade of the Living*

Part I, Chapter VIII (p. 95)

Coward-McCann, Inc. New York, New York, USA. 1930

**Cooper, James Fenimore** 1789–1851

American writer

...the earthquake had thrust upward a vast surface of the reef, completely altering the whole appearance of the shoal! In a word, nature had made another effort, and islands had been created, as it might be in the twinkling of an eye.

*The Crater*

Chapter XI (p. 174)

W.A. Townsend & Co. New York, New York, USA. 1861

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

Earthquakes traveling through the interior of the globe are like so many messengers sent out to explore a new land. The messages are constantly coming and seismologists are fast learning to read them.

*Our Mobile Earth*

Chapter I (p. 5)

Charles Scribner's Sons. New York, New York, USA. 1926

Our earth is very old, an old warrior that has lived through many battles. Nevertheless, the face of it is still changing, and science sees no certain limit of time for its stately evolution. Our solid earth, apparently so stable, inert, and finished, is changing, mobile, and still evolving. Its major quakings are largely the echoes of that divine far-off event, the building of our noble mountains. The lava floods and intriguing volcanoes tell us of the plasticity, mobility, of the deep interior of the globe. The slow coming and going of ancient shallow seas on the continental plateaus tell us of the rhythmic distortion of the deep interior-deep-seated flow and changes of volume. Mountain chains prove the earth's solid crust itself to be mobile in high degree. And the secret of it all – the secret of the earthquake, the secret of the 'temple of fire,' the secret of the ocean basin, the secret of the highland – is in the heart of the earth, forever invisible to human eyes.

*Our Mobile Earth*

Chapter VIII (p. 320)

Charles Scribner's Sons. New York, New York, USA. 1926

**Darwin, Charles Robert** 1809–82

English naturalist

A bad earthquake at once destroys the oldest associations: the earth, the very emblem of solidity, has moved beneath our feet like a thin crust over a fluid – one second of time has created in the mind a strange idea of insecurity, which hours of reflection would not have produced.

*The Voyage of The Beagle*

Chapter XIV (p. 302)

Heron Books. 1968

**de Quincey, Thomas** 1785–1859

English author

Some think that our planet is in that stage of her life which corresponds to the playful period of twelve or thirteen in a spirited girl. Such a girl, were it not that she is checked by a sweet natural sense of feminine reserve, you might call a romp; but not a hoyden, observe; no horse-play; oh no, nothing of that sort. And these people fancy that earthquakes, volcanoes, and all such little escapades, will be over, will "cease and determine," as soon as our Earth reaches the age of maidenly bashfulness. Poor thing! It's quite natural, you know, in a healthy growing girl. A little overflow of vivacity, a pirouette more or less, an earthquake plus or minus, what harm should that do to any of us!

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 169)

Adam & Charles Black. Edinburgh, Scotland. 1871

**Dyer, John** 1700?–58

Welsh poet

Disparting towers

Trembling all precipitate down dash'd,

Rattling around, loud thundering to the moon.

In Edward Thomas (ed.)

*The Poems of John Dyer*

The Ruins of Rome, l. 40

T.F. Unwin. London, England. 1903

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

We learn geology the morning after the earthquake, on ghastly diagrams of cloven mountains, upheaved plains, and the dry bed of the sea.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Considerations by the way (p. 1088)

The Library of America. New York, New York, USA. 1983

**Esar, Evan** 1899–1995

American humorist

[Earthquake] A topographical error.



*Esar's Comic Dictionary*

Earthquake

Doubleday. Garden City, New York, USA. 1983

**King, Ben** 1857–94

Poet

De eyarfquake a-shakin'

Jes' a short time ago

Was Belzabub a-pullin'

Out de clinkers down below.

*Ben King's Verse*

De Eyarfquake

Forbes & Company. Chicago, Illinois, USA. 1903

**Lucretius** ca. 99 BCE–55

Roman poet

...when the whole earth rocks under their feet and towns tumble with the shock or doubtfully threaten to fall, what wonder that mortal men abase themselves and make over to the gods in things here on earth high prerogatives and marvellous powers, sufficient to govern all things?

Translated by H.A.J. Munro

*T. Lucreti Cari de rerum natura libri sex*

Book V (p. 146)

George Bell & Sons. London, England. 1903

**Lyell, Sir Charles** 1797–1875

English geologist

...it must have appeared almost as improbable to the earlier geologists, that the laws of earthquakes should one day throw light on the origin of mountains, as it must to the first astronomers, that the fall of an apple should assist in explaining the motions of the moon.

*Principles of Geology* (Volume 3)

Chapter I (p. 5)

John Murray. London, England. 1830

**Lynch, John Joseph**

No biographical data available

Which would you rather have, a bursting planet or an earthquake here and there?

*New York Times*, 5 December, 1963

**Miller, Hugh** 1802–56

Scottish geologist and theologian

...day after day has there been a succession of earthquake shocks, that, as the plutonic paroxysm increases in intensity, become stronger and more frequent, and the mountain-waves roll outwards in ever-widening circles, to rise and fall in distant and solitary seas, or to break in long lines of foam on nameless islands unknown to the geographer.

*Sketch-book of Popular Geology*

Lecture Third (p. 109)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Miller, Jr., Walter M.** 1923–96

American science fiction writer

From the scourge of the earthquake,

*O Lord, deliver us.*

*A Canticle for Leibowitz*

Part I, Chapter 2

Bantam Books. New York, New York, USA. 1997

**Milne, Alan Alexander** 1882–1956

English poet, children's writer, and playwright

"It is snowing still," said Eeyore gloomily.

"So it is."

"And freezing."

"Is it?"

"Yes," said Eeyore. "However," he said, brightening up a little, "we haven't had an earthquake lately."

*The Complete Tales & Poems of Winnie-the-Pooh*

The House at Pooh Corner (p. 175)

Dutton Children's Books. New York, New York, USA. 2001

**Morton, Ron L.**

No biographical data available

Earthquakes are the brothers to volcanoes.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 3 (p. 78)

Plenum Press. New York, New York, USA. 1996

Earthquakes are movers and shakers and breakers; they are the CEOs of the planet.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 3 (p. 81)

Plenum Press. New York, New York, USA. 1996

**Muir, John** 1838–1914

American naturalist

...a low muffled underground rumbling and a slight rustling of the agitated trees, as if, in wrestling with the mountains, Nature were holding her breath.

*Our National Parks*

Chapter VIII (p. 262)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

It is always interesting to see people in dead earnest, from whatever cause, and earthquakes make everybody earnest.

*Our National Parks*

Chapter VIII (p. 264)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Riley, James Whitcomb** 1849–1916

American poet

Then – sudden – did the earth moan as it slept,

And start as one in evil dreams, and toss

Its peopled arms up, as the horror crept.



*The Complete Works of James Whitcomb Riley*, (Volume 5)  
The Earthquake  
P.F. Collier & Son Company. New York, New York, USA. 1916

I kin hump my back and take the rain,  
And I don't keer how she pours;  
I kin keep kind o'ca'm in a thunder-storm,  
No matter how loud she roars;  
I hain't much skeered o' the lightnin',  
Ner I hain't sich awful shakes  
Afeared o' *cyclones* – but I don't want none  
O' yer dad-burned old earthquakes!.

*The Complete Works of James Whitcomb Riley*, (Volume 5)  
A Fall-Crick View of the Earthquake  
P.F. Collier & Son Company. New York, New York, USA. 1916

### Schreiber, Hermann

No biographical data available

### Schreiber, Georg

No biographical data available

The earth bears us unwillingly upon her back. We carve into her in order to sink the foundations for our houses and now and again she shakes herself and with a brief shudder tumbles these houses about as if they were children's blocks.

Translated by Richard and Clara Winston

*Vanished Cities*

Part One (p. 3)

Alfred A. Knopf. New York, New York, USA. 1962

### Schwartz, David

No biographical data available

They aren't little puppies. They are big, biting dogs and they each get unleashed every few hundred years.

In Rick Gore

Living With California's Faults

*The National Geographic*, April, 1995 (p. 28)

### Shakespeare, William 1564–1616

English poet, playwright, and actor

Some say the Earth was feverous and did shake.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Macbeth*

Act II, Scene iii, l. 65

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Diseased nature oftentimes breaks forth  
In strange eruptions; oft the teeming earth  
Is with a kind of colic pinch'd and vex'd  
By the imprisoning of unruly wind  
Within her womb; which, for enlargement striving,  
Shakes the old beldame earth, and topples down  
Steeple and moss-grown towers.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The First Part of King Henry the Fourth*

Act III, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

DON PEDRO: Thou wilt quake for this shortly.

BENEDICT: I look for an earthquake then.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Much Ado About Nothing*

Act I, Scene ii

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Shaler, Nathaniel Southgate 1841–1906

American geologist

Human society is organized for a stable earth: its whole machinery supposes that while the other familiar elements of air and water are fluctuating and trustworthy, the earth affords a foundation which is firm. Now and then this implied compact with nature is broken, and the ground trembles beneath our feet. At such times we feel a painful sense of shipwrecked confidence: we learn how very precious to us was that trust in the earth which we gave without question. If the disturbance be of a momentary and unimportant kind, we may soon forget it, as we forget the rash word of a friend; if it be violent, we lose one of the substantial goods of life, our instinctive confidence in the earth beneath our feet.

*Aspects of the Earth: A Popular Account of Some Familiar Geological Phenomena*

The Stability of the Earth (pp. 1–2)

Charles Scribner's Sons. New York, New York, USA. 1889

### Shelley, Percy Bysshe 1792–1822

English poet

With hue like that when some great painter dips  
His pencil in the gloom of earthquake and eclipse.

*The Complete Poetical Works of Percy Bysshe Shelley*

Revolt of Islam Canto V, Stanza 23

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### Silone, Ignazio 1900–78

Italian novelist and journalist

An earthquake achieves what the law promises but does not in practice maintain – the equality of all men.

In Richard H S Crossman (ed.)

*The God That Failed*

Part I, Ignazio Silone (p. 92)

Harper & Brothers, New York, New York, USA. 1949

### Stillman, J. D. B.

American physician

There is something so mysterious in the nature and origin of that physical force that convulses the earth, and in a few moments buries thousands of human beings amidst the ruins of their proudest fabrics, that the slightest display of its power appalls the stoutest heart. In vain we invoke philosophy to our aid: reason accepts the postulate that “what has been may be again,” and the earthquake is a matter of fact after which philosophy gropes in obscurity, unable to say to the mighty commotion, “Thus far shall thou go, but no farther, and here shall thy proud waves be stayed.”

Concerning the Late Earthquake

*The Overland Monthly*, Volume 1, November, 1868 (p. 475)

**Stukeley, William** 1687–1765  
English antiquary

When so great and unusual a phenomenon, as an earthquake, and that repeated, happens among us; it will naturally excite a serious reflexion in everyone that is capable of thinking.

*The Philosophy of Earthquakes, Natural and Religious*  
To Martin Folkes (p. 5)  
C. Corbet. London, England. 1750

**Tennyson, Alfred (Lord)** 1809–92  
English poet

And all the fragments of the living rock (Huge blocks, which some old trembling of the world Had loosen'd from the mountain, till they fell Half-digging their own graves).

*The Works of Alfred Lord Tennyson, Poet Laureate*  
The Lover's Tale (p. 480)  
The Macmillan Co. New York, New York, USA. 1898

### The Bible (King James Version)

Thou hast made the earth to tremble; thou hast broken it: heal the breaches thereof; for it shaketh. Thou hast shewed thy people hard things: thou hast made us to drink the wine of astonishment.

Psalms 60:2–3

The mountains skipped like rams, and the little hills like lambs.

Psalms 114:4

And, behold, the veil of the temple was rent in twain from the top to the bottom; and the earth did quake, and the rocks rent;...

Matthew 27:51

... after the wind an earthquake; but the LORD was not in the earthquake:...

1 Kings 19:11

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

I will set it down here as a maxim that the operations of the human intellect are much accelerated by an earthquake. Usually I do not think rapidly – but I did upon this occasion. I thought rapidly, vividly, and distinctly. With the first shock of the five, I thought – “I recognize that motion – this is an earthquake.” With the second, I thought, “What a luxury this will be for the morning papers.” With the third shock, I thought, “Well my boy, you had better be getting out of this.” Each of these thoughts was only the hundredth part of a second in passing through my mind. There is no incentive to rapid reasoning like an earthquake. I then sidled out toward the middle of the street – and I may say that I sidled out with some degree of activity, too. There is nothing

like an earthquake to hurry a man when he starts to go anywhere.

The Great Earthquake in San Francisco  
*New York Weekly Review*, 11/25/1865

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

The deep and peculiar impression left on the mind by the first earthquake which we experience... is not, in my opinion, the result of a recollection of those fearful pictures of devastation presented to our imaginations by the historical narratives of the past, but is rather due to the sudden revelation of the delusive nature of the inherent faith by which we had clung to a belief in the immobility of the solid parts of the earth.

Translated by E.C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1) (p. 215)  
D. Appleton & Co. New York, New York, USA. 1850

We may flee from the crater of a volcano in active eruption, or from the dwelling whose destruction is threatened by the approach of the lava stream; but in an earthquake, direct our flight whithersoever we will, we still feel as if we trod upon the very focus of destruction.

Translated by E.C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1) (p. 215)  
D. Appleton & Co. New York, New York, USA. 1850

**Wordsworth, William** 1770–1850  
English poet

All things have second birth;  
The earthquake is not satisfied at once.

*The Complete Poetical Works of William Wordsworth*  
Resolution and Independence  
Crowell. New York, New York, USA. 1888

## EARTHQUAKE PREDICTION

**Richter, Charles** 1900–1985  
American seismologist

Since my first attachment to seismology, I have had a horror of [earthquake] predictions and predictors. Journalists and the general public rush to any suggestion of earthquake prediction like hogs toward a full trough.

Acceptance of the Medal of the Seismological Society of America  
*Bulletin of the Seismological Society of America*, Volume 67 1977

## ECHO

**Smith, Horace**

No biographical data available

ECHO – the shadow of a sound – a voice without a mouth, and words without a tongue.

*The Tin Trumpet: Or, Heads and Tales, For the Wise and Waggish*  
Echo (p. 137)  
Bradbury, Evans, & Co. London, England. 1869

## ECLIPSE

**Airy, Sir George Biddell** 1801–92

English mathematician and astronomer, Astronomer Royal from 1835 to 1881

...the general phenomenon [total eclipse] is perhaps the most awfully grand which man can witness.

On the Total Eclipse of 1851

*Edinburgh New Philosophical Journal*, Volume 51 April, 1851 (p. 76)

...during a total eclipse we are permitted a hasty glance at some of the secrets of nature which cannot be seen on any other occasion.

On the Total Solar Eclipse of 1851

*The Edinburgh New Philosophical Journal*, Volume 51 August, 1851 (p. 76)

[People] might suppose that a total eclipse is merely an intensified form of a partial eclipse; but, having himself witnessed a total eclipse, he was able to assure them that no degree of partial eclipse up to the last moment of the sun's appearance gave the least idea of a total eclipse, as regarded either the generally terrific appearances, or the singular nature of some of the phenomena.

On the Total Solar Eclipse of 1851

*The Edinburgh New Philosophical Journal*, Volume 51 August, 1851 (pp. 76–77)

**Archilochus** 710 BCE–676 BCE

Greek mercenary

Nothing can be surprising anymore or impossible or miraculous, now that Zeus, father of the Olympians has made night out of noonday, hiding the bright sunlight, and...fear has come upon mankind. After this, men can believe anything, expect anything. Don't any of you be surprised in future if land beasts change places with dolphins and go to live in their salty pastures, and get to like the sounding waves of the sea more than the land, while the dolphins prefer the mountains.

In F. Richard Stephenson

*Historical Eclipses and Earth's Rotation*

Chapter 10 (p. 338)

Cambridge University Press. Cambridge, England. 1997

Zeus, the father of the Olympic Gods, turned mid-day into night, hiding the light of the dazzling Sun; and sore fear came upon men.

Quoted in George Frederick Chambers

*The Story of Eclipses*

Chapter X (p. 93)

S.S. McClure Co. New York, New York, USA. 1909

### Author undetermined

The sky is an immense place where everything moves in its own way. Some go faster than others, some turn around themselves while they are going around the sun and each other. Sometimes the fast ones catch up with the slow ones and that is an eclipse. Also, when the moon

gets in the way we can't see the sun, and that is an eclipse too and everybody talks about it.

That is an important eclipse.

Reported by little girl who visited the Hayden Planetarium

*The Sky*, Volume 3–4, December, 1939 (p. 25)

Working like a carefully rehearsed team, the sun and moon teamed up yesterday to put on a dramatic celestial show, the plot calling for the moon to cast its shadow over the sun to create a eclipse.

Et Cetra

*The Physics Teacher*, Volume 18, Number 1, January, 1980 (p. 79)

### Baily, Francis

No biographical data available

...there was at the same time something in its singular and wonderful appearance that was appalling and I can readily imagine that uncivilised nations may occasionally have become alarmed and terrified at such an object.

Some Remarks on the Total Eclipse of the Sun on July 8th, 1842

*Memoirs of the Royal Astronomical Society*, Volume 15, 1845 (p. 6)

### Caithness, James Balharrie

No biographical data available

I watched the shadow of our globe  
Pass sheer across the moon,  
She sadly donned the somber robe,  
But glad emerging, soon  
Cast all its dismal folds aside,  
Bright through the heavens again to ride.

*Pastime Poems*

An Eclipse of the Moon (Second Version)

E. Macdonald. London, England. 1924

### Chinese ode

For the moon to be eclipsed  
Is but an ordinary matter.  
Now that the sun had been eclipsed  
How bad it is!

In Bertrand Russell

*The ABC of Relativity*

Chapter IV (p. 35)

George Allen & Unwin Ltd. London, England. 1958

### Dillard, Annie

1945–

American poet, essayist, novelist, and writing teacher

Seeing a partial eclipse bears the same relation to seeing a total eclipse as kissing a man does to marrying him, or as flying in an airplane does to falling out of an airplane.

*Teaching a Stone to Talk: Expeditions and Encounters*

Total Eclipse (p. 89)

Harper & Row, Publishers. New York, New York, USA. 1982

### Donne, John

1572–1631

English poet and divine

How great love is, presence best try all makes,  
But absence tryes how long this love will bee;

To take a latitude,  
Sun, or starres, are fitliest view'd  
At their brightest, but to conclude  
Of Longitudes, what other way have wee,  
But to marke when, and where the darke  
eclipses bee?

In Eric Rogers

*Astronomy for the Inquiring Mind*

Chapter 2 Facts and Early Progress (p. 33)

Princeton University Press. Princeton, New Jersey, USA. 1982

**Flammarion, Camille** 1842–1925

French astronomer and author

Eclipses, like comets, have always been interpreted as the indication of inevitable calamities. Human vanity sees the finger of God making signs to us on the least pretext, as if we were the end and aim of universal creation.

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter IX (p. 180)

Chatto & Windus. London, England. 1894

**Hardy, Thomas** 1840–1928

English poet and regional novelist

Thy shadow, Earth, from Pole to Central Sea,  
Now steals along upon the Moon's meek shine  
In even monochrome and curving line  
Of imperturbable serenity.

*The Works of Thomas Hardy in Prose and Verse*

At a Lunar Eclipse

Macmillan and Co. London, England. 1912

**Joslin, Rebecca R.**

No biographical data available

Now eclipses are elusive and provoking things...visiting the same locality only once in centuries. Consequently, it will not do so to sit down quietly at home and wait for one to come, but a person must be up and doing and on the chase.

*Chasing Eclipses: The Total Solar Eclipses of 1905, 1914, 1925* (pp. 1–2)

Walton Advertising & Printing. Boston, Massachusetts, USA. 1929

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

There is nothing in Astronomy which shews the great Sagacity of Human Understanding, and its deep Penetration, more than a clear Explication of the Suddain Disappearings of the Sun and the Moon, that is, of their Eclipses; and the accurate Predictions when they are to come to pass, which the Astronomers can now foretell almost to a Minute.

*An Introduction to the True Astronomy*

Lecture XI (p. 109)

Printed for Bernard Lintot. London, England. 1721

**Millay, Edna St. Vincent** 1892–1950

Poet and playwright

Cold of the sun's eclipse

When cocks crow for the first time hapless, and dogs in  
kennel howl

Abandoning the richly-stinking bone,

And the star at the edge of the shamed and altered sun  
shivers alone,

And over the pond the bat but not the swallow dips

And out comes the owl.

*Collected Poems*

No Earthly Enterprise

Harper. New York, New York, USA. 1956

**Pasachoff, Jay M.** 1943–

American astronomer

Some people see a partial eclipse and wonder why others talk so much about a total eclipse. Seeing a partial eclipse and saying that you have seen an eclipse is like standing outside an opera house and saying that you have seen the opera; in both cases, you have missed the main event.

In Donald H. Menzel and Jay M. Pasachoff

*A Field Guide to the Stars and Planets* (2nd edition, revised and enlarged.) (p. 409)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1983

**Pasachoff, Jay M.** 1943–

American astronomer

**Menzel, Donald Howard** 1901–76

American astronomer

Seeing a partial eclipse and saying that you have seen an eclipse is like standing outside an opera house and saying that you have seen the opera; in both cases you have missed the main event.

*A Field Guide to the Stars and Planets* (3rd edition)

Chapter 14 (p. 430)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1992

**Pindar, Paean IX**

No biographical data available

Beam of the Sun!

What wilt thou be about, far-seeing one,

O mother of mine eyes, O star supreme,

In time of day

Reft from us? Why, O why has thou perplexed

The might of man,

And wisdom's way,

Rushing forth on a darksome track?

In Cecilia Payne-Gaposchkin

*Introduction to Astronomy*

Chapter VI (p. 134)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**Plato** 428 BCE–347 BCE

Greek philosopher

...people may injure their bodily eye by observing and gazing on the sun during an eclipse, unless they take the precaution of only looking at the image reflected in the water, or in some similar medium.

In *Great Books of the Western World* (Volume 7)  
*Phaedo*  
 Section 99 (p. 242)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pliny (C. Plinius Secundus)** 23–79  
 Roman savant and author

The Eclipse of the Moon and Sun is a Thing throughout the universal Contemplation of Nature most marvellous, and resembling a Prodigy, and shews the Magnitude and Shadow of these two Planets. For it is evident that the Sun is hidden by the Intervention of the Moon; and the Moon again by the Opposition of the Earth ...

*Pliny's Natural History. In Thirty-seven Books*  
 Book II, Chapter X (p. 44)  
 Printed for the Club by G. Barclay. London, England. 1847–1849

**Poincaré, Jules Henri** 1854–1912  
 French mathematician and theoretical astronomer

Why do the rains, the tempests themselves seem to us to come by chance, so that many persons find it quite natural to pray for rain or shine, when they would think it ridiculous to pray for an eclipse?

*The Foundations of Science*  
*Science and Method*, Book I  
 Chapter IV, Section II (p. 398)  
 The Science Press. New York, New York, USA. 1913

**Serviss, Garrett Putman** 1851–1921  
 American science fiction writer

The calculation of an eclipse owes all its prestige to the sublimity of its data; the operation, in itself, requires no more mental effort than the preparation of a railway time-table.

*Curiosities of the Sky*  
 Preface (p. xv)  
 Harper & Brothers Publishers. New York, New York, USA. 1909

**Tennyson, Alfred (Lord)** 1809–92  
 English poet

As when the sun, a crescent of eclipse, Dreams over lake and lawn, and isles and capes.

*The Works of Alfred Lord Tennyson, Poet Laureate*  
 The Vision of Sin (p. 117)  
 The Macmillan Co. New York, New York, USA. 1898

### The Bible (King James Version)

And it shall come to pass in that day, saith the Lord GOD, that I will cause the sun to go down at noon, and I will darken the earth in the clear day: ...  
 Amos 8:9

And I will shew wonders in the heavens and in the earth, blood, and fire, and pillars of smoke. The sun shall be turned into darkness, and the moon into blood, before the great and the terrible day of the LORD come.  
 Joel 2:30–31

**Todd, Mabel Loomis** 1856–1932  
 American writer

...it often seems that celestial happenings [eclipse of the sun or moon] deign to be seen only from the most inaccessible parts of our globe.

*Total Eclipses of the Sun*  
 Robert Brothers. Boston, Massachusetts, USA. 1844

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
 American author and humorist

There was no response, for a moment, in that deep darkness and that graveyard hush. But when the silver rim of the sun pushed itself out a moment or two later, the assemblage broke loose with a vast shout and came pouring down like a deluge to smother me with blessings and gratitude ...

*A Connecticut Yankee in King Arthur's Court*  
 Chapter VI (p. 50)  
 Harper & Brothers Publishers. New York, New York, USA. 1917

**Wordsworth, William** 1770–1850  
 English poet

High on her speculative tower  
 Stood Science waiting for the hour  
 When Sol was destined to endure  
 That darkening of his radiant face  
 Which Superstition strove to chase,  
 Erewhile, with rites impure.

*The Complete Poetical Works of William Wordsworth*  
 The Eclipse of the Sun  
 Crowell. New York, New York, USA. 1888

**Zirker, Jack B.**  
 Astronomer

I look up. Incredible! It is the eye of God. A perfectly black disk, ringed with bright spiky streamers that stretch out in all directions.

*Total Eclipses of the Sun* (p. vi)  
 van Nostrand Reinhold. New York, New York, USA. 1984

## ECOLOGIST

**Adams, Charles C.** 1873–1955  
 American ecologist

Ecology has no aim, but ecologists have. The problems of the ecologist are not fundamentally different from those of any other kind of naturalist. The superficial differences in aim are due to the different points of views, or methods of approach, rather than to any essential difference in the character of the problem.

*Guide to the Study of Animal Ecology*  
 Chapter I (p. 1)  
 The Macmillan Company. New York, New York, USA. 1913



**Wilson, Edward O.** 1929–  
American biologist and author

Ecologists, like the organisms they study, cannot make nature conform to their perfect liking.

*The Diversity of Life*  
Chapter Nine (p. 165)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

## ECOLOGY

**Allaby, (John) Michael** 1933–  
Freelance science writer

Ecology is rather like sex – every new generation likes to think they were the first to discover it.

*The Times (London)*, 6 October, 1989

**Berry, Richard James Arthur** 1867–1962  
English anatomist

**Bradshaw, A. D.**  
No biographical data available

Ecology lacks an agreed theoretical core and is therefore easily destabilized and subject to intellectual fashion.

In R.J. Berry, T.J. Crawford and G.M. Hewitt (eds.)  
*Genes in Ecology*  
Genes in the Real World (p. 431)  
Blackwell Scientific Publications. Oxford, England. 1992

Ecology and genetics have always been uneasy bedfellows, despite their intrinsic complementarity; genetics is about what exists, ecology is about how it exists.

In R.J. Berry, T.J. Crawford and G.M. Hewitt (eds.)  
*Genes in Ecology*  
Genes in the Real World (p. 431)  
Blackwell Scientific Publications. Oxford, England. 1992

**Borland, Hal** 1900–78  
American writer

The pond and the wetlands are a world unto themselves. The adventurer there, be he novice or veteran, will be aware of ancient beginnings and insistent change. There he will see those subtle interrelationships of life which the specialist calls ecology.

*Beyond Your Doorstep: A Handbook to the Country*  
Chapter 5 (p. 103)  
Alfred A. Knopf. New York, New York, USA. 1962

**Colinvaux, Paul A.**  
No biographical data available

Ecology is a pleasant science. Those who follow it pass their time in trying to understand functions of the natural world, which are as mystifying as anything in physics but which also appeal to the animal cravings in humans. An ecologist can savor the life of a naturalist while using the methods of chemistry or the philosophy of mathematics.

*Introduction to Ecology*  
Preface (p. v)  
John Wiley & Sons, Inc. New York, New York, USA. 1973

**Elton, Charles S.** 1900–91  
English biologist

At a time when ecology and genetics are each racing swiftly towards one new concept after another, yet with little contact of thought between the two subjects, there may be some advantage in surveying, if only synoptically and in preliminary fashion, the largely uncharted territory between them.

In G.R. de Beer (ed.)  
*Evolution: Essays on Aspects of Evolutionary Biology Presented to Professor E.S. Goodrich on his Seventieth Birthday*  
Animal Numbers and Adaptation (p. 127)  
Clarendon Press. Oxford, England. 1938

...there is more ecology in the Old Testament or the plays of Shakespeare than in most of the zoological textbooks ever printed.

*Animal Ecology*  
Chapter II (p. 7)  
Sidgwick & Jackson, Ltd. London, England. 1927

**Foreman, Dave** 1947–  
American environmentalist

But, damn it, I am an animal. A living being of flesh and blood, storm and fury. The oceans of the Earth course through my veins, the winds of the sky fill my lungs, the very bedrock of the planet makes my bones. I am alive! I am not a machine, a mindless automaton, a cog in the industrial world, some New Age android. When a chain saw slices into the heartwood of a two-thousand-year-old Coast Redwood, it's slicing into my guts. When a bulldozer rips through the Amazon rain forest, it's ripping into my side. When a Japanese whaler fires an exploding harpoon into a great whale, my heart is blown to smithereens. I am the land, the land is me.

*Confessions of an Eco-Warrior*  
Chapter 1 (pp. 4–5)  
Harmony Books. New York, New York, USA. 1991

**Haber, Wolfgang** 1925  
German biologist

Scientific ecology works along a very great number of different lines – perhaps a typical feature of this discipline. In ecological research each element of these different approaches to work and the of the varied opinions formed about them plays its part.

*Universitas: A Quarterly German Review of the Arts and Sciences*,  
Volume 26, Number 2, 1984 (p. 88)

**Haeckel, Ernst Heinrich Philipp August** 1834–1919  
German biologist and philosopher

[Ecology is] the science of relations between organisms and their environment.

In Anna Bramwell  
*Ecology in the 20th Century: A History*  
Chapter 3 (p. 40)  
Yale University Press. New Haven, Connecticut, USA. 1989



**Herbert, Frank** 1920–86

American science fiction writer

The thing the ecologically illiterate don't realize about an ecosystem... is that it's a system. A System! A system maintains a certain fluid stability that can be destroyed by a misstep in just one niche. A system has order, a flowing from point to point. If something dams that flow, order collapses. The untrained might miss that collapse until it was too late. That's why the highest function of ecology is the understanding of consequences.

Enveloped in absolute mystery,

And without extra charge

I will give you at large

A Lesson in Natural History.

*Dune*

Appendix I (p. 402)

Chilton Book Company. Radnor, Pennsylvania, USA. 1965

**Kühnert, Franz** 1852–1918

No biographical data available

The protection of an animal or of a plant will be ineffectual so long as we do not also preserve that organism's conditions of life.

In Philippe Diolé

Translated by J.F. Bernard

*The Errant Ark: Man's Relationship with Animals*

Chapter Three (p. 69)

G.P. Putnam's Sons. New York, New York, USA. 1974

**Osborn, Fairfield** 1887–1969

American conservationist

There is no risk in making the flat statement that in a world devoid of other living creatures, man himself would die. This fact – call it a theory if you will – is far more provable than the accepted theory of relativity. Involved in it is, in truth, another kind of principle of relativity – the relatedness of all living things.

*Our Plundered Planet* (p. 60)

Grosset & Dunlap, Publishers. New York, New York, USA. 1951

**Richards, Herbert Maul** 1871–1928

No biographical data available

Ecology is the endeavor to uncover the plan of nature as it governs the relations of the different plant forms in a given area, to understand the why and the wherefore of the association of very different forms in one locality.

*Lectures on Science, Philosophy and Art, 1907–1908*

Botany (p. 15)

The Columbia University Press. New York, New York, USA. 1908

**Sontag, Susan** 1933–2004

American critic and writer

Guns have metamorphosed into cameras in this earnest comedy, the ecology safari, because nature has ceased to be what it had always been – what people needed protection from. Now nature – tamed, endangered, mortal – needs to

be protected from people. When we are afraid, we shoot. But when we are nostalgic, we take pictures.

*On Photography*

In *Plato's Cave* (p. 15)

Farrar, Straus & Giroux. New York, New York, USA. 1973

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

We travel together, passengers on a little space ship, dependent upon its vulnerable reserves of air and soil, committed for our safety to its security and peace, preserved from annihilation only by the care, the work, and, I will say, the love we give our fragile craft. We cannot maintain it half fortunate, half miserable, half confident, half despairing, half slave to the ancient enemies of mankind, half free in a liberation of resources undreamed of until this day. No craft, no crew, can travel safely with such vast contradictions. On their resolution depends the survival of us all.

Speech

United Nations Economic and Social Council, Geneva, Switzerland,

July 9, 1965

**Tansley, A. G.** 1917–

English ecologist

Every genuine worker in science is an explorer, who is continually meeting fresh things and fresh situations, to which he has to adapt his material and mental equipment. This is conspicuously true of our subject, and is one of the greatest attractions of ecology to the student who is at once eager, imaginative, and determined. To the lover of prescribed routine methods with the certainty of "safe" results the study of ecology is not to be recommended.

*Practical Plant Ecology: A Guide for Beginners in Field Studies of Plant Communities* (p. 97)

George Allen & Unwin Ltd. London, England. 1923

**Ward, Barbara** 1914–81

English author and educator

We cannot cheat on DNA. We cannot get round photosynthesis. We cannot say I am not going to give a damn about phytoplankton. All these tiny mechanisms provide the preconditions of our planetary life. To say we do not care is to say in the most literal sense that "we choose death."

In Maurice F. Strong (ed.)

*Who Speaks For Earth?*

Speech for Stockholm (p. 31)

W.W. Norton & Company, Inc. New York, New York, USA. 1973

**Wiener, Norbert** 1894–1964

American mathematician

For the more we get out of the world the less we leave, and in the long run we shall have to pay our debts at a time that may be very inconvenient for our survival.

*The Human Use of Human Beings*

Chapter II (p. 46)

Da Capo Press. New York, New York, USA. 1988

**Wilson, Edward O.** 1929–  
American biologist and author

A civilization able to envision God and to embark on the colonization of space will surely find the way to save the integrity of this planet and the magnificent life it harbors.

*The Future of Life*

Chapter 7 (p. 189)

Alfred A. Knopf. New York, New York, USA. 2002

## ECONOMIST

**Marshall, Alfred** 1842–1924  
English economist

Greedy then as the economist must be for facts, he must not be content with mere facts. Boundless as must be his gratitude to the great thinkers of the historic school, he must be suspicious of any direct light that the past is said to throw on the problems of the present.

In A.C. Pigou (ed.)

*Memorials of Alfred Marshall*

Chapter VI (p. 171)

Macmillan & Company, Limited. London, England. 1925

## ECOSYSTEM

**Haber, Wolfgang** 1925  
German biologist

Ecosystems are thus phenotypic and functional images of our environment and are divided up and delimited in different ways. New concepts such as agricultural ecosystems, urban ecosystems, etc. are now coming to be accepted. Together with natural, nearly natural and semi-natural ecosystems they provide the pattern which makes up a landscape.

*Universitas: A Quarterly German Review of the Arts and Sciences*,  
Volume 26, Number 2, 1984 (p. 88)

It is not enough to transfer the concept of the agricultural ecosystem to agricultural science and then to believe that justice has been done to ecological interests. We must at the same time go a step further and examine the role of the agricultural ecosystem in the cultivated landscape.

*Universitas: A Quarterly German Review of the Arts and Sciences*,  
Volume 26, Number 2, 1984 (p. 88)

All environmental areas, from the primeval forest to the large city, can be regarded as ecosystems and investigated accordingly, most of the attention being given to the lasting existence and functioning or 'equilibrium' of these systems.

*Universitas: A Quarterly German Review of the Arts and Sciences*,  
Volume 26, Number 2, 1984 (p. 88)

**Margalef, Ramón** 1919–2004  
Spanish ecologist

Evolution cannot be understood except in the frame of ecosystems.

*Perspectives in Ecological Theory*

Lecture 4 (p. 81)

The University of Chicago Press. Chicago, Illinois, USA. 1968

## EDIFICE

**Frege, Friedrich Ludwig Gottlob** 1848–1925  
German logician

Hardly anything more unfortunate can befall a scientific writer than to have one of the foundations of his edifice shaken after the work is finished.

In Peter Geach and Max Black

*Translations from the Philosophical Writings of Gottlob Frege*

Frege on Russell's Paradox (p. 214)

Basil Blackwell. Oxford, England. 1952

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Great edifices, like great mountains, are the work of ages.

*The Hunchback of Notre-Dame* (Volume 1)

Book III, Chapter I (p. 99)

Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1834

## EDUCATION

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

What Sculpture is to a Block of Marble, Education is to an Human Soul.

*The Spectator*

Number 215 (p. 173)

J.M. Dent & Co. London, England. 1847

**Aeschines** 389 BCE–314 BCE  
Greek statesman

For you are well aware that it is not only by bodily exercises, by educational institutions, or by lessons in music, that our youth are trained, but much more effectually by public examples.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 3)

Edward Howell. Liverpool, England. 1864

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The physical suffering of humanity, the wants of the poor, the craving of the hungry and naked, appeal to the sympathy of everyone who has a human heart. But there

are necessities which only the destitute student knows; there is a hunger and thirst which only the highest charity can understand and relieve, and on this solemn occasion let me say that every dollar given for higher education in whatever department of knowledge is likely to have a greater influence on the future character of our nation than even the thousands and hundred thousands and millions which we have already spent and are spending to raise the many to material ease and comfort.

*Address Delivered on the Centennial Anniversary of the Birth of Alexander von Humboldt* (p. 57)

Boston Society of Natural History. Boston, Massachusetts, USA. 1869

**Bailey, Liberty Hyde** 1858–1954

American horticulturist and botanist

Education should train persons to live, rather than to be scientists.

*Botany: An Elementary Text for Schools* (4th edition)

Paragraphs for the Teacher (p. vi)

The Macmillan Co. New York, New York, USA. 1901

The kernel of modern educational development is to relate the school-training to the daily life. Much of our education is not connected with the conditions in which the pupils live and is extraneous to the lives that they must lead.

*Cornell Nature-study Leaflets*

Leaflet III (p. 31)

J.B. Lyon Co. Albany, New York, USA. 1904

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

EDUCATION: *n.* That which discloses to the wise and disguises from the foolish their lack of understanding.

*The Collected Works of Ambrose Bierce* (Volume 7)

The Devil's Dictionary

The Neale Publishing Co. New York, New York, USA. 1911

**Bridgman, Percy Williams** 1882–1961

American physicist

I for one am not willing to admit that a man has been liberally educated for a free society who has not learned to view instinctively the doings of men against the background of the potentialities of the future rather than of the incoherencies of the past.

*Reflections of a Physicist*

Chapter 32 (p. 568)

Philosophical Library. New York, New York, USA. 1950

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

O ye! who teach the ingenious youth of nations,  
Holland, France, England, Germany, or Spain,

I pray ye flog them upon all occasions,

It mends their morals, never mind the pain.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 2

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Campbell, Norman R.** 1880–1948

English physicist and philosopher

If scientific education today is unsuited for those who are to make science their life work, it is even less suited for those to whom it is merely to be part of a general education. Men of science complain of the lack of a wide appreciation of scientific knowledge; what else can they expect if they offer to the world only the dry bones of knowledge from which the breath has departed? Nothing could be better adapted than the ordinary school course, with its tedious insistence on bare and uninspiring fact, to kill any rising enthusiasm. It is most important certainly, to impress the student with the nature of scientific truth and with the possibility of definite, positive knowledge concerning the material world.... But to insist on the truth of science and to neglect its meaning is to aggravate the evil which we seek to cure....

*Physics: The Elements*

Chapter VIII (p. 226)

At The University Press. Cambridge, England. 1920

**Coleridge, Stephen** 1854–1936

English author, barrister, and opponent of vivisection

...when I speak of a scientific education I mean an education that of necessity is confined to an acquisition only of those branches of knowledge comprised in the immutable laws that are implicit in matter organic or inorganic, and in the human conceptions of number, space, dimension, motion and force.

*The Idolatry of Science*

Chapter II (p. 5)

John Lane Co. London, England. 1920

The dominant object of a truly noble education is to make man magnanimous, and brave, and loyal, and truthful, and unselfish and merciful, and in all things to look up instead of down.

*The Idolatry of Science*

Chapter II (p. 7)

John Lane Co. London, England. 1920

**Conklin, Edwin Grant** 1863–1952

American zoologist

Education is habit-forming rather than information; illumination rather than indoctrination, inspiration rather than compulsion.

Science in the World Crisis

*The American Biology Teacher*, Volume 1, Number 8, May, 1939 (p. 206)

**Cooke, Josiah Parsons** 1827–94

American chemist

...in following out our theories of education, we avoid Scylla only to encounter Charybdis, and so, in specializing our courses of laboratory instruction, there is great danger of falling into the mechanical routine of a technical art, and losing sight of those grand ideas and

generalizations which give breadth and dignity to scientific knowledge.

*Scientific Culture: And Other Essays* (2nd edition)

Preface (pp. vi–vii)

D. Appleton & Co. New York, New York, USA. 1855

### Deller, Jr., J. R.

No biographical data available

Education is the process of telling smaller and smaller lies.

Tom, Dick, and Mary Discover the DFT

*IEEE Signal Processing Magazine*, April, 1994 (p. 36)

### Dewey, John 1859–1952

American philosopher and educator

When our schools truly become laboratories of knowledge-making, not mills fitted out with information-hoppers, there will no longer be need to discuss the place of science in education.

Science as Subject-Matter and as Method

*Science*, N.S. Volume 31, Number 787, January 28, 1910 (p. 127)

### Doyle, Sir Arthur Conan 1859–1930

Scottish writer

Education never ends, Watson. It is a series of lessons with the greatest for the last.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of the Red Circle* (p. 697)

Wings Books. New York, New York, USA. 1967

### Gull, Sir William Withey 1816–90

English physician

When one undertakes to show the way, he should know something of the path.

*A Collection of the Published Writings of William Withey Gull* (Volume 2)

*Notes and Aphorisms* (p. lix)

The New Sydenham Society. London, England. 1896

### Humphrey, Heman

No biographical data available

In every system of education, two things should be kept steadily in view – first, that the mind is to be gradually expanded and strengthened into vigorous manhood, by the proper exercise of its faculties; and secondly, that it is to be enriched and embellished with various knowledge.

*Miscellaneous Discourses and Reviews*

Inaugural Discourse (p. 232)

J.S. & C. Adams. Amherst, Massachusetts, USA. 1834

### Huxley, Thomas Henry 1825–95

English biologist

The great benefit which a scientific education bestows, whether as training or as knowledge, is dependent upon the extent to which the mind of the student is brought into immediate contact with the facts – upon the degree to which he learns the habit of appealing directly to Nature.

*Collected Essays* (Volume 8)

*A Lobster; or, The Study of Zoology* (p. 219)

Macmillan & Company Limited. London, England. 1904

That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself.

*Collected Essays* (Volume 3)

*Science and Education*

*A Liberal Education; and Where to Find It* (p. 86)

Macmillan & Company Limited. London, England. 1904

I am the last person to question the importance of genuine literary education, or to suppose that intellectual culture can be complete without it. An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that the Scientific College would turn out none but lopsided men.

*Collected Essays (Science and Culture)*

Address 1880

Opening of Mason College

No educational system can have a claim to permanence unless it recognizes the truth that education has two great ends to which everything else must be subordinated. The one of these is to increase knowledge; the other is to develop the love of right and the hatred of wrong.

Scientific Education: Notes of an After-Dinner Speech

*The Eclectic Magazine*, New Series, Volume X, July-December, 1869 (p. 156)

### Johnson, J. B.

No biographical data available

Education may be defined as a means of gradual emancipation from the thralldom of incompetence.

*Addresses to Engineering Students*

Two Kind of Education for Engineers (p. 25)

Waddell and Harrington. Kansas City, Missouri, USA. 1912

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

I shall meet with no contradiction when I say that without at least an elementary mathematical and scientific education a man remains a total stranger in the world in which he lives, a stranger in the civilisation of the time

that bears him. Whatever he meets in nature, or in the industrial world, either does not appeal to him at all, from his having neither eye nor ear for it, or it speaks to him in a totally unintelligible language.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On Instruction in the Classics and the Sciences (p. 330)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Maxwell, James Clerk** 1831–79

Scottish physicist

The education of man is so well provided for in the world around him, and so hopeless in any of the worlds which he makes for himself, that it becomes of the utmost importance to distinguish natural truth from artificial system, the development of a science from the envelopment of a craft.

Quoted in Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell: With a Selection from His Correspondence and Occasional Writings*

Chapter VIII (p. 234)

Macmillan & Co Ltd. London, England. 1882

**McCormick, Leander Hamilton** 1859–1934

American author, inventor, and scientist

Ignorance covers the eyes as banks of clouds conceal the sun. Education will dissipate the clouds of ignorance and reveal the sunshine of knowledge.

*Characterology*

Chapter XXVI (p. 589)

Rand McNally & Co. Chicago, Illinois, USA. 1920

**Mill, John Stuart** 1806–73

English political philosopher and economist

Education, in its larger sense, is one of the most inexhaustible of all topics. Though there is hardly any subject on which so much has been written, by so many of the wisest men, it is as fresh to those who come to it with a fresh mind, a mind not hopelessly filled full with other people's conclusions, as it was to the first explorers of it: and notwithstanding the great mass of excellent things which have been said respecting it, no thoughtful person finds any lack of things both great and small still waiting to be said, or waiting to be developed and followed out to their consequences.

*Inaugural Address: Delivered to the University of St. Andrews* (p. 3)

Longmans, Green, Reader & Dyer. London, England. 1867

Scientific education, apart from professional objects, is but a preparation for judging rightly of Man, and of his requirements and interests.

*Inaugural Address: Delivered to the University of St. Andrews* (p. 30)

Longmans, Green, Reader & Dyer. London, England. 1867

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

What, after all, is education but a subtle, slowly-affected change, due to the action upon us of the External; of

the written record of the great minds of all ages, of the beautiful and harmonious surroundings of nature and of art, and of the lives, good or ill, of our fellows – these alone educate us, these alone mould the developing minds.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 95)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

A man cannot become a competent surgeon without a full knowledge of human anatomy and physiology, and the physician without physiology and chemistry flounders along in an aimless fashion, never able to gain any accurate conception of disease, practicing a sort of popgun pharmacy, hitting now the malady and again the patient, he himself not knowing which.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Teaching and Thinking (p. 121)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

If the license to practice meant the completion of his education how sad it would be for the practitioner, how distressing to his patients! More clearly than any other the physician should illustrate the truth of Plato's saying that education is a life-long process.

The Importance of Post-Graduate Study

*Lancet*, Volume 2, 1900

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

What the world needs is a fusion of the sciences and the humanities. The humanities express the symbolic, poetic, and prophetic qualities of the human spirit. Without them we would not be conscious of our history; we would lose our aspirations and the grace of expression that move men's hearts. The sciences express the creative urge in man to construct a universe which is comprehensible in terms of the human intellect. Without them, mankind would find itself bewildered in a world of natural forces beyond comprehension, victims of ignorance, superstition and fear.

Commencement Address

Engineering & Science, California Institute of Technology

June, 1954

**Roscoe, Henry E.** 1833–1915

English chemist

Scientific education begins with no preconceived idea in accordance with which everything else must be moulded. It starts in simple communion with nature, and is content to pick up little by little the truth which she is always ready to communicate to patient enquirers.

*Essays and Addresses*

Lecture II (p. 25)

Macmillan & Co Ltd. London, England. 1874

**Rowland, Henry Augustus** 1848–1901

American physicist



The object of education is not only to produce a man who *knows*, but one who *does*; who makes his mark in the straggle of life and succeeds well in whatever he undertakes: who can solve the problems of nature and of humanity as they arise, and who, when he knows he is right, can boldly convince the world of the fact.

*The Physical Papers of Henry Augustus Rowland*

The Physical Laboratory in Modern Education (p. 617)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

BIRON: What is the end of study? let me know?

KING: Why, that to know, which else we should not know.

BIRON: Things hid and barr'd, you mean, from common sense?

KING: Ay, that is study's godlike recompense.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Love's Labor's Lost*

Act I, Scene i, l. 55–58

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Spencer, Herbert** 1829–1903

English social philosopher

To suppose that deciding whether a Mathematical or a Classical Education is the best, is deciding what is the proper curriculum, is much the same thing as to suppose that the whole of dietetics lies in ascertaining whether or not bread is more nutritive than potatoes!

*Education: Intellectual, Moral, and Physical* (pp. 12–13)

A.L. Burt Co. New York, New York, USA. 1892

**Standen, Anthony** 1907–??

Anglo-American science writer

...education, like everything else, goes in fads, and has the normal human tendency to put up with something bad for just so long, and then rush to the other extreme.

*Science Is a Sacred Cow*

Chapter II (p. 43)

E.P. Dutton & Company. New York, New York, USA. 1950

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

What does education often do? It makes a straight-cut ditch of a free-meandering brook.

*The Journal of Henry D. Thoreau* (Volume 2)

Undated (p. 83)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

**Tyndall, John** 1820–93

Irish-born English physicist

I do not think that it is the mission of this age, or of any other particular age, to lay down a system of education which shall hold good for all ages.

In Royal Institute of Great Britain

*Lectures on Education: Delivered at the Royal Institute of Great Britain*

On the Importance of the Study of Physics (p. 173)

John W. Parker & Son. London, England. 1854

**van Dyke, John Charles** 1856–1932

American art historian and critic

If we could but rid ourselves of the false ideas, which, taken . . . , are called education, we should know that there is nothing ugly under the sun, save that which comes from human distortion.

*The Desert*

Chapter X (p. 192)

Charles Scribner's Sons. New York, New York, USA. 1930

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

In education, as elsewhere, the broad primrose path leads to a nasty place.

*The Aims of Education and Other Essays*

Chapter I (p. 7)

The Macmillan Company. New York, New York, USA. 1959

## EDUCATOR

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

Above all material acquisitions, above all intellectual attainments, above even the refinements of culture, in the esteem and endeavor of true educators, rises the moral exaltation of an individual or of a people.

The Ethical Functions of Scientific Study

*The Journal of Geology*, Volume 2, Number 6, December, 1888 (p. 380)

**Lewis, C. S. (Clive Staples)** 1898–1963

English novelist, academic, and medievalist

For everyone pupil who needs to be guarded from a weak excess of sensibility there are three who need to be awakened from the slumbers of cold vulgarity. The task of the modern educator is not to cut down the jungles but to irrigate forests.

*The Abolition of Man*

Chapter 1 (p. 9)

The Macmillan Co. New York, New York, USA. 1947

## EFFECT

**Bartlett, Elisha** 1804–55

American physician

The effects of the treatment upon the disease can result only from an examination and analysis of a great number of individual instances, and by an application to the average result, of the calculation of probabilities. The law, whatever it is, may be relied upon, as positive and absolute, just in proportion to the fixed and uniform character of the compared facts, and to the greatness of their number . . .



In William E. Stempsey  
*Elisha Bartlett's Philosophy of Medicine*  
 Part II, Chapter XI (pp. 129–130)  
 Springer-Verlag, Dordrecht, The Netherlands. 2005

**Davy, Sir Humphry** 1778–1829  
 English chemist

We ought to reason from effects alone. False philosophy has uniformly depended upon making use of words which signify no definite ideas.

In John Davy  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
 Chapter II (p. 122)  
 Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836  
 Printed for Bell & Bradfute. Edinburgh, Scotland. 1825

**Hume, David** 1711–76  
 Scottish philosopher and historian

Effects will always correspond to causes ...  
*Essays and Treatises on Several Subjects* (Volume 1)  
 Essay III (p. 20)

**Laplace, Pierre Simon** 1749–1827  
 French mathematician, astronomer, and physicist

The phenomena of nature are most often enveloped by so many strange circumstances, and so great a number of disturbing causes mix their influence, that it is very difficult to recognize them. We may arrive at them only by multiplying the observations or the experiences, so that the strange effects finally destroy reciprocally each other.

*A Philosophical Essays on Probabilities*  
 Chapter IX (p. 73)  
 Dover Publications, Inc. New York, New York, USA. 1951

## EFFICIENT

**Hoyle, Sir Fred** 1915–2001  
 English mathematician, astronomer, and writer

If one is obliged to be efficient about everything the best that can be achieved is a moderate measure of competence.

*Of Men and Galaxies*  
 Motives and Aims of the Scientist (pp. 13–14)  
 University of Washington Press. Seattle, Washington, USA. 1964

## EFFORT

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

There is a time in every man's education when he arrives at the conviction that envy is ignorance; that imitation is suicide; that he must take himself for better, for worse, as his portion; that though the wide universe is full of good, no kernel of nourishing corn can come to him but

through his toil bestowed on that plot of ground which is given to him to till.

*Essays: First Series*  
 Essay II (p. 48)  
 Houghton Mifflin & Co. Boston, Massachusetts, USA. 1885

## EGG

**Agassiz, Jean Louis Rodolphe** 1807–73  
 Swiss-born American naturalist, geologist, and teacher

I have devoted my whole life to the study of Nature, and yet a single sentence may express all that I have done. I have shown that there is a correspondence between the succession of Fishes in geological times and the different stages of their growth in the egg – this is all. It chanced to be a result that was found to apply to other groups and has led to other conclusions of a like nature.

*Methods of Study in Natural History*  
 Chapter II (p. 23)  
 Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

**Bishop, Roy**  
 No biographical data available

The egg is smooth and very pale;  
 It has no nose, it has no tail;  
 It has no ears that one can see;  
 It has no wit, no repartee.  
 The Inefficacious Egg  
*The Living Age*, Volume 324 1925 (p. 124)

**Conklin, Edwin Grant** 1863–1952  
 American zoologist

We are vertebrates because our mothers were vertebrates and produced eggs of the vertebrate pattern; but the colour of our skin and hair and eyes, our sex, stature and mental peculiarities were determined by the sperm as well as by the egg from which we came. There is evidence that the chromosomes of the egg and sperm are the seat of the differential factors or determiners for Mendelian characters while the general polarity, symmetry and pattern of the embryo are determined by the cytoplasm of the egg.

*Heredity and Environment in the Development of Men* (5th edition)  
 The Cellular Basis (pp. 199–200)  
 Princeton University Press. Princeton, New Jersey, USA. 1922

**Cook, Joseph**  
 No biographical data available

Take the twittering swallows under the brown eaves, or your eagle on the cliff, or your lion in his lair: the egg, in each case, is the source of life; and, when the quickening begins, there is nothing to be seen at the centre of the egg but this structureless, colourless, viscid bioplasm. Nevertheless, it divides and subdivides, and weaves, in the one case a lion, and in the other a swallow, and in the other an eagle; and I affirm, in the name of all reason, that, from

the very first, the plan of the whole organism must be in view somewhere.

*Biology, With Preludes on Current Events*

Chapter IV (p. 42)

Richard D. Dickinson. London, England. 1879

**Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

Do you see this egg? With this you can topple every theological theory, every church or temple in the world.

Translated by Jean Stewart and Jonathan Kemp

*Diderot: Interpreter of Nature*

D'Alembert's Dream

Conversation between d'Alembert and Diderot (p. 57)

International Publishers. New York, New York, USA. 1938

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

Of the forms which life is able to bestow on her creations, that of the birds egg is one of the simplest and loveliest. Nowhere do we find the beauty of the circle and the ellipse, the geometrical bases of organic bodies, combined with greater precision. At one of the poles is the sphere, the perfect form, capable of enclosing the greatest volume in the smallest envelope; at the other is the point of the ellipsoid, which tempers the monotonous austerities of the big end.

*The Life of the Scorpion*

The Pentatoma and their Eggs (p. 183)

Dodd, Mead & Co. New York, New York, USA. 1923

With the exquisite simplicity of its geometry and its ornament, the bird's egg enchants the least cultivated eye.

*The Life of the Scorpion*

The Pentatoma and their Eggs (p. 184)

Dodd, Mead & Co. New York, New York, USA. 1923

**Harvey, William** 1578–1657

English physician

Everything from an egg.

*De Generatione Animalium*

Frontispiece

Printed by James Young. London, England. 1653

**Loeb, Jacques** 1859–1924

German-born American physiologist and biologist

...without a structure in the egg to begin with, no formation of a complicated organism is imaginable ...

*The Organism as a Whole: From a Physicochemical Viewpoint*

Chapter II (p. 39)

G.P. Putnam's Sons. New York, New York, USA. 1916

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

...the typical animal egg, once fertilized, develops as a unit; the secret fetus slips out of one stage of development into another, each stage geologic eons from the other, as it recapitulates animal evolution.

*Flowering Earth*

Chapter 4 (p. 48)

G.P. Putnam's Sons. New York, New York, USA. 1939

**EINSTEIN, ALBERT**

**Nordmann, Charles**

Astronomer

...whereas one needs only a little Latin to gain access to Spinoza, frightful monsters keep guard before Einstein, and their horrible grimaces seem to forbid us to approach him. They stand behind strange moving bars, sometimes rectangular and sometimes curvilinear, which are known as "co-ordinates." They bear names as frightful as themselves "contravariant and covariant vectors, tensors, scalars, determinants, orthogonal vectors, generalized symbols of three signs," and so on.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Chapter I (pp. 1–2)

Henry Holt & Co. New York, New York, USA. 1922

...Einstein may be a treasure, but there is a fearsome troop of mathematical reptiles keeping inquisitive folk away from it; though there can be no doubt that they have, like our Gothic gargoyles, a hidden, beauty of their own.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Chapter I (p. 2)

Henry Holt & Co. New York, New York, USA. 1922

**EINSTEIN'S THEORIES**

**Nordmann, Charles** 1881–1940

French mathematician and astronomer

Are not Einstein's theories, as some imperfectly informed writers have suggested, only a play of mathematical formulae (taking the word in the meaning given to it by both mathematicians and philosophers)? If they were only a towering mathematical structure in which the #'s shoot out their volutes in bewildering arabesques, with swan-neck integrals describing Louis XV patterns, they would have no interest whatever for the physicist, for the man who has to examine the nature of things before he talks about it.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Chapter I (pp. 25–26)

Henry Holt & Co. New York, New York, USA. 1922

Like some suspension bridge boldly thrown across an abyss, Einstein's theory rests, on the one side, on experimental phenomena, and it leads, at the other side, to

other, and hitherto unsuspected, phenomena, which it has enabled us to discover. Between these two solid experimental columns the mathematical reasoning is like the marvellous network of thousands of steel bars which represent the elegant and translucent structure of the bridge.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Chapter I (pp. 26–27)

Henry Holt & Co. New York, New York, USA. 1922

## EL NIÑO

**Maddox, John Royden** 1925–

Welsh chemist and physicist

The El Niño phenomenon [is] the geophysicists' equivalent of the universal solvent.

Great Greenhouse in the Sky?

*Nature*, Volume 306, 1983 (p. 221)

## ELECTRIC CIRCUIT

**Wheatstone, Charles** 1802–75

English scientist and inventor

Viewing the laws of the electric circuit from the point at which the labours of Ohm has placed us, there is scarcely any branch of experimental science in which so many and such various phenomena are expressed by formulae of such simplicity and generality ...

*Philosophical Transactions of the Royal Society of London Part I*

The Bakerian Lecture (p. 304)

Printed by Richard & John E. Taylor. London, England. 1893

## ELECTRIC CURRENT

**Tyndall, John** 1820–93

Irish-born English physicist

We start with a magnet of infinitesimal power, which gives rise to electric currents of infinitesimal strength. These react upon the magnet, exalt its attractive and repulsive forces, thus enabling it to produce stronger currents, which again react upon and enhance the power of their source. Thus we rise from an origin too feeble to produce the slightest spark or gleam, to an energy competent to produce the solar brilliancy of the electric light.

*Heat A Mode of Motion* (6th edition)

Lecture I (p. 1)

D. Appleton & Co. New York, New York, USA. 1915

**Warder, George Woodward** 1848–1907

American attorney

As man controls his body by the electric currents that communicate his thoughts thereto, so God controls the universe by the electric currents in nature.

*Invisible Light; Or, The Electric Theory of Creation*

Chapter I (p. 14)

G.W. Dillingham Co, Publishers. New York, New York, USA. 1900

## ELECTRICITY

**Arago, Francois** 1786–1853

French physicist

Thunder in the hands of nature is electricity in the hands of physicists.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1875*

Eulogy of Alexander Volta (p. 120)

Government Printing Office. Washington, D.C. 1876

**Barry, Dave 1947–**

American humor columnist

Electricity is actually made up of extremely tiny particles, called electrons, that you cannot see with the naked eye unless you have been drinking. Electrons travel at the speed of light, which in most American homes is 110 volts per hour. This is very fast. In the time it has taken you to read this sentence so far, an electron could have traveled all the way from San Francisco to Hackensack, New Jersey, although God alone knows why it would want to. The five main kinds of electricity are alternating current, direct current, lightning, static, and European. Most American homes have alternating current, which means that the electricity goes in one direction for a while, then goes in the other direction. This prevents harmful electron buildup in the wires.

*The Taming of the Screw*

Chapter 3 (p. 12)

Rodale Books. New York, New York, USA. 2000

**de Cisternay Dufay, Charles Francois**

No biographical data available

Chance has thrown my way another principle, more universal and remarkable... which casts a new Light on the subject of electricity. This principle is that there are two distinct Electricities, very different from each other; one of these I call vitreous Electricity; the other resinous Electricity. The first is that of Glass, Rock-Crystal, Precious Stones, Hair of Animals, Wool, and many other bodies. The second is that of Amber, Copal, Gum-Lac, Silk, Thread, Paper, and a vast number of other substances. The characteristic of these two Electricities is that a body of the Vitreous Electricity, for example, repels all such as are of the same Electricity; and on the contrary, attracts all those of the resinous electricity.... This Principle very naturally explains why the ends of Thread, of Silk or Wool recede from one another in the form of a Pencil or Broom when they have acquired an electric Quality.

*Philosophical Transactions of the Royal Society of London*, Volume 38, 1734 (p. 258)

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

I am somewhat exhausted; I wonder how a battery feels when it pours electricity into a non-conductor?

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Adventure of the Dying Detective* (p. 442)  
Wings Books. New York, New York, USA. 1967

**Faraday, Michael** 1791–1867  
English physicist and chemist

Such is...the progress which electricity has made in the last thirty years: chemistry and magnetism have successively acknowledged its overruling influence: and it is probable that every effect depending upon the powers of inorganic matter, and perhaps most of those related to vegetable and animal life, will ultimately be found subordinate to it.

*Experimental Researches in Electricity* (Volume 1)  
Eleventh Series, 1161 (p. 360)  
Richard & John Edward Taylor. London, England. 1839–1855

Wonderful as are the laws and phenomena of electricity when made evident to us in inorganic or dead matter, their interest can bear scarcely any comparison with that which attaches to the same force when connected with the nervous system and with life; and though the obscurity which for the present surrounds the subject may for the time also veil its importance, every advance in our knowledge of this mighty power in relation to inert things, helps to dissipate that obscurity, and to set forth more prominently the surpassing interest of this very high branch of Physical Philosophy.

*Experimental Researches in Electricity* (Volume 2)  
Notice of the character and direction of the electric (p. 1)  
force of the Gymnotus  
Richard & John Edward Taylor. London, England. 1844

Electricity is often called wonderful, beautiful; but it is so only in common with the other forces of nature. The beauty of electricity or of any other force is not that the power is mysterious, and unexpected, touching every sense at unawares in turn, but that it is under law, and that the taught intellect can even now govern it largely. The human mind is placed above, and not beneath it, and it is in such a point of view that the mental education afforded by science is rendered super-eminent in dignity, in practical application and utility; for by enabling the mind to apply the natural power through law, it conveys the gifts to God to man.

In Bence Jones  
*The Life and Letters of Faraday* (p. 404)  
J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1870

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

The electrical matter consists of particles extremely subtle, since it can permeate common matter, even the densest metals, with such ease and freedom as not to receive any perceptible resistance.

Quoted in *Nobel Lecture (Physics)*  
Robert A. Millikan  
The Electron and the Light-Quant from the Experimental Point of View (p. 54)

In going on with these Experiments, how many pretty systems do we build, which we soon find ourselves oblig'd to destroy! If there is not Use discover'd of Electricity, this, however, is something considerable, that it may help to make a vain Man humble.

In I. Bernard Cohen  
*Benjamin Franklin's Experiments*  
Chapter III, Section I  
Letter to Peter Collinson  
August 14, 1747 (p. 63)  
Harvard University Press. Cambridge, Massachusetts, USA. 1941

Dangerous, therefore, is it to take shelter under a tree, during a thundergust. It has been fatal to many, both men and beasts.

In I. Bernard Cohen  
*Benjamin Franklin's Experiments*  
Letter V  
Letter to John Mitchel  
April 29, 1749 (p. 209)  
Harvard University Press. Cambridge, Massachusetts, USA. 1941

**Freke, John** 1688–1756  
Surgeon

I think it is a great pity that the word electricity should ever have been given to so wonderful a phenomenon, which might properly be considered as the first principle in nature. Perhaps the word vivacity might not have been an improper one.

*Essay to Shew the Cause of Electricity*  
Appendix (p. 59)  
Printed for W. Innys. London, England. 1746

**Hawthorne, Nathaniel** 1804–64  
American novelist and short story writer

Is it a fact – or have I dreamed it – that by means of electricity the world of matter has become a great nerve, vibrating thousands of miles in a breathless point of time? Rather, the round globe is a vast head, a brain instinct with intelligence...

*The House of Seven Gables*  
The Flight of Two Owls (p. 264)  
Oxford University Press, Inc. Oxford, England. 1998

**Jortin, John** 1698–1770  
English divine

What tricks would not these monks have played, if they had possessed the secret of *electricity*?

*Remarks on Ecclesiastical History* (Volume 2)  
Remarks on His Miracles (p. 231)  
Lackington, Allen & Co. London, England. 1805

**Tesla, Nikola** 1856–1943  
Croatian-American electrical engineer

My definition of electricity is invisible light.

In George Woodward Warder  
*Invisible Light; Or, The Electric Theory of Creation*  
Cover of book  
G.W. Dillingham Co, Publishers. New York, New York, USA. 1900

**Thomson, Sir Joseph John** 1856–1940  
English physicist

The progress of electrical science has greatly been promoted by speculation as to the nature of electricity.

*Electricity and Matter*

Chapter I (p. 1)

Yale University Press. New Haven, Connecticut, USA. 1912

**Thurber, James** 1894–1961  
American writer and cartoonist

...her own mother lived the latter years of her life in the horrible suspicion that electricity was dripping invisibly all over the house. It leaked, she contended, out of empty sockets if the wall switch had been left on.

*The Thurber Carnival*

The Car We Had to Push (p. 186)

The Modern Library. New York, New York, USA. 1957

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

I see very well that this assumption of two imponderable fluids of opposite qualities is a rather complicated and artificial machinery and that the mathematical language of Clerk Maxwell's theory expresses the laws of the phenomena very simply and very truly with a much smaller number of hypothetical implications. But I confess I should really be at a loss to explain, without the use of mathematical formulas, what he considers a quantity of electricity and why such a quantity is constant, like that of a substance.

*The Modern Development of Faraday's Conception of Electricity*

Faraday Lecture

Delivered before the Fellows of the Chemical Society in London on

April 5, 1881

**Warder, George Woodward** 1848–1907  
American attorney

The vast universe hangs upon nothing in empty space but the invisible arms of electricity; but they are the invisible arms of Deity.

*Invisible Light; Or, The Electric Theory of Creation*

Chapter I (p. 14)

G.W. Dillingham Co, Publishers. New York, New York, USA. 1900

Electricity is the perpetual life motion of all material existence. It prevents stagnation and decay, and renews all changing forms and substances. By its positive and negative energy acting and reacting it produces and controls all the movements of visible and tangible things.

*Invisible Light; Or, The Electric Theory of Creation*

Chapter I (p. 17)

G.W. Dillingham Co, Publishers. New York, New York, USA. 1900

## ELECTROCARDIOGRAM

**Kraus, Jack**  
No biographical data available

ELECTROCARDIOGRAM: ticker tape.  
*Quote, the Weekly Digest*, February 5, 1967 (p. 117)

## ELECTROCARDIOGRAPHY

**Waller, Augustus Desiré** 1856–1922  
British scientist

If a pair of electrodes (zinc covered by chamois leather and moistened with brine) are strapped to the front and back of the chest, and connected with a Lippmann's capillary electrometer, the mercury in the latter will be seen to move slightly but sharply at each beat of the heart....

The electrical variation precedes the heart's beat.

*The Journal of Physiology*, Volume 8 1887 (p. 229)

Our new bit of knowledge is about the human heart, not in a metaphysical or figurative sense, not its motives, but only its action, not its power, but its electrical potential. Put into a single sentence, I am going to describe how the heart of man can be shown to act as an electrical organ, and what we learn from such action.

*British Medical Journal*, Volume 2, 1888

## ELECTROLYSIS

**Maxwell, James Clerk** 1831–79  
Scottish physicist

It is extremely improbable however that when we come to understand the true nature of electrolysis we shall retain in any form the theory of molecular charges, for then we shall have obtained a secure basis on which to form a true theory of electric currents, and so become independent of these provisional theories.

*A Treatise on Electricity and Magnetism*

Part II, Chapter IV (p. 381)

At The Clarendon Press. Oxford, England. 1904

## ELECTROMAGNETIC FIELD THEORY

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1896  
Polish physicist

The electromagnetic field theory is, for the modern physicist, as real as the chair on which he sits.



*The Evolution of Physics*  
Field and Ether (p. 158)  
Simon & Schuster. New York, New York, USA. 1938

## ELECTRON

**Allison, G. Burgess** 1951–  
Attorney

When you're dealing with electrons, it's pretty hard to tell one from the other.

*Law Practice Management*, Volume 9, 1994 (p. 14)

### Author undetermined

There were many electrons like this one in flight,  
But obeying Coulomb, they made small approach and then

Rapidly went apart. And the reason was that only  
At rest could they repel one another,  
But never attract!

In V. Grigoryev and G. Myakishev  
*The Forces of Nature*  
Chapter 7, The Song of the Electron (p. 239)  
Mir. Moscow, Russia. 1971

Nature herself does not even know which way the electron is going to go.

In Richard Feynman  
*The Character of Physical Law*  
Chapter 6 (p. 147)  
British Broadcasting Company. London, England. 1965

There was a jolly electron –  
alternately bound and free –  
Who toiled and spun from morn to night,  
no snark so lithe as he...

In Bernard Jaffe  
*Crucibles: The Story of Chemistry*  
Jolly Electron, Chapter XIV (p. 215)  
Dover Publications. New York, New York, USA. 1976

**Ball, Philip** 1962–  
English science writer

...in the water molecule, oxygen hogs the electrons like a selfish lover stealing most of the duvet.

*Life's Matrix: A Biography of Water*  
Part Two, Chapter 6 (p. 169)  
Farrar, Straus & Giroux. New York, New York, USA. 2000

**Benchley, Robert** 1889–1945  
American humorist and critic

The protons are positive and the electrons are negative,  
and, of the two, I am sure that the electrons are nicer.

*Benchley Lost and Found: 39 Prodigal Pieces*  
Atom Boy! (p. 81)  
Dover Publications. New York, New York, USA. 1970

**Birkeland, Kristian** 1867–1917  
Norwegian physicist

Space is filled with electrons and flying electric ions of all kinds.

In Eric J. Lerner  
*The Big Bang Never Happened*  
Chapter 5 (p. 169)  
Random House, Inc. New York, New York, USA. 1991

**Born, Max** 1882–1970  
German-born English physicist

It was through [Heisenberg's classic paper on the Uncertainty Principle] that the revolutionary character of the new conception became clear. It showed that not only the determinism of classical physics must be abandoned, but also the naive concept of reality which looked upon the particles of atomic physics as if they were very small grains of sand. At every instant a grain of sand has a definite position and velocity. This is not the case with an electron.

*Nobel Lectures, Physics 1942–1962*  
Nobel lecture for award received in 1954  
The Statistical Interpretation of Quantum Mechanics (p. 262)  
World Scientific Publishing Company. Singapore. 1998

**Bragg, Sir William Henry** 1862–1942  
English physicist

...an electron springs into existence.  
Electrons and Ether Waves  
*Scientific Monthly*, Volume XIV, February, 1922, Number 8 (p. 156)

**Davisson, Clinton J.** 1881–1958  
American physicist

We think we understand the regular reflection of light and x-rays – and we should understand the reflections of electrons as well if electrons were only waves instead of particles. It is rather as if one were to see a rabbit climbing a tree, and were to say, “well that is rather a strange for a rabbit to be doing, but after all there is really nothing to get excited about. Cats climb trees – so that if the rabbit were only a cat, we would understand its behavior perfectly.”

Quoted by Anthony French and Edwin Taylor  
*An Introduction to Quantum Physics* (p. 54)  
W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Dingle, Herbert** 1890–1978  
English astrophysicist

He thought he saw electrons swift  
Their charge and mass combine.  
He looked again and saw it was  
The cosmic sounding line.  
The population then, said he,



**Must be 1079.**

In Sir Arthur Eddington  
*The Expanding Universe*  
 Chapter IV Section IV (p. 113)  
 The University Press. Cambridge. 1933

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The electron, as it leaves the atom, crystallises out of Schrödinger's mist like a genie emerging from his bottle.

*The Nature of the Physical World*  
 Chapter IX (p. 199)  
 The Macmillan Company. New York, New York, USA. 1930

An electron is no more (and no less) hypothetical than a star.

*New Pathways in Science*  
 Chapter I, Section V (p. 21)  
 The Macmillan Company. New York, New York, USA. 1935

...an electron would not know how large it ought to be unless there existed independent lengths in space for it to measure itself against.

*The Mathematical Theory of Relativity*  
 Chapter V (p. 155)  
 At The University Press. Cambridge, England. 1930

**Einstein, Albert** 1879–1955

German-born physicist

...I should not want to be forced into abandoning strict causality without defending it more strongly than I have so far. I find the idea quite intolerable that an electron exposed to radiation should choose of its own free will not only its moment to jump off, but also its direction. In that case I would rather be a cobbler, or even an employee in a gaming-house, than a physicist.

In Ronald W. Clark  
*Einstein: The Life and Times*  
 Letter to M. Born, April 29, 1924 (p. 211)  
 The World Publishing Company. New York, New York, USA. 1971

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

It is the fact that the electrons cannot all get on top of each other that makes tables and everything else solid.

*The Feynman Lectures on Physics* (Volume 3)  
 Chapter 2–4 (p. 2–7)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Fournier d'Albe, E. E.**

No biographical data available

We may therefore, without in the least interfering with the efficiency of the electron...imagine it to be a veritable microcosm.

*The Electron Theory*  
 Chapter XVI (p. 288)  
 Longman, Green & Company. New York, New York, USA. 1906

**Frankel, Felice** 1945–

Science photographer

**Whitesides, George M.**

American chemist

Electrons know two verbs: seek and avoid. They seek the positive charges of atomic nuclei; they avoid the negative charges of other electrons. That is almost all they know.

*On the Surface of Things: Images of the Extraordinary in Science*  
 Microelectrodes (p. 99)  
 Chronicle Books. San Francisco, California, USA. 1997

**Gamow, George** 1904–68

Russian-born American physicist

To keep order and preserve the properties, I never permit more than two electrons to follow the same track; a ménage a trios always gives a lot of trouble, you know.

*Mr. Tompkins in Paperback*  
 Chapter 10 (p. 115)  
 At The University Press. Cambridge, England. 1965

**Gibson, Charles R.** 1870–1931

No biographical data available

...an electron is a real particle of negative electricity.

In Frederick Houk Law  
*Science in Literature*  
 Autobiography of an Electron (p. 253)  
 Harper & Brothers Publishers. New York, New York, USA. 1929

**Glashow, Sheldon L.** 1932–

American physicist

Much as a pitched baseball is given a spin about its axis, so also does the electron spin about. However, the microscopic quantum mechanical electron behaves very differently from a baseball. Baseballs can be old, new, clean, dirty, and can differ from one another in myriad ways. On the other hand, all electrons are absolutely identical to one another. There is a subtler difference as well. Baseballs may spin rapidly, slowly, or in the case of a knuckleball, not at all. Every electron in the universe (about 1080 of them!) is spinning at exactly the same rate. The magnitude of electron spin is an intrinsic and immutable characteristic of the electron. Only the axis about which the electron spins can be changed.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*  
 Chapter 3 (p. 56)  
 Warner Books. New York, New York, USA. 1988

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

But electrons do not move in clear-cut orbits like revolving celestial bodies. They dance, and the atom is a ballroom. The electrons perform stately waltzes, weave curvaceous tangos, jitter in spasmodic quicksteps, and rock to

frenetic rhythms. They are waves dancing to a choreography composed differently for each kind of atom.

*Masks of the Universe*

Chapter 8 (p. 123)

Macmillan Publishing Company, New York, New York, USA. 1985

### **Hoffmann, Banesh** 1906–86

Mathematician and educator

No longer could an electron roam fancy free wherever it wished but, more like a trolley car than a bus, it must keep strictly to the tracks laid down by Bohr, though, as we shall see shortly, it did have a little more freedom than the conventional trolley.

*The Strange Story of the Quantum*

Chapter V (p. 54)

Dover Publications, Inc. New York, New York, USA. 1959

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The hard sphere...has always a definite position in space; the electron apparently has not. A hard sphere takes up a very definite amount of room; an electron – well it is probably as meaningless to discuss how much room an electron takes up as it is to discuss how much room a fear, an anxiety, or an uncertainty takes up.

In Lincoln Barnett

*The Universe and Dr. Einstein*

Chapter 3 (p. 22)

William Sloane Associates. New York, New York, USA. 1948

The electrons may now be pictured as octopus-like structures with tentacles or “tubes of force” sticking out from it in every direction.

*Physics and Philosophy*

Chapter IV (p. 122)

Dover Publications, Inc. New York, New York, USA. 1981

### **Lederman, Leon** 1922–

American high-energy physicist

The “naked” electron is an imaginary object cut off from the influences of the field, whereas a “dressed” electron carries the imprint of the universe.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 7 (p. 280)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### **Leighton, Joseph Alexander**

No biographical data available

An atom or electron is like Zeno’s arrow in that it is always moving in the place where it is not.

*Man and the Cosmos: An Introduction to Metaphysics*

Chapter XXXV (p. 468)

D. Appleton & Co. New York, New York, USA. 1922

### **Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

Cynthia was like the high-frequency electrons which he learned to handle in the laboratory – the sort which at a

pressure of half a million volts will kiss the experimenter’s lips without burning them.

*White Lightning*

Chapter 3 (p. 15)

Covici-McGee. Chicago, Illinois, USA. 1933

...he had fallen head over heels in love...we might say that he had yielded as easily as zinc yields its electrons to copper, plating it round and defending it forever.

*White Lightning*

Chapter 30 (p. 130)

Covici-McGee. Chicago, Illinois, USA. 1933

### **Lewis, Gilbert Newton** 1875–1946

American chemist

...see all electrons are alike, and presumably leave no trail behind them, we cannot say that atom A loses an electron to atom B and atom C to atom D, but only that Atoms A and C have each lost an electron and atoms B and D have each gained one.

Valence and Tau Tomerism

*Journal of the American Chemical Society*, Volume 35, 1913

(pp. 1448–1455)

### **Lindley, David** 1956–

English astrophysicist and author

To argue whether the electron is really a wave or a particle is futile: an electron is an electron, and it behaves as an electron behaves. The observer may sometimes perceive wave properties in that behavior, and sometimes particle properties, and that, as Keats said, is all ye know, and all ye need to know. If we ask for more, what we are really asking for is a direct, metaphysical understanding of the nature of the electron, as if we could grasp its “true” nature with our minds and obtain some understanding of it beyond the scope of physical experimentation.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 2 (p. 75)

Basic Books. New York, New York, USA. 1993

### **Lodge, Sir Oliver** 1851–1940

English physicist

Electrons have come into existence somehow. The subject of origins usually lies outside science.

*The Ether and Electrons*

*Supplement to Nature*, Volume 112, Number 2805, August 4, 1923

(p. 191)

### **Millikan, Robert Andrews** 1868–1953

American physicist

The chemists in America has in general been content with what I have called a loafer electron theory. He has imagined the electrons sitting around on dry goods boxes at every corner [viz. the cubic atom], ready to shake hands with, or hold on to similar loafer electrons in other atoms.

Atomism in Modern Physics

*Journal of the Chemical Society*, 1924 (p. 1411)

The word “electron” was first suggested in 1891 by Dr. G. Johnstone Stoney as a name for the “natural unit of electricity,” namely, that quantity of electricity which must pass through a solution in order to liberate at one of the electrodes one atom of hydrogen or one atom of any univalent substance.

*The Electron*

Chapter II (p. 25)

The University of Chicago Press. Chicago, Illinois, USA. 1924

Indeed, nothing more beautifully simplifying has ever happened in the history of science than the whole series of discoveries culminating about 1914 which finally brought practically universal acceptance of the theory that the material world contains but two fundamental entities, namely, positive and negative electrons, exactly alike in charge, but differing widely in mass, the positive electron – now usually called a proton – being 1850 times heavier than the negative, now usually called simply the electron.

*Time, Matter and Values*

Chapter II (p. 46)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1932

A prominent literary writer recently spoke of the electron as “only the latest scientific hypothesis which will in its turn give way to the abra-ca-da-bra of tomorrow.”

*Nobel Lectures, Physics 1922–1941*

Nobel lecture for award received in 1923

The Electron and the Light-Quantum from the Experimental Point of View (p. 55)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

### **Oppenheimer, James Robert** 1904–67

American theoretical physicist

If we ask, for instance, whether the position of the electron remains the same, we must say “no”; if we ask whether the electron’s position changes with time we must say “no”; if we ask whether it is in motion, we must say “no.”

*Science and the Common Understanding*

Chapter 3 (p. 40)

Simon & Schuster. New York, New York, USA. 1953

### **Pauli, Wolfgang** 1900–58

Austrian-born physicist

The whole thing [quantum leap] seems a myth...but this is not supposed to happen with the electron: instead the frequency of vibration of the emitted light is said to lie somewhere between the orbital frequency before the mysterious jump and the orbital frequency after the jump. All this is sheer madness.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 3 (p. 36)

Harper & Row, Publishers. New York, New York, USA. 1971

### **Poincaré, Lucien** 1862–1920

French physicist

The electron has conquered Physics, and many worship the new idol rather blindly.

*The New Physics and Its Evolution*

Chapter XI (p. 324)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

### **Rutherford, Ernest** 1871–1937

English physicist

It seems to me that you would have to assume that the electron knows beforehand where it is going to stop.

*Rutherford at Manchester*

Letter to Niels Bohr, March 20, 1913 (p. 127)

W.A. Benjamin Inc. New York, New York, USA. 1963

### **Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

...this is the obvious way of registering the fact, that we never experiment with just one electron or atom or (small) molecule. In thought-experiments we sometimes assume that we do; this invariably entails ridiculous consequences.... In the first place it is fair to state that we are not experimenting with single particles, anymore than we can raise Ichthyosauria in the zoo. We are scrutinizing records of events long after they have happened.

Are There Quantum Jumps?

*British Journal for the Philosophy of Science*, Volume 3, 1952 (p. 109)

### **Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

...why the men who believe in electrons should regard themselves as less credulous than the men who believed in angels is not apparent to me.

In Homer D. Swander

*Man and the Gods: Three Tragedies*

Saint Joan, Preface, The Real Joan Is Not Marvellous for Us (p. 133)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

### **Standen, Anthony**

Anglo-American science writer

...nothing will do for Mr. Average Citizen but to stuff himself full of electrons, protons, neutrons, neutrinos, genes, chromosomes, glands, hormones, potassium, chloride, high-octane gasoline, ultrasonic vibrations, and the theory of relativity.

*Science Is a Sacred Cow*

Chapter I (p. 26)

E.P. Dutton. New York, New York, USA. 1950

### **Sullivan, John William Navin** 1886–1937

Irish mathematician

The electron is not, for example, an enduring something that can be tracked through time. Its mathematical description

does not involve that degree of definiteness. Any picture we form of the atom errs, as it were, by excess of solidity. The mathematical symbols refer to entities more indefinite than our pictorial imagination, limited as it is by experience of “gross matter,” can construct.

*The Bases of Modern Science*

Chapter XI (pp. 252–253)

Doubleday, Doran & Company, Inc. Garden City, New Jersey, USA. 1929

**Thomson, Sir George Paget** 1892–1975

English physicist

The goddess of learning is fabled to have sprung full-grown from the brain of Zeus, but it is seldom that a scientific conception is born in its final form, or owns a single parent. More often it is the product of a series of minds, each in turn modifying the ideas of those that came before, and providing material for those that come after. The electron is no exception.

*Nobel Lectures, Physics 1922–1941*

Nobel lecture for award received in 1937

Electronic Waves (p. 397)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

One may picture the free electron... as something like a gossamer spider floating through the air at the center of a number of radiating filaments which control its flight as the air wafts them about, or as they are caught by solid objects.

In Bernard Jaffe

*Crucibles: The Story of Chemistry*

Chapter XVI (p. 254)

Dover Publications. New York, New York, USA. 1976

An electron is like an able guerrilla leader who occupies a wide area with rumors of his presence, but when he strikes, he strikes with his whole force.

Electron Optics

*Nature*, Volume 129, Number 3246, 16 January, 1932 (p. 82)

**Very, Frank Washington** 1852–1927

Astronomer

The electrons are like little organisms, or least hearts, whose synchronous systole and diastole make the life of the universe, perpetually receiving and transmitting energy from an inexhaustible source.

*The Luminiferous Ether*

The Luminiferous Ether: Its Relation to the Atom (p. 40)

The Four Seas Co. Boston, Massachusetts, USA. 1919

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

How can it be that electrons exhibit wave and particle properties at the same time?... The quantum state represents a novel state of matter that cannot be described in the old-fashioned way. It exhibits features that do not occur with objects in our ordinary experience. This is

why we must use more abstract terms when we describe atomic reality. It may seem incredible to the noninitiated that an electron behaves in certain situations like a wave and in others like a particle.

In A.P. French and P.J. Kennedy (eds.)

*Niels Bohr: A Centenary Volume*

Niels Bohr, The Quantum, and the World (pp. 24–25)

Harvard University Press. Cambridge, Massachusetts, USA. 1985

**Wheeler, John Archibald** 1911–

American physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

Even with the lowly electron one must participate before one can give any meaning whatsoever to its position or its momentum. Is this firmly established result the tiny tip of a giant iceberg?... Great as was the crisis of 1911, today gravitational collapse confronts physics with its greatest crisis ever. At issue is the fate, not of matter alone, but of the universe itself... No more revolutionary views of man and the universe has one ever been driven to consider seriously than those that come out of pondering the paradox of collapse, the greatest crisis of physics of all time.

In Charles W. Misner et al

*Gravitation*

Part X, Chapter 44 (p. 1198)

W.H. Freeman & Company. San Francisco, California, USA. 1973

That an electron here has the same mass as an[other] electron... is also a triviality or a miracle. It is a triviality in quantum electrodynamics because it is assumed rather than derived. However, it is a miracle on any view that regards the universe as being from time to time “reprocessed.” How can electrons at different times and places in the present cycle of the universe have the same mass if the spectrum of particle masses differs between one cycle of the universe and another?...

Are particles of the same pattern identical in anyone cycle of the universe because they give identically patterned views of the same universe? No acceptable explanation for the miraculous identity of particles of the same type has ever been put forward. That identity must be regarded, not as a triviality, but as a central mystery of physics.

*Gravitation*

Part X, Chapter 44 (p. 1215)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The electrons seems to be borrowing the character which some people have assigned to the Mahatmas of Tibet.

*Science and the Modern World*

Chapter II (p. 53)

The Macmillan Company. New York, New York, USA. 1929

**Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer

...the electron seems to be aware of its own existence. It interacts with itself like any little self-abusive boy behind locked doors. When it does this it generates infinities – an infinite amount of energy, for example. But when mother-physicist comes home and opens the atomic door and observes the electron, the little angel is peacefully obeying the rules of the universe.

*Parallel Universes*

Chapter 6 (pp. 69–70)

Simon & Schuster. New York, New York, USA. 1988

**ELEGANCE****Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

In a word, the sentiment of mathematical elegance is naught else than the satisfaction due to some, I know not just what, adaptation between the solution just found and the needs of our mind, and it is because of this adaptation itself that the solution becomes an instrument to us.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (pp. 126–127)

Government Printing Office. Washington, D.C. 1910

**ELEMENT****Arnott, Neil** 1788–1874

Scottish physician

If it excite our admiration that a varied edifice, or even a magnificent city can be constructed of stone from one quarry, what must our feeling be to learn how few and simple the elements are out of which the sublime fabric of the universe, with all its orders of phenomena, has arisen, and is now sustained. These elements are general facts and laws which human sagacity is able to detect, and then to apply to endless purposes of human advantage.

*Elements of Physics*

Synopsis, or General Review (p. 19)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1856

If it excite our admiration that a varied edifice, or even a magnificent city can be constructed of stone from one quarry, what must our feeling be to learn how few and simple the elements are out of which the sublime fabric of the universe, with all its orders of phenomena, has arisen, and is now sustained.

*Elements of Physics*

Synopsis (p. 19)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1856

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

It seems not absurd to conceive that at the first production of mixed bodies, the universal matter whereof they among other parts of the universe consisted, was actually divided into little particles of several sizes and shapes variously moved.

*The Sceptical Chymist*

The First Part, Proposition I (p. 30)

Dawsons of Pall Mall. London, England. 1965

...I now mean by elements...certain Primitive and Simple, or perfectly unmingled bodies; which not being made of any other bodies, or of one another, are the Ingredients of which all those call'd perfectly mixt Bodies are immediately compounded, and into which they are ultimately resolved...

*The Sceptical Chymist*

The Sixth Part (p. 350)

Dawsons of Pall Mall. London, England. 1965

I must not look upon any body as a true principle or element, which is not perfectly homogeneous, but is further resolvable into any number of distinct substances.

In Eric John Holmyard

*Makers of Chemistry*

Robert Boyle (p. 138)

The Clarendon Press. Oxford, England. 1931

**Browne, B. P.**

No biographical data available

Every chemical element is regarded as having a distinct nature of its own, which nature, moreover, determines all its activities.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 7 (p. 96)

Longmans. London, England. 1967

**Clarke, Frank Wigglesworth** 1847–1931

American chemist

If, despite Mendeléeff's recent demurrer, we assume that the elements have been evolved from one primordial form of matter, their relative abundance becomes suggestive.

*Bulletin of the Philosophical Society of Washington*, Volume 11,

1889 (p. 131)

**Cowper, William** 1731–1800

English poet

Some say that in the origin of things,  
When all creation started into birth,  
The infant elements receiv'd a law  
From which they swerve not since.



*The Poetical Works of William Cowper*

The Task

Book 6

John W. Lovell Company. New York, New York, USA. No date

**Crookes, Sir William** 1832–1919

English chemist and physicist

These elements perplex us in our researches, baffle us in our speculations and haunt us in our very dreams. They stretch like an unknown sea before us, mocking, mystifying, and murmuring strange revelations and possibilities.

In C. Baskerville

The Elements: Verified and Unverified,

*Science*, New Series, Volume 19, Number 472, 15 January, 1904 (p. 93)

To discover a new element is a very fine thing but if you could decompose an element and tell us what it is made of – that would be a discovery indeed worth making.

*British Association Report*, 1887 (p. 559)

**Davidson, John** 1857–1909

Scottish poet

Fleet Street was once a silence in the ether.

The carbon, iron, copper, silicon,

Zinc, aluminum vapours, metalloids,

Constituents of the skeleton and shell

Of Fleet Street – of the woodwork, metalwork,

Brickwork, electric apparatus, drains

And printing-presses, conduits, pavement, road –

Were at the first unelemented space,

Imponderable tension in the dark

Consummate matter of eternity.

*Fleet Street*, 1. 54–62

Mitchell, Kennerley. New York, New York, USA. 1909

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

What connection do the books show between the fifty or sixty chemical elements and the historical eras?

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

History (p. 256)

The Library of America. New York, New York, USA. 1983

The four-quarters of the globe are no longer Europe, Asia, Africa and America, but Carbon, Oxygen, Hydrogen, and Nitrogen.

*The Works of Ralph Waldo Emerson* (Volume 3)

*Farming* (p. 303)

Harper & Brothers. New York, New York, USA. 1925

**Empedocles of Acragas** ca. 490 BCE–430 BCE

Greek pre-Socratic philosopher

...I shall tell you of a double process. At one time it increased so to be a single One out of Many; at another time it grew apart so as to be Many out of One – Fire and Water and Earth and the boundless height of Air...these things alone exist, and running through one another they become different things at different times, and are ever continuously the same.

In Kathleen Freeman

*Ancilla to the Pre-Socratic Philosophers*

Section 31. Empedocles of Acragas, 17 (pp. 53–54)

Harvard University Press. Cambridge, Massachusetts, USA. 1956

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

I am convinced that the spectrum of all chemical elements can be obtained...from quantum theory in a unique manner without physics by boneheaded calculation.

In Keith Hannabuss

*An Introduction to Quantum Theory*

Letter to Pascual Jordan, July 28, 1926 (p. 235)

Oxford University Press, Inc. Oxford, England. 1997

**Huxley, Thomas Henry** 1825–95

English biologist

When we know that living things are formed of the same elements as the inorganic world, that act and react upon it, bound by a thousand ties of natural piety, is it probable, nay is it possible, that they and they alone, should have no order in their seeming disorder, no unity in their seeming multiplicity, should suffer no explanation by the discovery of some central and sublime law of mutual connection?

*Collected Essays* (Volume 2)

*Darwiniana*

The Darwin Hypothesis (p. 13)

Macmillan & Company Ltd. London, England. 1904

**Keats, John** 1795–1821

English Romantic lyric poet

...To watch the abysm-birth of elements.

*The Complete Poetical Works and Letters of John Keats*

Endymion

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Kekule, August** 1829–96

German organic chemist

We have now come to the conviction that the chemical compounds found in the vegetable and animal kingdoms contain the same elements as the bodies existing in inanimate nature. We are convinced that in the one the elements obey the same laws as in the other, and consequently that no difference exists between inorganic and organic compounds with regard to either the matter or the forces concerned, or the number and the arrangement of the atoms.

In Carl Schorlemmer

*The Rise and Development of Organic Chemistry* (p. 84)

Macmillan & Co Ltd. London, England. 1894

**Kirkpatrick, Clifford** 1898–1970

American sociologist

The stars are flaming crucibles in which dancing electrons are combined and recombined as the elements take form in a process of cosmic alchemy.

*Religion in Human Affairs*

Chapter XVI (p. 454)

John Wiley & Sons, Inc. New York, New York, USA. 1929



**Lavoisier, Antoine Laurent** 1743–94  
French chemist

All that can be said upon the number and nature of elements is, in my opinion, confined to discussions entirely of a metaphysical nature. The subject only furnishes us with indefinite problems, which may be solved in a thousand different ways, not one of which, in all probability, is consistent with nature. I shall therefore only add upon this subject, that if, by the term elements, we mean to express those simple and indivisible atoms of which matter is composed, it is extremely probable we know nothing at all about them; but, if we apply the term elements, or principles of bodies, to express our idea of the last point which analysis is capable of reaching, we must admit, as elements, all the substances into which we are capable, by any means, to reduce bodies by decomposition.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xxiv)

Printed for William Creech. Edinburgh, Scotland. 1790

...if, by the term elements we mean to express those simple and indivisible atoms of which matter is composed, it is extremely probable that we know nothing about them; but if we apply the term elements, or principles of bodies, to express our idea of the last point which analysis is capable of reaching, we must admit as elements all the substances into which we are capable, by any means, to reduce bodies by decomposition. Not that we are entitled to affirm that these substances we consider as simple may not be compounded of two, or even of a greater number of principles; but since these principles cannot be separated, or rather since we have not hitherto discovered the means of separating them, they act with regard to us as simple substances, and we ought never to suppose them compounded until experiment and observation have proved them to be so.

*Elements of Chemistry*

Preface (pp. xxiii–xxiv)

Publisher undetermined

Edinburgh, Scotland. 1799

**Lewis, Edwin Herbert** 1866–1938  
American rhetorician, novelist, and poet

She ran over the list of elements and was astonished to find them arranged in a sort of musical scale. Each octave began with a sharp metallic clang and then became less metallic. She wondered why some great composer had not perceived this and written a symphony about it. In the evenings she began to improvise on the little old rosewood piano. When her fingers went flickering upward into the treble with soft murmurs or bright passion, and her delighted old father would ask her what she was playing, she would answer, “Oh, only oxygen.”

*White Lightning*

Chapter 74

Covici-McGee. Chicago, Illinois, USA. 1923

**Moissan, Henri** 1852–1907  
French chemist

The search for an element is always captivating.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 438)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Montague, James J.**

No biographical data available

The fact that Raphael was a whizz

At graphic composition

Was not at all because of his

Inordinate ambition.

Success, despite its practiced eye,

Would doubtless have defied him,

His greatness was created by

The elements inside him.

What's the Use of Worrying?

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 20, 20 October, 1932 (p. 257)

**Pallister, William Hales** 1877–1946  
Canadian physician

Within the atom is a whirling world,

A complex system in a vortex hurled:

Electrons charged with forces negative

Revolve around the protons positive

In varied spheres, in varied numbers, too,

Yet with a maximum of ninety-two

Designs, known as the elements to you

And proved by spectrum study to be true.

*Poems of Science*

Men and the Stars, Within the Atom (p. 51)

Playford Press. New York, New York, USA. 1931

**Rutherford, Ernest** 1871–1937  
English physicist

**Soddy, Frederick** 1877–1956  
English radiochemist

If elements heavier than uranium exist it is probable that they will be radioactive. The extreme delicacy of radioactivity as a means of chemical analysis would enable such elements to be recognized even if present in infinitesimal quantity. It is therefore to be expected that the number of radio-elements will be augmented in the future, and that considerably more than three at present recognized exist in minute quantity.

*Philosophical Magazine*, Volume 6, 1903 (p. 5:576)

**Sacks, Oliver W.** 1933–  
American neurologist and author

Thinking of all the malodorous sulfur compounds and the atrocious smell of selenium and tellurium compounds, I decided that these three elements formed an olfactory

as well as a chemical category, and thought of them thereafter as the “stinkogens.”

*Uncle Tungsten, Memories of a Chemical Boyhood*

Chapter 8 (p. 89)

Alfred A. Knopf. New York, New York, USA. 2001

**Shapley, Harlow** 1885–1972

American astronomer

Our studies of the universe show the uniformity of its chemical structure and generally of its physical laws. We are made of the same stuff as the stars, so when we study astronomy we are in a way only investigating our remote ancestry and our place in the universe of star stuff. Our very bodies consist of the same chemical elements found in the most distant nebulae, and our activities are guided by the same universal rules.

The Star Stuff That Is Man

*New York Times*, August 11, 1929

## ALUMINUM

**Verne, Jules** 1828–1905

French novelist

Aluminum cried his three colleagues in chorus.

“Unquestionably, my friends. This valuable metal possesses the whiteness of silver, the indestructibility of gold, the tenacity of iron, the fusibility of copper, the lightness of glass. It is easily wrought, it is very widely distributed, forming the base of most of the rocks, is three times lighter than iron, and seems to have been created for the express purpose of furnishing us with the material for our projectile.”

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter VII (p. 40)

A.L. Burt Company. New York, New York, USA. 1890

It is easily worked; it is widely spread in nature, alumina forming the bases of most rocks; it is three times lighter than iron; in short, it seems to have been created expressly to furnish material for our projectile!

*From Earth to the Moon*

Chapter VII (p. 50)

Barnes & Nobel Publishing. New York, New York, USA. 2005

## ANTIMONY

**Renaudot, Eusébe** 1646–1720

French theologian

We, the undersigned Doctors of medicine of the Faculty of Paris, certify to all to whom it may concern, that the qualities of antimony are recognized by us to be very useful for the cure of a number of illnesses. We certify this on the basis of long usage and continued experience. Further we declare that this remedy which has for so long been charged with having a poisonous malignity has

many rare virtues and that a physician can successfully employ it to combat a great number of diseases provided that he uses it with a prudence and discretion.

In Allen G. Debus

*The French Paracelsians*

Chapter 3 (p. 97)

Cambridge University Press. Cambridge, England. 1991

**Valentinus, Basilus** 1394–?

Alchemist

But antimony, like mercury, can best be compared to a round circle without end...and the more one investigates it, by suitable means, the more one discovers in it and learns from it; it cannot be mastered, in short, by one person alone because of the shortness of human life.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 95)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

## ARGON

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

Indeed, I have seen some indications that the anomalous properties of argon are brought as a kind of accusation against us. But we had the very best intentions in the matter. The facts were too much for us, and all that we can do now is apologize for ourselves and for the gas.

*Royal Institution Proceedings*, Volume 14, 1895 (p. 524)

## ARSENIC

**Valentinus, Basilus** 1394–?

Alchemist

For smelter fumes have I been named.

I am an evil, poisonous smoke.

But when from poison I am freed,

Through art and sleight of hand,

Then can I cure both man and beast,

From dire disease oft times direct them;

But prepare me correctly, and take great care

That you faithfully keep watchful guard over me;

For else am I poison, and poison remain,

That pierces the heart of many a one.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 20)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

## BISMUTH

**Calvino, Italo** 1923–1985

Italian writer and novelist

“Now a bismuth isotope is going to come out!” I said hastily, watching the newborn elements crackle froth from the crucible of a “supernova” star. “Let’s bet!”

Translated by William Weaver

*Cosmicomics*

How Much Shall We Bet? (p. 88)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

## CARBON

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

You will die but the carbon will not...[but] will return to the soil, and there a plant may take it up again in time, sending it once more on a cycle of plant and animal life.

Biography of an Atom – and the Universe

*New York Times*, 13 October, 1968

**Darwin, Erasmus** 1731–1802

English physician and poet

Hence sable coal his massy couch extends;  
And stars of gold that sparkle pyrite blends;  
Hence dull-eyed naphtha pours his pitchy streams,  
And jet uncoloured drinks the solar beams.

*The Botanic Garden*

Part I, Canto II, VI, l. 349–352

Jones & Company. London, England. 1825

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Somewhere, somehow, sometime, in the mysterious chemistry of carbon, the long march toward the talking animal had begun.

*The Immense Journey*

The Secret of Life (p. 198)

Random House, Inc. New York, New York, USA. 1957

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...life exists in the universe only because the carbon atom possesses certain exceptional properties.

*The Mysterious Universe*

Chapter I (p. 9)

The Macmillan Company. New York, New York, USA. 1932

**Prout, William** 1785–1850

English physician and chemist

...it is perhaps difficult to say what is most wonderful; but we have often thought that the Deity has displayed a greater stretch of power, in accommodating to such an extraordinary variety of changes, a material so unpromising and so refractory as charcoal, and in finally uniting it with the human mind, than was requisite for the creation of the human mind itself.

*Chemistry, Meteorology, and the Function of Digestion Considered With Reference to Natural Theology*

Book III, Chapter I (pp. 442–443)

William Pickering. London, England. 1834

## CHLORINE

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

Air, nitrogen, oxygen, hydrogen, carbonic-acid gas, and carbon monoxide are gases that not even the sharpest eyes can see; and most other gases are of like character in this respect, so that gases as a class are thought of by us as invisible. Now, however, we have a gas that is as subtle and impalpable as the others and yet can be seen very well.

*The Wonder Book of Chemistry*

Chlorine

A. & C. Boni. New York, New York, USA. 1930

## COBALT

**Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

Like most men he loved blue, and what he chiefly loved was a soft cobalt blue saturated with white light, as in petals of forget-me-not.

*White Lightning*

Chapter 27

Covici-McGee. Chicago, Illinois, USA. 1923

## COPPER

**Stephanus of Alexandria** ca. 620 AD

Byzantine philosopher, astronomer, and teacher

It is necessary to deprive matter of its qualities in order to draw out its soul.... Copper is like a man; it has a soul and a body;...the soul is the most subtle part...that is to say, the tinctorial spirit. The body is the ponderable, material, terrestrial thing, endowed with a shadow.... After a series of suitable treatments copper becomes without shadow and better than gold.

Quoted in Matthew Moncrieff Pattison Muir

*A History of Chemical Theories and Laws*

Part I, Chapter I (p. 5)

John Wiley & Sons. New York, New York, USA. 1907

## GOLD

**Geoffroy the Elder** 1672–1731

French chemist

...the most valuable and most precious of all Metals is the most useless in Physick, except when considered as an Antidote to Poverty.

*A Treatise of the Fossil, Vegetable and Animal Substances That Are Made Use of In Physik*

Printed for W. Innys & R. Manby. London, England. 1736

**Jonson, Ben** 1573?–1637

English dramatist and poet

Aye, for 'twere absurd to think  
That Nature in the Earth bred gold,  
Perfect in the instant.

*The Alchemist*

Act II, Scene 3, l. 139–141

Yale University Press. New Haven, Connecticut, USA. 1974

**Muir, John** 1838–1914

American naturalist

...for the strangely exciting stuff (gold) makes the timid  
bold enough for anything and the lazy destructively  
industrious.

*Our National Parks*

Chapter I (p. 11)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Even in Congress a sizable chunk of gold, carefully concealed,  
will outtalk and outfight all the nation on a subject like forestry...

Gold, gold, gold! How strong a voice that metal has!

*Our National Parks*

Chapter X (p. 361)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Gold, the grand attraction that lights the way into all  
kinds of wilderness and makes rough places smooth.

*Steep Trails*

Chapter XVII (p. 216)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## HELIUM

**Morris, Robert Tuttle** 1857–1945

American surgeon

When atoms lead the dance in matter, helium is the musician  
giving time and measure.

*Microbes and Men*

Chapter I (p. 34)

Doubleday Page & Co. Garden City, New York, USA. 1916

## HYDROGEN

### Author undetermined

To understand hydrogen is to understand all of physics.

Source undetermined

**Calvino, Italo** 1923–1985

Italian writer and novelist

When I was a kid, the only playthings we had in the  
whole universe were the hydrogen atoms, and we played  
with them all the time, I and another youngster my age  
whose name was Pfwfp.

What sort of games? That's simple enough to explain.  
Since space was curved, we sent the atoms rolling along  
its curve, like so many marbles, and the kid whose atom  
went farthest won the game.

Translated by William Weaver

*Cosmicomics*

Games Without End (p. 63)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

**Dalton, John** 1766–1844

English chemist and physicist

No new creation or destruction of matter is within the  
reach of chemical agency. We might as well attempt to  
introduce a new planet into the solar system, or to annihilate  
one already in existence, as to create or destroy a  
particle of hydrogen.

*New System of Chemical Philosophy* (Volume 1)

Part I, Chapter III (p. 212)

R. Bickerstaff. London, England. 1810

**Faraday, Michael** 1791–1867

English physicist and chemist

Although we should be able, from a knowledge of the  
importance of water, to form a very exalted idea of the  
value of hydrogen, as one of the elements which constitute  
it, yet it is by no means the highest point of view in  
which it can be placed before you. The attempt, indeed, to  
estimate the value of anyone element in nature would be  
vain and presumptuous, for it is not possible that we can  
understand every use to which it may be and is constantly  
applied; yet still I think it is proper that we should evince  
our consciousness, as far as it extends, of the benefits we  
continually enjoy.

In Bence Jones

*The Life and Letters of Faraday* (Volume 1)

Chapter IV (p. 220)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

## IODINE

**Pallister, William Hales** 1877–1946

Canadian physician

When you insist on living far inland  
And do not get your fish-food from the sea;  
When you forsake the ocean and the sand  
And cease to feed the fish you used to be;  
Perhaps you do not fully understand,  
If you disclaim your race,  
You'll get a funny-face.

So satisfy your iodine demand.

*Poems of Science*

De Ipsa Natura, Iodine (p. 221)

Playford Press. New York, New York, USA. 1931

## IRON

**Steele, Joel Dorman** 1836–86

American educator

Iron is Nature's universal dye. Without it the soil would  
be a dirty white – the color of snow in a time of thaw.

Instead of the pretty lively color of sand and pebbles, we should see the dull and somber hue of ashes; and instead of the glittering sand of the sea and lake shore, a plain drab or gray, which no wealth of sunshine or of spray could turn to beauty.

*The Story of the Rocks: Fourteen Weeks in Popular Geology*

Chapter II (p. 46)

A.S. Barnes & Co. New York, New York, USA. 1870

## LEAD

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Lead is the humblest of the metals; it is always put where it is invisible – and where it is indispensable. It is put on the keels of boats, where nobody can see it and everybody relies on it. It is put in the shrouds of the sea-sunken dead, whom we desire to see no more.

*Lunacy and Letters*

The Love of Lead (pp. 158–159)

Sneed & Ward, Inc. New York, New York, USA. 1958

## MERCURY

**Darwin, Erasmus** 1731–1802

English physician and poet

On vermil beds in Idria's mighty caves  
The living silver rolls its ponderous waves.

*The Botanic Garden*

Part I, Canto II, VII, l. 405–406

Jones & Company. London, England. 1825

**Flaubert, Gustave** 1821–90

French novelist

Mercury. Kills the patient with the disease.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Waite, A. E.**

No biographical data available

It is a fluid  
but does not moisten,  
and runs about,  
though it has no feet.

*The Hermetic and Alchemical Writings of Aureolus Phillippus*

*Theophrastus* (Volume 1) (p. 136)

J. Elliott & Company. London, England. 1954

## NITROGEN

**Crookes, Sir William** 1832–1919

English chemist and physicist

The fixation of nitrogen is vital to the progress of civilized humanity, and unless we can class it among the certainties to come, the great Caucasian race will cease to be the

foremost in the world, and will be squeezed out by the races to whom wheat bread is not the staff of life.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 23 (p. 421)

Longmans. London, England. 1967

**Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

There were persons in the faculty who were conscious of nitrogen, but the Riches were not. They were literary and easily deceived. They took their nitrogen as it came, and really thought it was peas and beans and eggs. They never stopped to think that they were constantly inhaling and exhaling nitrogen without brushing a single electron off its surface.

*White Lightning*

Chapter 7 (p. 39)

Covici-McGee. Chicago, Illinois, USA. 1923

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

For nitrogen plays a double role in human economy. It appears like Brahma in two aspects, Vishnu the Preserver and Siva the Destroyer.

In Bernard Jaffe

*New World of Chemistry*

Chapter 17 (p. 225)

Silver, Burdett & Company. New York, New York, USA. 1935

...nitrogen is a most unreliable and unsociable element. Like Kipling's cat it walks by its wild lone.

*Creative Chemistry*

Chapter II (p. 16)

The Century Co. New York, New York, USA. 1919

The air is four-fifths free nitrogen and if we could absorb it in our lungs as we do the oxygen of the other fifth a few minutes breathing would give us a full meal. But we let this free nitrogen all out again through our noses and then go and pay 35 cents a pound for steak or 60 cents a dozen for eggs in order to get enough combined nitrogen to live on. Though man is immersed in an ocean of nitrogen, yet he cannot make use of it. He is like Coleridge's "Ancient Mariner" with "water, water, everywhere, nor any drop to drink."

*Creative Chemistry*

Chapter II (p. 25)

The Century Co. New York, New York, USA. 1919

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

I am much puzzled by some recent results as to the density of nitrogen, and shall be obliged if any of your chemical readers can offer suggestions as to the cause. According to two methods of preparation I obtain quite distinct values.

*Scientific Papers* (Volume 1) V

Density of Nitrogen (p. 1)

At the University Press. Cambridge, England. 1904

**OXYGEN****Curtis, Edward**

No biographical data available

Newly liberated oxygen is like a boy newly released from school, active, aggressive, and up to mischief generally. Accordingly “nascent” oxygen, set free from water by chlorine, seizes instantly upon anything within reach that is oxidizable and – and marries it on the spot! Then self and spouse become a staid couple to whom the pranks of unmarried days are now forgotten and impossible.

*Nature and Health: A Popular Treatise on the Hygiene of the Person and the Home*

Chapter X (p. 243)

Henry Holt & Co. New York, New York, USA. 1906

**Darwin, Erasmus** 1731–1802

English physician and poet

When air’s pure essence joins the vital flood,  
And with phosphoric acid dyes the blood,  
Your virgin trains the transient heat dispart,  
And lead the soft combustion round the heart...

*The Botanic Garden*

Part I, Canto I, VIII, l. 400–402

Jones & Company. London, England. 1825

**Fridovitch, Irwin**

No biographical data available

Oxygen is toxic! We, whose lives depend upon a considerable supply of oxygen do not easily comprehend its toxicity. Our apparent comfort at the ambient level of oxygen is due to elaborate defenses against its very considerable toxicity.

Oxygen Is Toxic

*BioScience*, Volume 27, Number 27, July 1977 (p. 462)

**Mayow, John** 1641–79

English chemist and physiologist

If a small animal and a lighted candle be placed in a closed flask, so that no air can enter, in a short time the candle will go out, nor will the animal long survive.... The animal is not suffocated by the smoke of the candle.... The reason why the animal can live some time after the candle has gone out seems to be that the flame needs a continuous rapid and full supply of nitro-aereal particles.... For animals, a less aereal spirit is sufficient.... The movements of the lungs help not a little towards sucking in aereal particles which may remain in said flask and towards transferring them to the blood of the animal.

In William Stirling

*Some Apostles of Physiology*

Mayow, John (p. 45)

Waterlow & Sons. London, England. 1902

**Priestley, Joseph** 1733–1804

English theologian and scientist

On the 8th of this month I procured a mouse, and put it into a glass vessel, containing two ounce-measures of the air from mercurius calcinatus. Had it been common air, a full-grown mouse, as this was, would have lived in it about a quarter of an hour. In this air, however, my mouse lived a full hour; and though it was taken out seemingly dead, it appeared to have been only exceedingly chilled; for, upon being held to the fire, it presently revived, and appeared not to have received any harm from the experiment.

*Experiments and Observations on Different Kinds of Air* (Volume 2)

Book IV, Part I, Section I

Discovery of Oxygen (p. 115)

Thomas Pearson. Birmingham, England. 1790

**Robby the Robot (fictional character)**

I rarely use oxygen myself, sir. It promotes rust.

*Forbidden Planet*

Film (1956)

**Tilden, Sir William Augustus** 1842–1926

English chemist

Oxygen is entirely unmatched among the rest of the elements, both as regards the number and varied character of its compounds, and the important part which it plays in relation to combustion and life.

*Introduction to the Study of Chemical Philosophy*

10th Section II, Chapter X (p. 161)

Longmans, Green & Co. London, England. 1901

**Traube, Moritz** 1826–94

German physiological chemist

Truly, the history of oxygen is the history of life!

In W. Coleman

*Biology in the Nineteenth Century: Problems of Form, Function, and Transformation*

Chapter VI Function: The Animal Machine (p. 135)

John Wiley & Sons, Inc. New York, New York, USA. 1971

**PHOSPHORUS****Author undetermined**

Red phosphorus is used for matches so that people who are in the habit of chewing matches will not suffer.

Class-Room Chemical Emanations

*Journal of Chemical Education*, Volume 3, Number 1, 1926

**Darwin, Erasmus** 1731–1802

English physician and poet

Or mark with shining letters Kunckel’s name  
In the pale phosphor’s self-consuming flame.



*The Botanic Garden*

Part I, Canto I, V, l. 231–2

Jones & Company. London, England. 1825

**Reade, Charles** 1814–84

English novelist and dramatist

...Gerard was busy about the seated corpse and to his amazement, Denys saw a luminous glow spreading rapidly over the white face. Gerard blew out the candle. And on this the corpse's face shone still more like a glow-worms' head. Denys shook in his shoes and his teeth chattered.

'What in Heaven's name is this?' he whispered.

'Hush! 'tis but phosphorus. But 'twill serve.'

In half a minute Gerard's brush made the dead head a sight to strike any man with dismay. He put his art to a strange use and one unparalleled perhaps in the history of mankind. He illuminated his dead enemy's face to frighten his living foe; the staring eyes he made globes of fire; the teeth he left white...but the palate and tongue he tipped with fire...and on the brow he wrote in burning letters LA MORT.

*The Cloister and the Health; or, Maid, Wife, and Widow* (Volume 2)

Chapter XXXII (p. 82)

Rudd & Carlton. New York, New York, USA. 1861

**Smollett, Tobias George** 1721–71

Scottish novelist

But you and I know, that such a phosphorus is obtained from the most worthless and corrupted materials, such as rotten wood, putrefied veal, and stinking whiting.

*The Miscellaneous Works of Tobias Smollett, M.D.: With Memoirs of His Life* (Volume 6)

The Adventures of an Atom (p. 420)

Printed for Sylvester Doig. Edinburgh, Scotland. 1811

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Yes, Agassiz does recommend authors to eat fish, because the phosphorus in it makes brain. So far you are correct. But I cannot help you to a decision about the amount you need to eat – -at least, not with certainty. If the specimen composition you send is about your fair usual average, I should judge that a couple of whales would be all you would want for the present. Not the largest kind, but simply good middling-sized whales.

In Alban Bertram de Mille

*Literature in the Century* (Volume 2)

Part I, Chapter XV (p. 319)

W.&R. Chambers. London, England. 1903

**RADIUM**

**Armstrong, Henry Edward** 1848–1937

English organic chemist

**Lowry, Thomas Martin** 1874–1936

English organic chemist

...nature has endowed radium alone of all the elements with incurable suicidal monomania ...

The Phenomena of Luminosity and their Possible Correlation with Radio-Activity

*The Chemical News and Journal of Industrial Science*, Volume 88, August 21, 1903 (p. 25)

**Boys, Charles Vernon** 1855–1944

English inventor and physicist

The discovery by Professor and Madame Curie of what seems to be the everlasting production of heat in easily measurable quantity by a minute amount of a radium compound is so amazing that, even now that many of us have had the opportunity of seeing with our own eyes the heated thermometer, we are hardly able to believe what we see. This, which can barely be distinguished from the discovery of perpetual motion, which it is an axiom of science to call impossible, has left every chemist and physicist in a state of bewilderment... [T]his mystery is being attacked, and theories are being invented to account for the marvellous results of observation; but the theories themselves would, a few years ago, have seemed more wonderful and incredible than the facts, as we believe them to be, do to-day... With all this mystery before us, which I must confess myself wholly unable to follow.

*Report of the Seventy-third Meeting of the British Association for the Advancement of Science*

Presidential Address

*Report of the Annual Meeting* (pp. 527, 528)

John Murray. London, England. 1904

**Curie, Marie Sklodowska** 1867–1934

Polish-born French physical chemist

Radium is not to enrich anyone. It is an element; it is for all people.

*Pierre Curie*

Introduction (p. 24)

The Macmillan Company. New York, New York, USA. 1926

It is impossible. It would be contrary to scientific spirit... Physicists always publish their researches completely. If our discovery has a commercial future, that is an accident by which we must not profit. And radium is going to be of use in treating disease... It seems to me impossible to take advantage of that.

In Eve Curie

*Madame Curie*

Chapter XV (p. 204)

The Literary Guild of America, Inc. New York, New York, USA. 1937

I must remark here that the bold interpretation of the relationship existing between radium and helium rests entirely upon the certitude that radium has the same claim to be a chemical element as have all the other known elements, and that there can be no question of regarding it to be a molecular combination of helium with another element.

*Nobel Lectures, Chemistry 1901–1921*

Radium and the New Concepts in Chemistry

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Curie, Pierre** 1859–1906

French physicist

...radium could become dangerous in criminal hands, and here the question can be raised whether mankind benefits from knowing the secrets of Nature, whether it is ready to profit from it or whether this knowledge will not be harmful for it.

*Nobel Lectures, Physics 1901–1921*

Radioactive Substances, Especially Radium

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Horton, F.**

No biographical data available

A radium atom was dying,  
And just ere it burst up for aye,  
Corpuscles, which round it were flying,  
These last dying words heard to say.  
Oh, I am a radium atom.

The Radium Atom

*The American Physics Teacher*, Volume 7, Number 3, June, 1939 (p. 181)

**Rickard, Dorothy**

No biographical data available

Little Willie, full of glee,  
Put radium in Grandma's tea.  
Now he thinks it quite a lark  
To see her shining in the dark.

Source undetermined

Little Willie

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

'And so,' said the professor, 'we see that this Radium, which seemed at first a fantastic exception, a mad inversion of all that was most established and fundamental in the constitution of matter, is really at one with the rest of the elements. It does noticeably and forcibly what probably all the other elements are doing with an imperceptible slowness. It is like the single voice crying aloud that betrays the silent breathing multitude in the darkness.'

*The World Set Free*

Prelude, Section 8 (p. 22)

Charles Scribner's Sons. New York, New York, USA. 1926

## SODIUM

**Glashow, Sheldon L.** 1932–

American physicist

That is why the stove's flame turns yellow when the soup boils over. The table salt in the soup contains sodium, whose dominant spectral lines are bright yellow.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 3 (p. 50)

Warner Books. New York, New York, USA. 1988

## SULPHUR

**Author undetermined**

...the most useful of all volcanic productions is native sulphur, in which Mount Etna has been very prolific. It is to this mountain chiefly, therefore, that we are indebted for our beautiful fire-works – our squibs, crackers, Roman candles, serpents, Catherine-wheels, and sky-rockets. Would it had produced nothing more harmful than these! But it has also supplied one of the ingredients of that villainous gunpowder, which has been the means of thrusting so many of our fellow-creatures prematurely out of the world.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter 1

T. Nelson. London, England. 1890

But the most useful of all volcanic productions is native sulphur, in which Mount Etna has been very prolific. It is to this mountain chiefly, therefore, that we are indebted for our beautiful fire-works – our squibs, crackers, Roman candles, serpents, Catherine-wheels, and sky-rockets. Would it had produced nothing more harmful than these! But it has also supplied one of the ingredients of that villainous gunpowder, which has been the means of thrusting so many of our fellow-creatures prematurely out of the world.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter I

T. Nelson. London, England. 1890

**Duchesne, Joseph** 1544–1609

French Paracelsist

For as a man can never make a good closing mortar, of water and sand only, without the mixture of lime, which bindeth the other two together like oile and glue: so Sulphur as the oily substance is the mediator of Salt and Mercurie, and coupleth them both together: neither doth it only couple them to death, but it also represses and temperate the acrimonie of Salt, and the sharpnesse of Mercurie, which is found to bee very much therein.

In Allen G. Debus

*The French Paracelsians*

Chapter 3 (p. 55)

Cambridge University Press. Cambridge, England. 1991

**Masini, Count Vincenzo**

No biographical data available

Within the rocks, among the thorns,  
Between the cliffs, sulfur takes root;  
For gold, silver, copper, iron, and sulfur  
Likewise are plants.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 55)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

The smell of sulphur is strong, but not unpleasant for a sinner.

*Roughing It* (Volume 2)

Chapter XXXIII (p. 301)

Harper &amp; Brothers. New York, New York, USA. 1899

**TITANIUM****Klaproth, Martin Heinrich** 1743–1817

German chemist

Whenever no name can be found for a new fossil which indicates its peculiar and characteristic properties (in which situation I find myself at present), I think it best to choose such a denomination as means nothing of itself, and thus can give no rise to any erroneous ideas. In consequence of this, as I did in the case of uranium, I shall borrow the name for this metallic substance from mythology, and in particular from the Titans, the first sons of the earth. I therefore call this new metallic genus TITANIUM.

*Analytical Essays Towards Promoting the Chemical Knowledge of Mineral Substances*

Chapter XIV (p. 210)

T. Cadell. London, England. 1801

**URANIUM****Atkins, Peter William** 1940–

English theoretical chemist

...while the [strong] force has mastery over the little nuclei of light atoms, at uranium, with a couple of hundred particles packed into the nucleus, it is losing control, and the nucleus tends to fall apart. Whether or not it does so in a controlled way determines the level of social benevolence of the outcome.

*The Creation*

Chapter 1 (p. 13)

W.H. Freeman &amp; Co. Oxford, England. 1981

**Einstein, Albert** 1879–1955

German-born physicist

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future.

In Otto Nathan and Heinz Norden (eds.)

*Einstein on Peace*

Letter to F.D. Roosevelt

August 2, 1939

Simon &amp; Schuster. New York, New York, USA. 1960

**Glenn, Artie**

American song writer

Uranium, uranium, uranium, uranium

I'm gonna dig it some more!

Ooby, ooby, ooby, ooby.

*Uranium*

Sung by The Commodores

Dot 15 372, 1955

**Klaproth, Martin Heinrich** 1743–1817

German chemist

The number of known metals had been increased by one – from 17 to 18.... A few years ago we thrilled to hear of the discovery of the final planet by Sir William Herschel. He calls the new member of our solar system Uranus. I propose to borrow from the honor of that great discovery and call this new element Uranium.

In Lennard Bicknel

*The Deadly Element, the Story of Uranium* (p. 21)

Stein &amp; Day. New York, New York, USA. 1979

**Snow, Charles Percy** 1905–80

English novelist and scientist

...Bevill showed us his private dossier of the uranium project. We must not refer to it again by that name, he said: as with other projects of high secrecy, he copied out the "appreciations" in his own hand, keeping no copies: the documents were then mounted in a loose-leaf cover, on which he printed a pet name.

"I'm going to show you my name for this new stunt," he said, with a smile that was frank, shy and eager. And into that smile there crept the most salacious pleasure that many men show as they talk of secrets.

He turned over the cover, and we saw, painted in bold capitals, the words:

MR TOAD

"That's what we'll call it here, if you don't mind," he added.

*The New Men* (p. 17)

Charles Scribner's Sons. New York, New York, USA. 1955

**ZINC****Levi, Primo** 1919–87

Italian writer and chemist

Zinc, Zinck, zinco: they make tubs out of it for laundry, it is gray and its salts are colorless, it is not toxic, nor does it produce striking chromatic reactions; in short, it is a boring metal.

Translated by Raymond Rosenthal

*The Periodic Table*

Zinc (p. 33)

Schocken Books. New York, New York, USA. 1984

**ELEMENTARY****Corben, Herbert Charles** 1914–

Physicist

**de Benedetti, S.**

O biographical data available

“Elementary” is a delightfully ambiguous word. It can mean that which is easily understood (“Elementary, my dear Watson”) or that which is so fundamental that it is not understood at all.

The Ultimate Atom

*Scientific American*, Volume 191, Number 6, December, 1954 (p. 88)**ELEMENTS****Dalton, John** 1766–1844

English chemist and physicist

We do not know that anyone of the bodies denominated elementary, is absolutely decomposable ...

*A New System of Chemical Philosophy*

Part II

Chapter IV (pp. 221–222)

Printed by Russell &amp; Allen. Manchester, England 1810

**Lavoisier, Antoine Laurent** 1743–94

French chemist

It will, no doubt, be a matter of surprise, that in a treatise upon the elements of chemistry, there should be no chapter on the constituent and elementary parts of matter; but I shall take occasion, in this place, to remark, that the fondness for reducing all the bodies in nature to three or four elements, proceeds from a prejudice which has descended to us from the Greek Philosophers. The notion of four elements, which, by the variety of their proportions, compose all the known substances in nature, is a mere hypothesis, assumed long before the first principles of experimental philosophy or of chemistry had any existence. In those days, without possessing facts, they framed systems; while we, who have collected facts, seem determined to reject them, when they do not agree

with our prejudices. The authority of these fathers of human philosophy still carry great weight, and there is reason to fear that it will even bear hard upon generations yet to come.

Translated by Robert Kerr

*Elements of Chemistry* (Volume 1) (5th edition)

Preface (pp. xxv–xxvi)

Printed for W. Creech. Edinburgh, Scotland. 1802

All that can be said upon the number and nature of elements is, in my opinion, confined to discussions entirely of a metaphysical nature. The subject only furnishes us with indefinite problems, which may be solved in a thousand different ways, not one of which, in all probability, is consistent with nature. I shall therefore only add upon this subject, that if, by the term *elements*, we mean to express those simple and indivisible atoms of which matter is composed, it is extremely probable we know nothing at all about them; but, if we apply the term *elements*, or , to express our idea of the last point which analysis is capable of reaching, we must admit, as elements, all the substances into which we are capable, by any means, to reduce bodies by decomposition.

Translated by Robert Kerr

*Elements of Chemistry* (Volume 1) (5th edition)

Preface (pp. xxvii–xxviii)

Printed for W. Creech. Edinburgh, Scotland. 1802

**Millikan, Robert Andrews** 1868–1953

American physicist

We have been forced to admit for the first time in history not only the possibility of the fact of the growth and decay of the elements of matter. With radium and with uranium we do not see anything but the decay. And yet, somewhere, somehow, it is almost certain that these elements must be continuously forming. They are probably being put together now in the laboratory of the stars.... Can we ever learn to control the process. Why not? Only research can tell.

The Significance of Radium

*Science*, Volume LIV, Number 1383, July 1, 1921 (p. 5, 6)**Wald, George** 1906–97

American biologist and biochemist

Surely this is a great part of our dignity...that we can know, and that through us matter can know itself; that beginning with protons and electrons, out of the womb of time and the vastness of space, we can begin to understand; that organized as in us, the hydrogen, the carbon, the nitrogen, the oxygen, those 16 to 21 elements, the water, the sunlight – all, having become us, can begin to understand what they are, and how they came to be.

The Origins of Life

*Proceedings of the National Academy of Science USA*, Volume 52, Number 2, August, 1964 (p. 610)

**ELLIPSE****Author undetermined**

The sky is an immense place where everything moves in its own way. Some go faster than others, some turn around themselves while they are going around the sun and each other. Sometimes the fast ones catch up with the slow ones and that is an eclipse. Also, when the moon gets in the way we can't see the sun, and that is an eclipse too and everybody talks about it.

That is an important eclipse.

*The Sky*

Reported by little girl who visited the Hayden Planetarium  
December, 1939 (p. 25)

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

A circle no doubt has a certain appealing simplicity at the first glance, but one look at a healthy ellipse should have convinced even the most mystical of astronomers that that the perfect simplicity of the circle is akin to the vacant smile of complete idiocy. Compared to what an ellipse can tell us, a circle has nothing to say.

*The Handmaiden of the Sciences* (p. 26)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1937

It is also of interest in passing to record that at least some of the early astronomers favored the circle on account of its supposed harmonious perfection, not suspecting that a circle, with its smug rotundity, is little better than a geometrical platitude. A circle no doubt has a certain appealing simplicity at the first glance, but one look at a healthy ellipse should have convinced even the most mystical of astronomers that the perfect simplicity of the circle is akin to the vacant smile of complete idiocy.

*The Handmaiden of the Sciences*

Chapter 2 (p. 26)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Feynman, Richard P.** 1918–88

American theoretical physicist

I prefer to give you a demonstration that it's an ellipse in a completely strange, unique, [and] different way than you are used to. I am going to give what I will call an elementary demonstration. [But] "elementary" does not mean easy to understand. "Elementary" means that very little is required to know ahead of time in order to understand it, except to have an infinite amount of intelligence.

In David L. Goodstein and Judith R. Goodstein

*Feynman's Lost Lecture: The Motion of Planets Around the Sun*

The Motion of Planets Around the Sun, (March 13, 1964) (p. 148)

W.W. Norton & Company. New York, New York, USA. 1996

**Zelazny, Roger** 1937–55

American writer of fantasy and science fiction

An ellipse is fine for as far as it goes,

But modesty, away!

If I'm going to see Beauty without her clothes

Give me hyperbolas any old day.

*Doorways in the Sand*

Chapter 4 (p. 41)

Harper & Row, Publishers. New York, New York, USA. 1976

**ELLIPTIC FUNCTION****Bellman, Richard** 1920–84

Applied mathematician

The theory of elliptic functions is the fairyland of mathematics. The mathematician who once gazes upon this enchanting and wondrous domain crowded with the most beautiful relations and concepts is forever captivated.

*A Brief Introduction to Theta Functions*

Foreword (p. vii)

Holt, Rinehart & Winston. New York, New York, USA. 1961

**EMBELLISHMENT****Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Of all embellishments by which the efforts of man can enhance the beauty of natural scenery, those are the most effective which can give animation to the scene, while the spirit which they bestow is in unison with its general character.

*The Poetry of Architecture: Cottage, Villa, Etc*

The Cottage (p. 7)

John Wiley & Sons. New York, New York, USA. 1877

**EMERGENCE****Holland, John** 1929–

American computer scientist

It is unlikely that a topic as complicated as emergence will submit meekly to a concise definition, and I have no such definition.

*Emergence: From Chaos to Order*

Chapter 1 (p. 3)

Addison-Wesley Publishing, Inc. Reading, Massachusetts, USA. 1998

**EMOTION****Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

...the eyes of the investigator have neither laughter nor tears. In the actual work of science, emotion is dangerous.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 28)

William & Norgate. London, England. 1920



## EMPIRICISM

**von Liebig, Justus** 1803–73

German organic chemist

Science renders the powers of nature the servants of man, whilst empiricism subjects man to their service.

In John Gardner

*Familiar Letters on Chemistry*

Second Series

Letter II (p. 40)

Taylor &amp; Walton. London, England. 1844

## EMPIRICIST

**Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

The empiricist...thinks he believes only what he sees, but he is much at believing than at seeing.

*Skepticism and Animal Faith*

## ENDS AND MEANS

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

When Man makes an implement, he knows the purpose for which he makes it he knows the function assigned to it in his own intention. But as in making it there are a thousand chips and fragments of material which he casts aside, so in its final use it often produces consequences and results which he did not contemplate or foresee. But in Nature all this is different. Nature has no chips or fragments which she does not put to use; and as on the way to her apparent ends there are no incidents which she did not foresee, so beyond those ends there are no ulterior results which do not open out into new firmaments of Design.

*The Reign of Law* (4th American edition)

Chapter 2 (p. 81)

George Routledge &amp; Sons. New York, New York, USA. 1873

## ENERGY

**Aston, Francis W.** 1877–1945

English physicist and chemist

Should the research worker of the future discover some means of releasing this [atomic] energy in a form which could be employed, the human race will have at its command powers beyond the dreams of science fiction; but the remote possibility must always be considered that the energy once liberated will be completely uncontrollable and by its intense violence detonate all neighboring

substances. In this event the whole of the hydrogen on the earth might be transformed at once and the success of the experiment published at large to the universe as a new star.

*Nobel Lectures, Chemistry 1922–1941*

Nobel lecture for award received in 1922

Mass Spectra and Isotopes (p. 20)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Bachelard, Gaston** 1884–1962

French philosopher

The laboratory technician has succeeded in implementing by means of the atomic pile the Einsteinian principle of inertia of energy.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

The Philosophic Dialectic of the Concepts of Relativity, V (pp. 577–578)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Barrow, John D.** 1952–

English theoretical physicist

**Silk, Joseph** 1943–

Cosmologist

[Virtual particle pairs] are predicted to have a calculable effect upon the energy levels of atoms. The effect expected is minute – only a change of one part in a billion, but it has been confirmed by experimenters.

In 1953 Willis Lamb measured this excited energy state for a hydrogen atom. This is now called the Lamb shift. The energy difference predicted by the effects of the vacuum on atoms is so small that it is only detectable as a transition at microwave frequencies. The precision of microwave measurements is so great that Lamb was able to measure the shift to five significant figures. He subsequently received the Nobel Prize for his work. No doubt remains that virtual particles are really there.

*The Left Hand of Creation* (pp. 65–66)

J.M. Dent &amp; Sons. London, England. 1993

**Bishop, Morris** 1893–1973

American scholar and writer

Come, little lad; come, little lass,  
Your docile creed recite:

“We know that Energy equals Mass

By the Square of the Speed of Light.”

*A Bowl of Bishop: Museum Thoughts, and Other Verses* $E = MC^2$ 

Dial Press. New York, New York, USA. 1954

**Blake, William** 1757–1827

English poet, painter, and engraver

Energy is the only life...and Reason is the bound or outward circumference of Energy.



*The Complete Poetry and Prose of William Blake*  
The Marriage of Heaven and Hell, The Voice of the Devil, #2  
University of California Press. Berkeley, California, USA. 1982

Energy is eternal delight.

*The Complete Poetry and Prose of William Blake*  
The Marriage of Heaven and Hell, The Voice of the Devil, #3  
University of California Press. Berkeley, California, USA. 1982

**Born, Max** 1882–1970  
German-born English physicist

The release of nuclear energy is an event comparable to the first fire kindled by prehistoric man – though there is no modern Prometheus but teams of clever yet less heroic fellows, useless as inspiration for epic poetry...

*The Restless Universe*  
Postscript (p. 309)  
Dover Publications, Inc. New York, New York, USA. 1951

**Cooper, Gary** 1901–61  
American actor

The energy contained in the apple can destroy the world. And yet we cannot create one small apple.

*Cloak and Dagger*  
Film (1946)

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

Even though we can't see them, we know that these virtual particles are "really there" in empty space because they leave a detectable trace of their activities. One effect of virtual photons, for example, is to produce a tiny shift in the energy levels of atoms. They also cause an equally tiny change in the magnetic moment of electrons. These minute but significant alterations have been very accurately measured using spectroscopic techniques.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*  
Chapter 3 (p. 32)  
Basic Books. New York, New York, USA. 1994

In the everyday world, energy is always unalterably fixed; the law of energy conservation is a cornerstone of classical physics. But in the quantum microworld, energy can appear and disappear out of nowhere in a spontaneous and unpredictable fashion.

*God and the New Physics*  
Chapter 11 (p. 162)  
Simon & Schuster. New York, New York, USA. 1983

**Dickens, Charles** 1812–70  
English novelist

"Then idiots talk," said Eugene, leaning back, folding his arms, smoking with his eyes shut, and speaking slightly through his nose, "of Energy. If there is a word in the dictionary under any letter from A to Z that I abominate, it is energy."

*Our Mutual Friend*  
Chapter 3 (p. 34)  
Hurd & Houghton. New York, New York, USA. 1866

**Durant, William James** 1885–1981  
American historian and essayist

We see matter and we miss energy; we think that we know what matter is; but when at the heart of the atom we find energy, we are bewildered, and our categories melt away.

*The Story of Philosophy* (2nd edition) (p. 494)  
Garden City Publishing, Inc. New York, New York, USA. 1933

**Dyson, Freeman J.** 1923–  
American physicist and educator

We do not know how the scientists of the next century will define energy or in what strange jargon they will discuss it. But no matter what language the physicists use they will not come into contradiction with Blake. Energy will remain in some sense the lord and giver of life, a reality transcending our mathematical descriptions. Its nature lies at the heart of the mystery of our existence as animate beings in an inanimate universe.

Energy in the Universe  
*Scientific American*, Volume 224, Number 3, 1971 (p. 51)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

It is natural that our senses should have developed faculties for perceiving some of these intrinsic distinctions of the possible states of the world around us. I prefer to think of matter and energy, not as agents causing the degrees of curvature of the world, but as parts of our perceptions of the existence of the curvature.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*  
Chapter V (p. 92)  
At The University Press. Cambridge, England. 1921

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

Energy has mass and mass represents energy.

*The Evolution of Physics*  
The Time-Space Continuum (p. 197)  
Simon & Schuster. New York, New York, USA. 1961

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Coal is a portable climate. It carries the heat of the tropics to Labrador and the polar circle; and it is the means of transporting itself whithersoever it is wanted. Watt and Stephenson whispered in the ear of mankind their secret, that a half-ounce of coal will draw two tons a mile, and coal carries coal, by rail and by boat, to make Canada

as warm as Calcutta, and with its comfort brings its industrial power.

*Ralph Waldo Emerson: Essays and Lectures  
The Conduct of Life*  
Wealth (p. 990)

The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

One of the most impressive discoveries was the origin of the energy of the stars, that makes them continue to burn. One of the men who discovered this was out with his girl friend the night after he realized that nuclear reactions must be going on in the stars in order to make them shine. She said, “Look at how pretty the stars shine!” He said, “Yes, and right now I am the only man in the world who knows why they shine.” She merely laughed at him. She was not impressed with being out with the only man who, at that moment, knew why stars shine. Well, it is sad to be alone, but that is the way it is in this world.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 3–4 (pp. 3–7)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

There is a fact, or if you wish, a law governing all natural phenomena that are known to date. There is no known exception to this law – it is exact as far as we know. The law is called the conservation of energy. It states that there is a certain quantity, which we call energy, that does not change in the manifold changes which nature undergoes. That is a most abstract idea, because it is a mathematical principle; it says that there is a numerical quantity which does not change when something happens.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 4–1 (p. 4–1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

It is important to realize that in physics today, we have no knowledge of what energy is.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 4–1 (p. 4–2)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Gamow, George** 1904–68  
Russian-born American physicist

Atome preeemorrriale!  
All-containeeng Atome!  
Deesolved ento fragments excedeengly small.

Galaxies formeeng,  
Each wiz prrimal energy!

*Mr. Tompkins in Paperback*  
Chapter 6 (p. 57)  
At The University Press. Cambridge, England. 1965

**Guth, Alan** 1947–  
American physicist

It is said that there’s no such thing as a free lunch. But the universe is the ultimate free lunch.

In Stephen W. Hawking  
*A Brief History of Time: From the Big Bang to Black Holes*  
Chapter 8 (p. 129)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Hammond, Allen Lee**  
No biographical data available

**Metz, William D.**  
No biographical data available

A point about solar energy that government planners seem to have trouble grasping is that it is fundamentally different from other energy sources. Solar energy is democratic. It falls on everyone and can be put to use by individuals and small groups of people. The public enthusiasm for solar is perhaps as much a reflection for this unusual accessibility as it is a vote for the environmental kindness and inherent renewability of energy from the sun.

Solar Energy Research: Making Solar After the Nuclear Model?  
*Science*, Volume 197, Number 4300, July 15, 1977 (p. 241)

**Hampson, William**  
No biographical data available

Whenever we see energy displayed, we can always trace it, if we have sufficient knowledge of the facts, to some previously existing form or forms of energy.

*Radium Explained*  
Chapter 1 (p. 2)  
Dodd, Mead & Co. New York, New York, USA. 1905

**Hawking, Stephen William** 1942–  
English theoretical physicist

And where did the energy come from to create this matter? The answer is that it was borrowed from the gravitational energy of the universe. The universe has an enormous debt of negative gravitational energy, which exactly balances the positive energy of the matter. During the inflationary period the universe borrowed heavily from its gravitational energy to finance the creation of more matter...The debt of gravitational energy will not have to be paid until the end of the universe.

*Black Holes and Baby Universes and Other Essays*  
Chapter Nine (p. 97)  
Bantam Books. New York, New York, USA. 1987

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

Energy. I am energy. Sublime and meaningless Energy.  
I stream in floods across the empty ocean  
Of space, where island-universes float,  
Each like a little lonely boat.

*The Captive Shrew and Other Poems of a Biologist*  
Matter, Energy, Time and Space (p. 65)  
Harper & Brothers. New York, New York, USA. 1933

**Huxley, Thomas Henry** 1825–95  
English biologist

...naught endures save the flow of energy and the rational  
order which pervades it.

*Collected Essays* (Volume 9)  
*Evolution and Ethics* (p. 50)  
Macmillan & Company Ltd. London, England. 1904

**Johnson, George** 1952–  
American science writer

The weapons laboratory of Los Alamos stands as a  
reminder that our very power as pattern finders can work  
against us, that it is possible to discern enough of the uni-  
verse's underlying order to tap energy so powerful that  
it can destroy its discoverers or slowly poison them with  
its waste.

*Fire in the Mind: Science, Faith, and the Search For Order*  
Conclusion: The Ruins of Los Alamos (p. 326)  
Alfred A. Knopf. New York, New York, USA. 1995

**Joly, John** 1857–1933  
Irish physicist and geologist

The rolled-up crust of the earth is still rich in energy bor-  
rowed from earlier times, and the slow but mighty influ-  
ences of denudation and deposition are forever at work.  
And so, perchance, in some remote age the vanished  
Gondwana Land, the lost Atlantis, may once again arise,  
the seeds of resurrection even now being sown upon their  
graves from the endless harvests of pelagic life.

*Annual Report of the Board of Regents of the Smithsonian Institution,*  
1908  
Uranium and Geology (pp. 382–83)  
Government Printing Office. Washington, D.C. 1909

**Joule, James Prescott** 1818–89  
English physicist

You see, therefore, that living force may be converted into  
heat, and that heat may be converted into living force, or  
its equivalent attraction through space. All three, there-  
fore – namely, heat, living force, and attraction through  
space (to which I might also add light, were it consistent  
with the scope of the present lecture) – are mutually con-  
vertible into one another. In these conversions nothing  
is ever lost. The same quantity of heat will always be  
converted into the same quantity of living force. We can  
therefore express the equivalency in definite language  
applicable at all times and under all circumstances.

In E.C. Watson  
Joule's Only General Exposition of the Principle of Conservation of  
Energy  
"On Matter, Living Force and Heat" (1847)  
*American Journal of Physics*, Volume 15, Number 5, September–  
October, 1947 (p. 388)

**Larkin, Edgar Lucien** 1847–1924  
Astronomer

The most skillful detectives of nature are at work hourly  
in every possible way, striving to find out what matter is,  
and also energy. At present both are unknown; they may  
forever remain unknown, but if it can be proven that they  
are unknowable, this at least would afford a resting place  
for wandering thought, wandering along the borders of  
infinity.

*Radiant Energy and Its Analysis: Its Relation to Modern Astrophysics*  
Introductory (p. 15)  
Baumgardt Publishing Co. Los Angeles, California, USA. 1903

**Lemaître, Abbé Georges** 1894–1966  
Belgian astronomer and cosmologist

If we go back in the course of time we must find fewer  
and fewer quanta, until we find all the energy of the uni-  
verse packed in a few or even in a unique quantum.

The Beginning of the World from the Point of View of Quantum Theory  
*Nature*, Volume 127, Number 3210, May 9, 1931 (p. 706)

**Lilienthal, David E.** 1899–1981  
American businessman and Tennessee Valley Authority administrator

Atomic energy bears the same duality that has faced man  
from time immemorial, a duality expressed in the Book  
of Books thousands of years ago: "See, I have set before  
thee this day life and good and death and evil... therefore  
choose life...."

*This I Do Believe* (pp. 144–145)  
Harper & Row. New York, New York, USA. 1949

**Lindsay, R. Bruce** 1900–85  
American physicist

Of all the concepts or constructs of physics, energy, by  
its unifying capacity, has proved by all odds to be the  
most significant and successful. Its domain of application  
had indeed by now far transcended physics and covers all  
branches of science...it is the physical construct which  
has proved to contain the greatest meaning for all aspects  
of human life.

In R. Bruce Lindsay (ed.)  
*Energy: Historical Development of the Concept*  
The Concept of Energy and Its Early Historical Development (p. 13)  
Dowden, Hutchinson & Ross. Stroudsburg. 1975

**Meyerson, Emile** 1859–1933  
Polish-born French chemist

Energy really is only an integral; now, what we want  
to have is a substantial definition, like that of Leibniz,  
and this demand is justifiable to a certain degree, since  
our very conviction of the conservation of energy rests

in great part on this foundation.... And so the manuals of physics contain really two discordant definitions of energy, the first which is verbal, intelligible, capable of establishing our conviction, and false; and the second which is mathematical, exact, but lacking verbal expression.

Translated by Kate Loewenberg

*Identity & Reality*

Chapter VIII (p. 280)

George Allen & Unwin Ltd. London, England. 1930

**Morris, Richard** 1939–2003

American physicist and science writer

The uncertainty principle implies that particles can come into existence for short periods of time even when there is not enough energy to create them. In effect, they are created from uncertainties in energy. One could say that they briefly “borrow” the energy required for their creation, and then, a short time later, they pay the “debt” back and disappear again. Since these particles do not have a permanent existence, they are called virtual particles.

*The Edges of Science*

Chapter II (p. 24)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

**Moulton, Forest Ray** 1872–1952

American astronomer

The innumerable members of our galaxy assure us, however, that though the stars may be evaporating, so to speak, like the dew, their energies will in some way be integrated again.

*Astronomy*

Chapter XV (p. 471)

The Macmillan Company. New York, New York, USA. 1931

**Nichols, Ernest Fox** 1869–1924

American physicist

Our knowledge of the uncreatable and indestructible character of energy has given us a universal test which we may freely apply to all phenomena to prove our knowledge of them. For when the required energy relations are not satisfied by our explanations, it means we have not got to the bottom of the case, but must strike deeper in to realize the whole of the concealed mechanism.

*Lectures on Science, Philosophy and Art, 1907–1908*

Physics (p. 8)

The Columbia University Press. New York, New York, USA. 1908

**Pagels, Heinz R.** 1939–88

American physicist and science writer

In the last ten years physicists have learned more about the universe than in previous centuries – they have seen a new picture of reality requiring a conversion of our imaginations. The visible world is neither matter nor spirit but the invisible organization of energy.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Foreword (p. 13)

Simon & Schuster. New York, New York, USA. 1982

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

As a proposition of linguistics: “Energy” is the name of the mathematical expression in question.... As a proposition of psychology: our senses are such that we notice what is roughly the mathematical expression in question, and we are led nearer and nearer to it as we refine upon our crude perceptions by scientific observation.

*The ABC of Relativity*

Chapter XII (p. 113)

George Allen & Unwin Ltd. London, England. 1958

**Rutherford, Ernest** 1871–1937

English physicist

The energy produced by the breaking down of the atom is a very poor kind of thing. Anyone who expects a source of power from the transformation of these atoms is talking moonshine.

*Atom Powered World Absurd, Scientists Told*

*New York Herald Tribune*, September 12, 1933

**Sagan, Carl** 1934–96

American astronomer and author

The total amount of energy from outside the solar system ever received by all the radio telescopes on the planet Earth is less than the energy of a single snowflake striking the ground.

*Cosmos*

Chapter X (p. 261)

Random House, Inc. New York, New York, USA. 1980

**Schuster, Sir Arthur** 1851–1934

English physicist

Efforts have been made to look on energy as on something which can be labeled and identified through its various transformations. Thus we may feel a certain bit of energy radiating from a coal-fire, and if our knowledge was complete, we ought to be able to fix the time at which that identical bit of energy left the sun and arrived on the surface of the earth, setting up a chemical action in the leaves of the plant from which the coal has been derived. If we push this view to a logical conclusion, it seems to me that we must finally arrive at an atomic conception of energy, which some may consider an absurdity.

*Report of the British Association*

Presidential Address

Section A

1892 (p. 629)

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Energy, like grammar, should be used correctly; the unjust expenditure of energy or its unjust withholding should cease immediately.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #132 (p. 38)

Definition Press. New York, New York, USA. 1972

**Soddy, Frederick** 1877–1956  
English chemist

Energy, someone may say, is a mere abstraction, a mere term, not a real thing. As you will. In this, as in many another respects, it is like an abstraction no one would deny reality to, and that abstraction is wealth. Wealth is the power of purchasing, as energy is the power of working. I cannot show you energy, only its effects. Abstraction or not, energy is as real as wealth – I am not sure that they are not two aspects of the same thing.

*Science and Life*

Physical Force – Man's Servant or His Master? (p. 27)

Publisher undetermined. London, England. 1920

Before the doctrine of its conservation was established, energy was mysterious and unaccountable in its comings and goings. To-day it is no longer a mystery. The unaccounted-for appearance or disappearance of a quantity of energy in any process, however complex, would rouse as much scientific interest as the mysterious appearance or disappearance of matter. When it appears it must come from somewhere, and when it disappears it must go somewhere.

*Matter and Energy*

Chapter I (p. 19)

Henry Holt & Co. New York, New York, USA. 1912

**Stallo, John Bernhard** 1823–1900  
Russian political leader

In a general sense, this doctrine [conservation of energy] is coeval with the dawn of human intelligence. It is nothing more than an application of the simple principle that nothing can come from or to nothing...

*The Concepts and Theories of Modern Physics* (pp. 68–69)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Steele, Joel Dorman** 1836–86  
American educator and textbook writer

The sunbeam comes to the earth as simply motion of ether-waves, yet it is the grand source of beauty and power. Its heat, light, and chemical energy work everywhere the wonder of life and motion. In the growing plant, the burning coal, the flying bird, the glaring lightning, the blooming flower, the rushing engine, the roaring cataract, the pattering rain – we see only varied manifestations of this one protean energy which we receive from the sun.

*Popular Physics*

Chapter VII (p. 188)

American Book Company. New York, New York, USA. 1896

**Szent-Györgyi, Albert** 1893–1986  
Hungarian-born American biochemist

A living cell requires energy not only for all its functions, but also for the maintenance of its structure. Without energy life would be extinguished instantaneously, and the cellular fabric would collapse.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1937

Oxidation, Energy Transfer, and Vitamins (p. 440)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Teller, Edward** 1908–2003  
Hungarian-born American nuclear physicist

It took us eighteen months to build the first nuclear power generator; it now takes twelve years; that's progress.

In Milton Friedman and Rose Friedman

*Free to Choose: A Personal Statement* (p. 191)

Harcourt, Brace Jovanovich, Inc. New York, New York, USA. 1980

**Tyndall, John** 1820–93  
Irish-born British physicist

This law generalizes the aphorism of Solomon, that there is nothing new under the sun, by teaching us to detect everywhere, under its infinite variety of appearances, the same primeval force. To nature, nothing can be added; from nature nothing can be taken away; the sum of her energies is constant.... Waves may change to ripples and ripples to waves – magnitude may be substituted for number, and number for magnitude – asteroids may aggregate to suns, suns may resolve themselves into florae and faunae, and florae and faunae melt in air – the flux of power is eternally the same. It rolls in music throughout the ages, and all terrestrial energy – the manifestations of life as well as the display of phenomena, are but the modulations of its rhythm.

In Henry Adams

*The Degradation of the Democratic Dogma*

A Letter to American Teachers of History, Chapter I (pp. 144–145)

Peter Smith. New York, New York, USA. 1949

**Umov, N. A.**  
No biographical data available

Science has taught people to use the energy concealed in the bowels of the Earth. It must lead man to the treasure-chests of heaven, too, and teach him to accumulate the energy of the Sun's rays.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Moscow, Russia. 1979

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

The universe...has its limited supply of energy, which works in it under ever-varying forms, indestructible, incapable of increase, eternal, and unchangeable like matter.

In Franz Himstedt

*Annual Report of the Board of Regents of the Smithsonian Institution, 1906*

Radioactivity (p. 121)

Government Printing Office. Washington, D.C. 1907



**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...we know now that the atom, that once we thought hard and impenetrable, and indivisible and final and – lifeless – lifeless, is really a reservoir of immense energy.  
*The World Set Free*  
Prelude, Section 8  
Macmillan & Company Ltd. London, England. 1914

## ENERGY STATE

**Free, E. E.**

No biographical data available

Imagine a series of race tracks one inside the other. Imagine these tracks are separated by high board fences. Put a race horse in the outermost track and instruct him to run around it until when he happens to feel like it, he has to jump the inside fence into the next track, run around it for a while, and then jump into the next fence, and so on until he reaches the innermost track of all. If, then you watch this procedure from the field outside the outermost fence, you will not see the horse at all as long as he is running in a single track. The fences hide him. But whenever he jumps from one track into the next, you will see him for an instant as he goes over.

In Bernard Jaffe

*Crucibles: The Story of Chemistry* (pp. 244–245)  
Dover Publications. New York, New York, USA. 1976

## ENGINE

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

Don't talk to me of your Archimedes' lever. He was an absentminded person with a mathematical imagination. Mathematics commands all my respect, but I have no use for engines. Give me the right word and the right accent and I will move the world.

*A Personal Record*

A Familiar Preface (p. 2)

Harper & Brothers Publishers. New York, New York, USA. 1912

## ENGINEER

**Alger, John R. M.**  
American engineer

**Hays, Carl V.**

No biographical data available

The engineer is concerned with creating material objectives to serve human needs.... The engineer uses the knowledge and understanding developed by the scientist. In the absence of such knowledge, the engineer proceeds to a schedule by making judicious assumptions about the designs in order to insure successful solutions.

*Creative Synthesis in Design* (p. 2)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1964

An inexperienced engineer commonly believes that he can accomplish about twice as much as he can in fact accomplish in a given time.

*Creative Synthesis in Design* (p. 58)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1964

The greatest difference between engineers and other professionals is that engineers do not offer a person-to-person service, nor are their services a matter of life, freedom, or property, of deep personal concern. Most engineers thrive on promotion and expansion of business, new inventions, new buildings, and more consumption of goods. Obviously, then, they are tempted to whip up trade, advertise, seek out clients, and promote deals. This spirit leads to competition. Until this is recognized, I see no hope of solving the problem of engineering professional development.

*Ethical Problems in Engineering* (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1965

It takes a wise man to give the right answer to a technical question that involves the conflicting rights and desires of a number of people. Yet the engineer is often required to give such an answer and on very short notice.

*Ethical Problems in Engineering* (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1965

**Aronin, Ben** 1904–80  
Poet and musical talent

I'll carry the story along from here  
And sing you the song of the engineer.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

Adam to Atoms, Scene XV, Ballad of the Engineer – 1840–1865 (p. 89)  
Centennial of Engineering. Chicago, Illinois. 1952

**Arwaker, Edmund** 1712–30  
English poet

I learnt t'intrench a Camp, and Bulwarks rear,  
With all the Cunning of an Engineer.

*Pia Desidera*

Book the Second, l. 805

William Andrews Clark Memorial Library. Los Angeles, California, USA. 1972

## Author undetermined

A good engineer must be of inflexible integrity, sober, truthful, accurate, resolute, discrete, of cool and sound judgment; must have courage to resist and repeal attempts at intimidation, a firmness that is proof against solicitation, flattery, or improper bias of any kind; must take an interest in his work; must be energetic, quick to decide, prompt to act; must be as fair and impartial as a judge on the bench; must have experience in his work and in dealing with men, which implies some maturity of years; and must have business habits and knowledge of accounts.



Men who combine these qualities are not to be picked up every day. Still they can be found, and when found, they are worth their price; rather they are beyond price, and their value cannot be estimated by dollars.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.) *Vocational Guidance in Engineering Lines* (p. 483)  
The Mack Printing Company, Easton, Pennsylvania, USA. 1933

...whenever an engineer learns something new in technics, it is his bounden duty to put it in writing and see that it is published where it will reach the eyes of his confrères and be always available to them. It is absolutely a crime for any man to die possessed of useful knowledge in which nobody else shares.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.) *Vocational Guidance in Engineering Lines* (Lines First edition) (p. 10)  
The Mack Printing Company, Easton, Pennsylvania, USA. 1933

[Chemical engineers]...are not even able to persuade the engineers that we are engineers.

*American Institute of Chemical Engineers Bulletin*, No. 24, 1921 (p. 53)

What is the difference between Mechanical Engineers and Civil Engineers?

Mechanical Engineers build weapons;

Civil Engineers build targets.

Source undetermined

To the engineer, all matter in the universe can be placed into one of two categories: (1) things that need to be fixed, and (2) things that will need to be fixed after you've had a few minutes to play with them. Engineers like to solve problems. If there are no problems handily available, they will create their own problems. Normal people don't understand this concept; they believe that if it ain't broke, don't fix it. Engineers believe that if it ain't broke, it doesn't have enough features yet.

Source undetermined

When considering the behavior of a howitzer:

A mathematician will be able to calculate where the shell will land.

A physicist will be able to explain how the shell gets there.

An engineer will stand there and try to catch it.

Source undetermined

Clothes are the lowest priority for an engineer, assuming the basic thresholds for temperature and decency have been satisfied. If no appendages are freezing or sticking together, and if no genitalia or mammary glands are swinging around in plain view, then the objective of clothing has been met. Anything else is a waste.

Source undetermined

Engineers are always honest in matters of technology and human relationships. That's why it's a good idea to keep engineers away from customers, romantic interests, and other people who can't handle the truth.

Source undetermined

**Bailey, Philip James** 1816–1902

English poet

Even as when

In planning some steel-rutted road, long years

Dreamed of – where now the fire-horse ramps, steam-breath'd,

Sweating red coal-drops on his panting path –

The deep-eyed engineer his level lays

Inscrutable, and anon, the hills with men,

Brood of his brain swarm.

*Festus: A Poem*

Scene XXVIII (p. 472)

George Routledge & Sons, Limited. London, England. 1893

**Baillie, Joanna** 1762–1851

Scottish poet

Some thousand carcasses, living and dead,

Of those who first shall glut the en'my's rage,

Push'd in, pell-mell, by those who press behind

Will rear for us a bridge to mount the breach

Where ablest engineers had work'd in vain.

*Miscellaneous Plays*

Constantine Paleologus, l. 23–27

Garland Publishing, Inc. New York, New York, USA. 1977

**Birchmore, Sue**

No biographical data available

The best scientists are poets, the real engineer is an artist.

In E. Garfield

Creativity and Science

*Current Comments*, Part I, Number 43, 23 October, 1989 (p. 296)

**Blough, Roger M.** 1904–85

American industrialists

We do not do ourselves a good turn by becoming panicky at the idea of the mere number of engineers that are being produced in other countries, or by consciously engaging in a technological numbers race.

*American Engineer*, Volume 26, Number 7, July 1956 (p. 5)

**Boelter, L. M. K.**

No biographical data available

Engineers participate in the activities which make the resources of nature available in a form beneficial to man and provide systems which will perform optimally and economically.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 9)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Born, Max** 1882–1970

German-born British physicist

The engineer, who has cunningly contrived to make the blind and deaf molecules in their mad, senseless rush drive an engine, may well feel proud of himself.

*The Restless Universe*

Chapter 1 (p. 16)

Dover Publications, Inc. New York, New York, USA. 1951

### Bradley, Duane

No biographical data available

[Engineers] are men with wings on their minds. These wings are courage and imagination – when an engineer decides that a job is not too big for him, and starts finding a way to do it, he is using his wings.

*Engineers Did It!*

Chapter 1 (p. 8)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1958

### Brandeis, Louis Dembitz 1856–1941

Lawyer, reformer, and Supreme Court justice

The engineer spoke in figures – a language implying certitude.

In Alfred Lief (ed.)

*The Social and Economic Views of Mr. Justice Brandeis* (p. 141)

Vanguard Press. New York, New York, USA. 1930

### Brome, Alexander 1620–66

English poet

All trades did shew their skill in this,

Each wise an Engineer:

The Mairress took the tool in hand,

The maids the stones did bear.

*Rump: or An Exact Collection of the Choycest Poems and songs Relating to the Latest Times*

On the Demolishing the Forts

Printed for Henry Brome. London, England. 1662

### Buchanan, Scott 1895–1968

American educator and philosopher

The engineer is fast taking the position of authority, superseding the priest, the scholar, and the statesman in our organized thought and actions.

*Poetry and Mathematics*

Chapter 1 (pp. 37–38)

The University of Chicago Press. Cambridge, England. 1975

Watch the engineer and you will learn many things, but do not ask him about mathematics, unless you want to see quite another thing, how technology and folk-lore get invented and broadcast.

*Poetry and Mathematics*

Chapter 1 (p. 38)

The University of Chicago Press. Chicago, Illinois, USA. 1975

The engineer sings as he works – often he only whistles – and in that singing there is the magic of poetry. The engineer's science, like the sailor's chanty, is good literature.

*Poetry and Mathematics*

Chapter 1 (pp. 38–39)

The University of Chicago Press. Chicago, Illinois, USA. 1975

### Churchill, Winston Spencer 1882–1965

British prime minister, statesman, soldier, and author

We want a lot of engineers in the modern world, but we do not want a world of engineers. We want some scientists, but we must keep them in their proper place.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

University of London, November 18, 1948 (p. 363)

George Allen & Unwin Ltd. London, England. 1956

### Colclaser, R. G.

No biographical data available

In many segments of industry, the young man is looked upon first as an engineer and second as an electrical engineer with specific knowledge. Industrial problems do not divide themselves neatly into the areas of electrical, mechanical, chemical, or civil engineering; rather, they are considered as general problems requiring a solution which the young engineer is expected to provide. In the majority of cases he must produce a physical device which will accomplish a desired result. This is not a “textbook” solution but an original, creative effort.

A Design School for the Young Engineer in Industry

*Engineering Education*, March, 1968 (p. 812)

### Compton, Karl Taylor 1887–1954

American educator and physicist

For the benefit of society, as well as for the most efficient work of the engineer, it is essential that the engineer... be trained to think not only of his specific engineering projects, but also of their larger significance in the economic and social order.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

*During the Years 1930–1949* (p. 49)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA.

1955

If the engineer is to bring his influence to bear on broad public questions he must approach them, not with technical arrogance, but with sympathetic understanding.

*Engineering and Social Progress*

*Journal of Engineering Education*, Volume 30, Number 1, September, 1939 (p. 14)

### Cook, Morris L.

No biographical data available

The more I think of it, the more I feel that the fundamental consideration in the work of an engineer – if he is ever to pull himself out of his present status of being a hired servant – is that he shall make public interest the master test of his work.

In Edwin T. Layton

*The Revolt of the Engineers*

Letter to A.G. Christie, June 9, 1921 (p. 159)

Press of Case Western Reserve University. Cleveland, Ohio, USA. 1971

**Crichton, Michael** 1942–  
American novelist

Let's keep it in perspective, Hammond said. You get the engineering correct and the animals will fall into place...

*Jurassic Park*  
The Tour (p. 141)  
Alfred A. Knopf. New York, New York, USA. 1990

**Cross, Hardy** 1885–1959  
American professor of civil and structural engineering

It is important that men know that engineers do not build alone with concrete and steel or by formulas and charts, but more than anything else by faith, hope and charity – faith in their methods, their training, in the men with whom they work, faith in humanity, in the worthwhileness of life; hope that by use of these they may find men, money, materials and methods, not blind wishes but judicious hopes; charity that involves the sympathetic understanding of the human element and willingness.

*Engineers and Ivory Towers*  
The Education of an Engineer (p. 59)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Darrow, Karl Kelchner** 1891–1982  
American physicist

But here is another who took up the study of physics as soon as he came to college, and continued it all through his student days, and his career consists in controlling and directing physical phenomena by his knowledge of physical laws, or in designing machines which depend on physical principles. And what does he call himself, and what does the world call him? An electrical engineer or a radio engineer, a designer of lenses or a maker of turbines, a naval engineer or an acoustical engineer, a mechanical engineer or an aerodynamical engineer, and only the census tables could say what else!

*The Renaissance of Physics*  
Chapter I (p. 4)  
The Macmillan Company. New York, New York, USA. 1936

**Davis, Chandler** 1926–  
American mathematician

Any applied mathematicians – any engineer using mathematics – works sometimes more and sometimes less mathematically. When he is most mathematical he makes least appeal to experience.

*Boston Studies In the Philosophy of Science* (Volume 15)  
For Dirk Struk, Materialist Mathematics (p. 38)  
D. Reidel Publishing Company. Dordrecht, Netherlands.

**de Beauvoir, Simone** 1908–1986  
French author and philosopher

He was living like an engineer in a mechanical world. No wonder he had become dry as a stone.

*The Mandarins*  
Chapter 3 (p. 156)  
W.W. Norton & Company, Inc. New York, New York, USA. 1999

**de Camp, L. Sprague** 1907–2000  
American science fiction writer

Civilization, as we know it today, owes its existence to the engineers. These are the men who, down the long centuries, have learned to exploit the properties of matter and the sources of power for the benefit of mankind. By an organized, rational effort to use the material world around them, engineers devised the myriad comforts and conveniences that mark the difference between our lives and those of our fore-fathers thousands of years ago. The story of civilization is, in a sense, the story of engineering – that long and arduous struggle to make the forces of nature work for man's good.

*The Ancient Engineers*  
Chapter One (p. 1)  
Ballantine Books. New York, New York, USA. 1974

**de Vega, Lope** 1562–1635  
Spanish poet and playwright

*Es amor grande ingeniero:*  
*Las máquinas de Arquímedes*  
*No son encarecimiento*  
*Para las que tiene amor.*  
Love is a mighty engineer,  
Not Archimedes' skill could add  
One jot or tittle to the power  
Of the machines that Love controls.  
*La Hermosa Fea*  
Act II, Scene 7  
Publisher undetermined

**Dean, Jr., Robert C.**  
No biographical data available

...the job of the engineer is to change the world...  
In Daniel V. DeSimone  
*Education for Innovation*  
Trade-Offs and Constraints (p. 111)  
Pergamon Press. New York, New York, USA. 1968

**Defoe, Daniel** 1660–1731  
English pamphleteer, journalist, and novelist

The Legislators are the Engineers,  
Who when 'tis out of Order make Repairs:  
The People are the Owners, 'twas for them  
The first Inventor drew the ancient Scheme.  
'Tis for their Benefit it works, and they  
The Charges of maintaining it defray:  
And if their Governours unfaithful prove,  
They, Engineers or Managers remove.  
Unkind Contention sometimes there appears  
Between the Managers and Engineers:  
Such Strife is always to the Owners wrong,

And once it made the Work stand still too long;  
Till William came, and loos'd the Fatal Chain,  
And set the Engineers to work again:  
And having made the wondrous thing complete,  
To Anne's unerring Hand he left the Helm of State.

*Selected Poetry and Prose of Daniel Defoe*

The Mock Mourners, l. 92–107

Holt, Rinehart & Winston. New York, New York, USA. 1968

### **DeSimone, Daniel V.**

No biographical data available

### **Cross, Hardy** 1885–1959

American engineer

...an engineer is supposed to be more than a mobile repository of knowledge who is adept at attacking single-answer problems.

*Education for Innovation*

Introduction (p. 13)

Pergamon Press. New York, New York, USA. 1968

### **Dibdin, Charles Isaac Mungo** 1768–1833

English songwriter

Goletta's walls, for tactic science fam'd,  
Boast of the age, impregnable proclaim'd,  
No dam afford to stop the raging tide,  
All hearts conjoin'd, and ev'ry nerve applied;  
The bulwark cracks; the engineer applies  
Incessant art's destructive energies...

*Young Arthur*

Subject VI, Lament, l. 2738–2743

Chadwyck-Healey. Cambridge, England. 1992

### **Dieudonné, Jean** 1906–92

French mathematician and educator

Engineers, always looking for optimal values for the measures of magnitudes which interest them, think of mathematicians as custodians of a fund of formulae, to be supplied to them on demand.

*Mathematics – The Music of Reason*

Chapter I, Section 1 (p. 7)

Springer-Verlag. Berlin, Germany. 1992

### **Dodge, A. Y.**

No biographical data available

...many engineers treat all new things pessimistically.

In Joseph Rossman

*Industrial Creativity: The Psychology of the Inventor*

Chapter XIV (p. 220)

University Books. New Hyde Park, New York, USA. 1964

### **DuBridge, Lee Alvin** 1901–94

American physicist

The scientist or engineer – like every other human being – bears also the responsibility of being a useful member of his community...and should speak on issues which can be addressed with competence – including joining hands with other citizens when called to tasks of peace.

In Thomas Hager

*Force of Nature: The Life of Linus Pauling*

Chapter 15 (p. 347)

Simon & Schuster. New York, New York, USA. 1995

### **Dumas, Hal S.**

No biographical data available

It is the engineer who must always be the link between the idea and actuality, between the probable and the practical. It is he who makes realities out of dreams. He is indeed the solvent which blends together the many different parts of our great industrial mechanism and produces a smoothly working whole.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

The Telephone Engineer and His Job (p. 750)

Centennial of Engineering. Chicago, Illinois. 1952

It is the job of the engineer to search out the means by which the ideas of the inventor can be put to work in the service of the public. He also knocks on the door of the ivory tower of the pure scientist and calls forth new inventions to meet the needs and wants of the public.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

The Telephone Engineer and His Job (p. 751)

Centennial of Engineering. Chicago, Illinois. 1952

### **Dunning, John R.**

No biographical data available

How engineers and scientists who daily drink thinly diluted, but treated sewage, and on a rationed basis at that; travel to and from work via arteries of congested, noisy traffic through asphalt jungles of soot and acid-blackened buildings; breathe smog-filled air symptomized by hacking and coughing, and tear-filled eyes, pay exorbitant clothing and home cleaning bills; and see the progressive deterioration of natural beauty; [how they can] continue to tolerate all of these things and more without doing something about it is incomprehensible.

*The Urban Frontier and the Engineer*

Pamphlet distributed by the Office of School Relations, Columbia University

### **Durand, William Frederick**

US Naval Officer

...no one knows better than the engineer the need of discrimination between the sure ground of known data and formal logic, on the one hand – as exemplified, say, by mathematical operations – and acts of judgment on the other; and no one has learned through wider experience than the engineer the need of applying his conclusions in the light of that component part which, of necessity, has been dependent on estimate and judgment.

Presidential Address

*Transactions of The American Society of Mechanical Engineers,*

Volume 47, 1925

**Dyson, Freeman J.** 1923–

American physicist and educator

A good scientist is a person with original ideas. A good engineer is a person who makes a design that works with as few original ideas as possible. There are no prima donnas in engineering.

*Disturbing the Universe*

Chapter 10 (p. 114)

Basic Books, Inc., Publishers. New York, New York, USA. 1979

**Edwards, Llewellyn Nathaniel** 1873–1952

No biographical data available

Engineers bridging chasms wide  
So people may reach the other side;  
Dreamers, yes, but doers too,  
Developing the strange and new.

*A Record of History and Evolution of Early American Bridges*

Builders of Bridges (p. xi)

University Press. Orono, Maine, USA. 1936

The engineer historian gathers a need of satisfaction and pleasure in tracing the progress made by predecessors in his art; reviewing their accomplishments; analyzing their solutions of problems; and examining the monuments of their industry and skill. He sees definitely and unmistakably that advances made in a given period have marked the way to greater accomplishments in a succeeding period.

*A Record of History and Evolution of Early American Bridges*

Builders of Bridges (p. xii)

University Press. Orono, Maine, USA. 1936

**Egerton, Sarah** 1670–1723

English poet

So some unlucky Engineer  
Does all the fit Materials compound,  
That are in Art or Nature found;  
Will glorious Fire-Works prepare.

*Poems on Several Occasions*

The Advice, Part II, l. 41–44

Chadwyck-Healey. Cambridge, England. 1992

**Eisenhower, Dwight David** 1890–1969

34th president of the USA

Engineers build for the future, not merely for the needs of men but for their dreams as well. Thus, inherently, the engineer's work is a fearless optimism that life will go forward, and that the future is worth working for.

*American Engineer*, December, 1951 (p. 5)**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The machine unmakes the man. Now that the machine is so perfect, the engineer is nobody.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)*Society and Solitude*

Works and Days (p. 165)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Emmet, William LeRoy** 1859–1941

American electrical engineer

The all-important word to the engineer is WHY, and it is astonishing how few people in the ordinary pursuits of human affairs ever think it worthwhile to trouble themselves about that question, or to make much effort to find out whether the answer suggested will bear analysis.

*The Autobiography of an Engineer*

Chapter XII (p. 226)

The American Society of Mechanical Engineers. New York, New York, USA. 1940

**Evans, Sebastian** 1830–1909

Author

And there we kept pacing to and fro,  
In a frenzy of mute surmising:  
Quoth the Engineer in a whisper low:  
“Is the tide in the river rising?”

*In the Studio, A Decade of Poems*

A Tale of a Trumpeter, l. 61–64

Macmillan &amp; Company. London, England. 1875

Parapet, buttress, and arch and pier  
Beyond are as sound as ever!  
Now show us thy skill, Sir Engineer,  
For a roadway over the River!

*In the Studio, A Decade of Poems*

A Tale of a Trumpeter, l. 117–120

Macmillan &amp; Company. London, England. 1875

**Everett, Edward** 1794–1865

Whig Party politician

A large part of the training of the engineer, civil and military, as far as preparatory studies are concerned; of the builder of every fabric of wood, or stone, or metal, designed to stand upon the earth, or bridge the stream, or resist or float upon the wave; of the surveyor who lays out a building lot in a city, or runs a boundary line between powerful governments across a continent; of the geographer, navigator, hydrographer, and astronomer – must be derived from the mathematics.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 90)

Little, Brown &amp; Co. Boston, Massachusetts, USA. 1857

**Farquhar, George** 1678–1707

Irish dramatist

Rise thou prostrate Engineer, not all thy undermining  
Skill shall reach my Heart.

*The Beaux' Stratagem*

Act V, Scene II (p. 82)

Appleton-Century-Crofts. New York, New York, USA. 1967

**Finch, James Kip** 1883–167

American engineer

From the earliest days of recorded history the men now known as engineers – civil, chemical and mechanical,



mining and metallurgical – have provided for man's unfolding material needs and wants. Engineering has, in fact, not only played an ever increasing role in man's material life, but has had a profound effect on human relations, in shaping modern social, economic, and political aims, ideals, and institutions. Indeed, the promises which engineering and engineered industry offer today stir the hopes, interest, and ambitions of the less-developed nations of the world.

*The Story of Engineering* (p. v)

Doubleday, Garden City, New York, USA. 1960

**Flanders, Ralph E.** 1922–75

English actor and singer

There is an engineering approach to (our) problems. The engineer has an objective. He studies and analyzes the materials with which he has to deal. He acquaints himself with the natural forces which he cannot change, which are more powerful than he is, but to which he must adapt himself so that he may make use of them.

*American Engineer*, November, 1952 (p. 6)

**Florman, Samuel C.** 1925–

Author and professional engineer

The civil engineer, with his hands literally in the soil, is existentially wedded to the earth, more so than any other man except perhaps the farmer.

*The Existential Pleasures of Engineering*

Chapter 9 (pp. 121–122)

St. Martin's Press, New York, New York, USA. 1976

Taken as a whole, engineers – and the technologists, craftsmen, and tinkerers from whom they spring – are, and always have been, as decent, moral, and law-abiding a group of men as one could find. Absorbed in their technical pursuits, they are singularly free of the greed, duplicity, and hostility that characterize so many of their fellows and that have caused so much grief.

Comment: Engineers and the End of Innocence

*Technology and Culture*, Volume 10, Number 1, 1969 (p. 14)

The nation needs engineers who are able to communicate, who are prepared for leadership roles, who are sensitive to the worthy objectives of our civilization and the place of technology within it, and whose creative imaginations are nourished from the richest possible sources – spiritual, intellectual, and artistic. Furthermore, engineers as a group need to preserve their professional self-esteem – and the esteem of the greater community – by guarding against an insensitive mechanical approach to the work they do. And finally, individual engineers deserve the chance to enrich their lives with art, literature, history – the best our civilization has to offer.

*The Civilized Engineer*

Chapter 19 (p. 195)

St. Martin's Press, New York, New York, USA. 1985

...public-safety policies are properly established, not by well-intentioned engineers, but by legislators, bureaucrats, judges, and juries, in response to facts presented by expert advisers.... It would be a poor policy indeed that relied upon the impulse of individual engineers.

*Blaming Technology*

Moral Blueprints (p. 174)

St. Martin's Press, New York, New York, USA. 1981

**Freund, C. J.**

No biographical data available

People are not afraid of engineers, thank goodness, but they are excessively afraid of much that engineers contrive.

Engineering Education and Freedom from Fear

*Journal of Engineering Education*, Volume 40, Number 1, September, 1949 (p. 11)

Surely there is no greater menace in the world than a superbly competent engineer who is equally content to engage himself to a benefactor of the human race or to some monster of cruelty and vice.

Engineering Education and Freedom from Fear

*Journal of Engineering Education*, Volume 40, Number 1, September, 1949 (p. 11)

**Freyssinet, Eugene** 1879–1962

French structural and civil engineer

Some people will say that a respect for regulations is essential and that engineers need not check the hypotheses on which they are based. This is a convenient theory, but a false one. Men who draw up regulations can be wrong like other men.

*Cement and Concrete Association Library Translation No. 59*

The Birth of Prestressing

London, England. 1956

**Gäbor, Dennis** 1900–79

Hungarian-English physicist

Short of a compulsory humanistic indoctrination of all scientists and engineers, with a "Hippocratic oath" of never using their brains to kill people, I believe that the best makeshift solution at present is to give the alphas alternative outlets for their dangerous brainpower, and this may well be provided by space research.

*Inventing the Future*

The Future of Uncommon Man (p. 156)

Secker & Warburg, London, England. 1963

**Galbraith, John Kenneth** 1908–2006

Canadian-American economist

...the enemy of the market is not ideology but the engineer.

*The New Industrial State*

Chapter III, Section 5 (p. 33)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1967



**Gillmor, R. E.**

No biographical data available

My observation...is that the engineer feels his professional responsibility to mankind just as much as does the physician and the military man. He does not (always) take an oath as they do, but his sense of professional responsibility is as deep in his heart as any oath could make it.

*American Engineer*, Volume 26, Number 9, September, 1956 (p. 5)

**Glegg, Gordon L.**

American engineer

A scientist can discover a new star but he cannot make one. He would have to ask an engineer to do it for him.

In Isaac Asimov

*Isaac Asimov's Book of Science and Nature Quotations* (p. 79)

Weidenfeld & Nicolson. New York, New York, USA. 1988

**Golder, H. Q.**

No biographical data available

The scientist is interested in the right answer, the engineer in the best answer now.

In Robert F. Legget

*Geology and Engineering*

Forward (p. xii)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1962

**Grace, Eugene G.**

No biographical data available

Thousands of engineers can design bridges, calculate strains and stresses, and draw up specifications for machines, but the great engineer is the man who can tell whether the bridge or the machine should be built at all, where it should be built, and when.

In George C. Beakley

*Careers in Engineering and Technology* (p. 33)

The Macmillan Company. New York, New York, USA. 1984

**Gruenberg, Benjamin C.**

No biographical data available

Scientific studies develop...the habit of mind that submits every idea to rigid test. Much of the loose thinking in social, political, and economic affairs would be avoided if workers in these fields possessed real training in scientific thinking. The scientist and engineer have built the modern world, and they hold the key to its control and coordination.

*Science and the Public Mind*

Chapter IV (p. 34)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1935

**Hamerton, Philip Gilbert** 1834–94

English artist and writer

Some have iron thews and sinews, some are muscular of mind;

Learned savans, skilful blacksmiths, each are noble in their kind.

But to give the savan's wisdom to the hammer and the shears,

Come those intermediate workers – England's civil engineers.

*The Isles of Loch Awe and Other Poems of My Youth*

The Britannia Bridge, l. 1–4

W. E. Painter. London, England. 1855

**Herbert, George** 1593–1633

English metaphysical poets

Wit's an unruly engine, wildly striking

Sometimes a friend, sometimes the engineer.

*The Country Parson: the Temple*

The Church Porch, l. 241–2 (p. 129)

Paulist Press. New York, New York, USA. 1981

**Hogben, Lancelot** 1895–1975

English zoologist

This is not the age of pamphleteers. It is the age of the engineers. The spark gap is mightier than the pen. Democracy will not be salvaged by men who can talk fluently, debate forcefully, and quote aptly.

*Science for the Citizen*

Epilogue (p. 1075)

Alfred A. Knopf. New York, New York, USA. 1938

**Hood, Thomas** 1582–98

English poet and editor

John Jones he was a builder's clerk,

On ninety pounds a year,

Before his head was engine-turn'd

To be an engineer!

*The Complete Poetical Works of Thomas Hood*

John Jones: A Pathetic Ballad

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Hoover, Herbert** 1874–1964

31st president of the USA

There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings jobs and homes to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.

*The Memoirs of Herbert Hoover* (Volume 1)

The Profession of Engineering (pp. 132–133)

The Macmillan Company. New York, New York, USA. 1952

I hope you will forgive my dreadful curiosity, but I should like awfully to know – what is your profession? I replied that I was an engineer. She emitted an involuntary exclamation, and said Why, I thought you were a gentleman!

*The Memoirs of Herbert Hoover* (Volume 1)

The Profession of Engineering (p. 132)

The Macmillan Company. New York, New York, USA. 1952

**Howland, W. E.**

No biographical data available

**Wiley, R. B.**

No biographical data available

It might be supposed that engineers, who are so largely responsible for the increase in the productive capacity of men and of nations, would be the first to enjoy, or at least to seek to enjoy, the benefits of their own accomplishments; that they would utilize, or seek to utilize in a prolonged period of education, the leisure time made possible by the improvement in productive efficiency which they brought about. That they do not do so is evidence of the need for the enrichment of their education: they don't know what they are missing.

Backsight at a Turning Point

*Civil Engineering*, Volume XI, Number 4, April, 1941 (pp. 199–200)

**Huxley, Thomas Henry** 1825–95

English biologist

I ask anyone who has adopted the calling of an engineer, how much time he lost when he left school, because he had to devote himself to pursuits which were absolutely novel and strange, and of which he had not obtained the remotest conception from his instructors.

Scientific Education: Notes of an After Dinner Speech

*Macmillan's Magazine*, Volume XX, July, 1869 (p. 178)

**Jewett, Frank B.** 1879–1949

American physicist

Thus in many directions the engineers of the future, in my judgment, must of necessity deal with a much more certain and more intimate knowledge of the materials with which he works than we have been wont to deal with in the past. As a result of this more intimate knowledge his structures will be more refined and his factors of safety in many directions are bound to be less because the old elements of uncertainty will have in large measure disappeared.

Problems of Engineers

*Science*, Volume 75, 1932

**Johnson, Eric**

No biographical data available

Our present day diplomats are engineers and they take less pleasure from the marble fountain in a formal garden than from the sinking of a tube well or construction of an irrigation system.

*American Engineer*, September, 1952 (p. 6)

**Johnson, J. B.**

No biographical data available

We must remember, however, that the mind of the engineer is primarily a workshop and not a warehouse or lumber-room of mere information.

*Addresses to Engineering Students*

Two Kind of Education for Engineers (p. 28)

Waddell and Harrington. Kansas City, Missouri, USA. 1912

**Johnson, James Weldon** 1871–1938

American writer, poet, and statesman

And so we ride  
Over land and tide,  
Without a thought of fear –  
Man never had  
The faith in God  
That he has in an engineer!

*Fifty Years & Other Poems*

The Word of An Engineer

The Cornhill Company. Boston, Massachusetts, USA. 1917

**Kac, Mark** 1914–84

Polish mathematician

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Schwartz, Jacob T.** 1930–

American mathematician

Whatever one may think about engineers, one must admit they write clearly, to the point, and engagingly. They have realized long ago that if you wish the reader to follow rather than decipher, the linear deductive technique of exposition is the worst.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

Chapter One (p. 2)

Springer-Verlag. New York, New York, USA. 1992

**Kendall, J. D.**

No biographical data available

A mining engineer who is not a geologist, is like a metallurgist who is not a chemist – simply a one-legged man.

*The Iron Ores of Great Britain and Ireland*

Part II, Chapter II (p. 339)

Crosby Lockwood & Son. London, England. 1893

**Keyser, Cassius Jackson** 1862–1947

American mathematician

The characteristic marks of the great engineer will be four: Magnanimity – Scientific Intelligence – Humanity – Action.

*Mathematical Philosophy: A Study of Fate and Freedom*

Science and Engineering (p. 462)

E.P. Dutton & Company. New York, New York, USA. 1922

**Killian, Jr., James R.** 1904–88

American manager

...you can be neither an effective scientist, engineer, executive, economist, nor architect without acquiring understanding of our society and of human relationships.

*American Engineer*, Volume 26, Number 5, May, 1956 (p. 3)

**Kingsley, Charles** 1819–75

English clergyman and author

So give me the political economist, the sanitary reformer, the engineer; and take your saints and virgins, relics and miracles. The spinning-jenny and the railroad, Cunard's liners and the electric telegraph, are to me... signs that we are, on some points at least, in harmony with the universe...

*The Works of Charles Kingsley* (Volume 2)

Yeast, Chapter 5 (p. 82)

Macmillan & Company Ltd. London, England. 1881

**Kipling, Rudyard** 1865–1936

British writer and poet

When the Waters were dried an' the Earth did appear,  
("It's all one," says the Sapper),  
The Lord He created the Engineer,  
Her Majesty's Royal Engineer,  
With the rank and pay of a Sapper.

*Collected Verse of Rudyard Kipling*

Sappers

Doubleday, Page. Garden City, New York, USA. 1915

**Layton, Jr., Edwin T.**

Historian of technology

The engineer is both a scientist and a businessman. Engineering is a scientific profession, yet the test of the engineer's work lies not in the laboratory, but in the marketplace.

*The Revolt of the Engineers*

Chapter 1 (p. 1)

The Press of Case Western University, Cleveland, Ohio, USA, 1971

Engineers, as a rule are not and do not pretend to be philosophers in the sense of building up consistent systems of thought following logically from certain premises. If anything, they pride themselves on being hard-headed practical men concerned only with facts, disdaining mere speculation or opinion. In practice, however, engineers do make many assumptions about the nature of the universe, of man, and of society.

*The Revolt of the Engineers* (p. 9)

The Press of Case Western University, Cleveland, Ohio, USA, 1971

The cement binding the engineer to his profession was scientific knowledge. All the themes leading toward a closer identification of the engineer with his profession rested on the assumption that the engineer was an applied scientist. It was the cumulative character of scientific knowledge that gave weight to engineers' claims to be the agents of progress and enlightenment.

*The Revolt of the Engineers*

Chapter 3 (p. 58)

The Press of Case Western University, Cleveland, Ohio, USA, 1971

**Le Corbusier (Charles-Edouard****Jeanneret)** 1887–1965

Swiss architect and city planner

The Engineer, inspired by the law of Economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 7)

The Architectural Press. London, England. 1965

Working by calculations, engineers employ geometrical forms, satisfying our eyes by their geometry and our understanding of their mathematics; their work is one the direct line of good art.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 8)

The Architectural Press. London, England. 1965

Engineers fabricate the tools of their time. Everything, that is to say, except houses and moth-eaten boudoirs.

Translated by Frederick Etchells

*Towards a New Architecture*

The Engineer's Aesthetic and Architecture (p. 18)

The Architectural Press. London, England. 1965

Our engineers are healthy and virile, active and useful, balanced and happy in their work. Our architects are disillusioned and unemployed, boastful or peevish. This is because there will soon be nothing more for them to do. We no longer have the money to erect historical souvenirs. At the same time, we have got to wash!

Translated by Frederick Etchells

*Towards a New Architecture*

The Engineer's Aesthetic and Architecture (pp. 18–19)

The Architectural Press. London, England. 1965

Our engineers produce architecture, for they employ a mathematical calculation which derives from natural law, and their works give us the feeling of HARMONY. The engineer therefore has his own aesthetic, for he must, in making his calculations, qualify some of the terms of his equation; and it is here that taste intervenes. Now, in handling a mathematical problem, a man is regarding it from a purely abstract point of view, and in such a state, his taste must follow a sure and certain path.

Translated by Frederick Etchells

*Towards a New Architecture*

The Engineer's Aesthetic and Architecture (p. 19)

The Architectural Press. London, England. 1965

**Leonard McCoy (Fictional character)**

I know engineers. They love to change things.

*Star Trek – The Motion Picture*

The film (2001)

**Lincoln, P. M.**

No biographical data available

The physicist's interest is scientific, the engineer's utilitarian. The physicist's eternal question is, *Why?* the engineer's, *Of what use?*

Carona and the Ionic Theory

*The Electric Journal*, Volume 8, Number 2, February, 1911 (p. 117)

**Lovejoy, Thomas E.** 1941–

Tropical biologist

Genetic engineers don't make new genes, they rearrange existing ones.

In Jamie Murphy

The Quiet Apocalypse

*Time*, 13 October, 1986 (p. 80)

Natural species are the library from which genetic engineers can work.

In Jamie Murphy

The Quiet Apocalypse

*Time*, 13 October, 1986 (p. 80)

**Mackay, Charles** 1814–89

English poet and journalist

Old King Coal was a merry old soul:

Quoth he, "We travel slow;

I should like to roam the wide world round,

As fast as the wild winds blow."

And he call'd for his skilful engineers;

And soon through hills and vales,

O'er rivers wide, through tunnels vast,

The flying trains like lightning pass'd,

On the ribs of the mighty Rails.

*Ballads and Lyrical Poems*

Old King Cole, l. 28–36

Routledge. London, England. 1856

**Mason, William** 1725–97

English poet

Here midway down, upon the nearer bank

Plant thy thick row of thorns, and, to defend

Their infant shoots, beneath, on oaken stakes,

Extend a rail of elm, securely arm'd

With speculated paling, in such sort

As, round some citadel, the engineer

Directs his sharp stockade.

*The English Garden: A Poem*

Book the Second, l. 288–293

Garland Publications. New York, New York, USA. 1982

**Matthews, Ernest R.**

Engineer

The marine engineer has no greater problem to deal with than this. The construction of harbours upon a sandy coast is always risky, resulting in no end of trouble and expense.... The interference with the natural sand-travel upon a coast cannot but be injurious; the breaking of any of Nature's laws has a detrimental effect.

*Coast Erosion and Protection*

Chapter XIII (pp. 158–159)

Watchmaker Publishing. Seaside, Oregon, USA. 2003

**McCullough, David** 1933–

American writer

Engineers who read, who paint, who grow roses and collect fossils and write poetry, who fall asleep in lectures, very human-like, even civilized civil engineers are scattered all through the historical record. Civil engineers have been known to go to the theater, yes indeed; they have taken pleasure in good music and fine wine and the company of charming women. There is even historical evidence of the existence among a few civil engineers of a sense of humor.

Civil Engineers Are People

*Civil Engineering*, December, 1978 (p. 47)

**Michener, James A.** 1907–97

American novelist

Scientists are men who dream about doing things. Engineers do them...if you want to be an engineer but find you have ten thumbs, you become a scientist.

*Space*

Chapter III (p. 173)

Random House, Inc. New York, New York, USA. 1982

**Mitchell, Margaret** 1900–49

American author

The South produced statesmen and soldiers, planters and doctors, lawyers and poets, but certainly not engineers or mechanics. Let Yankees adopt such low callings.

*Gone With the Wind*

Part Two, Chapter VIII (p. 147)

Macmillan Publishing Company. New York, New York, USA. 1936

**Morison, George S.** 1842–1903

Civil engineer

We are the priests of the new epoch without superstitions.

Address at the Annual Convention

*Transactions of the American Society of Civil Engineers*, June, 1895

(p. 483)

Any man who is thoroughly capable of understanding and handling a machine may be called a mechanical engineer, but only he who knows the principles behind that machine so thoroughly that he would be able to design it or adapt it to a new purpose...can be classed as a civil engineer.

Address at the Annual Convention

*Transactions of the American Society of Civil Engineers*, June, 1895

**Morley, Christopher** 1890–1957

American writer

Having made up our mind to become an engineer, we thought it would be a mistake not to take advantage of all possible aid.

*The Powder of Sympathy*

Adventures of a Curricular Engineer (p. 82)

Doubleday, Page & Company. Garden City, New York, USA. 1923

**Murray, Robert Fuller** 1863–94

American-born English writer

They went to the north, they went to the south,  
And into the west went they,  
Till they found a civil, civil engineer,  
And unto him did say: "Now tell to us, thou civil engi-  
neer,  
If this be fit to drink." And they showed him a cup of the  
town water,  
Which was as black as ink.

*Robert F. Murray: His Poems*

A Ballad of the Town Water

Longmans, Green & Company. London, England. 1894

**Pagnol, Marcel** 1895–74

French film director and playwright

*Il faut se méfier des ingénieurs: ça commence par la  
machine à coudre, ça finit par la bombe atomique.*

One has to look out for engineers – they begin with sew-  
ing machines and end up with the atomic bomb.

*critique des critiques*

Chapter 3 (p. 38)

Nagel. Paris, France. 1949

**Petroski, Henry** 1942–

Civil engineer

Engineers...are not superhuman. They make mistakes in  
their assumptions, in their calculations, in their conclu-  
sions. That they make mistakes is forgivable; that they  
catch them is imperative. Thus it is the essence of mod-  
ern engineering not only to be able to check one's own  
work, but also to have one's work checked and to be able  
to check the work of others.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 52)

St. Martin's Press. New York, New York, USA. 1985

The work of the engineer is not unlike that of the writer.  
How the original design for a new bridge comes to be  
may involve as great a leap of the imagination as the first  
draft of a novel.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 78)

St. Martin's Press. New York, New York, USA. 1985

The engineer no less than the poet sees the faults in his  
creations, and he learns more from his mistakes and those  
of others than he does from all the masterpieces created  
by himself and his peers.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 82)

St. Martin's Press. New York, New York, USA. 1985

**Pickering, William H.** 1910–2004

New Zealand-born rocket scientist

We need a new kind of engineer, one who can build  
bridges to society as well as bridges across rivers.

The Engineer–1968

*The Bridge of ETA Kappa Nu*, May, 1968 (p. 7)

**Rae, John A.**

No biographical data available

...the scientist wants to know chiefly for the sake of  
knowing; the engineer wants to know for the sake of  
using.

Science and Engineering in the History of Aviation

*Technology and Culture*, Fall 1961 (p. 291)

**Rankine, William John Macquorn** 1820–72

Scottish engineer and physicist

Thus it is that the commonest objects are by science ren-  
dered precious; and in like manner the engineer or the  
mechanic, who plans and works with understanding of  
the natural laws that regulate the results of his operations,  
raise to the dignity of a Sage.

*A Manual of Applied Mechanics*

Preliminary Dissertation on the Harmony of Theory and Practice in

Mechanics (p. 11)

Charles Griffin and Company. London, England. 1877

**Rawnsley, Hardwicke Drummond** 1851–1920

English clergyman and poet

Yet as I watch the marvelous engineer

Guess at wind-pressure, and on favoring wind

Send forth at will her silk from stores within,

One message for men's souls I seem to hear

"Let others live to eat, I eat to spin,

Joy's soul is work: God helps the worker's mind!"

*The Spider's Message*

At a Gilchrist Lecture, I. 9–14

Publisher undetermined

**Salisbury, J. Kenneth**

No biographical data available

One normally tends to catalog engineers either as ana-  
lyzers or as synthesizers – the analyzers are the appraisers  
and evaluators; the synthesizers are those who are  
creative and ingenious in devising new ways of doing  
things. This sharp division is somewhat fallacious, how-  
ever, because there is considerable overlapping.

Qualities Industry Wants in Its Engineers

*General Electric Review*, May, 1952 (p. 17)

**Sand, George (Amantine-Lucile-Aurore**

**Dupin)** 1804–76

French novelist and feminist

Another places upon his nose a pair of paper or wooden  
spectacles; he performs the duty of engineer – comes,  
goes, makes a plan, looks at the workmen, draws lines,  
plays the pedant, cries that everything is being ruined,  
causes the work to be abandoned and resumed at his will,  
and directs it at great length and as absurdly as possible.

*The Haunted Pool*

Chapter IV, The Cabbage

Shameless Hussy Press. San Lorenzo, California. 1976



**Seeger, Peggy** 1935–  
American folk singer

When I was a little girl I wished I was a boy  
I tagged along behind the gang and wore my corduroys.  
Everybody said I only did it to annoy  
But I was gonna be an engineer.  
Recorded by Frankie Armstrong

**Seely, Bruce E.**  
No biographical data available

We have the man who fires the boiler and pulls the throttle  
dubbed a locomotive or stationary engineer; we have the  
woman who fires the stove and cooks the dinner dubbed  
the domestic engineer, and it will not be long before the  
barefooted African, who pounds the mud into the brick  
molds, will be calling himself a ceramic engineer.  
SHOT, the History of Technology, and Engineering Education  
*Technology and Culture*, Volume 36, Number 4, October, 1995  
(p. 744)

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

For 'tis the sport to have the engineer  
Hoist with his own petard.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Hamlet, Prince of Denmark*  
Act III, Scene iv, l. 206  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Now there is no calculation that an engineer can make as  
to the behavior of a girder under a strain, of an astronomer  
as to the recurrence of a comet, more certain than the  
calculation that under such circumstances we shall  
be dismembered unnecessarily in all directions by surgeons  
who believe the operations to be necessary solely  
because they want to perform them.  
*The Doctor's Dilemma*  
Preface on Doctors (p. vi)  
Brentano's. New York, New York, USA. 1920

STRAKER: Very nice sort of place, Oxford, I should  
think, for people that like that sort of place. They teach  
you to be a gentleman there. In the Polytechnic they teach  
you to be an engineer or such like.  
*Man and Superman: A Comedy and a Philosophy*  
Act II (p. 40)  
The Heritage Press. New York, New York, USA. No date

**Shute, Nevil** 1899–1960  
English novelist

It has been said that an engineer is a man who can do for  
ten shillings what any fool can do for a pound...  
*Slide Rule: The Autobiography of an Engineer*  
Chapter 3 (p. 64)  
William Morow & Company. New York, New York, USA. 1954

**Slichter, Charles S.**  
Mathematician

It grates on me to hear mathematics spoken of as a tool.  
Mathematics is to the engineer a basal science and not a  
tool. The spirit of that science is of more value to the engineer  
than the particular things that can be accomplished.  
The engineer need not be a mathematician, but he needs  
to think mathematically, and, to my mind, he needs the  
power of mathematical thought more than skill in manipulating  
a few mathematical tools in mechanical fashion.  
The Teaching of Mathematics to Students of Engineering  
*Science*, Volume 28, Number 713, August 28, 1908 (p. 263)

**Snow, Charles Percy** 1905–80  
English novelist and scientist

Pure scientists have by and large been dim-witted about  
engineers and applied science. They couldn't get interested.  
They wouldn't recognize that many of the problems  
were as intellectually exacting as pure problems, and that  
many of the solutions were as satisfying and beautiful.  
Their instinct – perhaps sharpened in this country by the  
passion to find a new snobbism wherever possible, and to  
invent one if it doesn't exist – was to take it for granted  
that applied science was an occupation for second rate  
minds. I say this more sharply because thirty years ago  
I took precisely that line myself.  
*The Two Cultures and the Scientific Revolution*  
Chapter III (p. 33)  
Cambridge University Press. New York, New York, USA. 1961

...engineers have to live their lives in an organized  
community, and however odd they are underneath they  
manage to present a disciplined face to the world.  
*Two Cultures and The Scientific Revolution*  
Chapter III (p. 33)  
Cambridge University Press. New York, New York, USA. 1961

**Stalin, Joseph** 1879–1953  
Soviet Russian political leader and general secretary of Communist Party

The writer is an engineer of the human soul.  
In John Gunther  
*Inside Russia Today* (p. 284)  
Harper & Row. New York, New York, USA. 1958

**Starkey, W. L.**  
No biographical data available

The engineer knows that it is easier to analyze a machine  
than it is to design one. Engineering analysis is simpler  
than engineering synthesis or design.  
The Ingredients of Design  
*Mechanical Engineering*, May, 1966

**Stassen, Harold E.**  
No biographical data available

The building of a just and durable peace absolutely  
requires the sustained strength which flows in such a  
large measure from the work of engineers.  
*American Engineer*, Volume 26, Number 3, March, 1956 (p. 3)



**Sterrett, The Right Reverend Frank W.**

No biographical data available

Many a battle has been lost because men lacked confidence in the outcome. That has not been characteristic of the Engineer. He is accustomed to face hard tasks demanding his best. The rebuilding and restoring of an ordered world present such a problem. It seems to me there is a continuing place of dignity for the Engineer of tomorrow.

*American Engineer*, June, 1951 (p. 3)

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

The engineer of today is confronted with a library of acquired results; tables and formulae to the value of folios full have been calculated and recorded; and the student finds everywhere in front of him the footprints of the pioneers. In the eighteenth century the field was largely unexplored; the engineer must read with his own eyes the face of nature.

*Records of a Family of Engineers*

Chapter I (p. 212)

Chatto & Windus. London, England. 1912

The seas into which his labours carried the new engineer were still scarce charted, the coasts still dark; his way on shore was often far beyond the convenience of any road; the isles in which he must sojourn were still partly savage. He must toss much in boats; he must often adventure on horseback by the dubious bridle-track through unfrequented wildernesses; he must sometimes plant his lighthouse in the very camp of wreckers; and he was continually enforced to the vicissitudes of outdoor life.

*Records of a Family of Engineers*

Chapter I (p. 213)

Chatto & Windus. London, England. 1912

The engineer was not only exposed to the hazards of the sea; he must often ford his way by land to remote and scarce accessible places, beyond reach of the mail or the post-chaise, even the tracery of the bridle-path, and guided by natives across bog and heather.

*Records of a Family of Engineers*

Chapter II, Part I (p. 241)

Chatto & Windus. London, England. 1912

With the civil engineer, more properly so called (if anything can be proper with this awkward coinage), the obligation starts with the beginning. He is always the practical man. The rains, the winds and the waves, the complexity and the fitfulness of nature, are always before him. He has to deal with the unpredictable, with those forces (in Smeaton's phrase) that "are subject to no calculation"; and still he must predict, still calculate them, at his peril.

*Records of a Family of Engineers*

Chapter II, Part III (p. 261)

Chatto & Windus. London, England. 1912

Even the mechanical engineer comes at last to an end of his figures, and must stand up, a practical man, face to face with the discrepancies of nature and the hiatuses of theory.

*Records of a Family of Engineers*

Chapter II, Part III (p. 261)

Chatto & Windus. London, England. 1912

The duty of the engineer is twofold – to design the work, and to see the work done.

*Records of a Family of Engineers*

Chapter II, Part III (p. 265)

Chatto & Windus. London, England. 1912

**Thring, Meredith Wooldridge**

Engineer

The creative engineer uses his three brains. He uses his intellectual brain as an applied scientist to understand the laws of science and to see that the things which he invents do not break these laws. He uses his emotional brain for the act of invention, and he uses his physical brain – his brain with his hands, feet and body – for the proper understanding of the design of things that will work.

On the Threshold

*Proceedings of the Institution of Mechanical Engineers*, Volume 179,

Part I, 1963–64 (p. 1089)

...this type of engineer is the leaven that leavens the whole of the country. If a country has plenty of creative engineers doing real creative work, it moves forward with the times. If it does not, it falls behind, however good all its other people are.

On the Threshold

*Proceedings of the Institution of Mechanical Engineers*, Volume 179,

Part I, 1963–64 (p. 1089)

**US Army Corps of Engineers**

Let's try!

Motto

**Verne, Jules** 1828–1905

French novelist

Our worthy engineer belonged to that class of men whose brain is always on the boil, like a kettle on a hot fire. In some of these brain kettles the ideas bubble over, in others they just simmer quietly.

In Charles F. Horne (ed.)

*Works of Jules Verne* (Volume 9)

*The Underground City*, Chapter I, Contradictory Letters

F. Tyler Daniels Company. New York, New York, USA. 1911

**Vollmer, James**

No biographical data available

No longer can an engineer expect to work in a given specialty for most of his life. Within five years a problem area of broad interest can be completely mined out partly because of the number of miners, and partly because of the sophistication of their equipment.

Engineering, Growing, Steady State, or Evanescent  
*The Bridge of ETA Kappa Nu*, Volume 65, Number 4, August, 1969

**von Karman, Theodore** 1881–1963  
 Hungarian-born American engineer

The scientist merely explores that which exists, while the engineer creates what has never existed before.

Creativity Is a Task, Not a Trait  
*Machine Design*, May 25, 1967

**Walker, Eric A.**  
 American engineer

...the modern engineer's primary concern should be that of designing and creating the things that society needs, and the spark of genius must be nurtured and developed to the maximum extent.

*Report of the World Congress on Engineering Education*  
 Engineering Education Around the World, Held June 21–25, 1965

...when an engineer goes to work, he is no longer just an analyst of problems but a synthesizer.

Our Tradition-Bound Colleges  
*Engineering Education*, October, 1969 (p. 89)

**Ward, Edward**

Their Engineer his utmost Cunning try'd,  
 But found no Skreen could his Approaches hide;  
 For all the various Stratagems he us'd,  
 Ended thro' Royal Conduct, still confus'd.

*A Fair Shell, BUT a Rotten Kernel*, l. 233–236  
 Printed for B. Bragge. London, England. 1705

**Whittier, John** 1807–92  
 American poet

Beat by hot hail, and wet with bloody rain,  
 The myriad-handed pioneer may pour,  
 And the wild West with the roused North combine  
 And heave the engineer of evil with his mine.

*The Complete Poetical Works of John Greenleaf Whittier*  
 To a Southern Statesman  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1894

**Wickenden, W. E.**  
 No biographical data available

...man-made machines and the harnessing of natural resources are progressively relieving humanity from the distress of an oppressively heavy physical toil and are affording improved opportunity for the development of mind and spirit. This is the challenging opportunity – and responsibility – of the engineer and his profession.

*American Engineer*, November, 1951 (p. 7)

**Wigner, Eugene Paul** 1902–95  
 Hungarian-born American physicist

Part of the art and skill of the engineer and of the experimental physicist is to create conditions in which certain events are sure to occur.

*Symmetries and Reflections*  
 Chapter 3 (p. 29)  
 Ox Bow Press, Woodbridge, Connecticut, USA. 1979

**Winne, Harry A.**  
 No biographical data available

It is the engineer's responsibility to take the new research discoveries as they come along and to put them to work for the benefit of man, and to find ways of doing it that industry and the people can afford.

*American Engineer*, February 17–23, 1952 (p. 4)

**Winsor, Dorothy A.**  
 No biographical data available

Engineers tend to prefer saying that they are being convincing rather than persuasive, and the very fact that they choose a different term suggests that, at least for them, persuasion has associations that are not applicable to the relationship between engineers and their readers.

*Writing Like an Engineer: A Rhetorical Education* (p. 3)  
 Lawrence Erlbaum Associates. Mahwah, New Jersey, USA. 1996

Scientists and engineers may all study physical reality, but the scientist is usually considered successful if he or she has contributed to theory while the engineer is less interested in generating theory for its own sake than in doing whatever is necessary to design and produce useful artifacts. A scientist who does not understand a phenomenon has failed; but an engineer who does not fully understand a device may still be considered successful if the device works well enough. Scientists and engineers thus operate with different standards for success that affect the way they argue.

*Writing Like an Engineer: A Rhetorical Education* (p. 10)  
 Lawrence Erlbaum Associates. Mahwah, New Jersey, USA. 1996

**Woodson, Thomas T.**  
 No biographical data available

...estimation and order-of-magnitude analysis are the hallmarks of the engineer.

*Introduction to Engineering Design* (p. 107)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

The engineer uses all the analysis and quantification he can command; but in the end, the decisions are made subjectively; and there is no avoiding it.

*Introduction to Engineering Design* (p. 204)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

**Wright, Harold Bell** 1872–1944  
 American writer

It was the last night out. Supper was over and the men, with their pipes and cigarettes, settled themselves in various careless attitudes of repose after the long day.... All were strong, clean-cut, vigorous specimens of intelligent, healthy manhood, for in all the professions, not excepting the army and navy, there can be found no finer body of men than our civil engineers.

*The Winning of Barbara Worth*  
Chapter V (pp. 86–87)  
The Book Supply Company Publishers. Chicago, Illinois, USA. 1911

**Zener, Clarence** 1905–93  
American physicist

Engineers have traditionally been people who work toward the attainment of practical goals.... [I]f a particular task requires the use of some practical goals. If a particular task requires the use of some particular physical phenomenon, then the more he understands this particular phenomenon the better able he will be to reach his goal. However, as an engineer he could not care less about his understanding per se. In contrast, scientists have traditionally been people whose sole drive was to understand the world around them. They could not care less what use was made of this understanding.

Engineering in the Future  
*Florida Engineer*, October, 1965

## ENGINEERING

### MARTIANS BUILD TWO IMMENSE CANALS IN TWO YEARS

Vast Engineering Works Accomplished in an Incredibly Short Time by Our Planetary Neighbors.

Front page headline  
*New York Times*, August 27, 1911

### American Society for Engineering Education

The engineering profession is the channel by which science can greatly improve our way of life, provided it assumes the initiative of leadership rather than the passive role of the hired consultant.

*Goals of Engineering Education, the Preliminary Report* (p. 15)  
American Society for Engineering Education. Washington, D.C. 1968

**Asimov, Isaac** 1920–92  
American author and biochemist

Science can amuse and fascinate us all, but it is engineering that changes the world.

*Isaac Asimov's Book of Science and Nature Quotations* (p. 78)  
Weidenfeld & Nicolson. New York, New York, USA. 1988

### Author undetermined

Every rocket-firing that is successful is hailed as a scientific achievement; everyone that is a failure is regarded as an engineering failure.

Source undetermined

...trying to apply the higher mathematics to engineering is like looking into the clouds with a telescope of high power in search of facts within our grasp on the surface of the earth.

Quoted in George L. Vose

*van Nostrand's Engineering Magazine*  
The Training for Students in Civil Engineering  
Volume XXVIII 1883 (p. 196)

**Billington, David**  
No biographical data available

Engineering or technology is the making of things that did not previously exist, whereas science is the discovering of things that have long existed. Technological results are forms that exist only because people want to make them, whereas scientific results are formulations of what exists independently of human intentions.

*The Tower and The Bridge: The New Art of Structural Engineering*  
Chapter 1 (p. 9)  
Princeton University Press. Princeton, New Jersey, USA. 1983

### British Engineer to the Royal Aeronautical Society

Aeroplanes are not designed by science, but by art in spite of some pretense and humbug to the contrary. I do not mean to suggest that engineering can do without science, on the contrary, it stands on scientific foundations, but there is a big gap between scientific research and the engineering product which has to be bridged by the art of the engineer.

In Walter G. Vincenti  
*What Engineers Know and How They Know It*  
Chapter 1 (p. 4)  
The Johns Hopkins University Press. Baltimore. 1990

**Capp, Al** 1909–79  
American comic strip artist

If half the engineering effort and public interest that go into the research of the American bosom had gone into our guided-missile program, we would now be running hot-dog stands on the moon.

*Reader's Digest*, July 1958 (p. 116)

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

The characteristic feature of our age results from the wedding of science and engineering. It is the working together of disciplined curiosity and purposeful ingenuity to create new materials, new forces, and new opportunities which powerfully affect our manner of living and ways of thinking.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 1)  
Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

Engineering education is the sine qua non of this technical age. Unless it is effective and adequate our type of civilization cannot go forward. To be effective, it must be progressive, for engineering art is not static; it is very dynamic.

*A Scientist Speaks: Excerpts From Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 49)  
Undergraduate Association, Massachusetts Institute of Technology.  
Cambridge, Massachusetts, USA. 1955

The question of engineering should be of interest not only to those of us who are engineers, but to the entire public which lives in an engineering world.

*A Scientist Speaks: Excerpts From Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 49)  
Undergraduate Association, Massachusetts Institute of Technology.  
Cambridge, Massachusetts, USA. 1955

More recently in the development of a program of biological engineering, based upon physical, chemical, and biological operations, a similar attempt has been made to synthesize an appropriate training for the handling of a great variety of biological situations, whether they be in the food industry or in the hospital or medical or biological research fields. I suspect that there may be other directions in which an analogous approach may be made to simplify the educational program and at the same time increase the power acquired by the student.

*A Scientist Speaks: Excerpts From Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 53)  
Undergraduate Association, Massachusetts Institute of Technology.  
Cambridge, Massachusetts, USA. 1955

### **Cross, Hardy** 1885–1959

American professor of civil and structural engineering

It is customary to think of engineering as a part of a trilogy, pure science, applied science and engineering. It needs emphasis that this trilogy is only one of a triad of trilogies into which engineering fits.... [T]he second is economic theory, finance and engineering; and the third is social relations, industrial relations, engineering. Many engineering problems are as closely allied to social problems as they are to pure science.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 56)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

Engineering then is not merely a mathematical science. It must be approached with a sense of proportion and aesthetics.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 64)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

### **DeSimone, Daniel V.**

No biographical data available

### **Cross, Hardy** 1885–1959

American professor of civil and structural engineering

Engineering is a profession, an art of action and synthesis and not simply a body of knowledge. Its highest calling is to invent and innovate.

*Education for Innovation*

Introduction (pp. 1–2)

Pergamon Press. New York, New York, USA. 1968

## **Editor**

Most young men when entering technical schools have no adequate conception of what the engineering profession really is. Many of them undertake the course either because their parents desire them to receive a useful education or because they think that engineering is a good calling in which to make a living; but very few of them enter on account of a heartfelt admiration of engineering as the profession of progress, to which are due practically all the wonderful developments of the world during the last one hundred years – developments that have so added to the comforts and conveniences of man as to make life truly worth living instead of a burden grievous to be borne.

In John Alexander Low Waddell and John Lyle Harrington

*Addresses to Engineering Students* (2nd edition) (p. 1)

Waddell and Harrington. Kansas City, Missouri, USA. 1912

### **Elgerd, Olle I.**

No biographical data available

Engineering is an art of simplification, and the rules – when and how to simplify – are a matter of experience and intuition.

In Robert L. Bailey

*Disciplined Creativity for Engineers*

Table 14–1 (p. 433)

Ann Arbor Science Publishers. Ann Arbor, Michigan, USA. 1978

### **Emmerson, G. S.**

No biographical data available

Modern scientific principle has been drawn from the investigation of natural laws, technology has developed from the experience of doing, and the two have been combined by means of mathematical system to form what we call engineering.

*Engineering Education: A Social History* (p. 7)

Publisher undetermined

### **Emmet, William LeRoy** 1859–1941

American electrical engineer

There may be said to be two kinds of engineering, that which is essentially creative, and that which is practiced in pursuit of known methods.

*The Autobiography of an Engineer*

Chapter XII (p. 224)

The American Society of Mechanical Engineers. New York, New York, USA. 1940

Engineering is to a very large extent dependent upon detail...

*The Autobiography of an Engineer*

Chapter XII (p. 225)

The American Society of Mechanical Engineers. New York, New York, USA. 1940

### **Everitt, W. L.**

No biographical data available

It is easier to distinguish between the “scientific function” and the “engineering function” than to distinguish

between the man who should be called a scientist and [he] who should be termed an engineer. Many men perform both functions, and do it very well...

In Panel on Engineering Infrastructure

*Engineering Infrastructure Diagramming and Modeling*

Appendix A (p. 73)

National Academy Press. Washington, D.C. 1986

### **Ferguson, Eugene S.**

American technological historian

Engineering drawings are expressed in a graphic language, the grammar and syntax of which are learned through use; it also has idioms that only initiates will recognize. And because the drawings are neatly made and produced on large sheets of paper, they exhume an air of great authority and definitive completeness.

*Engineering and the Mind's Eye*

Chapter 1 (p. 3)

The MIT Press. Cambridge, Massachusetts, USA. 1992

### **Fish, J. C. L.**

No biographical data available

Every engineering structure, with few exceptions, is first suggested by economic requirements; and the design of every part, excepting few, and of the whole is finally judged from the economic standpoint.

*Engineering Economics: First Principles*

Preface (p. v)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1915

### **Flinn, Alfred D.**

No biographical data available

In fact "engineering" now often signifies a new system of thought, a fresh method of attack upon the world's problems the antithesis of traditionalism, with its precedents and dogmas.

Leadership in Economic Progress

*Civil Engineering*, Volume 2, Number 4, April, 1932 (p. 242)

### **Florman, Samuel C.** 1925–

Author and professional engineer

When engineers attempt to write creatively...the results are usually disastrous.

*Engineering and the Liberal Arts: A Technologist's Guide to History, Literature, Philosophy, Art, and Music*

Chapter Four (p. 92)

McGraw Hill Book Company, Inc. New York, New York, USA. 1968

As engineering becomes increasingly central to the shaping of society, it is ever more important that engineers become introspective. Rather than merely revel in our technical successes, we should intensify our efforts to explore, define, and improve the philosophical foundations of our professions.

*The Civilized Engineer*

Introduction (p. xii)

St. Martin's Press. New York, New York, USA. 1985

Engineering is committed to the prospect of new discoveries, and engineers still look eagerly to ever receding horizons. We are tinkerers at heart; we cannot keep our hands off the world. However, the over-optimism, and perhaps even arrogance, that had been creeping into the engineering view is being replaced by a more thoughtful but still enthusiastic commitment to change.

*The Civilized Engineer*

Chapter 5 (p. 76)

St. Martin's Press. New York, New York, USA. 1985

Engineering is superficial only to those who view it superficially. At the heart of engineering lies existential joy.

*The Existential Pleasures of Engineering*

Chapter 8 (p. 101)

St. Martin's Press. New York, New York, USA. 1976

...without imagination, heightened awareness, moral sense, and some reference to the general culture, the engineering experience becomes less meaningful, less fulfilling than it should be.

*The Civilized Engineer*

Chapter 2 (p. 24)

St. Martin's Press. New York, New York, USA. 1985

### **Friedel, Robert**

No biographical data available

Technology is simply not...largely the province of engineers, and "engineering" is certainly not coextensive with "technology."

Engineering in the 20th Century

*Technology and Culture*, October, 1968, Special Issue (p. 669)

### **Fung, Y. C. B.** 1919–

Chinese scientist

...for engineering, the method is scientific, the mode is quantitative, the dictum is economy, the concern is human.

In David L. Arm (ed.)

*Journeys in Science: Small Steps, Great Strides*

An Approach to Bioengineering (p. 108)

University of New Mexico Press. Albuquerque, New Mexico, USA. 1967

### **Gillette, H. P.**

No biographical data available

Engineering is the conscious application of science to the problems of economic production.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### **Grinter, L. E.**

No biographical data available

Engineering is far from static, for it is essentially a creative profession.

Report on Evaluation of Engineering Education (1952–1955)

*Journal of Engineering Education*, Volume 46, Number 1, September, 1955



**Groat, Benjamin Feland**

Engineer

Mathematics is mathematics and engineering is engineering.

The Teaching of Mathematics to Students of Engineering  
*Science*, Volume 28, Number 714, September 4, 1908 (p. 290)

**Hamilton, L. L.**

No biographical data available

It has been my lot for many years  
To read reports by engineers:  
Of projects, jobs, and tasks and such  
From which I should learn very much.  
Alas! alack! I am undid  
And maybe soon I'll flip my lid,  
Unless someone can help me out  
And tell me what they're all about.  
They do not mean what they say  
But start in the middle and go each way.  
The outline is missing, the form is lax  
No useful punctuation, or correct syntax.  
The object is a secret beautifully kept,  
And conclusions avoided in manner adept.  
Oh here I go, I've blown my top.  
About a thing no one can stop.  
Just let me say before I'm muzzled,  
I'm not the only one who's puzzled.

Engineer Report

*American Engineer*, Volume 29, Number 6, June, 1959 (p. 4)

**Hammond, H. P.**

No biographical data available

Throughout the whole fabric of engineering education, therefore, there must be interwoven with instruction in scientific principles...the encouragement of creative talent...

Engineering Education After the War

*Journal of Engineering Education*, Volume 43, Number 9, May, 1944 (p. 599)

...the engineering profession clearly cannot isolate itself from this complex of men and functions as a well-defined caste...

Report of Committee on Aims and Scope of Engineering Curricula

*Journal of Engineering Education*, Volume 30, Number 7, March, 1940

**Hammond, John Hays** 1855–1936

American mining engineer

Chemical engineering more than any other, may be called the engineering of the future. It is the result of an evolution in which most of the other branches have played a part.... The chemical engineer stands today on the threshold of a vast virgin realm; in it lie the secrets of life and prosperity for mankind in the future of the world.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

The Story of Chemical Engineering (p. 176)

Centennial of Engineering. Chicago, Illinois. 1952

**Harris, A. J.**

No biographical data available

The foundation of engineering is knowledge of materials, not, as engineers are so often apt to preach, a knowledge of mathematics...knowledge of what [materials] are made of, how they are made, how they are shaped, how you fit them together, how they stand up to stress, how they break, how they catch fire, how they react to all the various agencies of ruin which are perpetually nibbling at them, how in due course they fall down.

Architectural Misconceptions of Engineering 3rd Series

*Journal of the Royal Institute of British Architects*, Volume 68 (p. 130)

**Hellmund, R. E.**

No biographical data available

Engineering is an activity other than pure manual and physical work which brings about the utilization of the materials and laws of nature for the good of humanity.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Hicks, Beatrice Alice** 1919–79

American engineer

Women think that an engineer is a man in hip boots building a dam. They don't realize that 95% of engineering is done in a nice air-conditioned office.

*Mademoiselle*, 1952**Holloman, J. Herbert**

No biographical data available

There are deeply held feelings that engineering education has become too science-based and has become removed to some degree from the creative act that the engineer or inventor has to perform to bring the results of science and technology to the benefit of society.

In Daniel V. DeSimone

*Education for Innovation*

Creative Engineering and the Needs of Society (p. 23)

Pergamon Press. New York, New York, USA. 1968

...we cannot effectively talk about the needs of engineering until we have reflected on the needs of society.

In Daniel V. DeSimone

*Education for Innovation*

Creative Engineering and the Needs of Society (p. 23)

Pergamon Press. New York, New York, USA. 1968

**Hoover, Herbert** 1874–1964

31st president of the USA



...engineering without imagination sinks to a trade.

*The Memoirs of Herbert Hoover* (Volume 1)  
The Profession of Engineering (p. 132)  
The Macmillan Company. New York, New York, USA. 1952

From the point of view of accuracy and intellectual honesty the more men of engineering background who become public officials, the better for representative government.

*The Memoirs of Herbert Hoover* (Volume 1)  
The Profession of Engineering (p. 132)  
The Macmillan Company. New York, New York, USA. 1952

### Hoover, T. J.

No biographical data available

### Fish, J. C. L.

No biographical data available

Engineering is the professional and systematic application of science to the efficient utilization of natural resources to produce wealth.

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 8)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

...we may say that we have already considered with disfavor the possibility of the universe having been planned by a biologist or an engineer; from the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician.

*The Mysterious Universe*  
Chapter V (p. 165)  
The Macmillan Company. New York, New York, USA. 1932

### Kiddle, Alfred W.

No biographical data available

Engineering is the art or science of utilizing, directing or instructing others in the utilization of the principles, forces, properties and substances of nature in the production, manufacture, construction, operation and use of things...or of means, methods, machines, devices and structures...

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 7)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Kipling, Rudyard 1865–1936

British writer and poet

Good morn, M'Andrew!

Back again?

An' how's your bilge to-day?

Miscallin' technicalities but handlin' me my chair

To drink Madeira wi' three Earls –

the auld Fleet Engineer

That started as a boiler-whelp –  
when steam and he were low.

*Collected Verse of Rudyard Kipling*  
McAndrew's Hymn (p. 35)  
Doubleday, Page. Garden City, New York, USA. 1915

### Kirkpatrick, Sidney D.

No biographical data available

Chemical engineering is that branch of engineering concerned with the development and application of manufacturing processes in which chemical or certain physical changes of material are involved. These processes may usually be resolved into a coordinated series of unit physical operations and unit chemical processes. The work of the chemical engineer is concerned primarily with the design, construction and operation of equipment and plants in which these unit operations and processes are applied. Chemistry, physics and mathematics are the underlying sciences of chemical engineering, and economics its guide in practice.

In Albert B. Newman  
Development of Chemical Engineering Education in the United States  
*American Institute of Chemical Engineers Transactions*, Volume 34,  
Number 3a, July 25, 1938 (pp. 6–7)

### Lindsay, S. E.

No biographical data available

Engineering is the practice of safe and economic application of the scientific laws governing the forces and materials of nature by means of organization, design and construction, for the general benefit of mankind.

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 8)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Little, Arthur D.

No biographical data available

Chemical engineering as a science...is not a composite of chemistry and mechanical and civil engineering, but a science of itself, the basis of which is those unit operations which in their proper sequence and coordination constitute a chemical process as conducted on the industrial scale. These operations, as grinding, extracting, roasting, crystallizing, distilling, air-drying, separating, and so on, are not the subject matter of chemistry as such nor of mechanical engineering. Their treatment in the quantitative way...and...the materials and equipment concerned in them is the province of chemical engineering. It is this selective emphasis on the unit operations themselves in their quantitative aspects that differentiates chemical engineering from industrial chemistry, which is concerned primarily with general processes and products.

In Terry S. Reynolds  
Special Issue, Defining Professional Boundaries: Chemical Engineering in the Early 20th Century  
*Technology and Culture*, October, 1968 (p. 709)

**Lower, Lennie** 1903–47  
Australian humorist

Talk of iron! We knew a man who had so much iron that he was full of nuts and bolts. Matter of fact, he lived on nuts and bolted his meals. After he was operated on for appendicitis he had to be riveted. If he wanted to turn around, he had to use a spanner. Threw himself under a train and wrecked the train. Rusted away after a long and peaceful life, and was pronounced dead by one of the best engineers in the country.

*Here's Another*

Lonely Sardine (p. 102)

Publisher undetermined

**Mailer, Norman** 1923–  
American author

Physics was sex, conception and the communion of the family – engineering was getting the eggs out on time.

...physics was love and engineering was marriage.

*Of a Fire on the Moon*

Part II, Chapter I, Section v (p. 178)

Little, Brown and Company. Boston, Massachusetts, USA. 1969

**McCune, Francis K.** ?–2000  
Nuclear engineer

The characteristics of a productive facility and the signals from a social system furnish very specific facts which must become every bit as much a part of an engineering idea as any technology or scientific principle...

*Elements of Competitive Engineering*

1965 Engineering Deans' Symposium, Pamphlet by General Electric Company. No date

Engineering's prime mission is the creation of technical things and services useful to man.

*Elements of Competitive Engineering*

1965 Engineering Deans' Symposium, Pamphlet by General Electric Company. No date

...at the very core of engineering there is just one thing – an act of creative thought, or in other words the process of having an idea.

*Elements of Competitive Engineering*

1965 Engineering Deans' Symposium, Pamphlet by General Electric Company. No date

**Morison, George S.** 1842–1903  
Civil engineer

Accurate engineering knowledge must succeed commercial guesses.

Address at the Annual Convention

*Transactions of the American Society of Civil Engineers*, June, 1895 (p. 474)

**Mr. Westmacott**

No biographical data available

Engineering brings all other sciences into play; chemical or physical discoveries, such as those of Faraday, would

be of little practical use if engineers were not ready with mechanical appliances to carry them out, and make them commercially successful in the way best suited to each.

In Walter R. Browne

Science and Engineering

*Scientific American Supplement*, Number 417, December 29, 1883

**Nicks, Oran W.**

A great deal of engineering is based on previous work.

*Far Travelers*

Creating an Exploring Machine (p. 18)

NASA. Washington, D.C. 1985

**O'Brien, M. P.**

No biographical data available

The activity characteristic of professional engineering is the design of structures, machines, circuits, or processes, or of combinations of these elements into systems or plants and the analysis and prediction of their performance and costs under specified working conditions.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Parsons, William Barclay**

No biographical data available

It is not the technical excellence of an engineering design which alone determines its merit but rather the completeness with which it meets the economic and social needs of its day.

In James Kip Finch

*Engineering and Western Civilization* (p. vii)

Address at the Inauguration of the Columbia Student Chapter of the American Society of Civil Engineers, 1927

**Petroski, Henry** 1942–

Civil engineer

Engineering, like poetry, is an attempt to approach perfection. And engineers, like poets, are seldom completely satisfied with their creations. They notice, even if no one else does, the word that is not quite *le mot juste* or the hairline crack that blemishes the structure.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 83)

St. Martin's Press. New York, New York, USA. 1985

**Piaget, Jean** 1896–1980

Swiss psychologist

Engineering – is more pragmatic and less – relatively less – speculative; it is production, operation, and management, as well as research, analysis, planning and design. Its goal is usually a clearly specified utility such as public health, communication, power, transportation, or housing, rather than the attainment of abstract truth.

*Phi Kappa Phi Journal*

In Thomas C. Dean

Challenges in Higher Education

**Poisson, Simeon-Denis** 1781–1840  
French mathematician

The engineer should receive a complete mathematical education, but for what should it serve him? To see the different aspects of things and to see them quickly; he has no time to hunt mice.

*The Foundations of Science  
Science and Method*, Book II (p. 438)  
The Science Press. New York, New York, USA. 1913

**Rogers, G. F. C.**  
Engineer

Engineering refers to the practice of organizing the design and construction [and, I would add, operation] of any artifact which transforms the physical world around us to meet some recognized need.

*The Nature of Engineering: A Philosophy of Technology* (p. 51)  
Macmillan & Company Ltd. London, England. 1983

**Scott, Chas F.**  
No biographical data available

Engineering is a mode of thinking.  
The Aims of the Society  
*Engineering Education*, Volume 12, Number 3, November, 1921 (p. 103)

**Shewhart, Walter Andrew** 1891–1967  
American statistician

The fundamental difference between engineering with and without statistics boils down to the difference between the use of a scientific method based upon the concept of laws of nature that do not allow for chance or uncertainty and a scientific method based upon the concepts of laws of probability as an attribute of nature.  
University of Pennsylvania Bicentennial Conference, September 16–21, 1940

**Smith, R. B.**  
No biographical data available

Engineering is the art of skillful approximation; the practice of gamesmanship in the highest form. In the end it is a method broad enough to tame the unknown, a means of combing disciplined judgment with intuition, courage with responsibility, and scientific competence within the practical aspects of time, of cost, and of talent. This is the exciting view of modern-day engineering that a vigorous profession can insist be the theme for education and training of its youth. It is an outlook that generates its strength and its grandeur not in the discovery of facts but in their application; not in receiving, but in giving. It is an outlook that requires many tools of science and the ability to manipulate them intelligently. In the end, it is a welding of theory and practice to build an early, strong, and useful result. Except as a valuable discipline of the mind, a formal education in technology is sterile until it is applied.

Professional Responsibility of Engineering  
*Mechanical Engineering*, Volume 86, Number 1, January, 1964

Engineering is a method and a philosophy for coping with that which is uncertain at the earliest possible moment and to the ultimate service to mankind. It is not a science struggling for a place in the sun. Engineering is science extrapolation from existing knowledge rather than interpolation between known points. Because engineering is science in action – the practice of decision making at the earliest moment – it has been defined as the art of skillful approximation. No situation in engineering is simple enough to be solved precisely, and none worth evaluating is solved exactly. Never are there sufficient facts, sufficient time, or sufficient money for an exact solution, for if by chance there were, the answer would be of academic and not economic interest to society. These are the circumstances that make engineering so vital and so creative.

Engineering Is...  
*Mechanical Engineering*, Volume 86, Number 5, May, 1964

**Smith, Willard A.**  
No biographical data available

Engineering is the science of economy, of conserving the energy, kinetic and potential, provided and stored up by nature for the use of man. It is the business of engineering to utilize this energy to the best advantage, so that there may be the least possible waste.

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (pp. 6–7)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Solzhenitsyn, Aleksandr Isayevich** 1918–  
Russian novelist and historian

There are all kinds of engineers. Some of them here have built successful careers selling soda water.

Translated by Thomas P. Whitney  
*The First Circle*  
Chapter 4 (p. 15)  
Harper & Row. New York, New York, USA. 1968

**Spencer-Brown, George** 1923–  
English mathematician and polymath

Doing engineering is practicing the art of the organized forcing of technological change.

Engineer-Scientist  
*Electronics*, Volume 32, Number 47, November 20, 1959 (p. 53)

**Sporn, Philip** 1896–1978  
American engineer

The scientist usually works – but very seldom under the pressure of a timetable – in a field of his special interest, in which he has generally chosen to stake out a narrow sector for his own specialization. The engineer, on the other hand, while also operating within the area of his

own competence, has to tackle a variety of problems, some of which may be new to him, but to which he has to apply his scientifically based knowledge and skill to produce workable and practical solutions; this work includes economics and involves both analysis and synthesis, generally within a rigid time limit. This is technology and engineering.

*Foundations of Engineering: Cornell College Engineering Lectures, Spring 1963* (pp. 12–13)  
The Macmillan Company. New York, New York, USA. 1963

**Steinmetz, Charles Proteus** 1865–1923

German-American electrical engineer and inventor

Indeed, the most important part of engineering work – and also of other scientific work – is the determination of the method of attacking the problem, whatever it may be.

In John Charles Lounsbury Fish  
*The Engineering Method* (p. 1)  
Stanford University Press. Stanford, California, USA. 1950

Engineering investigations evidently are of no value, unless they can be communicated to those to whom they are of interest.

In John Charles Lounsbury Fish  
*The Engineering Method* (p. 290)  
Stanford University Press. Stanford, California, USA. 1950

**Stott, Henry G.**

American engineer

Engineering is the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race.

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 6)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Taylor, E. S.**

American aircraft engine pioneer

The analytical part of an engineering education now seems to be considered the most difficult, most challenging part, while the remainder of engineering is considered to be an exercise of a lower order, conducted in a physical region located nearer the seat of the pants than the brain.

Report on Engineering Design  
*Journal of Engineering Education*, Volume 51, Number 8, April, 1961  
(p. 655)

**The Federated American Engineering Society**

Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of man, and the art of organizing and of directing human activities in connection therewith.

*Preamble to Constitution*

**Thring, Meredith Wooldridge**

Engineer

The roots of the tree are pure science...and a peculiar thing coming in here, called aesthetics, about which the architects and some other people are very concerned. The trunk of the tree is called human understanding and, in particular, applied mathematics. The branches of the tree are engineering and the extreme twigs are the growing new fields of engineering in which things are really happening...pure science is the roots which feed the tree but the actual growth of new life comes on the twigs of extremely specialized engineering. Some sort of scheme of knowledge like this is important.

On the Threshold  
*Proceedings of the Institution of Mechanical Engineers*, Volume 179,  
Part 1, 1964–65 (pp. 1089, 1091)

**Tredgold, Thomas** 1788–1829

English engineer

[Engineering is the] art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, harbors, moles, breakwaters, and light-houses, and in the art of navigation by artificial power for the purposes of commerce, and in the drainage of cities and towns.

*Institution of Civil Engineers*  
Charter 1828

**Waddell, John Alexander Low** 1854–1938

American bridge engineer

**Skinner, Frank W.**

American engineer

Engineering is more closely akin to the arts than perhaps any other of the professions; first, because it requires the maximum of natural aptitude and of liking for the work in order to offset other factors; second, because it demands, like the arts, an almost selfless consecration to the job; and, third, because out of the hundreds who faithfully devote themselves to the task, only a few are destined to receive any significant reward – in either money or fame.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.)  
*Vocational Guidance in Engineering Lines*  
Foreword (p. vi)  
The Mack Printing Company, Easton, Pennsylvania, USA. 1933

Engineering is the science and art of efficient dealing with materials and forces...it involves the most economic design and execution...assuring, when properly performed, the most advantageous combination of accuracy, safety, durability, speed, simplicity, efficiency, and economy possible for the conditions of design and service.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.)  
*Vocational Guidance in Engineering Lines*  
 Chapter II (p. 6)  
 The Mack Printing Company, Easton, Pennsylvania, USA. 1933

### Walker, Eric A.

American engineer

Science aims at the discovery, verification, and organization of fact and information...engineering is fundamentally committed to the translation of scientific facts and information to concrete machines, structures, materials, processes, and the like that can be used by men.

Engineers and/or Scientists

*Journal of Engineering Education*, Volume 51, February, 1961 (pp. 419–421)

### Wellington, Arthur Mellen 1847–1895

Civil engineer

...to define it rudely but not inaptly, [engineering] is the art of doing that well with one dollar which any bungler can do with two after a fashion.

*The Economic Theory of the Location of Railways: An Analysis of the Conditions Controlling the Laying out of Railways to Effect This Most Judicious Expenditure of Capital*

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1887

### Winsor, Dorothy A.

No biographical data available

Engineering is knowledge work. That is, although the goal of engineering may be to produce useful objects, engineers do not construct such object themselves. Rather they aim to generate knowledge that will allow such objects to be built.

*Writing Like an Engineer: A Rhetorical Education* (p. 5)

Lawrence Erlbaum Associates. Mahwah, New Jersey, USA. 1966

## ENGINEERING TERMS

### Author undetermined

A number of different approaches are being tried – We don't know where we're going, but we're moving.

Close project coordination – We should have asked someone else; or, let's spread the responsibility for this.

Customer satisfaction is believed assured – We are so far behind schedule that the customer was happy to get anything at all from us.

Developed after years of intensive research – It was discovered by accident.

Extensive effort is being applied on a fresh approach to the problem – We just hired three new guys; we'll let them kick it around for a while.

Major Technological Breakthrough – Back to the drawing board.

Modifications are underway to correct certain minor difficulties – We threw the whole thing out and are starting from scratch.

Preliminary operational tests are inconclusive – The darn thing blew up when we threw the switch.

Project slightly behind original schedule due to unforeseen difficulties – We are working on something else.

Test results were extremely gratifying – It works, and are we surprised!

The designs are well within allowable limits – We just made it, stretching a point or two.

The design will be finalized in the next reporting period – We haven't started this job yet, but we've got to say something.

The entire concept will have to be abandoned – The only guy who understood the thing quit.

Source undetermined

## ENGINEER'S CREED

### Author undetermined

Engineers have different objectives when it comes to social interaction.

'Normal' people expect to accomplish several unrealistic things from social interaction:

Stimulating and thought-provoking conversation

Important social contacts

A feeling of connectedness with other humans

In contrast to 'normal' people, engineers have rational objectives for social interactions:

Get it over with as soon as possible.

Avoid getting invited to something unpleasant.

Demonstrate mental superiority and mastery of all subjects.  
 Source undetermined

I take the vision which comes from dreams and apply the magic of science and mathematics, adding the heritage of my profession and my knowledge of nature's materials to create a design.

I organize the efforts and skills of my fellow workers employing the capital of the thrifty and the products of many industries, and together we work toward our goal undaunted by hazards and obstacles.

And when we have completed our task all can see that the dreams and plans have materialized for the comfort and welfare of all.

I am an Engineer. I serve mankind by making dreams come true.

Source undetermined



## ENIGMA

**Davy, Sir Humphry** 1778–1829  
English chemist

There will always be enigmas for us in nature as in philosophy, which will keep alive the faculty of research, and the active power of investigation. And it is much wiser to rejoice that *something* has been discovered, than to regret that so much is still concealed from us.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (pp. 216–217)

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**Poe, Edgar Allan** 1809–49  
American short story writer

...it may well be doubted whether human ingenuity can construct an enigma of the kind which human ingenuity may not, by proper application, resolve.

*Tales of Mystery and Imagination*

The Gold Bug (p. 32)

Henry Frowde. London, England. 1902

## ENLIGHTENMENT

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Every item of natural history is both a joy to behold and an instrument of our potential enlightenment.

*Leonardo's Mountain of Clams and the Diet of Worms*

Part III, Chapter 9 (p. 204)

Harmon Brown, New York, New York, USA. 1998

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

The wealth and variety of physics itself, the greater wealth and variety of the natural sciences taken as a whole, the more familiar, yet still strange and far wider wealth of the life of the human spirit, enriched by complementary, not at once compatible ways, irreducible one to the other, have a greater harmony. They are the elements of man's sorrow and his splendor, his frailty and his power, his death, his passing, and his undying needs.

*Science and the Common Understanding*

Chapter 5 (p. 82)

Simon & Schuster. New York, New York, USA. 1954

## ENOUGH ROPE PRINCIPLE

**Albert, Michael H.**  
Mathematician

**Nowakowski, Richard J.**  
No biographical data available

**Wolfe, David** 1962–  
No biographical data available

If you are in a losing position, it pays to follow the *Enough Rope Principle*: Make the position as complicated as you can with your next move.\*

\* (footnote) at least one of the authors feels compelled to add, *except if you are playing against a small child..*

*Lessons in Play: An Introduction to Combinatorial Game Theory*

Chapter I (p. 18)

A.K. Peters. Wellesley, Massachusetts, USA. 2007

## ENQUIRY, OBJECTS OF

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

We must never forget that it is principles, not phenomena – laws, not insulated independent facts – which are the objects of enquiry to the natural philosopher.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (pp. 13–14)

Longman, Brown, Green & Longmans. London, England. 1845

## ENTOMOLOGIST

**Cable, George W.** 1844–1925  
American author and reformer

When, hypocritically clad in dressing-gown and slippers, I stopped at my guest's inner door and Fontenette opened it just enough to let me enter, I saw, indeed, a wonderful sight. The entomologist had lighted up the room, and it was filled, filled! with gorgeous moths as large as my hand and all of a kind, dancing across one another's airy paths in a bewildering maze or alighting and quivering on this thing and that. The mosquito-net, draping almost from ceiling to floor, was beflowered with them majestically displaying in splendid alternation their upper and under colors, or, with wings lifted and vibrant, tipping to one side and another as they crept up the white mesh, like painted and gilded sails in a fairies' regatta.

*Strong Hearts*

The Entomologist

Chapter X (p. 130)

MSS Information Corporation. New York, New York, USA. 1970

**Cuppy, Will** 1884–1929  
American humorist and critic

Entomologists are people who want Ants around. If there are no Ants around, they will go where Ants are.

*How to Attract the Wombat*

The Ant (fn 1, p. 137)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist



Every traveler is a self-taught entomologist.  
*The Autocrat of the Breakfast-Table* (p. 278)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

### Mattingly, P. F.

No biographical data available

There is a popular superstition to the effect that museum entomologists devote their time to the fabrication of mommets. These are small, artificially constructed images into which pins are stuck, mainly with a view to making life less tolerable for other entomologists. The museum entomologist calls them species, but they bear little resemblance to the species actually encountered in nature. Such a view is exaggerated, but it may contain a grain of truth. Most of us could probably do more to give our species reality by giving thought to the distributional data available to us than in fact we do.

Towards a Zoogeography of the Mosquitoes  
*Systematics Publication*, Volume 4, 1962 (p. 17)

### Oehlenschläger, Adam Gottlob 1779–1850

Danish poet

Does he who searches Nature's secrets scruples  
 To stick a pin into an insect?

In Ainsworth R. Spofford and Charles Gibbon  
*The Library of Choice Literature and Encyclopaedia of Universal  
 Authorship* (Volume 7)

*Aladdin's Wonderful Lamp* (p. 210)  
 Gebbie & Company, Publishers. Philadelphia, Pennsylvania, USA. 1893

### Pope, Alexander 1688–1744

English poet

O! Would the Sons of Men 3 once think their Eyes And  
 Reason given them but to study Flies!

*The Poetical Works of Alexander Pope* (Volume 3)  
*The Dunciad*  
 Book IV  
 George Bell & Sons. London, England. 1891

### Victim, A.

No biographical data available

O gentle reader drop a tear  
 For one beneath this stone  
 In life he named 7,000 bugs  
 To science, all unknown.

Obituary of an Entomologist  
*Entomological News*, Volume 13, Number 9, 1902 (p. 297)

### Wheeler, William Morton 1865–1937

American entomologist

An entomologist no less interested in his fellow men than in the insects may with increasing years of observation find increasing resemblance between the two – some insects seeming almost human and some humans behaving very much like insects.

Translated by William Morton Wheeler

*The Foibles of Insects*  
 The Physiognomy of Insects (p. 3)  
 Alfred A. Knopf. New York, New York, USA. 1928

## ENTOMOLOGY

### Author undetermined

No science is so generally slighted, ignored, and misunderstood as is Entomology. Hysterical humanitarians, novelists, poets, political agitators, classical students, speak in terms of contempt or horror of the “fly-hunter.”

Economic Entomology  
*The Journal of Science*, Volume IV, Number c, April, 1882 (p. 208)

A gentle reader drop a tear  
 For one beneath this stone  
 In life he named 7,000 bugs  
 To science, all unknown.

But now, alack!  
 He is condemned  
 In a place I dare not name

With his own books,  
 through endless years  
 To identify the same.  
 Obituary of an Entomologist  
*Entomological News*, Volume 13, Number 9, 1902 (p. 297)

### Cable, George W. 1844–1925

American author and reformer

He had lost life by making knowledge its ultimate end, and was still delving on, with never a laugh and never a cheer, feeding his emaciated heart on the locusts and wild honey of entomology and botany...

*Strong Hearts*  
 The Entomologist  
 Chapter III (p. 100)  
 MSS Information Corporation. New York, New York, USA. 1970

### Evans, Howard Ensign 1919–2002

Entomologist

If insects were the size of birds, or people the size of mice, “bug watchers” would be as prevalent as bird watchers, and entomologists would command the budget of the Defense Department. But as it is, entomologists have a good deal of trouble explaining what their science is all about, or for that matter how it is spelled.

*The Pleasures of Entomology: Portraits of Insects and the People Who Study them*  
 Preface (p. 9)  
 Smithsonian Institution Press. Washington, D.C. 1985

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

I suppose you are an entomologist? – I said with a note of interrogation. – Not quite so ambitious as that, sir. I should like to put my eye on the individual entitled to

that name! A society may call itself an Entomological Society, but a man who arrogates such a broad title as that to himself, in the present state of science, is a pretender sir, a dilettante, an imposter! No man can be truly called an entomologist, sir; the subject is too vast for any single human intelligence to grasp.

*The Poet at the Breakfast-Table*

Chapter II (p. 49)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Howard, Leland O.** 1857–1950

American entomologist

People think entomologists have small minds because they interest themselves in small animals.

In Edwin Teale

*Circle of the Seasons*

February 19 (p. 34)

Dodd, Mead & Company. New York, New York, USA. 1953

**Howes, Paul Griswold** 1918–85

Naturalist

Wherever one searches in the world of insects there is something new to be found. Perhaps only an unrecorded habit, or a slight problem to be solved, yet each problem leads to another, and soon one is led unconsciously into the depths of the study. Once in, there appears to be no way out, and I for one do not wish to retrace my steps to the freedom I knew before the fascination of this study laid hold of me.

*Insect Behavior*

Preface

R.G. Badger. Boston, Massachusetts, USA. 1919

**Kirby, William** 1759–1850

English entomologist

**Spence, William** 1783–1860

English entomologist

...in the minds of most men...an Entomologist is synonymous with everything futile and childish. [Involved in a] science which, in nine companies out of ten companies with which he may associate, promises to signalise him as an object of pity or contempt.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Preface to the First Edition (p. ix)

Longman, Green, Longman & Roberts. London, England. 1860

With regard to the amusement and instruction of the student, much doubtless may be derived from anyone of the sciences alluded to [mineralogy, biology]; but Entomology certainly is not behind any of her sisters in these respects; and if you are fond of novelty, and anxious to make new discoveries, she will open to you a more ample field for these than either Botany or the higher branches of Zoology.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter 1 (p. 3)

Longman, Brown, Green, Longmans & Robert. London, England. 1858

**Nash, Ogden** 1902–71

American writer of humorous poetry

He was an eminent etymologist,  
which is to say he knew nothing but bugs.  
He could tell the Coleoptera from the Lepidoptera,  
And the Aphidae and the Katydididae  
from the Grasshoptera.

*Verses from 1929 On*

The Strange Case of the Entomologist's Heart

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Entomology extends the limits of being in new directions, so that I walk in nature with a sense of greater space and freedom. It suggests, besides, that the universe is not rough-hewn, but perfect in its details.

*Excursions*

Natural History of Massachusetts (p. 42)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1887

**Wood, Robert William** 1868–1955

American physicist

The Plover and the Clover can be told apart with ease,  
By paying close attention to the habit of the Bees,  
For En-to-molo-gists aver, the Bee can be in Clover,  
While Ety-molo-gists concur, there is no B in Plover.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*

The Clover. The Plover (p. 3)

Dover Publications, Inc. New York, New York, USA. 1959

## ENTROPY

**Clasius, Rudolph** 1822–88

German mathematician

For the present I will confine myself to announcing as a result of my argument that if we think of that quantity which with reference to a single body I have called its entropy, as formed in a consistent way, with consideration of all the circumstances, for the whole universe, and if we use in connection with it the other simpler concept of energy, we can express the fundamental laws of the universe which correspond to the two fundamental laws of the mechanical theory of heat in the following simple form. 1. The energy of the universe is constant. 2. The entropy of the universe tends toward a maximum.

Ueber verschiedene für die Anwendung bequeme Formen der

Hauptgleichungen der mechanischen Wärmetheorie

*Annalen der Physik und Chemie*, Volume 125, 1865

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

An important property of most cellular automata is that their rules are irreversible, *i.e.*, not symmetric in time. They thus escape from the strictures of the second law of

thermodynamics, which is based on reversibility in the underlying microscopic dynamics. For this reason...the entropy of automaton states can decrease, and order can spontaneously appear out of disorder.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 5 (p. 67)

Simon & Schuster. New York, New York, USA. 1988

There exists alongside the entropy arrow another arrow of time, equally fundamental and no less subtle in nature. Its origin lies shrouded in mystery, but its presence is undeniable. I refer to the fact that the universe is *progressing* – through complexity – to ever more developed and elaborate states of matter and energy... There has been a tendency for scientists to simply deny the existence of the optimistic arrow.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 2 (p. 20)

Simon & Schuster. New York, New York, USA. 1988

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

From the point of view of philosophy of science the conception associated with entropy must I think be ranked as the greatest contribution of the nineteenth century to scientific thought.

*The Nature of the Physical World*

Chapter V (p. 103)

The Macmillan Company. New York, New York, USA. 1930

The direction of time's arrow could only be determined by that incongruous mixture of theology and statistics known as the second law of thermodynamics...

*The Nature of the Physical World*

Chapter XV (p. 338)

The Macmillan Company. New York, New York, USA. 1930

### **Gamow, George** 1904–68

Russian-born American physicist

Holy Entropy!.... It's boiling!

*Mr. Tompkins in Paperback*

Chapter 9 (p. 110)

At The University Press. Cambridge, England. 1965

### **Jahn, Robert**

Professor of Aerospace Science

The concept of entropy no means restricted to mechanical situations. The unfortunate fate of Humpty-Dumpty is an example of a drastic entropy of quite a different system. His demise from a highly organized whole egg to one that was completely scrambled was also highly irreversible.

*Continuum*, Volume 7, Number 6, March, 1985 (p. 38)

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The fabric of the universe weathers, crumbles, and dissolves with age, and no restoration or reconstruction is possible. The second law of thermodynamics compels the material universe to move ever in the same direction along the same road, a road which ends only in death and annihilation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1929*

The Physics of the Universe (p. 178)

Government Printing Office. Washington, D.C. 1930

### **Jungck, J. R.**

No biographical data available

...entropy will not be the nemesis of evolution; on the contrary, the selection of entropy-driven processes in biological systems has been responsible for the evolution of the sophisticated organization of contemporary biota.

In D.J. Depew and B.H. Weaver (eds.)

*Molecular Evolution: Prebiological and Biological*

Thermodynamics and Self Assembly: An Empirical Example Relating to Entropy and Evolution (p. 107)

Plenum Press. New York, New York, USA. 1972

### **Lappe, Marc** 1943–2005

Author, medical ethicist, and toxicologist

Living organisms are engaged in a constant battle to maintain themselves against the forces of entropy and decay.

*Evolutionary Medicine: Rethinking the Origins of Disease* (p. 51)

Sierra Club Books. San Francisco, California, USA. 1994

### **Leacock, Stephen** 1869–1944

Canadian humorist

All physicists sooner or later say, "Let us call it Entropy..."

*The Boy I Left Behind Me*

Chapter VI (p. 175)

The Bodely Head. London, England. 1947

### **Musser, George**

No biographical data available

No demon or mortal has ever challenged the second law of thermodynamics and won.

Taming Maxwell's Demon

*Scientific American*, Volume 280, Number 2, February, 1999 (p. 24)

### **Planck, Max** 1858–1947

German physicist

It would be absurd to assume that the validity of the second law depends in any way on the skill of the physicist or chemist in observing or experimenting. The gist of the

second law has nothing to do with experiment; the law asserts briefly that there exists in nature a quantity which changes always in the same sense in all natural processes. The proposition stated in this general form may be correct or incorrect; but whichever it may be, it will remain so, irrespective of whether thinking and measuring beings exist on earth or not.... The limitations to the law, if any, must lie in the same province as its essential idea, in the observed Nature, and not in the Observer. That man's experience is called upon in the deduction of the law is of no consequence; for that is, in fact, our only way of arriving at knowledge of natural law. But the law once discovered must receive recognition of its independence, at least in so far as Natural Law can be said to exist independent of Mind. Whoever denies this must deny the possibility of natural science.

*Treatise on Thermodynamics* (p. 106)

Longmans, Green & Company. London, England. 1903

### **Sears, Francis Weston** 1898–1975

American physicist

There is no concept in the whole field of physics which is more difficult to understand than is the concept of entropy, nor is there one which is more fundamental.

*Principles of Physics I: Mechanics, Heat, and Sound* (2nd edition) (p. 459)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1944

### **von Neumann, John** 1903–57

Hungarian-American mathematician

You should call it entropy for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one knows what entropy really is, so in a debate you will always have the advantage.

In M. Tribus and E.C. McIrvine

Energy and Information

*Scientific American*, Volume 224, Number 3, 1971 (p. 180)

### **Wiener, Norbert** 1894–1964

American mathematician

...the characteristic tendency of entropy is to increase. As entropy increases, the universe, and all closed systems in the universe, tend naturally to deteriorate and lose their distinctiveness, to move from the least to the most probable state, from a state of organization and differentiation in which distinctions and forms exist, to a state of chaos and sameness.

*The Human Use of Human Beings*

Preface (p. 12)

Da Capo Press. New York, New York, USA. 1988

### **Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

...entropy is an anthropomorphic concept...

Quoted by E.T. Jaynes

Gibbs vs. Boltzmann Entropies

*American Journal of Physics*, Volume 33, Number 5, May, 1965 (p. 398)

## **ENVIRONMENT**

### **Abbey, Edward** 1927–89

American environmentalist and nature writer

Not only the pretty birds, but also the predators and reptiles, the ugly and unloved, the organic and inorganic – all belong here, with us, on the same small planet.

In Joseph Wood Krutch

*The Great Chain of Life*

Preface

Houghton Mifflin Company. Boston, Massachusetts, USA. 1977

Mr. Krutch's contribution...has been his recognition and communication of the discovery that the natural world must be treated as an equal partner. That a world entirely conquered by technology, entirely dominated by industrial processes, entirely occupied by man and machine, would be a world unfit to live in. Perhaps impossible to live in.

In Joseph Wood Krutch

*The Great Chain of Life*

Preface

Houghton Mifflin Company. Boston, Massachusetts, USA. 1977

### **Bartram, William** 1739–1823

American naturalist

This world, as a glorious apartment of the boundless palace of the Sovereign Creator, is furnished with an infinite variety of animated scenes, inexpressibly beautiful and pleasing, equally free to the inspection and enjoyment of all his creatures.

*Travels and Other Writings*

Introduction (p. 13)

Library of America. New York, New York, USA. 1996

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

Like all good things in life, we seem to have noticed the environment only when it began to deteriorate.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 112)

The Rockefeller University Press. New York, New York, USA. 1978

### **Commoner, Barry** 1917–

American biologist, ecologist, and educator

The environment makes up a huge, enormously complex living machine that forms a thin dynamic layer on the

earth's surface, and every human activity depends on the integrity and the proper functioning of this machine. Without the photosynthetic activity of green plants, there would be no oxygen for our engines, smelters, and furnaces, let alone support for human and animal life. Without the action of the plants, animals, and microorganisms that live in them, we could have no pure water in our lakes and rivers. Without the biological processes that have gone on in the soil for thousands of years, we could have neither food crops, oil, nor coal. This machine is our biological capital, the basic apparatus on which our total productivity depends. If we destroy it, our most advanced technology will become useless and any economic and political system that depends on it will founder. The environmental crisis is a signal of this approaching catastrophe.

*The Closing Circle: Nature, Man & Technology*

Chapter 2 (pp. 16–17)

Alfred A. Knopf. New York, New York, USA. 1971

**Douglas, William O.** 1898–1980

US Supreme Court Associate Justice

I've often thought that if our zoning boards could be put in charge of botanists, of zoologists and geologists, and people who know about the earth, we would have much more wisdom in such planning than we have when we leave it to the engineers.

In Judd L. Teller

*Government and the Democratic Process: A Symposium by American and Israeli Experts*

David Ariel (p. 16)

American Histadrut Cultural Exchange Institute. New York, New York, USA. 1969

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Each cell, each living being has a multipotential biochemical personality but the physiochemical environment determines the one under which it manifests itself.

*Louis Pasteur: Free Lance of Science*

Chapter XIII (p. 383)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

The total effect of the environmental crisis cannot be evaluated because it is spread throughout the whole social structure.

*Reason Awake*

Chapter 5 (p. 170)

Columbia University Press. New York, New York, USA. 1970

Despite all the new powers of science, or perhaps because of them, man is no longer able to achieve real mastery over his environment.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas Today* 1964

*Biological Sciences and Medicine* (p. 267)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1964

**Elton, Charles S.** 1900–91

English biologist

It is usual to speak of an animal as living in a certain physical and chemical environment, but it should always be remembered that strictly speaking we cannot say exactly where the animal ends and the environment begins – unless it is dead, in which case it has ceased to be a proper animal at all...

*Animal Ecology*

Chapter IV (p. 34)

Sidgwick & Jackson, Ltd. London, England. 1927

**Ford, Gerald R.** 1913–2006

26th president of the USA

We have come tardily to the tremendous task of cleaning up our environment. We should have moved with similar zeal at least a decade ago. But no purpose is served by post-mortems. With visionary zeal but with the greatest realism, we must now address ourselves to the vast problems that confront us.

In Michael V. Doyle

*Gerald R. Ford, Selected Speeches*

Earth Day Address (p. 84)

R.W. Beatty. Arlington, Virginia, USA. 1973

**Fuller, Sarah Margaret** 1810–50

American journalist

Nature provides exceptions to every rule.

*The Dial*, July 1843

**Geikie, Sir Archibald** 1835–1924

English geologist

It must be owned that man, in much of his struggle with the world around him, has fought blindly for his own ultimate interests. His contest, successful for the moment, has too often led to sure and sad disaster. Stripping forests from hill and mountain, he has gained his immediate object in the possession of their abundant stores of timber; but he has laid open the slopes to be parched by drought, or swept bare by rain.

*Geological Sketches at Home and Abroad*

Chapter XIII (p. 305)

The Macmillan Co. New York, New York, USA. 1882

**Gold, Thomas** 1920–2004

Austrian astrophysicist

It is we who live in the extreme environments.

*The Deep Hot Biosphere* (p. v)

Springer-Verlag. New York, New York, USA. 1999

**Gulick, John T.** 1832–1923

American missionary and evolutionist

If my contention [that different forms arise in identical environments] is in accord with the facts, the assumption



which we often meet that change in the organism is controlled in all its details by change in the environment, and that, therefore, human progress is ruled by an external fate, is certainly contrary to fact.

*Evolution, Racial and Habitudinal: Racial & Habitudinal*

Preface (p. iv)

Carnegie Institution of Washington. Washington, D.C. 1905

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

Mountains are earth's undecaying monuments.

*The Great Stoneface: And Other Tales of the White Mountains*

Sketches from Memory, the Notch of the White Mountains (p. 68)

Houghton Mifflin Publishers. Boston, Massachusetts, USA. 1889

**Hornaday, William Temple** 1854–1937

American naturalist

No man has a right, either moral or legal, to destroy or squander an inheritance of his children that he holds for them in trust. And man, the wasteful and greedy spend-thrift that he is, has not created even the humblest of the species of birds, mammals and fishes that adorn and enrich this earth.

*Our Vanishing Wild Life: Its Extermination and Preservation*

Chapter II (p. 7)

Charles Scribner's Sons. New York, New York, USA. 1913

**Hubbard, Henry Vincent** 1875–1947

American landscape architect

Man obtains from his environment two things which he desires, usefulness and beauty, and all material progress in civilization has consisted in his modification of his surroundings to serve these two needs.

*An Introduction to the Study of Landscape Design*

Chapter I (p. 1)

The Macmillan Co. New York, New York, USA. 1917

**Kennedy, John F.** 1917–63

26th president of the USA

The effort to improve the conditions of man, however, is not a task for the few. It is the task of all nations – acting alone, acting in groups, acting in the United Nations, for plague and pestilence, and plunder and pollution, the hazards of nature, and the hunger of children are the foes of every nation. The earth, the sea, and the air are the concern of every nation. And science, technology, and education can be the ally of every nation.

Address before the 18th General Assembly of the United Nations

September 20, 1963

Never before has man had such capacity to control his own environment, to end thirst and hunger, to conquer poverty and disease, to banish illiteracy and massive human misery. We have the power to make this the best generation of mankind in the history of the world – or to make it the last.

Address before the 18th General Assembly of the United Nations

September 20, 1963

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

A bucketful of water may support ten thousand copepods; but a water snake may require a marsh to himself, as a whale needs league upon league of sea, or a bear the half of a mountainside. It is a question if there be any biologic advantage in mastering your environment when you need such a quantity of it to support you.

*An Almanac for Moderns*

April Sixteenth (p. 29)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Rickover, Hyman G.** 1900–86

American naval nuclear engineer

It is a profound mistake to think of land only in terms of its money values and, however natural it may be for individuals to do this, the nation or state should never do so. It should instead act always to preserve, foster, and cause to be developed to the maximum of its capacity not the monetary, but the real and physical value of every acre of its soil, both rural and urban. This is its educative, esthetic, and, in the fullest and widest sense of the meaning, productive, creative and enduring worth.

Testimony

House Appropriations defense subcommittee, June 19, 1973

**Rousseau, Jean-Jacques** 1712–78

Swiss-French philosopher

It is in man's heart that the life of nature's spectacle exists; to see it, one must feel it.

Translated by Allan Bloom

*Emile*

Book III (p. 169)

Basic Books, Inc. New York, New York, USA. 1979

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

It may be that God made the world, but that is no reason why we should not make it over.

*The Scientific Outlook*

Chapter VII (p. 156)

George Allen & Unwin. London, England. 1931

**Smith, Homer W.**

Renal physiologist

All samples of the fossil record...suggest that some death-dealing enemy, swift, merciless and irresistible, lurked in every corner of the world. This enemy, we believe, was the medium in which the early vertebrates were undergoing evolution; it was an enemy that pursued them every minute of the day and night, one from which there was no escape though they deployed from Spitsbergen to Colorado – the physical-chemical danger inherent in their new environment: their fresh-water home.

*From Fish to Philosopher*

Chapter III (p. 31)

Little, Brown & Company. Boston, Massachusetts, USA. 1953



**Snyder, Gary** 1930–

American poet, essayist, and environmental activist

A properly radical environmentalist position is in no way antihuman. We grasp the pain of the human condition in its full complexity, and add the awareness of how desperately endangered certain key species and habitats have become.... The critical argument now within environmental circles is between those who operate from a human-centered resource management mentality and those whose values reflect an awareness of the whole of nature.

*The Practice of the Wild*

Survival and Sacrament (p. 181)

North Point Press. San Francisco, California, USA. 1990

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...Nature, even when she is scant and thin outwardly, satisfies us still by the assurance of a certain generosity at the roots.

*The Writings of Henry David Thoreau* (Volume 1)*A Week on the Concord and Merrimac Rivers*

Thursday (p. 419)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

What is the use of a house if you haven't got a tolerable planet to put it on? – if you cannot tolerate the planet it is.

*Essays and Other Writings of Henry Thoreau*

Letter to Harrison Blake May 20, 1860 (p. 250)

Walter Scott. London, England. 1891

**Wilson, Edward O.** 1929–

American biologist and author

Perhaps the time has come to cease calling it the “environmentalist” view, as though it were a lobbying effort outside the mainstream of human activity, and to start calling it the real-world view.

*The Future of Life*

Chapter 2 (p. 28)

Alfred A. Knopf. New York, New York, USA. 2002

**ENVIRONMENTAL PRESERVATION****Thatcher, Margaret** 1925–

British politician

We need our reason to teach us today that we are not, that we must not try to be, the lords of all we survey. We are not the lords, we are the Lord's creatures, the trustees of this planet, charged today with preserving life itself – preserving life with all its mystery and all its wonder.

In Alon Tal

*Speaking of Earth*

The Prospect of Climate Change (p. 133)

Rutgers University Press. New Brunswick, Maine, USA. 2006

**ENVIRONMENTALIST****Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Environmentalists continually face the political reality that support and funding can be won for soft, cuddly, and “attractive” animals, but not for slimy, grubby, and ugly creatures (of potentially greater evolutionary interest and practical significance) or for habitats.

*Eight Little Piggies: Reflections in Natural History*

Chapter 2 (p. 44)

W.W. Norton &amp; Co. New York, New York, USA. 1993

**ENZYME****Shaw, William R.**

No biographical data available

The light of the firefly's tiny torch at dusk  
Destroy and build great structures in the realm  
Of molecules while we with prying eyes  
And puny instruments attempt to watch,  
To marvel, and – perhaps – to understand.

The Kinetics of Enzyme Catalyzed Reactions, the Enzymes

*The Journal of Chemical Education*, Volume 34, Number 1, January,

1951 (p. 22)

**Wroblewski, Feliz**

No biographical data available

Enzymes are manifestations of nature's impatience.

Enzymes in Medical Diagnosis

*Scientific American*, Volume 205, Number 2, August, 1961 (p. 99)**EPILOGUE****Wilson, David Scofield**

No biographical data available

An epilogue is a chance to have an additional say: a say upon, a say over and above, a say around, and a say toward.

*In the Presence of Nature*

Epilogue (p. 187)

University of Massachusetts Press. Amherst. 1978

**EPISTEMOLOGIST****Čapek, Milič** 1909–97

Czechoslovakian philosopher and physicist

The task of an epistemologist in contemporary physics is therefore a little like that of the psychoanalyst: to detect the remnants of classical thought beneath the verbal denials and conscious rejections.

*The Philosophical Impact of Contemporary Physics*

Introduction (p. xv)

van Nostrand. New York, New York, USA. 1961

## EPISTEMOLOGY

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Between physics and philosophy there lies a debatable territory which I shall call *scientific epistemology*.

*The Philosophy of Physical Science*

Chapter I (p. 1)

The University Press. Cambridge, England. 1932

**Macintosh, Douglas Clyde** 1877–1948  
American Protestant theologian

The method of idealistic epistemology is like that of the quack physician; it first administers a drug which makes the patient's ailment chronic, thus making its own further services seem permanently indispensable.

*The Problem of Knowledge*

Chapter XIV (p. 334)

The Macmillan Co. New York, New York, USA. 1915

**Mivart, St. George Jackson** 1827–1900  
English biologist

This science [epistemology] of the grounds and ground-work of science is one to the study of which gifted minds are spontaneously impelled, as ordinary minds are impelled to acquire at least the rudiments of ordinary scientific truth.

*The Groundwork of Science; A Study of Epistemology*

Chapter I (p. 2)

G.P. Putnam's Sons. New York, New York, USA. 1898

## EPITAPH

**Kepler, Johannes** 1571–1630  
German astronomer

I measured the skies, now the shadows I measure  
Skybound was the mind, Earthbound the body rests.

*Johannes Kepler gesammelte Werke* (Volume 19) (p. 393)

C. H. Beck. Munchen, Germany. 1937

**von Fraunhofer, Joseph** 1787–1828  
German optician

*Approximavit sidera*

[He brought the stars closer]

Translated by J. S. Ames

*Prismatic and Diffraction Spectra*

Epitaph placed on his grave stone (p. 61)

Harper & Brothers Publishers. New York, New York, USA. 1898

## EQUAL

**L'Engle, Madeleine** 1918–2007  
American writer

Like and equal are two entirely different things

*A Wrinkle in Time*

Chapter 9 (p. 160)

Dell Publishing Co. New York, New York, USA. 1962

## EQUALITY

**Jevons, William Stanley** 1835–82  
English economist and logician

Although it might seem that there are few terms more free from ambiguity than the term equal, yet scientific men do employ it with at least four meanings, which it is desirable to distinguish. These meanings I may describe as

(1) Absolute Equality.

(2) Sub-equality.

(3) Apparent Equality.

(4) Probable Equality.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXI (p. 479)

Macmillan & Co Ltd. London, England. 1887

**Vauvenargues** 1715–47  
French writer

It is untrue that equality is a law of nature. Nature has made nothing equal; her sovereign law is subordination and dependence.

In Translated by Elizabeth Lee

In Jean de La Bruyère and Vauvenargues

*La Bruyère and Vauvenargues: Selections from the Characters, Reflexions and Maxims*

Reflections and Maxims (p. 180)

Archibald Constable & Co, Ltd. Westminster, England. 1903

## EQUATION

**Albert Einstein (Fictional character)**

My work involves the imagination, and is expressed through equations.

In Willard Simms

*Einstein: A Stage Portrait* (p. 15)

The Dramatic Publishing Co.

**Berlinski, David** 1942–  
American mathematician

Late-alphabetic variables such as  $x$  and  $y$  act as ordinary English pronouns, bits of grammar indicating where something is unknown, even as *He did it* leaves in the dark both *who* he is, and *what* he did. Solving an algebraic equation (or any equation at all) is a matter of determining who *he* is, or what *he* did, this on the basis of various clues left lying about the equation.

*A Tour of the Calculus*

Chapter 4 (p. 27)

Pantheon Books. New York, New York, USA. 1995

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

No equations, however impressive and complex, can arrive at the truth if the initial assumptions are incorrect.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter I (p. 7)

Bantam Books. New York, New York, USA. 1971

**Cournot, Antoine Augustin** 1801–77

French economist, philosopher, and mathematician

**Fisher, Irving** 1867–1947

American economist

Anyone who understands algebraic notation, reads at a glance in an equation results reached arithmetically only with great labour and pains.

Translated by Nathan T. Bacon

*Researches Into the Mathematical Principles of the Theory of Wealth* (p. 4)

A.M. Kelley. New York, New York, USA. 1960

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

I consider that I understand an equation when I can predict the properties of its solutions, without actually solving it.

In Frank Wilczek and Betsy Devine

*Longing for the Harmonies*

Chapter 13 (p. 102)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1988

If one is working from the point of view of getting beauty in one's equation...one is on a sure line of progress.

The Evolution of the Physicist's Picture of Nature

*Scientific American*, Volume 208, Number 5, May, 1963 (p. 47)

...it is more important to have beauty in one's equations than to have them fit experiment.

The Evolution of the Physicist's Picture of Nature

*Scientific American*, Volume 208, Number 5, May, 1963 (p. 47)**Einstein, Albert** 1879–1955

German-born physicist

Equations are more important to me, because politics is for the present, but an equation is something for eternity.

In Stephen W. Hawking

*A Brief History of Time: From the Big Bang to Black Holes*

Albert Einstein (p. 178)

Bantam Books. Toronto, Ontario, Canada. 1988

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

Where did we get that [Schrödinger's equation] from? It's not possible to derive it from anything you know. It came out of the mind of Schrödinger.

*The Feynman Lectures on Physics* (Volume 3)

Chapter 16–5 (p. 16–12)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Gell-Mann, Murray** 1929–

American physicist

How can it be that writing down a few simple and elegant formulae, like short poems governed by strict rules such as those of the sonnet or the waka, can predict universal regularities of Nature? Perhaps we see equations as simple because they are easily expressed in terms of mathematical notation already invented at an earlier stage of development of the science, and thus what appears to us as elegance of description really reflects the interconnectedness of Nature's laws at different levels.

*Les Prix Nobel. The Nobel Prizes in 1969*

Nobel banquet speech for award received in 1969

Nobel Foundation. Stockholm, Sweden. 1970

**Guillen, Michael**

American mathematician and physicist

It is impossible to understand the true meaning of an equation, or to appreciate its beauty, unless it is read in the delightfully quirky language in which it was penned.

*Five Equations That Changed the World*

Introduction (p. 3)

Hyperion. New York, New York, USA. 1995

**Hawking, Stephen William** 1942–

English theoretical physicist

Each equation, I was told, would halve the sales of the book. But that was okay. Equations are necessary if you are doing accountancy, but they are the boring part of mathematics. Most of the interesting ideas can be conveyed by words or pictures.

*A Brief History of Time: A Reader's Companion*

Introduction (p. vii)

Bantam Books. Toronto, Ontario, Canada. 1988

**Hertz, Heinrich** 1857–94

German physicist

Maxwell's theory is Maxwell's system of equations.

*Electric Waves: Being Researches on the Propagation of Electric Action with Finite Velocity Through Space* (p. 21)

Macmillan &amp; Company Ltd. London, England. 1893

**Holton, Gerald** 1922–

Research professor of physics and science history

**Roller, Duane H. D.** ?–1994

Science historian

Without the clear understanding that equations in physical science always have hidden limitations, we cannot expect to interpret or apply them successfully. For instance, we would continually be tempted to make unwarranted extrapolations and interpolations. We would be in the catastrophic position of a navigator who has to negotiate a rocky channel without having any idea of the length, width, and draft of his ship.

*Foundations of Modern Physical Science*

Chapter I (pp. 4–5)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**London, Jack** 1876–16  
American author

The difference between the sun's position and the position where the sun ought to be if it were a decent, self-respecting sun is called the Equation of Time.

*The Cruise of the Snark*

Chapter 14 (p. 244)

The Macmillan Company. New York, New York, USA. 1911

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

If  $x$  is the population of the USA and  $y$  is the degree of imbecility of the average American, then democracy is the theory that  $x \times y$  is less than  $y$ .

*A Mencken Chrestomathy*

Chapter XXX (p. 621)

Alfred A. Knopf. New York, New York, USA. 1949

**Peirce, Benjamin** 1809–80  
American mathematician

Gentlemen, we have not the slightest idea of what this equation means, but we may be sure that it means something very important.

In J.L. Coolidge

The Number  $e$

*The American Mathematical Monthly*, Volume 57, Number 9, November, 1950 (p. 591)

**Ramanujan, Srinivasa** 1887–1920  
Indian mathematician

An equation for me has no meaning unless it expresses a thought of God.

*The Man Who Knew Infinity: A life of the Genius, Ramanujan*

Chapter Two (p. 67)

Charles Scribner's Sons. New York, New York, USA. 1991

**Root-Bernstein, Robert Scott**  
No biographical data available

Being able to solve mathematical equations is useless if you don't understand what the equation represents in real life.

*Discovering*

Day Six (p. 338)

Harvard University Press. Cambridge, Massachusetts, USA. 1989

**Saaty, Thomas L.**  
American mathematician

Equations are the lifeblood of applied mathematics and science.

*Modern Nonlinear Equations*

Preface

Dover Publications, Inc. New York, New York, USA. 1981

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

...after our mathematical instruments have enabled us to cross the mountains we dare not conclude anything

until we have confronted our new vision (i.e., our new set of equations) with reality, and made sure that our symbols have still a meaning. We can never keep away from nature very long otherwise our arguments risk to go awry, as happened so often in mediaeval times when the necessity of frequent verifications was not yet realized. Like the Libyan giant, Antæus, we must be able to touch the ground from time to time in order to recruit our strength.

*The History of Science and the New Humanism*

Chapter I (p. 41)

H. Holt & Co. New York, New York, USA. 1931

**Shapiro, Gilbert** 1934–2001  
American physicist

Just as one can appreciate the beauty of a Beethoven quartet without being able to read a note of music, it is possible to learn about the scope and power and, yes, beauty of a scientific explanation of nature without solving equations.

*Physics Without Math*

Preface

Pre Prentice-Hall Inc. Englewood Cliffs, New Jersey, USA. 1979

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Every moment of time dictated and determined the following moment, and was itself dictated and determined by the moment that came before it. Everything was calculable: everything happened because it must; the commandments were erased from the tables of the law; and in their place came the cosmic algebra: the equations of the mathematicians.

*Too True to Be Good, Village Wooing and On the Rocks*

*Too True to Be Good: A Political Extravaganza*

Act III

Constable & Company Ltd. London, England. 1934

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

We always stand in the middle of an equation, past equaling future.

*The System of Animate Nature: The Gifford Lectures Delivered in the*

*University of St. Andrews in the Years 1915 and 1916* Volume 2

Lecture XI (p. 358)

Henry Holt & Co. New York, New York, USA. 1920

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

I do believe in simplicity. When the mathematician would solve a difficult problem he first frees the equation from all encumbrances, and reduces it to its simplest terms.

In William Peterfield Trent

*Cambridge History of American Literature* (Volume 2)

Book II, (Continued.) Chapter X, Thoreau (p. 8)

Cambridge University Press. Cambridge, England. 1917–21

**Trautman, Andrzej** 1933–  
Polish mathematician

It is important to remember that the physical interpretation of the mathematical notions occurring in a physical theory must be compatible with the equations of the theory.

In P.G. Bergmann and V. de Sabbata (eds.)  
*Cosmology and Gravitation: Spin, Torsion, Rotation, and Supergravity*  
Generalities on Geometric Theories of Gravitation (p. 4)  
Plenum Press. New York, New York, USA. 1980

## EQUILIBRIUM

### Author undetermined

Normality factor is that factor which, when added in the correct amount, produces, or tends to produce, equilibrium in a solution.

Class-Room Chemical Emanations  
*Journal of Chemical Education*, Volume 3, Number 1, 1926

**Sommerfeld, Arnold** 1868–1951  
German physicist

Reversible processes are not, in fact, processes at all, they are sequences of states of equilibrium. The processes which we encounter in real life are always irreversible processes.

*Thermodynamics and Statistical Mechanics, Lectures on Theoretical Physics*  
Volume V, Translated by J. Kestin (p. 19)  
Academic Press. New York, New York, USA. 1956

## ERG

**Struve, Otto** 1897–1963  
Russian-American astronomer

An erg is a very small amount of energy: it is about the amount that a moderately slow mosquito transfers when it collides with your forehead – and this does not include the sting!

The Evolution of Stars  
*Scientific American*, Volume 188, Number 3, March, 1953 (p. 34)

## EROSION

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

No one can know how much land has already gone down into the stomach of the sea. The waves have been but one among several of its caterers.

*Autobiography of Earth*  
Chapter VI (p. 177)  
Coward-McCann, Inc. New York, New York, USA. 1935

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

The highest mountain may be levelled with the plain from which it springs, without the loss of real territory in the land; but when the ocean makes encroachment on the basis of our earth, the mountain, unsupported, tumbles with its weight; and with the accession of hard bodies, moveable with the agitation of the waves, gives to the sea the power of undermining farther and farther into the solid basis of our land.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter I, Section IV (p. 189)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Lawson, Andrew C.**  
Geologist

Geology has to do with many cycles, but the greatest of these is the erosional flow of rock mass from the continents to the sea and the isostatic return flow of equivalent mass from beneath the sea to the land.

The Isostasy of Large Deltas  
*Geological Society American Bulletin*, Volume 149, 1938 (p. 416)

**Le Guin, Ursula K.** 1929–  
American writer of science fiction and fantasy

Watch this, gents. Watch the lady act like a woman. For that's what she did. The well-behaved, quiet, pretty, serene, domestic creature peaceably yielding herself to the uses of man all of a sudden said No. And she spat dirt and smoke and steam.... She swore and belched and farted, threatened and shook and swelled, and then she spoke. They heard her voice two hundred miles away. "Here I go," she said. I'm doing my thing now. Old Nobodaddy you better JUMP.

A Very Warm Mountain  
*Parabola*, Volume 5, 1980

**Tennyson, Alfred (Lord)** 1809–92  
English poet

The moanings of the homeless sea, The sound of streams that swift or slow Draw down Aeonian hills, and sow The dust of continents to be;

*The Works of Alfred Lord Tennyson, Poet Laureate*  
In Memoriam (p. 251)  
The Macmillan Co. New York, New York, USA. 1898

## ERROR

**Abel, Reuben** 1911–  
Writer

We must avoid here two complementary errors: on the one hand that the world has a unique, intrinsic, pre-existing structure awaiting our grasp; and on the other

hand that the world is in utter chaos. The first error is that of the student who marveled at how the astronomers could find out the true names of the distant constellations. The second error is that of Lewis Carroll's Walrus who grouped shoes with ships and sealing wax, and cabbages with kings...

*Man Is the Measure: A Cordial Invitation to the Central Problems of Philosophy*  
Chapter 1 (pp. 16–17)  
The Free Press. New York, New York, USA. 1976

**Adams, Franklin Pierce** 1881–1960  
American columnist and author

If frequently I fret and fume,  
And absolutely will not smile,  
I err in company with Hume,  
Old Socrates and T. Carlyle.

*Tobogganing on Parnassus*  
Erring in Company  
Doubleday, Page. Garden City, New York, USA. 1913

**Adams, George** 1750–95  
English instrument maker

It is of the utmost importance to your real advancement in science, to avoid every source of error, or whatever may lead you to form an erroneous judgment. Now a true judgment can only be obtained by a profound view of nature, and a strict examination into the mutual connections and dependencies of things; you will hence see the necessity of strict and accurate examination, of time to acquire the requisite knowledge, and of attention to comprehend it: for among the various sources of error, we may reckon the precipitation of our judgment and a presumptuous ignorance as the principal.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture II (p. 27)  
Printed by R. Hindmarsh. London, England. 1794

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

An error is the more dangerous in proportion to the degree of truth which it contains.

Translated by Mrs. Humphrey Ward  
*Amiel's Journal*  
December 26, 1852 (p. 43)  
A.L. Burt Company, Publishers. New York, New York, USA. 189?

**Anscombe, Francis John** 1918–2001  
English-born American statistician

One sufficiently erroneous reading can wreck the whole of a statistical analysis, however many observations there are.

Rejection of Outliers  
*Technometrics*, Volume 2, 1960 (p. 226)

## Author undetermined

A Type III error is a good solution to the wrong problem.

A Type IV error is a wrong solution to the wrong problem.

Source undetermined

**Baker, Henry** 1698–1774  
English naturalist

Remember that Truth alone is the Matter that you are in search after; and if you have been mistaken, let not Vanity seduce you to persist in your Mistake.

*The Microscope Made Easy*  
Part I, Chapter XV, Cautions in Viewing Objects (p. 62)  
Printed for R. Dodsley. London, England. 1743

**Beard, George M.**

No biographical data available

...as quantitative truth is of all forms of truth the most absolute and satisfying, so quantitative error is of all forms of error the most complete and illusory.

*Experiments with Living Human Beings*  
*Popular Science Monthly*, Volume 14, 1879 (p. 751)

**Bernard, Claude** 1813–78  
French physiologist

If the facts used as a basis of reasoning are ill-established or erroneous, everything will crumble or be falsified; and it is thus that errors in scientific theories most often originate in errors of fact.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section III (p. 13)  
Henry Schuman, Inc. New York, New York, USA. 1927

There are people who seek to find truth, but there are those who seek above all to uncover the errors of their contemporaries.

Translated by Hebbel H. Hoff, Lucienne Guillemain and Roger Guillemain  
*The Cahier Rouge of Claude Bernard* (p. 115)  
Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

The problem of error has preoccupied philosophers since the earliest antiquity. According to the subtle remark made by a famous Greek philosopher, the man who makes a mistake is twice ignorant, for he does not know the correct answer, and he does not know that he does not know it.

Translated by Douglas Scott  
*Probability and Certainty*  
Chapter 9 (p. 114)  
Walker & Company. New York, New York, USA. 1963



**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Science is a very human form of knowledge. We are always at the brink of the known, we always feel forward for what is to be hoped. Every judgment in science stands on the edge of error, and is personal. Science is a tribute to what we can know although we are fallible.

*The Ascent of Man*

Chapter 11 (p. 374)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Brown, Samuel** 1817–56

Chemist

Is it necessary to the nature of a science that it be all true, and that it contain no admixture of error? By no means: else chemistry was no science during the reign of phlogiston; optics no science during the predominance of the materialistic theory of light; the Lavoisierian chemistry no science as long as oxygen was taken for the principle of acidity; ay, and the chemistry of to-day might very easily be proved to be no science anymore than the rest.

*Lectures on the Atomic Theory and Essays Scientific and Literary*

(Volume 1)

Essay II (pp. 147–148)

Thomas Constable & Co. Edinburgh, Scotland. 1858

**Burke, Edmund** 1729–97

English statesman and philosopher

...though men err in assigning the causes of natural operations, the works of nature are by this means under their consideration ...

*The Works of the Right Hon. Edmund Burke: With a Biographical and Critical Introduction*

*An Abridgment of English History*

Chapter II (p. 529)

Holdsworth & Ball. London, England. 1834

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

For error and mistake are infinite,

But truth has but one way to be i' th' right.

*The Poetical Works of Samuel Butler* (Volume 2)

Miscellaneous Thoughts, l. 114

Bell & Daldy. London, England. 1835

**Cage, Jr., John Milton** 1912–92

An error is simply a failure to adjust immediately from a preconception to an actuality.

*Silence* (p. 170)

Wesleyan University Press. Middletown, Connecticut, USA. 1961

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

No error at all! They were positively steeped in error!

*The Complete Works of Lewis Carroll*

*A Tangled Tale* (p. 1063)

The Modern Library. New York, New York, USA. 1936

**Chappell, Edwin**

No biographical data available

Pepys probably did not much increase his popularity in the Grafton by getting Dartmouth to call for the dead-reckoning from twelve different persons on board, especially as this was done before they sighted land. Their errors were subsequently found to be very considerable – one was as much as seventy leagues out! It is interesting to note that the inference drawn from these discrepancies was that the chart must be wrong, and it was corrected accordingly.

*The Tangier Papers of Samuel Pepys* (p. xxxviii)

Navy Records Society, Volume 73, 1935

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

I prefer, before heaven, to go astray with Plato, your reverence for whom I know, and admiration for whom I learn from your lips, rather than hold true views with his opponents.

Translated by J.E. King

*Cicero in Twenty Eight Volumes (XVIII)*

Tusculanarum Disputationum, l. 17 (p. 47)

Harvard University Press. Cambridge, Massachusetts, USA. 1921

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

It is almost as difficult to make a man unlearn his errors, as his knowledge. Mal-information is more hopeless than non-information; for error is always more busy than ignorance. Ignorance is a blank sheet, on which we may write; but error is a scribbled one, from which we must first erase. Ignorance is contented to stand still with her back to the truth; but error is more presumptuous, and proceeds in the same direction. Ignorance has no light, but error follows a false one. The consequence is, that error, when she retraces her footsteps, has farther to go, before we can arrive at the truth, than ignorance.

*Lacon; or Many Things in a Few Words* (p. 17)

William Gowans. New York, New York, USA. 1849

**Cooke, Josiah Parsons** 1827–94

American chemist

...in science there is not only a wrong way, but this wrong way is so easy and alluring that you will most certainly stray into it unless you strive earnestly to keep out of it.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 22)

D. Appleton & Co. New York, New York, USA. 1855

**Cowper, William** 1731–1800

English poet

Man, on the dubious waves of error toss'd.

*The Poetical Works of William Cowper*

Truth, l. 1

John W. Lovell Company. New York, New York, USA. No date

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

O mathematicians, throw light on this error.

Translated by Edward MacCurdy  
*The Notebooks of Leonardo da Vinci* (Volume 1)  
Philosophy (p. 64)  
George Braziller. New York, New York, USA. 1958

**Darwin, Charles Robert** 1809–82  
English naturalist

...to kill an error is as good a service as, and sometimes even better than, the establishing of a new truth or fact.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 2)  
Letter 752, Darwin to Wilson, March 5, 1879 (p. 422)  
D. Appleton & Company. New York, New York, USA. 1903

**Davy, Sir Humphry** 1778–1829  
English chemist

Experimental science hardly ever affords us more than approximations to truth; and whenever many agents are concerned we are in great danger of being mistaken.

*The Collected Works of Sir Humphry Davy* (Volume 1)  
Memories of the Life of Sir Humphry Davy  
Chapter II (pp. 69–70)  
Smith, Elder & Company. London, England. 1839–1840

**Dawkins, Richard** 1941–  
English ethologist, evolutionary biologist, and popular science writer

...statisticians distinguish false positive from false negative errors, sometimes called type 1 and type 2 errors respectively.... There is a type 3 error in which your mind goes totally blank whenever you try to remember which is which of type 1 and type 2.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 7 (p. 171)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

Precision is expressed by an international standard, viz., the standard error. It measures the average of the difference between a complete coverage and a long series of estimates formed from samples drawn from this complete coverage by a particular procedure or drawing, and processed by a particular estimating formula.

On the Presentation of the Results of Sample Surveys as Legal Evidence  
*Journal of the American Statistical Association*, Volume 49, Number 268, December, 1954 (p. 820)

**Diamond, Solomon** 1906–98  
No biographical data available

Error does not carry any recognizable badge, for when we change our point of view, to focus on a different problem, what had been error may become information, and what had been information may become error.

*Information and Error: An Introduction to Statistical Analysis*  
Chapter 1 (p. 7)  
Basic Books, Inc. New York, New York, USA. 1959

Here, by the grace of Chance, we've staked a Mean,  
Uncertain marker of elusive Truth.

But have we caught a fact, or trapped a doubt  
Within this stretching span of confidence –  
A shadow world four standard errors wide,  
All swollen by the stint of observation?  
For recollect that once in twenty times  
The phantom Truth will even lie beyond  
That span, in the unending thin-drawn tails  
Which point to the infinitude of Error.

*Information and Error: An Introduction to Statistical Analysis*  
Third Interlude (p. 120)  
Basic Books, Inc. New York, New York, USA. 1959

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

Errors, like straws, upon the surface flow,  
He who would search for pearls must dive below.

*The Poetical Works of Dryden*  
All for Love, Prologue  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Duncan, Otis Dudley** 1921–  
American demographer and sociologist

A mature science, with respect to the matter of errors in variables, is not one that measures its variables without error, for this is impossible. It is, rather, a science which properly manages its errors, controlling their magnitudes and correctly calculating their implications for substantive conclusions.

*Introduction to Structural Equation Models*  
Chapter 9 (p. 114)  
Academic Press. New York, New York, USA. 1975

**Edgeworth, Francis Ysidro** 1845–1926  
Irish economist and statistician

However we define error, the idea of calculating its extent may appear paradoxical. A science of errors seems a contradiction in terms.

The Element of Chance in Competitive Examinations  
*Journal of the Royal Statistical Society*, Volume 53, 1890, (p. 462)

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

...a vigorous error vigorously pursued has kept the embryos of truth a-breathing ...

*Middlemarch* (Volume 2)  
Book V, XLVIII (p. 74)  
William Blackwood & Sons. Edinburgh, Scotland. 1907

**Enriques, Federigo** 1871–1946  
Italian mathematician

Man's determination not to be deceived is precisely the origin of the problem of knowledge. The question is always and only this: to learn to know and to grasp reality in the midst of a thousand causes of error which tend to vitiate our observation.

Translated by Katharine Head Royce

*Problems of Science*

Chapter I (p. 10)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

**Evans, Bergen** 1904–78

Author

No error is harmless.

*The Natural History of Nonsense*

Chapter 19 (p. 274)

Alfred A. Knopf. New York, New York, USA. 1947

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

An error removed is tantamount to a truth gained...

Translated by Alexander Teixeira de Mattos

*Bramble Bees and Others*

Chapter 1 (p. 20)

Dodd, Mead &amp; Co. New York, New York, USA. 1915

**Fischer, Ernst Peter** 1947–

No biographical data available

The way to wisdom, I explain,

Is easy to express,

To err and err and err again

But less and less and less.

Translated by Elizabeth Oehlkers

*Beauty and the Beast*

Chapter 5 (p. 93)

Plenum Trade. New York, New York, USA. 1999

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The phrase “Errors of the Second Kind”, although apparently only a harmless piece of technical jargon, is useful as indicating the type of mental confusion in which it was coined.

Statistical Methods and Scientific Induction

*Journal of the Royal Statistical Society*, Series B, Number 17, 1955

(p. 73)

**Froude, James Anthony** 1818–94

English historian and biographer

...no vehement error can exist in this world with impunity...

*Short Studies on Great Subjects* (Volume 1)

Spinoza (p. 394)

Longmans, Green &amp; Company. London, England. 1879

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

SAM: An error? What error?

*The Complete Plays of Gilbert and Sullivan**The Pirates of Penzance*

Act I (p. 122)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1976

**Girtanner, Christopher** 1760–1800

Chemist and physician

Let us not be attached to systems, but to truth; and when Nature speaks, let us listen to her voice in preference to that of a Stahl or a Lavoissier, a Descartes or a Newton. Whatever may be the result of our experiments, we shall profit by them: as we run the risqué of losing nothing but error, let us hasten to subject ourselves to that loss.

Memoir on Azot, and on the Question, Whether it be a simple or a compound Body

*Philosophical Magazine*, Volume VI (p. 337)**Goddard, Robert H.** 1882–1945

American physicist

The fact that errors in scientific reasoning are so common should not serve as a discouragement. Every fallacy we detect can show us where we are at fault, and guide us toward the truth.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things For Granted (p. 66)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

One cannot always be right in our complex world; no dishonor attends an incorrect choice among plausible outcomes drawn from a properly constructed argument.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Six, Chapter 23 (p. 299)

Random House, Inc. New York, New York, USA. 1995

We learn from our errors, perhaps most of all from our shameful mistakes.

*Dinosaur in a Haystack*

Chapter 30 (p. 388)

Harmony Books. New York, New York, USA. 1995

Great thinkers are never passive before facts. They ask questions of nature; they do not follow her humbly. They have hopes and hunches, and they try hard to construct the world in their light. Hence, great thinkers also make great errors.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 23 (p. 236)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1980

...honorable errors do not count as failures in science, but as seeds for progress in the quintessential activity of correction.

*Leonardo's Mountain of Clams and the Diet of Worms*

Part III, Chapter 8 (p. 163)

Harmon Brown. New York, New York, USA. 1998

**HAL 9000 (Fictional character)**

I don't think there is any question about it. It can only be attributable to human error. This sort of thing has cropped up before, and it has always been due to human error

*2001: A Space Odyssey*

Film (1968)

**Heinlein, Robert A.** 1907–88

American science fiction writer

I shot an error into the air. It's still going...everywhere.

*Expanded Universe*

The Happy Days Ahead (p. 514)

Penguin Putnam, Inc. New York, New York, USA. 1980

**Hippocrates** 460 BCE–377 BCE

Greek physician

I know that the common herd of physicians, like the vulgar, if there happen to have been any innovation made about that day, such as the bath being used, a walk taken, or any unusual food eaten, all which were better done than otherwise, attribute notwithstanding the cause of these disorders, to some of these things, being ignorant of the true cause, but proscribing what may have been very proper.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On Ancient Medicine, 21 (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

Nature itself cannot err.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 4 (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...errors of definitions multiply themselves according as the reckoning proceeds, and lead men into absurdities, which at last they see, but cannot avoid, without reckoning anew from the beginning ...

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth,*

*Ecclesiastical and Civil* (2nd edition)

Chapter IV (p. 25)

George Routledge & Sons. London, England. 1886

**Huxley, Thomas Henry** 1825–95

English biologist

Next to being right in this world, the best of all things is to be clearly and definitely wrong. If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere; but if you are absolutely and thoroughly and persistently wrong, you must, some of these days, have the extreme good fortune of knocking your head against a fact, and that sets you all straight again.

*Collected Essays* (Volume 3)

*Science and Education*

On Science and Art in Relation to Education (p. 174)

Macmillan & Company Ltd. London, England. 1904

It sounds paradoxical to say that the attainment of scientific truth has been effected, to a great extent, by the help of scientific errors. But the subject-matter of physical science is furnished by observation, which cannot extend beyond the limits of our faculties; while, even within those limits, we cannot be certain that any observation is absolutely exact and exhaustive. Hence it follows that

any given generalisation from observation may be true, within the limits of our powers of observation at a given time, and yet turn out to be untrue, when those powers of observation are directly or indirectly enlarged.

*Method and Results: Essays*

The Progress of Science (p. 63)

D. Appleton & Co. New York, New York, USA. 1898

It may fairly be doubted whether any generalisation, or hypothesis, based upon physical data is absolutely true, in the sense that a mathematical proposition is so; but, if its errors can become apparent only outside the limits of practicable observation, it may be just as usefully adopted for one of the symbols of that algebra by which we interpret Nature, as if it were absolutely true.

*Method and Results: Essays*

The Progress of Science (p. 64)

D. Appleton & Co. New York, New York, USA. 1898

...there is no greater mistake than the hasty conclusion that opinions are worthless because they are badly argued.

*Collected Essays* (Volume 1)

*Method and Result*

Natural and Political Rights (p. 369)

Macmillan & Company Ltd. London, England. 1904

...irrationally held truths may be more harmful than reasoned errors.

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of (p. 229)

Macmillan & Company Ltd. London, England. 1904

**Jaki, Stanley L.** 1924

Benedictine priest and physicist

To realize that one has made an error is the privilege of the human intellect.

*The Limits of a Limitless Science: And Other Essays*

Chapter 3 (p. 32)

ISI Books. Wilmington, Delaware, USA. 2000

**James, William** 1842–1910

American philosopher and psychologist

Believe truth! Shun error! – these, we see, are two materially different laws; and by choosing between them we may end by colouring differently our whole intellectual life. We may regard the chase for truth as paramount, and the avoidance of error as secondary; or we may, on the other hand, treat the avoidance of error as more imperative, and let truth take its chance.... Our errors are surely not such awful solemn things. In a world where we are so certain to incur them in spite of all our caution, a certain lightness of heart seems healthier than this excessive nervousness on their behalf. At any rate, it seems the fittest thing for the empiricist philosopher.

*The Will to Believe and Other Essays in Popular Philosophy*

The Will to Believe

Sections VII & VIII (p. 18)

Dover Publications, Inc. New York, New York, USA. 1956

**Jefferson, Thomas** 1743–1826  
3rd president of the USA

Error of opinion may be tolerated where reason is left free to combat it.

*The Inaugural Addresses of the Presidents of the United States*  
First Inaugural Address at Washington DC, March 4, 1801

**Jevons, William Stanley** 1835–82  
English economist and logician

...quantities which are called errors in one case, may really be most important and interesting phenomena in another investigation. When we speak of eliminating error we really mean disentangling the complicated phenomena of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book III, Chapter XV (p. 339)  
Macmillan & Company Ltd. London, England. 1887

It is surprising to learn the number of causes of error which enter into the simplest experiment, when we strive to attain rigid accuracy.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book IV, Chapter XXI (p. 468)  
Macmillan & Co Ltd. London, England. 1877

**Koyré, Alexandre** 1892–1964  
Russian-born French philosopher

What good is it then to spend time on error? Isn't the important thing the final success, the discovery, and not the tortuous paths that one followed and on which one could have gotten lost?...What is important for posterity is in fact the discovery or invention. Nonetheless (at least for the historian-philosopher) it is the dead end, the error...which are sometimes as important as the successes. They can, maybe, be even more important. They are...instructive by permitting us, sometimes, to grasp and to comprehend the secret paths of thought.

Translated by J. Mepham  
*Galilean Studies* (p. 77)  
The Harvester Press. Hassocks, England. 1978

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

In spite of the errors into which I may have been led, the work may possibly contain ideas and arguments that will have a certain value for the advancement of knowledge, until such time as the great subjects, with which I have ventured to deal, are treated anew by men capable of shedding further light upon them.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter VIII (p. 405)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

[Science] dissipates errors born of ignorance about our true relations with nature, errors the more damaging in that the social order should rest only on those relations. TRUTH! JUSTICE! Those are the immutable laws. Let us banish the dangerous maxim that it is sometimes useful to depart from them and to deceive or enslave mankind to assure its happiness.

In Charles Coulston Gillispie  
*Pierre-Simon Laplace, 1749–1827: A Life in Exact Science*  
Chapter XIX (p. 175)  
Princeton University Press. Princeton, New Jersey, USA. 1997

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

The only method of preventing such errors from taking place, and of correcting them when formed, is to restrain and simplify our reasoning as much as possible. This depends entirely upon ourselves, and the neglect of it is the only source of our mistakes.

*Elements of Chemistry in a New Systematic Order*  
Preface of the Author (p. xviii)  
Printed for William Creech. Edinburgh, Scotland. 1790

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

We err when we expect more enlightenment from an hypothesis than from the facts themselves.

*The Science of Mechanics* (5th edition)  
Chapter V, Part I (p. 600)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maimonides, Moses** 1135–1204  
Spanish-born philosopher, jurist, and physician

Today he can discover his errors of yesterday and tomorrow he may obtain light on what he thinks himself sure of today.

In H.P. Charles and B.C. Knight (eds.)  
*Organization and Control in Prokaryotic Cells. Twentieth Symposium of the Society For General Microbiology*  
Editor's Preface (p. xi)  
Cambridge University Press. Cambridge, England. 1970

**Mayr, Ernst** 1904–2005  
German-born American biologist

It is curious how often erroneous theories have had a beneficial effect for particular branches of science.

*The Growth of Biological Thought: Diversity, Evolution and Inheritance*  
Chapter 20 (p. 847)  
Harvard University Press. Cambridge, Massachusetts, USA. 1982

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician



...the errors are not the art, but in the artificers.

*Mathematical Principles of Natural Philosophy*

Preface to the First Edition

E.P. Dutton & Company. New York, New York, USA. 1922

**Mill, John Stuart** 1806–73

English political philosopher and economist

A fundamental error is seldom expelled from philosophy by a single victory. It retreats slowly, defends every inch of ground, and often retains a footing in some remote fastness after it has been driven from the open country.

*A System of Logic, Ratiocinative and Inductive*

Chapter VI (p. 77)

Harper & Brothers Publishers. New York, New York, USA. 1867

**Neyman, Jerzy** 1894–1981

Russian-born American statistician

Whenever we attempt to test a hypothesis we naturally try to avoid errors in judging it. This seems to indicate the right way of proceeding: when choosing a test we should try to minimize the frequency of errors that may be committed in applying it.

*Lectures and Conferences on Mathematical Statistics*

Chapter I, Part 3 (p. 55)

U.S. Department of agriculture. Washington, D.C. 1952

**Nicolle, Charles** 1866–1936

French Bacteriologist

Error is all around us and creeps in at the least opportunity. Every method is imperfect.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Nine (p. 102)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

...errors in judgment must occur in the practice of an Art which consists largely in balancing probabilities...

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Teacher and Student (p. 19)

Publisher undetermined

**Parrot, Max**

No biographical data available

If it is useful to make discoveries in natural science, it is not less so, to correct as many as possible of the errors which arise in this domain of human knowledge, and which are sustained by the authority or the assent of respectable savants.

Translated by J. Griscom

Considerations Upon the Temperature of the Terrestrial Globe

*American Journal of Science and Arts*, Volume 26, I, Article II, July 1834

**Pascal, Blaise** 1623–62

French mathematician and physicist

...the most powerful cause of error is the war existing between the senses and reason.

*Thoughts*

Section II (p. 38)

P.F. Collier & Son. New York, New York, USA. 1910

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

In those sciences of measurement which are the least subject to error – meteorology, geodesy, and metrical astronomy – no man of self-respect ever now states his results, without affixing to it its probable error; and if this practice is not followed in other sciences it is because in those the probable errors are too vast to be estimated.

In Justus Buchler (ed.)

*Philosophical Writings of Peirce* (p. 3)

Dover Publications. New York, New York, USA. 1955

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

A final word about the theory of errors. Here it is that the causes are complex and multitude. To how many snares is not the observer exposed, even with the best instruments.

*The Foundations of Science*

*Science and Method*, Book I

Chapter IV, Section IV (p. 402)

The Science Press. New York, New York, USA. 1913

**Pomfret, John** 1667–1702

English poet and clergyman

The best may slip, and the most cautious fall;  
He's more than mortal that ne'er err'd at all.

*The Poetical Works of John Pomfret*

Love Triumphant over Reason, l. 145

At The Apollo Press. Edinburgh, Scotland. 1779

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

But science is one of the very few human activities – perhaps the only one – in which errors are systematically criticized and fairly often, in time, corrected. This is why we can say that, in science, we often learn from our mistakes, and why we can speak clearly and sensibly about making progress there.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10, Section I (p. 216)

Harper & Row, Publishers. New York, New York, USA. 1963

**Reagan, Ronald W.** 1911–2004

40th president of the USA

I will stand on, and continue to use, the figures I have used, because I believe they are correct. Now, I'm not going to deny that you don't now and then slip up on something; no one bats a thousand.

On Bandwagon, Reagan Seeks to Stiffen Credibility Grip

*Washington Post*, 20 April, 1980 (A8)



**Rey, Jean** 1583–1645  
French physician and chemist

An error, however trivial, committed at the commencement of any discipline, increases as we progress, and most often involves us in very thorny difficulties.

*Essays of Jean Rey*

Essay V (p. 11)

William F. Glay. Edinburgh, Scotland 1895

I know not what fatal calamity has invaded the sciences, for when an error is born with them and with the lapse of time becomes as it were fixed there, those who profess these sciences will not suffer its withdrawal.

*Essays of Jean Rey*

Essay XII (p. 12)

William F. Clay. Edinburgh, Scotland. 1895

It is said of Hercules that no sooner had he cut off one of the heads of that Hydra which devastated the Lernasan marsh, than two others sprang forth. My condition is similar. The error that I combat teems with opinions, which are so many heads: if I cut off one, we see two appear.

*Essays of Jean Rey*

Essay XXV (p. 49)

William F. Clay. Edinburgh, Scotland. 1895

### **Russell, Cheryl**

No biographical data available

Always expect to find at least one error when you proof-read your own statistics. If you don't, you are probably making the same mistake twice.

In Tom Parker

*Rules of Thumb* (p. 124)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1983

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

The error of our eye directs our mind. What error leads must err.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Troilus and Cressida*

Act V, Scene ii, l. 110–111

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

When truth is divided, errors multiply.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #360 (p. 147)

Definition Press. New York, New York, USA. 1972

### **Smith, Henry John Stephen** 1826–83

Irish mathematician

In science error is always possible, often close at hand; and the constant necessity for being on our guard against it is one important part of the education which science provides.

*The Collected Mathematical Papers of Henry John Stephen Smith*  
(Volume 2)

Appendix I (p. 688)

At The Clarendon Press. Oxford, England. 1894

### **Sterne, Laurence** 1713–68

English novelist and humorist

...error...creeps in through the minute holes and small crevices which human nature leaves unguarded.

*Tristram Shandy*

Chapter XIX (p. 127)

Derby & Jackson. New York, New York, USA. 1857

The laws of nature will defend themselves – but error – (he would add, looking earnestly at my mother) – error, Sir, creeps in thro' the minute holes and small crevices which human nature leaves unguarded.

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 1)

Book II, Chapter XIX (p. 131)

Macmillan & Company Ltd. London, England. 1900

In a word, he would say, error was error – no matter where it fell – whether in a fraction – or a pound – 'twas alike fatal to truth, and she was kept down at the bottom of her well, as inevitably by mistake in the dust of a butterfly's win – as in the disk of the sun, the moon, and all the stars of heaven put together.

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 1)

Book II, Chapter XIX (p. 131)

Macmillan & Company Ltd. London, England. 1900

### **Stetson, Harlan True** 1885–1964

American astronomer and physicist

The more closely emotional response is entwined with error, the more difficult does it become to change one's thinking.

In Joseph Jastrow (ed.)

*The Story of Human Error*

Error in Astronomy (p. 45)

D. Appleton-Century Company, Incorporated. New York, New York, USA. 1936

### **Thomas, Lewis** 1913–93

American physician and biologist

Biology needs a better word than "error" for the driving force in evolution. Or maybe "error" will do after all, when you remember that it came from an old root meaning to wander about, looking for something.

*The Medusa and the Snail: More Notes of a Biology Watcher*

The Wonderful Mistake (p. 30)

The Viking Press. New York, New York, USA. 1979

### **Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The definitizing of error is often the beginning of its disappearance. When the evil genie of the Eastern tales

took on definite bodily form there was some chance of tackling him; as a mere wraith he was unassailable.

*Introduction to Science*

Chapter I (p. 29)

Henry Holt & Co. New York, New York, USA. 1911

### **Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

One cannot too soon forget his errors...

*The Writings of Henry David Thoreau* (Volume 8)

*Winter*

9 Jan 1842 (p. 144)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Tukey, John W.** 1915–2000

American statistician

For the Bureau has worked hard to learn the accuracy of its measurements and it supplies with each weight a certificate indicating how much the weight may differ from exactly one pound. The calibration of the weight is valuable just because its possible error is known. When the Bureau of the Census makes an enumeration, there are errors, which they acknowledge. They know the extent of the errors from many sources and they try to learn more about those from others.... It is far easier to put out a figure, than to accompany the figure with a wise and reasoned account of its liability to systematic and fluctuating errors. Yet if the figure is...to serve as the basis of an important decision, the accompanying amount may be more important than the figures themselves.

Memorandum on Statistics in the Federal Government

*The American Statistician*, Volume 3, Number 5, February, 1949 (p. 9)

### **Tupper, Martin Farquhar** 1810–89

English writer and poet

Error is a hardy plant; it flourishes in every soil.

*Proverbial Philosophy: A Book of Thoughts and Arguments*

Of Truth in Things False (p. 5)

J. Hatchard & Son. London, England. 1842

### **van de Kamp, Peter**

No biographical data available

...should we not come to the rescue of a cosmic phenomenon trying to reveal itself in a sea of errors?

*Dark Companions of Stars: Astrometric Commentary on the Lower End of the Main Sequence*

Chapter 15 (p. 322)

D. Reidel Publishing Company. Dordrecht, Netherlands. 1986

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Error is to truth as sleep is to waking. As though refreshed, one returns from erring to the path of truth.

*Wisdom and Experience*

Science and Philosophy (p. 126)

Routledge & Kegan Paul Ltd. London, England. 1949

I could have never have known so well how paltry men are, and how little they care for really high aims, if I had not tested them by my scientific researches. Thus I saw that most men only care for science so far as they get a living by it, and that they worship even error when it affords them a substance.

In Johann Peter Eckermann

*Conversations with Goethe*

Wednesday, October 12, 1825 (p. 119)

J.M. Dent & Sons Ltd. London, England. 1970

It is difficult to know how to treat the errors of the age. If a man oppose them, he stands alone; if he surrender to them, they bring him neither joy nor credit.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#521 (p. 185)

The Macmillan Co. New York, New York, USA. 1906

To err is to be as though truth did not exist. To lay bare the error to oneself and others is retrospective discovery.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#524 (p. 186)

The Macmillan Co. New York, New York, USA. 1906

The orbits of certainties touch one another; but in the interstices there is room enough for error to go forth and prevail.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#528 (p. 187)

The Macmillan Co. New York, New York, USA. 1906

There is a sort of men who never go wrong, because they never propose to themselves anything reasonable to do.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 168)

William Blackwood & Sons. Edinburgh, Scotland. 1883

### **von Helmholtz, Hermann** 1821–94

German scientist and philosopher

But any pride I might have felt in my conclusions was perceptibly lessened by the fact that I knew that the solution of these problems had almost always come to me as the gradual generalisation of favourable examples, by a series of fortunate conjectures, after many errors. I am fain to compare myself with a wanderer on the mountains who, not knowing the path, climbs slowly and painfully upwards and often has to retrace his steps because he can go no further – then, whether by taking thought or from luck, discovers a new track that leads him on a little till at length when he reaches the summit he finds to his shame that there is a royal road, by which he might have ascended, had he only had the wits to find the right approach to it. In my works, I naturally said nothing about my mistake to the reader, but only described the

made track by which he may now reach the same heights without difficulty.

In L. Koenigsberger  
*Hermann von Helmholtz* (pp. 180–181)  
At the Clarendon Press. Oxford, England. 1906

**von Liebig, Justus** 1803–73

German organic chemist

The imagination, in thousands of cases, gives rise to thousands of errors, and nothing is more hurtful to the progress of natural science – nothing has more power in limiting and distorting our views of natural phenomena, than an old established error. It is infinitely difficult to refute a false doctrine, precisely because it rests on the conviction that that is true which is really false.

*Familiar Letters on Chemistry*  
Letter I (p. 18)  
Walton & Maberly. London, England. 1859

A hundred-weight of error will not form one grain of truth.

In John Gardner  
*Familiar Letters on Chemistry*  
Second Series  
Letter I (p. 27)  
Taylor & Walton. London, England. 1844

Error is transient; truth alone is eternal. Error is only the shadow cast by truth, when its rays are arrested on their path by human ignorance and intellectual opacity.

*Familiar Letters on Chemistry*  
Letter IV (p. 68)  
Walton & Maberly. London, England. 1859

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

It is true that man is still, as he always has been, subject to error; his judgments are often incorrect, his beliefs false, his opinions changeable from age to age. But experience of error is his best guide to truth, often dearly bought, and, therefore, the more to be relied upon. And what is it but the accumulated experience of past ages that serves us as a beacon light to warn us from error, to guide us in the way of truth.

*My Life*  
Chapter XIV (pp. 203–204)  
Chapman & Hall. London, England. 1905

**Ward, Lester Frank** 1898–1970

American sociologist

...it is the misfortune of all truly great minds to be wedded to errors as well as to truths.

*Dynamic Sociology* (Volume 1)  
Chapter I (p. 83)  
D. Appleton & Company. New York, New York, USA. 1910

**Watson, Alfred N.**

No biographical data available

A standard error is just as bad as any other error.

Statement made at a meeting of the American Statistical Association, Chicago, 1942

**Whewell, William** 1794–1866

English philosopher and historian

...we may see how theories may be highly estimable, though they contain false representations of the real state of things, and may be extremely useful, though they involve unnecessary complexity. In the advance of knowledge, the value of the true part of the theory may much outweigh the accompanying error, and the use of a rule may be little impaired by its want of simplicity.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 1)  
Book III, Chapter III, Section 2 (p. 181)  
John W. Parker. London, England. 1837

...all who discover truths, must have reasoned upon many errors to obtain each truth ...

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)  
Book XI, Chapter V (p. 56)  
John W. Parker. London, England. 1867

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There is great room for error here.

*Science and the Modern World*  
Chapter II (p. 35)  
The Macmillan Company. New York, New York, USA. 1929

The results of science are never quite true. By a healthy independence of thought perhaps we sometimes avoid adding other people's errors to our own.

*The Aims of Education and Other Essays*  
Chapter X (p. 233)  
The Macmillan Company. New York, New York, USA. 1959

**Wright, Wilbur** 1867–1912

American aeronautical engineer

If a man is in too big a hurry to give up an error he is liable to give up some truth with it, and in accepting the arguments of the other man he is sure to get some error with it.

In Fred C. Kelly (ed.)  
*Miracle at Kitty Hawk*  
Chapter III, Letter from Wilbur Wright to George A. Spratt, April 27, 1903 (p. 89)  
Farrar, Straus & Young. New York, New York, USA. 1951

**ERUPTION**

**Virgil** 70 BCE– 19 BCE

Roman epic, didactic, and idyllic poet

...but Aetna hard at hand

With hideous ruin thunders, and anon

Shoots a dark cloud to heaven or whirling smoke  
Pitch-black, with glowing ashes, and aloft  
Heaves balls of fire, and licks the stars, anon  
Rocks and the upturn entrails of the hill  
Spews forth, and heaps the molten stones in air  
Booming, and from his lowest depth upboils.

In *Great Books of the Western World* (Volume 13)

*The Aeneid*

Book III, l. 571–577 (p. 162)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ESCAPE VELOCITY

**Hale, Edward Everett** 1822–1909

American author and Unitarian clergyman

...If from the surface of the earth, by a gigantic pea-shooter, you could shoot a pea upward from Greenwich, aimed northward as well as upward; if you drove it so fast and far that when its power of ascent was exhausted, and it began to fall, it should clear the earth, and pass outside the North Pole; if you had given it sufficient power to get it half round the earth without touching, that pea would clear the earth forever.

...

“But a pea is so small!” “Yes,” said Q., “but we must make a large pea.”

*His Level Best: And Other Stories*

The Brick Moon (pp. 34–35)

Roberts Brothers. Boston, Massachusetts, USA. 1885

## ESCHATOLOGY

**Dyson, Freeman J.** 1923–

American physicist and educator

I hope...to hasten the arrival of the day when eschatology, the study of the end of the universe, will be a respectable scientific discipline and not merely a branch of theology.

Time Without End: Physics and Biology in an Open Universe

*Review of Modern Physics*, Volume 51, Number 3

## ESOTERIC

**Taylor, Angus E.**

American mathematician

One of the difficulties which a mathematician has in describing his work to non-mathematicians is that the present day language of mathematics has become so esoteric that a well educated layman, or even a group of scientists, can comprehend essentially nothing of the discourse which mathematicians hold with each other, or of the accounts of their latest researches which are published in their professional journals.

Some Aspects of Mathematical Research

*American Scientist*, Volume 35, Number 2, April, 1947 (p. 211)

## ESTEEM

**Lucretius** ca. 99 BCE–55

Roman poet

That which was in esteem, falls at length into utter disrepute; and then another thing mounts up and issues out of its degraded state and every day is more and more coveted and blossoms forth high in honour when discovered and is in marvellous repute with men.

Translated by H.A.J. Munro

*T. Lucreti Cari De rerum natura libri sex*

Book V (p. 147)

George Bell & Sons. London, England. 1903

## ESTIMATE

**Bowley, Arthur Lyon** 1869–1957

English statistician and economist

A statistical estimate may be good or bad, accurate or the reverse; but in almost all cases it is likely to be more accurate than a casual observer's impression, and in the nature of things can only be disproved by statistical methods.

*Elements of Statistics*

Chapter I (p. 9)

P.S. King & Son. London, England. 1901

**King, W. J.**

No biographical data available

Ideally another man's promises should be negotiable instruments, like his personal check, in compiling estimates.

The Unwritten Laws of Engineering

*Mechanical Engineering*, June, 1944 (p. 4)

## ETERNITY

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Whatever may happen to thee, it was prepared for thee from all eternity; and the implication of causes was from eternity spinning the thread of thy being, and of that which is incident to it.

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book X, #5 (p. 296)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bürgel, Bruno Hans** 1875–1948

German astronomer

Flowers and men, stars and mountains, may pass away, but the stream of eternity rolls on forever.

Translated by Stella Bloch

*Astronomy for All*

Chapter I (p. 5)

Cassell & Co., Ltd. London, England. 1911

**Cronkite, Walter** 1916–  
American broadcast journalist

When Moses was alive, these pyramids were a thousand years old – Here began the history of architecture. Here people learned to measure time by a calendar, to plot the stars by astronomy and chart the earth by geometry. And here they developed that most awesome of all ideas – the idea of eternity.

CBS TV 28 June, 1980  
*Eternal Egypt*

**Dewar, Redcote**

No biographical data available

The grandeur of eternity is...but in keeping with the immensity of the universe.

*From Matter to Man: A New Theory of the Universe*  
Chapter III (p. 34)  
Chapman & Hall, Ltd. London, England. 1898

**Drew, Joseph**

No biographical data available

The eternity of all things, and yet all things undergoing change, is a subject few care to; investigate. The eternity of matter, the eternity of space, the eternity of time, and the eternity of thought, are subjects beyond the comprehension of the masses, who view such questions as mere flights of the imagination, only to be indulged in by those who are not engaged in the stern realities of the battle of life.

*Our Home in the Stars*  
Our Home in the Stars (p. 18)  
Elliot Stock. London, England. 1872

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

One is glad of eternity, when we find so much to learn.

*Journals of Ralph Waldo Emerson: 1824–32*  
July 26, 1824 (p. 4)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1909

**Flammarion, Camille** 1842–1925  
French astronomer and writer

The Stars are...symbols of Eternity.

Translated by Frances Alice Welby  
*Astronomy for Amateurs*  
Introduction (p. 12)  
D. Appleton & Co. New York, New York, USA. 1915

**Geikie, Sir Archibald** 1835–1924  
English geologist

It is not a pleasant experience to discover that a fortune which one has unconcernedly believed to be ample has somehow taken to itself wings and disappeared. When the geologist was suddenly awakened by the energetic

warning of the physicist, who assured him that he had enormously overdrawn his account with past time, it was but natural under the circumstances that he should think the accountant to be mistaken, who thus returned to him dishonored the large drafts he had made on eternity.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1895*  
Geological Change and Time (p. 125)  
Government Printing Office. Washington, D.C. 1896

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

If eternity is silliness, then infinity of space is sheer madness.

*Masks of the Universe*  
Chapter 12 (p. 202)  
The Macmillan Company. New York, New York, USA. 1985

**Jefferies, Richard** 1848–87  
English naturalist and author

Only by walking hand in hand with nature, only by a reverent and loving study of the mysteries forever around us, is it possible to disabuse the mind of the narrow view, the contracted belief that time is now and eternity tomorrow. Eternity is to-day.

*The Hills and the Vale*  
Nature and Eternity (p. 294)  
Duckworth & Co. London, England. 1909

**Paine, Thomas** 1737–1809  
Anglo-American political theorist and writer

It is difficult beyond description to conceive that space can have no end; but it is more difficult to conceive an end. It is difficult beyond the power of man to conceive an eternal duration of what we call time; but it is more impossible to conceive a time when there shall be no time.

*The Age of Reason*  
Part First, Chapter X (p. 25)  
W. B. Cooke & W. M. Scott. Toronto, Ontario, Canada. 1887

**Roux, Joseph** 1725–93  
French cartographer

“Time restores all things.” Wrong! Time restores many things, but eternity alone restores all.

Translated by Isabel F. Hapgood  
*Meditations of a Parish Priest: Thoughts*  
Chapter VI, VIII (p. 111)  
Thomas Y. Crowell & Co. New York, New York, USA. 1886

**Stoppard, Tom** 1937–  
Czech-born English playwright

ROS: Eternity is a terrible thought. I mean, where’s it going to end?

*Rosencrantz and Guildenstern Are Dead*  
Act Two (p. 71)  
Grove Press, Inc. New York, New York, USA. 1967



**Vaughan, Henry** 1621–95  
English metaphysical poet

I saw eternity the other night,  
Like a great ring of pure and endless light,  
All calm, as it was bright: –  
And round beneath it,  
Time, in hours, days, years,  
Driven by the spheres,  
Like a vast shadow moved; in which the World  
And all her train were hurl'd.

*Poetry and Selected Prose*

A Vision

Oxford University Press, Inc. London, England. 1963

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

The clock indicates the moment – but what does eternity  
indicate?

*Leaves of Grass*

Song of Myself, verse 44

Doubleday, Page & Co. Garden City, New York, USA. 1919

**Young, Edward** 1683–1765  
English poet and dramatist

Eternity is written in the skies.

*Night Thoughts*

Night IX

Printed by R. Nobels for R. Edwards. London, England. 1797

## ETHER

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

One thing we are sure of. and that is the reality and  
substantiality of the luminiferous ether.

*Popular Lectures and Addresses* (Volume 1)

The Wave Theory of Light (p. 317)

Macmillan & Co Ltd. London, England. 1891

**Lodge, Sir Oliver** 1851–1940  
English physicist

For well nigh a century we have had a wave theory of  
light; and a wave theory of light is almost certainly true.  
It is directly demonstrable that light consists of waves of  
some kind or other, and that these waves travel at a cer-  
tain well-known velocity – achieving a distance equal to  
seven times the circumference of the Earth every second;  
from New York to London and back in the thirtieth part  
of a second; and taking only eight minutes on the journey  
from the Sun to the Earth. This propagation in time of an  
undulatory disturbance necessarily involves a medium. If  
waves setting out from the Sun exist in space eight min-  
utes before striking our eyes, there must necessarily be  
in space some medium which conveys them. Waves we  
cannot have, unless they be waves in something.

*The Ether of Space*

Harper & Brothers. London, England. 1909

**Lorentz, Hendrik Antoon** 1853–1928  
Dutch physicist

Indeed, one of the most important of our fundamental  
assumptions must be that the ether not only occupies all  
space between molecules, atoms, or electrons, but that it  
pervades all these particles. We shall add the hypothesis  
that, though the particles may move, the ether always  
remains at rest.

*The Theory of Electrons and its Applications to the Phenomena of Light  
and Radiant Heat*

Chapter I (p. 11)

B.G. Teubner. Leipzig, Germany. 1916

I cannot but regard the ether, which can be the seat of an  
electromagnetic field with its energy and its vibrations, as  
endowed with a certain degree of substantiality, however  
different it may be from all ordinary matter.

*The Theory of Electrons and its Applications to the Phenomena of Light  
and Radiant Heat* (2nd edition)

Chapter V (p. 230)

B.G. Teubner. Leipzig, Germany. 1916

**Michaelson, Albert Abraham** 1852–1931  
Prussian-born American physicist

**Morely, Edward Williams** 1838–1923  
American scientist

It appears, from all that precedes, reasonably certain that  
if there be any relative motion between the earth and the  
luminiferous ether, it must be small ...

On the Relative Motion of the Earth and the Luminiferous Ether

*The American Journal of Science*, Volume XXXIV, Number 203,

November, 1887 (p. 341)

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

It matters little whether the ether really exists; that is the  
affair of metaphysicians. The essential thing for us is that  
everything happens as if it existed...

...some day, no doubt, the ether will be thrown aside as  
useless.

*The Foundations of Science*

*Science and Hypothesis*, Chapter XII (p. 174)

The Science Press. New York, New York, USA. 1913

**Thomson, Sir Joseph John** 1856–1940  
English physicist

At first sight the idea that we are immersed in a medium  
almost infinitely denser than lead might seem inconceiv-  
able; it is not so if we remember that in all probability  
matter is composed mainly of holes. We may, in fact,  
regard matter as possessing a bird-cage kind of structure,  
in which the volume of the ether disturbed by the wires  
when the structure is moved is infinitesimal in compari-  
son with the volume enclosed by them.

*Annual Report of the Board of Regents of the Smithsonian Institution*,  
1909

Progress in Physics

Government Printing Office. Washington, D.C. 1910



## ETHER SPACE

**Anaxagoras** ca. 500 BCE–428 BCE  
Greek philosopher of nature

The formation of the world began with a vortex, formed out of chaos by Energy. This vortex started at the center and gradually spread. It separated matter into two regions, the rare, hot, dry and light material, the aether, in the outer regions, and the heavier, cooler, moist material, the air, in the inner regions. The air condensed in the center of the vortex, and out of the air, the clouds, water and earth separated. But after the formation of earth, because of the growing violence of the rotary motion, the surrounding fiery aether tore stones away from the earth and kindled them to stars, just as stones in a whirlpool rush outward more than water. The sun, moon and all the stars are stones on fire, ...are moved round by the revolution of the aether.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 2, Section 2. 1 (p. 60)

Macmillan. New York, New York, USA. 1967

### **Bruncken, Herbert Gerhardt**

No biographical data

Eddington, Einstein, and Jeans one night

Sailed off on an ether wave,

Sailed on a curve of celestial light

Into the cosmic cave.

A Space-Time Lullaby

*The Physics Teacher*, Volume 1, Number 1, April, 1963 (p. 47)

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

As far as and beyond the remotest stars the world is filled with aether. It permeates the interstices of the atoms. Aether is everywhere.... There is no space without aether, and no aether which does not occupy space.

*New Pathways in Science*

Chapter II, Section IV (pp. 38–39)

The Macmillan Company. New York, New York, USA. 1935

### **Einstein, Albert** 1879–1955

German-born physicist

We may sum up as follows: According to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, an ether exists. Space without an ether is inconceivable.

*The World as I See It* (p. 204)

Philosophical Library. New York, New York, USA. 1949

### **Hoffmann, Banesh** 1906–86

Mathematician and educator

First we had the luminiferous ether.

Then we had the electromagnetic ether.

And now we haven't e(i)ther.

*The Strange Story of the Quantum*

Chapter III (p. 33)

Dover Publications, Inc. New York, New York, USA. 1959

### **Lodge, Sir Oliver** 1851–1940

English physicist

The first thing to realize about the ether is its absolute continuity. A deep-sea fish has probably no means of apprehending the existence of water; it is too uniformly immersed in it: and that is our condition in regard to ether.

*Ether and Reality*

Hodder & Stoughton. London, England. 1930

All pieces of matter and all particles are connected together by the ether and by nothing else. In it they move freely and of it they may be composed. We must study the kind of connection between matter and ether. The particles embedded in the ether are not independent of it, they are closely connected with it, it is probable that they are formed out of it: they are not like grains of sand suspended in water, they seem more like minute crystals formed in a mother liquor.

*Ether and Reality*

Hodder & Stoughton. London, England. 1930

### **Maxwell, James Clerk** 1831–79

Scottish physicist

Ethers were invented for the planets to swim in, to constitute electric atmospheres and magnetic effluvia, to convey sensations from one part of our body to another, till all space was filled several times over with ether.

In Sir James Jeans

*The Mysterious Universe*

Chapter IV (p. 97)

The Macmillan Company. New York, New York, USA. 1932

### **Planck, Max** 1858–1947

German physicist

The ether, this child of sorrow of classical mechanics...

In Jean-Pierre Luminet

*Black Holes* (p. 18)

Cambridge University Press. New York, New York, USA. 1992

### **Thomson, Sir Joseph John** 1856–1940

English physicist

In fact, all mass is mass of the ether; all momentum, momentum of the ether; and all kinetic energy, energy of the ether. This view, it should be said, requires the density of the ether to be immensely greater than that of any known substance.

In Sir Oliver Lodge

*Ether and Reality*

Hodder & Stoughton. London, England. 1930

## ETHICS

### Accreditation Board for Engineering and Technology

Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by:

- I. using their knowledge and skill for the enhancement of human welfare;
  - II. being honest and impartial, and serving with fidelity the public, their employer;
  - III. striving to increase the competence and prestige of the engineering profession;
- and
- IV. supporting the professional and technical societies of their disciplines.

*Code of Ethics for Engineers*  
October, 1977

**Baruch, Bernard M.** 1870–1965  
American presidential advisor

Science has taught us how to put the atom to work. But to make it work for good instead of for evil lies in the domain dealing with the principles of human duty. We are now facing a problem more of ethics than physics.

Address to United Nations Atomic Energy Commission  
UN Headquarters, New York City, June 14, 1946

**Cabot, Richard Clarke** 1868–1939  
American physician

Ethics and Science need to shake hands.

*The Meaning of Right and Wrong*  
Introduction (p. 10)  
The Macmillan Company. New York, New York, USA. 1933

**Caplan, Arthur**  
No biographical data available

The use of fetuses as organ and tissue donors is a ticking time bomb of bioethics.

In Joe Levine  
Help from the Unborn  
*Time*, Volume 129, Number 2, January 12, 1987 (p. 62)

**Einstein, Albert** 1879–1955  
German-born physicist

Scientific statements of facts and relations, indeed, cannot produce ethical derivatives. However, ethical derivatives can be made rational and coherent by logical thinking and empirical knowledge. If we can agree on some fundamental ethical propositions, then other ethical propositions can be derived from them, provided that the original premises are stated with sufficient precision. Such ethical premises play a similar role in ethics to that played by axioms in mathematics.

In Philipp Frank  
*Relativity – A Richer Truth*  
The Laws of Science and the Laws of Ethics (p. 9)  
Jonathan Cape. London, England. 1951

A man's ethical behavior should be based effectually on sympathy, education, and social ties and needs; no religious basis is necessary. Man would indeed be in a poor way if he had to be restrained by fear of punishment and hope of reward after death.

Religion and Science  
*New York Times Magazine*, November 9, 1930

**Florman, Samuel C.** 1925–  
Author and professional engineer

As a professional, I abide by established standards.... As a human being I hope that I deal adequately with each day's portion of moral dilemmas. But between legality on the one hand and individual predilection on the other, there is hardly any room for the abstraction called "engineering ethics."

*Blaming Technology*  
Moral Blueprints (p. 172)  
St. Martin's Press. New York, New York, USA. 1981

**Graham, Loren R.**  
No biographical data available

Science should submit to ethics, not ethics to science.

*Between Science and Values*  
Introduction (p. 26)  
Columbia University Press. New York, New York, USA. 1981

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

We do not know whether we shall succeed in once more expressing the spiritual form of our future communities in the old religious language. A rationalistic play with words and concepts is of very little assistance here; the most important preconditions are honesty and directness. But since ethics is the basis for the communal life of men, and ethics can only be derived from that fundamental human attitude which I have called the spiritual pattern of the community, we must bend all our efforts to reuniting ourselves, along with the younger generation, in a common human outlook. I am convinced that we can succeed in this if again, we can find the right balance between the two kinds of truth.

In Ken Wilbur (ed.)  
*Quantum Questions*  
Chapter 3 (p. 45)  
Shambhala Publications, Inc. Boston, Massachusetts, USA. 2001

**Hess, Elmer**  
No biographical data available

If a man is good in his heart, then he is an ethical member of any group in society. If he is bad in his heart, he is an

unethical member. To me the ethics of medical practice is as simple as that.

Do Doctors Charge Too Much?  
*American Weekly*, April 24, 1955

### Hill, Archibald V.

No biographical data available

If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the foreseeable consequences are evil?

Quoted in Crispin Tickell

*Climatic Change*

Chapter 2 (p. 37)

Center for International Affairs, Harvard University, USA. 1977

### Huxley, Thomas Henry 1825–95

English biologist

...cosmic nature is no school of virtue, but the headquarters of the enemy of ethical nature.

*Collected Essays*

Evolution And Ethics (p. 75)

Macmillan & Co Ltd. London, England. 1894

### Lynd, Robert Wilson 1879–1949

English writer

It is an engaging problem in ethics whether, if you have been lent a cottage, you have the right to feed the mice.

*The Peal of Bells*

Chapter II (p. 9)

Methuen & Company Ltd. London, England. 1924

### Marshall, T. H.

No biographical data available

Ethical codes are based on the belief that between professional and client there is a relationship of trust, and between buyer and seller there is not.

The Recent History of Professionalism in Relation to Social Structure and Social Philosophy

*Canadian Journal of Economics and Political Science*, V (p. 327)

### Pascal, Blaise 1623–62

French mathematician and physicist

Physical science will not console me for the ignorance of morality in the times of affliction But the science of ethics will always console me for the ignorance of the physical sciences.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section II, 67

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Ethics and science have their own domain which touch but do not interpenetrate. The one shows us to what goal we should aspire, the other, given the goal, teaches us how to attain it. So they can never conflict since they can

never meet. There can no more be immoral science than there can be scientific morals.

*The Foundations of Science*

*The Value of Science*, Introduction (p. 206)

The Science Press. New York, New York, USA. 1913

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

The hope of getting some argument or theory to share our responsibilities is, I believe, one of the basic motives of “scientific” ethics.

*The Open Society and Its Enemies* (Volume 1)

Chapter 5, # 18 (p. 511)

Princeton University Press. Princeton, New Jersey, USA. 1950

### Rowland, Henry Augustus 1848–1901

American physicist

Science may not be able to provide a complete code of ethics, but it does teach that every action carries with it a consequence – not in another world but in this – to be felt either by ourselves or by others, in our own time or the generations to come.

*Discovery, Or, The Spirit and Service of Science*

Chapter III (p. 46)

Macmillan & Co Ltd. London, England. 1916

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

Science can discuss the causes of desires, and the means for realizing them, but it cannot contain any genuinely ethical sentences, because it is concerned with what is true or false.

*Religion and Science*

Science and Ethics (p. 237)

Henry Holt & Company. New York, New York, USA. 1935

Science, by itself, cannot supply us with an ethic. It can show us how to achieve a given end, and it may show us that some ends cannot be achieved.

The Science to Save Us from Science

*The New York Times Magazine*, March 19, 1950

Ethics is in origin the art of recommending to others the sacrifices required for co-operation with oneself.

*Mysticism and Logic: And Other Essays*

Chapter VI (p. 108)

Longmans, Green & Co. London, England. 1919

### Sigma Xi

Whether or not you agree that trimming and cooking are likely to lead on to downright forgery, there is little to support the argument that trimming and cooking are less reprehensible and more forgivable. Whatever the rationalization is, in the last analysis one can no more be a little bit dishonest than one can be a little bit pregnant. Commit any of these three sins and your scientific research career is in jeopardy and deserves to be.

*Honor in Science*

Chapter 3 (p. 14)

New Haven, Connecticut, USA. 1986

**Stackman, Elvin** 1885–1979

American plant pathologist

Science cannot stop while ethics catches up...and nobody should expect scientists to do all the thinking for the country.

U.S. Science Holds Its Biggest Powwow

*Life*, January 9, 1950 (p. 17)

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

...the application of fundamental discoveries in science is altogether too remote for it to be possible to control such discoveries at the source.

*British Association Report*, 1938 (p. 20)

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Ethics are not the result of reflection; they are beautiful nature, created and innate. In a greater or lesser degree they are Nature's gift to all; in a high degree they belong to a few highly-gifted minds.

Translated by Otto Wenckstern

*Goethe's Opinions on the World, Mankind, Literature, Science, and Art* (p. 6)

John W. Parker & Son. London, England. 1853

**Wiener, Norbert** 1894–1964

American mathematician

Those of us who have contributed to the new science of cybernetics thus stand in a moral position which is, to say the least, not very comfortable. We have contributed to the initiation of a new science which...embraces technical developments with great possibilities for good and for evil.

*Cybernetics; Or, Control and Communication in the Animal and the Machine*

Introduction (p. 28)

The MIT Press. Cambridge, Massachusetts, USA. 1961

**Wilson, Edward O.** 1929–

American biologist and author

Scientists and humanists should consider together the possibility that the time has come for ethics to be removed temporarily from the hands of philosophers and biologized.

*Sociobiology: The New Synthesis*

Part III, Chapter 27 (p. 562)

Harvard University Press. Cambridge, Massachusetts, USA. 1975

An enduring environmental ethic will aim to preserve not only the health and freedom of our species, but access to the world in which the human spirit was born.

*The Diversity of Life*

Chapter Fifteen (p. 381)

W.W. Norton & Company, Inc. New York, New York, USA. 1992

## ETHNOLOGIST

**Wallace, Alfred Russel** 1820–1913

English humanist, naturalist, and geographer

...no man can be a good ethnologist who does not travel, and not travel merely, but reside, as I do, months and years with each race ...

*My Life* (Volume 1)

Chapter XXII (p. 366)

George Bell & Sons. London, England. 1905

## ETHNOLOGY

**Fergusson, James** 1808–86

Scottish architectural historian

...Ethnology, based merely on Language and Physiology, is like Geology based only on Mineralogy and Chemistry.

*History of the Modern Styles of Architecture*

Conclusion (p. 494)

John Murray. London, England. 1862

## ETIQUETTE

**Flexner, Abraham** 1866–1959

American educator

It becomes a serious question of professional etiquette, who should speak first or loudest – the pathologist, armed with his microscope, or the clinician, brandishing his stethoscope.... The way to be unscientific is to be partial – whether to the laboratory or to the hospital, it matters not. The test of a good education in medicine is the thorough interpenetration of both standpoints in their product, the young graduate.

*Medical Education in the United States and Canada*

Chapter VI (pp. 91–92)

The Carnegie Foundation. New York, New York, USA. 1910

## EUCLID

**Abbott, Lymon** 1835–1922

American theologian and author

...if you want an infallible book go not to the Bible but to Euclid.

Quoted by G.B. Halsted

The Message of Non-Euclidean Geometry

*Proceedings of the American Association for the Advancement of Science*, December 1903-January 1904 (p. 352)

**Dostoevsky, Fyodor Mikhailovich** 1821–81

Russian novelist

...if God exists and if He really did create the world, then, as we all know, He created it according to the geometry of Euclid and the human mind with the conception of only three dimensions in space. Yet there have been and still are geometers and philosophers, and even some

of the most distinguished, who doubt whether the whole universe, or to speak more widely, the whole of being, was only created in Euclid's geometry; they even dare to dream that two parallel lines, which according to Euclid can never meet on earth, may meet somewhere in infinity. I have come to the conclusion that, since I can't understand even that, I can't expect to understand about God.

*The Brothers Karamazov*

Book V, Chapter 3

The Modern Library. New York, New York, USA. 1950

**Einstein, Albert** 1879–1955

German-born physicist

In your schooldays most of you who read this book made acquaintance with the noble building of Euclid's geometry, and you remember – perhaps with more respect than love – the magnificent structure, on the lofty staircase of which you were chased about for uncounted hours by conscientious teachers.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Part I, Chapter 1 (p. 5)

Pi Press. New York, New York, USA. 2005

**Keyser, Cassius Jackson** 1862–1947

American mathematician

The Elements of Euclid is as small a part of mathematics as the Iliad is of literature; or as the sculpture of Phidias is of the world's total art.

In Columbia University

*Lectures on Science, Philosophy and Art 1907–1908* (p. 8)

New York, New York, USA. 1908

**Lindsay, Vachel** 1879–1931

American poet

Old Euclid drew a circle  
On a sand-beach long ago,  
He bound it and enclosed it  
With angles thus and so.

*The Congo and Other Poems*

Euclid

The Macmillan Company. New York, New York, USA. 1914

**Sylvester, James Joseph** 1814–97

English mathematician

The early study of Euclid made me a hater of Geometry, which I hope may plead my excuse if I have shocked the opinions of any in this room (and I know there are some who rank Euclid as second in sacredness to the Bible alone, and as one of the advanced outposts of the British Constitution) by the tone in which I have previously alluded to it as a school-book...

*The Collected Mathematical Papers of James Joseph Sylvester*

Presidential Address to the British Association (p. 660)

University Press. Cambridge, England. 1904–12

**Turner, H. H. (Herbert Hall)** 1861–1930

English astronomer

When Euclid framed his definitions  
He did not miss "the point";  
Space was prescribed by his conditions  
For angles twain conjoint.

*The Mathematical Gazette*, Volume VI, Number 100, October, 1912

(p. 403)

**EUGENICS**

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

[Eugenics] must be introduced into the national conscience, like a new religion. It has, indeed, strong claim to become an orthodox religious tenet for the future, for Eugenics co-operates with the workings of Nature by securing that humanity shall be represented by the fittest races. What Nature does blindly, slowly and ruthlessly, man must do providently, quickly and kindly.

*Essays in Eugenics*

Eugenics: Its Definition, Scope and Aims (p. 42)

The Eugenics Education Society. London, England. 1909

The creed of eugenics is founded upon the idea of evolution...

*Essays in Eugenics*

Eugenics as a Factor in Religion (p. 68)

The Eugenics Education Society. London, England. 1909

Eugenics is the study of the agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally. The feeble nations of the world are necessarily giving way before the nobler varieties of mankind.

Hereditary Character and Talent

*Macmillan's Magazine*, November, 1864

The chief result of these Inquiries has been to elicit the religious significance of the doctrine of evolution. It suggests an alteration in our mental attitude, and imposes a new moral duty. The new mental attitude is one of a greater sense of moral freedom, responsibility, and opportunity; the new duty which is supposed to be exercised concurrently with, and not in opposition to the old ones upon which the social fabric depends, is an endeavor to further evolution, especially that of the human race.

*Inquiries into Human Faculty and Its Development*

Conclusion (p. 220)

AMS Press. New York, New York, USA. 1973

The publication in 1859 of *The Origin of Species* by Charles Darwin made a marked epoch in my own mental development, as it did in that of human thought generally. Its effect was to demolish a multitude of dogmatic

barriers by a single stroke, and to arouse a spirit of rebellion against all ancient authorities whose positive and unauthenticated statements were contradicted by modern science.

*Memories of My Life*

Chapter 20 (p. 287)

Methuen & Company Ltd. London, England. 1908

## EUREKA

**Archimedes of Syracuse** 287 BCE–212 BCE  
Sicilian mathematician

I have found it!

In Marcus Vitruvius Pollio

Translated by J. Gwilt

*The Architecture of Marcus Vitruvius Pollio*

Book IX, Section 10 (p. 205)

Lockwood & Company. London, England. 1874

**Hawking, Stephen William** 1942–  
English theoretical physicist

There's nothing like the Eureka moment, of discovering something that no one knew before.

Lecture

The Future of Theoretical Physics and Cosmology: Stephen Hawking

60th Birthday Symposium

Stephen Hawking's 60 Years in a Nutshell

January 11, 2002

## EUTHANASIA

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

A recovery in my case, and at my age, is impossible; the kindest wish of my friends is Euthanasia.

In George Atherton Aitken

*The Life and Works of John Arbuthnot, M.D.*

Letter to A. Pope, July 17, 1734 (p. 148)

At The Clarendon Press. Oxford, England. 1892

## EVAPORATION

**Anacreon** 570 BCE–488 BCE  
Greek lyric poet

The sea drinks the air, the sun Drinks the sea,...

Translated by Thomas Stanley

*Anacreon*

The Need of Drinking (p. 23)

Merrill & Baker. New York, New York, USA. 1899

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Evaporation is an unseen heavenward waterfall.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 81)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Dalton, John** 1766–1844  
English chemist and physicist

Evaporation is that process in nature by which water and other liquids are absorbed into the atmosphere, or are converted into elastic fluids, and diffused through the atmosphere; the liquid thus changed, is termed vapour, and the vapour is characterized by the name of the liquid from which it was generated, as aqueous vapour, or the vapour derived from water, &c.

*Meteorological Observations and Essays* (2nd edition)

Sixth Essay (p. 125)

Printed by Harrison & Crosfield. Manchester, England. 1834

**Warren, Henry White** 1831–1912  
Teacher, lecturer, and author

The sunshine says to the sea, held in the grasp of gravitation, "Rise from your bed! Let millions of tons of water fly on the wings of the viewless air, hundreds of miles to the distant mountains, and pour there those millions of tons that shall refresh a whole continent, and shall gather in rivers fitted to bear the commerce and the navies of nations." Gravitation says, "I will hold every particle of this ocean as near the centre of the earth as I can." Sunshine speaks with its word of power, and says, "Up and away!" And in the wreathing mists of morning these myriads of tons rise in the air, flyaway hundreds of miles, and supply all the Niagaras, Mississippis and Amazons of earth. The sun says to the earth, wrapped in the mantle of winter, "Bloom again;" and the snows melt, the ice retires, and vegetation breaks forth, birds sing, and spring is about us.

*Recreations in Astronomy*

Chapter II (p. 36)

Chautauqua Press. New York, New York, USA. 1886

## EVENT

### Charlie Chan (Fictional character)

Strange events permit themselves the luxury of occurring in strange places.

*The Chinese Ring*

Film (1944)

**Einstein, Albert** 1879–1955  
German-born physicist

...one must first know an event before one can test a theory related to this event.

In Carola Baumgardt

*Johannes Kepler: Life and Letters*

Introduction (p. 10)

Philosophical Library. New York, New York, USA. 1951

**Ferguson, Kitty**  
Science writer

Events in the heavens happen in their own good time and not before, and they are often not repeatable. Astronomers



have learned to take what's an offer and make the best of it.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*

Prologue (p. 4)

Walker & Company. New York, New York, USA. 1999

**Keyser, Cassius Jackson** 1862–1947

American mathematician

In the whole universe of events, none is more wonderful than the birth of wonder, none more curious than the nascence of curiosity itself, nothing to compare with the dawning of consciousness in the ancient dark and the gradual extension of psychic life and illumination throughout a cosmos that before had only been.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

The Universe and Beyond (p. 127)

Columbia University Press. New York, New York, USA. 1916

**Milne, Edward Arthur** 1896–1950

English astrophysicist and cosmologist

Not only the laws of nature, but also the events occurring in nature, the world itself, must appear the same to all observers, wherever they may be.

*Zeitschrift für Betriebswirtschaft*, Volume 6, 1933 (p. 1)

**Payne-Gaposchkin, Cecilia** 1900–79

British-American astronomer

The cosmic drama is played out on a vast scale in time and space. The mind, moving “on wings as swift as meditation,” perceives today the events that were passing at the bounds of the observable universe several thousand million years ago – events of which the news has just reached us, carried with the speed of light. Some of these events seem foreign to us, like the customs of a distant land. They may stem from a different stage of development. We catch a glimpse of the drama that is being played out on the fringes of the world, and they carry a suggestion of the Theater of the Absurd.

*Stars and Clusters*

Chapter I (p. 1)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Whewell, William** 1794–1866

English philosopher and historian

All external objects and events which we can contemplate are viewed as having relations of Space, Time, and Number; and are subject to the general conditions which these Ideas impose, as well as to the particular laws which belong to each class of objects and occurrences.

*History of Scientific Ideas: Being the First Part of The Philosophy of the* (Volume 1) (3rd edition)

Part I, Book II, Chapter I (p. 88)

John W. Parker & Son. London, England. 1858

## EVERYTHING

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

We ourselves, and with each other by our converse, can create, not an architecture of global scope, but an immense, intricate network of intimacy, illumination, and understanding. Everything cannot be connected with everything in the world we live in. Everything can be connected with anything.

*The Growth of Science and the Structure of Culture*

*Daedalus*, Winter 1958 (p. 76)

## EVIDENCE

**Childe, V. Gordon** 1892–1957

Australian philologist

Almost every statement in prehistory should be qualified by the phrase: ‘On the evidence available today the balance of probability favors the view that’.

*Man Makes Himself*

Preface (p. 5)

Lo 1936

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

I see no sense in publishing a condensation of papers in which I went to so much trouble to discuss the subject in detail. I should have to omit all my evidence and rely on a type of categorical statement which would not make my results any easier to understand. The characteristic ruminant activity of ungulate animals, which consists in the regurgitation of what has already been chewed over, is anything but stimulating to my appetite...

*Memories, Dreams, Reflections*

Introduction (pp. xiii)

Vintage Books. New York, New York, USA. 1963

**Mackin, J. Hoover** 1905–68

American geologist

...evidence is hard to come by, it is largely circumstantial, and there is never enough of it.

In Claude C. Albritton

*The Fabric of Geology*

Rational and Empirical Methods of Investigation in Geology (pp. 159–160)

Addison-Wesley Publishing Company, Inc. Reading, Massachusetts, USA. 1963

**Pasteur, Louis** 1822–95

French chemist

...I am the most hesitating of men, the most fearful of committing myself when I lack evidence. But on the

contrary, no consideration can keep me from defending what I hold as true when I can rely on solid scientific evidence.

In Rene Dubos

*Louis Pasteur: Free Lance of Science*

Chapter III (p. 76)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Sagan, Carl** 1934–96

American astronomer and author

I believe that the extraordinary should certainly be pursued. But extraordinary claims require extraordinary evidence.

*Broca's Brain: Reflections on the Romance of Science*

Part II, Chapter 5 (p. 62)

Random House, Inc. New York, New York, USA. 1979

**Shapiro, Robert** 1935–

DNA researcher

The mere statement that something is true need not be considered evidence in its favor no matter how many voices join in the chorus.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*

Chapter One (p. 34)

Summit Books. New York, New York, USA. 1986

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

It was not my opinion; I think there is no sense in forming an opinion when there is no evidence to form it on. If you build a person without any bones in him he may look fair enough to the eye, but he will be limber and cannot stand up; and I consider that evidence is the bones of an opinion.

*Personal Recollections of Joan of Arc*

Chapter II (pp. 8–9)

Oxford University Press, Inc. New York, New York, USA. 1996

## EVOLUTION

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Has joy any survival value in the operations of evolution? I suspect that it does; I suspect that the morose and fearful are doomed to quick extinction.

*Desert Solitaire*

Water (p. 143)

Ballantine Books. New York, New York, USA. 1968

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Many were increasingly of the opinion that they'd all made a big mistake in coming down from the trees in the first place. And some said that even the trees had been a bad move, and that no one should ever have left the oceans.

*So Long, and Thanks for All the Fish*

Harmony Books. New York, New York, USA. 1984

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born U.S. naturalist, geologist, and teacher

It is not true that a slight variation among the successive offspring of the same stock goes on increasing until the difference amounts to a specific distinction. On the contrary, it is a matter of fact that extreme variations finally degenerate or become sterile; like monstrosities they die out, or return to their type.

Evolution and Permanence of Type

*The Atlantic Monthly*, January, 1874

**Allen, Grant** 1848–99

Naturalist

In the mud of the Cambrian main

Did our earliest ancestors dive;

From a shapeless, albuminous grain

We mortals are being derived.

*The Evolutionist at Large*

A Ballade of Evolution

Chatto & Windus. London, England. 1881

**Aquinas, St. Thomas** 1227?–74

Dominican philosopher and theologian

We see that things which lack intelligence, such as natural bodies, act for an end, and this is evident from their acting always, or nearly always, in the same way, so as to obtain the best result. Hence it is plain that not fortuitously, but designedly, do they achieve their end. Now whatever lacks intelligence cannot move towards an end, unless it be directed by some being endowed with knowledge and intelligence; as the arrow is shot to its mark by the archer. Therefore some intelligent being exists by whom all natural things are directed to their end; and this being we call God.

*Summa Theologia*

eq. 2, art. 3

H. Regnery Company. Chicago, Illinois, USA. 1966

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Observe constantly that all things take place by change, and accustom thyself to consider that the nature of the Universe loves nothing so much as to change the things which are, and to make new things like them.

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, #36 (p. 266)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Nature which governs the whole will soon change all things which thou seest, and out of their substance will make other things, and again other things from the substance of them, in order that the world may be ever new.

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book VII, #25 (p. 281)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

But anyone who properly considers the subject, will find natural philosophy to be, after the word of God, the surest remedy against superstition, and the most approved support of faith. She is therefore rightly bestowed upon religion as a most faithful attendant, for the one exhibits the will and the other the power of God. Nor was he wrong who observed, “Ye err, not knowing the Scriptures and the power of God;” thus uniting in one bond the revelation of his will, and the contemplation of his power.

In *Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 89 (p. 124)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Let us begin from God, and show that our pursuit from its exceeding goodness clearly proceeds from him, the Author of good and Father of light.

In *Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 93 (p. 125)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bak, Per** 1947–2003

Physicist

History, including that of evolution, is just “one damned thing after another.” We can explain in hindsight what has happened, but we cannot predict what will happen in the future. The Danish philosopher Soren Kierkegaard expressed the same view in his famous phrase “Life is understood backwards, but must be lived forwards.”

*How Nature Works: The Science of Self-Organized Criticality*

Chapter 1 (pp. 7–8)

Springer-Verlag. New York, New York, USA. 1996

**Barbellion, Wilhelm Nero Pilate** 1889–1919

English author

How I hate the man who talks about the “brute creation,” with an ugly emphasis on brute.... As for me, I am proud of my close kinship with other animals. I take a jealous pride in my Simian ancestry. I like to think that I was once a magnificent hairy fellow living in the trees, and that my frame has come down through geological time via sea jelly and worms and Amphioxus, Fish, Dinosaurs, and Apes. Who would exchange these for the pallid couple in the Garden of Eden?

In Clarence Day, Jr.

*This Simian World*

Frontispiece

Alfred A. Knopf. New York, New York, USA. 1941

**Bates, Henry Walter** 1825–92

English naturalist and explorer

...on these expanded membranes [*i.e.*, butterfly wings] Nature writes, as on a tablet, the story of the modifications of species.... As the laws of nature must be the

same for all beings, the conclusions furnished by this group of insects must be applicable to the whole organic world...

*The Naturalist on the River Amazons* (Volume 2)

Chapter V (p. 346)

John Murray. London, England. 1863

**Bateson, William** 1861–1926

English biologist and geneticist

Modern research lends not the smallest encouragement or sanction to the view that gradual evolution occurs by the transformation of masses of individuals, though that fancy has fixed itself on popular imagination.

Address of the President of the British Association for the Advancement of Science, August 14, 1914

[T]hough we must hold to our faith in the evolution of species, there is little evidence as to how it has come about, and no clear proof that the process is continuing in any considerable degree at the present time.

Address of the President of the British Association for the Advancement of Science, August 20, 1914

It is easy to imagine how Man was evolved from an Amoeba, but we cannot form a plausible guess as to how *Veronica agrestis* and *Veronica polita* were evolved, either one from the other, or both from a common form. We have not even an inkling of the steps by which a Silver Wyandotte fowl descended from *Gallus bankiva*, and we can scarcely even believe that it did.

In J. Arthur Thomson

*Concerning Evolution*

Chapter II, Section 11 (p. 99)

Yale University Press. New Haven, Connecticut, USA. 1925

Every theory of evolution must be such as to accord with the facts of physics and chemistry, a primary necessity to which our predecessors paid small heed. For them the unknown was a rich mine of possibilities on which they could freely draw. For us it is rather an impenetrable mountain out of which the truth can be chipped in rare and isolated fragments.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1915)

Heredity (p. 366)

Government Printing Office. Washington, D.C. 1916

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

If single acts [of creation] would evince design, how much more a vast universe, that by inherent laws gradually builded itself, and then created its own plants and animals, a universe so adjusted that it left by the way the poorest things, and steadily wrought toward more complex, ingenious, and beautiful results! Who designed this mighty machine, created matter, gave to it its laws, and impressed upon it that tendency which has brought forth the almost infinite results on the globe, and wrought them

into a perfect system? Design by wholesale is grander than design by retail.

*Evolution and Religion*

Part I

Divine Providence and Design (p. 115)

Fords, Howard & Hulbert. New York, New York, USA. 1885

**Behe, Michael** 1952–

American biochemist, author, and proponent of “intelligent design”

By irreducibly complex I mean a single system composed of several well-matched, interacting parts that contribute to the basic function, wherein the removal of anyone of the parts causes the system to effectively cease functioning. An irreducibly complex system cannot be produced directly (that is, by continuously improving the initial function, which continues to work by the same mechanism) by slight, successive modification of a precursor, system, because any precursors to an irreducibly complex system that is missing a part is by definition nonfunctional.

*Darwin's Black Box*

Chapter 2 (p. 39)

The Free Press. New York, New York, USA. 1996

In the abstract, it might be tempting to imagine that irreducible complexity simply requires multiple simultaneous mutations – that evolution might be far chancier than we thought, but still possible. Such an appeal to brute luck can never be refuted. . . . Luck is metaphysical speculation; scientific explanations invoke causes.

*Darwin's Black Box*

Chapter 2 (p. 40)

The Free Press. New York, New York, USA. 1996

In the face of the enormous complexity that modern biochemistry has uncovered in the cell, the scientific community is paralyzed. No one at Harvard University, no one at the National Institutes of Health, no member of the National Academy of Sciences, no Nobel prize winner – no one at all can give a detailed account of how the cilium, or vision, or blood clotting, or any complex biochemical process might have developed in a Darwinian fashion.

*Darwin's Black Box*

Chapter 9 (p. 187)

The Free Press. New York, New York, USA. 1996

...some proponents [of artificial life] see great significance in the fact that they can write short computer programs which display images on the screen that resemble biological objects such as a clam shell. The implication is that it doesn't take much to make a clam. But a biologist or biochemist would want to know, if you opened the computer clam, would you see a pearl inside? If you enlarged the image sufficiently, would you see cilia and ribosomes and mitochondria and intracellular transport systems and all the other systems that real, live organisms need?

*Darwin's Black Box*

Chapter 9 (p. 191)

The Free Press. New York, New York, USA. 1996

**Bergson, Henri** 1859–1941

French philosopher

...evolution does not mark out a solitary route...it takes directions without aiming at ends, and...it remains inventive even in its adaptations.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter II (p. 108)

The Modern Library. New York, New York, USA. 1944

**Berra, Tim M.** 1943–

Professor Emeritus of Evolution, Ecology and Organismal Biology

They [Fundamentalists] long for the return of a more moral America, an America that may never have been. All around them they see what they perceive as declining morality and spirituality. They reason that if humans share ancestry with the other animals, we have no reason to behave as anything other than animals. This view neglects the fact that humans are the only known animals with the ability to contemplate the consequences of their own actions. It also fails to recognize that there is a great deal of good in the world, the nightly news notwithstanding. Crime existed long before the theory of evolution, even before the writing of the Bible, and biologists do not like crime anymore than the creationists do. Evolutionary theory is not a license to run amok, and neither is a belief in the literal interpretation of the Bible a guarantor of moral behavior.

*Evolution and the Myth of Creationism*

Chapter 5 (p. 143)

Stanford University Press. Stanford, California, USA. 1990

**Borland, Hal** 1900–78

American writer

Evolution is not a straight-line process, like industrial manufacturing. If it were, the old models would be discontinued entirely and only the very newest ones would be made. If that were true in nature, creatures without backbones would have vanished when vertebrates evolved, fish would have vanished when amphibians evolved, amphibians would have vanished when reptiles came along, and reptiles would have vanished when the birds and mammals came along.

*The Enduring Pattern*

Life – Flesh and Blood: Reptiles (p. 189)

Simon & Schuster. New York, New York, USA. 1959

**Bounoure, Louis**

No biographical data available

Evolutionism is a fairy tale for grown-ups. This theory has helped nothing in the progress of science. It is useless.

*The Advocate*, March 8, 1984 (p. 17)

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

It is clear that for his own welfare man must first alter his thinking about nature and himself. He must realize that the gods are not unanimous in the desire to elevate any creature to Olympus.

*Parade of the Living*  
Part III, Chapter XX (p. 278)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Brenner, Sydney** 1927–  
South African-born English molecular biologist

Anything that is produced by evolution is bound to be a bit of a mess.

In Roger Lewin  
Why Is Development So Illogical?  
*Science*, Volume 224, Number 4655, 22 June, 1984 (p. 1328)

**Brown, Relis B.**  
No biographical data available

The piecing together of the evolution story is comparable to the reconstruction of an atom-bombed metropolitan telephone exchange by a child who has only seen a few telephone receivers.

*Biology* (p. 531)  
D.C. Heath & Company. Boston, Massachusetts, USA. 1961

**Bryan, William Jennings** 1860–1925  
American lawyer, orator, and politician

All the ills from which America suffers can be traced back to the teaching of evolution. It would be better to destroy every other book ever written, and save just the first three verses of Genesis.

In Richard Hofstadter  
*Anti-Intellectualism in American Life*  
Chapter V (p. 125)  
Alfred A. Knopf. New York, New York, USA. 1963

**Bulgakov, Mikhail** 1891–1940  
Russian novelist and playwright

Oh, what a marvelous affirmation of evolutionary theory!  
Oh, what a great chain extends from a dog to Mendeleev the chemist!

In Michael D. Gordin  
*A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table*  
Chapter 1 (p. 3)  
Basic Books. New York, New York, USA. 2004

**Burroughs, John** 1837–1921  
American naturalist and writer

Invisible, impalpable forces streaming around us and through us; perpetual change and transformation on every hand; every day a day of creation, every night a revelation of unspeakable grandeur; suns and systems forming in the cyclones of stardust; the whole starry host of heavens flowing like a meadow brook.

In Frances Mason  
*Creation by Evolution*  
Why Must We Be Evolutionists? (p. 23)  
The Macmillan Company. New York, New York, USA. 1928

Evolution is not a mere process; it is a progress; it is not a circle, but a spiral.

*Under The Apple Tree*  
A Prophet of the Soul (p. 226)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

[An] organism must act in one or other of these two ways: It must either change slowly and continuously with the surroundings, paying cash for everything, meeting the smallest change with a corresponding modification so far as is found convenient; or it must put off change as long as possible, and then make larger and more sweeping changes.

*God the Known and God the Unknown*  
Introduction (p. 14)  
Yale University Press. New Haven, Connecticut, USA. 1917

**Calvino, Italo** 1923–1985  
Italian writer and novelist

When you're young, all evolution lies before you, every road is open to you, and at the same time you can enjoy the fact of being there on the rock, flat mollusk-pulp, damp and happy. If you compare yourself with the limitations that come afterwards, if you think of how having one form excludes other forms, of the monotonous routine where you finally feel trapped, well, I don't mind saying life was beautiful in those days.

Translated by William Weaver  
*Cosmicomics*  
The Spiral (p. 142)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1965

**Campbell, J. H.**  
No biographical data available

In fact, nearly every scientist who has written on the general subject of evolution has felt compelled to show how deftly he can skate toward the abyss of teleology without falling in.

In D.J. Depew and B.H. Weaver (eds.)  
*Evolution at a Crossroads: The New Biology and the New Philosophy of Science*  
An Organizational Interpretation of Evolution (p. 163)  
MIT Press. Cambridge, Massachusetts, USA. 1985

**Carpenter, William Benjamin** 1813–85  
English physiologist and naturalist

...when the doctrine of evolution is looked at in its moral aspect, as one which leads man ever onwards and upwards, and which encourages his brightest anticipations of the ultimate triumph of truth over error, of knowledge over ignorance, of right over wrong, of good over



evil, who shall presume to say that the convergence of all these great lines of thought, each of them the resultant of the patient toil of a whole army of scientific workers, is a fact of no account?

*Nature and Man: Essays Scientific and Philosophical*  
Essays, VII (pp. 237–238)  
Kegan Paul, Trench & Co. London, England. 1888

**Carruth, William Herbert** 1859–1924  
American poet

A fire-mist and a planet,  
A crystal and a cell,  
A jelly-fish and a saurian,  
And caves where the  
cave-men dwell;  
Then a sense of law  
and beauty  
And a face turned from the clod –  
Some call it Evolution,  
And others call it  
God.

*Each in His Own Tongue*  
Wise-Parslow Company. New York, New York, USA. 1925

**Carson, Rachel** 1907–64  
American marine biologist and author

It is true that I accept the theory of evolution as the most logical one that has ever been put forward to explain the development of living creatures on this earth. As far as I am concerned, however, there is absolutely no conflict between a belief in evolution and a belief in God as the creator. Believing as I do in evolution, I merely believe that is the method by which God created, and is still creating, life on earth. And it is a method so marvelously conceived that to study it in detail is to increase – and certainly never to diminish – one’s reverence and awe both for the Creator and the process.

In Paul Brooks  
*The House of Life: Rachel Carson at Work*  
The Writer and His Subject (p. 9)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1972

**Cecil, Hugh Mortimer** 1868–1959  
No biographical data available

The theory of evolution having conquered the intelligence of the whole of the civilised world, even theologians have no longer the hardihood to deny its truth; and the old weapon of persecution no longer lying, ready to their hand, they have adopted the new method of stealing their opponents thunder.

*Pseudo-philosophy at the End of the Nineteenth Century*  
Introduction (p. 4)  
The University Limited  
London, England. 1897

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English writer

Man is not merely an evolution but rather a revolution. That he has a backbone or other parts upon a similar pattern to birds and fishes is an obvious fact, whatever be the meaning of the fact. But if we attempt to regard him, as it were, as a quadruped standing on his hind legs, we shall find what follows far more fantastic and subversive than if he were standing on his head.

*The Everlasting Man*  
Chapter I (p. 6)  
Dodd, Mead & Company. New York, New York, USA. 1925

There may be a broken trail of stones and bones faintly suggesting the development of the human body. There is nothing even faintly suggesting such a development of this human mind.

*The Everlasting Man*  
Chapter I (p. 22)  
Dodd, Mead & Company. New York, New York, USA. 1925

...the dogmatism of Darwinians has been too strong for the agnosticism of Darwin; and men have insensibly fallen into turning this entirely negative term [the “Missing Link”] into a positive image. They talk of searching for the habits and habitat of the Missing Link; as if one were to talk of being on friendly terms with the gap in a narrative or the hole in an argument, of taking a walk with a *non-sequitur* or dining with an undistributed middle.

*The Everlasting Man*  
Chapter II (p. 27)  
Dodd, Mead & Company. New York, New York, USA. 1925

**Coleridge, Stephen** 1854–1936  
English author, barrister and opponent of vivisection

An hypothesis nothing more is advanced by the scientific that man is no more than an improved arboreal ape, and all the bishops, priests and deacons tumble over one another in their haste to endorse the degrading doctrine and to accept a gorilla as the origin of mankind.

*The Idolatry of Science*  
Chapter II (pp. 8–9)  
John Lane Co. London, England. 1920

**Collins, Mortimer** 1827–76  
English writer and novelist

There was an Ape in the days that were earlier;  
Centuries passed and his hair became curlier;  
Centuries more gave a thumb to his wrist –  
Then he was Man – and a Positivist.

*Selections from the Poetical Works of Mortimer Collins*  
The Posit  
Stanza 5  
Richard Bently & Son. London, England. 1886



**Coulter, John Merle** 1851–1928  
American botanist and educator

The meaning of evolution is probably more misunderstood than any doctrine of science. The reason is that it has been discussed very freely by those who are not informed, and in this way much misinformation has been propagated.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1926)

The History of Organic Evolution (p. 319)  
Government Printing Office. Washington, D.C. 1927

**Cousteau, Jacques-Yves** 1910–77  
French naval officer and ocean explorer

The story of evolution is probably the most fascinating of all we have to tell because it reaches into our very fiber. It ties all forms of life together and provides us with a common bond to plants and animals. Basically, we are composed of the same substances and possess the same basic drives, making us all brothers in a cosmic experiment. Astronomers tell us that the earth should continue to exist another five billion years. Since life has only been around for three billion years, we are still in our youth. The insights gained through the study of evolution will assure us a future and allow us to determine our destiny.

*The Ocean World of Jacques Cousteau: The Adventure of Life*  
Introduction (p. 9)

The World Publishing Company. New York, New York, USA. 1973

**Crick, Francis Harry Compton** 1916–2004  
English molecular biologist, physicist, and neuroscientist

The age of the earth is now established beyond any reasonable doubt as very great, yet in the USA millions of Fundamentalists still stoutly defend the naive view that it is relatively short, an opinion deduced from reading the Christian Bible too literally. They also usually deny that animals and plants have evolved and changed radically over such long periods, although this is equally well established. This gives one little confidence that what they have to say about the process of natural selection is likely to be unbiased, since their views are predetermined by a slavish adherence to religious dogmas.

*The Astonishing Hypothesis: The Scientific Search for the Soul*  
Chapter 18 (pp. 261–262)

Charles Scribner's Sons. New York, New York, USA. 1994

Every time I write a paper on the origin of life, I determine I will never write another one, because there is too much speculation running after too few facts.

*Life Itself: Its Origin and Nature* (p. 153)

Simon & Schuster. New York, New York, USA. 1981

I have no doubt, as will emerge later, that this loss of faith in Christian religion and my growing attachment to science plays a dominant part in my scientific career, not so much on a day-to-day basis but in the choice of what I have considered interesting and important.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 1 (p. 11)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

Biologists must constantly keep in mind that what they see was not designed, but rather evolved. It might be thought, therefore, that evolutionary arguments would play a large part in guiding biological research, but this is far from the case. It is difficult enough to study what is happening now. To figure out exactly what happened in evolution is even more difficult. Thus evolutionary achievements can be used as hints to suggest possible lines of research, but it is highly dangerous to trust them too much.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (pp. 138–139)

Basic Books, Inc. New York, New York, USA. 1988

**Crothers, Samuel McChord** 1857–1927  
American clergyman and writer

Evolution is a cosmic game of Pussy wants a corner. Each creature has its eye on some snug corner where it would rest in peace. Each corner is occupied by some creature that is not altogether satisfied and that is on the lookout for a larger sphere. There is much beckoning between those who are desirous of making a change. Now and then some bold spirit gives up his assured position and scrambles for something better. The chances are that the adventurer finds it harder to attain the coveted place than he thought.

*The Gentle Reader*

The Mission of Humor (pp. 68–69)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Darwin, Charles Robert** 1809–82  
English naturalist

...the expression often used by Mr. Herbert Spencer of the Survival of the Fittest is more accurate, and is sometimes equally convenient.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*  
Chapter III (p. 32)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*  
Chapter XV (p. 243)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter XV (p. 243)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.

*The Origin of Species*  
 Chapter XV (pp. 528–529)  
 P.F. Collier & Son. New York, New York, USA. 1909

On the same principle, if a man were to make a machine for some special purpose but were to use old wheels, springs and pulleys, only slightly altered, the whole machine, with all its parts, might be said to be specially contrived for its present purpose. Thus throughout nature almost every part of each living being has probably served, in a slightly modified condition, for diverse purposes, and has acted in the living machinery of many ancient and distinct specific forms.

*The Works of Charles Darwin* (Volume 17)  
*The Various Contrivances by Which Orchids Are Fertilized by Insects*  
 Chapter IX (p. 283)  
 New York University Press. New York, New York, USA. 1987

For my own part I would as soon be descended from that heroic little monkey, who braved his dreaded enemy in order to save the life of his keeper, or from that old baboon, who descending from the mountains, carried away in triumph his young comrade from a crowd of astonished dogs – as from a savage who delights to torture his enemies, offers up bloody sacrifices, practises infanticide without remorse, treats his wives like slaves, knows no decency, and is haunted by the grossest superstitions.

In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
 Part III, Chapter XXI (pp. 596–597)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact of his having thus risen, instead of having been aboriginally placed there, may give him hope for a still higher destiny in the distant future. But we are not here concerned with hopes or fears, only with the truth as far as our reason permits us to discover it; and I have given the evidence to the best of my ability.

In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
 Part III, Chapter XXI (p. 597)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I am actually weary of telling people that I do not pretend to adduce direct evidence of one species changing into another, but I believe that this view is in the main correct, because so many phenomena can thus be grouped and explained.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
 Letter 124, Darwin to F.W. Hutton, April 20, 1861 (p. 184)  
 D. Appleton & Company. New York, New York, USA. 1903

## **Darwin, Erasmus** 1731–1802

English physician and poet

“The world has been evolved, not created: it has arisen little by little from a small beginning, and has increased through the activity of the elemental forces embodied in itself, and so has rather grown than come into being at an almighty word.” What a sublime idea of the infinite might of the great Architect, the Cause of all causes, the Father of all fathers, the Ens Entium! For if we would compare the Infinite, it would surely require a greater Infinite to cause the causes of effects than to produce the effects themselves.

In George Bernard Shaw  
*Back to Methuselah*  
 Preface (p. xx)  
 Constable & Company Ltd. London, England. 1921

All animals undergo perpetual transformations; which are in part produced by their own exertions...and many of these acquired forms or propensities are transmitted to their posterity.

*Zoonomia* (Volume 1)  
 Section XXXIX.4 (p. 502)  
 Printed for J. Johnson. London, England. 1794

... would it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine, that all warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end!

*Zoonomia* (Volume 1)  
 Section XXXIX.4 (p. 505)  
 Printed for J. Johnson. London, England. 1794

## **Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

The account of the origin of life that I shall give is necessarily speculative; by definition, nobody was around to see what happened.

*The Selfish Gene*  
 Chapter 2 (p. 15)  
 Oxford University Press, Inc. Oxford, England. 1976

Evolution is very possibly not, in actual fact, always gradual. But it must be gradual when it is being used to explain the coming into existence of complicated, apparently designed objects, like eyes. For if it is not gradual in these cases, it ceases to have any explanatory power at all. Without gradualness in these cases, we are back to miracle, which is simply a synonym for the total absence of explanation.

*River Out of Eden: A Darwinian View of Life*  
Chapter 3 (p. 83)  
Basic Books. New York, New York, USA. 1995

Biology is the study of complicated things that give the appearance of having been designed for a purpose.

*The Blind Watchmaker*  
Chapter 1 (p. 1)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

...Darwin made it possible to be an intellectually fulfilled atheist.

*The Blind Watchmaker*  
Chapter 1 (p. 6)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

In the Cambrian strata of rocks, vintage about 600 million years, are the oldest ones in which we find most of the major invertebrate groups. And we find many of them already in an advanced state of evolution, the very first time they appear. It is as though they were just planted there, without any evolutionary history. Needless to say, this appearance of sudden planting has delighted creationists.

*The Blind Watchmaker*  
Chapter 9 (p. 229)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

For Darwin, any evolution that had to be helped over the jumps by God was no evolution at all. It made a nonsense of the central point of evolution.

*The Blind Watchmaker*  
Chapter 9 (p. 249)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

My argument will be that Darwinism is the only known theory that is in principle capable of explaining certain aspects of life. If I am right it means that, even if there were no actual evidence in favor of Darwinian theory (there is, of course) we should still be justified in preferring it over all rival theories.

One way to dramatize this point is to make a prediction. I predict that, if a form of life is ever discovered in another part of the universe, however outlandish and weirdly alien that form of life may be in detail, it will be found to resemble life on earth in one key respect: it will have evolved by some kind of Darwinian natural selection.

*The Blind Watchmaker*  
Chapter 11 (pp. 287–288)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

The more statistically improbable a thing is, the less can we believe that it just happened by blind chance. Superficially the obvious alternative to chance is an intelligent

Designer. But Charles Darwin showed how it is possible for blind physical forces to mimic the effects of conscious design, and, by operating as a cumulative filter of chance variations, to lead eventual to organized and adaptive complexity, to mosquitoes and mammoths, to humans and therefore, indirectly, to books and computers. Darwin's theory is now supported by all the available relevant evidence, and its truth is not doubted by any serious modern biologist.

*The Necessity of Darwinism*  
*New Scientist*, Volume 94, 15 April, 1982 (p. 130)

I want to return now to the charge that science is just a faith. The more extreme version of that charge – and one that I often encounter as both a scientist and a rationalist – is an accusation of zealotry and bigotry in scientists themselves as great as that found in religious people. Sometimes there may be a little bit of justice in this accusation.

*The Humanist*  
*Is Science a Religion?*, January, 1997

**Day, Clarence S.** 1874–1935  
American writer

As to modesty and decency, if we are simians we have done well, considering: but if we are something else – fallen angels – we have indeed fallen far.

*This Simian World*  
Chapter Thirteen (p. 75)  
Alfred A. Knopf. New York, New York, USA. 1941

**Denton, Michael J.** 1943–  
British-Australian molecular biologist

Protein molecules are the ultimate stuff of life. If we think of the cell as being analogous to a factory, then the proteins can be thought of as analogous to the machines on the factory floor which carry out individually or in groups of all the essential activities on which the life of the cell depends. Each protein is a sort of micro-miniaturized machine, so small that it must be magnified a million times before it is visible to the human eye. The structure and functioning of these fascinating work horses of the cell was a complete mystery until the 1950s.

*Evolution: A Theory in Crisis*  
Chapter 10 (p. 234)  
Adler & Adler. Bethesda, Maryland, USA. 1986

No living system can be thought of as being primitive or ancestral with respect to any other system, nor is there the slightest empirical hint of an evolutionary sequence among all the incredibly diverse cells on earth.

*Evolution: A Theory in Crisis*  
Chapter 11 (p. 250)  
Adler & Adler. Bethesda, Maryland, USA. 1986

Molecular biology has shown that even the simplest of all living systems on the earth today, bacterial cells, are exceedingly complex objects. Although the tiniest bacterial cells are incredibly small, weighing less than 10–12 g,

each is in effect a veritable micro-miniaturized factory containing thousands of exquisitely designed pieces of intricate molecular machinery, made up altogether of one hundred thousand million atoms, far more complicated than any machine built by man and absolutely without parallel in the nonliving world.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 250)

Adler & Adler. Bethesda, Maryland, USA. 1986

Considering the way the prebiotic soup is referred to in so many discussions of the origin of life as an already established reality, it comes as something of a shock to realize that there is absolutely no positive evidence for its existence.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 261)

Adler & Adler. Bethesda, Maryland, USA. 1986

The complexity of the simplest known type of cell is so great that it is impossible to accept that such an object could have been thrown together suddenly by some kind of freakish, vastly improbable, event. Such an occurrence would be indistinguishable from a miracle.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 264)

Adler & Adler. Bethesda, Maryland, USA. 1986

The impossibility of gradual functional transformation is virtually self-evident in the case of proteins: mere causal observation reveals that a protein is an interacting whole, the function of every amino acid being more or less (like letters in a sentence or cogwheels in a watch) essential to the function of the entire system. To change, for example, the shape and function of the active site (like changing the verb in a sentence or an important cogwheel in a watch) in isolation throughout the molecule, destabilizing the whole system and rendering it useless.

*Evolution: A Theory in Crisis*

Chapter 13 (p. 321)

Adler & Adler. Bethesda, Maryland, USA. 1986

When a number of enzymes are necessary for the assembly of a particular compound, they are arranged adjacent to each other so that, after each step in the operation, the partially completed compound can be conveniently passed to the next enzyme which performs the next chemical operation and so on until the compound is finally assembled. The process is so efficient that some compounds can be assembled in less than a second, while in many cases the same synthetic operations carried out by chemists, even in a well-equipped lab, would take several hours or days or even weeks.

*Evolution: A Theory in Crisis*

Chapter 14 (p. 334)

Adler & Adler. Bethesda, Maryland, USA. 1986

At the heart of the problem lay a seeming paradox – proteins can do many things, but they cannot perform

the function of storing and transmitting information for their own construction. On the other hand, DNA can store information, but cannot manufacture anything nor duplicate itself. So DNA needs proteins and proteins need DNA. A seemingly unbreakable cycle – the ultimate chicken-and-egg problem.

*Nature's Destiny: How the Laws of Biology Reveal Purpose In the Universe*

Part 2, Chapter 12 (p. 293)

The Free Press, New York, New York, USA; 1998

### **DeVore, Irvén** 1934–

American anthropologist

I personally cannot discern a shred of evidence for “[intelligent] design.” If 97% of all creatures have gone extinct, some plan isn’t working very well!

Presentation

Cosmic Questions, Conference, Smithsonian Institute, April, 1999

### **Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

The faster death goes, the faster evolution goes.

*Pilgrim at Tinker Creek*

Chapter 10, II (p. 175)

Harper’s Magazine Press. New York, New York, USA. 1974

### **Disraeli, Benjamin, First Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

What is the question now placed before society with the glib assurance which to me is most astonishing? That question is this: Is man an ape or an angel? I, my lord, I am on the side of the angels. I repudiate with indignation and abhorrence those new fangled theories.

Speech

Oxford Diocesan Conference, 25 November, 1864

You know, all is development. The principle is perpetually going on. First, there was nothing, then there was something; then – I forget the next – I think there were shells, then fishes; the we came – let me see – did we come next? Never mind that; we came at last. And at the next change there will be something very superior to us – something with wings. Ah! That’s it: we were fishes, and I believe we shall be crows.

*Tancred*

Book I, Chapter IX

H. Colburn. London, England. 1847

### **Dobzhansky, Theodosius** 1900–75

Russian-American scientist

The long pageant of evolution extending over one billion years appears to have been brought about by fundamental causes which are still in operation and which can be experimented with today.

*Genetics and The Origin of Species*

Preface to the Third Edition (p. ix)

Columbia University Press. New York, New York, USA. 1951

### Nothing in Biology Makes Sense Except in the Light of Evolution

Title of article

*The American Biology Teacher*, Volume 35, March, 1973 (p. 125)

Seen in the light of evolution, biology is, perhaps, intellectually the most satisfying and inspiring science. Without that light it becomes a pile of sundry facts – some of them interesting or curious but making no meaningful picture as a whole.

Nothing in Biology Makes Sense Except in the Light of Evolution

*The American Biology Teacher*, Volume 35, March, 1973 (p. 129)

Evolution comprises all the stages of the development of the universe: the cosmic, biological, and the human or cultural developments. Attempts to restrict the concept of evolution to biology are gratuitous. Life is a product of the evolution of inorganic nature, and man is a product of the evolution of life.

Changing Man

*Science*, Volume 155, Number 3761, 27 January, 1967 (p. 409)

Evolution is a creative process, in precisely the same sense in which composing a poem or a symphony, carving a statue, or painting a picture are creative acts.... It renders possible formations of living systems that would otherwise be infinitely improbable. Nothing can be simpler and more ingenious than its mode of operation: gene constellations that fit the environment survive better and reproduce more often than those that fit less well.

*Genetics of the Evolutionary Process*

Chapter 12, Evolution as a Creative Process (pp. 430, 431)

Columbia University Press. New York, New York, USA. 1970

I venture another, and perhaps equally reckless generalization – nothing makes sense in biology except in the light of evolution, *sub specie evolutionism*. If the living world has not arisen from common ancestors by means of an evolutionary process, then the fundamental unity of living things is a hoax and their diversity, a joke.

Biology, Molecular and Organismic

*American Zoologist*, Volume 4, 1964 (p. 449)

...any evolution theory which disregard the established genetic principles is faulty at its source.

*Genetics and The Origin of Species*

Chapter I (p. 12)

Columbia University Press. New York, New York, USA. 1951

### Dowdeswell, Wilfrid Hogarth 1914–96

No biographical data available

Studies centered exclusively on the past tend inevitably to obscure the present and future, thus fostering the idea that evolution has come to a comparative standstill at the present time or is proceeding too slowly to be detected.

*The Mechanism of Evolution* (p. 1)

Heinemann. London, England. 1955

### Drummond, Henry 1851–97

Scottish clergyman and author

No man can run up the natural lines of Evolution without coming to Christianity at the top.

*The Lowell Lectures on the Ascent of Man* (3rd edition)

Chapter X (p. 342)

James Pott & Co. New York, New York, USA. 1894

### Dubos, René Jules 1901–82

French-born American microbiologist and environmentalist

Most enlightened persons now accept as a fact that everything in the cosmos – from heavenly bodies to human beings – has developed and continues to develop through evolutionary processes.

Humanistic Biology

*American Scientist*, Volume 53, Number 1, March, 1965 (p. 6)

### Dyson, Freeman J. 1923–

American physicist and educator

In five billion years or less, we've evolved from some sort of primordial slime into human beings. What will happen in another ten billion years? It's just utterly impossible to conceive of ourselves changing as drastically as that over and over again, for I think all you can say is that the material form that life would take on in that kind of time scale is completely open.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Imagine... (p. 351)

Ticknor & Fields. New York, New York, USA. 1984

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The stately drama of stellar evolution turns out to be more like the hair-breadth escapades of the films. The music of the spheres has almost a suggestion of – jazz.

*Stars and Atoms*

Lecture I (p. 27)

Yale University Press. London, England. 1927

### Eiseley, Loren C. 1907–77

American anthropologist, educator, and author

Life, even cellular life, may exist out yonder in the dark. But high or low in nature, it will not wear the shape of man. That shape is the evolutionary product of a strange, long wandering through the attics of the forest roof, and so great are the chances of failure, that nothing precisely and identically human is likely to ever come that way again.

*The Immense Journey*

Little Men and Flying Saucers (pp. 160–161)

Vintage Books. New York, New York, USA. 1957

It was the failures who had always won, but by the time they won they had come to be called successes. This is the final paradox, which men call evolution.



*The Star Thrower*

The Inner Galaxy, III (p. 311)

Times Books. New York, New York, USA. 1978

**Eldredge, Niles** 1943–

American paleontologist

CHARLES ROBERT DARWIN stands among the giants of Western thought because he convinced a majority of his peers that all of life shares a single, if complex, history. He taught us that we can understand life's history in purely naturalistic terms, without recourse to the supernatural or divine.

*Time Frames: The Rethinking of Darwinian Evolution and The Theory of Punctuated Equilibria*

PREFACE (p. 13)

Simon & Schuster. New York, New York, USA. 1985

As a paleontologist, I readily concede that my long dead fossils, lacking any traces of their soft anatomies or behaviors, are totally mute on the subject of reproduction and transmission of genetic information. And this is, I acknowledge, a major limitation to our data.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 2)

John Wiley & Sons, Inc. New York, New York, USA. 1995

Simple extrapolation does not work. I found that out back in the 1960s as I tried in vain to document examples of the kind of slow, steady directional change we all thought ought to be there, ever since Darwin told us that natural selection should leave precisely such a telltale signal as we collect our fossils up cliff faces. I found instead, that once species appear in the fossil record, they tend not to change much at all. Species remain imperturbably, implacably resistant to chance as a matter of course.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1995

Stasis is now abundantly well documented as the preeminent pale ontological pattern in the evolutionary history of species.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 77)

John Wiley & Sons, Inc. New York, New York, USA. 1995

No wonder paleontologists shied away from evolution for so long. It seems never to happen. Assiduous collecting of cliff faces yields zigzags, minor oscillations, and the very occasional slight accumulation of change – over millions of years, at a rate too slow to really account for all the prodigious change that has occurred in evolutionary history. When we do see the introduction of evolutionary novelty, it usually shows up with a bang and often with no firm evidence that the organisms did not evolve elsewhere! Evolution cannot forever be going on someplace else. Yet that's how the fossil record has struck many a forlorn paleontologist looking to learn something about evolution.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 95)

John Wiley & Sons, Inc. New York, New York, USA. 1995

But we saw – as did several pale ontological contemporaries of Darwin – that if you do collect a series of fossils up through a sequence of sedimentary rock, and if you don't see much evidence of anatomical change through that series, that is indeed evidence that substantial gradual evolutionary change has not occurred within that species lineage, no matter how guppy the record may be. That's why the evidence for stasis now appears so overwhelming.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 96)

John Wiley & Sons, Inc. New York, New York, USA. 1995

I needed to explain why evolution leaves an entirely different sort of pattern in the rock record than Darwin – and his long string of successors, including many paleontologists – had supposed.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 97)

John Wiley & Sons, Inc. New York, New York, USA. 1995

The persistent pattern of no change within samples, coupled with the abrupt appearance of new species – organisms marked with anatomical innovations – had to be telling us something about the way the evolutionary process works.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 97)

John Wiley & Sons, Inc. New York, New York, USA. 1995

Scientists, being as a rule more or less human beings, passionately stick up for their ideas, their pet theories. It's up to someone else to show you are wrong.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 221)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Each animal or vegetable form remembers the next inferior and predicts the next higher.

*Letters and Social Aims*

Poetry and Imagination (p. 8)

James R. Osgood & Company. Boston, Massachusetts, USA. 1876

How far off yet is the trilobite! how far the quadruped! how inconceivably remote is man! All duly arrive, and then race after race of men. It is a long way from granite to the oyster; farther yet to Plato and the preaching of the immortality of the soul.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

Nature (p. 546)

The Library of America. New York, New York, USA. 1983

A SUBTLE chain of countless rings  
The next unto the farthest brings;



The eye reads omens where it goes,  
And speaks all languages the rose;  
And, striving to be man, the worm  
Mounts through all the spires of form.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
Nature (p. 281)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### Fana, C.

No biographical data available

[Hypotheses] on the origin of species are an indication of our mental tendencies rather than the synthetic result of facts incontrovertibly ascertained. Let us admit without further preamble: the success attained by the theory of evolution is not due primarily to its self-evident character, for even the most generally admitted facts cannot always be reconciled with it, but rather to the sympathy of the scientific world for the dogma of continuity of natural phenomena.

*Brain and Heart* (p. 41)  
Oxford University Press, Inc. Oxford, England. 1926

### Feyerabend, Paul K. 1924–94

Austrian-born American philosopher of science

Science, surely, was always in the forefront of the fight against authoritarianism and superstition. It is to science that we owe our increased intellectual freedom *vis-à-vis* religious beliefs; it is to science that we owe the liberation of mankind from ancient and rigid forms of thought. Today these forms of thought are nothing but bad dreams – and this we learned from science. Science and enlightenment are one and the same thing – even the most radical critics of society believe this.

*Knowledge Science and Relativism*  
Chapter 8 (p. 181)  
Cambridge University Press. Cambridge, England. 1999

Will the laymen be able to come to a correct judgment? Most certainly, for the competence, the complications and the successes of science are vastly exaggerated. One of the most exhilarating experiences is to see how a lawyer, who is a layman, can find holes in the testimony, the technical testimony, of the most advanced expert and thus prepare the jury for its verdict. Science is not a closed book that is understood only after years of training. It is an intellectual discipline that can be examined and criticized by anyone who is interested and that looks difficult and profound only because of a systematic campaign of obfuscation carried out by many scientists (though, I am happy to say, not by all).

*Knowledge Science and Relativism*  
Chapter 8 (p. 187)  
Cambridge University Press. Cambridge, England. 1999

Three cheers for the fundamentalists in California who succeeded in having a dogmatic formulation of the theory of evolution removed from the text books and an account

of Genesis included. (But I know that they would become as chauvinistic and totalitarian as scientists are today when given the chance to run society all by themselves. Ideologies are marvelous when used in the companies of other ideologies. They become boring and doctrinaire as soon as their merits lead to the removal of their opponents.) The most important change, however, will have to occur in the field of education.

*Knowledge Science and Relativism*  
Chapter 8 (pp. 187–188)  
Cambridge University Press. Cambridge, England. 1999

Using stories we may of course also introduce “scientific” accounts, say, of the origin of the world and thus make the children acquainted with science as well. But science must not be given any special position except for pointing out that there are lots of people who believe in it. Later on the stories which have been told will be supplemented with “reasons,” where by reasons I mean further accounts of the kind found in the tradition to which the story belongs. And, of course, there will also be contrary reasons. Both reasons and contrary reasons will be told by the experts in the fields and so the young generation becomes acquainted with all kinds of sermons and all types of wayfarers.

*Knowledge Science and Relativism*  
Chapter 8 (p. 189)  
Cambridge University Press. Cambridge, England. 1999

### Futuyma, Douglas J. 1942–

American biologist

Evolution, a fact rather than mere hypothesis, is the central unifying concept in biology. By extension it affects almost all other fields of knowledge and thought and must be considered one of the most influential concepts in Western thought.

*Evolutionary Biology*  
Chapter One (p. 14)  
Sinauer Associates. Sunderland, Massachusetts, USA. 1979

### Gaarder, Jostein 1952–

Norwegian intellectual

Several million years ago a little seed appeared which split in two, and as time passed, this little seed changed into elephants, and apple trees, raspberries and orangutans. Do you follow me...?

Translated by Sarah Jane Hails  
*The Solitaire Mystery* (p. 84)  
Penguin Group (USA)  
1997

### Gale, Barry

No biographical data available

Though often brilliantly and ingeniously composed, his argument was based, in many instances, on new and often unsubstantiated hypotheses, sometimes fuzzy analogies and metaphors, the repudiation of compet-

ing explanations, and a frequent plea to complexity and general ignorance, rather than compelling, clearly incontrovertible evidence in its own support; and it is clear that Darwin knew this.

*Evolution Without Evidence: Charles Darwin and the Origin of Species* (p. 101)  
University of New Mexico Press. Albuquerque, New Mexico, USA. 1982

Yet even here, where Darwin's arguments are strongest, nagging questions remain. For example, a reader of the Origin might be justified in wondering what Creationist view Darwin is referring to. Perhaps this is a problem more for the present-day reader. Darwin's contemporaries may have known exactly what he meant, though I doubt it. Often the Creationist position seems merely a straw man – set up only to be knocked down. The constraints on space in the Origin, which led Darwin to abandon his original intention of arguing on both sides of the mutability issue, add to this feeling. The result is that the Creationist position is never clearly defined in the Origin.

*Evolution Without Evidence: Charles Darwin and the Origin of Species* (p. 139)  
University of New Mexico Press. Albuquerque, New Mexico, USA. 1982

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer and statistician

The conditions that direct the order of the whole of the living world around us, are marked by their persistence in improving the birthright of successive generations. They determine, at much cost of individual comfort, that each plant and animal shall, on the general average, be endowed at its birth with more suitable natural faculties than those of its representative in the preceding generation.

*Inquiries into Human Faculty and Its Development*  
The Observed Order of Events (p. 194)  
AMS Press. New York, New York, USA. 1973

**Gamow, George** 1904–68  
Russian-born American physicist

Indeed, it took less than an hour to make the atoms, a few hundred million years to make the stars and planets, but five billion years to make man.

*The Creation of the Universe*  
Conclusion (p. 139)  
The Viking Press. New York, New York, USA. 1952

**Geddes, Patrick** 1854–1932  
Scottish biologist and botanist

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

Yet ideas of unity amid diversity, of order amid change, have also long been growing, even finding expression, and this not merely, as sporadically in all ages, in impressions and speculations on decline or on better things; but in clearer and more comprehensive surveys of

the processes of change, even inquiries into its method. These, in fact, have gone towards making up that general idea we now more or less share, of the universe as not only orderly, but in the process of change. Changing order, orderly change, and this everywhere – in nature inorganic and organic, in individual and in social life – for this vast conception, now everywhere diffusing, often expressed, rarely as yet applied, we need some general term – and this is Evolution.

*Evolution*  
Introduction (pp. viii–ix)  
Henry Holt & Company. New York, New York, USA. 1911

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

I am, in point of fact, a particularly haughty and exclusive person, of pre-Adamite ancestral descent. You will understand this when I tell you that I can trace my ancestry back to a protoplasmal, primordial, atomic globule.

*The Complete Plays of Gilbert and Sullivan*  
*The Mikado*  
Operetta, Act I  
W.W. Norton & Company, Inc. New York, New York, USA. 1976

...a Darwinian Man, though well-behaved,  
At best is only a monkey shaved!  
*The Complete Plays of Gilbert and Sullivan*  
*Princess Ida*  
Operetta, Act II  
W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Gish, D. T.**  
No biographical data available

Furthermore, the architects of the modern synthetic theory of evolution have so skillfully constructed their theory that it is not capable of falsification. The theory is so plastic that it is capable of explaining anything.

*Evolution? The Fossils Say No!*  
Chapter I (p. 17)  
Creation-Life Publishers. San Diego, California, USA. 1979

**Gould, Donald** 1919–2002  
English medical writer and editor

The scientific establishment bears a grisly resemblance to the Spanish Inquisition. Either you accept the rules and attitudes and beliefs promulgated by the “papacy” (for which read, perhaps, the Royal Society or the Royal College of Physicians), or face a dreadful retribution. We will not actually burn you at the stake, because that sanction, unhappily, is now no longer available under our milksop laws. But we will make damned sure that you are a dead duck in our trade.

Letting Poetry Loose in the Laboratory  
*New Scientist*, August 29, 1992 (p. 51)

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Well evolution is a theory. It is also a fact. And facts and theories are different things, not rungs in a hierarchy of increasing certainty. Facts are the world's data. Theories are structures of ideas that explain and interpret facts. Facts do not go away when scientists debate rival theories to explain them. Einstein's theory of gravitation replaced Newton's, but apples did not suspend themselves in mid-air, pending the outcome. And humans evolved from ape-like ancestors whether they did so by Darwin's proposed mechanism or by some other yet to be discovered.

*Hen's Teeth and Horses Toes*

Evolution as Fact and Theory (p. 254)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

Since we proposed punctuated equilibria to explain trends, it is infuriating to be quoted again and again by creationists – whether through design or stupidity, I do not know – as admitting that the fossil record includes no transitional forms. Transitional forms are generally lacking at the species level, but they are abundant between larger groups.

*Hen's Teeth and Horses Toes*

Evolution as Fact and Theory (p. 260)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

These shortest-term studies are elegant and important, but they cannot represent the general mode for building patterns in the history of life. The reason strikes most people as deeply paradoxical, even funny – but the argument truly cannot be gainsaid. Evolutionary rates of a moment, as measured for guppies and lizards, are vastly too rapid to represent the general modes of change that build life's history through geological ages.... These measured changes over years and decades are too fast by several orders of magnitude to build the history of life by simple cumulation. Reznick's guppy rates range from 3,700 to 45,000 darwins (a standard metric for evolution, expressed as change in units of standard deviation – a measure of variation around the mean value of a trait in a population – per million years). By contrast, rates for major trends in the fossil record generally range from 0.1 to 1.0 darwin. Reznick himself states that “the estimated rates [for guppies] are...four to seven orders of magnitude greater than those observed in the fossil record” (that is, ten thousand to ten million times faster!).

This View of Life, the Paradox of the Visibly Irrelevant

*Natural History*, Volume 106, Number 11, December, 1997 (pp. 62, 64)

Orchids manufacture their intricate devices from the common components of ordinary flowers, parts usually fitted for very different functions. If God had designed a beautiful machine to reflect his wisdom and power, surely he would not have used a collection of parts generally fashioned for other purposes. Orchids were not made by an ideal engineer; they are jury-rigged from

a limited set of available components. Thus, they must have evolved from ordinary flowers.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 1 (p. 20)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

Odd arrangements and funny solutions are the proof of evolution – paths that a sensible God would never tread but that a natural process, constrained by history, follows performe.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 1 (pp. 20–21)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

I emphatically do not assert the general “truth” of this philosophy of punctuational change. Any attempt to support the exclusive validity of such a grandiose notion would border on the nonsensical.... Nonetheless, I will confess to a personal belief that a punctuational view may prove to map tempos of biological and geographic change more accurately and more often than any of its competitors – if only because complex systems in steady state are both common and highly resistant to change. As my colleague British geologist Derek V. Ager writes in supporting a punctuational view of geologic change: “The history of anyone part of the earth, like the life of a soldier, consists of long periods of boredom and short terror.”

*The Panda's Thumb: Reflections in Natural History*

Chapter 17 (p. 185)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

Two organisms may maintain the same feature because both inherited it from a common ancestor. These are homologous similarities, and they indicate “propinquity of dissent,” to use Darwin's words. Forelimbs of people, porpoises, bats and horses provide the classic example of homology in most textbooks. They look different, and do different things, but are built of the same bones. No engineer, starting from scratch each time, would have built such disparate structures from the same parts. Therefore, the parts existed before the particular set of structures now housing them: they were, in short, inherited from a common ancestor.

*The Panda's Thumb: More Reflections In Natural History*

Chapter 24 (p. 248)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

We talk about the “march from monad to man” (old-style language again) as though evolution followed continuous pathways to progress along unbroken lineages. Nothing could be further from reality. I do not deny that, through time, the most “advanced” organism has tended to increase in complexity. But the sequence [allocated in most texts] from jellyfish to trilobite to nautiloid to armored fish to dinosaur to monkey to human is no lineage at all, but a chronological set of termini on unrelated evolutionary trunks. Moreover life shows no trend

to complexity in the usual sense – only an asymmetrical expansion of diversity around a starting point constrained to be simple.

*Eight Little Piggies: Reflections in Natural History*

Tires to Sandals (p. 322)

W.W. Norton & Company, Inc. New York, New York, USA. 1993

There is no progress in evolution. The fact of evolutionary change through time doesn't represent progress as we know it. Progress is not inevitable. Much of evolution is downward in terms of morphological complexity, rather than upward. We're not marching toward some greater thing. The actual history of life is awfully damn curious in the light of our usual expectation that there's some predictable drive toward a generally increasing complexity in time. If that's so, life certainly took its time about it: five-sixths of the history of life is the story of single-celled creatures only.

*The Third Culture*

The Pattern of Life's History (p. 52)

Simon & Shuster. New York, New York, USA. 1995

We cannot understand much of the history of late nineteenth- and early twentieth-century anthropology, with its plethora of taxonomic names proposed for nearly every scrap of fossil bone, unless we appreciate its obsession with the identification and ranking of races. For many schemes of classification sought to tag the various fossils as ancestors of modern races and to use their relative age and apishness as a criterion for racial superiority.

Human Equality Is a Contingent Fact of History

*Natural History*, Volume 93, Number 11, November, 1984 (p. 28)

We are here because one odd group of fishes had a peculiar fin anatomy that could transform into legs for terrestrial creatures; because the earth never froze entirely during an ice age; because a small and tenuous species, arising in Africa a quarter of a million years ago, has managed, so far, to survive by hook and by crook. We may yearn for a "higher" answer – but none exists.

*Life magazine*, December, 1988

The absence of fossil evidence for intermediary stages between major transitions in organic design, indeed our inability, even in our imagination, to construct functional intermediates in many cases, has been a persistent and nagging problem for gradualistic accounts of evolution. Is a New and General Theory of Evolution Emerging?

*Paleobiology*, January, 1980 (p. 127)

The history of most fossil species includes two features particularly inconsistent with gradualism: 1. Stasis. Most species exhibit no directional change during their tenure on earth. They appear in the fossil record looking much the same as when they disappear; morphological change is usually limited and directionless. 2. Sudden appearance. In any local area, a species does not arise gradually by the steady transformation of its ancestors; it appears all at once and "fully formed."

Evolution's Erratic Pace

*Natural History*, Volume 86, Number 5, May, 1977 (p. 14)

The extreme rarity of transitional forms in the fossil record persists as the trade secret of paleontology. The evolutionary trees that adorn our textbooks have data only at the tips and nodes of their branches; the rest is inference, however reasonable, not the evidence of fossils...

Evolution's Erratic Pace

*Natural History*, Volume 86, Number 5, May, 1977 (p. 14)

Scientific claims must be testable; we must, in principal, be able to envision a set of observations that would render them false. Miracles cannot be judged by this criterion, as Whitcomb and Morris have admitted. But is all creationists' writing merely about untestable singularities? Are arguments never made in proper scientific form? Creationists do offer some testable statements, and these are amenable to scientific analysis. Why, then, do I continue to claim that creationism isn't science? Simply because these relatively few statements have been tested and conclusively refuted.

In Ashley Montagu (ed.)

*Science and Creationism*

Genesis vs. Geology (pp. 130–131)

Oxford University Press, Inc. New York, New York, USA. 1984

Sediments between 4 and 10 million years in age are potential guardians of the Holy Grail of human evolution – the period when our lineage began its separate end run to later domination, and a time for which no fossil evidence exists at all.

Empire of the Apes

*Natural History*, Volume 96, Number 5, May, 1987 (p. 24)

Gradualism, the idea that all change must be smooth, slow, and steady, was never read from the rocks. It was primarily a prejudice of nineteenth-century liberalism facing a world in revolution. But it continues to color our supposedly objective reading of life's history.

This View of Life, An Early Start

*Natural History*, Volume 87, Number 2, February, 1978 (p. 24)

All paleontologists know that the fossil record contains precious little in the way of intermediate forms; transitions between major groups are characteristically abrupt. Gradualists usually extract themselves from this dilemma by invoking the extreme imperfection of the fossil record – if only one step in a thousand survives as a fossil, geology will not record continuous change. Although I reject this argument...let us grant the traditional escape and ask a different question. Even though we have no direct evidence for smooth transitions, can we invent a reasonable sequence of intermediate forms – that is, viable, functioning organisms – between ancestors and descendants in major structural transitions? Of what possible use are the imperfect incipient stages of useful structures? What good is half a jaw or half a wing? The concept of preadaptation provides the conventional answer by permitting us to argue that incipient stages performed different functions. The half jaw worked



perfectly well as a series of gill-supporting bones; the half wing may have trapped prey or controlled body temperature. I regard preadaptation as an important, even an indispensable, concept. But a plausible story is not necessarily true. I do not doubt that preadaptation can save gradualism in some cases, but does it permit us to invent a tale of continuity in most or all cases? I submit, although it may only reflect my lack of imagination, that the answer is no...

This View of Life. The Return of Hopeful Monsters  
*Natural History*, Volume 86, Number 6, June, 1977 (pp. 24–25)

But our ways of learning about the world are strongly influenced by the social preconceptions and biased modes of thinking that each scientist must apply to any problem. The stereotype of a fully rational and objective “scientific method,” with individual scientists as logical (and interchangeable) robots, is self-serving mythology.

This View of Life. In the Mind of the Beholder  
*Natural History*, Volume 103, Number 2, February, 1994 (p. 14)

Darwin has been vindicated by a rich Precambrian record, all discovered in the past thirty years. Yet the peculiar character of this evidence has not matched Darwin’s prediction of a continuous rise in complexity toward Cambrian life, and the problem of the Cambrian explosion has remained as stubborn as ever – if not more so, since our confusion now rests on knowledge, rather than ignorance about the nature of Precambrian life.

*Wonderful Life: The Burgess Shale and The Nature of History*  
Chapter II (p. 57)  
W.W. Norton & Company, Inc. New York, New York, USA. 1989

If justification required eyewitness testimony, we would have no sciences of deep time – no geology, no ancient human history either. (Should I believe Julius Caesar ever existed? The hard bony evidence for human evolution... surely exceeds our reliable documentation of Caesar’s life.)

Dorothy, It’s Really Oz  
*Time Magazine*, August 23, 1999 (p. 59)

It seems the height of antiquated hubris to claim that the universe carried on as it did for billions of years in order to form a comfortable abode for us. Chance and historical contingency give the world of life most of its glory and fascination. I sit here happy to be alive and sure that some reason must exist for “why me?” Or the earth might have been totally covered with water, and an octopus might now be telling its children why the eight-legged God of all things had made such a perfect world for cephalopods. Sure we fit. We wouldn’t be here if we didn’t. But the world wasn’t made for us and it will endure without us.

*An Urchin in the Storm: Essays About Books and Ideas*  
Chapter 14 (p. 206)  
W.W. Norton & Company, Inc. New York, New York, USA. 1987

In the bad old days, before men rose from their armchairs to look at rocks in the field, biblical limitations of the

Mosaic chronology precluded any understanding of our earth’s history.

*Time’s Arrow, Time’s Cycle: Myth and Metaphor in the Discovery of Geological Time*  
Chapter 1 (p. 5)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

[Darwin’s notebooks] include many statements showing that he espoused but feared to expose something he perceived as far more heretical than evolution itself: philosophical materialism – the postulate that matter is the stuff of all existence and that all mental and spiritual phenomena are its by-products.

*Ever Since Darwin: Reflections in Natural History*  
Chapter 1 Darwin’s Delay (p. 24)  
W.W. Norton & Company, Inc. New York, New York, USA. 1977

We will be a bit freer, a bit more enlightened, a bit readier to work for planetary preservation with the rest of kindred life, when we truly know why each and every last one of us is a monkey’s uncle.

*Dinosaur in a Haystack*  
Chapter 30 (p. 400)  
Harmony Books. New York, New York, USA. 1995

**Grassé, Pierre P.** 1895–1985  
French zoologist

Through use and abuse of hidden postulates, of bold, often ill-founded extrapolations, a pseudoscience has been created. It is taking root in the very heart of biology and is leading astray many biochemists and biologists, who sincerely believe that the accuracy of fundamental concepts has been demonstrated, which is not the case.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
An Introduction to the Study of Evolution (p. 6)  
Academic Press. New York, New York, USA. 1977

Today, our duty is to destroy the myth of evolution, considered as a simple, understood, and explained phenomenon which keeps rapidly unfolding before us. Biologists must be encouraged to think about the weaknesses of the interpretations and extrapolations that theoreticians put forward or lay down as established truths. The deceit is sometimes unconscious, but not always, since some people, owing to their sectarianism, purposely overlook reality and refuse to acknowledge the inadequacies and the falsity of their beliefs.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
An Introduction to the Study of Evolution (p. 8)  
Academic Press. New York, New York, USA. 1977

It follows that any explanation of the mechanism in creative evolution of the fundamental structural plans is heavily burdened with hypotheses. This should appear as an epigraph to every book on evolution. The lack of direct evidence leads to the formation of pure conjectures as to the genesis of the phyla; we do not even have a

basis to determine the extent to which these opinions are correct.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter II (p. 31)  
Academic Press. New York, New York, USA. 1977

What is the use of their unceasing mutations, if they do not change? In sum, the mutations of bacteria and viruses are merely hereditary fluctuations around a median position; a swing to the right, a swing to the left, but no final evolutionary effect.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 87)  
Academic Press. New York, New York, USA. 1977

Once one has noticed microvariations (on the one hand) and specific stability (on the other), it seems very difficult to conclude that the former (microvariation) comes into play in the evolutionary process.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 88)  
Academic Press. New York, New York, USA. 1977

Some contemporary biologists, as soon as they observe a mutation, talk about evolution. They are implicitly supporting the following syllogism: mutations are the only evolutionary variations, all living beings undergo mutations, therefore all living beings evolve. This logical scheme is, however, unacceptable: first, because its major premise is neither obvious nor general; second, because its conclusion does not agree with the facts. No matter how numerous they may be, mutations do not produce any kind of evolution.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 88)  
Academic Press. New York, New York, USA. 1977

The opportune appearance of mutations permitting animals and plants to meet their needs seems hard to believe. Yet the Darwinian theory is even more demanding: a single plant, a single animal would require thousands and thousands of lucky, appropriate events. Thus, miracles would become the rule: events with an infinitesimal probability could not fail to occur.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter IV (p. 103)  
Academic Press. New York, New York, USA. 1977

**Greene, Graham** 1904–1991

English novelist, playwright, and critic

God...created a number of possibilities in case some of his prototypes failed – that is the meaning of evolution.

*Travels with My Aunt*  
Part 2, Chapter 7 (p. 227)

Penguin Books. Harmondsworth, England. 1977

**Guiterman, Arthur** 1871–1943

Poet

Recall from Time's abyssal chasm  
That piece of primal protoplasm  
The First Amoeba, strangely splendid,  
From whom we're all of us descended.

*Gaily the Troubadour*

Ode to the Amoeba

E.P. Dutton & Company, Inc. New York, New York, USA. 1936

**Haeckel, Ernst Heinrich Philipp**

**August** 1834–1919

German biologist and philosopher

Our concern is rather with the unparalleled influence that Darwinism, and its application to man, have had during the last forty years on the whole province of science; and at the same time, with its irreconcilable opposition to the dogmas of the Churches.

*Last Words on Evolution: A Popular Retrospect and Summary* (p. 36)  
P. Eckler Publishing Company. New York, New York, USA. 1920

It was obvious that both the general theory of evolution and its extension to man in particular must meet from the first with the most determined resistance on the part of the Churches. Both were in flagrant contradiction to the Mosaic story of creation, and other Biblical dogmas that were involved in it, and are still taught in our elementary schools. It is creditable to the shrewdness of the theologians and their associates, the metaphysicians, that they at once rejected Darwinism, and made a particularly energetic resistance in their writings to its chief consequence, the descent of man from ape. This resistance seemed the more justified and hopeful as, for seven or eight years after Darwin's appearance, few biologists accepted his theory, and the general attitude amongst them was one of cold skepticism.

*Last Words on Evolution: A Popular Retrospect and Summary*  
(pp. 38–39)

P. Eckler Publishing Company. New York, New York, USA. 1920

Our science of evolution won its greatest triumph when, at the beginning of the twentieth century, its most powerful opponents, the Churches, became reconciled to it, and endeavored to bring their dogmas into line with it.

*Last Words on Evolution: A Popular Retrospect and Summary* (p. 55)  
P. Eckler Publishing Company. New York, New York, USA. 1920

This determination of the position of man in nature, and of his relation to the totality of things – this question of all questions for mankind as Huxley justly calls it – is finally solved by the knowledge that man is descended from animals.

Translated by E. Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)  
Chapter I (p. 6)

D. Appleton & Co. New York, New York, USA. 1892



Perhaps nothing will make the full meaning of the theory of descent clearer than calling it “the *non-miraculous history of creation.*”

Translated by E. Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)  
Chapter I (p. 7)

D. Appleton & Co. New York, New York, USA. 1892

**Hawkins, Gerald S.** 1928–2003

English archaeoastronomer

We should expect to find stars and galaxies in all stages of evolution as they form from existing material and then decay. For stars this is certainly the case.... There may be a similar evolutionary process for galaxies, but at the moment we do not have enough experimental evidence to give us the clues to the evolutionary pattern.

A New Theory of the Universe

*Science Digest*, Volume 52, November, 1962 (p. 45)

**Herford, Oliver** 1863–1935

American writer and illustrator

Child-ren, behold the Chim-pan-zee;  
He sits on the an-ces-tral tree  
From which we sprang in ag-es gone.  
I'm glad we sprang: had we held on,  
We might, for aught that I can say,  
Be horrid Chim-pan-zees to-day.

*A Child's Primer of Natural History*

The Chimpanzee

Charles Scribner's Sons. New York, New York, USA. 1899

**Holmes, Jr., Oliver Wendell** 1841–1935

American jurist

When one thinks coldly I see no reason for attributing to man a significance different in kind from that which belongs to a baboon or to a grain of sand.

*Holmes-Pollock Letters*

August 30, 1907

**Hooper, Judith**

American biology writer

They conceived the evidence that would carry the vital intellectual argument, but at its core lay flawed science, dubious methodology and wishful thinking. Clustered around the peppered moth is a swarm of human ambition, and self-delusions shared among some of the most renowned evolutionary biologists of our era.

*Of Moths and Men: The Untold Story of Science and the Peppered Moth*  
Prologue: The Moths of Oxford (pp. xix–xx)

W.W. Norton & Company, Inc. New York, New York, USA. 2002

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

The chance that higher life forms might have emerged in this way is comparable with the chance that “a tornado

sweeping through a junk yard might assemble a Boeing 747 from the materials therein.”

Hoyle on Evolution

*Nature*, Volume 294, Number 5837, November 12, 1981 (p. 105)

At all events, anyone with even a nodding acquaintance with the Rubik cube will concede the near-impossibility of a solution being obtained by a blind person moving the cube faces at random. Now imagine 1050 blind persons each with a scrambled Rubik cube, and try to conceive of the chance of them all simultaneously arriving at the solved form. You then have the chance of arriving by random shuffling of just one of the many biopolymers on which life depends. The notion that not only the biopolymers but the operating programme of a living cell could be arrived at by chance in a primordial organic soup here on the Earth is evidently nonsense of a high order.

The Big Bang in Astronomy

*New Scientist*, November 19, 1981 (pp. 521–527)

**Huxley, Aldous** 1894–1963

English writer and critic

I had motives for not wanting the world to have a meaning; consequently assumed that it had none, and was able without any difficulty to find satisfying reasons for this assumption. The philosopher who finds no meaning in the world is not concerned exclusively with a problem in pure metaphysics, he is also concerned to prove that there is no valid reason why he personally should not do as he wants to do, or why his friends should not seize political power and govern in the way that they find most advantageous to themselves.... For myself, the philosophy of meaninglessness was essentially an instrument of liberation, sexual and political.

*Ends and Means*

Chapter XIV (p. 270)

Chatto & Windus. London, England. 1938

A poor degenerate from the ape,  
Whose hands are four, whose tail's a limb,  
I contemplate my flaccid shape  
And know I may not rival him.

*Leda*

First Philosopher's Song

George H. Doran Company. New York, New York, USA. 1920

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Evolution may lay claim to be considered the most central and the most important of the problems of biology. For an attack upon it we need facts and methods from every branch of the science – ecology, genetics, paleontology, geographical distribution, embryology, systematics, comparative anatomy – not to mention reinforcements from other disciplines such as geology, geography, and mathematics.

*Evolution: The Modern Synthesis*

Chapter I (p. 13)

George Allen & Unwin Ltd. London, England. 1942

There is no more need to postulate an élan vital or a guiding purpose to account for evolutionary progress than to account for adaptation, for degeneration or any other form of specialization.... The purpose manifested in evolution, whether in adaptation, specialization, or biological progress, is only an apparent purpose. It is just as much a product of blind forces as is the falling of a stone to earth or the ebb and flow of the tides. It is we who have read purpose into evolution, as earlier men projected will and emotion into inorganic phenomena like storm or earthquake.

*Evolution: The Modern Synthesis*

Chapter 10 (pp. 568, 576)

George Allen & Unwin Ltd. London, England. 1942

The concept of evolution was soon extended into other than biological fields. Inorganic subjects such as the life-histories of stars and the formation of the chemical elements on the one hand, and on the other hand subjects like linguistics, social anthropology, and comparative law an religion, began to be studied for an evolutionary angle, until today we are enabled to see evolution as a universal and all pervading process.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain Their Various Fields to the Layman*

Biology (p. 272)

Simon & Schuster. New York, New York, USA. 1955

Evolutionary science is a discipline or subject in its own right. But it is [also] the joint product of a number of separate branches of study and learning. Biology provides its central and largest component, but it has also received indispensable contributions from pure physics and chemistry, cosmogony and geology among the natural sciences, and among human studies from history and social science, archaeology and prehistory, psychology and anthropology. As a result, the present is the first period in which we have been able to grasp that the universe is a process in time and to get a first glimpse of our true relation with it. We can see ourselves as history, and can see that history in its proper relation with the history of the universe as a whole.

*Evolution in Action*

Chapter 1 (pp. 1–2)

Harper & Bothers. New York, New York, USA. 1953

Evolution in the extended sense can be defined as a directional and essentially irreversible process occurring in time, which in its course gives rise to an increase of variety and an increasingly high level of organization in its products. Our present knowledge indeed forces us to the view that the whole of reality is evolution – a single process of self-transformation.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain Their Various Fields to the Layman*

Evolution and Genetics (p. 278)

Simon & Schuster. New York, New York, USA. 1955

As a result of a thousand million years of evolution, the universe is becoming conscious of itself, able to understand something of its past history and possible future.... It is as if man had been suddenly appointed managing director of the biggest business of all, the business of evolution – appointed without being asked if he wanted it, and without proper warning and preparation. What is more, he can't refuse the job. Whether he wants to or not, whether he is conscious of what he is doing or not, he is in point of fact determining the future direction of evolution on this earth. That is his inescapable destiny, and the sooner he realizes it and starts believing in it, the better for all concerned.

*New Bottles for Old Wine*

Transhumanism (p. 13)

Harper & Brothers Publishers. New York, New York, USA. 1957

## **Huxley, Thomas Henry** 1825–95

English biologist

Unity of plan everywhere lies hidden under the mask of diversity of structure – the complex is everywhere evolved out of the simple.

*Collected Essays* (Volume 8)

*A Lobster; or, The Study of Zoology* (pp. 205–206)

Macmillan & Company Ltd. London, England. 1904

The hypothesis of special creation is not only a mere specious mask for our ignorance; its existence in Biology marks the youth and imperfection of the science. For what is the history of every science but the history of the elimination of the notion of creative, or other interferences, with the natural order of the phenomena? Harmonious order governing eternally continuous progress – the web and woof of matter and force interweaving by slow degrees, without a broken thread, that veil which lies between us and the Infinite – that universe which alone we know or can know; such is the picture which science draws of the world.

*The Origin of Species*

*Westminster Review*, New Series, Volume 17, 1860 (pp. 541–570)

It is very desirable to remember that evolution is not an explanation of the cosmic process, but merely a generalized statement of the method and results of that process.

*Evolution and Ethics*

Prolegomena (p. 6)

Harper & Brothers Publishers. New York, New York, USA. 1942

Natural knowledge tends more and more to the conclusion that “all the choir of heaven and furniture of the earth” are the transitory forms of parcels of cosmic substance wending along the road of evolution, from

nebulous potentiality, through endless growths of sun and planet and satellite; through all varieties of matter; through infinite diversities of life and thought; possibly, through modes of being of which we neither have a conception, nor are competent to form any, back to the indefinable latency from which they arose.

*Collected Essays* (Volume 9)

Evolution and Ethics (p. 50)

Macmillan & Company Ltd. London, England. 1904

If it [theory of evolution] had not existed, the palaeontologist would have had to invent it.

*Collected Essays* (Volume 4)

*The Rise and Progress of Palaeontology* (p. 44)

Macmillan & Company Ltd. London, England. 1904

I would rather be the offspring of two apes than be a man and afraid to face the truth.

In Cyril Bibby

*T.H. Huxley: Scientist, Humanist, and Educator*

Chapter XIII (p. 259)

Horizon Press. New York, New York, USA. 1960

I have endeavored to show that no absolute structural line of demarcation... can be drawn between the animal world and ourselves; and I may add the expression of my belief that the attempts to draw a psychical distinction is equally futile, and even the highest faculties of feeling and of intellect begin to germinate in lower forms of life. At the same time, no one is more strongly convinced than I am of the vastness of the gulf between civilized man and the brutes; or is more certain that whether from them or not, he is assuredly not of them.

*Collected Essays* (Volume 7)

*On the Relations of Man to the Lower Animals* (p. 152)

Macmillan & Company Ltd. London, England. 1904

If the fundamental proposition of evolution is true, that the entire world, living and non-living, is the result of the mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed, it is no less certain that the existing world lay, potentially, in the cosmic vapor, and that a sufficient intellect could, from a knowledge of the properties of the molecules of that vapor, have predicted, say the state of the Fauna of Great Britain in 1869, with as much certainty as one can say what will happen to the vapor of the breath in a cold winter's day.

In Henri Bergson

*Creative Evolution*

Chapter I (p. 38)

The Modern Library. New York, New York, USA. 1944

...the whole world, living and not living, is the result of the mutual interaction, according to laws, of the forces... possessed by the molecules of which the primitive nebulosity of the universe was composed.

*The Reception of the Origin of Species* (p. 18)

Kessinger Publishing. Whitefish, Montana, USA. 2004

The doctrine of evolution in biology is the necessary result of the logical application of the principles of uniformitarianism to the phenomena of life. Darwin is the natural successor of Hutton and Lyell, and the "Origin of Species" the logical sequence of the "Principles of Geology."

*Darwiniana*

Chapter VII (p. 232)

D. Appleton & Co. New York, New York, USA. 1896

There is a wider teleology which is not touched by the doctrine of evolution, but is actually based upon the fundamental proposition of evolution. The teleological and the mechanical views of Nature are not necessarily mutually exclusive. The teleologist can always defy the evolutionist to disprove that the primordial molecular arrangement was not intended to evolve the phenomena of the universe.

The Genealogy of Animals

*The Academy*, Number 1, October, 1869 (p. 13)

Nor is the value of the doctrine of Evolution to the philosophic thinker [is not] diminished by the fact that it applies the same method to the living and the not-living world; and embraces, in one stupendous analogy, the growth of a solar system from molecular chaos, the shaping of the earth from the nebulous cubhood of its youth, through innumerable changes and immeasurable ages, to its present form ...

*Lay Sermons, Addresses and Reviews*

Chapter XI (p. 243)

D. Appleton & Co. New York, New York, USA. 1903

### **Jacob, François** 1920–

French biologist

Evolution is a tinkerer.

In Francis Crick

*What Mad Pursuit: A Personal View of Scientific Discovery*

Introduction (p. 5)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

### **Jastrow, Robert** 1925–

American space scientist

At present, science has no satisfactory answer to the question of the origin of life on the earth. Perhaps the appearance of life on the earth is a miracle. Scientists are reluctant to accept that view, but their choices are limited; either life was created on the earth by the will of a being outside the grasp of scientific understanding, or it evolved on our planet spontaneously, through chemical reactions occurring in nonliving matter lying on the surface of the planet. The first theory places the question of the origin of life beyond the reach of scientific inquiry. It is a statement of faith in the power of a Supreme Being not subject to the laws of science. The second theory is also an act of faith. The act of faith consists in assuming that the scientific view of the origin of life is correct, without having concrete evidence to support that belief.

*Until the Sun Dies*

Chapter 7 (p. 62)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

### **Jeffers, Robinson** 1887–1962

American poet

You [Pacific Ocean] were much younger when we crawled out of the womb and lay in the sun's eye on the tideline.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

Continent's End (p. 16)

Stanford University Press. Stanford, California. USA. 1988

And the earth is a particle of dust by a sand-grain sun, lost in a nameless cove of the shores of a continent.

Galaxy on galaxy, innumerable swirls of innumerable stars, endured as it were forever and humanity

Came into being, its two or three million years are a moment, in a moment it will certainly cease out from being

And galaxy on galaxy endure after that as it were forever...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 2)

Margrave (p. 160)

Stanford University Press. Stanford, California. USA. 1988

### **Johnny (Fictional character)**

Louise: "How did you get here?"

Johnny: "Well, basically, there was this little dot, right? And the dot went bang and the bang expanded. Energy formed into matter, matter cooled, matter lived, the amoeba to fish, to fish to fowl, to fowl to frog, to frog to mammal, the mammal to monkey, to monkey to man, amo amas amat, quid pro quo, memento mori, ad infinitum, sprinkle on a little bit of grated cheese and leave under the grill till Doomsday."

*Naked*

Film (1993)

### **Johnson, Philip**

Law professor

Persons who want naturalistic evolution to be accepted as unquestioned fact must therefore use their cultural authority to enact rules of discourse that protect the purported fact from the attacks of unbelievers. First, they can identify science with naturalism, which means that they insist as a matter of first principle that no consideration whatever be given to the possibility that mind or spirit preceded matter. Second, they can impose a rule of procedure that disqualifies purely negative argument, so that a theory which obtains some very modest degree of empirical support can become immune to disproof until and unless it is supplanted by a better naturalistic theory.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October, 1990

Darwinists believe that the mutation-selection mechanism accomplishes wonders of creativity not because the wonders can be demonstrated, but because they cannot think of a more plausible explanation for the existence of wonders that does not involve an unacceptable creator, *i.e.*, a being or force outside the world of nature.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October, 1990

The problem with scientific naturalism as a worldview is that it takes a sound methodological premise of natural science and transforms it into a dogmatic statement about the nature of the universe. Science is committed by definition to empiricism, by which I mean that scientists seek to find truth by observation, experiment, and calculation rather than by studying sacred books or achieving mystical states of mind. It may well be, however, that there are certain questions – important questions, ones to which we desperately want to know the answers – that cannot be answered by the methods available to our science. These may include not only broad philosophical issues such as whether the universe has a purpose, but also questions we have become accustomed to think of as empirical, such as how life first began or how complex biological systems were put together.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October, 1990

Creationists are disqualified from making a positive case, because science by definition is based upon naturalism. The rules of science also disqualify any purely negative argumentation designed to dilute the persuasiveness of the theory of evolution. Creationism is thus out of court and out of the classroom – before any consideration of evidence. Put yourself in the place of a creationist who has been silenced by that logic, and you may feel like a criminal defendant who has just been told that the law does not recognize so absurd a concept as "innocence."

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October, 1990

For the scientific materialist the materialism comes first; the science comes thereafter. We might therefore more accurately term them "materialists employing science." And if materialism is true, then some materialistic theory of evolution has to be true simply as a matter of logical deduction, regardless of the evidence.

The Unraveling of Scientific Materialism

*First Things*, November, 1997

### **Kauffman, Stuart A.**

American theoretical biologist

Evolution is chance caught on a wing.

*At Home in the Universe*

Chapter 5 (p. 97)

Oxford University Press. New York, New York, USA. 1995

**Keith, Arthur** 1866–1955  
English anatomist

The fossil remains found at Piltdown by Mr. Dawson set students of man's evolution the most difficult task that has confronted them hitherto. In his characterization, Piltdown man was quite unlike any fossil type known to us. Sir Arthur Smith Woodward was impressed by his simian similarities; I, on the other hand, was impressed by those features which, as I thought then, were eminently human and modern. Hence arose those discrepancies between us – discrepancies of a quarter of a century ago. Since then, much has happened. Discoveries are being made which help to throw Piltdown man into his proper place in the crowded throng of evolving human forms. We now know that when the Piltdown type was being evolved in England – or at the western end of the Old World – a totally different type had come into being in the Eastern lands of the Old World.... So long as man is interested in his long past history, in the vicissitudes which our early forerunners passed through, and the varying fate which overtook them, the name of Charles Dawson is certain of remembrance.

The Piltdown Man Discovery

*Nature*, Volume 142, Number 3587, July 30, 1938 (p. 197)

Meantime let me say that the conclusion I have come to is this: the law of Christ is incompatible with the law of evolution as far as the law of evolution has worked hitherto. Nay, the two laws are at war with each other; the law of Christ can never prevail until the law of evolution is destroyed.

*Evolution and Ethics*

Chapter 4 (p. 15)

G.P. Putnam's Sons. New York, New York, USA. 1947

Christianity makes no distinction of race or of color; it seeks to break down all racial barriers. In this respect the hand of Christianity is against that of Nature, for are not the races of mankind the evolutionary harvest which Nature has toiled through long ages to produce? May we not say, then, that Christianity is anti-evolutionary in its aim?

*Evolution and Ethics*

Chapter 17 (p. 72)

G.P. Putnam's Sons. New York, New York, USA. 1947

The German Fuhrer, as I have consistently maintained, is an evolutionist; he has consciously sought to make the practice of Germany conform to the theory of evolution.

*Evolution and Ethics*

Chapter 40 (p. 230)

G.P. Putnam's Sons. New York, New York, USA. 1947

**King, Ben** 1857–94  
Poet

We seem to exist in a hazardous time,  
Driftin' along here through space;

Nobody knows just when we begun,  
Or how fur we've gone in the race.

*Ben King's Verse*

Evolution, Stanza 1

Forbes & Company. Chicago, Illinois, USA. 1903

**Kipling, Rudyard** 1865–1936  
British writer and poet

We are very slightly changed  
From the semi-apes who ranged  
India's prehistoric clay;  
He that drew the longest bow  
Ran his brother down, you know,  
As we run men down to-day.

*Rudyard Kipling's Verse*

A General Summary

Hodder & Stroughton. London, England. 1919

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

Evolution has made countless mistakes; for every existing species hundreds must have perished in the past; the fossil record is a waste-basket of the Chief Designer's discarded hypotheses. It is by no means unlikely that *Homo sapiens*, too, is the victim of some minute error in construction – perhaps in the circuitry of his nervous system – which makes him prone to delusions, and urges him toward self-destruction.

In Arne Tiselius and Sam Nilsson (eds.)

*The Place of Value in a World of Fact*

The Urge to Self Destruction (p. 298)

John Wiley & Sons, Inc. New York, New York, USA. 1970

**Leopold, Aldo** 1886–1948  
American naturalist

We know now what was unknown to all the preceding caravan of generations: that men are only fellow-voyagers with other creatures in the odyssey of evolution.

*A Sand County Almanac, with Essays on Conservation from Round River*

Part II, Wisconsin (p. 117)

Sierra Club. San Francisco, California, USA. 1970

**Levi, Primo** 1919–87  
Italian writer and chemist

...evolution has always proved itself to be enormously more intelligent than the best evolutionists.

Translated by Raymond Rosenthal

*Other People's Trades*

Inventing an Animal (p. 38)

Summit Books. New York, New York, USA. 1989

**Lewin, Roger Amos**  
Anthropologist

The central question of the Chicago conference was whether the mechanisms underlying microevolution can be extrapolated to explain the phenomena of



macroevolution. At the risk of doing violence to the positions of some of the people at the meeting, the answer can be given as a clear, No...

Evolution Theory Under Fire

*Science*, Volume 210, Number 4472, November 21, 1980 (p. 883)

How is it that trained men, the greatest experts of their day, could look at a set of modern human bones, the cranial fragments, and “see” a clear simian signature in them; and see in an apes jaw the unmistakable signs of humanity? The answers, inevitably, have to do with the scientist’s expectations and their effects on the interpretation of the data.

*Bones of Contention*

Chapter 3, The Taung Child: Rejection (p. 61)

Simon & Schuster Inc. New York, New York, USA. 1987

It is, in fact, a common fantasy, promulgated mostly by the scientific profession itself, that in the search for objective truth, data dictate conclusions. If this were the case, then each scientist faced with the same data would necessarily reach the same conclusion. But as we’ve seen earlier and will see again and again, frequently this does not happen. Data are just as often molded to fit preferred conclusions.

*Bones of Contention*

Chapter 4, The Taung Child: Accepted (p. 68)

Simon & Schuster Inc. New York, New York, USA. 1987

The key issue is the ability correctly to infer a genetic relationship between two species on the basis of a similarity in appearance, at gross and detailed levels of anatomy. Sometimes this approach...can be deceptive, partly because similarity does not necessarily imply an identical genetic heritage: a shark (which is a fish) and a porpoise (which is a mammal) look similar.

*Bones of Contention*

Chapter 6, Rama’s Ape Destroyed (p. 123)

Simon & Schuster Inc. New York, New York, USA. 1987

Racism, as we would characterize it today, was explicit in the writings of virtually all the major anthropologists of the first decades of this century, simply because it was the generally accepted world view. The language of the epic tale so often employed by Arthur Keith, Grafton Elliot Smith, Henry Fairfield Osborn, and their contemporaries fitted perfectly an imperialistic view of the world, in which Caucasians were the most revered product of a grand evolutionary march to nobility.

*Bones of Contention*

Chapter 13, Man’s Place in Nature (p. 307)

Simon & Schuster Inc. New York, New York, USA. 1987

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Lead us, Evolution, lead us,  
Up the future’s endless stair;  
Chop us, change us, prod us, weed us.  
For stagnation is despair:

Groping, guessing, yet progressing,  
Lead us nobody knows where.

*Poems*

Evolutionary Hymn

G. Bles. London, England. 1964

**Lewontin, Richard C.** 1929–

American evolutionary geneticist and philosopher of science

We take the side of science in spite of the patent absurdity of some of its constructs, in spite of its failure to fulfill many of its extravagant promises of health and life, in spite of the tolerance of the scientific community for unsubstantiated just-so stories, because we have a prior commitment, a commitment to materialism. It is not that the methods and institutions of science somehow compel us to accept a material explanation of the phenomenal world, but, on the contrary, that we are forced by our a priori adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations, no matter how counter-intuitive, no matter how mystifying to the uninitiated. Moreover, that materialism is an absolute, for we cannot allow a Divine Foot in the door.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997

The problem is to get [the creationists] to reject irrational and supernatural explanations of the world, the demons that exist only in their imaginations, and to accept a social and intellectual apparatus, Science, as the only begetter of truth. The reason that people do not have a correct view of nature is not that they are ignorant of this or that fact about the material world, but that they look to the wrong sources in their attempt to understand.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997

As to assertions without adequate evidence, the literature of science is filled with them, especially the literature of popular science writing. Carl Sagan’s list of the “best contemporary science-popularizers” includes E.O. Wilson, Lewis Thomas, and Richard Dawkins, each of whom has put unsubstantiated assertions or counterfactual claims at the very center of the stories they have retailed in the market.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997

Given the immense extent, inherent complexity, and counterintuitive nature of scientific knowledge, it is impossible for anyone, including non-specialist scientists, to retrace the intellectual paths that lead to scientific conclusions about nature. In the end we must trust the experts and they, in turn, exploit their authority as experts and their rhetorical skills to secure our attention and our belief in things that we do not really understand.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997



It is said that there is no place for an argument from authority in science. The community of science is constantly self-critical.... It is certainly true that within each narrowly defined scientific field there is constant challenge to new technical claims and to old wisdom.... But when scientists transgress the bounds of their own specialty they have no choice but to accept the claims of authority, even though they do not know how solid the grounds of those claims may be. Who am I to believe... quantum physics if not Steven Weinberg, or about the solar system if not Carl Sagan? What worries me is that they may believe what Dawkins and Wilson tell them about evolution.

Billions and Billions of Demons

*New York Review of Books*, January 9, 1997

Creationists have capitalized on scientific disputes among biologists on the details of the evolutionary process by pretending that serious students of the subject are themselves in doubt about evolution. Evolutionary study is a living science; as such it is rich with controversy about particular issues of detail and mechanism. Creationists have extracted published statements in those controversies and used them dishonestly to suggest that biologists are in doubt about the fact of organic evolution. Local school boards and students must clearly be impressed that scientists in universities seem themselves to be denying evolution.

*BioScience*, September, 1981 (p. 559)

The only alternative is to say that they did arise from muck because God's finger went out and touched that muck. That is to say, there was a non-natural process. And that's really where the action is. Either you think that complex organisms arose by non-natural phenomena, or you think that they arose by natural phenomena. If they arose by natural phenomena, they had to evolve. And that's all there is to it.

*The Electric Windmill: An Inadvertent Autobiography*

Agnostic Evolutionists (p. 205)

Regnery Gateway. Washington, D.C. 1988

[S]cience, like other productive activities, like the state, the family, sport, is a social institution completely integrated into and influenced by the structure of all our other social institutions. The problems that science deals with, the ideas that it uses in investigating those problems, even the so-called scientific results that come out of scientific investigation, are all deeply influenced by predispositions that derive from the society in which we live. Scientists do not begin life as scientists after all, but as social beings immersed in a family, a state, a productive structure, and they view nature through a lens that has been molded by their social experience.

*Biology as Ideology*

A Reasonable Skepticism (p. 3)

HarperCollins. New York, New York, USA. 1993

It is the great irony of modern evolutionary genetics that the spirit of explanation has moved more and more towards optimal adaptation, while the technical developments of population genetics of the past 30 years have been increasingly to show the efficacy of non adaptive forces in evolution.

A Natural Selection

*Nature*, Volume 339, Number 6220, 11 May, 1989 (p. 107)

### Long, J. M.

No biographical data available

To one not correctly informed, the word Evolution is full of materialistic and atheistic associations, as though it were a denial of the spirituality of man and the existence of God. Nothing can be farther from the truth than such an idea. Evolution, so far from aiming to set aside the idea of a first Creative Cause, claims to be the manifestation of a Power which no human thought can fully comprehend.

*The Synthetic Philosophy an Organon of the Sciences*

*The Kansas City Review of Science and Industry*, Volume 4, Number 11, March, 1881 (p. 650)

### Lull, Richard Swann 1867–1957

American paleontologist

Since Darwin's day, Evolution has been more and more generally accepted, until now in the minds of informed, thinking men there is no doubt that it is the only logical way whereby the creation can be interpreted and understood. We are not so sure, however, as to the modus operandi, but we may rest assured that the process has been in accordance with great natural laws, some of which are as yet unknown, perhaps unknowable.

*Organic Evolution*

Part I, Chapter I (p. 15)

The Macmillan Company. New York, New York, USA. 1961

The great heart of nature beats, its throbbing stimulates the pulse of life, and not until that heart is stilled forever will the rhythmic tide of evolution cease to flow.

*Organic Evolution*

Epilogue (p. 698)

The Macmillan Company. New York, New York, USA. 1961

### Lunn, Arnold 1888–1974

English writer

Whatever may befall this theory in the future, whether it is to be superseded by some other theory or not, Darwin's everlasting title to glory will be that he explained the seemingly marvelous adaptation of living things by the mere action of natural factors without looking to a divine intervention, without resorting to any finalist or metaphysical hypothesis.

*The Flight from Reason: A Study of the Victorian Heresay* (p. 68)

Eyre & Spottiswoode Ltd. London, England. 1932

### Lyell, Sir Charles 1797–1875

English geologist

...at successive periods of the past, the same area of land and water has been inhabited by species of animals and plants even more distinct than those which now people the antipodes, or which now co-exist in the arctic, temperate, and tropical zones.

*The Student's Elements of Geology* (3rd edition)

Chapter VIII (p. 125)

Harper & Brothers Publishers. New York, New York, USA. 1878

**Macartney, Frederick T.** 1887–1980

Australian poet

Man's evolution from the brute  
Affords him, with so many gains,  
Life, liberty and the pursuit  
Of peak-time buses, trams and trains.

*Gaily the Troubadour*

Pantoum: Aspects of Evolution

E.P. Dutton & Company, Inc. New York, New York, USA. 1936

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

The bees have existed for many thousands of years; we have watched them for ten or twelve lustres. And if it could even be proved that no change has occurred in the hive since we first opened it, should we have the right to conclude that nothing had changed before our first questioning glance? Do we not know that in the evolution of species a century is but as a drop of rain that is caught in the whirl of the river, and that millenaries glide as swiftly over the life of universal matter as single years over the history of a people?

*The Life of the Bee*

Chapter VIII (p. 369)

Dodd, Mead & Company. New York, New York, USA. 1929

**Margulis, Lynn** 1938–

American cell biologist and evolutionist

**Sagan, Dorion** 1959–

American science writer

Far from leaving microorganisms behind on an evolutionary "ladder," we are both surrounded by them and composed of them.

*Microcosmos*

Introduction (p. 14)

Summit Books. New York, New York, USA. 1986

As we examine ourselves as products of symbiosis over billions of years, the supporting evidence for our multimicrobe ancestry becomes overwhelming. Our bodies contain a veritable history of life on Earth. Our cells maintain an environment that is carbon- and hydrogen-rich, like that of the Earth when life began. They live in a medium of water and salts like the composition of the early seas. We became who we are by the coming together of bacterial partners in a watery environment. Although the evolutionary dynamics of DNA, genetic transfer, and

symbiosis were not discovered until almost a century after Charles Darwin's death in 1882, he had the shrewdness to write, "We cannot fathom the marvelous complexity of an organic being; but on the hypothesis here advanced this complexity is much increased. Each living creature must be looked at as a microcosm – a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars in heaven."

*Microcosmos*

Introduction (p. 18)

Summit Books. New York, New York, USA. 1986

Our bodies, like those of all life, preserve the environment of an earlier Earth. We coexist with present-day microbes and harbor remnants of others, symbiotically subsumed within our cells. In this way, the microcosm lives on in us and we in it.

*Microcosmos*

Introduction (p. 20)

Summit Books. New York, New York, USA. 1986

...a hydrogen-rich environment exposed to energy in the presence of carbon – conditions that certainly existed throughout our solar system, if not the universe – will, by the rules of chemistry, produce the building blocks of life.

*Microcosmos*

Chapter 2 (p. 52)

Summit Books. New York, New York, USA. 1986

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

From what flat wastes of cosmic slime,  
And stung by what quick fire,  
Sunward the restless races climb! –  
Men risen out of mire!

*Unrest*

**Maxwell, James Clerk** 1831–79

Scottish physicist

No theory of evolution can be formed to account for the similarity of molecules, for evolution necessarily implies continuous change, and the molecule is incapable of growth or decay, of generation or destruction.

Quoted in Frederick Soddy

*The Interpretation of Radium and the Structure of the Atom*

Chapter X (p. 215)

J. Murray. London, England. 1909

**Maynard Smith, John** 1920–2004

English evolutionary biologist

Thus, horses have very stiff backbones, and a consequence of this is that people can ride them. However, we would not say that the function of a horse's backbone is to enable people to ride horses, because we do not think that horse's backbones evolved as they did so as to enable people, in the future, to ride.

In G.A. Dover and R.B. Flavell (eds.)  
*Genome Evolution*  
 Special Volume  
 No. 20  
 Overview – Unsolved Evolutionary Problems (p. 378)

**Mayr, Ernst** 1904–2005  
 German-born American biologist

Why did it take so long for evolution to be seriously proposed? And why did Darwinism face such an uphill battle after it was proposed? The reason is that Darwin challenged some of the basic beliefs of his age. Four of them were pillars of Christian dogma.

*One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought*  
 Chapter Four (p. 38)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1991

There is indeed one belief that all true original Darwinians held in common, and that was their rejection of creationism, their rejection of special creation. This was the flag around which they assembled and under which they marched. When Hull claimed that “the Darwinians did not totally agree with each other, even over essentials”, he overlooked one essential on which all these Darwinians agreed. Nothing was more essential for them than to decide whether evolution is a natural phenomenon or something controlled by God. The conviction that the diversity of the natural world was the result of natural processes and not the work of God was the idea that brought all the so-called Darwinians together in spite of their disagreements on other of Darwin’s theories.

*One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought*  
 Chapter Seven (p. 99)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1991

We live in an age that places great value on molecular biology. Let me emphasize the equal importance of evolutionary biology. The very survival of man on this globe may depend on a correct understanding of the evolutionary forces and their application to man. The meaning of race, of the impact of mutation, whether spontaneous or radiation-induced, of hybridization, of competition – all these evolutionary phenomena are of the utmost importance for the human species. Fortunately the large number of biologists who continue to cultivate the evolutionary vineyard is an indication of how many biologists realize this: we must acquire an understanding of the operation of the various factors of evolution not only for the sake of understanding our universe, but indeed very directly for the sake of the future of man.

*Cold Spring Harbor Symposia on Quantitative Biology*  
 Genetics and Twentieth Century Darwinism, Where Are We?  
 Volume XXIV, 1959 (p. 13)  
 Cold Spring Harbor Laboratory. Cold Spring Harbor, New York, USA.

The demarcation between science and theology is perhaps easiest, because scientists do not invoke the supernatural to explain how the natural world works, and they do not rely on divine revelation to understand it. When early humans tried to give explanations for natural phenomena, particularly for disasters, invariably they invoked supernatural beings and forces, and even today divine revelation is as legitimate a source of truth for many pious Christians as is science. Virtually all scientists known to me personally have religion in the best sense of this word, but scientists do not invoke supernatural or divine revelation.

*This Is Biology: The Science of the Living World*  
 Chapter 2 (p. 33)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1997

The theory of evolution is quite rightly called the greatest unifying theory in biology.

*Populations, Species, and Evolution*  
 Chapter 1 (p. 1)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1970

The basic framework of the theory is that evolution is a two-stage phenomenon: the production of variation and the sorting of the variants by natural selection. Yet agreement on this basic thesis does not mean that the work of the evolutionist is completed. The basic theory is in many instances hardly more than a postulate and its application raises numerous questions in almost every concrete case.

*Populations, Species, and Evolution*  
 Chapter 1 (p. 6)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1970

The occurrence of genetic monstrosities by mutation, for instance the homeotic mutant in *Drosophila*, is well substantiated, but they are such evident freaks that these monsters can be designated only as “hopeless.” They are so utterly unbalanced that they would not have the slightest chance of escaping elimination through stabilizing selection. Giving a thrush the wings of a falcon does not make it a better flier. Indeed, having all the other equipment of a thrush, it would probably hardly be able to fly at all. It is a general rule, of which every geneticist and breeder can give numerous examples, that the more drastically a mutation affects the phenotype, the more likely it is to reduce fitness. To believe that such a drastic mutation would produce a viable new type, capable of occupying a new adaptive zone, is equivalent to believing in miracles.

*Populations, Species, and Evolution*  
 Chapter 15 (p. 253)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1970

The finding of a suitable mate for the “hopeless monster” and the establishment of reproductive isolation from the

normal members of the parental population seem to me insurmountable difficulties [of survival].

*Populations, Species, and Evolution*

Chapter 15 (p. 253)

Harvard University Press. Cambridge, Massachusetts, USA. 1970

Every anti-evolutionist prior to 1859 allowed for the intermittent, if not constant, interference by the Creator. The natural causes postulated by the evolutionists completely separated God from his creation, for all practical purposes. The new explanatory model replaced planned teleology by the haphazard process of natural selection. This required a new concept of God and a new basis for religion.

The Nature of the Darwinian Revolution

*Science*, Volume 176, Number 4038, June 2, 1972 (p. 988)

Evolutionary biology, in contrast with physics and chemistry, is a historical science – the evolutionist attempts to explain events and processes that have already taken place. Laws and experiments are inappropriate techniques for the explication of such events and processes. Instead one constructs a historical narrative, consisting of a tentative reconstruction of the particular scenario that led to the events one is trying to explain.

Darwin's Influence on Modern Thought

*Scientific American*, Volume 283, Number 1, July 2000 (p. 80)

Anything truly novel always seemed to appear quite abruptly in the fossil record.

*Toward a New Philosophy of Biology: Observations of an Evolutionist*

On the Evolutionary Synthesis and After (p. 530)

Harvard University Press. Cambridge, Massachusetts, USA. 1988

I am taking a new look at the Darwinian revolution of 1859, perhaps the most fundamental of all intellectual revolutions in the history of mankind. It not only eliminated man's anthropocentrism, but affected every metaphysical and ethical concept, if consistently applied.

The Nature of the Darwinian Revolution

*Science*, Volume 176, Number 4038, June 2, 1972 (p. 981)

It is quite true, as several recent authors have indicated, that Darwin's book was misnamed, because it is a book on evolutionary changes in general and the factors that control them (selectivity, and so forth), but not a treatise on the origin of species.

*Systematics and The Origin of Species*

Chapter VII (p. 147)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

In high school I read Haeckel's *Weltratsel* naively and avidly, not as a guide to evolutionary studies but to have ammunition in arguments about the Bible and religion!

*The Evolutionary Synthesis*

Biographical Essay (p. 413)

Harvard University Press. Cambridge, Massachusetts, USA. 1980

## McCloud, James

No biographical data available

Progressive evolution is the universal plan. Everything which we meet in the world around us, matter and mind, every individual and all congregated masses, begin their course as germs and unfold in slow progression.... The faculties of all intelligent creation, all that you call mind, all that you call heart, are framed for an interminable series of evolutions.... It is not mainly the mould of this mighty frame of things which establishes it, it is the fact that creation is eternally unfolding new resources and presenting itself under successive and amazing combinations of which no creature in the universe had imagined it capable.

In Frances Mason

*Creation by Evolution*

Why Must We Be Evolutionists? (p. 23)

The Macmillan Company. New York, New York, USA. 1928

## Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

## Medawar, J. S.

No biographical data available

For a biologist the alternative to thinking in evolutionary terms is not to think at all.

*The Life Science: Current Ideas of Biology*

Chapter Two (p. 24)

Harper & Row Publishers. New York, New York, USA. 1977

...the testimony of Design is only for those who, secure in their beliefs already, are in no need of confirmation. This is just as well, for there is no theological comfort in the ampliation of DNA and it is no use looking to evolution. The balance sheet of evolution has so closely written a debit column of all the blood and pain that goes with the natural process that not even the smoothest accountancy can make the transaction seem morally solvent to any standards of morals that human beings are accustomed to.

*The Life Science: Current Ideas of Biology*

Chapter Twenty-Three (p. 169)

Harper & Row Publishers. New York, New York, USA. 1977

## Miller, Kenneth R. 1948–

American biology professor and author

We know from astronomy that the universe had a beginning, from physics that the future is both open and unpredictable, from geology and paleontology that the whole of life has been a process of change and transformation. From biology we know that our tissues are not impenetrable reservoirs of vital magic, but a stunning matrix of complex wonders, ultimately explicable in terms of

biochemistry and molecular biology. With such knowledge we can see, perhaps for the first time, why a Creator would have allowed our species to be fashioned by the process of evolution.

*Finding Darwin's God*

Chapter 9 (p. 290)

HarperCollins Publishers, Inc. New York, New York, USA. 1999

### Moody, Paul

No biographical data available

Does not science prove that there is no Creator? Emphatically, science does not prove that! Actually science proves nothing about first causes at all.

*Introduction to Evolution* (2nd edition) (p. 513)

Harper & Brothers Publishers. New York, New York, USA. 1953

The more I study science the more I am impressed with the thought that this world and universe have a definite design and a design suggests a designer. It may be possible to have a design without a designer, a picture without an artist, but my mind is unable to conceive of such a situation.

*Introduction to Evolution* (2nd edition) (p. 514)

Harper & Brothers Publishers. New York, New York, USA. 1953

### Morley, John First Viscount Morley

**of Blackburn** 1838–1923

British statesman and writer

Evolution is not a force, but a process; not a cause, but a law.

*On Compromise*

Chapter V (p. 210)

Macmillan & Company Ltd. London, England. 1886

### Morris, Desmond 1928–

Zoologist and ethnologist

There are one hundred and ninety-three living species of monkeys and apes. One hundred and ninety-two of them are covered with hair. The exception is a naked ape self-named *Homo sapiens*. This unusual and highly successful species spends a great deal of time examining his higher motives and an equal amount of time studiously ignoring his fundamental ones. He is proud that he has the biggest brain of all the primates, but attempts to conceal the fact that he also has the biggest penis, preferring to accord this honour falsely to the mighty gorilla. He is an intensely vocal, acutely exploratory, over-crowded ape, and it is high time we examined his basic behavior.

*The Naked Ape*

Introduction (p. 9)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

### Morris, Henry 1918–2006

American creationist

Evolution is the root of atheism, of communism, Nazism, behaviorism, racism, economic imperialism, militarism,

libertinism, anarchism, and all manner of anti-Christian systems of belief and practice.

*The Remarkable Birth of Planet Earth*

Chapter VII (p. 75)

Creation-Life Publishers. San Diego, California, USA. 1972

### Muggeridge, Malcolm 1903–80

English journalist and social critic

I myself am convinced that the theory of evolution, especially the extent to which it's been applied, will be one of the great jokes in the history books of the future. Posterity will marvel that so very flimsy and dubious an hypothesis could be accepted with the incredible credulity that it has.

*The Advocate*, March 8, 1984 (p. 17)

### Neaves, Lord Charles 1800–76

English author

Pouter, tumbler and fantail are from the same source; The racer and hack may be traced to one horse; So men were developed from monkeys of course Which nobody can deny.

In John Burroughs (ed.)

*Songs of Nature*

The Origin of Species

Doubleday, Page & Company. Garden City, New York, USA. 1912

### Newman, H. H.

No biographical data available

There are no rival hypotheses except the outworn and completely refuted idea of special creation, now retained only by the ignorant, the dogmatic, and the prejudiced.

*Evolution, Genetics, and Eugenics*

Chapter III (p. 51)

Greenwood Press Publishers. New York, New York, USA. 1969

### Newman, John Henry 1907–66

Mathematician and mathematical historian

...I see nothing in the theory of evolution inconsistent with an Almighty Creator and Protector.

*Letters and Diaries*

Letter to David Brown, 4 April, 1874 (p. 44)

### Oparin, Alexander Ivanovich 1894–1980

Russian biochemist

From our point of view, therefore, the modern process of evolution of living organisms is fundamentally nothing more than the addition of some new links to an endless chain of transformations of matter, a chain the beginning of which extends to the very dawn of existence of our planet.

*The Origin of Life*

Chapter VIII (p. 245)

Dover Publications, Inc. New York, New York, USA. 1953



**Osborn, Henry Fairfield** 1857–1935  
American paleontologist and geologist

In truth, from the period of the earliest stages of Greek thought man has been eager to discover some natural cause of evolution, and to abandon the idea of supernatural intervention in the order of nature.

*The Origin and Evolution of Life* (pp. ix–x)  
Charles Scribner's Sons. New York, New York, USA. 1918

**Patterson, Colin** 1933–98  
English paleontologist

...it seemed obvious to [Darwin] that, if his theory of evolution [were] correct, fossils ought to provide incontrovertible proof of it, since each stratum should contain links between the species of earlier and later strata, and if sufficient fossils were collected, it would be possible to arrange them in ancestor descendent sequences and so build up a precise picture of the course of evolution. This was not so in Darwin's time, and today, after more than another hundred years of assiduous fossil collecting, the picture still has extensive gaps.

*Evolution*  
Chapter 11–2 (p. 128)  
British Museum of Natural History. London, England. 1978

Fossils may tell us many things, but one thing they can never disclose is whether they were ancestors of anything else.

*Evolution*  
Chapter 11–2 (p. 133)  
British Museum of Natural History. London, England. 1978

...we must ask first whether the theory of evolution by natural selection is scientific or pseudoscientific.... Taking the first part of the theory, that evolution has occurred, it says that the history of life is a single process of species-splitting and progression. This process must be unique and unrepeatable, like the history of England. This part of the theory is therefore a historical theory, about unique events, and unique events are, by definition, not part of science, for they are unrepeatable and so not subject to test.

*Evolution*  
Chapter 12–2 (p. 145)  
British Museum of Natural History. London, England. 1978

Just as pre-Darwinian biology was carried out by people whose faith was in the Creator and His plan, post-Darwinian biology is being carried out by people whose faith is in, almost, the deity of Darwin. They've seen their task as to elaborate his theory and to fill the gaps in it, to fill the trunk and twigs of the tree. But it seems to me that the theoretical framework has very little impact on the actual progress of the work in biological research. In a way some aspects of Darwinism and of neo-Darwinism seem to me to have held back the progress of science.

*The Listener*, October 8, 1981 (p. 392)

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist and author

In short, evolution is not so much progress as it is simply change. It does not leave all its primitive forms behind. It carries them over from age to age, well knowing that they are the precious base of the pyramid on which the more fantastic and costly experiments must be carried.

*An Almanac for Moderns*  
April Eighteenth (p. 31)  
G.P. Putnam's Sons. New York, New York, USA. 1935

Evolution is not a mere product of life, like starch or blood; it is a part of life itself, just as flow is part of a river.

*An Almanac for Moderns*  
July Twenty-Eighth (p. 141)  
G.P. Putnam's Sons. New York, New York, USA. 1935

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

The evolution of life on earth, or of human society, is a unique historical process. [From such] a process, we may assume, for example, the laws of mechanics, of chemistry, of heredity and segregation, of natural selection, etc. Its description, however, is not a law but only a singular historical statement.

*The Poverty of Historicism*  
Chapter IV (p. 108)  
The Beacon Press. Boston, Massachusetts, USA. 1957

**Proctor, Richard Anthony** 1837–88  
English astronomer

It is singular that the theory which – of all those advanced since Newton established the law of gravitation – has given to thoughtful minds the grandest conceptions of Nature and the laws of Nature, should have been, of all theories perhaps ever suggested by man, the most thoroughly misunderstood. There can be no doubt that many who recognise the real significance of the theory of natural development, who know that its influence is by no means limited to biological evolution, but has been felt in the far wider – the infinitely wide – field of cosmical evolution, have been pained by the thought that with the widening of the domain of development, the belief in a power working in and through all things seems to be set on one side in the name of universal evolution.

*Mysteries of Time and Space*  
Newton and Darwin (p. 1)  
R. Worthington  
New York, New York, USA. 1883

**Proudfit, David Law** 1842–97  
American poet

A man sat on a rock and sought  
Refreshment from his thumb;  
A dinotherium wandered by



And scared him some.  
His name was Smith.  
The kind of rock  
He sat upon was shale.  
One feature quite distinguished him:  
He had a tail.

In Frederic Lawrence Knowles  
*A Treasury of Humorous Poetry*  
Prehistoric Smith (p. 106)  
Colonial Press. Boston, Massachusetts, USA. 1902

**Purcell, Rosamond** 1933–2004  
American critic and writer

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

Evolution is a quirky take of old structures pressed and altered to new functions.

*Illuminations: A Bestiary*  
Angler Fish (p. 23)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Reade, Winwood** 1838–75  
Philosopher and historian

There is a certain class of people who prefer to say that their fathers came down in the world through their own follies than to boast that they rose in the world through their own industry and talents. It is the same shabby-genteel sentiment, the same vanity of birth, which makes men prefer to believe that they are degenerated angels, rather than elevated apes.

*The Martyrdom of Man*  
Chapter III, Amphibious Mankind (p. 351)  
E.P. Dutton & Company. New York, New York, 1926

**Roberts, Catherine**  
No biographical data available

Derived from the Latin *e* (out) and *volvere* (to roll), the basic meaning of evolve is to roll out, unfold, develop. Thus, despite the seemingly random and fortuitous nature of many of the hereditary variations that permanently alter evolving individuals and populations, the scientific age generally regards the evolution of life on earth as a continuous progression from the simple to the complex and more highly organized, which has culminated in a biosphere dominated by man.

*Science, Animals, and Evolution: Reflections on Some Unrealized Potentials of Biology and Medicine*  
Introduction (p. 3)  
Greenwood Press Publishers. Westport, Connecticut, USA. 1980

**Ruse, Michael** 1940–  
English historian and philosopher of science

...one often sees it said that “evolution is not a fact, but a theory.” Is this the essence of my claim? Not really! Indeed, I suggest that this wise-sounding statement is confused to the point of falsity: it almost certainly

is if, without regard for cause, one means no more by “evolution” than the claim that all organisms developed naturally from primitive beginnings. Evolution is a fact, fact, FACT!

*Darwinism Defended: A Guide to the Evolution Controversies*  
Part I, Chapter 2 (p. 58)  
Addison-Wesley, Advanced Book Program. Reading, Massachusetts, USA. 1982

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

It appears that during those ages when animals were torturing each other with ferocious horns and agonizing stings, Omnipotence was quietly waiting for the ultimate emergence of man, with his still more widely diffused cruelty. Why the Creator should have preferred to reach his goal by a process, instead of going straight to it, these modern theologians do not tell us.

*Religion and Science*  
Evolution (p. 80)  
Henry Holt & Company. New York, New York, USA. 1935

That Man is the product of causes which had no provision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and beliefs, are but the outcome of accidental collocations of atoms... that all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of Man’s achievement must inevitably be buried beneath the debris of a universe in ruins – all these things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand. Only within the scaffolding of unyielding despair, can the soul’s habitation henceforth be safely built.

*Mysticism and Logic and Other Essays*  
Chapter III (p. 47)  
Longmans, Green & Company. London, England. 1925

**Sagan, Carl** 1934–96  
American astronomer and author

We are the product of 4.5 billion years of fortuitous, slow, biological evolution. There is no reason to think that the evolutionary process has stopped. Man is a transitional animal. He is not the climax of creation.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 1 (p. 5)  
Dell Publishing, Inc. New York, New York, USA. 1975

Life forms developed that were finely attuned to their specific environments, exquisitely adapted to the conditions. But the conditions changed. The organisms were too specialized. They died. Other organisms were less well adapted, but they were more generalized. The conditions changed, the climate varied, but the organisms were able to continue. Many more species of organisms have

died during the history of the Earth than are alive today. The secret of evolution is time and death.

*Cosmic Connection: An Extraterrestrial Perspective*

Chapter 1 (p. 5)

Anchor Press/Doubleday. Garden City, New York, USA. 1973

A being quite like us, but with a small physiological difference – a third eye, say or blue hair covering the nose and forehead – somehow evokes feelings of revulsion. Such feelings may have had adaptive value at one time in defending our small tribe against the beasts and neighbors. But in our time such feelings are obsolete and dangerous.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 1 (p. 7)

Dell Publishing, Inc. New York, New York, USA. 1975

Occasionally someone remarks on what a lucky coincidence it is that the Earth is perfectly suitable for life – moderate enough temperatures, liquid water, oxygen atmosphere, and so on. But this is, at least in part, a confusion of cause and effect. We earthlings are supremely well adapted to the environment of the Earth because we grew up here. Those earlier forms of life that were not well adapted died. We are descended from the organisms that did well. Organisms that evolve on a quite different world will doubtless sing its praises too.

*Cosmos*

Chapter II (p. 24)

Random House, Inc. New York, New York, USA. 1980

The pattern of evolutionary causality is a web of astonishing complexity; the incompleteness of our understanding humbles us.

*Cosmos*

Chapter XI (p. 234)

Ballentine Books. New York, New York, USA. 1985

**Savage, Jay Mathers** 1928–

No biographical data available

No serious biologist today doubts the fact of evolution... the fact of evolution is amply clear.... We do not need a listing of evidences to demonstrate the fact of evolution anymore than we need to demonstrate the existence of mountain ranges.

*Evolution*

Preface (pp. v, vi)

Holt, Rinehart & Winston. New York, New York, USA. 1963

**Schaffer, E. A.**

No biographical data available

...setting aside as devoid of scientific foundation the idea of immediate supernatural intervention in the first production of life, we are not only justified in believing, but compelled to believe, that living matter must have owed its origin to causes similar in character to those which have been instrumental in producing all other forms of matter in the universe, in other words, to a process of gradual evolution.

In J. Keosian

*The Origin of Life*

Chapter Two (p. 12)

Reinhold Book Corporation. New York, New York, USA. 1964

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Those whom we called brutes had their revenge when Darwin showed us that they were our cousins.

*The Revolutionist's Handbook & Pocket Companion*

Maxims for Revolutionists, Time's Revenges (p. 58)

USA. 1962

No doubt it is natural to a snail to think that any evolution which threatens to do away with shells will result in general death from exposure.

In Dan H. Laurence (ed.)

*Shaw's Music: The Complete Music Criticism in Three Volumes*

(Volume 3)

The Perfect Wagnerite, Not Love, But Life

M. Reinhardt. London, England. 1981

The pursuit of omnipotence and omniscience. Greater power and greater knowledge: these are what we are all pursuing even at the risk of our lives and the sacrifice of our pleasures. Evolution is that pursuit and nothing else. It is the path to godhead. A man differs from a microbe only in being further on the path.

*Back to Methuselah*

Part II, XXXIII (p. 76)

Constable & Company Ltd. London, England. 1921

**Sherrington, Sir Charles** 1857–1952

English physiologist

Nature, often as she hugs the old, seems seldom or never to revert to a past once abandoned.... Evolution can scrap but not revive.

*Man on His Nature*

Chapter V (p. 135)

Doubleday Anchor Books. Garden City, New York, USA. 1955

**Simpson, George Gaylord** 1902–84

American paleontologist

Until comparatively recently, many – probably most – biologists agreed with Darwin that the problem of the origin of life was not yet amenable to scientific study. Now, however, almost all biologists agree that the problem can be attacked scientifically. The consensus is that life did arise naturally from the nonliving and that even the first living things were not specially created.

*This View of Life: The World of an Evolutionist*

Chapter One (p. 11)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

Organic evolution is one of the basic facts and characteristics of the objective world. From one point of view it is the basic thing about that world, because it is the process by which the universe's greatest complexities arise and systematic organization culminates. Being the process by which we ourselves came to be, it is crucial

for comprehension of our place in and relationship to the objective world.

*This View of Life: The World of an Evolutionist*

Preface (p. vii)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

Suppose that the most fundamental and general principle of a science had been known for over a century and had long since become a main basis for understanding and research by scientists in that field. You would surely assume that the principle would be taken as a matter of course by everyone with even a nodding acquaintance with the science. It would obviously be taught everywhere as basic to the science at any level of education. If you think that about biology, however, you are wrong. Evolution is such a principle in biology. Although almost everyone has heard of it, most Americans have only the scantest and most distorted idea of its real nature and significance.

*This View of Life: The World of an Evolutionist*

Chapter Two (p. 26)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

The basic problems of evolution are so broad that they cannot hopefully be attacked from the point of view of a single scientific discipline.

*Tempo and Mode in Evolution*

Introduction (p. xv)

Columbia University Press. New York, New York, USA. 1944

The fact that theories are not subject to absolute and final proof has led to a serious vulgar misapprehension. Theory is contrasted with fact as if the two had no relationship or were antitheses: "Evolution is only a theory, not a fact." Of course, theories are not facts. They are generalizations about facts and explanations of facts, based on and tested by facts. As such they may be just as certain – merit just as much confidence – as what are popularly termed "facts." Belief that the sun will rise tomorrow is the confident application of a generalization. The theory that life has evolved is founded on much more evidence than supports the generalization that the sun rises every day. In the vernacular, we are justified in calling both "facts."

*Life: An Introduction to Biology* (2nd edition)

Chapter 1 (p. 16)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

Evolution has no purpose; man must supply this for himself.

*The Meaning of Evolution*

Part III, Chapter XIX (p. 311)

Yale University Press. New Haven, Connecticut, USA. 1967

It has been said by some theorists that cases like that of the crocodile, virtually unchanged for 100 million years and more, represent a failure of the evolutionary force, a blind alley, a long senescence. As I gazed at my antagonist, it occurred to me how false this is. Here was no

failure but an adaptation so successful that once developed it has never needed to change. Is it, perhaps, not the success but the failure of adaptation that has forced evolving life onward to what we, at least, consider higher levels?

*The Dechronization of Sam Magruder*

The Dechronization of Sam Magruder (p. 55)

St. Martin's Press. New York, New York, USA. 1996

...The fossil record shows very clearly that there is no central line leading steadily, in a goal-directed way, from a protozoan to man. Instead there has been continual and extremely intricate branching, and whatever course we follow through the branches there are repeated changes both in the rate and in the direction of evolution. Man is the end of one ultimate twig... Even slight changes in earlier parts of the history would have profound cumulative effects on all descendent organisms through the succeeding millions of generations.... The existing species would surely have been different if the start had been different, and if any stage of the histories of organisms and their environments had been different. Thus the existence of our present species depends on a very precise sequence of causative events through some two billion years or more. Man cannot be an exception to this rule. If the causal chain had been different, *Homo sapiens* would not exist.

The Nonprevalence of Humanoids

*Science*, Volume 143, Number 3608, February 21, 1964 (p. 773)

### **Skinner, Cornelia Otis** 1901–79

American actress and writer

It is disturbing to discover in oneself these curious revelations of the validity of the Darwinian theory. If it is true that we have sprung from the ape, there are occasions when my own spring appears not to have been very far.

*The Ape in Me*

The Ape in Me (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1959

### **Smith, Langdon** 1858–1908

American poet

When you were a tadpole and I was a fish,  
In the Paleozoic time,  
And side by side on the ebbing tide,  
We sprawled through the ooze and slime...  
My heart was rife with the joy of life,  
For I loved you even then.

In E. Halderman-Julius

*Poems of Evolution*

Evolution

Halderman-Julius. Girard, Kansas, USA. 1924

In the mud of the Cambrian main  
Did our earliest ancestor dive: From a shapeless albuminous grain  
We mortals our being derive.

He could split himself up into five,  
Or roll himself round like a ball;  
For the fittest will always survive,  
While the weakest go to the wall.

*Evolution: A Fantasy*

A Ballade of Evolution Stanza I

John W. Luce & Co. Boston, Massachusetts, USA. 1915

The theologians, who from the beginning of time have accredited themselves as the custodians of all fundamental truth having, by hasty discards of old dogmas, survived the shock of learning that the earth is round, and that the sun, moon and stars are held in place in the universe by the force of gravity, continued to hold as they had for some four thousand years to the theory of individual creation as set forth by the biblical authors. In the main this proposition had passed unchallenged even by scientists, though before Darwin, as he is at pains to record with all possible detail, some naturalists, to make use of a very general term, expressed the opinion that changed conditions of life had given rise to a sufficient differentiation in individual forms to create new species. Nor did Philosophy herself in those days steer her bark far enough from the shores of dogma to catch the broad sweeping current of the law of change.

*Evolution, A Fantasy*

Fifty Years of Evolution (p. 45)

Luce & Co. 1909

### Sonneberg, Walter

No biographical data available

Evolution is readily accepted as a theory because it implies that we are approaching perfection.

*Social Eccentricities*

Social Eccentricities (p. 2)

Broadway Publishing Co. New York, New York, USA. 1906

### Spencer, Herbert 1820–1903

English social philosopher

If a single cell, under appropriate conditions, becomes a man in the space of a few years, there can surely be no difficulty in understanding how, under appropriate conditions, a cell may, in the course of untold millions of years give origin to the human race.

*The Principles of Biology* (Volume 1)

Part III, Chapter III, Section 118 (p. 350)

D. Appleton & Company. New York, New York, USA. 1897

Slowly, but surely, evolution brings about an increasing amount of happiness; all evils being but incidental.

*The Principles of Biology* (Volume 1)

Part II, Chapter III, Section 120 (p. 354)

D. Appleton & Company. New York, New York, USA. 1897

The survival of the fittest, which I have here sought to express in mechanical terms, is that which Mr. Darwin has called “natural selection, or the preservation of favoured races in the struggle for life.”

*The Principles of Biology* (Volume 1)

Part III, Chapter XII, Section 165 (pp. 444–445)

D. Appleton & Company. New York, New York, USA. 1897

...universal evolution is in itself the negation of an absolute commencement of anything. Construed in terms of evolution, every kind of being is conceived as a product of modification wrought by insensible gradations upon a preexisting kind of being; and this holds as fully of the supposed “commencement of organic life” as of all subsequent developments of organic life.... That organic matter was not produced all at once, but was reached through steps, we are well warranted in believing by the experiences of chemists.

*The Principles of Biology* (Volume 1)

On Alleged “Spontaneous Generation” and on the Hypothesis of Physiological Units (p. 482)

D. Appleton & Company. New York, New York, USA. 1897

### Stanier, R. Y.

No biographical data available

It might have happened thus; but we shall surely never know with certainty. Evolutionary speculation constitutes a kind of metascience, which has the same intellectual fascination for some biologists that metaphysical speculation possessed for some medieval scholastics. It can be considered a relatively harmless habit, like eating peanuts, unless it assumes the form of an obsession; then it becomes a vice.

In H.P. Charles and B.C. Knight (eds.)

*Organization and Control in Prokaryotic Cells. Twentieth Symposium of the Society for General Microbiology*

Some Aspects of the Biology of Cells and Their Possible Evolutionary Significance (p. 31)

Cambridge University Press. Cambridge, England. 1970

### Teilhard de Chardin, Pierre 1881–1955

French Jesuit, paleontologist, and biologist

Is evolution a theory, a system, or a hypothesis? It is much more – it is a general postulate to which all theories, all hypotheses, all systems must henceforward bow and which they must satisfy in order to be thinkable and true. Evolution is a light which illuminates all facts, a trajectory which all lines of thought must follow – this is what evolution is.

In Theodosius Dobzhansky

Nothing in Biology Makes Sense Except in the Light of Evolution

*The American Biology Teacher*, Volume 35, Number 3, March, 1973 (p. 129)

### Tennyson, Alfred (Lord) 1809–92

English poet

Evolution ever climbing after some ideal good  
And Reversion ever dragging Evolution in the mud.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Sixty Years After, Stanza 100

Oxford University Press, Inc. London, England. 1953

As nine months go to the shaping an infant ripe for his birth,  
So many a million of ages have gone to the making of man.

*Alfred Tennyson's Poetical Works*

Maude, Part I, Section IV, Stanza VI

Oxford University Press, Inc. London, England. 1953

**Thomas, Lewis** 1913–93

American physician and biologist

In evolutionary terms, we have only just arrived.... We cannot trace ourselves back more than a few thousand years before losing sight of what we think of as the real human article.... And [we are] vulnerable, error-prone still, at risk of leaving only a thin layer of radioactive fossils.

In Lynn Margulis and Dorion Sagan

*Microcosmos*

Foreword (pp. 10, 11)

Summit Books. New York, New York, USA. 1986

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The Evolution-idea is a master-key that opens many doors. It is a luminous interpretation of the world, throwing the light of the past upon the present.

*The Outline of Science* (Volume 1)

Chapter II (p. 55)

G.P. Putnam's Sons. New York, New York, USA. 1937

Organic evolution means that the present is the child of the past and the parent of the future.

*The Outline of Science* (Volume 1)

Chapter II (p. 56)

G.P. Putnam's Sons. New York, New York, USA. 1937

Evolution just means that the present is the child of the past and the parent of the future.

In Francis Mason (ed.)

*Creation by Evolution*

Why Must We Be Evolutionists? (p. 13)

The Macmillan Company. New York, New York, USA. 1928

...we must bear in mind the fact that millions of years are spent in the fashioning of minutiae of perfection in types which are certainly not near the highway of evolution that led to backboned animals and eventually to man. Nothing is too remote, too minute, too trivial – everything must be finished and refined.

*The System of Animate Nature* (Volume 2)

Lecture XII (p. 394)

William & Norgate. London, England. 1920

**Torrey, Ray Ethan** 1887–1956

Botanist

All of us are human beings first and scientists afterwards, and the laws of evolution which we have seen written in the plant world are the laws of evolution of all life – of your life and of mine. In studying these laws in their universal application you may, if you will, find some of the deepest satisfactions which life has to offer, and, as

the years go by, you may slowly win to the concept of a living, organic universe whose highest values are not alien to those of human nature.

*General Botany for Colleges*

Summary (p. 431)

The Century Company. New York, New York, USA. 1932

**Trevelyan, George Macaulay** 1876–1962

English historian

Man's evolution is far more extraordinary than the first chapter of Genesis used to lead people to suppose. Man's history, pre-history, ancient, medieval and modern, is by far the most wonderful thing in the Universe [about] which any news has come through to us.

*History and the Reader* (pp. 24–25)

Cambridge University Press. London, England. 1945

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Evolution is the law of policies: Darwin said it, Socrates endorsed it, Cuvier proved it and established it for all time in his paper on "The Survival of the Fittest." These are illustrious names, this is a mighty doctrine: nothing can ever remove it from its firm base, nothing dissolve it, but evolution.

In John Tukey (ed.)

*Mark Twain's Which Was the Dream? And Other Symbolic Writings of the Later Years.*

Three Thousand Years Among the Microbes, Chapter 8 (pp. 467–468)

University of California Press. Berkeley, California, USA. 1968

...it now seems plain to me that that theory ought to be vacated in favor of a new and truer one...the Descent of Man from the Higher Animals.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Man's Place in the Animal World (p. 207)

The Library of America. New York, New York, USA. 1992

...you cannot make an oyster out of whole cloth, you must make the oyster's ancestor first. This is not done in a day. You must make a vast variety or invertebrates, to start with – belemnites, trilobites, jebustites, Amalekites, and that sort of fry, and put them to soak in a primary sea, and wait and see what will happen.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Was the World Made for Man? (p. 573)

The Library of America. New York, New York, USA. 1992

Man has been here 32,000 years. That it took a hundred million years to prepare the world for him is proof that that is what it was done for. I suppose it is. I dunno. If the Eiffel tower were now representing the world's age, the skin of paint on the pinnacle-knob at its summit would represent man's share of that age; & anybody would perceive that that skin was what the tower was built for. I reckon they would. I dunno.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Was the World Made for Man? (p. 576)

The Library of America. New York, New York, USA. 1992



**Tyndall, John** 1820–93  
Irish-born English physicist

It [the evolutionary hypothesis] does not solve – it does not profess to solve – the ultimate mystery of this universe. It leaves, in fact, that mystery untouched. For, granting the nebula and its potential life, the question whence they came would still remain to baffle and bewilder us. At bottom the hypothesis does nothing more than “transport the conception of life’s origin to an indefinitely distant past.”

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 2)  
Chapter VIII (p. 133)  
D. Appleton & Co. New York, New York, USA. 1896

**Wald, George** 1906–97  
American biologist and biochemist

Evolution advances, not by a priori design, but by the selection of what works best out of whatever choices offer. We are the products of editing, rather than of authorship.

The Origin of Optical Activity  
*Annals of the New York Academy of Science*, Volume 66, 1957 (p. 367)

**Wallace, David Rains**  
No biographical data available

Evolution has no sense of history. It does not abandon past accomplishments to the fossil museum, but continues to play with them as though they’d happened yesterday.

*The Klamath Knot: Explorations of Myth and Evolution*  
Primal Ooze (p. 45)  
Sierra Club Book. San Francisco, California, USA. 1983

**Wallin, Ivan E.** 1883–1969  
American biologist

Organic evolution may be likened to a mammoth, creeping, kaleidoscopic procession which began to move when life first appeared upon earth. In the beginning the procession was small. With the passing eons of time, there has been an ever increasing multitude, slowly, but steadily, moving forward. New forms have constantly joined the procession, and old forms have dropped out. We have not been able to look back into the distant past and learn from when the procession started; we are not able to look forward into the future and predict where the procession means to go; we are only trying to analyze and determine the nature of the factors responsible for the kaleidoscopic nature of the procession as it appears today.

*Symbioticism and The Origin of Species*  
Chapter X (p. 147)  
Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**Watson, James D.** 1928–  
American geneticist and biophysicist

Today, evolution is an accepted fact for everyone but a fundamentalist minority, whose objections are not based

on reasoning but on doctrinaire adherence to religious principles.

*Molecular Biology of the Gene* (5th edition)  
Chapter I (p. 5)  
Benjamin Cummings. San Francisco, California, USA. 2004

Evolution itself is accepted by zoologists not because it has been observed to occur or is supported by logically coherent arguments, but because it does fit all the facts of taxonomy, of palaeontology, and of geographical distribution, and because no alternative explanation is credible.

Adaptation  
*Nature*, Volume 124, Number 3119, August 10, 1929 (p. 231)

**Watts, Alan Wilson** 1915–73  
American philosopher

Things which are made, such as houses, furniture, and machines, are an assemblage of parts put together, or shaped, like sculpture, from the outside inwards. But things which grow shape themselves from within outwards.

*Nature, Man, and Woman*  
Part I, Chapter 1 (p. 39)  
Vintage Books. New York, New York, USA. 1970

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

It is possible to believe that all the past is but the beginning of a beginning, and that all that is and has been is but the twilight of the dawn. It is possible to believe that all that the human mind has ever accomplished is but the dream before the awakening. A day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars.

*The Discovery of the Future* (p. 61)  
B.W. Huebsch. New York, New York, USA. 1913

...no rational mind can question the invincible nature of the evolutionary case.

*Mind at the End of Its Tether*  
Chapter VIII (p. 29)  
William Heinemann Ltd. London, England. 1945

I never yet heard of a useless thing that was not ground out of existence by evolution sooner or later.

*Seven Science Fiction Novels of H. G. Wells*  
*The Island of Dr. Moreau*  
Chapter the Fourteenth (p. 133)  
Dover Publications, Inc. New York, New York, USA. 1934

**White, Timothy**  
No biographical data available

You don’t gradually go from being a quadruped to being a biped. What would the intermediate stage be – a triped? I’ve never seen one of those.

In Donald C. Johanson and Maitland A. Edey  
*Lucy: The Beginnings of Humankind*  
Chapter 16 (p. 309)  
Simon & Schuster. New York, New York, USA. 1981



**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The doctrine of evolution...interprets the vanishing of species and of sporadically variant individuals, as being due to maladjustment to the environment. This explanation has its measure of truth: it is one of the great generalizations of science. But enthusiasts have so strained its interpretation as to make it explain nothing, by reason of the fact that it explains everything. We hardly ever know the definite character of the struggle which occasioned the disappearance. The phrase is like the liturgical refrain of a litany, chanted over the fossils of vanished species.

*The Function of Reason*

Chapter I (pp. 3–4)

Beacon Press. Boston, Massachusetts, USA. 1929

**Wilber, Ken** 1949–  
American philosopher

...is there any conceivable reason that evolution, which has labored so mightily for fifteen billion years and produced so much wonderment, would just up and abruptly cease? Are there not higher spirals lying ahead? If we have discerned even the vaguest features of time's arrow, can we not stand on tiptoe and foresee dimly the arrow's arc into tomorrow?

*Sex, Ecology, Spirituality: The Spirit of Evolution*

Chapter 5 (p. 204)

Shambhala. Boston, Massachusetts, USA. 1995

**Willis, John Christopher** 1868–1958  
No biographical data available

The process of evolution appears not to be a matter of natural selection of chance variations of adaptational value. Rather it is working upon some definite law that we do not yet comprehend. The law probably began its operations with the commencement of life, and it is carrying this on according to some definite plan.

*The Course of Evolution by Differentiation or Divergent Mutation Rather Than by Selection* (p. 191)

The University Press. Cambridge, England. 1940

**Wilson, Edward O.** 1929–  
American biologist and author

...theology made no provision for evolution. The biblical authors had missed the most important revelation of all! Could it be that they were not really privy to the thoughts of God?

*Consilience: The Unity of Knowledge*

Chapter 1 (p. 6)

Alfred A. Knopf. New York, New York, USA. 1998

...the evolutionary epic is probably the best myth we will ever have.

*On Human Nature*

Chapter 9 (p. 201)

Harvard University Press. Cambridge, Massachusetts, USA. 1978

Evolution on a large scale unfolds, like much of human history, as a succession of dynasties.

*The Diversity of Life*

Chapter Seven (p. 94)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

...evolution has devised a hundred ways to macerate livers and turn blood into a parasite's broth.

*Biophilia*

Bernhardsdorp (pp. 12–13)

Harvard University Press. Cambridge, Massachusetts, USA. 1984

## EVOLUTION OF EARTH

**Hobbs, William Herbert** 1864–1953  
American geologist

Anyone who has examined into the history of the theories of earth evolution must have been astounded to observe the manner in which the unique and the difficultly explainable has been made to take the place of the common and the natural in deriving the framework of these theories.

*Earth Evolution and Its Facial Expression*

Chapter XIV (p. 174)

The Macmillan Co. New York, New York, USA. 1921

## EXAMINATION

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

You will remember, of course, always to get the weather-gage of your patient. I mean, to place him so that the light falls on his face and not on yours. It is a kind of ocular duel that is about to take place between you; you are going to look through his features into his pulmonary and hepatic and other internal machinery, and he is going to look into yours quite as sharply to see what you think about his probabilities for time or eternity.

*Medical Essays*

The Young Practitioner (p. 387)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Huxley, Thomas Henry** 1825–95  
English biologist

Examination, like fire, is a good servant, but a bad master; and there seems to me to be some danger of its becoming our master. I by no means stand alone in this opinion. Experienced friends of mine do not hesitate to say that students whose career they watch appear to them to become deteriorated by the constant effort to pass this or that examination, just as we hear of men's brains becoming affected by the daily necessity of catching a train. They work to pass, not to know; and outraged Science takes her revenge. They do pass, and they don't know.

*Collected Essays* (Volume 3)  
*Science and Education*  
 Universities: Actual and Ideal (p. 228)  
 Macmillan & Company Ltd. London, England. 1904

**Mayo, Charles Horace** 1865–1939  
 American physician

Examination must be within reason for the sick, or near-sick, and its extent will be based on the judgment and experience of the physician.

When Does Disease Begin? Can This Be Determined by Health Examination?

*Minnesota Medicine*, Volume 15, January, 1932

**Mayo, William J.** 1861–1939  
 American physician

The examining physician often hesitates to make the necessary examination because it involves soiling the finger.

The Cancer Problem

*Lancet*, Volume 35, July 1, 1915

Sometimes I wonder whether today we take sufficient care to make a thorough physical examination before our patient starts off on the round of the laboratories, which have become so necessary that oftentimes we do not fully appreciate the value of our five senses in estimating the condition of the patient.

*Collected Papers of the Mayo Clinic & Mayo Foundation*  
 Discussion of Paper by T.E. Keys, Volume 30, 1938

## EXAMPLE

**Halmos, Paul R.** 1916–2006  
 Hungarian-born American mathematician

A good stock of examples, as large as possible, is indispensable for a thorough understanding of any concept, and when I want to learn something new, I make it my first job to build one.

In Joseph A. Gallian

*Contemporary Abstract Algebra*

Chapter 2 (p. 34)

D.C. Heath & Company. Lexington, Massachusetts, USA. 1994

**Kaplansky, Irving** 1917–2006  
 Canadian-born American mathematician

Certainly one thing is to look at the first case – the easiest case that you don't understand completely. That general theorem down the road – hopefully you'll get to it by and by. The second piece of advice: do examples. Do a million examples. I think there are shameful cases of people making silly and reckless conjectures just because they didn't take the trouble to look at the first few examples. A well-chosen example can teach you so much.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 131)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

## EXCAVATE

**Petrie, William Matthew Flinders**  
 Archaeologist

In few kinds of work are the results so directly dependent on the personality of the worker as they are in excavating. The old saying that a man finds what he looks for in a subject, is too true; or if he has not enough insight to ensure finding what he looks for, it is at least sadly true that he does not find anything that he does not look for.

*Methods & Aims in Archaeology*

Chapter I (p. 2)

Macmillan & Co. London, England. 1904

## EXCAVATION

**Browne, Sir Thomas** 1605–82  
 English author and physician

The treasures of time lie high, in Urnes, Coynes, and Monuments, scarce below the roots of some vegetables.

*Hydriotophia*

Chapter I (p. 2)

Printed for Hen. Brome. London, England. 1658

**Marinatos, Spyridon** 1901–74  
 Greek archaeologist

To excavate is to open a book written in the language that the centuries have spoken into the earth.

*New York Times*, 11 January, 1972

**Wheeler, Sir Mortimer** 1890–1976  
 English archaeologist

...the excavator without an intelligent policy may be described as an archaeological food-gatherer, master of a skill, perhaps, but not creative in the wider terms of constructive science.

*Archaeology from the Earth*

Chapter X (p. 129)

At The Clarendon Press. Oxford, England. 1954

## EXCELLENT HYPOTHESIS

**Boyle, Robert** 1627–91  
 English natural philosopher and theological writer

The Qualities and Conditions of an Excellent Hypothesis are:

That It be not Precarious, but have sufficient Grounds In the nature of the Thing Itself or at least be well recommended by some Auxiliary Proofs.

That It be the Simplest of all the good ones we are able to frame, at least containing nothing that is superfluous or Impertinent.

That It be the only Hypothesis that can Explicate the Phenomena; or at least, that do's Explicate them so well.

That it enable a skilful Naturalist to foretell future Phenomena by the Congruity or Incongruity to it; and especially the event of such Experlm'ts as are aptly devis'd to examine It, as Things that ought, or ought not, to be consequent to It.

In Michael Alexander Stewart

*Selected Philosophical Papers of Robert Boyle*

MS Notes on a Good and an Excellent Hypothesis (p. 119)

Hackett Publishing. Indianapolis, Indiana, USA. 1991

## EXCEPTION

**Bateson, William** 1861–1926

English biologist and geneticist

Treasure your exceptions!... Keep them always uncovered and in sight. Exceptions are like the rough brick-work of a growing building which tells that there is more to come and shows where the next construction will be.

*The Method and Scope of Genetics*

An Inaugural Lecture, Delivered 23 October, 1908 (p. 21)

**Feynman, Richard P.** 1918–88

American theoretical physicist

...“The exception proves that the rule is wrong.” That is the principle of science. If there is an exception to any rule, and if it can be proved by observation, that rule is wrong.

*The Meaning of It All*

Chapter I (pp. 15–16)

Perseus Books. Reading, Massachusetts. USA. 1998

**Hackett, L. W.**

No biographical data available

Investigators are always divided into those who are looking for rules and those who are looking for exceptions.

In Marston Bates

*The Natural History of Mosquitoes*

Chapter XI (p. 163)

The Macmillan Company. New York, New York, USA. 1949

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The young man knows the rules, but the old man knows the exceptions.

*The Young Practitioner*

Address

Bellevue Hospital College, March 2, 1871

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

A well-chosen word usually suffices to do away with the exceptions from which the rules stated in the old way suffer; this is why we have created negative quantities, imaginaries, points at infinity, and what not. And exceptions, we must not forget, are pernicious because they hide the laws.

The Future of Mathematics

*Monist*, Volume 20, Number 1, January, 1910 (p. 83)

## EXCLUDED MIDDLE

**Hilbert, David** 1862–1943

German mathematician

Existence proofs carried out with the help of the principle of excluded middle usually are especially attractive because of their surprising brevity and elegance. Taking the principle of excluded middle from the mathematician would be the same...[as] proscribing the telescope to the astronomer or to the boxer the use of his fists.

In Sahotra Sarkar

*The Emergence of Logical Empiricism*

The Foundations of Mathematics (pp. 239–240)

Garland Publishing. New York, New York, USA. 1996

## EXCRETION

**May, John**

No biographical data available

**Marten, Michael**

No biographical data available

Human beings use four times as much water to remove their excreta as they use for all other purposes, including drinking, cooking and washing. Is it pure, disinterested hygiene, or are we somehow washing away our sins? Although we take an obsessive interest in one activity and pretend the other does not exist, it is a fundamental equation that if you eat, you excrete ...

*The Book of Beasts*

EXCRETION (p. 57)

The Viking Press. New York, New York, USA. 1982

## EXISTENCE

**Bergson, Henri** 1859–1941

French philosopher

...I pass from state to state. I am warm or cold, I am merry or sad, I work or I do nothing, I look at what is around me or I think of something else. Sensations, feelings, volitions, ideas – such are the changes into which my existence is divided and which color it in turns.

I change, then, without ceasing.

Translated by Arthur Mitchell

*Creative evolution*

Chapter I (p. 1)

Henry Holt & Co. New York, New York, USA. 1913

**Bray, Henry Truro**

No biographical data available

In the study of the stars, suns, and planets we find wonderful existences all bound together by sympathetic bonds, actuated by one general impulse, and acting under one general law, and producing a harmony incomparably greater than that seen in man as the result of the united organic forces which constitute his being.

*The Living Universe* (3rd edition)  
Chapter XI (p. 154)  
The Truro Publishing Co. Chicago, Illinois, USA. 1914

**Einstein, Albert** 1879–1955  
German-born physicist

Of what is significant in one's own existence one is hardly aware, and it certainly should not bother the other fellow.

*Out of My Later Years* (p. 3)  
Thames & Hudson. London, England. 1950

**Good, John Mason** 1764–1827  
English physician and author

...it is natural history alone that can find us a clew to the labyrinth, that enables us to repose faith in the records of antiquity, and that establishes the important position, that the extravagance of a description is no argument against the truth of a description, and that it is somewhat too much to deny that a thing has existed formerly, for the mere reason that it does not exist now.

*The Book of Nature*  
Series I, Lecture XV (p. 171)  
Belknap & Hammersley. Hartford, Connecticut, USA. 1844

**Hoffmann, Banesh** 1906–86  
Mathematician and educator

True, the universe is more than a collection of objective experimental data; more than the complexus of theories, abstractions, and special assumptions devised to hold the data together; more, indeed, than any construct modeled on this cold objectivity. For there is a deeper, more subjective world, a world of sensation and emotion, of aesthetic, moral, and religious values as yet beyond the grasp of objective science. And towering majestically over all, inscrutable and inescapable, is the awful mystery of Existence itself, to confound the mind with an eternal enigma.

*The Strange Story of the Quantum*  
Chapter XIV (pp. 189–190)  
Dover Publications, Inc. New York, New York, USA. 1959

**Huxley, Thomas Henry** 1825–95  
English biologist

*Kraft und Stoff* – force and matter – are paraded as the Alpha and Omega of existence. This I apprehend is the fundamental article of the faith materialistic; and whosoever does not hold it is condemned by the more zealous of the persuasion (as I have some reason to know) to the Inferno appointed for fools or hypocrites.

*Evolution and Ethics*  
Science and Morals (p. 129)  
D. Appleton & Co. New York, New York, USA. 1902

**Scott Cary (Fictional character)**

That [man's] existence begins and ends is man's conception, not nature's. And I felt my body dwindling, melting,

becoming nothing. My fears melted away. And in their place came acceptance. All this vast majesty of creation, it had to mean something. And then I meant something, too. Yes, smaller than the smallest, I meant something, too. To God, there is no zero. I still exist!

*The Incredible Shrinking Man*  
Film (1957)  
Closing soliloquy narration

**Wheeler, John Archibald** 1911–  
American physicist and educator

Existence, the preposterous miracle of existence! To whom has the world of opening day never come as an unbelievable sight? And to whom have the stars overhead and the hand and voice nearby never appeared as unutterably wonderful, totally beyond understanding? I know no great thinker of any land or era who does not regard existence as the mystery of all mysteries.

Hermann Weyl and the Unity of Knowledge  
*American Scientist*, Volume 74, July–August, 1986 (p. 371)

## EXPAND

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

A spherical world, closed but continually expanding, is a new playground for thought.

*The Expanding Universe*  
Chapter III, Section I (p. 66)  
The University Press. Cambridge. 1933

## EXPERIENCE

**Adams, Henry Brooks** 1838–1918  
American man of letters

All experience is an arch to build upon.

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter VI (p. 87)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

## Author undetermined

Experience supplies opinions, but science yields certainties.

*The British Controversialist and Literary Magazine*  
European Philosophy (p. 404)  
Houlston & Wright. London, England. 1864

**Balfour, Arthur James** 1848–1930  
British prime minister

It is experience which has given us our first real knowledge of Nature and her laws. It is experience, in the shape of observation and experiment, which has given us the raw material out of which hypothesis and inference have slowly elaborated that richer conception of the material world which constitutes perhaps the chief, and certainly the most characteristic, glory of the modern mind.

*The Foundations of Belief*  
Part II, Chapter I, Section III (p. 113)  
Longmans, Green & Company. London, England. 1912

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

The rare genius with a flair for research will not benefit from instruction in the methods of research, but most would-be research workers are not geniuses, and some guidance as to how to go about research should help them to become productive earlier than they would if left to find these things out for themselves by the wasteful method of personal experience.

*The Art of Scientific Investigation*  
Preface (pp. x–xi)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bohn, H. G.**  
No biographical data available

Experience is the mother of science.

*A Handbook of Proverbs* (p. 352)  
George Bell & Sons. London, England. 1904

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

The great extension of our experience in recent years has brought to light the insufficiency of our simple mechanical conceptions and, as a consequence, has shaken the foundation on which the customary interpretation of observation was based...

*Atomic Theory and the Description of Nature*  
Introductory Survey (p. 2)  
Cambridge University Press. Cambridge, England. 1934

**Born, Max** 1882–1970  
German-born English physicist

My advice to those who wish to learn the art of scientific prophecy is not to rely on abstract reason, but to decipher the secret language of Nature from Nature's documents, the facts of experience.

*Experiment and Theory in Physics* (p. 44)  
Cambridge University Press. Cambridge, England. 1944

**Bowen, Elizabeth** 1899–1973  
Anglo-Irish writer

Experience isn't interesting till it begins to repeat itself – in fact, till it does that, it hardly is experience.

*Death of the Heart*  
The World (p. 8)  
Alfred A. Knopf. New York, New York, USA. 1938

**Braithwaite, Richard B.** 1900–90  
Philosopher

The peaks of science may appear to be floating in the clouds, but their foundations are in the hard facts of experience.

*Scientific Explanation*  
Chapter XI (p. 354)  
At The University Press. Cambridge, England. 1959

**Brackenridge, Hugh Henry** 1748–1816  
Scottish born American writer

...experience is a great softener of the mind; it gives knowledge.

*Modern Chivalry: Containing the Adventures of a Captain and Teague O'Regan* Volume 2  
Chapter XIV (p. 155)  
Johnson & Warner. Philadelphia, Pennsylvania, USA. 1815

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Science is nothing else than the search to discover unity in the wild variety of nature – or more exactly, in the variety of our experience.

*Science and Human Values*  
The Creative Mind (p. 16)  
Harper & Row Publishers. New York, New York, USA. 1965

There are two experiences on which our visual world is based: that gravity is vertical, and that the horizontal stands at right angles to it.

*The Ascent of Man*  
Chapter 5 (p. 157)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

When ninety-nine hundredths of one set of phenomena are presented while the hundredth is withdrawn without apparent cause, so that we can no longer do something which according to our past experience we shall find no difficulty whatever in doing – then we may guess what a bee must feel as it goes flying up and down a window-pane. Then we have doubts thrown upon the fundamental axiom of life – *i.e.*, that like antecedents will be followed by like consequents. On this we go mad and die in a short time.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
Bee in a Window Pane (p. 89)  
Jonathan Cape. London, England. 1951

**Camus, Albert** 1913–60  
Algerian-French author and philosopher

You cannot acquire experience by making experiments. You cannot create experience. You must undergo it.

*Notebooks 1935–1951*  
Notebook I, May 1935–September 1937 (p. 5)  
Marlowe & Company. New York, New York, USA. 1998

**Cardozo, Benjamin N.** 1870–1938  
American jurist

Often a liberal antidote of experience supplies a sovereign cure for a paralyzing abstraction built upon a theory.



*The Paradoxes of Legal Science*

Chapter IV (p. 125)

Columbia University Press. New York, New York, USA. 1928

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

To most men, experience is like the stern lights of a ship,  
which illumine only the track it has passed.

*The Table Talk and Omniana of Samuel Taylor Coleridge*

Additional Table Talk

Experience (p. 319)

George Bell & Sons. London, England. 1884

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

The interpreter of the wonders of nature is experience.  
It never misleads us, only our grasp can do it with us.  
Until we can establish a general rule, we must accept  
the help of experience. Although nature begins with the  
cause, and with the experiment, we must do it inversely,  
we must discover the cause with experiments.

In Ferenc. Szabadváry

*History of Analytical Chemistry*

Chapter III (pp. 21–22)

Gordon & Breach Science. Langhore, Pennsylvania, USA. 1992

...good judgment is born of clear understanding, and a  
clear understanding comes of reasons derived from sound  
rules, and sound rules are the issue of sound experience –  
the common mother to all the sciences and arts.

*The Literary Works of Leonardo da Vinci* (Volume 1)

18 (p. 119)

University of California Press. Berkeley, California, USA. 1977

But first I shall test by experiment before I proceed fur-  
ther, because my intention is to consult experience first  
and then with reasoning show why such experience is  
bound to operate in such a way.

*The Literary Works of Leonardo da Vinci* (Volume 2)

1148 (p. 239)

University of California Press. Berkeley, California, USA. 1977

Experience is never at fault; it is only your judgment that  
is in error in promising itself such results from experi-  
ence as are not caused by our experiments. For having  
given a beginning, what follows from it must necessarily  
be a natural development of such a beginning, unless it  
has been subject to a contrary influence, while, if it is  
affected by any contrary influence, the result which ought  
to follow from the aforesaid beginning will be found to  
partake of this contrary influence in a greater or less  
degree in proportion to the said influence is more or less  
powerful than the aforesaid beginning.

*The Literary Works of Leonardo da Vinci* (Volume 2)

1153 (p. 240)

University of California Press. Berkeley, California, USA. 1977

Nature is full of infinite causes which were never set  
forth in experience.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 72)

George Braziller. New York, New York, USA. 1958

**Davy, Sir Humphry** 1778–1829

English chemist

Experience must be our guide ; experience, or moral feel-  
ing, founded on accurate and distinct knowledge.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 213)

Longman, Rees, Orme, Brown, Green & Longman London, England.  
1836

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

...experience itself, the mother of all the sciences.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part I, Chapter 21 (p. 63)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

Experience without theory teaches nothing.

*Out of the Crisis*

Chapter 11 (p. 317)

Massachusetts Institute of Technology Press. Cambridge, Massachu-  
setts, USA. 1986

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Science aims at constructing a world which shall be sym-  
bolic of the world of commonplace experience.

*The Nature of the Physical World*

Introduction (p. xiii)

The Macmillan Company. New York, New York, USA. 1930

The cleavage between the scientific and the extra-  
scientific domain of experience is, I believe, not a cleav-  
age between the concrete and the transcendental, but  
between the metrical and non-metrical.

*The Nature of the Physical World*

Chapter XIII (p. 275)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

Our experience hitherto justifies us in believing that  
nature is the realization of the simplest conceivable math-  
ematical ideas. I am convinced that we can discover by  
means of purely mathematical constructions the concepts  
and laws connecting them with each other, which fur-  
nish the key to the understanding of natural phenomena.  
Experience may suggest the appropriate mathematical  
concepts, but they most certainly cannot be deduced from  
it. Experience remains, of course, the sole criterion of



the physical utility of a mathematical construction. But the creative principle resides in mathematics. In a certain sense, therefore, I hold it true that pure thought can grasp reality, as the ancients dreamed.

*Ideas and Opinions*

On the Method of Theoretical Physics (p. 267)

Crown Publishers, Inc. New York, New York, USA. 1954

Experience alone can decide truth.

On the Generalized Theory of Gravitation

*Scientific American*, Volume 182, Number 4, April, 1950 (p. 17)

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Experience has been declared, with equal truth and poetry, to adopt occasionally the tone, and attain to something like the certainty, of Prophecy. In the contemplating mind the past and the future are linked by a bond as indissoluble as that which connects them in their actual sequence.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Quetelet on Probabilities (p. 365)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

**Hertz, Heinrich** 1857–94

German physicist

...that which is gained from experience can again be annulled by experience.

*The Principles of Mechanics Presented in a New Form*

Introduction (p. 9)

Dover Publications, Inc. New York, New York, USA. No date

**Hine, Reginald Leslie**

No biographical data available

That is the worst of learning from experience; it takes too long. Often it takes a lifetime. "Experience," said Sainte-Beuve, "is like the pole-star; it only guides a man in the evening, and rises when he is going to rest."

*Confessions of an Un-Common Attorney*

Part One, Reflections Upon the Married Estate (p. 91)

Macmillan. New York, New York, USA. 1945

**Hoffmann, Friedrich** 1660–1742

German physician

In medicine there are two supports – experience, which is the first parent of truth; and reason, which is the key to medical science. Experience comes first in order, and reason follows. Hence in medical affairs reasons which are not founded on experience have no value.

*Fundamenta Medicinæ*

Physiology, Chapter I, 7 (p. 5)

American Elsevier. New York, New York, USA. 1971

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

There is not, and never has been, a human being who was capable of thinking straight, except by checking his thoughts against objective experience.

*Of Men and Galaxies*

Motives and Aims of the Scientist (p. 16)

University of Washington Press. Seattle, Washington, USA. 1964

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

...man is not confined to what he sees; he has the experience of former men.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section IV (p. 190)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**James, William** 1842–1910

American philosopher and psychologist

...all the magnificent achievements of mathematical and physical science – our doctrines of evolution, of uniformity of law, and the rest – proceed from our indomitable desire to cast the world into a more rational shape in our minds than the shape into which it is thrown there by the crude order of our experience.

*The Will to Believe and Other Essays in Popular Philosophy*

The Dilemma of Determinism (p. 147)

Dover Publications, Inc. New York, New York, USA. 1956

**Jevons, William Stanley** 1835–82

English economist and logician

The wider our experience, the more minute our examination of the globe, the greater the accumulation of well-reasoned knowledge – the fewer in all probability will be the failures of inference compared with the successes.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Introduction (p. 3)

The Macmillan Co. New York, New York, USA. 1887

Experience gives us the materials of knowledge: induction digests those materials, and yields us general knowledge.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter I (p. 12)

Macmillan & Company Ltd. London, England. 1892

When we merely note and record the phenomena which occur around us in the ordinary course of nature we are said to observe. When we change the course of nature by the intervention of our muscular powers, and thus produce unusual combinations and conditions of phenomena, we are said to experiment. Herschel justly remarked that we might properly call these two modes of experience passive and active observation. In both cases we must certainly employ our senses to observe, and an experiment differs from a mere observation in the fact that we more or less influence the character of the events which we observe.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book IV, Chapter XVIII (p. 400)  
Macmillan & Co Ltd. London, England. 1887

**Kant, Immanuel** 1724–1804

German philosopher

There can be no doubt that all our knowledge begins with experience. For how should our faculty of knowledge be awakened into action did not objects affecting our senses partly of themselves produce representations, partly arouse the activity of our understanding to compare these representations, and, by combining or separating them, work up the raw material of the sensible impressions into that knowledge of objects which is entitled experience?

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Introduction, Part I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

That all our knowledge begins with experience there can be no doubt. For how is it possible that the faculty of cognition should be awakened into exercise otherwise than by means of objects which affect our senses, and partly of themselves produce representations, partly rouse our powers of understanding into activity, to compare, to connect, or to separate these, and so to convert the raw material of our sensuous impressions into a knowledge of objects, which is called experience?

Translated by J.M.D. Meiklejohn

*Critique of Pure Reason*

Chapter I (p. 43)

P.F. Collier & Son. New York, New York, USA. 1901

All cognition of things from mere pure Understanding and Reason is nothing but mere illusion and only in experience is there truth.

In John Pentland Mahaffy and John Henry

*Kant's Critical Philosophy for English Readers* (Volume 2)

Appendix (p. 147)

Macmillan & Co Ltd. London, England. 1889

**Kirchoff, Gustav Robert** 1824–87

German physicist

Experience is the collecting of what is similar in different particular perceptions.

In Robert von Helmholtz

*Annual Report of the Board of Regents of the Smithsonian Institution, 1889*

A Memoir of Gustav Robert Kirchoff (p. 539)

Government Printing Office, Washington, D.C. 1889

**Latham, Peter Mere** 1789–1875

English physician

Wherefore then serveth experience, and of what use is it? Its first and best use is for the guidance of him that has it. Its next, and hardly less important use, is that it enables him to judge rightly the experience of others.

In William B. Bean

*Aphorisms from Latham* (p. 93)

Prairie Press. Iowa City, Iowa, USA. 1962

Nothing is so difficult to deal with as man's own Experience, how to value it according to amount, what to conclude from it, and how to use it and do good with it.

In William B. Bean

*Aphorisms From Latham* (p. 94)

Prairie Press. Iowa City, Iowa, USA. 1962

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

The Etruscans are not a theory or a thesis. If anything, they are an experience.

*Etruscan Places*

Chapter VI (p. 197)

Folio Society, London, England. 1972

**Lewis, Clarence Irving** 1883–1964

American philosopher

...knowing begins and ends in experience; but it does not end in the experience in which it begins.

Experience and Meaning

*The Philosophical Review*, Volume XLIII, 1934 (p. 134)

**Luciano, Giano**

No biographical data available

...nothing short of seeing a thing will help you know it. If you wish to know that pepper is hot and that vinegar is cooling, that colocynth and absinthe are bitter, that honey is sweet, and that aconite is poison; that the magnet attracts steel, that arsenic whitens brass, and that tutia turns it of an orange color, you will, in everyone of those cases, have to verify the assertion by experience.

*The New Pearl of Great Price*

Arguments in Favor of Our Most Glorious Art (pp. 86–87)

Arno Press. New York, New York, USA. 1974

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Mathematical and physiological researches have shown that the space of experience is simply an actual case of many conceivable cases, about whose peculiar properties experience alone can instruct us.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 205)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Margenau, Henry** 1901–97

American physicist

Human experience in its immediacy, in its factual character, is like the liquid matrix before the crystal grows – unorganized, irregular, and largely bare of meaning.

*Open Vistas Philosophical Perspectives of Modern Science*

Chapter 2 (pp. 36–37)

Yale University Press. New Haven, Connecticut, USA. 1961

**May, Donald C.**

No biographical data available

**Mead, George H.** 1863–1931

American philosopher, sociologist, and psychologist

...in the world of immediate experience, the world of things is there. Trees grow, day follows night, and death supervenes upon life. One may not say that relations here are external or even internal. They are not relations at all. They are lost in the indiscernibility of things and events, which are what they are. The world which is the test of all observations and all scientific hypothetical reconstruction has in itself no system that can be isolated as a structure of laws, or uniformities, though all laws and formulations of uniformities must be brought to its court for its imprimatur.

*The Philosophy of the Act*

Chapter II (p. 31)

The University of Chicago, Chicago, Illinois, USA; 1938

**Mellor, Joseph William** 1863–1938

Chemist

Experience is the well-spring of true knowledge; experience alone can teach something new; it alone is irrefutable; it alone can give certainty.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
(Volume 1)

Chapter I (p. 5)

Longman, Green &amp; Co. London, England. 1922

**Shaw, George Bernard** 1856–1950

Irish playwright

...mind you, that you have a sound scientific theory to correlate your observations at the bedside. Mere experience by itself is nothing. If I take my dog to the bedside with me, he sees what I see. But he learns nothing from it. Why? Because he's not a scientific dog.

*The Doctor's Dilemma*

Act I (p. 110)

Penguin Books. Baltimore, Maryland, USA. 1954

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

The experience of science – to stub your toe hard and then notice that it was really a rock on which you stubbed it – this experience is something that is hard to communicate by popularization, by education, or by talk. It is almost as hard to tell a man what it is like to find out something new about the world as it is to describe a mystical experience to a chap who has never had any hint of such an experience.

*The Open Mind*

Chapter VII (pp. 126–127)

Simon &amp; Schuster. New York, New York, USA. 1955

**Paré, Ambroise** 1510–90

French surgeon

Science without experience does not bring much confidence.

Attributed to be one of Paré's canons

**Planck, Max** 1858–1947

German physicist

It is only when we have planted our feet on the firm ground which can be won only with the help of the experience of real life, that we have a right to feel secure in surrendering to our belief in a philosophy of the world based upon a faith in the rational ordering of this world.

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter IV (p. 125)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1936

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...it must be possible for an empirical scientific system to be refuted by experience.

*The Logic of Scientific Discovery*

Part I, Chapter I, Section 6 (p. 41)

Basic Books, Inc. New York, New York, USA. 1959

Even the careful and sober testing of our ideas by experience is in its turn inspired by ideas: experiment is planned action in which every step is guided by theory. We do not stumble upon our experiences, nor do we let them flow over us like a stream. Rather, we have to be active: we have to "make" our experiences. It is we who always formulate the questions to be put to nature; it is we who try again and again to put these questions so as to elicit a clear-cut "yes" or "no" (for nature does not give an answer unless pressed for it). And in the end, it is again we who give the answer; it is we ourselves who, after severe scrutiny, decide upon the answer to the question which we put to nature – after protracted and earnest attempts to elicit from her an unequivocal 'no.'

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 280)

Basic Books, Inc. New York, New York, USA. 1959

**Roberts, W. Milnor**

No biographical data available

From the laying out of a line of tunnel to its final completion, the work may be either a series of experiments (made at the expense of the proprietors of the project), or a series of judicious applications of the results of previous experience.

In Henry Drinker

*Tunneling, Explosive Compounds and Rock Drills* (p. 1005)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1878

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Mind you, that you have a sound scientific theory to correlate your observations at the bedside. Mere experience by itself is nothing. If I take my dog to the bedside with me, he sees what I see. But he learns nothing from it. Why? Because he's not a scientific dog.

*The Doctor's Dilemma*

Act I (p. 26)

Brentano's. New York, New York, USA. 1920

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

... we have come to the edge of a world of which we have no experience, and where all our preconceptions must be recast.

*On Growth and Form* (Volume 1)

Chapter II (p. 77)

At The University Press. Cambridge, England. 1951

**Tyndall, John** 1820–93  
Irish-born English physicist

Experience... can only deal with the past; and the moment we attempt to project experience a hair's breadth beyond the point it has at any moment reached, we are condemned by reason.

*Fragments of Science for Unscientific People*

Chapter III (p. 55)

D. Appleton & Co. New York, New York, USA. 1875

All our notions of Nature, however exalted or however grotesque, have some foundation in experience.

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)

Lecture I (p. 4)

D. Appleton & Co. New York, New York, USA. 1901

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

We should be careful to get out of an experience only the wisdom that is in it – and stop there; lest we be like the cat that sits down on a hot stove-lid. She will never sit down on a hot stove-lid again – and that is well; but she will also never sit down on a cold one anymore.

*Following the Equator* (Volume 1)

Chapter XI (p. 125)

Harper & Brothers Publishers. New York, New York, USA. 1899

**von Baeyer, Adolf** 1835–1917  
German-born physicist and author

Men who are capable of modifying their first beliefs are very rare. This ability was one of the reasons for the success of Claude Bernard and Pasteur. Out of a very vivid imagination they forged new hypotheses all the time but abandoned them with equal ease as soon as experience contradicted them.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 141)

W.A. Benjamin. New York, New York, USA. 1965

**von Liebig, Justus** 1803–73  
German organic chemist

A *fact* simply tells us of its existence, but *experience* ought to inform us why it exists.

In John Blyth

*Letters on Modern Agriculture*

Letter XII (p. 233)

Walton & Maberly. London, England. 1859

**Whewell, William** 1794–1866  
English philosopher and historian

Experience can discover universal truths, though she cannot give them universality.

*History of Scientific Ideas* (Volume 1) (p. 270)

J. W. Parker & Son. London, England. 1858

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

DUMBY: Experience is the name everyone gives to their mistakes.

*The Works of Oscar Wilde* (Volume 5)

*Lady Windermere's Fan*, Third Act (p. 60)

Lamb Publishing Company. New York, New York, USA. 1909

## EXPERIMENT

### The Bible (King James Version)

Prove all things; hold fast that which is good.

*1 Thessalonians 5:21*

**Alcott, Louisa May** 1832–88  
American author

You may try your experiment for a week and see how you like it.

*Little Women*

Chapter 11 (p. 87)

Little, Brown & Co. Boston, Massachusetts, USA. 1922

**Asimov, Isaac** 1920–92  
American author and biochemist

There are fashions in science as in everything else. Conduct an experiment that brings about an unusual success and before you can say, "There are a dozen imitations!" there are a dozen imitations!

*Asimov on Chemistry*

Welcome, Stranger! (p. 55)

Anchor Press/Doubleday. Garden City, New York, USA. 1974

### Author undetermined

I am afraid... that the experiments you quote, M. Pasteur, will turn against you.... The world into which you wish to take us is really too fantastic.

Translated by Mrs. R.L. Devonshire  
 In René Valléry-Radot  
*The Life of Pasteur* (p. 99)  
 Doubleday, Page & Co. New York, New York, USA. 1919

It is all very well to theorize, but it is what we learn from experiment that really counts.

Source undetermined

**Bachelard, Gaston** 1885–1962  
 French philosopher

Any work of science, no matter what its point of departure, cannot become fully convincing until it crosses the boundary between the theoretical and the experimental: Experimentation must give way to argument, and argument must have recourse to experimentation.

*The New Scientific Spirit* (p. 3)  
 Beacon Press. 1984

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

...we must first, by every kind of experiment, elicit the discovery of causes and true axioms, and seek for experiments which may afford light rather than profit.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 70 (p. 116)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

All true and fruitful natural philosophy hath a double scale or ladder, ascendent and descendent, ascending from experiments to the invention of causes, and descending from causes to the invention of new experiments.

In *Great Books of the Western World* (Volume 30)  
*The Advancement of Learning*  
 Second Book, Chapter VII, Section 1 (p. 42)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960  
 Scottish-American mathematician and educator

Experiment as scientists understand it is admittedly an indispensable adjunct to the progress of civilization and its probable destruction.

*The Handmaiden of the Sciences*  
 Chapter 1 (p. 7)  
 Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Bernard, Claude** 1813–78  
 French physiologist

Considered in itself, the experimental method is nothing but reasoning by whose help we methodically submit our ideas to experience – the experience of fact.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Introduction (p. 2)  
 Henry Schuman, Inc. New York, New York, USA. 1927

Experimentation is undeniably harder in medicine than in any other science; but for that very reason, it was never so necessary, and indeed so indispensable.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Introduction (pp. 2–3)  
 Henry Schuman, Inc. New York, New York, USA. 1927

...an experiment is fundamentally just an observation induced with some object or another.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter I, Section v (p. 19)  
 Henry Schuman, Inc. New York, New York, USA. 1927

...we must not deceive ourselves, morals do not forbid making experiments on one's neighbor or on one's self; in everyday life men do nothing but experiment on one another. Christian morals forbid only one thing, doing ill to one's neighbor. So, among the experiments that may be tried on man, those that can only harm are forbidden, those that are innocent are permissible, and those that may do good are obligatory.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part Two, Chapter II, Section III (p. 102)  
 Henry Schuman, Inc. New York, New York, USA. 1927

There never are any unsuccessful experiments: they are all successful in their own definite conditions, so that negatives cannot nullify positive results.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part Two, Chapter II, Section VI (p. 117)  
 Henry Schuman, Inc. New York, New York, USA. 1927

Experimentation is, properly speaking, nothing more than the decomposition of a phenomenon into its elements. One removes them in succession, and observes what is lacking, in order to identify the role of each of these elements in the total production of the phenomenon.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin  
*The Cahier Rouge of Claude Bernard* (p. 36)  
 Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

In the sciences there is doubtless a very close connection between observation and experimentation. Nevertheless it is necessary to distinguish them because everything would become confused.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin  
*The Cahier Rouge of Claude Bernard* (p. 37)  
 Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

**Bloch, Arthur** 1948–  
 American humorist

If an experiment works, something has gone wrong.

*Murphy's Law*  
 Finagle's First Law (p. 15)  
 Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

The experiment may be considered a success if no more than 50% of the observed measurements must be discarded to obtain a correspondence with the theory.

*Murphy's Law*  
 Maier's Law: Corollary (p. 47)  
 Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981



**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

In every experiment on living organisms, there must remain an uncertainty as regards the physical conditions to which they are subjected, and the idea suggests itself that the minimal freedom we must allow the organism in this respect is just large enough to permit it, so to say, to hide its ultimate secrets from us.

Light and Life  
*Nature*, Volume 131, Number 3309, April 1, 1933 (p. 458)

**Bolton, Henry Carrington** 1843–1903  
American chemist, bibliographer, and historian

...reliance on the dicta and data of investigators whose very names may be unknown lies at the very foundation of physical science, and without this faith in authority the structure would fall to the ground; not the blind faith in authority of the unreasoning kind that prevailed in the Middle Ages, but the rational belief in the concurrent testimony of individuals who have recorded the results of their experiments and observations, and whose statements can be verified...

In Joseph William Mellor  
*Higher Mathematics for Students of Chemistry and Physics* (p. 291)  
Dover Publications. New York, New York, USA. 1955

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

I am not a little pleased to find that you are resolved on this occasion to insist rather on experiments than syllogisms...fore...those dialectical subtleties, that the schoolmen too often employ...are wont much more to declare the wit of him that uses them, than increase the knowledge or remove the doubts of sober lovers of truth. And such capricious subtleties do indeed often puzzle and sometimes silence men, but rarely satisfy them. Being like the tricks of jugglers, whereby men doubt not but they are cheated, though oftentimes they cannot declare by what flights they are imposed on.

*The Sceptical Chymist*  
Introductory Preface (pp. 17–18)  
J.M. Dent & Sons. London, England. 1911

**Boys, Charles Vernon** 1855–1944  
English inventor and physicist

I would remind you then that when we want to find out anything that we do not know, there are two ways of proceeding. We may either ask somebody else who does know, or read what the most learned men have written about it, which is a very good plan if anybody happens to be able to answer our question; or else we may adopt the other plan, and by arranging an experiment, try for ourselves.

*Soap-bubbles and the Forces which Mould Them* (p. 11)  
Society for Promoting Christian Knowledge. London, England. 1896

**Brewster, George**  
No biographical data available

By the unerring test of experiment, we shall, upon a small scale, within the immediate purview of the senses, determine the laws and the agencies, by which it is ever governed Having ascertained these, with satisfactory certainty, they will serve the valuable purpose of a chart, a compass and a pilot, as it were, upon the broad and interminable ocean of investigation, far from the sight of land.

*A New Philosophy of Matter, Showing the Identity of All the Imponderables*  
Lecture II (p. 21)  
Crocker & Brewster. Boston, Massachusetts, USA. 1843

**Bridges, Horace J.**  
No biographical data available

Scientific experiments are like Nebuchadnezzar's dream – Daniel must first tell the dream before he goes on to the interpretation.

The Revival of Spiritualism  
*The Standard*, Volume VII, Number 20, July, 1920 (p. 18)

**Browning, Robert** 1812–89  
English poet

Just an experiment first, for candor's sake.  
*The Poems and Plays of Robert Browning*  
Mr. Sludge, "The Medium"  
The Modern Library. New York, New York, USA. 1934

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Every cold empirick, when his heart is expanded by a successful experiment, swells into a theorist...

*The Works of Samuel Johnson, LL.D.* (Volume 2)  
Preface to Shakespeare (p. 340)  
H. G. Bohn. London, England. 1854

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

"The first thing I've got to do," said Alice to herself as she wandered in the woods, "is to grow to my right size again; and the second thing is to find my way into that lovely garden. I think that will be the best plan." It sounded an excellent plan, no doubt; the only difficulty was that she had not the smallest idea how to set about it...

*The Complete Works of Lewis Carroll*  
*Alice's Adventures in Wonderland*  
Chapter IV (p. 50)  
The Modern Library. New York, New York, USA. 1936

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Never say no to an experiment.  
*Voices in the Labyrinth: Nature, Man and Science* (p. 81)  
The Seabury Press. New York, New York, USA. 1977



**Charlie Chan (Fictional character)**

No experiment is failure until last experiment is success.

*Dark Alibi*

Film (1946)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Never say no to an experiment.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 7, Section II (p. 81)

The Seabury Press. New York, New York, USA. 1977

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

...he that builds the vessel of experiment, and actually navigates the wide ocean of science, who neither intimidated by the risk of failure, nor the expence of the outfit, realises all that the other had only imagined, and returning laden with the stores of knowledge, communicates liberally that which he has won so laudably, surely the attainments of such a man are as fully entitled to our gratitude, as the anticipations of the other to our admiration.

*Lacon: Or, Many Things in Few Words*

CXLII (p. 81)

Longman, Rees, Orme, Brown & Green. London, England. 1826

**Comte, Auguste** 1798–1857

French philosopher

Experiment cannot but be less and less decisive, in proportion to the complexity of the phenomena to be explored.

*The Positive Philosophy of Auguste Comte* (Volume 2)

Book V, Chapter I (p. 13)

George Bell & Sons. London, England. 1896

**Cox, Gertrude M.** 1900–78

Statistician

The statistician who supposes that his main contribution to the planning of an experiment will involve statistical theory, finds repeatedly that he makes his most valuable contribution simply by persuading the investigator to explain why he wishes to do the experiment, by persuading him to justify the experimental treatments, and to explain why it is that the experiment, when completed, will assist him in his research.

*Lecture III*

Lecture in Washington, 11 January, 1951

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Experiment is the interpreter of nature. Experiments never deceive. It is our judgment which sometimes deceives itself because it expects results which experiment refuses. We must consult experiment, varying the circumstances, until we have deduced general rules, for experiment alone can furnish reliable rules.

In Oswald Blackwood

*Introductory College Physics* (p. 47)

John Wiley & Sons, Inc. New York, New York, USA. 1939

Experience does not ever err, it is only your judgment that errs in promising itself results which are not caused by your experiments.

In Daniel J. Boorstin

*The Discoverers*

Part Ten (p. 337)

Random House, Inc. New York, New York, USA. 1983

In treating any particular subject I would first of all make some experiments, because my design is first to refer to experiments and then to demonstrate why bodies are constrained to act in such a manner. This is the method we ought to follow in investigating the phenomena of Nature. Theory is the general, experiments are the soldiers. Experiment is the interpreter of the artifices of Nature. It is never wrong; but our judgment is sometimes deceived because we are expecting results which experiment refuses to give. We must consult experiment and vary the circumstances, till we have deduced general laws, for it alone can furnish us with them.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 129)

Macmillan & Company Ltd. London, England. 1918

**Dalton, John** 1766–1844

English chemist and physicist

...my head is too full of triangles, chymical processes and electrical experiments, etc., to think much of marriage.

In H. Spencer Lewis (ed.)

*Rosierucian Manual*

Letter to Jonathan Otley, 1796 (pp. 109–110)

Kessinger Publishing Company. Kila, Montana, USA. 2003

...those who are conversant in practical chemistry, know that not more than one new experiment in five is fit to be reported to the public; the rest are found, upon due reflection, to be some way or other defective, and are useful only as they shew the source of error, and the means of avoiding it.

*A New System of Chemical Philosophy* (Volume 1)

Part 2, Preface

R. Bickerstaff. London, England. 1810

**Darwin, Charles Robert** 1809–82

English naturalist

Extravagant theories, however, in those parts of philosophy, where our knowledge is yet imperfect, are not without their use; as they encourage the execution of laborious experiments, or the investigation of ingenious deductions, to confirm or refute them.

In E. Krause

*Erasmus Darwin with a Preliminary Notice by Charles Darwin*

(pp. 139–140)

John Murray. London, England. 1879

If you knew some of the experiments (if they may be so-called) which I am trying, you would have a good right to sneer, for they are so absurd even in my opinion that I dare not tell you.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

C. Darwin to J.D. Hooker [April 14th, 1855] (p. 415)

D. Appleton & Company. New York, New York, USA. 1896

**Davy, John** 1790–1868

English chemist

Appearances in these things are most deceptive: in the theatre experiments are made for illustration, and are generally of a simple kind, and easily comprehended, and the minds of the audience are prepared by the lecturer to follow and understand them. In the laboratory, on the contrary, this aid is wanting when most necessary; and, in consequence, operations... of a very accurate kind, and carried on with a perfect design, may appear confused to the uninitiated, or to the uninitiated.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter V (pp. 259–260)

Smith, Elder & Company. London, England. 1839–1840

In the progress of an art, from its rudest to its more perfect state, the whole process depends upon experiment. Science is in fact nothing more than the refinement of common sense making use of facts already known to acquire new facts.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (p. 234)

J. Murray. London, England. 1830

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

‘Tis no easy matter to be able to make an Experiment with accuracy. The least fact, which offers itself to our consideration, takes in so many other facts, which modify or compose it, that it requires the utmost dexterity to lay open the several branches of its composition, and no less sagacity to find ‘em out.

In Michael Roberts and E.R. Thomas

*Newton and the Origin of Colours*

Chapter I (p. 6)

G. Bell & Sons Ltd. London, England. 1934

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

We must know more about a plan than the probabilities of selection. We must know also the procedure by which to draw the sampling units, and the formula or procedure by which to calculate the estimate.

*Sample Design in Business Research* (p. 39)

John Wiley & Sons, Inc. New York, New York, USA. 1960

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The experiment serves two purposes, often independent one from the other: it allows the observation of new facts, hitherto either unsuspected, or not yet well defined; and it determines whether a working hypothesis fits the world of observable facts.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Experimentation (p. 13)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Dewey, John** 1859–1952

American philosopher and educator

Active experimentation must force the apparent facts of nature into forms different to those in which they familiarly present themselves; and thus make them tell the truth about themselves, as torture may compel an unwilling witness to reveal what he has been concealing.

*Reconstruction in Philosophy*

Chapter II (p. 32)

Henry Holt & Co. New York, New York, USA. 1920

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...he is an incorruptible watch-dog who will not allow anything to pass which is not observationally true.

*The Philosophy of Physical Science*

Chapter VII, Section II (p. 112)

The Macmillan Company. New York, New York, USA. 1939

**Edison, Thomas Alva** 1847–1931

American inventor

The only way to keep ahead of the procession is to experiment. If you don't, the other fellow will. When there's no experimenting there's no progress. Stop experimenting and you go backward. If anything goes wrong, experiment until you get to the very bottom of the trouble.

In Frank Lewis Dyer

*Edison – His Life and Inventions* (Volume 2)

Chapter XXIV (p. 617)

Harper & Brothers. New York, New York, USA. 1929

**Ehrlich, Paul** 1854–1915

German scientist

Much testing; accuracy and precision in experiment; no guesswork or self-deception.

In Martha Marquardt

*Paul Ehrlich*

Chapter XIII (p. 134)

Henry Schuman. New York, New York, USA. 1951

**Eldridge, Paul** 1888–1982

American educator

Those who fear muddy feet will never discover new paths.

*Maxims for a Modern Man*

1286

T. Yoseloff. New York, New York, USA. 1965

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The lessons of science should be experimental also. The sight of the planet through a telescope is worth all the course on astronomy: the shock of the electric spark in the elbow outvalues all the theories; the taste of the nitrous oxide, the firing of an artificial volcano, are better than volumes of chemistry.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

New England Reformers (p. 594)

The Library of America. New York, New York, USA. 1983

In childhood we fancied ourselves walled in by the horizon, as by a glass bell, and doubted not by distant travel we should reach the baths of the descending sun and stars. On experiment the horizon flies before us and leaves us on an endless common, sheltered by no glass bell.

*The Conduct of Life*

Considerations by the Way (p. 267)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Faraday, Michael** 1791–1867

English physicist and chemist

Nothing is too wonderful to be true, if it be consistent with the laws of nature, and in such things as these, experiment is the best test of such consistency.

In T. Martin (ed.)

*Diary*

March 19, 1849

Publisher undetermined

As an experimentalist, I feel bound to let experiment guide me into any train of thought which it may justify; being satisfied that experiment, like analysis, must lead to strict truth if rightly interpreted; and believing also that it is in its nature far more suggestive of new trains of thought and new conditions of natural power.

In Sylvanus P. Thompson

*Michael Faraday: His Life and Work*

Chapter VI (p. 242)

Cassell & Company Ltd. London, England. 1901

Let the imagination go, guiding it by judgment and principle but holding it in and directing it by experiment.

In L. Pearce Williams

*Michael Faraday: A Biography* (p. 467)

Basic Books, Inc. New York, New York, USA. 1965

ALL THIS is A DREAM. Still examine it by a few experiments. Nothing is too wonderful to be true, if it be consistent with the laws of nature; and in such things as these, experiment is the best test of such consistency.

In Bence Jones

*The Life and Letters of Faraday* (Volume 2)

Chapter III (p. 253)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

**Ferris, Timothy** 1944–

American science writer

Science is distinguished not for asserting that nature is rational, but for constantly testing claims to that or any other affect by observation and experiment.

*The Whole Shebang: A State-of-the Universe's Report*

Cosmic Evolution (p. 201)

Simon & Schuster. New York, New York, USA. 1996

**Feynman, Richard P.** 1918–88

American theoretical physicist

If science is to progress, what we need is the ability to experiment, honestly in reporting the results – the results must be reported without somebody saying what they would like the results to have been – and finally – an important thing – the intelligence to interpret the results. An important point about this intelligence is that it should not be sure ahead of time what must be. It cannot be prejudiced, and say “That is very unlikely; I don’t like that.”

*The Character of Physical Law*

Chapter 6 (p. 148)

BBC. London, England. 1965

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

A lady declares that by tasting a cup of tea made with milk she can discriminate whether the milk or the tea infusion was first added to the cup. We will consider the problem of designating an experiment by means of which this assertion can be tested.

*The Design of Experiments*

I, 5 (p. 11)

Hafner Publishing Company. New York, New York, USA. 1971

Our view... Is that it is an essential characteristic of experimentation that it is carried out with limited resources, and an essential part of the subject of experimental design to ascertain how these should be best applied; or, in particular, to which causes of disturbance care should be given, and which ought to be deliberately ignored.

*The Design of Experiments* (p. 18)

To consult the statistician after an experiment is finished is often merely to ask him to conduct a post mortem examination. He can perhaps say what the experiment died of.

Presidential Address, First Indian Statistical Conference, 1938

*Sankhya*, Volume 4, 1938 (p. 17)

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

Let the experiment be made.

In I. Bernard Cohen

*Benjamin Franklin's Experiments*

Letter XVII

Letter to Dr. L –

March 18, 1755 (p. 334)

Harvard University Press. Cambridge, Massachusetts, USA. 1941

...all philosophical Experiments that let Light into the Nature of Things, tend to increase the Power of Man

over Matter, and multiply the Conveniences of Pleasure of Life.

*Autobiography of Benjamin Franklin* (p. 261)  
J.B. Lippincott & Co. Boston, Massachusetts, USA. 1868

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

One cannot repeat experiments too often when the problem is one of determining a relationship.

In Maurice Crosland  
*Gay-Lussac: Scientist and Bourgeois*  
Chapter 3 (p. 70)  
Cambridge University Press. Cambridge, England. 1978

**Giddings, Franklin H.** 1855–1931  
American sociologist

In scientific experimentation we control everything that happens. We determine when it shall occur and where. We arrange circumstances and surroundings, atmosphere and temperatures; possible ways of getting in and possible ways of getting out. We take something that has been in, or put in something that has been out, and see what happens.

*The Scientific Study of Human Society*  
Chapter III (p. 55)  
The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1924

**Gleick, James** 1954–  
American author, journalist, and essayist

Theorists conduct experiments with their brains. Experimenters have to use their hands, too. Theorists are thinkers, experimenters are craftsmen. The theorist needs no accomplice. The experimenter has to muster graduate students, cajole machinists, flatter lab assistants. The theorist operates in a pristine place free of noise, of vibration, of dirt. The experimenter develops an intimacy with matter as a sculptor does with clay, battling it, shaping it, and engaging it. The theorist invents his companions, as a naive Romeo imagined his ideal Juliet. The experimenter's lovers sweat, complain, and fart.

*Chaos: Making a New Science*  
Strange Attractors (p. 125)  
The Viking Press. New York, New York, USA. 1987

**Gonseth, Ferdinand** 1890–1975  
Swiss mathematician

An experiment is a question which man asks of nature; one result of the observation is an answer which nature yields to man.

*The Primeval Atom*  
Preface (p. 8)  
D. van Nostrand Company, Inc. New York, New York, USA. 1950

**Gore, George** 1826–1909  
English electrochemist

In scientific study also, as in other abstruse meditations, the mind soon becomes exhausted by intense thinking, but is usually relieved by preparing and making experiments.

*The Art of Scientific Discovery*  
Chapter XXXIII (p. 313)  
Longmans, Green & Company. London, England. 1878

**Green, Celia** 1935–  
English philosopher and psychologist

There are some things that are sure to go wrong as soon as they stop going right.

*The Decline and Fall of Science*  
Aphorisms (p. 171)  
Hamilton. London, England. 1976

**Gregg, Alan** 1890–1957  
American medical educator and philosopher

Experiment as compared with mere observation has some of the characteristics of cross-examining nature rather than merely overhearing her.

*The Furtherance of Medical Research*  
Chapter I (p. 7)  
Yale University Press. New Haven, Connecticut, USA. 1941

Experiments are like cross-questioning a witness who will tell the truth but not the whole truth.

*The Furtherance of Medical Research*  
Chapter III (p. 89)  
Yale University Press. New Haven, Connecticut, USA. 1941

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

The hope that new experiments will lead us back to objective events in time and space is about as well-founded as the hope of discovering the end of the world in the unexplored regions of the Antarctic.

In Nick Herbert  
*Quantum Reality: Beyond the New Physics*  
Chapter 2 (p. 17)  
Anchor Press. Garden City, New York, USA. 1985

**Hinsdale, Burke Aaron** 1837–1900  
American educator

Experiments are like examples, of which it has been said: Examples may be heaped until they hide The rules that they were made to render plain.

*Studies in Education: Science, Art, History*  
Chapter III (p. 72)  
Werner School Book Co. Chicago, Illinois, USA. 1896

**Hooke, Robert** 1635–1703  
English physicist

If you're trying to establish cause-and-effect relationships, do try to do so with a properly designed experiment.

In J.M. Tanur

*Statistics: A Guide to the Unknown*

Statistics, Sports, and Some Other Things (p. 195)

Wadsworth & Brooks. Pacific Grove, California, USA. 1989

### **Hume, David** 1711–76

Scottish philosopher and historian

...[it is] justly esteemed an unpardonable temerity to judge the whole course of nature from one single experiment, however accurate or certain.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section VII, Part II (p. 476)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hunter, John** 1728–93

Scottish surgeon

Why think? Why not try the experiment?

*The Life of Edward Jenner*

Chapter 2 (p. 33)

Letter to Edward Jenner, August 2, 1775

H. Colburn. London, England. 1837

### **Huxley, Thomas Henry** 1825–95

English biologist

Ancient traditions, when tested by the severe processes of modern investigation, commonly enough fade away into mere dreams: but it is singular how often the dream turns out to have been a half-waking one, presaging a reality.

*Man's Place in Nature and Other Anthropological Essays*

Chapter I (p. 1)

D. Appleton & Company. New York, New York, USA. 1896

### **James, P. D.**

No biographical data available

There comes a time when every scientist, even God, has to write off an experiment.

*Devices and Desires*

Book Five, Chapter 8 (p. 330)

Alfred A. Knopf. New York, New York, USA. 1990

### **Jefferson, Thomas** 1743–1826

3rd president of the USA

...in the full tide of successful experiment ...

*The Inaugural Addresses of the Presidents of the United States*

First Inaugural Address at Washington DC, March 4, 1801

### **Jevons, William Stanley** 1835–82

English economist and logician

When we merely note and record the phenomena which occur around us in the ordinary course of nature we are said to observe. When we change the course of nature by the intervention of our will and muscular powers, and thus produce unusual combinations and conditions of phenomena, we are said to experiment. Sir John Herschel has justly remarked that we might properly call these two

modes of experience passive and active observation....

[A]n experiment differs from a mere observation in the fact that we more or less influence the character of the events which we observe.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book III, Chapter XVIII (p. 400)

Macmillan & Company Ltd. London, England. 1887

### **Kant, Immanuel** 1724–1804

German philosopher

When Galileo let balls of a particular weight, which he had determined himself, roll down an inclined plane; or when Torricelli made the air carry a weight, which he had previously determined to be equal to that of a certain column of water; when at a still later stage Stahl changed metal into calx, and calx back again into metal, by first withdrawing something and then restoring it; then a new light was flashed on all students of nature.... Reason, holding in one hand its principles according to which concordant phenomena alone can be admitted as laws of nature, and in the other hand the experiment which it has devised according to those principles, must approach nature for instruction; but not as a pupil, to be taught just what the master pleases, but as a judge, who forces the witnesses to answer the questions he puts to them.... Thus after many centuries of groping, the study of nature was first made to walk along the sure path of a science.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Second Preface

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Kapitza, Pyetr Leonidovich** 1894–1984

Russian physicist

...theory is a good thing but a good experiment lasts forever.

Science East and West: Reflections of Peter Kapitza (Book Review by Nevill Mott)

*Nature*, Volume 288, Number 5791, 11 December, 1980 (p. 627)

### **Kluckhohn, Clyde** 1905–60

American anthropologist

Nonliterate societies represent the end results of many different experiments carried out by nature.

*Mirror For Man: The Relation of Anthropology to Modern Life*

Chapter I (p. 15)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1949

### **Latham, Peter Mere** 1789–1875

English physician

Experiment is like a man traveling to some far off place, and finding no place by the way where he can sit down and rest himself, and few or no guide posts to tell him whether he be in the right direction for it or not. Still he holds on. Perhaps he has been there before, and is pretty sure of this being the direction in which he found it. Or, perhaps he



has never been there, but some of his friends have, and they told him of this being the right road to it. And so it may be that, by his own sagacity and the help of well-informed friends, he reaches it at last. Or, after all his own pains, and all his friends can do for him, it may be that he never reaches it at all.

In William B. Bean

*Aphorisms from Latham* (p. 91)

Prairie Press. Iowa City, Iowa, USA. 1962

### Lavoisier, Antoine Laurent 1743–94

French chemist

We ought, in every instance, to submit our reasoning to the test of experiment, and never to search for truth but by the natural road of experiment and observation.

*Elements of Chemistry in a New Systematic Order*

Preface

W. Creech. Edinburgh, Scotland. 1790

We must trust in nothing but facts. These are presented to us by nature and cannot deceive. We ought in every instance to submit our reasoning to the test of experiment. It is especially necessary to guard against the extravagances of imagination which incline to step beyond the bounds of truth.

In Bernard Jaffe

*New World of Chemistry*

Chapter 1 (p. 1)

Silver, Burdett & Company. New York, New York, USA. 1935

...for nothing is created in the operations either of art or of nature, and it can be taken as an axiom that in every operation an equal quality and quantity of matter exists both before and after the operation, that the quality and quantity of the principles remain the same and that only changes and modifications occur. The whole art of making experiments in chemistry is founded on this principle: we must always suppose an exact equality or equation between the principles of the body examined and those of the products of its analysis.

*Traite Elementaire de Chemie* (p. 130)

Dover Publications. New York, New York, USA. 1965

### Lederman, Leon 1922–

American high-energy physicist

Colleague reader, please read this to your uncertain teenager con brio! Tell him or her that (1) experiments often fail, and (2) they don't always fail.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 9 (p. 396)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### Leibniz, Gottfried Wilhelm 1646–1716

German philosopher and mathematician

If it were as easy in other matters to verify reasonings by experiments, there would not be such differing opinions. But the trouble is that experiments in physics are

difficult and cost a great deal; and in metaphysics they are impossible, unless God out of love for us perform a miracle in order to acquaint us with remote immaterial things.

In Philip Wiener

*Selections*

The Method of Mathematics

Preface

Charles Scribner's Sons. New York, New York, USA. 1951

### Leslie, Sir John 1766–1832

Scottish physicist and mathematician

Experiment is a more efficient mean than Observation, for exploring the secrets of Nature. It requires no constant fatigue of watching, but comes in a great measure under the control of the inquirer, who may often at will either hasten or delay the expected event.

*Elements of Natural Philosophy: Including Mechanics and Hydrostatics* (Volume 1)

Introduction (p. xi)

Oliber & Boyd. Edinburgh, Scotland. 1829

### Linnaeus, Carl (von Linné) 1707–78

Swedish botanist and explorer

I am quite aware that this road is obscured by mists that may pass over it from time to time. Yet these mists will be easily dispersed as soon as it is possible to employ widely the light of experiments. For Nature remains always the same; when she seems to be different it is because of the inevitable defects of our observations.

In Johann Wolfgang von Goeth

*The Botanical Writings* (p. 30)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

### Loftus, Elizabeth

No biographical data available

Science is based on a fundamental insight – that the degree to which an idea seems true has nothing to do with whether it is true, and the way to distinguish factual ideas from false ones is to test them by experiment.

Who Is the Cat That Curiosity Killed?

*Nature*, Nov/Dec 1998 (p. 60)

### Lomonosov, Mikhail 1711–65

Russian poet, scientist, and grammarian

I value one experiment higher than a thousand opinions born of the imagination.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Moscow, Russia. 1979

### Lugosi, Bela 1882–1956

Hungarian film star

My life is consecrated to great experiments.

*Murders in the Rue Morgue*

Film (1932)



**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Experiments are never absolutely exact, but they at least may lead the inquiring mind to *conjecture* that...key which will clear up the connection of all the facts...

*The Science of Mechanics* (5th edition)  
Chapter I, Part I, Section 6 (pp. 25–26)  
The Open Court Publishing Company, La Salle, Illinois, USA. 1942

**Maxwell, James Clerk** 1831–79  
Scottish physicist

An Experiment, like every other event which takes place, is a natural phenomenon; but in a Scientific Experiment the circumstances are so arranged that the relations between a particular set of phenomena may be studied to the best advantage. In designing an Experiment the agents and the phenomena to be studied are marked off from all others and regarded as the Field of Investigation.

In W.D. Niven (ed.)  
*The Scientific Papers of James Clerk Maxwell* (Volume 2)  
General Considerations Concerning Scientific Apparatus (p. 505)  
At The University Press, Cambridge, England. 1890

In every experiment we have first to make our senses familiar with the phenomenon ...

In Lewis Campbell and William Garnett  
*The Life of James Clerk Maxwell*  
Chapter XII (p. 355)  
Macmillan & Company Ltd. London, England. 1882

**Mayer, Alfred Marshall** 1836–97  
Physicist

Teach the pupil to read Nature in the language of experiment. Instruct him to guide with thoughtfulness the work of his hand, and with attention to receive the teachings of his eyes and ears.

*Sound*  
Preface (p. 6)  
D. Appleton & Co. New York, New York, USA. 1879

When the teacher has once obtained the mastery over the experiments he will never after be willing to teach without them; for, as an honest teacher, he will know that he cannot teach without them.

*Sound*  
Preface (p. 6)  
D. Appleton & Co. New York, New York, USA. 1879

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

It is a truism to say that a “good” experiment is precisely that which spares us the exertion of thinking: the better it is, the less we have to worry about its interpretation, about what it “really” means.

*Induction and Intuition in Scientific Thought*  
Chapter I, Section 3 (p. 15)  
American Philosophical Society, Philadelphia, Pennsylvania, USA. 1969

All experimentation is criticism. If an experiment does not hold out the possibility of causing one to revise one’s views, it is hard to see why it should be done at all.

*Advice to a Young Scientist*  
Chapter 11 (p. 94)  
Basic Books, Inc. New York, New York, USA. 1979

**Mellor, Joseph William** 1863–1938  
Chemist

Every experiment has the character of a specific question. The skilled experimenter knows what he is asking, and he tries his best to interpret nature’s reply, be it affirmative, negative, or evasive.

*Modern Inorganic Chemistry*  
Chapter I (p. 4)  
Longmans, Green & Co. London, England. 1912

Trial by a combat of wits in disputations has no attraction for the seeker after truth; to him, the appeal to experiment is the last and only test of the merit of an opinion, conjecture, or hypothesis.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
Chapter I (p. 16)  
Longman, Green & Co. London, England. 1922

**Mendeleyev, Dmitry Ivanovich** 1834–1907  
Russian chemist

Under the all-penetrating control of experiment, a new theory, even if crude, is quickly strengthened, provided it be founded on a sufficient basis; the asperities are removed, it is amended by degrees, and soon loses the phantom light of a shadowy form or of one founded on mere prejudice; it is able to lead to logical conclusions and to submit to experimental proof.

The Periodic Law of the Chemical Elements  
*Journal of the Chemical Society*, Volume 55, 1889 (p. 634)

...experiment itself cannot give truth, but it gives the means of destroying erroneous representations whilst confirming those which are true in all their consequences.

Translated by George Kamensky  
In Thomas Atkinson Lawson  
*The Principles of Chemistry* (Volume I)  
Introduction (p. 15)  
Longmans, Green & Co. London, England. 1891

**Mitchell, Silas Weir** 1829–1914  
American physician and author

In science, all sorts of things present themselves and you watch them; the facts are tested, accepted, rejected, or set aside, and at last experiments are made following some apparently fruitful ideas.

*Weir Mitchell, His Life and Letters* (p. 76)  
Duffield & Company. New York, New York, USA. 1929

### National Research Council (U.S.)

There is only one way to find out: Experiment and observe.

*Physics in Perspective* (Volume 1)  
Chapter 3 (p. 63)  
National Academy of Sciences  
Washington, D.C. 1972

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

We are certainly not to relinquish the evidence of experiments for the sake of dreams and vain fictions of our own devising; nor are we to recede from the analogy of Nature, which is wont to be simple, and always consonant to itself.

In *Great Books of the Western World* (Volume 34)  
*Mathematical Principles of Natural Philosophy*  
Book III, Comment to third rule (p. 270)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Panofsky, Wolfgang** 1919–  
German-American physicist

As experimental techniques have grown from the top of a laboratory bench to the large accelerators of today, the basic components have changed vastly in scale but only little in basic function. More important, the motivation of those engaged in this type of experimentation has hardly changed at all.

Particle Substructure: A Common Theme of Discovery in this Century  
*Contemporary Physics*, Volume 20, Number 1, 1982 (p. 23)

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541  
Alchemist and mystic

Every experiment is like a weapon which must be used in its particular way – a spear to thrust, a club to strike. Experimenting requires a man who knows when to thrust and when to strike, each according to need and fashion.

In J. M. Stillman  
The Contributions of Paracelsus to Medical Science and Practice  
*The Monist*, Volume 27, 1917 (p. 398)

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Do not draw this conclusion from your experiment, that there remains nothing for you to know; but rather that there remains an infinity for you to know.

Translated by William Finlayson Trotter  
*Thoughts*  
Number 231 (p. 83)  
P.F. Colier & Son. New York, New York, USA. 1910

**Pasteur, Louis** 1822–95  
French chemist

...marvelous experimental method, of which one can say, in truth, not that it is sufficient for every purpose, but that it rarely leads astray, and then only those who do not use it well. It...eliminates certain facts, brings forth others, interrogates nature, compels it to reply and stops only when the mind is fully satisfied. The charm of our

studies, the enchantment of science, is that, everywhere and always, we can give the justification of our principles and the proof of our discoveries.

In René Dubos  
*Pasteur and Modern Science*  
Chapter I (p. 12)  
Science Tech Publishers. Madison, Wisconsin, USA. 1988

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

Experiment alone crowns the efforts of medicine, experiment limited only by the natural range of the powers of the human mind.

*Experimental Psychology and Other Essays*  
Fusion of Principal, Branches of Medicine in Modern Experimentation as Demonstrated by the Example of Digestion (p. 488)  
Philosophical Library. New York, New York, USA. 1957

...observation collects that which nature has to offer, whereas experiment takes from her that which it desires.

*Experimental Psychology and Other Essays*  
Fusion of Principal, Branches of Medicine in Modern Experimentation as Demonstrated by the Example of Digestion (p. 488)  
Philosophical Library. New York, New York, USA. 1957

**Pearson, Karl** 1857–1936  
English mathematician

It is the old experience that a rude instrument in the hand of a master craftsman will achieve more than the finest tool wielded by the uninspired journeyman.

*Life, Letters and Labours of Francis Galton* (Volume 3) (p. 50)  
University Press. Cambridge, England. 1914–30

**Pirsig, Robert M.** 1928–  
American writer

An experiment is a failure only when it also fails adequately to test the hypothesis in question, when the data it produces don't prove anything one way or the other.

*Zen and the Art of Motorcycle Maintenance* (p. 102)  
1974

The TV scientist who mutters sadly "The experiment is a failure: we have failed to achieve what we hoped for," is suffering mainly from a bad scriptwriter. An experiment is never a failure solely because it fails to achieve predicted results. An experiment is a failure only when it also fails adequately to test the hypothesis in question, when the data it produces don't prove anything one way or the other.

*Zen and the Art of Motorcycle Maintenance: An Inquiry Into Values*  
Part II, Chapter 9 (pp. 109–110)  
William Morrow & Company, Inc. New York, New York, USA. 1974

**Planck, Max** 1858–1947  
German physicist

An experiment is a question which science poses to Nature, and a measurement is the recording of Nature's answer.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part III (p. 110)  
Philosophical Library. New York, New York, USA. 1949

Experimenters are the shock troops of science.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part III (p. 110)  
Philosophical Library. New York, New York, USA. 1949

It is wholly absurd to maintain that an intellectual experiment is important only in proportion as it can be checked by measurement; for if this were so, there could be no exact geometrical proof. A line drawn on paper is not really a line but a more or less narrow strip, and a point a larger or smaller spot.

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter I (p. 27)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

**Plato** 428 BCE–347 BCE

Greek philosopher

POLUS: O Chaeophon, there are many arts among mankind which are experimental, and have their origin in experience, for experience makes the days of men to proceed according to art, and inexperience according to chance, and different persons in different ways are proficient in different arts, and the best persons in the best arts.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 448 (p. 253)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Experiment is the sole source of truth. It alone can teach us something new; it alone can give us certainty.

*The Foundations of Science*

*Science and Hypothesis*, Part IV

Chapter IX (p. 127)

The Science Press. New York, New York, USA. 1913

It is often said that experiments must be made without preconceived idea. That is impossible. Not only would it make all experiment barren, but that would be attempted which could not be done.

*The Foundations of Science*

*Science and Hypothesis*, Part IV

Chapter IX (p. 129)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

A mighty maze! but not without a plan...

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, l. 6

Houghton Mifflin Company. New York, New York, USA. 1903

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

I admit, of course, that we attempt to control the purely speculative elements of our theories by ingenious

experiments. Nevertheless, all our experiments are guided by theory and they cannot be interpreted except by theory. It is our inventiveness, our imagination, our intellect, and especially the use of our critical faculties in discussing and comparing our theories that make it possible for our knowledge to grow.

In C.J. Whitrow

*Einstein: The Man and His Achievement*

Einstein: Early Years (p. 28)

BBC. London, England. 1967

**Portier, Paul**

No biographical data available

It seems to me to be useless for us to deliver passionate long verbal duels in order to establish who is right or wrong. It is necessary to search in good faith on the part of each other for the truth; there are two different points of view and only experiments carried out over a sufficient time will give us definitive scientific results.

In Jan Sapp

*Evolution by Association: A History of Symbiosis*

Chapter 7 (p. 97)

Oxford University Press, Inc. New York, New York, USA. 1994

**Priestley, Joseph** 1733–1804

English theologian and scientist

The history of science cannot but animate us in our attempts to advance still further, and suggest methods and experiments to assist us in our future progress.

In John G. McEvoy

Electricity, Knowledge, and the Nature of Progress in Priestley's Thought

*British Journal of the History of Science*, Volume 12, 1979 (p. 6)

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

We don't teach our students enough of the intellectual content of experiments – their novelty and their capacity for opening new fields.... My own view is that you take these things personally. You do an experiment because your own philosophy makes you want to know the result. It's too hard, and life is too short, to spend your time doing something because someone else has said it's important. You must feel the thing yourself...

Profiles–Physicists, I

*The New Yorker Magazine*, October 13, 1975

**Robertson, Howard P.**

No biographical data available

What is needed is a homely experiment which could be carried out in the basement with parts from an old sewing machine and an Ingersol watch, with an old file of Popular Mechanics standing by for reference!

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Geometry as a Branch of Physics (p. 326)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Röntgen, Wilhelm Conrad** 1845–1923

German physicist

The experiment is the most powerful and most reliable lever enabling us to extract secrets from nature.... The experiment must constitute the final judgment as to whether a hypothesis should be retained or be discarded.

In O. Glasser

*Wilhelm Conrad Röntgen and the Early History of the Roentgen Rays*  
(p. 74)

Charles C. Thomas, Springfield. 1934

### **Rothman, Tony** 1953–

American cosmologist

The Physicist's Code: A single good observation is worth a century of bad philosophy.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Introduction (p. xii)

Ballantine Books, New York, New York, USA. 1995

Principle of Magnification: New discoveries follow on the heels of new equipment.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 2 (p. 56)

Ballantine Books, New York, New York, USA. 1995

### **Rumford, Benjamin**

No biographical data available

It frequently happens, that in the ordinary affairs and occupations of life, opportunities present themselves of contemplating some of the most curious operations of Nature; and very interesting philosophical experiments might often be made, almost without trouble or expense, by means of machinery contrived for the mere mechanical purposes of the arts and manufacturers.

Heat Is a Form of Motion: An Experiment in Boring Cannon

*Philosophical Transactions of the Royal Society of London*, Volume 88, 1798

### **Russell, Sir E. John** 1872–1965

English agriculturalist

A committee or an investigator considering a scheme of experiments should first...ask whether each experiment or question is framed in such a way that a definite answer can be given. The chief requirement is simplicity; only one question should be asked at a time.

Field Experiments: How They are Made and What They Are

*Journal of the Ministry of Agriculture of Great Britain*, Volume 32, 1926 (p. 989)

### **Rutherford, Ernest** 1871–1937

English physicist

Experiment without imagination or imagination without recourse to experiment, can accomplish little, but for effective progress, a happy blend of these two powers is necessary.

The Electrical Structure of Matter

*Science*, Volume 58, Number 1499, September 21, 1923 (p. 221)

If your experiment needs statistics, you ought to have done a better experiment.

In N.T. Bailey

*The Mathematical Approach to Biology and Medicine*

Chapter 2 (p. 23)

John Wiley & Sons, Inc. New York, New York, USA. 1967

### **Sagan, Carl** 1934–96

American astronomer and author

When theory is not adequate in science, the only realistic approach is experimental. Experiment is the touchstone of science on which the theories are framed. It is the court of last resort.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 5 (p. 37)

Dell Publishing, Inc. New York, New York, USA. 1975

Wherever possible, scientists experiment. Which experiments suggest themselves often depends on which theories currently prevail. Scientists are intent on testing those theories to the breaking point. They do not trust what is intuitively obvious. That the Earth is flat was once obvious. That heavy bodies fall faster than light ones was once obvious. That bloodsucking leeches cure most diseases was once obvious. That some people are naturally and by divine decree slaves was once obvious. That there is such a place as the center of the Universe, and that the Earth sits in that exalted spot was once obvious. That there is an absolute standard of rest was once obvious. The truth may be puzzling or counterintuitive. It may contradict deeply held beliefs. Experiment is how we get a handle on it.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 36)

Random House, Inc. New York, New York, USA. 1995

### **Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

We never experiment with just one electron or atom... anymore than we can raise Ichthyosauria in the zoo.

*British Journal For the Philosophy of Science*, Volume III, Number 11, November, 1952

### **Snyder, Solomon**

American physician

Of course, if you can predict the consequences of your own experiments before they commence, your research is very likely to be boring.

*Brainstorming*

Chapter 10 (p. 195)

Harvard University Press. Cambridge, Massachusetts, USA. 1989

### **Stenger, Victor J.** 1935–

American Physicist

The instruments of modern science have provided us with greatly enhanced capabilities for gathering data about the universe. With our microscopes, telescopes, and particle detectors, we are no longer bound by the limitations of human sensory apparatus or of our confinement to this

tiny planet. And we have learned to rely more on the rational interpretation of the reading of these instruments than on preconceived notions based on everyday experience.

*Physics and Psychics: The Search for a World Beyond the Senses*  
Chapter 14 (p. 296)  
Prometheus Books. Buffalo, New York, USA. 1990

### Swenson, Jr., Lloyd S.

No biographical data available

For sheer intellectual drama, nothing can surpass the encounter between a great experiment and a great theory.

*The Ethereal Aether*  
Foreword (p. xix)  
University of Texas Press. Austin, Texas, USA. 1972

### The Bible (King James Version)

For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it?

Luke 14:28

### Dr. Pretorius (Fictional character)

My experiments did not turn out quite like yours, Henry. But science, like love, has her little surprises.

*Bride of Frankenstein*  
Film (1935)

### Thomson, Sir George Paget 1892–1975

English physicist

...in order to make an experiment meaningful one must have a theory as to what matters for the experiment.

*The Inspiration of Science*  
Chapter II (p. 15)  
Oxford University Press, Inc. London, England. 1961

### Titchener, Edward Bradford 1867–1927

English-born American psychologist

An experiment is an observation that can be repeated, isolated and varied. The more frequently you can repeat an observation, the more likely are you to see clearly what is there and to describe accurately what you have seen. The more strictly you can isolate an observation, the easier does your task of observation become, and the less danger is there of your being led astray by irrelevant circumstances, or of placing emphasis on the wrong point. The more widely you can vary an observation, the more clearly will be the uniformity of experience stand out, and the better is your chance of discovering laws.

*A Text-Book of Psychology*  
Subject-Matter, Method and Problem of Psychology, Section 6 (p. 20)  
The Macmillan Company. New York, New York, USA. 1912

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Tuesday. She has taken up with a snake now. The other animals are glad, for she was always experimenting with them and bothering them; and I am glad, because the snake talks, and this enables me to get a rest.

*Adam's Diary*  
Tuesday (p. 39)  
Harper & Brothers Publishers. New York, New York, USA. 1904

It is best to prove things by actual experiment; then you know; whereas if you depend on guessing and supposing and conjecturing, you will never get educated.

*Eve's Diary*  
Friday (p. 85)  
Harper & Brothers Publishers. New York, New York, USA. 1906

Some things you can't find out; but you will never know you can't by guessing and supposing; no, you have to be patient and go on experimenting until you find out that you can't find out. And it is delightful to have it that way, it makes the world so interesting. If there wasn't anything to find out, it would be dull. Even trying to find out and not finding out is just as interesting as trying to find out and finding out; and I don't know but more so.

*Eve's Diary*  
Friday (p. 87)  
Harper & Brothers Publishers. New York, New York, USA. 1906

### Tyndall, John 1820–93

Irish-born English physicist

Experiments have two great uses – a use in discovery and verification, and a use in tuition. They were long ago defined as the investigator's language addressed to Nature, to which she sends intelligible replies. These replies, however, usually reach the questioner in whispers too feeble for the public ear.

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)  
Lecture I (p. 3)  
D. Appleton & Co. New York, New York, USA. 1901

Experiment, as I have said, is the language by which we address Nature, and through which she sends her replies; in the use of this language a lack of straightforwardness is as possible and as prejudicial as in the spoken language of the tongue. If you wish to become acquainted with the truth of Nature, you must from the first resolve to deal with her sincerely.

*Fragments of Science for Unscientific People*  
Chapter XIII (p. 361)  
D. Appleton & Co. New York, New York, USA. 1875

Do not think the work dull; you are conversing with Nature, and must acquire over her language a certain grace and mastery, which practice can alone impart. Let every movement be made with care, and avoid slovenliness from the outset. Experiment...is the language by which we address Nature, and through which she sends her replies; in the use of this language a lack of straightforwardness is as possible, and as prejudicial, as in the



spoken language of the tongue. If, therefore, you wish to become acquainted with the truth of Nature, you must from the first resolve to deal with her sincerely.

*Fragments of Science*

Part One

A Lecture to School Masters (pp. 366–367)

P.F. Collier & Son. New York, New York, USA. 1901

**von Baeyer, Adolf** 1835–1917

German-born physicist and author

I never undertook my experiments to see if I was right but to see how compounds behaved. This disposition accounts for my indifference to theories.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 140)

W.A. Benjamin. New York, New York, USA. 1965

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

It is a calamity that the use of experiment has severed nature from man, so that he is content to understand nature merely through what artificial instruments reveal and by so doing even restricts her achievements.... Microscopes and telescopes, in actual fact, confuse man's innate clarity of mind.

In Ernst Lehrs

*Man or Matter: Introduction to a Spiritual Understanding of Nature on*

*the Basis of Goethe's Method of Training Observation and Thought*

Part II, Chapter IV (pp. 111, 106)

Faber & Faber Ltd. London, England. 1958

There is much that is true which does not admit of being calculated; just as there are a great many things that cannot be brought to the test of a decisive experiment.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#547 (p. 191)

The Macmillan Co. New York, New York, USA. 1906

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

From the time when man in interrogating nature began to experiment, or to produce phenomena under definite conditions, and to collect and record the fruits of experience, so that investigation might no longer be restricted by the short limits of a single life, the philosophy of nature laid aside the vague and poetic forms with which she had at first been clothed, and has adopted a more severe character – she now weighs the value of observations, and no longer divines, but combines and reasons.

*Cosmos: A Sketch of a Physical Description of the Universe*

Introduction (p. 5)

Longman, Brown, Green & Longmans. London, England. 1849

**von Liebig, Justus** 1803–73

German organic chemist

The success of an experiment, or of a process, depends far less upon mechanical skill, than knowledge. Failure is

the result of ignorance, and discoveries are made, not by manual dexterity, but by skill in combination, and by that intellectual power which creates new thoughts.

In John Blyth

*Familiar Letters on Chemistry* (4th edition)

Letter I (p. 12)

Walton & Maberly. London, England. 1859

The true philosopher always seeks to explain and illustrate the facts of nature by creating phenomena; that is, by experiments, the devising and discovery of which is his task, and by which he causes the object of his investigation to speak, as it were, intelligibly to him.

In John Gardner

*Familiar Letters on Chemistry*

Second Series

Letter I (p. 26)

Taylor & Walton. London, England. 1844

**Wald, George** 1906–97

American biologist and biochemist

I have often had cause to feel that my hands are cleverer than my head. That is a crude way of characterizing the dialectics of experimentation. When it is going well, it is like a quiet conversation with Nature. One asks a question and gets an answer; then one asks the next question, and gets the next answer. An experiment is a device to make Nature speak intelligibly. After that one has only to listen.

*Nobel Lecture, Physiology or Medicine 1963–1970*

*The Molecular Basis of Visual Excitation* (p. 292)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Watts, W. W.**

No biographical data available

The training of the mind solely by means of experiments carefully designed to eliminate all confusing and collateral elements savours too much of 'milk for babes' and too little of 'strong meat for men.'

*Report of the Seventy-third Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 645)

John Murray. London, England. 1904

**Weinberg, Steven** 1933–

American nuclear physicist

It appears that anything you say about the way that theory and experiment may interact is likely to be correct, and anything you say about the way that theory and experiment must interact is likely to be wrong.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Chapter V (p. 128)

Pantheon Books. New York, New York, USA. 1992

**Weyl, Hermann** 1885–1955

German mathematician

Allow me to express now, once and for all, my deep respect for the work of the experimenter and for his fight



to wring significant facts from an inflexible Nature, who says so distinctly “No” and so indistinctly “Yes” to our theories.

Translated by H.P. Robertson

*The Theory of Groups and Quantum Mechanics*

Introduction (p. xx)

Dover Publications, Inc. New York, New York, USA. 1950

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There is always more chance of hitting upon something valuable when you aren't too sure what you want to hit upon.

In Lucien Price

*Dialogues of Alfred North Whitehead*

Dialogue XLII, September 11, 1945 (p. 344)

Little Brown. Boston, Massachusetts, USA. 1954

...experiment is nothing else than a mode of cooking the facts for the sake of exemplifying the law.

*Adventures of Ideas*

Chapter VI (p. 111)

The Macmillan Company. New York, New York, USA. 1956

**Whately, Richard** 1787–1863

English theologian

If everyone would record his experiments and observations, science would be much benefited.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard*

*Whately, D.D.*

Apothegm 51 (p. 5)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Zinsser, Hans** 1878–1940

American bacteriologist

The life of a student of any science is a constant series of frustrations. From his own observations and those of others, a trellis of theory is built up beyond the solid stakes of fact. The investigator tests these, perched on scaffoldings of experiment which break down again and again and are, as often, reconstructed with the weak points reinforced. Eventually, as soon as he has tied down an elusive shoot, he loses interest and is lured by the ones a little higher up. There is never an end, and never a complete satisfaction – as there may be in the arts, when a perfect sonnet or a good statue is, in itself, final and forever.

*As I Remember Him: the Biography of R.S.*

Chapter XX (p. 330)

Little, Brown & Company. Boston, Massachusetts, USA. 1940

## EXPERIMENT, INTELLECTUAL

**Planck, Max** 1858–1947

German physicist

An intellectual experiment is not tied down to any limits of accuracy, for thoughts are more subtle than atoms or electrons ...

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter I (p. 27)

W.W. Norton & Co. New York, New York, USA. 1936

## EXPERIMENTAL DESIGN

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

Our view... is that it is an essential characteristic of experimentation that it is carried out with limited resources, and an essential part of the subject of experimental design to ascertain how these should be best applied; or, in particular, to which causes of disturbance care should be given, and which ought to be deliberately ignored.

*The Design of Experiments* (p. 18)

Oliver & Boyd. Edinburgh, Scotland 1951

## EXPERIMENTAL ERROR

**Crookes, Sir William** 1832–1919

English chemist and physicist

A scientific man engaged in any special pursuit has much difficulty in making clear, to even the scientific public, the result of his experiments. The benefit of his research may be perfectly apparent; but if his experiments have been conducted with rigour there will be a certain individual departure from a general standard in the results, which, if he merely state his conclusions, will confuse the attentive reader. Perhaps certain of the experiments were performed under better test conditions, and their numerical results are therefore more nearly correct than the results of another series of experiments. Should this be the case, to take an average of the results would yield an empirical result, deviating considerably from the truth. Yet many of our most eminent experimentalists are satisfied with recording their experiments, and leave the student of their labours in an uncomfortable uncertainty as to the exact value of the entire system of experiment.

On the Probability of Error in Experimental Research

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

*Industrial Arts, Manufactures, and Technology*, Volume 3, New Series,

Number 37, January, 1873 (p. 1)

## EXPERIMENTAL FINDING

**Shapley, Harlow** 1885–1972

American astronomer

A hypothesis or theory is clear, decisive, and positive, but it is believed by no one but the man who created it. Experimental findings, on the other hand, are messy, inexact things, which are believed by everyone except the man who did the work.

*Review of Scientific Instruments*, Volume 6, 1922 (p. 96)

## EXPERIMENTAL METHOD

**Bernard, Claude** 1813–78  
French physiologist

Considered by itself, the experimental method is nothing but reasoning by whose help we methodically submit our ideas to experience – the experience of facts.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Introduction (p. 2)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Hacking, Ian** 1936–  
Canadian-born philosopher of science

Philosophers of science constantly discuss theories and representation of reality, but say almost nothing about experiment, technology, or the use of knowledge to alter the world. This is odd, because “experimental method” used to be just another name for scientific method.... I hope [to] initiate a Back-to-Bacon movement, in which we attend more seriously to experimental science. Experimentation has a life of its own.

*Representing and Intervening: Introductory Topics in the Philosophy of Natural Science* (p. 143, fn)  
Cambridge University Press. Cambridge, England. 1983

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

The great intellectual division of mankind is not along geographical or racial lines, but between those who understand and practice the experimental method and those who do not understand and do not practice it.

*A History of Science* (p. 29)  
Williams & Wilkins Company. Baltimore, Maryland, USA. 1948

**Tolman, Edward Chance** 1886–1959  
American psychologist

I shall devote this paper to a description of experiments with rats. But I shall also attempt in a few words at the close to indicate the significance of these findings on rats for the clinical behavior of men. Most of the rat investigations, which I shall report, were carried out in the Berkeley laboratory. But I shall also include, occasionally, accounts of the behavior of non-Berkeley rats who obviously have misspent their lives in out-of-State laboratories.

*Cognitive Maps in Rats and Men*  
*The Psychological Review*, Volume 55, Number 4, 1948 (p. 189)

## EXPERIMENTAL SCIENCE

**Davy, Sir Humphry** 1778–1829  
English chemist

Experimental science hardly ever affords us more than approximations to truth; and whenever many agents are concerned we are in great danger of being mistaken.

In John Davy  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
Chapter II (p. 122)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

## EXPERIMENTATION

**Bernard, Claude** 1813–78  
French physiologist

All those who restrict themselves to speaking of experimentation from the fireside do nothing for science; rather they harm it.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin  
*The Cahier Rouge of Claude Bernard* (p. 94)  
Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

## EXPERIMENTER

**Bernard, Claude** 1813–78  
French physiologist

An experimenter facing natural phenomena is like a spectator watching a dumb show. He is in some sort the examining magistrate for nature; only instead of grappling with men who seek to deceive him by lying confessions or false witness, he is dealing with natural phenomena which for him are persons whose language and customs he does not know, persons living in the midst of circumstances unknown to him, yet persons whose designs he wishes to learn.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter II, Section I (p. 31)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Brillouin, Léon** 1889–1969  
French physicist

Perfect logic and faultless deduction make a pleasant theoretical structure, but it may be right or wrong; the experimenter is the only one to decide, and he is always right.

*Scientific Uncertainty and Information*  
Chapter III (p. 38)  
Academic Press. New York, New York, USA. 1964

**Deutsch, Martin** 1917–2002  
Austrian-born American physicist

It is of course the ambition of every experimenter...to make a discovery, to sail safely between the Scylla of intellectual prejudice which makes us reject evidence not really integrated without preconceived notions, and the Charybdis of irrelevance which has swallowed many working days spent in pursuit of instrumental artifice.

*Evidence*  
*Daedalus*, Fall 1958 (pp. 97–98)

**Pasteur, Louis** 1822–95  
French chemist

The illusions of an experimenter form a great part of his power. These are the preconceived ideas which serve to guide him. Many of them vanish in the long path which he must travel, but one fine day he discovers and proves that some of them are adequate to the truth. Then he finds himself master of facts and of new principles, the application of which sooner or later bestows their benefits.

In Graham Lusk  
*Pasteur, the Man*  
*Science*, Volume 57, Number 1466, February 2, 1923 (p. 149)

**Tyndall, John** 1820–93  
Irish-born British physicist

The child grows, but is still an experimenter: he grasps at the moon, and his failure teaches him to respect distance. At length, his little fingers acquire sufficient mechanical tact to lay hold of a spoon. He thrusts the instrument into his mouth, hurts his gums and thus learns the impenetrability of matter. He lets the spoon fall, and jumps with delight to hear it rattle against the table. The experiment made by accident is repeated with intention, and thus the young student receives his first lesson upon sound and gravitation. There are pains and penalties, however, in the path of the enquirer: he is sure to go wrong, and Nature is just as sure to inform him of the fact. He falls downstairs, burns his fingers, cuts his hand, scalds his tongue, and in this way learns the conditions of his physical well being. This is Nature's way of proceeding, and it is wonderful what progress her pupil makes.

*Fragments of Science* (Volume 1) (p. 283)  
D. Appleton & Company. New York, New York, USA. 1896

## EXPERIMENTALIST

**Rubbia, Carlo** 1934–  
Italian physicist

I have to talk to you as an experimentalist, not as a theorist. I don't have a telephone line to God.

In Gary Taubes  
*Nobel Dreams*  
Chapter 15 (p. 222)  
Random House, Inc. New York, New York, USA. 1986

## EXPERT

**Bonney, Thomas George** 1833–1923  
English geologist

...experts sometimes suffer from an hypertrophy of learning and an atrophy of common sense to which men of wider outlook and more general culture can apply a wholesome correction.

*The Story of Our Planet*  
Preface (p. iv)  
The Cassell Publishing Co. New York, New York, USA. 1893

**Hall, Granville Stanley** 1844–1924  
American psychologist and educator

Every great expert should feel it his duty to put the best that is in him in a form most interesting and profitable to a cultured lay audience ...

*Adolescence: Its Psychology and Its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education* (Volume 2)  
Chapter XVI (p. 548)  
D. Appleton & Co. New York, New York, USA. 1907

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Always listen to experts. They'll tell you what can't be done, and why. Then do it.

*The Notebooks of Lazarus Long* (p. 1)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Mamet, David** 1947–  
American author, essayist and screenwriter

The poker player learns that sometimes both science and common sense are wrong; that the bumblebee can fly; that, perhaps, one should never trust an expert; that there are more things in heaven and earth than are dreamt of by those with an academic bent.

*Writing in Restaurants*  
Things I Have Learned Playing Poker on the Hill  
The Viking Press. New York, New York, USA. 1986

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

There is something inherently comforting about a panel of experts. One knows that the partial and inadequate and slanted and personal views that he expresses will be corrected by the less partial, less personal views of everyone else on the panel...

*The Open Mind*  
Chapter VII (p. 119)  
Simon & Schuster. New York, New York, USA. 1955

## EXPLAIN

**Burroughs, John** 1837–1921  
American naturalist and essayist

Little things explain big things. A grain of sand is the Alps on a small scale. A drop of water illustrates the laws of the ocean. The fall of an apple revealed to the mind of Newton the laws of the spheres.

*The Heart of Burroughs's Journals*  
May 15, 1857 (p. 9)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

I wish he would explain his explanation.

*The Works of Lord Byron, Including the Suppressed Poems*  
Dedication to Don Juan  
Grigg & Eliot. Philadelphia, Pennsylvania, USA. 1846

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

We can explain it all, but understand only very little.  
*Voices in the Labyrinth: Nature, Man and Science* (p. 21)  
The Seabury Press. New York, New York, USA. 1977

**von Liebig, Justus** 1803–73  
German organic chemist

The difficulty of explaining the facts ought not at once to deter us from investigating them in all their bearings, and ascertaining the extent of their influence.

In John Blyth

*Letters on Modern Agriculture*

Letter III (p. 43)

Walton & Maberly. London, England. 1859

## EXPLANATION

**Atkins, Peter William** 1940–  
English physical chemist and writer

I shall take your mind on a journey. It is a journey of comprehension, taking us to the edge of space, time, and understanding. On it I shall argue that there is nothing that cannot be understood, that there is nothing that cannot be explained, and that everything is extraordinarily simple.

A great deal of the universe does not need any explanation. Elephants, for example. Once molecules have learnt to compete and to create other molecules in their own image, elephants, and things resembling elephants, will in due course be found roaming through the countryside.

*The Creation*

Chapter 1 (p. 3)

W.H. Freeman. San Francisco, California, USA. 1981

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

I trust that this explanation has illuminated an obscure matter, but I have my doubts.

*The Handmaiden of the Sciences*

Chapter 1 (p. 19)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Bernal, John Desmond** 1901–71  
Irish-born physicist and x-ray crystallographer

It is characteristic of science that the full explanations are often seized in their essence by the percipient scientist long in advance of any possible proof.

*The Origin of Life*

Appendix I

Comments on Haldane's Paper on the Origins of Life (p. 251)

The World Publishing Company, Cleveland, Ohio, USA. 1967

**Berzelius, Jöns Jacob** 1779–1848  
Swedish chemist

We thus obtain a fictitious explanation by which we believe to have understood that which we cannot yet understand, and whereby the attention is diverted away from the matter to be explained which then remains all the longer unelucidated. I should like to repeat once again what I have stated so often before, namely that in Science fictitious, prematurely enunciated explanations invariably lead astray, and that the only method to obtain positive knowledge is to leave the incomprehensible unexplained until sooner or later the explanation emerges of its own accord from facts which are so plain that divided opinions about them can scarcely arise. Not to believe that there is more to be seen than can clearly and plainly be appreciated, and to regard the rest as material for further investigation, is a scientific principle which should not be violated but it is one which precisely those persons who are gifted with a lively mind and a fertile imagination find most difficult to follow.

Quoted in Eduard Buchner

*Nobel Lectures, Chemistry 1901–1921*

On Catalysis

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

Conventional science attempts to explain things exactly, in terms of general principles. Any sort of explanation for the shape of a snowflake or a coastline could not be of this sort.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 3 (p. 22)

Simon & Schuster. New York, New York, USA. 1988

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Perhaps when a man has special knowledge and special powers like my own, it rather encourages him to seek a complex explanation when a simple one is at hand.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Abbey Grange* (p. 498)

Wings Books. New York, New York, USA. 1967

**Fort, Charles** 1874–1932  
American writer

The fate of all explanation is to close one door only to have another fly wide open.

*The Book of the Damned*

Chapter III (p. 32)

Boni & Liveright. New York, New York, USA. 1919

**Freund, Ida** 1863–1914  
Austrian-born chemist

There is inherent in the human mind a desire to find an explanation – or as some would prefer to have it called, a description – of the phenomena of nature, by means of speculations concerning the ultimate constitution of matter.

*The Study of Chemical Composition*

Chapter IX (p. 226)

At the University Press. Cambridge, England. 1904

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Familiar objects and events are far from presenting themselves to our senses in that aspect and with those connections under which science requires them to be viewed, and which constitute their rational explanation.

*Outlines of Astronomy*

Introduction (p. 1)

D. Appleton & Co. New York, New York, USA. 1876

**Huxley, Thomas Henry** 1825–95  
English biologist

...no explanation of anything can be complete, because human knowledge, at its best, goes but a very little way back towards the beginning of things.

*Introductory*

Article 3 (p. 7)

Macmillan & Company Ltd. London, England. 1907

**Jerome, Fred**  
American journalist and science writer

Explain, explain, explain – but without resentment.

In Barbara Gastel

*Presenting Science to the Public*

Chapter 2 (p. 24)

ISI Press. Philadelphia, Pennsylvania, USA. 1983

**Mallock, William Hurrell** 1849–1923  
Writer

[Things] are as they are, because they were as they were.

*Religion as a Credible Doctrine: A Study of the Fundamental Difficulty*

Chapter XI (p. 233)

Chapman & Hall, Ltd. London, England. 1903

**Mitchell, Maria** 1818–89  
American astronomer and educator

...you cannot get a man of genius to explain steps, he leaps.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter VII (p. 138)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Poynting, John Henry** 1852–1914  
English physicist

The aim of explanation... is to reduce the number of laws as far as possible, by showing that laws, at first separated, may be merged in one; to reduce the number of chapters in the book of science by showing that some are truly mere sub-sections of chapters already written.

Address to the British Association

*Chemical News and Journal of Industrial Science*, Volume 80, Number 2079, September 29, 1899 (p. 155)

...the physicist is examining the garment of Nature, learning of how many, or rather of how few, different kinds of thread it is woven, finding how each separate thread enters into the pattern, and seeking from the pattern woven in the past to know the pattern yet to come.

*Report of the Sixty-ninth Meeting British Association for the Advancement of Science*

The President's Address (p. 618)

John Murray. London, England. 1900

**Scriven, Michael**

No biographical data available

...whatever an explanation actually does, in order to be called an explanation at all it must be capable of making clear something not preciously clear, *i.e.* of increasing or producing understanding of something. The difference between explaining and “merely” informing, does not, I shall argue, consist in explaining being something “more than” or even something intrinsically different from informing or describing, but in its being the appropriate piece of informing or describing, the appropriateness being a matter of its relation to a particular context.

In H. Feigl and G. Maxwell (eds.)

*Minnesota Studies in the Philosophy of Science* (Volume 3)

Scientific Explanation, Space and Time, Explanations, Predictions, and Laws (pp. 175–176)

University of Minnesota Press. Minneapolis, Minnesota, USA. 1962

**Smith, George Otis** 1871–1944  
American geologist

The scientific community must be effective in communicating the results of its work to the public in a way that can be understood and used. The need for this is acute, for the complexity and difficulty of environmental and resource problems require full use of all the knowledge scientists can muster. The wisdom of the actions of both the government and private sectors depends in large part on their understanding of resource characteristics.

Paper presented to the Society of Economic Geologists at the Amherst Meeting

December 28, 1921

**von Schlegel, Friedrich** 1772–1829  
German philosopher, critic, and writer

There are three kinds of explanation in science: explanations which throw a light upon, or give a hint at a matter; explanations which do not explain anything; and explanations which obscure everything.



*Dialogue on Poetry and Literary Aphorisms*

Selected Aphorisms from the Athenaeum

Aphorism 82 (p. 138)

The Pennsylvania State University Press, University Park, Pennsylvania, USA. 1968

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

If we say there is a limit – the ultimate atom – then, as all size is comparative, we can imagine a being to whom this atom seems as large as an apple or even a house does to us; and we then find it quite unthinkable that this mass of matter should be in its nature absolutely indivisible even by an infinite force. It follows that all explanations of phenomena can only be partial explanations. They can inform us of the last change or the last series of changes which brought about the actual conditions now existing, and they can often enable us to predict future changes to a limited extent; but both the infinite past and the remote future are alike beyond our powers. Yet the explanations that the theory of evolution gives us are none the less real and none the less important, especially when we compare its teachings with the wild guesses or the total ignorance of the thinkers of earlier ages.

Evolution

*The Sun (New York)*, 23 December, 1900 (p. 4a)**Wilson, Andrew** 1852–1912

No biographical data available

It is impossible, of course, that science should be studied in schools without the aid of books; but I would rank the help of works of reference as very subsidiary to that of active teaching by lectures, questions, and verbal explanation.

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

The Place, Method, and Advantage of Biology in Education (p. 17)

Chatto &amp; Windus. London, England. 1879

**Wolpert, Lewis** 1929–

British embryologist

There is a relevant story about Charles II, who once invited fellows of the Royal Society to explain to him why a fish when it is dead weighs more than when it was alive. The fellows responded with ingenious explanations, until the King pointed out that what he had told them was just not true.

*The Unnatural Nature of Science*

Chapter 5 (p. 98)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**EXPLICIT****Alon, Noga**

Mathematician

There is an explicit way to define what explicit is.

International Congress of Mathematics 2002

Beijing

August 23, 2002

**EXPLORATION****Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

It would indeed be dishonourable to mankind, if the regions of the material globe, the earth, the sea, and stars should be so prodigiously developed and illustrated in our age, and yet the boundaries of the intellectual globe should be confined to the narrow discoveries of the ancients.

*The Works of Francis Bacon, Lord Chancellor of England (Volume 14)**Novum Organum*

Book I (p. 60)

William Pickering. London, England. 1831

**Clarke, Arthur C.** 1917–

English science and science fiction writer

The urge to explore, to discover, to “follow knowledge like a sinking star,” is a primary human impulse which needs and can receive no further justification than its own existence.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 3)

Harper &amp; Brothers Publishers. New York, New York, USA. 1959

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

We shall not cease from exploration

And the end of all our exploring

Will be to arrive where we started

And know the place for the first time.

Through the unknown, remembered gate

When the last of earth left to discover

Is that which was the beginning.

*The Collected Poems and Plays 1909–1950*

Little Gidding, Part V, stanza 2 (p. 145)

Harcourt, Brace &amp; World, Inc. New York, New York, USA. 1952

**Feynman, Richard P.** 1918–88

American theoretical physicist

...the way I think of what we're doing is we're exploring, we're trying to find out as much as we can about the world. People say to me, “Are you looking for the ultimate laws of physics?” No, I'm not, I'm just looking to find out more about the world and if it turns out there is a simple ultimate law which explains everything, so be it, that would be very nice to discover. If it turns out it's like an onion with millions of layers and we're just sick and tired of looking at the layers, then that's the way it is, but whatever way it comes out its nature is there and she's going to come out the way she is, and therefore when we go to investigate it we shouldn't predecide what it is we're trying to do except to try to find out more about it. In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 1 (p. 23)

Perseus Books. Cambridge, Massachusetts, USA. 1999



**Gleick, James** 1954–  
American author, journalist, and essayist

As Feynman said, the hadron-hadron work [in the Stanford Linear Accelerator Center, SLAC] was like trying to figure out a pocket watch by smashing two of them together and watching the pieces fly out.

*Genius: The Life and Science of Richard Feynman*  
Caltec (p. 392)  
Pantheon Books, New York, New York, USA. 1992

**Hunter, Mark**  
No biographical data available

There has never been an age like ours. We rocket our spaceships to the dark side of the moon, and probe the mysteries at the very edge of the universe. We map mountain ranges buried beneath the sea. We journey to the strange world inside the atom, and dig out the secret of life from microscopic specks within the cell. We travel back in time to view the explosive birth of the universe. We peer into the heart of stars. This is an age of unparalleled exploration where man has never gone before, we go. To where man thought he could never go, we find a way. We find a way even to the center of the earth.

*Fantastic Journeys: Five Great Quests of Modern Science*  
The Journey to the Center of the Earth (p. 1)  
Walker, New York, New York, USA. 1980

**Lipmann, Fritz** 1899–86  
German-born American biochemist

...the drive and urge to explore nature in all its facets is one of the most important functions of humanity.

*Les Prix Nobel. The Nobel Prizes in 1953*  
Nobel banquet speech for award received in 1953  
Nobel Foundation, Stockholm, Sweden. 1954

### Report of the President's Commission on Implementation of United States Space Exploration Policy

Like the explorers of the past and the pioneers of flight in the last century, we cannot today identify all that we will gain from space exploration;

*A Journey to Inspire, Innovate, and Discover*  
Concluding Comments (p. 51)  
United States Government Printing Office, Washington, D.C. June, 2004

**Severinus, Petrus** 1540–1602  
Swedish anatomist

Go, my sons, buy stout shoes, climb the mountains, search the valleys, the deserts, the seas shores, and the deep recesses of the earth. Mark well the various kinds of minerals, note their properties and their mode of origin.

In Frank Dawson Adams  
*The Birth and Development of the Geological Sciences*  
Chapter VII (p. 210)  
Dover Publications, Inc. 1938

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Thus far into the bowels of the land have we marched on without impediment.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*The Tragedy of King Richard the Third*  
Act V, Scene ii, l. 3–4  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thomas, Lewis** 1913–93  
American physician and biologist

It is fascinating that the word “explore” does not apply to the searching aspect of the activity, but has its origins in the sounds we make while engaged in it. We like to think of exploring in science as a lonely, meditative business, and so it is in the first stages, but always, sooner or later, before the enterprise reaches completion, as we explore, we call to each other, communicate, publish, send letters to the editor, present papers, cry out on finding.

*The Lives of a Cell: Notes of a Biology Watcher*  
On Societies as Organisms (p. 15)  
The Viking Press, New York, New York, USA. 1974

**Verne, Jules** 1828–1905  
French novelist

Descend into the crater of Yocul of Sneffels, which the shade of Scartaris caresses, before the kalends of July, audacious traveler, and you will reach the center of the earth. I did it.

*A Journey to the Center of The Earth*  
Chapter 3 (p. 21)  
The Limited Editions Club, New York, New York, USA. 1966

**von Liebig, Justus** 1803–73  
German organic chemist

It is, unquestionably, worthy of a nation – a great nation – to send out travellers for the purpose of increasing our knowledge of distant and unexplored regions, and to make us acquainted with the plants and animals inhabiting them, and even to make great sacrifices in fitting out expeditions for these important objects.

In John Gardner  
*Familiar Letters on Chemistry*  
Second Series  
Letter I (p. 3)  
Taylor & Walton, London, England. 1844

**Waller, William H.**  
No biographical data available

**Hodge, Paul W.**  
No biographical data available

It is through intrepid seeking that our species has come this far. And it will be through our continuing exploration of the Solar System, Milky Way, and Universe that

we will fulfill whatever cosmic role may await us. The adventure has just begun!

*Galaxies and the Cosmic Frontier*

Part III, Epilogue (p. 273)

Harvard University Press. Cambridge, Massachusetts, USA. 2003

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Ah who shall soothe these feverish children?

Who justify these restless explorations?

*The Complete Prose Works of Walt Whitman*

Passage to India

Small, Maynard & Company. Boston, Massachusetts, USA. 1898

## EXPLORE

**Andrews, Roy Chapman** 1884–1960

American naturalist and explorer

Today there remain but a few small areas on the world's map unmarked by explorers' trails. Human courage and endurance have conquered the Poles; the secrets of the tropical jungles have been revealed. The highest mountains of the earth have heard the voice of man. But this does not mean that the youth of the future has no new worlds to vanquish. It means only that the explorer must change his methods.

*On the Trail of Ancient Man* (p. 5)

G.P. Putnam's Sons. New York, New York, USA. 1926

**Clarke, Arthur C.** 1917–

English science and science fiction writer

We will not exhaust the marvels of the physical Universe until we have explored the whole Cosmos – and *that* prospect is still, to say the least, satisfyingly remote, if indeed it is theoretically possible. We have scarcely begun a voyage of discovery which may never have an end.

*The Exploration of Space*

Chapter 18 (p. 194)

Harper & Brothers Publishers. New York, New York, USA. 1951

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

Who is there that would not, if he could, explore the untrodden yet brilliant domains of infinite space, the garden of God, ever blossoming with golden flowers, and thus acquire for himself divine wisdom? If we would become as gods, and walk with God, we must learn to partake the food, and drink the beverage, of the gods.

*Nature and Culture*

Chapter 1 (p. 39)

Lee & Shepard. Boston, Massachusetts, USA. 1875

## EXPLORER

**Hildebrand, Joel Henry** 1881–1983

American educator and chemist

To seek out and discover Nature's mysteries is not a pursuit that requires utilitarian justification. The world owes an incalculable debt to the explorers who have led the way to new fields of thought and endeavor. It is these men who pave the way not only for the miner, the railroad builder and the farmer, but, most important of all, for others who love Nature and whose spirits are enriched by her knowledge.

*Principles of Chemistry*

Chapter I (p. 4)

The Macmillan Co. New York, New York, USA. 1918

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

...it is as natural to be an explorer as it is to be a potato grower, it is rarer but it is as natural; it is as natural to seek explanations and arrange facts as it is to make love, or adorn a hut, or show kindness to a child. It is a folly I will not even dispute about, that man's only natural implement is the spade. Imagination, pride, exalted desire are just as much Man, as are hunger and thirst and sexual curiosities and the panic dread of unknown things...

*The Research Magnificent*

Chapter I (p. 124)

The Macmillan Co. New York, New York, USA. 1915

## EXPONENTIAL

**Bartlett, Albert A.**

American physicist

The greatest shortcoming of the human race is man's inability to understand the exponential function.

The Exponential Function

*The Physics Teacher*, Volume 14, Number 7, October, 1976 (p. 394)

**Hardin, Garrett** 1915–2003

American ecologist and microbiologist

[One must show the greatest respect towards] anything that increases exponentially, no matter how small.

*Exploring New Ethics for Survival: The Voyage of the Spaceship Beagle*

Chapter 5 (p. 45)

Penguin Books. New York, New York, USA. 1973

## EXPOSITION

**Duncan, Robert Kennedy** 1919–88

American poet

The historical method of treatment is the death of clear exposition.

*The New Knowledge: A Popular Account of the New Physics and the New Chemistry in Their Relation to the New Theory of Matter*

Preface (p. vii)

A.S. Barnes & Co. New York, New York, USA. 1910

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

...there is no scorn more profound, or on the whole more justifiable, than that of the men who make for the men who explain. Exposition, criticism, appreciation, is work for the second-rate minds.

*A Mathematician's Apology*

Section I (p. 61)

Cambridge University Press. Cambridge, England. 1967

## EXPRESSION

**Born, Max** 1882–1970

German-born English physicist

Physicists are very broad-minded in this respect; they will continue using obsolete expressions like ether, and no harm is done. For them a matter of terminology is not serious until a new quantitative law is involved.

*Natural Philosophy of Cause and Chance*

Chapter VIII (pp. 74–75)

Clarendon Press. Oxford, England. 1949

## EXTERMINATION

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

the human race little knows

all the sadness it

causes the insect world

*The Lives and Times of Archy and Mehitable*

Pity the Poor Spider (p. 27)

Doubleday, Doran & Co., Inc. Garden City, New York, USA. 1933

## EXTERNAL WORLD

**Saint-Hilaire, Étienne Geoffroy** 1772–1844

French Naturalist

The external world is all-powerful in alteration of the form of organized bodies...these [modifications] are inherited, and they influence all the rest of the organization of the animal, because if these modifications lead to injurious effects, the animals which exhibit them perish and are replaced by others of a somewhat different form, a form changed so as to be adapted to the new environment.

In Henry Fairfield Osborn

*From the Greeks to Darwin: An Outline of the Development of the Evolution Idea*

Section 5 (p. 199)

The Macmillan Company. New York, New York, USA. 1905

## EXTINCT

**Cuppy, Will** 1884–1929

American humorist and critic

The Age of Reptiles ended because it had gone on long enough and it was all a mistake in the first place.

*How to Become Extinct*

The Dinosaur (p. 93)

Dover Publications. New York, New York, USA. 1964

**Lydekker, Richard** 1849–1915

English naturalist and geologist

While the century which has lately closed may fairly lay claim to the gratitude of posterity on account of the magnificent tale of zoological work accomplished during its course, it is, on the other hand, undoubtedly open to the charge of having permitted the total extermination of not a few animals, and of having allowed the numbers of others to be so reduced that their disappearance, at least as truly wild creatures, can scarcely be delayed very many years longer.

*Mostly Mammals, Zoological Essays*

Part I (p. 1)

Dodd, Mead & Co. New York, New York, USA. 1903

## EXTINCTION

**Carlton, J. T.**

No biographical data available

The future historians of science may well find that a crisis that was upon us at the end of the 20th century was the extinction of the systematist, the extinction of the naturalist, the extinction of the biogeographer – those who would tell the tales of the potential demise of global marine diversity.

Nonextinction of Marine Invertebrates

*American Zoologist*, Volume 33, Number 6, 1993 (p. 507)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

You can stop splitting the atom; you can stop visiting the moon; you can stop using aerosols; you may even decide not to kill entire populations by the use of a few bombs. But you cannot recall a new form of life.

*Science* 1976

**Clemens, William**

No biographical data available

...the impact theory of extinction? It's cods wallop.

The Debate Over Dinosaur Extinction Takes an Unusually

Rancorous Turn

*New York Times*, January 19, 1988 (p. c3)

**Cuppy, Will** 1884–1929

American humorist and critic

The Age of Reptiles ended because it had gone on long enough and it was all a mistake in the first place.

*How to Become Extinct*

Dover Publications. New York, New York, USA. 1964

**Darwin, Charles Robert** 1809–82

English naturalist

This wonderful relationship in the same continent between the dead and the living, will, I do not doubt, hereafter throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter X (p. 365)

D. Appleton &amp; Company. New York, New York, USA. 1896

The extinction of species has been involved in the most gratuitous mystery. Some authors have even supposed that, as the individual has a definite length of life, so have species a definite duration. No one can have marveled more than I have done at the extinction of species. When I found in La Plata the tooth of a horse embedded with the remains of Mastodon, Megatherium, Toxodon and other extinct monsters, which all co-existed with still living shells at a very late geological period, I was filled with astonishment...

In *Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter XI (p. 169)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Duve, Christian** 1917–

English cytologist and biochemist

The disappearance of living species is not just a blow to orchid growers, butterfly collectors, and beetle buffs. It is an irremediable loss of precious information, the biological equivalent of the burning of the library of Alexandria in 641. It is the destruction of a large part of the book of life before it can be read, the irreplaceable loss of vital clues to biological evolution and our own history. Resources of potentially great practical benefit may be lost. With each daily shrinking of the biosphere, a valuable source of food or a molecule that could have cured malaria, AIDS, or some other scourge may be vanishing forever.

*Vital Dust: Life As a Cosmic Imperative*

Chapter 30 (p. 275)

Basic Books. New York, New York, USA. 1995

**Editorial**

Terrestrial events, like volcanic activity or change in climate or sea level, are the most immediate possible cause of mass extinctions. Astronomers should leave

to astrologers the task of seeking the causes of earthly events in the stars.

Miscasting the Dinosaur's Horoscope

*New York Times*, April 2, 1985**Eldredge, Niles** 1943–

American paleontologist

Thus extinctions, in the abstract consideration of life's entire history, have paved the way for the truly new, including, of course, ourselves. But now that we are here, it is not inconsistent at all to want to see our own species survive. To hell with innovation, let's try to stick around.

*Life Pulse Episodes from the Story of the Fossil Record*

Chapter 8 The Cenozoic (p. 240)

Facts on File Publications, New York. 1987

**Flanders, Michael** 1922–75

English actor and singer

**Minale, Marcello**

No biographical data available

The Brontosaurus

Had a brain

No bigger than

A crisp;

The Dodo

Had a stammer

And the Mammoth

Had a lisp;

The Auk

Was just too Aukward –

Now they're none of them

Alive.

Each one,

(like Man),

Had shown himself

Unfit to survive.

This story

Points a moral:

Now it's

We

Who wear the pants.

The extinction

Of these species

Holds a lesson

For us

ANTS.

*Creatures Great and Small*

Introductory Poem

Holt, Rinehart &amp; Winston. New York, New York, USA. 1965

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Extinction, for most people, carries many of the connotations attributed to sex not so long ago – a rather

disreputable business, frequent in occurrence, but not to anyone's credit, and certainly not to be discussed in proper in circles. But, like sex, extinction is an ineluctable part of life. It is the ultimate fate of all species, not the lot of unfortunate and ill-designed creatures. It is no sign of failure.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 25 (p. 266)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Hornaday, William Temple** 1854–1937

American naturalist

We have no right, legal, moral or commercial, to exterminate any valuable or interesting species; because none of them belong to us, to exterminate or not, as we please.

For the People of any civilized nation to permit the slaughter of the wild birds that protect its crops, its fruits and its forests from the insect hordes is worse than folly. It is sheer orneriness and idiocy. People who are either so lazy or asinine as to permit the slaughter of their best friends deserve to have their crops destroyed and their forests ravaged.

*Our Vanishing Wild Life*

Chapter VI (pp. 53–54)

Charles Scribner's Sons. New York, New York, USA. 1913

**Jefferson, Thomas** 1743–1826

3rd president of the USA

The movements of nature are in a never ending circle. The animal species which has once been put into a train of motion is still probably moving in that train. For, if one link in nature's chain might be lost, another and another might be lost, till this whole system of things should vanish by piece-meal.

In William Berryman Scott

*A History of Land Mammals in the Western Hemisphere*

Chapter XVI (pp. 597–598)

The Macmillan Co. New York, New York, USA. 1913

...the bones exist: therefore the animal has existed. The movements of nature are in a never ending circle. The animal species which has once been put into a train of motion is probably still moving in that train. For if one link in nature's chain might be lost, another and another might be lost, till the whole system of things should vanish [sic] by piece-meal.

In Merrill D. Peterson

*Thomas Jefferson and the New Nation*

Science and Politics (p. 578)

Oxford University Press. New York, New York, USA. 1970

**Lamarck, Jean-Baptiste Pierre**

**Antoine** 1744–1829

French biologist

I am still doubtful whether the means adopted by nature to ensure the preservation of species or races have been so inadequate that entire races are now extinct or lost.

If there really are lost species, it can doubtless only be among the large animals that live on the dry parts of the earth; where man exercises absolute sway, and has compassed the destruction of all the individuals of some species which he has not wished to preserve or domesticate.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter III (p. 44)

The University of Chicago Press. Chicago, Illinois, USA. 1984

One must therefore never expect to find among living species all those which are found in the fossil state, and yet one may not assume that any species has really been lost or rendered extinct. It is certainly possible that among the largest animals some species have been extinguished as a consequence of the multiplication of man in the places which they inhabited. But this conjecture cannot be established from the consideration of fossils alone: we shall only be sure on this point when all the habitable globe is perfectly known.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Introductory Lecture for 1800 (p. 433)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Leidy, Joseph** 1823–91

The utter desolation of the scene, the dried-up water-courses, the absence of any moving object, and the profound silence which prevailed, produced a feeling that was positively oppressive. When I then thought of the buttes beneath my feet, with their entombed remains of multitudes of animals forever extinct, and reflected upon the time when the country teemed with life, I truly felt that I was standing on the wreck of a former world.

*Contributions to the Extinct Vertebrate Fauna of the Western Territories*

U. S. Government Printing Office. Washington, D.C. 1873

**Lindbergh, Anne Morrow** 1906–2001

American aviator and writer

Wilderness is threatened everywhere. The extinction of animals is not the only danger; man faces the loss of a breathing space for all that is wild and free in his spirit. And not only his spirit, his physical welfare also, even his survival, is imperiled by the extermination of other life on this planet.

*Earth Shine*

Immersion in Life (p. 70)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Nash, Ogden** 1902–71

American writer of humorous poetry

Last night in the museum's hall  
The fossils gathered for a ball  
There were no drums or saxophones,  
But just the clatter of their bones,  
A rolling, rattling, carefree circus

Of mammoth polkas and mazurkas.  
 Pterodactyls and brontosaurus  
 Sang ghostly prehistoric choruses.  
 Amid the mastodonic wassail  
 I caught the eye of one small fossil.  
 Cheer up, sad world, he said, and winked –  
 It's kind of fun to be extinct.

*Carnival of the Animals*  
 Extinction  
 Music by Saint-Saens

**Lyell, Sir Charles** 1797–1875  
 English geologist

It appears, that from the remotest periods there has ever been a coming in of new organic forms, and an extinction of those which pre-existed on the earth; some species having endured for a longer, others for a shorter time; but none having ever reappeared after once dying out. The law which has governed the creation and extinction of species seems to be expressed in the verse of the poet .... Nature made it, and then broke the die.

*Elements of Geology*  
 Chapter XIII (p. 275)  
 John Murray. London, England. 1838

**Muir, John** 1838–1914  
 American naturalist

Why ought man to value himself as more than an infinitely small composing unit of the one great unit of creation?...The universe would be incomplete without man, but it would also be incomplete without the smallest transmicroscopic creature that dwells beyond our conceptual eyes and knowledge.

*A Thousand Mile Walk to the Gulf*  
 Chapter VI (p. 139)  
 Houghton Mifflin Company. Boston Massachusetts, USA. 1916

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932  
 Latvian-born German chemist

Only when the very last of all the offspring perishes may death be regarded as the victor.

*Individuality and Immortality*  
 Individuality and Immortality (p. 14)  
 Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1906

**Playfair, John** 1748–1819  
 Scottish geologist, physicist, and mathematician

The inhabitants of the globe, then, like all the other parts of it, are subject to change. It is not only the individual that perishes, but whole *species*, and even perhaps *genera*, are extinguished.

*The Works of John Playfair* (Volume 1)  
*Illustrations of the Huttonian Theory*, Paragraph 413 (p. 458)  
 Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**Raup, David Malcolm** 1933–  
 American paleontologist

Mass extinction is box office, a darling of the popular press, the subject of cover stories and television documentaries, many books, even a rock song.... At the end of 1989, The Associated Press designated mass extinction as one of the “Top 10 Scientific Advances of the Decade.” Everybody has weighed in, from the *Economist* to *National Geographic*.

*Extinction: Bad Genes or Bad Luck?*  
 Chapter 4 (p. 64)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1991

**Roosevelt, Theodore** 1858–1919  
 26th president of the USA

When I hear of the destruction of a species I feel as if all the works of some great writer had perished ...

Protect All Birds  
*Werner's Magazine: A Magazine of Expression*, Volume 23, March-August, 1899 (p. 169)

**Saunders, W. E.**  
 Naturalist

What good reason is there for the extermination of any form of life because it sometimes kills what we are pleased to call “game?” Are we so narrow-minded that we can endure the existence of nothing but ourselves and the things we wish to kill?

In R.J. Rutter (ed.)  
*W.E. Saunders, Naturalist: A Memorial Volume*  
 Saundersisms (p. 50)  
 Federation of Ontario Naturalists. Toronto, Ontario, Canada. 1949

**Scheffer, Victor B.**  
 Zoologist

Although Nature needs thousands or millions of years to create a species, man needs only a few dozen years to destroy one.

*Spires of Form*  
 The Counted and the Uncounted (p. 18)  
 University of Washington Press. Seattle, Washington, USA. 1983

**Silverberg, Robert** 1935–  
 American writer

There is no reason to weep for the trilobites and the dinosaurs. Their disappearance was not our doing. They fell victim to the mighty workings of the laws of nature and were swept to oblivion after enduring for many millions of years. Let us reserve our sorrow for the more recently departed. They were here not so long ago and now are gone, leaving behind them nothing more than bones, stuffed specimens, and a few sketches and tales of travelers.



*The Auk, The Dodo, and the Oryx*

Chapter 1 (p. 23)

Thomas Y. Crowell Co. New York, New York, USA. 1967

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

I love to see that Nature is so rife with life that myriads can be afforded to be sacrificed and suffered to prey on one another; that tender organizations can be so serenely squashed out of existence like pulp.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter XVII (p. 490)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

...the first appearance of animals now existing can in many cases be traced, their numbers gradually increasing in the more recent formations, while species continually die out and disappear, so that the present condition of the organic world is clearly derived by a natural process of gradual extinction and creation of species from that of the latest geological periods.

*Natural Selection and Tropical Nature: Essays on Descriptive and Theoretical Biology*

Chapter I (p. 4)

Macmillan & Company Ltd. London, England. 1891

**Weisburd, Stefi**

Poet

With all the paleontologists looking up to the stars for an explanation of what caused mass extinctions of life on our planet, and with all the astrophysicists looking at the rocks below their feet for clues to comet showers or asteroids that might have bombarded the earth, it's a wonder that more scientists aren't complaining of neckaches.

Extinction Wars – Battle Over Cause of Dinosaurs' Demise

*Science News*, February 1, 1986

## EXTRATERRESTRIAL LIFE

**Abbot, Charles Greeley** 1872–1973

American astrophysicist

If we could talk freely with intelligences existing on another world, having a history, social customs and laws, and religious faiths developed absolutely independently from those of this world our conversation would be not only one of surpassing interest to science and the humanities, but what a guide it might prove to statesmen and sociologists!

*Annual Report of the Board of Regents of the Smithsonian Institution, 1920*

The Habitability of Venus, Mars, and Other Worlds (p. 171)

Government Printing Office. Washington, D.C. 1922

**Abelson, Philip H.** 1913–2004

American physicist

Often we are faced with a very large body of facts, and the problem is to know upon which facts to place a value. But it is not a matter of selecting *which* facts with regard to the existence of extraterrestrial life – the problem here is that there are virtually *no* facts. It is largely a speculative matter, and I speculate that there is no life.

In Shirley Thomas

*Men of Space; Profiles of the Scientists Who Probe for Life in Space* (Volume 6)

Philip H. Abelson (p. 1)

Chilton Books. Philadelphia, Pennsylvania, USA. 1963

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Somewhere in the cosmos...along with all the planets inhabited by humanoids, reptiloids, fishoids, walking treeoids, and superintelligent shades of the color blue, there was also a planet entirely given over to ballpoint life forms. And it was to this planet that unattended ballpoints would make their way, slipping away quietly through wormholes in space to a world where they could enjoy the uniquely ballpointed life-style.

*The Ultimate Hitchhiker's Guide to the Galaxy*

The Hitchhiker's Guide to the Galaxy

Chapter 21 (p. 99)

The Ballantine Book Company. New York, New York, USA. 2002

**Amend, Bill** 1962–

American cartoonist

I think that if advanced beings were visiting Earth, we'd know it by their laughter.

*Fox Trot*

Comic strip

**Brewster, David** 1781–1868

Scottish scientist, inventor and writer

To believe that the Earth was the only place where organic life was given and taken away – the only field where great physical revolutions were in play, would be to detract from the wisdom and beneficence of the Creator. To the laws of nature we dare not assign either limitation or locality. Wherever there is matter, we may predict its laws and its elements, and wherever are its elements, we may anticipate the existence of beings that are to use them. Wherever light shines, there must be an eye to welcome it; wherever air expands, there must be beings to breathe it; wherever heat vivifies, there must be life to be revived.

*The Importance of Literature to Men of Business*

Address (p. 308)

John J. Griffin & Co. London, England. 1852

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Quoth She: Th' Inhabitants o' the Moon,  
 Who when the Sun shines hot at Noon,  
 Do live in Cellars underground  
 Of eight Miles deep and eighty round  
 (In which at once they fortify  
 Against the Sun and th' Enemy)  
 Which they count towns and Cities there,  
 Because their People's civiller  
 Than those rude Peasants, that are found  
 To live upon the upper Ground,  
 Call'd Privolvans, with whom they are  
 Perpetually at open War.

In René Lamar (ed.)

*Satires and Miscellaneous Prose*

The Elephant in the Moon

The University Press. Cambridge, England. 1928

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Nearly a hundred thousand million stars are turning in the circle of the Milky Way, and long ago other races on the world of other suns must have scaled and passed the heights that we have reached. Think of such civilisations, far back in time against the fading afterglow of Creation, masters of a universe so young that life as yet had come only to a handful of worlds. Theirs would have been a loneliness we cannot imagine, the loneliness of gods looking out across infinity and finding none to share their thoughts.

The Sentine

*10 Story Fantasy*, Spring 1951

When we meet our peers among the stars, we need have nothing to fear save our own shortcomings.

*The Exploration of Space*

Chapter 18 (p. 193)

Harper & Brothers Publishers. New York, New York, USA. 1951

We have seen that there is little likelihood of encountering intelligence elsewhere in the Solar System. That contact may have to wait for the day, perhaps ages hence, when we can reach the stars. But sooner or later it must come.

*The Exploration of Space*

Chapter 18 (p. 191)

Harper & Brothers Publishers. New York, New York, USA. 1951

The signal vanished for agonizing seconds, then came back much clearer, though not appreciably louder.

“...relay this information to Earth”. Using my suit radio – no idea if it has enough range, but it's the only chance. Please listen carefully. THERE IS LIFE ON EUROPA. I repeat: “THERE IS LIFE ON EUROPA ...”

*2010: Odyssey Two*

Chapter 11 (p. 74)

The Ballentine Publishing Group

1982

**Cocconi, Giuseppe** 1914–

Physicist

**Morrison, Philip** 1900–58

Australian naturalist

...the presence of interstellar signals is entirely consistent with all we now know, and that if signals are present the means of detecting them is now at hand. Few will deny the profound importance, practical and philosophical, which the detection of interstellar communications would have. We therefore feel that a discriminating search for signals deserves a considerable effort. The probability of success is difficult to estimate; but if we never search the chance of success is zero.

Searching for Interstellar Communications

*Nature*, Volume 184, Number 4690, September, 1959 (p. 846)

**Crowe, Michael J.**

American educator

Remarkable above all is the extent to which this idea was discussed. From Cape Town to Copenhagen, from Dorpat to Dundee, from Saint Petersburg to Salt Lake City, terrestrials talked of extraterrestrials. Their conclusions appeared in books and pamphlets, in penny newspapers and ponderous journals, in sermons and scriptural commentaries, in poems and plays, and even in a hymn and on a tombstone. Oxford dons and observatory directors, sea captains and heads of state, radical reformers and ultramontane conservatives, scientists and sages, the orthodox as well as the heterodox – all had their say.

*The Extraterrestrial Life Debate, 1750–1900* (p. 162)

Courier Dover Publications. Mineola, New York, USA. 1999

**Darling, David** 1953–

Freelance science writer

Unless astrobiologists are very much mistaken, or we lose the willpower to carry through these great projects, within two decades we'll be able to point to some stars in the night sky and say, “There live other creatures.”

*Life Everywhere: The Maverick Science of Astrobiology*

Chapter 8 (p. 167)

Basic Books. New York, New York, USA. 2001

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

So you, too, come from the sky! Which is your planet?

Translated by Katherine Woods

*The Little Prince*

Part III (p. 14)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Diamond, Jared** 1937–

American evolutionary biologist

Think again of those astronomers who beamed radio signals into Space from Arecibo, describing Earth's location

and its inhabitants. In its suicidal folly that act rivaled the folly of the last Inca emperor, Atahualpa, who described to his gold-crazy Spanish captors the wealth of his capital and provided them with guides for the journey. If there really are any radio civilizations within listening distance of us, then for heaven's sake let's turn off our own transmitters and try to escape detection, or we are doomed. Fortunately for us, the silence from Outer Space is deafening.... What woodpeckers teach us about flying saucers is that we're unlikely to ever see one.

*The Third Chimpanzee: The Evolution and Future of the Human Animal* Part Three, Chapter 12 (pp. 214–215)  
HarperCollins Publishers. New York, New York, USA. 1992

**Dietrich, Marlene** 1901–92  
German-born American actress and singer

Until they come to see us from their planet, I wait patiently. I hear them saying: Don't call us, we'll call you.

*Marlene Dietrich's ABC*  
Venus  
Ungar. New York, New York, USA. 1984

**Dyson, Freeman J.** 1923–  
American physicist and educator

I do not believe we yet know enough about stars, planets, life and mind to give us a firm basis for deciding whether the presence of intelligence in the universe is probable or improbable. Many biologists and chemists have concluded from inadequate evidence that the development of intelligent life should be a frequent occurrence in our galaxy. Having examined their evidence and heard their arguments, I consider it just as likely that no intelligent species other than our own has ever existed. The question can only be answered by unprejudiced observation.

*Intelligence in the Universe*  
*Mercury*, November–December, 1972

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

...the mind is irresistibly drawn to play with the thought that somewhere in the universe there may be other beings – a little lower than the angels" whom Man may regard as his equals – or perhaps his superiors.

*The Nature of the Physical World*  
Chapter VIII (pp. 169–170)  
The University Press. New York, New York, USA. 1929

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator and author

So deep is the conviction that there must be life out there beyond the dark, one thinks that if they are more advanced than ourselves they may come across space at any moment, perhaps in our generation. Later, contemplating the infinity of time, one wonders if perchance their messages came long ago, hurtling into the swamp

muck of the steaming coal forests, the bright projectile clambered over by hissing reptiles, and the delicate instruments running mindlessly down with no report.

*The Immense Journey*  
Little Men and Flying Saucers (p. 144)  
Vintage Books. New York, New York, USA. 1957

In a universe whose size is beyond human imagining, where our world floats like a dust mote in the void of night, men have grown inconceivably lonely. We scan the time scale and the mechanisms of life itself for portents and signs of the invisible. As the only thinking mammals on the planet – perhaps the only thinking animals in the entire sidereal universe – the burden of consciousness has grown heavy upon us. We watch the stars, but the signs are uncertain. We uncover the bones of the past and seek for our origins. There is a path there, but it appears to wander. The vagaries of the road may have a meaning, however; it is thus we torture ourselves.

*The Immense Journey*  
Little Men and Flying Saucers (pp. 161–162)  
Vintage Books. New York, New York, USA. 1957

...nowhere in all space or on a thousand worlds will there be men to share our loneliness. There may be wisdom; there may be power; somewhere across space great instruments, handled by strange, manipulative organs, may stare vainly at our floating cloud wrack, their owners yearning as we yearn. Nevertheless, in the nature of life and in the principles of evolution we have had our answer. Of men, elsewhere, and beyond, there will be none forever.

*The Immense Journey*  
Little Men and Flying Saucers (p. 162)  
Vintage Books. New York, New York, USA. 1957

In the millions of planets and infinity of time – surely there must be a possibility that man is not a unique event.

*Is Man Alone in Space?*  
*Scientific American*, Volume 189, Number 1, July, 1953 (p. 80)

Man bitterly resists the lonely thought that he may be the only creature of his kind in the universe.

*Is Man Alone in Space?*  
*Scientific American*, Volume 189, Number 1, July, 1953 (p. 80)

**Flammarion, Camille** 1842–1925  
French astronomer and writer

At our side, on the floating islands which accompany us through space, and in the bosom of the inaccessible depths of Infinitude, other worlds, our sisters, also bear living creatures, who at the same time in an indefinite progress, and towards a perfection which shines above all destinies like a star in the depths of the heavens.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter VI (p. 69)  
Chatto & Windus. London, England. 1894

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

Sometimes I think we're alone. Sometimes I think we're not. In either case, the thought is quite staggering.

In James A. Haught (ed.)  
*2000 Years of Disbelief: Famous People with the Courage to Doubt*  
Part Seven: The Mid- and Late Twentieth Century Chapter 71 (p. 290)  
Prometheus Books. Amherst, New York, USA. 1996

**Giraudoux, Jean** 1882–1944  
French novelist, playwright, and essayist

COUNTRESS: ...are you so stupid as to think that just because we're alone here, there's nobody else in the room? Do you consider us so boring or so repulsive that of all the millions of beings, imaginary or otherwise, who are prowling around in space looking for a little company, there is not one who might possibly enjoy spending a moment with us? On the contrary, my dear – my house is full of guests...

English adaptation by Maurice Valency  
*The Madwoman of Chailloit*  
Act Two (p. 94)  
Random House, Inc. New York, New York, USA. 1947

**Haber, Heinz** 1913–90  
German physicist

Science, no less than the poet and the preacher, knows how marvelous the phenomenon of life really is and the actual discovery of the marvelous spark on another world will be more soul-stirring and portentous than the wildest dreams of the generations before us.

*Stars, Men and Atoms*  
Chapter 9 (p. 154)  
Golden Press. New York, New York, USA. 1962

The far spaces of the galaxies are teeming with life; but the life-bearing planets are separated by awesome gaps of space and time. We are lost in space – marooned in the small section of the universe assigned to us.

*Stars, Men and Atoms*  
Chapter 10 (p. 163)  
Golden Press. New York, New York, USA. 1962

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

...he must have studied astronomy to little purpose, who can suppose man to be the only object of his Creator's care, or who does not see in the vast and wonderful apparatus around us provision for other races of animated beings.

*A Treatise on Astronomy*  
Chapter XII (pp. 355–356)  
Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1851

**Hey, Nigel S.** 1936–  
American science writer

We know of no other planet that has an environment that is even remotely like ours. We are protected by an

invisible magnetic bubble, enlivened by the cycles of water and air, with the whole scenario perfected (from our perspective) by the forces of sunlight and the great heat source that lies deep below Earth's crust. Yet when we looked at Io's fountains we knew they were volcanoes, and when we saw the terraced hills of Mars we knew that lakes must have lain there. Our knowledge of the universe is guided by our observations at home, on Planet Earth.

*Solar System*  
Chapter 6 (p. 137)  
Weidenfeld & Nicolson. London, England. 2002

**Horowitz, Norman H.** 1915–2005  
American scientist

There are doubtless some who, unwilling to accept the notion of a lifeless Mars, will maintain that the interpretation I have given is unproved. They are right. It is impossible to prove that any of the reactions detected by the Viking instruments were not biological in origin. It is equally impossible to prove from any result of the Viking instruments that the rocks seen at the landing sites are not living organisms that happen to look like rocks.... The field is open to every fantasy. Centuries of human experience warn us, however, that such an approach is not the way to discover the truth.

*The Search for Life on Mars*  
*Scientific American*, Volume 237, Number 5, November, 1977 (p. 61)

**Hoyle, Sir Fred** 1915–2001  
English mathematician, astronomer, and writer

With so many possible planetary systems, should we not expect inhabited planets to be moving around some of the nearby stars? We certainly should.

*Lifecloud: The Origin of Life in the Universe*  
Chapter 16 (pp. 145–146)  
Harper & Row Publishers. New York, New York, USA. 1978

## Humanoid Progenitor

You're wondering who we are, why we have done this, how it has come that I stand before you, the image of a being from so long ago. Life evolved in my planet before all others in this part of the galaxy. We left our world, explored the stars, and found none like ourselves. Our civilization thrived for ages but what is the life of one race compared to the vast stretches of cosmic time? We knew that one day we would be gone – that nothing of us would survive. So, we left you. Our scientists seeded the primordial oceans of many worlds where life was in its infancy. The seed codes directed your evolution toward a physical form resembling ours. This body you see before you – which is of course shaped as yours is shaped. For you are the end result. The seed codes also contained this message, which was scattered in fragments on many different worlds. It was our hope that you would have to come together in fellowship and companionship to hear

this message. And if you can see and hear me, our hope has been fulfilled. You are a monument not to our greatness but to our existence. That was our wish – that you too would know life and would keep alive our memory. There is something of us in each of you. And so, something of you in each other. Remember us.

*Star Trek: The Next Generation*

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

A Man that is of Copernicus's Opinion, that this Earth of ours is a planet, carry'd round and enlighten'd by the Sun, like the rest of them, cannot but sometimes have a fancy, that it's not improbable that the rest of the Planets have their Dress and Furniture, nay and their Inhabitants too as well as this Earth of ours.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the First (pp. 1–2)

Printed for T. Childe. London, England. 1698

### **John, Alien Visitor (Fictional character)**

I'll try to put this in terms that you commonly use. I'm a scientist. We were all scientists. We came here to learn about your world. Our idea was to find out everything: your history, your biology, everything. We came here to learn. We're not that different from you, genetically, biologically. But what you call evolution has changed us. We see things in you that we no longer recognize in ourselves.

*Taken*

Film (2002)

**Jones, Sir Harold Spencer** 1890–1960  
10th Astronomer Royal of England

We see the Earth as a small planet, one member of a family of planets revolving round the Sun; the Sun, in turn, is an average star situated somewhat far out from the centre of a vast system, in which the stars are numbered by many thousands of millions; there are many millions of such systems, more or less similar to each other, peopling space to the farthest limits to which modern exploration has reached.

Can it be that throughout the vast deeps of space nowhere but on our own little Earth is life to be found?

*Life on Other Worlds*

Chapter I (p. 19)

The Macmillan Company. New York, New York, USA. 1954

**Lardner, Dionysius** 1793–1859  
British physicist and astronomer

When we walk forth on a serene night and direct our view to the aspect of the heavens, there are certain reflections which will present themselves to every mind gifted with

the slightest power of contemplation. Are those shining orbs which so richly decorate the firmament peopled with creatures endowed like ourselves with reason to discover, with sense to love, and with imagination ...

*Popular Lectures on Science and Art*

The Plurality of Worlds (p. 51)

Henry W. Law. New York, New York, USA. 1856

**Lebowitz, Fran** 1951–  
American comedian

Not too long ago the USA succeeded in landing on Mars an unmanned spacecraft, the chief purpose of which was to ascertain whether or not anyone lives there. The results are not all in yet but there is, I am afraid, little doubt that the answer will be in the affirmative. It is pointless to assume that the earth alone is afflicted with the phenomenon of life.

*Metropolitan Life*

Mars: Living in a Small Way (p. 134)

Fawcett Crest. New York, New York, USA. 1978

**Leonard, Jonathan Norton** 1903–75  
No biographical data available

Now, for the first time in the stargazing history of man, the planets are within our reach. Guesses as to what we might find in that mystery-shrouded domain demand the utmost from our imagination.... In a sense they will also be excursions back through the millennia to the earliest eons of our native star system.

*How We Will Explore the Outer Planets*

Chapter I (p. 7)

G.P. Putnam's Sons. New York, New York, USA. 1973

Scientists point out that there is nothing miraculous or unrepeatable about the appearance of life on earth. They believe it would happen again, given the same sufficient time and the same set of circumstances. It would even happen under very different circumstances. There is no reason to believe that conditions in the atmosphere and oceans of the primitive earth were modified by any outside power to make them favorable for the development of life. They just happened that way, and it is likely that life would have appeared even if conditions had been considerably different.

In Martin Gardner (ed.)

*The Sacred Beetle*

Other-Worldly Life (pp. 186–187)

Prometheus Books. Buffalo, New York, USA. 1957

**Lévi-Strauss, Claude** 1908–  
French social anthropologist and structuralist

Just as the individual is not alone in the group, nor any one society alone among the others, so man is not alone in the universe.

*Tristes Tropiques*

Chapter 40 (p. 414)

Athenaeum. New York, New York, USA. 1974



**Lowell, Percival** 1855–1916  
American astronomer

Like the savage who fears nothing so much as a strange man, like Crusoe who grows pale at the sight of footprints not his own, the civilized thinker instinctively turns from the thought of mind other than the one he himself knows.

*Mars*

Chapter VI (p. 210)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

The theory of the existence of intelligent life on Mars may be likened to the atomic theory in chemistry in that in both we are led to the belief in units which we are alike unable to define.

*Mars and Its Canals*

Chapter XXXII (p. 376)

**Maunder, Walter Edward**

No biographical data available

Nothing can be affirmed, nothing denied, concerning the possibility of intelligences existing on the Moon or even in the Sun if we are unable to ascertain under what limitations those particular intelligences subsist. Gnomes, sylphs, elves, and fairies, and all similar conceptions, escape the possibility of discussion by our ignorance of their properties. As nothing can be asserted of them they remain beyond investigation, as they are beyond sight and touch.

*Are the Planets Inhabited?*

Chapter I (p. 3)

Harper & Brothers Publishers. London, England. 1913

**Metrodorus of Chios** 4th century BCE

Greek Presocratic philosopher

...it would be strange if a single ear of corn grew in a large plain or there were only one world in the infinite.

In F.M. Cornford

Innumerable Worlds in Pre-Socratic Philosophy

*The Classical Quarterly*, January, 1934 (p. 13)

**Milton, John** 1608–74

English poet

Dream not of other Worlds; what Creatures there Live, in what state, condition or degree...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VIII, l. 175–176

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Narrator**

Yes, it's Superman, strange visitor from another planet, with powers and abilities far beyond those of mortal men! Superman, who can change the course of mighty rivers, bend steel with his bare hands, and who, disguised as Clark Kent, mild-mannered reporter for a great metropolitan

newspaper, fights a never-ending battle for truth, justice and the American way!

*The Adventures of Superman*

Television series (1952)

The Heavens. Once an object of superstition, awe and fear. Now a vast region for growing knowledge. The distance of Venus, the atmosphere of Mars, the size of Jupiter, and the speed of Mercury. All this and more we know. But their greatest mystery the heavens have kept a secret. What sort of life, if any, inhabits these other planets? Human life, like ours? Or life extremely lower in the scale. Or dangerously higher.

Opening narrative

*Invaders from Mars*

Film (1953)

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

It is, therefore, contrary to all the analogies of nature to suppose that life began only on a single world.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter VI (p. 125)

Harper & Brothers Publishers. New York, New York, USA. 1906

It is, therefore, perfectly reasonable to suppose that beings, not only animated, but endowed with reason, inhabit countless worlds in space.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter VII (p. 132)

Harper & Brothers Publishers. New York, New York, USA. 1906

**Oliver, Bernard M.** 1916–1995

First director of Hewlett-Packard Labs

The question of whether there is intelligent life out there depends, in the last analysis, upon how intelligent that life is.

The Search for Extraterrestrial Life

*Engineering and Science*, Dec 1974

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

...there is every reason now to see in the origin of life not a "happy accident" but a completely regular phenomenon, an inherent component of the total evolutionary development of our planet. The search for life beyond Earth is thus only a part of the more general question which confronts science, of the origin of life in the universe.

In M Calvin and O.G. Gazenko (eds.)

*Theoretical and Experimental Prerequisites of Exobiology*

Foundations of Space Biology and Medicine, Volume I, Theoretical and Experimental Prerequisites of Exobiology, Chapter 7 (p. 321)

**Pallister, William Hales** 1877–1946

Canadian physician

No one can yet show proof that there exists A single planet save the solar ones.



But space is wide and high, and time is long,  
 And there are millions more of other suns.  
 So men imagine why they do not know  
 And they assume that surely there must be  
 Some other planets, peopled like our own;  
 Some other worlds with creatures such as we.

*Poems of Science*

Other Worlds and Ours, Life on Other Planets (p. 210)  
 Playford Press. New York, New York, USA. 1931

**Pauling, Linus** 1901–94  
 American chemist

In the solar system there are so many stars and so many planets and the process and the origin of life is a pretty straightforward one [extraterrestrial life] that will occur when conditions are right, when the chemical composition, temperature and other factors are right.

In Denis Brian

*The Voice of Genius*

Chapter One (p. 27)

Perseus Publishing. Cambridge, Massachusetts, USA. 1995

**Pope, Alexander** 1688–1744  
 English poet

He, who through vast immensity can pierce,  
 See worlds on worlds compose one universe,  
 Observe how system into system runs,  
 What other planets circle other suns,  
 What varied Being peoples every star,  
 May tell why Heaven has made us as we are...

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, l. 23–28

Houghton Mifflin Company. New York, New York, USA. 1903

**Sagan, Carl** 1934–96  
 American astronomer and author

To seek the beings of other worlds is the rarest of adventures – an adventure we will all be fortunate enough to share.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1964*

The Quest for Life Beyond the Earth (p. 306)

Government Printing Office. Washington, D.C. 1965

We are like the inhabitants of an isolated valley in New Guinea who communicate with societies in neighboring valleys (quite different societies, I might add) by runner and by drum. When asked how a very advanced society will communicate, they might guess by an extremely rapid runner or by an improbably large drum. They might not guess a technology beyond their ken. And yet, all the while, a vast international cable and radio traffic passes over them, around them, and through them.... We will listen for the interstellar drums, but we will miss the interstellar cables. We are likely to receive our first messages from the drummers of the neighboring galactic

valleys – from civilizations only somewhat in our future. The civilizations vastly more advanced than [us], will be, for a long time, remote both in distance and in accessibility. At a future time of vigorous interstellar radio traffic, the very advanced civilizations may be, for us, still insubstantial legends.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 31 (pp. 224, 224–5)

Dell Publishing, Inc. New York, New York, USA. 1975

On some [planets], intelligent life may have evolved, reworking the planetary surface in some massive engineering enterprise. These are our brothers and sisters in the Cosmos. Are they very different from us? What is their form, biochemistry, neurobiology, history, politics, science, technology, art, music, religion, philosophy? Perhaps one day we will know them.

*Cosmos*

Chapter I (p. 11)

Random House, Inc. New York, New York, USA. 1980

Occasionally, I get a letter from someone who is in “contact” with extraterrestrials. I am invited to “ask them anything.” And over the years I’ve prepared a little list of questions. The extraterrestrials are very advanced, remember. So I ask things like, “Please provide a short proof of Fermat’s Last Theorem.” I write out the simple equation with the exponents.... It’s a stimulating exercise to think of questions to which no human today knows the answers, but where a correct answer would immediately be recognized as such. It’s even more challenging to formulate such questions in fields other than mathematics. Perhaps we should hold a contest and collect the best responses in “Ten Questions to Ask an Alien.”

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 6 (p. 100, fn)

Random House, Inc. New York, New York, USA. 1995

...there are a million other civilizations, all fabulously ugly, and all a lot smarter than us. Knowing this seems to me to be a useful and character-building experience for mankind.

In Richard Berendzen (ed.)

*Life Beyond Earth & the Mind of Man*

Sagan (p. 64)

National Aeronautics and Space Administration, Scientific and Technical Information Office. Washington, D.C. 1973

The discovery of life on some other world will, among many things, be for us a humbling experience...

*Intelligent Life in the Universe* (p. 22)

Holden-Day. San Francisco, California, USA. 1966

After centuries of muddy surmise, unfettered speculation, stodgy conservatism, and unimaginative disinterest, the subject of extraterrestrial life has finally come of age.

*Cosmic Connection: An Extraterrestrial Perspective*

Preface (p. viii)

Anchor Press/Doubleday. Garden City, New York, USA. 1973

**Sagan, Carl** 1934–96  
American astronomer and author

**Newman, William I.**  
No biographical data available

We think it possible that the Milky Way Galaxy is teeming with civilizations as far beyond our level of advance as we are beyond the ants, and paying us about as much attention as we pay to the ants.

The Solipsist Approach to Extraterrestrial Intelligence  
*Quarterly Journal of the Royal Astronomical Society*, Volume 24, Number 3, June, 1983 (p. 120)

**Sakharov, Andrei** 1921–89  
Soviet physicist and dissident

In infinite space many civilizations are bound to exist, among them societies that may be wiser and more “successful” than ours. I support the cosmological hypothesis which states that the development of the universe is repeated in its basic characteristics an infinite number of times. . . . Yet this should not minimize our sacred endeavors in this world of ours, where, like faint glimmers in the dark, we have emerged for a moment from the nothingness of dark unconscious into material existence.

*Nobel Lectures, Peace 1971–1980*  
Nobel lecture for award received in 1975  
Peace, Progress, Human Rights  
World Scientific Publishing Company, Singapore. 1997

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

GLENDOWER: I can call spirits from the vasty deep.  
HOTSPUR: Why, so can I, or so can any man;  
But will they come when you do call them?

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*The First Part of King Henry the Fourth*  
Act III, Scene i, l. 53–55  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

HORATIO: O day and night, but this is wondrous strange!

HAMLET: And therefore as a stranger give it welcome.  
There are more things in heaven and earth, Horatio,  
Than are dreamt of in your philosophy.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Hamlet, Prince of Denmark*  
Act I, Scene v, l. 164–167  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

DRIER: Mr. Shaw, do you believe in life on other planets?

SHAW: Indeed I do.

DRIER: But, Mr. Shaw, what proof do you have?

Shaw: The proof is that they’re using us for an insane asylum.

*Chemistry*, Volume 42, Number 4, April, 1969 (p. 2)

**Teng Mu** 1247–1306  
Chinese scholar

Heaven and earth are large, yet in the whole of space they are but as a small grain of rice. . . . It is as if the whole of empty space were a tree, and heaven and earth were one of its fruits. Empty space is like a kingdom, and heaven and earth no more than a single individual person in that kingdom. Upon one tree there are many fruits, and in one kingdom many people. How unreasonable it would be to suppose that besides the heaven and earth which we can see that there are no other heavens and no other earths?

In Joseph Needham  
*Science and Civilisation in China* (Volume 3)  
Chapter 20 (p. 221)  
Cambridge University Press. Cambridge, England. 1959

**Thomas, R. S.**  
No biographical data available

I am alone on the surface of a turning planet. What to do but, like Michelangelo’s Adam, put my hand out into unknown space, hoping for the reciprocating touch?

*Between Here and Now*  
Threshold (p. 110)  
Macmillan & Company Ltd. London, England. 1981

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935  
Russian research scientist

Is it probable for Europe to be inhabited and not the other parts of the world? Can one island have inhabitants and numerous other islands have none? Is it conceivable for one apple-tree in the infinite orchard of the Universe to bear fruit, while innumerable other trees have nothing but foliage?

In Adam Starchild (ed.)  
*The Science Fiction of Konstantin Tsiolkovsky*  
Dreams of the Earth and Sky (pp. 153–154)  
University Press of the Pacific, Inc. Seattle, Washington, USA. 1979

**von Braun, Wernher** 1912–77  
German-American rocket scientist

Our sun is one of 100 billion stars in our galaxy. Our galaxy is one of billions of galaxies populating the universe. It would be the height of presumption to think that we are the only living things in that enormous immensity.

Text of the Address by von Braun Before the Publishers’ Group Meeting Here  
*New York Times*, 29 April, 1960, L 20, column 2

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

No one would have believed in the last years of the nineteenth century that this world was being watched keenly

and closely by intelligences greater than man's and yet as mortal as his own...

*Seven Famous Novels by H.G. Wells*

*The War of the Worlds*, Book I, Chapter 1 (p. 265)

Alfred A. Knopf. New York, New York, USA. 1934

Those who have never seen a living Martian can scarcely imagine the strange horror of its appearance.

*Seven Famous Novels by H.G. Wells*

*The War of the Worlds*, Book I, Chapter 4 (p. 276)

Alfred A. Knopf. New York, New York, USA. 1934

**Whewell, William** 1794–1866

English philosopher and historian

[The inhabitants of Jupiter] it would seem, be cartilaginous and glutinous masses.... [I]f life be there, it does not seem in any way likely, that the living things can be anything higher in the scale of being, than such boneless, watery, pulpy creatures...

*The Plurality of Worlds*

Chapter IX (pp. 208–209)

Gould & Lincoln. Boston, Massachusetts, USA. 1854

## EXTRAORDINARY

**von Ebner-Eschenbach, Marie** 1830–1916

Austrian novelist

No one ever accomplished the ordinary who did not attempt the extraordinary.

Translated by Annis Lee Wister

*Aphorisms*

Number 8

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

## EXTRAVAGANT

**Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Do not be deterred, if you have examined minutely, by any dread of being deemed extravagant. The possibilities of existence run so deeply into the extravagant, that there is scarcely any conception too extraordinary for nature to realize.

In Hugh Miller

*The Old Red Sandstone*

Chapter III (p. 52)

John B. Alden, Publisher. New York, New York, USA. 1892

## EXTREME VALUE

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

There is here no need of throwing out “extreme cases.” Far from that, it is precisely in the extreme cases that the power and beauty of the magic eyeglass is most apparent and most marvellous. Let me take back the word “magic,” though; for the reasonableness of it is just its crowning charm.

In A.G. Sedgwick

*The 19th Century: A Review of Progress During the Past One Hundred*

*Years in the Chief Departments of Human Activity*

The Century's Great Men in Science (p. 317)

G.P. Putnam's Sons. New York, New York, USA. 1901

## EYE, ANIMAL

**Buber, Martin** 1878–1965

Austrian-Jewish philosopher

An animal's eyes have the power to speak a great language.

Translated by Ronald Gregor Smith

*I and Thou* (2nd edition)

Part III (p. 75)

Continuum. London, England. 2004

## F

### FACT

#### A Traveler

When facts have been gathered, sorted, and piled, the mound is an observatory.

*Frost and Fire* (Volume 2)

Chapter XXVIII (p. 1)

Edmonston & Douglas. Edinburgh, Scotland. 1865

**Abbott, Edwin A.** 1838–1926

English clergyman and author

From dreams I proceed to facts.

*Flatland* (p. 68)

Barnes & Noble, Inc. New York, New York, USA. 1963

**Adams, Henry Brooks** 1838–1918

American man of letters

The facts seemed certain, or at least as certain as other facts; all they needed was explanation.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XXIX (p. 433)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Philosophers and theologians have yet to learn that a physical fact is as sacred as a moral principle.

Evolution and Permanence of Type

*The Atlantic Monthly*, 1874 (p. 92)

Facts are stupid things until brought into connection with some general law.

In James Orton

*Comparative Zoology, Structural and Systematic*

Preceding Chapter XXI (p. 222)

Harper & Brothers. New York, New York, USA. 1877

The only true scientific system must be one in which the thought, the intellectual structure, rises out of, and is based upon, facts.

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907

**Alcott, Louisa May** 1832–88

American author

...entrenching himself behind an undeniable fact.

*Little Women*

Chapter XXXV (p. 304)

Books, Inc., Publishers. New York, New York, USA. 1950

## American Museum of Natural History

Every specimen is a permanent fact.

Plaque at entrance to the Earth History Hall

**Ampere, Andre-Marie** 1775–1836

French physicist

Those periods of history when phenomena previously thought to be due to totally diverse causes have been reduced to a single principle were almost always accompanied by the discovery of many new facts, because a new approach in the conception of causes suggests a multitude of new experiments to try and explanations to verify.

In Peter Louis Galison

*How Experiments End*

Chapter 2 (p. 28)

The University of Chicago Press. Chicago, Illinois, USA. 1987

**Aristotle** 384 BCE–322 BCE

Greek philosopher

...with a true view all the data harmonize, but with a false one the facts soon clash.

In *Great Books of the Western World* (Volume 9)

*The Nicomachean Ethics*

Book I, Chapter VIII, Section 1098b[10] (p. 13)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Arnold, Matthew** 1822–88

English poet and critic

Deny the facts altogether, I think, he hardly can.

Literature and Science

*Nineteenth Century*, August, 1882 (p. 216)

#### Author undetermined

Never base your argument on a fact: for if the fact is disproved what becomes of the argument.

In Robert John Strutt

*Life of John William Strutt: Third Baron Rayleigh* (fn, p. 270)

University of Wisconsin Press. Madison, Wisconsin, USA. 1968

My mind is like a coal chute down which many tons of facts have rumbled, leaving only a little dust behind.

In Edward Hodnett

*The Art of Problem Solving*

Part I, Chapter 6 (p. 42)

Harper & Brothers. New York, New York, USA. 1955

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Facts, however, will ultimately prevail; we must therefore take care that they be not against us.

In Jean Andrew de Luc

Translated by Henry de La Fite

*An Elementary Treatise on Geology*

Section 93 (p. 82)

F.C. & J. Rivington. London, England. 1809

**Balchin, Nigel** 1908–70  
English novelist

“Well facts are facts” said Tilly sulkily.  
“So they are, and figures are figures. Stop subtracting the date and get with it.”

*The Small Back Room* (p. 24)  
Collins. London, England. 1943

Am I supposed to give all the facts, or some of the facts, or my opinions or your opinions or what?

*The Small Back Room* (p. 53)  
Collins. London, England. 1943

**Barrett, Thomas Squire**  
No biographical data available

A deep feeling on our part that all our science is really nothing but a collection and classification of isolated but analogous facts – and that anything beyond this is outside the, i.e. inductive science. I do not, of course, include the mathematical or the sciences of the unconditioned. limits of our knowledge (at least as those limits at present are) – ought to teach us how emphatically superficial even our deepest discoveries are, and how infinitesimal is our knowledge of the marvelous secrets and vast resources of nature.

*The Philosophy of Science: A Contribution Thereto, on Cause and Effect* (2nd edition)  
Chapter III (pp. 155–156)  
Provost & Co. London, England. 1872

**Barrie, Sir James M.** 1860–1937  
Scottish journalist, writer, and dramatist

Facts were never pleasing to him. He acquired them with reluctance and got rid of them with relief. He was never on terms with them until he had stood them on their heads.

*The Greenwood Hat*  
Love me Never or Forever (pp. 50–51)  
Charles Scribner’s Sons. New York, New York, USA. 1938

**Barry, Frederick** 1876–1943  
Historian of science

To an ordinary person a fact is a fact, and that is all there is to be said about it.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 91)  
Columbia University Press. New York, New York, USA. 1927

A fact is no simple thing.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 91)  
Columbia University Press. New York, New York, USA. 1927

Facts are to begin with, coercive.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 92)  
Columbia University Press. New York, New York, USA. 1927

**Baruch, Bernard M.** 1870–1965  
American presidential advisor

If you get all the facts, your judgment can be right; if you don’t get all the facts, it can’t be right.

*St. Louis Post Dispatch*, 21 June, 1965 (p. 5a)

**Bates, Marston** 1906–74  
American zoologist

Facts are the raw material of science – the bricks from which our model of the universe must be built – and we are rightly taught to search for sound and solid facts, for strong and heavy bricks that will serve us well in building foundations, for clean and polished bricks that will fit neatly into ornamental towers. But while accumulating the bricks may be a contribution to science, we must take care that the pile does not become a hopelessly discouraging jumble. For science itself is not brickmaking – it is, at the workaday and technical level, bricklaying; and at the creative and artistic level, architecture, the designing of an edifice that will utilize all the bricks to the very best of advantage.

*The Natural History of Mosquitoes*  
Introduction (p. 1)  
Macmillan Company. New York, New York, USA. 1949

**Beaumont, William** 1785–1853  
American army surgeon

My opinions may be doubted, denied, or approved, according as they conflict or agree with the opinions of each individual who may read them; but their worth will be best determined by the foundation on which they rest – the incontrovertible facts.

*William Beaumont: A Pioneer American Physiologist*  
*Experiments and Observations on the Gastric Juice and the Physiology of Digestion*, Preface (p. 200)  
The C.V. Mosby Company. St. Louis, Missouri, USA. 1981

I submit a body of facts which cannot be invalidated. My opinions may be doubted, denied, or approved, according as they conflict or agree with the opinions of each individual who may read them; but their worth will be best determined by the foundation on which they rest – the incontrovertible facts.

*Experiments and Observations on the Gastric Juice, and the Physiology of Digestion*  
Preface (p. 3)  
Maclachlan & Stewart. Edinburgh, Scotland. 1838

Facts are more persuasive than arguments, however ingeniously made, and by their eloquence ...

*Experiments and Observations on the Gastric Juice, and the Physiology of Digestion*  
Chapter 6 (p. 93)  
Maclachlan & Stewart. Edinburgh, Scotland. 1838

**Beebe, William** 1877–1962  
American ornithologist

Scientific facts, more often than is known, are learned by accident.

*Half Mile Down*

Chapter 9 (p. 174)

Harcourt, Brace & Company. New York, New York, USA. 1934

**Belinsky, Vissarion Grigoryevich** 1811–48

Russian writer and literary critic

In science one must search for ideas. If there are no ideas, there is no science. A knowledge of facts is only valuable in so far as facts conceal ideas: facts without ideas are just the sweepings of the brain and the memory.

In S. A. Vengerov (ed.)

*Complete Collected Works of V. G. Belinsky* (Volume 2) (p. 348)

Publisher undetermined

**Bernard, Claude** 1813–78

French physiologist

If the facts used as a basis for reasoning are ill-established or erroneous, everything will crumble or be falsified; and it is thus that errors in scientific theories most often originate in errors of fact.

*An Introduction to the Study of Experimental Medicine*

Part I, Chapter I, Section III (p. 13)

Henry Schuman, Inc. New York, New York, USA. 1927

Facts are neither great nor small in themselves.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section II (p. 34)

Henry Schuman, Inc. New York, New York, USA. 1927

A fact is nothing in itself, it has value only through the idea connected with it or through the proof it supplies.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section vii (p. 53)

Henry Schuman, Inc. New York, New York, USA. 1927

When we meet a fact which contradicts a prevailing theory, we must accept the fact and abandon the theory, even when the theory is supported by great names and generally accepted.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter II, Section ii (p. 164)

Henry Schuman, Inc. New York, New York, USA. 1927

Facts never exclude one another, they are simply explained by differences in the conditions in which they are born.

Translated by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

...an experimenter can never deny a fact that he has seen and observed, merely because he cannot rediscover it.

Translated by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

It is a statistikal fakt, that the wicked work harder tew reach Hell, than the righteous do tew git to heaven.

*Old Probability: Perhaps Rain – Perhaps Not*

April, 1870 (Green Section)

G.W. Carleton & Company, Publishers. New York, New York, USA. 1879

**Boehm, George A. W.** 1922–93

American editor and mathematician

Mathematics has always been abstract, but pure mathematicians are pushing abstraction to new limits. To them mathematics is an art they pursue for art's sake, and they do not much care whether it will ever have any practical use.

*Annual Report of the Board of Regents of the Smithsonian Institution (1959)*

The New Uses of the Abstract (p. 309)

Government Printing Office, Washington, D.C. 1960

**Bohm, David** 1917–92

American physicist

...it is important to note that facts are not to be considered as if they were independently existent objects that we might find or pick up in the laboratory.... In a certain sense, we “make” the fact. That is to say, beginning with immediate perception of an actual situation, we develop the fact by giving it further order, form and structure with the aid of our theoretical concepts.

*Wholeness and the Implicate Order*

Chapter 6 (p. 142)

Routledge. London, England. 1995

**Boole, George** 1815–64

English mathematician

Now there is this reason for grounding the order of exposition upon the historical sequence of discovery, that by so doing we are most likely to present each new form of truth to the mind, precisely at that stage at which the mind is most fitted to receive it, or even, like that of the discoverer, to go forth to meet it. Of the many forms of false culture, a premature converse with abstractions is perhaps the most likely to prove fatal to the growth of a masculine vigor of intellect.

*A Treatise on Differential Equations* (4th edition)

Preface to the First Edition (p. vi)

Macmillan & Co Ltd. London, England. 1877

**Boutroux, Émile** 1845–1921

French philosopher

The world is an endless variety of facts, linked together by necessary and immutable bonds.

Translated by Fred Rothwell

*The Contingency of the Laws of Nature* (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1916

...the senses afford a primary conception of the world, which they show to be a mass of facts, endless in their



variety. Man may observe, analyse, and describe them with ever-increasing exactness: this very description constitutes science.

Translated by Fred Rothwell

*The Contingency of the Laws of Nature* (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1916

### **Bradbury, Ray** 1920–

American writer

...facts quite often, I fear to confess, like lawyers, put me to sleep at noon. Not theories, however.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Foreword (p. x)

Harper & Row, Publishers. New York, New York, USA. 1973

### **Bradford, Gamaliel** 1863–1932

American biographer

Observed facts must be built up, woven together, ordered, arranged, systematized into conclusions and theories by reflection and reason, if they are to have full bearing on life and the universe. Knowledge is the accumulation of facts. Wisdom is the establishment of relations. And just because the latter process is delicate and perilous, it is all the more delightful. The lofty scorn of the true philosopher for mere perception is well shown in Royer Collard's remark: "There is nothing so despicable as a fact." Which does not prevent philosophers or any one else from making facts the essential basis of all discussion of relations.

*Darwin*

Chapter II (p. 44)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1926

...the mere collection of facts, without some basis of theory for guidance and elucidation, is foolish and profitless.

*Darwin*

Chapter II (p. 47)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1926

### **Brewster, David** 1781–1868

Scottish scientist, inventor and writer

A collection of facts, however skillfully they may be conjured with, can never yield general laws unless they contain that master-fact in which the discovery resides, or upon which the law mainly depends.

In Margaret Maria Gordon

*The Home Life of Sir David Brewster* (3rd edition)

Chapter VIII (p. 72)

David Douglas. Edinburgh, Scotland 1881

### **Bridgman, Percy Williams** 1882–1961

American physicist

...the fact has always been for the physicist the one ultimate thing from which there is no appeal, and in the face

of which the only possible attitude is a humility almost religious.

*The Logic of Modern Physics*

Chapter I (pp. 2–3)

The Macmillan Company. New York, New York, USA. 1927

### **Brinton, Willard Cope**

No biographical data available

It is often with impotent exasperation that a person having the knowledge sees some fallacious conclusion accepted, or some wrong policy adopted, just because known facts cannot be marshaled and presented in such manner as to be effective.

*Graphic Methods for Presenting Facts*

Chapter I (p. 1)

The Engineering Magazine Co. New York, New York, USA. 1914

Ordinarily, facts do not speak for themselves. When they do speak for themselves, the wrong conclusions are often drawn from them. Unless the facts are presented in a clear and interesting manner, they are about as effective as a phonograph record with the phonograph missing.

*Graphic Methods for Presenting Facts*

Chapter I (p. 2)

The Engineering Magazine Co. New York, New York, USA. 1914

### **Brown, Samuel** 1817–56

Chemist

Facts are the body of science, and the idea of those facts is its spirit.

*Lectures on the Atomic Theory and Essays Scientific and Literary* (Volume 1)

The History of Science (p. 301)

Thomas Constable & Co. Edinburgh, Scotland. 1858

### **Browning, Robert** 1812–89

English poet

...This plain, plump fact.

*The Poems and Plays of Robert Browning*

Mr. Sludge, "The Medium"

The Modern Library. New York, New York, USA. 1934

But facts are facts and flinch not.

*The Poems and Plays of Robert Browning*

The Ring and the Book

Part II, Half-Rome, l. 1049

The Modern Library. New York, New York, USA. 1934

### **Buchner, Ludwig** 1824–99

German physician and philosopher

...in the long run there is no contending against facts; it is useless to "kick against the pricks."

*Force and Matter*

Preface to the First Edition (p. vi)

Truth Seeker. New York, New York, USA. 1950

But enough of facts!

*Force and Matter*

Brain and Mind (p. 231)

Truth Seeker. New York, New York, USA. 1950

**Buckley, Arabella B.** 1840–1929  
English naturalist and science writer

No one can love dry facts; we must clothe them with real meaning and love the truths they tell, if we wish to enjoy science.

*The Fairy-Land of Science*  
Lecture I (p. 32)  
D. Appleton & Company. New York, New York, USA. 1899

**Burns, Robert** 1759–96  
Scottish poet

Facts are chieftains that winna ding an' downa be disputed. Facts are entities which cannot be manipulated or disputed.

*The Complete Poetical Works of Robert Burns*  
A Dream, l. 30  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Burroughs, John** 1837–1921  
American naturalist and writer

To treat your facts with imagination is one thing; to imagine your facts is quite another.

*The Heart of Burroughs's Journals*  
October 24, 1907  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1928

A fact that has passed through the mind of man, like lime or iron that has passed through his blood, has some quality or property superadded or brought out that it did not possess before.

*Signs and Seasons*  
Chapter I (p. 36)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Butlerov, Aleksandr Mikhailovich** 1828–86  
Russian chemist

Facts not explained by the existing theories are probably the most valuable for science, for their study is most likely to lead to its early advancement.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

A seemingly trivial fact, singular and insignificant today, may tomorrow become the nucleus of a new, fruitful field of knowledge in connection with some new discovery.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

**Carlyle, Thomas** 1795–1881  
English historian and essayist

I grow to honor facts more and more, and theory less and less. A fact, it seems to me, is a great thing – a sentence printed, if not by God, then at least by the Devil.

In Joseph Slater (ed.)  
*The Correspondence of Emerson and Carlyle*  
Letter to Ralph Waldo Emerson  
April 29, 1836 (pp. 146–147)  
Columbia University Press. New York, New York, USA. 1964

Conclusive facts are inseparable from unconclusive except by a head that already understands and knows.

*English and Other Critical Essays*  
Chartism (p. 170)  
J.M. Dent & sons Ltd. London, England. 1950

**Carpenter, William Benjamin** 1813–85  
English physiologist and naturalist

Were we able to ascertain facts regarding the changes which take place in the interior of the living body as easily as the astronomer observes the place of a planet, or the chemist the decomposition of a salt, there is no reason whatever to prevent these facts being generalized in the same manner and to the same degree with those of the physical sciences.

Review of A History of the Inductive Sciences, Physiology An Inductive Science  
*British and Foreign Medical Review*, Volume 5, 1838 (p. 340)

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

First accumulate a mass of Facts: and then construct a Theory.

*The Complete Works of Lewis Carroll*  
*Sylvie and Bruno*  
Chapter XVIII (p. 423)  
The Modern Library. New York, New York, USA. 1936

The Theory hardly rose to the dignity of a Working Hypothesis. Clearly more Facts were needed.

*The Complete Works of Lewis Carroll*  
*Sylvie and Bruno*  
Chapter XVIII (p. 424)  
The Modern Library. New York, New York, USA. 1936

**Carson, Rachel** 1907–64  
American marine biologist and author

If facts are the seeds that later produce knowledge and wisdom, then the emotions and the impressions of the senses are the fertile soil in which the seeds must grow.

*The Sense of Wonder* (p. 48)  
Harper & Row, Publishers, New York 1984

**Charlie Chan (Fictional character)**

Small things sometimes tell large tales.

*Charlie Chan at the Opera*  
Film (1936)

Facts like photographic film – must be exposed before developing.

*Charlie Chan at the Circus*  
Film (1936)

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

The mind lingers with pleasure upon the facts that fall happily into the embrace of the theory, and feels a natural indifference toward those that assume a refractory or meaningless attitude.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 4  
The Methods of the Earth-Sciences (p. 480)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

As happens always in science, it is the facts that pull the thoughts to the bottom of the sea of oblivion.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 139)  
The Rockefeller University Press. New York, New York, USA. 1978

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

I thought it was the task of the natural sciences to discover the facts of nature, not to create them.

Quoted in Abir-Am, Pnina  
The Politics of Macromolecules: Molecular Biologists, Biochemists, and Rhetoric  
*Osiris*, Volume 7, 1992

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Science itself is only the exaggeration and specialisation of this thirst for useless fact, which is the mark of the youth of man. But science has become strangely separated from the mere news and scandal of flowers and birds; men have ceased to see that a pterodactyl as a pterodactyl. The rebuilding of this bridge between science and human nature is one of the greatest needs of mankind. We have all to show that before we go on to any visions or creations we can be contented with a planet of miracles.

*The Apostle and the Wild Ducks, and other Essays*  
Literature and Information (p. 130)  
Elek. London, England. 1975

Facts as facts do not always create a spirit of reality, because reality is a spirit.

*Come to Think of It*  
On the Classics (p. 49)  
Methuen & Company Ltd. London, England. 1932

Facts by themselves can often feed the flames of madness, because sanity is spent.

*Come to Think of It*  
On the Classics (p. 49)  
Methuen & Company Ltd. London, England. 1932

The moment you step into the world of facts, you step into a world of limits.

*Orthodoxy*  
Chapter III (p. 71)  
John Lane Company. New York, New York, USA. 1918

The truths of religion are unprovable; the facts of science are unproved.

*The Uses of Diversity*  
Christian Science (p. 52)  
Methuen & Company Ltd. London, England. 1920

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

You must look at facts because they look at you.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, May 7, 1925 (p. 132)  
George Allen & Unwin Ltd. London, England. 1956

I like the martial and commanding air with which the right honorable Gentleman treats facts. He stands no nonsense from them.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, February 19, 1909 (p. 132)  
George Allen & Unwin Ltd. London, England. 1956

A balloon goes up quite easily for a certain distance, but after a certain distance it refuses to go up any further, because the air is too rarefied to float it and sustain it. And, therefore, I would say, let us examine the concrete facts.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, St. Andrew's Hall, Glasgow, October 11, 1906 (p. 133)  
George Allen & Unwin Ltd. London, England. 1956

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Some facts are so incredible that they are believed at once, for no one could possibly have imagined them.

*The Lost Worlds of 2001*  
Chapter 30 (p. 175)  
New American Library. New York, New York, USA. 1972

**Cohen, Jerome**

No biographical data available

Every lawyer knows that the name of the game is what label you succeed in imposing on the facts.

Tense Triangle – What to Do About Taiwan  
*Time*, June 7, 1971 (p. 24)

**Cohen, Morris Raphael** 1880–1947  
American philosopher

Begin with collecting the facts? Ay, but what facts?

*Reason and Nature*  
Chapter Three, Section I (p. 76)  
The Free Press, Publishers, Glencoe, Illinois, USA. 1931

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Facts...are not truths; they are not conclusions; they are not even premises, but in the nature and parts of

premises. The truth depends on, and is only arrived at, by a legitimate deduction from all the facts which are truly material.

*The Table Talk and Omniana of Samuel Taylor Coleridge*

Table-Talk

December 27, 1831 (p. 147)

George Bell & Sons. London, England. 1884

**Collingwood, Robin George** 1889–1943

English historian and philosopher

Different kinds of facts, having different degrees of scientific value, are ascertainable in these two ways. Facts ascertainable by mere observation are what are called common-sense facts, i.e. facts accessible to a common-place mind on occasions frequent enough to be rather often perceived and of such a kind that their characteristics can be adequately perceived without trouble: so that the facts concerning them can be familiar to persons not especially gifted and not especially alert.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part II, Chapter XXXI, aphorism 31.47 (p. 250)

At The Clarendon Press. Oxford, England. 1942

**Collins, Wilkie** 1824–89

English novelist

“Facts?” he repeated. “Take a drop more grog, Mr. Franklin, and you’ll get over the weakness of believing facts!” “Foul play, Sir.”

*The Moonstone*

Second Narrative, Chapter IV (p. 275)

International Collectors Library. Garden City, New York, USA. 1900

**Conrad, Joseph** 1857–1924

Polish-born English novelist

They demand facts from him, as if facts could explain anything.

*Lord Jim*

Chapter IV (p. 21)

Rinehart & Company, Inc. New York, New York, USA. 1957

...it is impossible to lay the ghost of a fact.

*Lord Jim*

Chapter XIX (p. 169)

Rinehart & Company, Inc. New York, New York, USA. 1957

...The language of facts, that are so often more enigmatic than the craftiest arrangement of words.

*Lord Jim*

Chapter XXXVI (p. 295)

Rinehart & Company, Inc. New York, New York, USA. 1957

**Cooke, Josiah Parsons** 1827–94

American chemist

In every physical science we have carefully to distinguish between the facts which form its subject-matter and the theories by which we attempt to explain these facts, and group them in our scientific systems.

*The New Chemistry*

Lecture I (p. 9)

D. Appleton & Company. New York, New York, USA. 1876

**Coulter, John Merle** 1851–1928

American botanist and educator

Facts are like stepping stones; so long as one can get a reasonably close series of them he can make some progress in a given direction, but when he steps beyond them he flounders. As one travels away from a fact its significance in any conclusion becomes more and more attenuated, until presently the vanishing point is reached, like the rays of light from a candle.

*The Mission of Science in Education*

*Science*, N.S. Volume XII, Number 295, August 24, 1900 (p. 286)

We are not called upon to construct a theory of the universe even upon every well-attested fact, and the sooner this is learned the more time will be saved and the more functional will the observing powers remain.

*The Mission of Science in Education*

*Science*, N.S. Volume XII, Number 295, August 24, 1900 (p. 286)

**Courtney, Leonard Henry** 1832–1918

English politician

After all, facts are facts, and although we may quote one to another with a chuckle the words of the Wise Statesman, “Lies – damned lies – and statistics,” still there are some easy figures the simplest must understand, and the astutest cannot wriggle out of.

*To My Fellow-Disciples at Saratoga Springs*

*The National Review [London]*, Volume 26, 1895 (p. 25)

**Cousins, Norman** 1915–90

World Federalist leader

There is a tendency to mistake data for wisdom, just as there has always been a tendency to confuse logic with values, intelligence with insight. Unobstructed access to facts can produce unlimited good only if it is matched by the desire and ability to find out what they mean and where they lead. Facts are terrible things if left sprawling and unattended. They are too easily regarded as evaluated certainties rather than as the rawest of raw materials crying to be processed into the texture of logic.

*Human Options: An Autobiographical Notebook*

W.W. Norton & Co. New York, New York, USA. 1981

**Crawford, F. Marion** 1854–1909

American novelist

Facts make life long – not years.

*Don Orsino*

Chapter XV (p. 233)

The Macmillan Company. New York, New York, USA. 1926

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

In so far as engineers deal with facts that can be measured they use mathematics to combine these facts and to deduce their conclusions. But often the facts are not subject to exact measurement or else the combinations are of facts that are incommensurable.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 64)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

The constant and insistent need that engineers feel for any scrap of fact from which they may predict natural phenomena tends to develop a hunger for anything that even resembles a fact. This in turn may lead to a wolfish and gluttonous attitude, a gobbling up of every statement or opinion, figure or formula, indiscriminately and incessantly. The result is often intellectual autointoxication from hunks and gobs of unselected, undigested and indigestible material.

*Engineers and Ivory Towers*

For Mans Use of God's Gifts (p. 99)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

...engineers need to select their mental diet carefully and when they go a-fishing after facts they want a fish fry and not a chowder.

*Engineers and Ivory Towers*

For Mans Use of God's Gifts (p. 99)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Crothers, Samuel McChord** 1857–1927

American clergyman and writer

The trouble with facts is that there are so many of them.

*The Gentle Reader*

That History Should Be Readable (p. 183)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Darbishire, Arthur Dukinfield** 1879–1915

Statistician

Facts are like the dolls of the ventriloquist and say what we want them to.

*An Introduction to a Biology*

Chapter I (p. 9)  
Funk & Wagnalls Co. New York, New York, USA. 1917

**Darwin, Charles Robert** 1809–82

English naturalist

One great source of perplexity to me is an utter ignorance whether I note the right facts, and whether they are of sufficient importance to interest others.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter VI (p. 208)  
D. Appleton & Company. New York, New York, USA. 1896

Nothing is so vexatious to me, as so constantly finding myself drawing different conclusions from better judges than myself, from the same facts.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)  
Letter to J.D. Hooker, July 30, 1856 (p. 439)  
D. Appleton & Company. New York, New York, USA. 1896

False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for every one takes a

salutary pleasure in proving their falseness: and when this is done, one path towards error is closed and the road to truth is often at the same time opened.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part III, Chapter XXI (p. 590)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...no one has a right to speculate without distinct facts...

*The Voyage of The Beagle*

Chapter XVII (p. 378)  
Heron Books. 1968

**Davy, Sir Humphry** 1778–1829

English chemist

When I consider the variety of theories that may be formed on the slender foundation of one or two facts, I am convinced that it is the business of the true philosopher to avoid them altogether. It is more laborious to accumulate facts than to reason concerning them; but one good experiment is of more value than the ingenuity of a brain like Newton's.

In Sir William Ramsay

*Essays Biographical and Chemical*

The Great London Chemists  
Section II (p. 46)  
Archibald Constable & Company Ltd. London, England. 1908

The human mind, deriving all its ideas from the senses when in a state of healthy exertion, sooner or later uniformly refers to facts. And when hypotheses are used merely as instruments for comparing facts and for ascertaining their minute relations, they promote in the highest degree the efforts of inventive genius and tend to impress on the understanding the true and unperverted images of nature.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Lecture Seven (p. 102)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

Insulated, striking, but unexplained facts in science, are to the philosopher what green branches and fruits in the ocean are to the mariner voyaging for discovery; they are omens of land, which, even though he himself should not have the felicity of attaining, he may yet indicate to others.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 217)  
Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**de La Beche, Henry Thomas** 1796–1855

English geologist

Facts brought to light by practice are to general progress that which experiments are to experimental philosophy,-they have to be properly explained by the best methods



at command, after they have been satisfactorily proved to be facts ...

*Records of the School of Mines and of Science Applied to the Arts* (Volume 1), Part I  
Inaugural Discourse (p. 20)  
Longman, Brown, Green & Longmans. London, England. 1852

**de Unamuno, Miguel** 1864–1936  
Spanish philosopher and writer

Science is the most intimate school of resignation and humility, for it teaches us to bow for the seemingly most insignificant of facts.

Translated by J.E. Crawford Fitch  
*The Tragic Sense of Life in Men and in Peoples*  
Chapter IX (p. 197)  
Macmillan & Company Ltd. London, England. 1921

...science robs men of wisdom and usually converts them into phantom beings loaded up with facts.

*Essays and Soliloquies*  
Some Arbitrary Reflections Upon Europeanization (p. 55)  
Alfred A. Knopf. New York, New York, USA. 1925

**Deluc, Jean-André** 1727–1817  
Swiss geologist

It is true that a controversy approaches its conclusion by the accumulation of facts that impinge upon it, it is only so provided these “facts” are without ambiguity in their implications. For otherwise, twisted by the rival hypotheses, and sometimes with so many more words that they convey less sense, these “facts” so multiply the extraneous questions that controversies become endless. Thus prejudice and imagination freely hold sway and logic is replaced by fashion.

In Jan Golinski  
*Precision Instruments and the Demonstrative Order of Proof in Lavoisier’s Chemistry* (p. 30)  
*Osiris*, 2nd Series, Volume 9, 1994

**Dewey, John** 1859–1952  
American philosopher and educator

It is not truly realistic or scientific to take short views, to sacrifice the future to immediate pressure, to ignore facts and forces that are disagreeable and to magnify the enduring quality of whatever falls in with immediate desire. It is false that the evils of the situation arise from absence of ideals; they spring from wrong ideals.

*Reconstruction In Philosophy*  
Chapter V (p. 130)  
Beacon Press. Boston, Massachusetts, USA. 1920

...the facts of nature are multitudinous, inexhaustible, they begin nowhere and end nowhere in particular, and hence are not, just as facts, the best material for the education of those whose lives are centered in quite local situations and whose careers are irretrievably partial and specific.

Science as Subject-Matter and as Method  
*Science*, N.S. Volume 31, Number 787, January 28, 1910 (p. 122)

**Dickens, Charles** 1812–70  
English novelist

The labors of others have raised for us an immense reservoir of important facts.

*The Posthumous Papers of the Pickwick Club*  
Chapter IV (p. 39)  
Dodd, Mead & Company. New York, New York, USA. 1944

Now, what I want are facts.... Facts alone are wanted in life.

*Hard Times*  
Book the First, Chapter I (p. 1)  
J.M. Dent & Sons Ltd. London, England. 1966

Why, then, you are not to see anywhere, what you don't see in fact; you are not to have anywhere, what you don't have in fact. What is called Taste, is only another name for Fact.

*Hard Times* (Volume 1)  
Book I, Chapter II (p. 209)  
Chapman & Hall, Ltd. London, England. 1858

The speaker, and the schoolmaster, and the third grown person present, all backed a little, and swept with their eyes the inclined plane of little vessels then and there arranged in order, ready to have imperial gallons of facts poured into them until they were full to the brim.

*Hard Times* (Volume 2)  
Book I, Chapter I (p. 206)  
Chapman & Hall, Ltd. London, England. 1858

“Fact, fact, fact!” said the gentleman. And “Fact, fact, fact!” repeated Thomas Gradgrind. “You are to be in all things regulated and governed,” said the gentleman, “by fact. We hope to have, before long, a board of fact, composed of commissioners of fact, who will force the people to be a people of fact, and of nothing but fact. You must discard the word Fancy altogether. You have nothing to do with it.”

*Hard Times*  
Book the First, Chapter II (p. 8)  
The Limited Edition Club. New York, New York, USA. 1966

Facts and Figures! Put ‘em down.

*The Chimes*  
First Quarter  
Printed by G. W. Jones. London, England. 1931

**Dickinson, Frances**  
No biographical data available

I know no facts, when listed for scientific purposes, to be “indecicate, indecent, obscene, or nasty.” These adjectives express relative conditions in social life. The varied conditions of human beings from physical and psychological standpoints should be handled without sentiment and prejudice if scientific conclusions are to be reached and present conditions bettered.

*The Gynecologic Consideration of the Sexual Act* (p. 49)  
The Henry O. Shepard Company. Chicago, Illinois, USA. 1900



**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

There is nothing more deceptive than an obvious fact.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Boscombe Valley Mystery* (p. 137)  
Wings Books. New York, New York, USA. 1967

“I find it hard enough to tackle facts, Holmes, without flying away after theories and fancies.”

“You are right,” said Holmes demurely; “you do find it very hard to tackle the facts.”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Boscombe Valley Mystery* (p. 144)  
Wings Books. New York, New York, USA. 1967

Some facts should be suppressed, or at least, a just sense of proportion should be observed in treating them. The only point in the case which deserved mention was the curious analytical reasoning from effects to causes, by which I succeeded in unraveling it.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Sign of the Four*, Chapter 1 (p. 611)  
Wings Books. New York, New York, USA. 1967

It is, of course, a trifle, but there is nothing so important as trifles.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Man with the Twisted Lip* (p. 379)  
Wings Books. New York, New York, USA. 1967

“I should have more faith,” he said; “I ought to know by this time that when a fact appears to be opposed to a long train of deductions, it invariably proves to be capable of bearing some other interpretation.”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 7 (p. 194)  
Wings Books. New York, New York, USA. 1967

If you will find the facts, perhaps others may find the explanation.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Problem of Thor Bridge* (p. 601)  
Wings Books. New York, New York, USA. 1967

It is of the highest importance in the art of detection to be able to recognize out of a number of facts which are incidental and which are vital.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Reigate Squires* (p. 341)  
Wings Books. New York, New York, USA. 1967

A further knowledge of facts is necessary before I would venture to give a final and definite opinion.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of Wisteria Lodge* (p. 244)  
Wings Books. New York, New York, USA. 1967

You should consider your brain originally is like a little empty attic, and you have to stock it with furniture as you choose. A fool takes in all lumber of every sort that he comes across, so that the knowledge which might be useful to him gets crowded out, or at best is jumbled up with a lot of other things, so that he has difficulty in laying his hands upon it. Now the skilled workman is very careful indeed as to what he takes into his brain attic. He will have nothing but the tools which may help him in doing his work, but of these he has a large assortment and all in the most perfect order. It is a mistake to think that that a little room has elastic walls and can distend to any extent. Depend upon it there comes a time when for every addition of knowledge you forgot something that you knew before. It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones.

*The Works of A. Conan Doyle*  
*A Study in Scarlet* (p. 20)  
D. Appleton & Co. New York, New York, USA. 1902

**Duhem, Pierre-Maurice-Marie** 1861–1916  
French physicist and mathematician

Whoever sees in physical experiments only the observation of facts would not understand the role played by corrections in these experiments; he would not understand, furthermore, what is meant in speaking of ‘systematic errors’ that an experiment may involve.

*The Aim and Structure of Physical Theory*  
Part II, Chapter IV (p. 158)  
Princeton University Press. Princeton, New Jersey, USA. 1954

But, once again, what the physical states as the result of an experiment is not the recital of observed facts, but the interpretation and the transposing of these facts into the ideal, abstract, symbolic world created by the theories he regards as established.

*The Aim and Structure of Physical Theory*  
Part II, Chapter IV (p. 159)  
Princeton University Press. Princeton, New Jersey, USA. 1954

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

With fuller knowledge we should sweep away the references to probability and substitute the exact facts.

*The Nature of the Physical World*  
Chapter XIV (p. 305)  
The Macmillan Company. New York, New York, USA. 1930

But are we sure of our observational facts? Scientific men are rather fond of saying pontifically that one ought to be quite sure of one’s observational facts before embarking on theory. Fortunately those who give this advice do not practice what they preach. Observation and theory

get on best when they are mixed together, both helping one another in the pursuit of truth. It is a good rule not to put overmuch confidence in a theory until it has been confirmed by observation. I hope I shall not shock the experimental physicists too much if I add that it is also a good rule not to put overmuch confidence in the observational results that are put forward until they have been confirmed by theory.

*New Pathways in Science*  
The Expanding Universe (p. 211)

**Einstein, Albert** 1879–1955  
German-born physicist

The justification for a physical concept lies exclusively in its clear and unambiguous relation to facts that can be experienced.

In A.P. French  
*Einstein: A Centenary Volume*  
Chapter 12 (p. 229)  
Harvard University Press. Cambridge, Massachusetts, USA. 1979

It seems that the human mind has first to construct forms independently before we can find them in things. Kepler's marvelous achievement is a particularly fine example of the truth that knowledge cannot spring from experience alone, but only from the comparison of the inventions of the mind with observed fact.

*Ideas and Opinions*  
Johannes Kepler (p. 266)  
Crown Publishers, Inc. New York, New York, USA. 1954

**Eldridge, Paul** 1888–1982  
American educator

We hew and saw and plane facts to make them dovetail with our prejudices, so that they become mere ornaments with which to parade our objectivity.

*Maxims for a Modern Man*  
2098  
T. Yoseloff. New York, New York, USA. 1965

Combining superstition with facts is often as efficacious as breaking rocks with fists.

*Maxims for a Modern Man*  
2159  
T. Yoseloff. New York, New York, USA. 1965

Facts only emphasize that men are guided by fancies.

*Maxims For a Modern Man*  
2168  
T. Yoseloff. New York, New York, USA. 1965

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

You seem to have a decided faculty for digesting facts as evidence.

*The George Eliot Letters* (Volume 2) (p. 205)  
Yale University Press. New Haven, Connecticut, USA. 1954–1978

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

To the wise, therefore, a fact is true poetry, and the most beautiful of fables.

*Ralph Waldo Emerson: Essays and Lectures*  
*Nature: Addresses, and Lectures*  
Prospects (p. 55)  
The Library of America. New York, New York, USA. 1983

Is it any better if the student...aims to make a mechanical whole of...science...by a numerical addition of all the facts that fall within his vision.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)  
*Essays: First Series*  
Chapter XI (p. 339)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

No facts are to me sacred; none are profane; I simply experiment, an endless seeker, with no Past at my back.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: First Series*  
Circles (p. 412)  
The Library of America. New York, New York, USA. 1983

Time dissipates to shining ether the solid angularity of facts. No anchor, no cable, no fences avail to keep a fact a fact.

*Essays: First and Second Series*  
History (p. 9)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1903

Who cares what the fact was, when we have thus made a constellation of it to hang in heaven an immortal sign?

*Essays: First and Second Series*  
History (p. 14)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1903

Every known fact in natural science was divined by the presentiment of somebody, before it was actually verified.

*The Complete Works of Ralph Waldo Emerson* (Volume 3)  
*Essays: Second Series*  
Nature (p. 183)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

I distrust the facts and the inferences.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: Second Series*  
Experience (p. 475)  
The Library of America. New York, New York, USA. 1983

A little fact is worth a whole limbo of dreams...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)  
*Lectures and Biographical Sketches*  
The Superlative (p. 166)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Everett, Edward** 1794–1865  
Whig Party politician

There are facts in this great and wondrous universe, which it is delightful to trace, though we cannot as yet discern their relations to the service of man.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

An Address (p. 76)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

I am not too fond of tangible, indisputable truths; I will not follow you in your sophistical suppositions. I want genuine facts, well-observed, scrupulously-tested facts.

Translated by Alexander Teixeira de Mattos

*The Life of the Weevil*

Chapter x (p. 164)

Hodder & Stoughton. London, England. nd

...what explanation shall I give of the wonderful facts which I have set forth? Why, none, absolutely none. I do not explain facts, I relate them.

Translated by Alexander Teixeira de Mattos

*Bramble Bees and Others*

Chapter V (p. 191)

Dodd, Mead & Co. New York, New York, USA. 1915

**Faraday, Michael** 1791–1867

English physicist and chemist

I could trust a fact and always cross-question an assertion.

In Oswald Blackwood

*Introductory College Physics* (p. 413)

John Wiley & Sons, Inc. New York, New York, USA. 1939

...it is always safe and philosophic to distinguish, as much as is in our power, fact from theory; the experience of past ages is sufficient to show us the wisdom of such a course; and considering the constant tendency of the mind to rest on an assumption, and, when it answers every present purpose, to forget that it is an assumption, we ought to remember that it, in such cases, becomes a prejudice, and inevitably interferes, more or less, with a clear-sighted judgment. I cannot doubt but that he who, as a wise philosopher, has most power of penetrating the secrets of nature, and guessing by hypothesis at her mode of working, will also be most careful, for his own safe progress and that of others, to distinguish that knowledge which consists of assumption, by which I mean theory and hypothesis, from that which is the knowledge of facts and laws; never raising the former to the dignity or authority of the latter, nor confusing the latter more than is inevitable with the former.

A Speculation Touching Electric Conduction and the Nature of Matter  
*Philosophical Magazine*, Volume XXIV, January–June, 1844 (p. 136)

Facts are plentiful enough, but we know not how to class them; many are overlooked because they seem uninteresting; but remember that what led Newton to pursue and discover the law of gravity, and ultimately the laws by which worlds revolve, was – the fall of an apple.

In Bence Jones

*The Life and Letters of Faraday* (Volume I)

Chapter I (p. 25)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

No theory ever agrees with all the facts in its domain, yet it is not always the theory that is to blame. Facts are constituted by older ideologies, and a clash between facts and theories may be proof of progress.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 5 (p. 55)

Verso. London, England. 1978

...science is not sacrosanct. The restrictions it imposes (and there are many such restrictions though it is not easy to spell them out) are not necessary in order to have general coherent and successful views about the world. There are myths, there are the dogmas of theology, there is metaphysics, and there are many other ways of constructing a world-view. It is clear that a fruitful exchange between science and such “non-scientific” world-views will be in even greater need of anarchism than is science itself. Thus anarchism is not only possible, it is necessary both for the internal progress of science and for the development of our culture as a whole.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 15 (p. 180)

Verso. London, England. 1978

Facts contain ideological components, older views, natural interpretations, which have vanished from sight or perhaps never were formulated in an explicit manner. These components are highly suspicious, first because of their age, because of their archaic origin, and, secondly, because their very nature protects them from critical examination and always has protected them from such an examination.

In R.G. Colodny

*The Nature and Function of Scientific Theories*

Problems of Empiricism, Part II (p. 310)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1970

**Fischer, Martin H.** 1879–1962

German-American physician

Facts are not science – as the dictionary is not literature.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 21)

C.C. Thomas. Springfield, Illinois, USA. 1944

Search for facts which reach but to the ankle of this colossus in scientific interest and philosophical consequences, and you will find but pigmies crawling at the foot of a giant!

Translated by John Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter VI (p. 163)

Chatto & Windus. London, England. 1907

**Foster, Sir Michael** 1836–1907  
English physiologist and educator

...facts are things which the well-trained mind can pick up and make use of as it goes along at any time and in any place; whereas the mind which is not well trained will miss the facts or pick up the wrong ones, or put to a wrong use even the right ones which it has in hand.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*

Recent Advances in Science, and Their Bearing on Medicine and Surgery (pp. 340–341)  
Government Printing Office. Washington, D.C. 1899

**France, Anatole (Jean Jacques Brousson)** 1844–1924  
French writer

Less facts! Less facts, if you please, and more figures.

*Anatole France Himself*

Less Facts (p. 71)  
J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1925

**Freeman, R. Austin** 1862–1943  
British physician and mystery novelist

...not only must all prejudices and preconceptions be avoided, but when information is received from outside, the actual undeniable facts must be carefully sifted from the inferences which usually accompany them.

*The Great Portrait Mystery*

Percival Bland's Proxy  
Hodder & Stoughton. London, England. 1918

**Frege, Friedrich Ludwig Gottlob** 1848–1925  
German logician

“Facts, facts, facts,” cries the scientist if he wants to emphasize the necessity of a firm foundation for science. What is a fact? A fact is a thought that is true. But the scientist will surely not recognize something which depends on men’s varying states of mind to be the firm foundation of science.

In Michael Beaney (ed.)

*The Frege Reader*

Thought (p. 342)  
Blackwell Publishers, Malden, Massachusetts, USA. 1997

**Froude, James Anthony** 1818–94  
English historian and biographer

We may make our own opinions, but facts were made for us; and, if we evade or deny them, it will be the worse for us.

*Short Studies on Great Subjects* (Volume 1)

Times of Erasmus, Desiderius and Luther (p. 41)  
Longmans, Green & Company. London, England. 1879

These are facts which no casuistry can explain away.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 11)  
Charles Scribner’s Sons. New York, New York, USA. 1890

The necessitarian falls back upon the experienced reality of facts.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 11)

Charles Scribner’s Sons. New York, New York, USA. 1890

It is through a conviction of the inadequacy of all formulas to cover the facts of nature, it is by a constant recollection of the fallibility of the best instructed intelligence, and by an unintermittent skepticism which goes out of its way to look for difficulties, that scientific progress has been made possible.

*Short Studies on Great Subjects* (Volume 2)

The Grammar of Assent (pp. 89–90)

Charles Scribner’s Sons. New York, New York, USA. 1890

Facts can be accurately known to us only by the most rigid observation and sustained and scrutinizing skepticism...

*Short Studies on Great Subjects* (Volume 2)

Scientific Method Applied to History (p. 453)

Charles Scribner’s Sons. New York, New York, USA. 1890

**Gage, Simon Henry**  
No biographical data available

...when one looks about him the plainest, largest fact he sees is that of the distinction between living and lifeless things.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Processes of Life Revealed by the Microscope; A Plea for Physiological Histology (p. 384)

Government Printing Office. Washington, D.C. 1898

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

Some years ago I discovered many astronomical facts till then unknown.

Their novelty and their antagonism to some physical propositions commonly received by the schools did stir up against me many who professed the vulgar philosophy, as if, forsooth, I had with my own hand placed these things in the heavens to obscure and disturb nature and science.

*The Authority of Scripture in Philosophical Controversies*

Section I

The Defenders of Fallacy

W.H. Wise. New York, New York, USA. 1910

...facts which at first seem improbable will, even on scant explanation, drop the cloak which has hidden them and stand forth in naked and simple beauty.

*Dialogues Concerning Two New Sciences*

First Day (p. 4)

The Macmillan Co. New York, New York, USA. 1914

SALVAIATI: Please observe...how facts which at first seem improbable will, even on scant explanation, drop the cloak which has hidden them and stand forth in naked and simple beauty.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 132)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I would rather discover a single fact, even a small one, than debate the great issues at length without discovering anything at all.

In David L. Goodstein and Judith R. Goodstein  
*Feynman's Lost Lecture: The Motion of Planets Around the Sun*  
Introduction (p. 17)  
W.W. Norton & Company, Inc. New York, New York, USA. 1996

Time has proved every one of my statements, and proving them has also proved that my opponents were of two kinds. Those who had doubted simply because the discoveries were new and strange have been gradually converted, while those whose incredulity was based on personal ill-will to me have shut their eyes to the facts and have endeavored to asperse my moral character and to ruin me.

In Arthur Mee and J.A. Hammerton  
*The World's Greatest Books* (Volume 13)  
*The Defenders of Fallacy* (p. 170)  
McKinley, Stoke & Mackekzu. 1910

**Gardner, Earl Stanley** 1889–1970  
American author

Facts themselves are meaningless. It's only the interpretation we give those facts which counts.

*The Case of the Perjured Parrot* (p. 171)  
Amereon Ltd. Mattituck, New York, USA. 1939

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

In the natural sciences and especially in chemistry generalizations should result from the detailed knowledge of each fact, they should not precede it. It is really only after having acquired this knowledge that we can be assured whether they have something in common...

In Maurice Crosland  
*Gay-Lussac: Scientist and Bourgeois*  
Chapter 3 (p. 67)  
Cambridge University Press. Cambridge, England. 1978

A fact is not novel if it has an analogue which could have some interest. A fact which does not fit in with a series of known facts is a fact which deserves particular attention. If the mind had to retain all individual facts, it could not manage and science would not exist; but when these facts can be connected by general laws and by theories, when a large number of these facts can be represented by a single one, one can remember them more easily, one can generalise one's ideas, one can compare one general fact with another general fact and discoveries can succeed each other. It is only when laws can be introduced into a science that it assumes the true character of science.

In Maurice Crosland  
*Gay-Lussac: Scientist and Bourgeois*  
Chapter 3 (p. 70)  
Cambridge University Press. Cambridge, England. 1978

**George, William H.**

No biographical data available

...[while] the traditional way is to regard the facts of science as something like the parts of a jig-saw puzzle, which can be fitted together in one and only one way, I regard them rather as the tiny pieces of a mosaic, which can be fitted together in many ways. A new theory in an old subject is, for me, a new mosaic pattern made with the pieces taken from an older pattern.

*The Scientist in Action: A Scientific Study of His Methods*  
Personal Basis (p. 335)  
Williams & Norgate Ltd. London, England. 1936

**Giddings, Franklin H.** 1855–1931

American sociologist

The scientific study of any subject is a substitution of businesslike ways of "making sure" about it for the lazy habit of "taking it for granted" and the worse habit of making irresponsible assertions about it. To make sure it is necessary to have done with a careless "looking into it" and to undertake precise observations, many times repeated...[it] is necessary to make measurements and accountings, to substitute realistic thinking (an honest dealing with facts as they are) for wishful or fanciful thinking (a self-deceiving day-dreaming) and to carry on a systematic "checking up"...science is nothing more nor less than getting at facts, and trying to understand them...

Societal Variables  
*The Journal of Social Forces*, Volume I, Number 4, May, 1923 (p. 345)

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

Her taste exact  
For faultless fact  
Amounts to a disease.

*The Complete Plays of Gilbert and Sullivan*  
*The Mikado*  
Act II (p. 334)  
W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Gilman, Charlotte Perkins** 1860–1935

American writer and feminist

The acts and facts of today continually diverge from the concepts of yesterday.

*Human Work*  
Concept and Conduct (p. 41)  
McClure, Philips & Company. New York, New York, USA. 1904

**Gold, Thomas** 1920–2004

Austrian astrophysicist



If many years go by in a field in which no significant new facts come to light, the field sharpens up the opinions and gives the appearance that the problem is solved.

New Ideas in Science

*Journal of Scientific Exploration*, Volume 3, Number 2, 1989 (p. 107)

### Gooday, Graeme

No biographical data available

We have tables properly arranged in regard to light, microscopes and dissecting instruments, and we work through the structure of a certain number of animals and plants...the student has before him, first, a picture of the structure he ought to see; secondly the structure itself worked out, and if with these aids, and such needful explanations and practical hints as a demonstrator can supply, he cannot make out the facts for himself in the material supplied to him, he had better take to some other pursuit than that of biological science.

Nature in the Laboratory

*British Journal For the History of Science*, Volume 24, 1991 (pp. 339–340)

### Gore, George 1826–1909

No biographical data available

Facts are crude knowledge and constitute the raw materials of science.

*The Art of Scientific Discovery*

Chapter VII (p. 83)

Longmans, Green & Company. London, England. 1878

Every fact and every discovery casts a light beyond itself, and the extent to which this light is perceived depends upon the man.

*The Art of Scientific Discovery*

Chapter XXX (p. 294)

Longmans, Green & Co. London, England. 1878

### Gould, Stephen Jay 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Facts do not “speak for themselves”; they are read in the light of theory. Creative thought, in science as much as in the arts, is the motor of changing opinion. Science is a quintessentially human activity, not a mechanized, robot-like accumulation of objective information, leading by laws of logic to inescapable interpretation.

*Ever Since Darwin: Reflections in Natural History*

Chapter 20 The Validation of Continental Drift (pp. 161–162)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

Darwin has been vindicated by a rich Precambrian record, all discovered in the past thirty years. Yet the peculiar character of this evidence has not matched Darwin’s prediction of a continuous rise in complexity toward Cambrian life, and the problem of the Cambrian explosion has remained as stubborn as ever – if not more so, since our confusion now rests on knowledge, rather than ignorance about the nature of Precambrian life.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter II (p. 57)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

Theoretical arguments may be dazzling, but give me a good old fact any time.

*Leonardo’s Mountain of Clams and the Diet of Worms*

Part III, Chapter 8 (p. 176)

Harmon Brown. New York, New York, USA. 1998

Gradualism, the idea that all change must be smooth, slow, and steady, was never read from the rocks. It was primarily a prejudice of nineteenth-century liberalism facing a world in revolution. But it continues to color our supposedly objective reading of life’s history.

This View of Life, an Early Start

*Natural History*, Volume 87, Number 2, February, 1978 (p. 24)

Facts cannot be divorced from cultural contexts.

What Color Is a Zebra?

*Natural History*, Volume 90, Number 8, August 1981 (p. 16)

Moreover, “fact” doesn’t mean “absolute certainty”; there ain’t no such animal in an exciting and complex world. The final proofs of logic and mathematics flow deductively from stated premises and achieve certainty only because they are NOT about the empirical world. Evolutionists make no claim for perpetual truth, though creationists often do (and then attack us falsely for a style of argument that they themselves favor).

Evolution as Fact and Theory

*Discover*, May, 1981

In science “fact” can only mean “confirmed to such a degree that it would be perverse to withhold provisional consent.” I suppose that apples might start to rise tomorrow, but the possibility does not merit equal time in physics classrooms.

Evolution as Fact and Theory

*Discover*, May, 1981

### Greenstein, Jesse L. 1909–2002

American astronomer

Knowing how hard it is to collect a fact, you understand why most people want to have some fun analyzing it.

Great American Scientists: The Astronomer

*Fortune*, Volume 61, Number 5, May, 1960 (p. 149)

### Gregg, Alan 1890–1957

American medical educator and philosopher

A statistical resume of 1000 opinions about gravity before Newton’s time would not have given us the law. You cannot always arrive at facts through other folks’ opinions or observations.

In Wilder Penfield

*The Difficult Art of Giving: The Epic of Alan Gregg*

Chapter 8 (p. 124)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

### Gregory, Sir Richard Arman 1864–1952

British science writer and journalist



Facts which appear to be opposed to prevailing belief or theory are often reached in science, but if they stand unaltered after being subjected to rigorous and critical examination they must be adhered to and the belief or theory abandoned.

*Discovery, Or, The Spirit and Service of Science*  
Chapter I (p. 12)  
Macmillan & Co Ltd. London, England. 1918

Facts which seem trivial in themselves may be rich in suggestion to the thoughtful mind.

*Discovery; or, The Spirit and Service of Science*  
Chapter IX (p. 244)  
Macmillan & Company Ltd. London, England. 1918

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

...you must constantly be returning from the unfamiliar facts of science to the familiar facts of everyday experience.... I think that popular science can be of real value by emphasizing the unity of human knowledge and endeavor, at their best. This fact is hardly stressed at all in the ordinary teaching of science, and good popular science should correct this fault, both by showing how science is created by technology and creates it, and by showing the relation between scientific and other forms of thought.

In J. Maynard Smith (ed.)  
*On Being the Right Size and Other Essays*  
How To Write a Popular Scientific Article (pp. 155, 158)  
Oxford University Press, Inc. Oxford, England. 1985

**Hanson, Norwood Russell** 1924–67  
American philosopher of science

Facts are simply the things that happen; hard, sheer, plain and unvarnished.

*Patterns of Discovery*  
Chapter II (p. 31)  
At The University Press. Cambridge, England. 1958

**Hardy, A. S.**  
No biographical data available

Isolated facts are meaningless. The preoccupation of the scientific observer is their correlation. His note-books are full of facts waiting coordination. To see is not enough, to explain is everything. The discovery of a germ is important, but vastly more so is its unknown relation to that other fact, the diseased organism.

Letters and Life II  
*The Andover Review*, Volume XIII, June, 1890 (p. 664)

**Hare, Hobart Amory**  
American sportsman

At first it is impossible for the novice to cast aside the minor symptoms, which the patient emphasizes as his major ones, and to perceive clearly that one or two facts that have been belittled in the narration of the story of the illness are in reality the stalk about which everything in the case must be made to cluster.

*Practical Diagnosis*  
Introduction (p. 17)  
Lea Brothers & Company. Philadelphia, Pennsylvania, USA. 1902

**Harrison, Harry** 1925–  
American science fiction writer

There was an explanation for everything, once you had your facts straight.

*Deathworld* (p. 88)  
Little Brown Book Group Ltd. London, England. 1991

Just because you know a thing is true in theory doesn't make it true in fact.

*Deathworld* (p. 153)  
Berkeley Books. New York, New York, USA. 1960

**Hawkins, Michael**  
English astronomer

Facts are like stuffed animals in a glass case, only remotely suggesting the wild uncertain environment in which they had their being and which was an inextricable part of their nature.

*Hunting Down the Universe: The Missing Mass, Primordial Black Holes, and Other Dark Matters*  
Chapter 2 (pp. 25–26)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Hawley, Gessner G.**  
No biographical data available

To SIMPLIFY and personalize scientific facts and ideas without distorting them to some extent is practically impossible. Whoever is rash enough to attempt to do so at once finds himself daintily impaled on one or the other horn of a (dilemma: whether to strain the facts into all sorts of dubious analogies in an effort to make his presentation interesting, thereby incurring the righteous wrath of top-notch scientists; or to hew rigidly to the line of technical accuracy on all points, at the risk of being unintelligible to those who turn to his work for information). The one easy way to resolve this state of affairs is to be a minor genius, with a profound knowledge of science coupled with a flair for imparting its concepts correctly and clearly without being other than entertaining in the process. Short of this, the only solution is to decide which is more important – to secure the unqualified approval of experts, or to reward the intelligent curiosity of laymen with at least some measure of comprehensible explanation.

*Seeing the Invisible: The Story of the Electron Microscope*  
Preface (p. ix)  
Alfred A. Knopf. New York, New York, USA. 1945

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

Facts are of not much use, considered as facts. They bewilder by their number and their apparent incoherency.

*Electromagnetic Theory* (Volume 1)  
Chapter I (p. 12)  
D. van Nostrand Co. New York, New York, USA. 1893

**Heinlein, Robert A.** 1907–88  
American science fiction writer

What are the facts? Again and again and again – what are the facts? Shun wishful thinking, ignore divine revelation, forget what ‘the stars foretell,’ avoid opinion, care not what the neighbors think, never mind the unguessable ‘verdict of history,’ – what are the facts, and to how many decimal places? You pilot always into an unknown future; facts are your only clue. Get the facts!

*Time Enough for Love*

Intermission (p. 264)

G.P. Putnam’s Sons. New York, New York, USA. 1973

When an apparent fact runs contrary to logic and common sense, it’s obvious that you have failed to interpret the fact correctly.

*Orphans of the Sky*

Part II (p. 116)

The New American Library. New York, New York, USA. 1965

A fact has no “why.” There it stands, self demonstrating.

*The Menace from Earth*

The Year of the Jackpot (p. 22)

Dennis Dobson. London, England. 1959

A fact doesn’t have to be understood to be true. Sure, any reasonable mind wants explanations, but it’s silly to reject facts that don’t fit your philosophy.

*Assignment in Eternity* (Volume 1)

Elsewhen (p. 111)

Fantasy Press. Reading, Pennsylvania, USA. 1953

### **Hercule Peroit (Fictional character)**

Facts. Those are the cobbles that make up the road along which we travel.

### **Heyworth, Sir Geoffrey**

No biographical data available

The more facts one has, the better the judgment one can make, but one must never forget the corollary that the more facts one has, the easier it is to put them together wrong.

Inaugural Address

Royal Statistical Society, 1949

### **Hickok, Laurens Perseus** 1798–1888

No biographical data available

Facts are things made – *res gestae, facta*. They have the nature that is given to them by their Maker; and in knowing only the fact, there is no capability for knowing why their nature is thus and not otherwise. The Maker has so constituted the fact, but in our ignorance of what determined Him in the making, we can only find in experience that the fact is, and can by no means say why it is.

*Rational Cosmology: Or, The Eternal Principles and the Necessary*

*Laws of the Universe*

Introduction (p. 13)

D. Appleton & Co. New York, New York, USA. 1858

### **Hobbes, Thomas** 1588–1679

English philosopher and political theorist

...science is the knowledge of consequences, and dependence of one fact upon another...

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 5 (p. 60)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hodnett, Edward** 1901–84

Illustration historian

Much of the difficulty of problem solving comes from the impossibility of getting all the facts together before making a decision.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 43)

Harper & Brothers. New York, New York, USA. 1955

Ignorance of the significance of facts renders us as blind to the solution of a problem as if we were matching colors in the dark.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 43)

Harper & Brothers. New York, New York, USA. 1955

A fact not recognized for what it signifies has no more value than a precious stone in a savage’s collection of shells and pebbles.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 43)

Harper & Brothers. New York, New York, USA. 1955

The necessity for getting facts straight leads the professional problem solver to take what seems to the layman fantastic pains in checking even small details.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 48)

Harper & Brothers. New York, New York, USA. 1955

What you call a fact may with good reason not seem a fact to the other fellow.

*The Art of Problem Solving*

Part I, Chapter 7 (p. 50)

Harper & Brothers. New York, New York, USA. 1955

### **Hoffer, Eric** 1902–83

American longshoreman and philosopher

The war on the present is usually a war on fact. Facts are the toys of men who live and die at leisure. They who are engrossed in the rapid realization of an extravagant hope tend to view facts as something base and unclean. Facts are counterrevolutionary.

*The Passionate State of Mind, and Other Aphorisms*

No. 73

Harper & Brothers. New York, New York, USA. 1955

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

All generous minds have a horror of what are commonly called “facts.” They are the brute beasts of the intellectual domain.

*The Autocrat of the Breakfast-Table*

Chapter I (p. 5)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Scientific knowledge, even in the most modest persons, has mingled with it a something which partakes of insolence. Absolute, peremptory facts are bullies.

*The Autocrat of the Breakfast-Table*

Chapter III (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Facts always yield the place of honor in conversation, to thoughts about facts; but if a false note is uttered, down comes the finger on the key and the man of facts asserts his true dignity.

*The Autocrat of the Breakfast-Table*

Chapter VI (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

A Pseudo-science does not necessarily consist wholly of lies.... When we have one fact found us, we are very apt to supply the next out of our own imagination.

*The Professor at the Breakfast Table*

Chapter VIII (p. 249)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Hooker, Worthington** 1806–67

American physician

The physician who narrows his view down to a certain set of facts is in danger of becoming enamored of them. And if he does, he is straightway in the fog and mists of error. He forsakes the practical for a fruitless will o’ the wisp pursuit of the ideal, all the while believing that he has found vast mines of truth, and very confident that his search is to be still more abundantly rewarded.

*Lessons from the History of Medical Delusions* (p. 35)

Baker & Scribner. New York, New York, USA. 1850

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

To look facts in the face is the duty of every sensible person.

*The Man Who Laughs* (II.4.iv)

G. Routledge & Sons. London, England. 1889

Every fact is a logarithm; one added term ramifies it until it is thoroughly transformed. In the general aspect of things, the great lines of creation take shape and arrange themselves into groups; beneath lies the unfathomable.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 405)

The Heritage Press. New York, New York, USA. 1961

**Husserl, Edmund** 1859–1938

German philosopher

Merely fact-minded sciences make merely fact-minded people.

Translated by David Carr

*The Crisis of European Sciences and Transcendental Phenomenology: An Introduction to Phenomenological Philosophy*

Part I, Section 1 (p. 6)

Northwestern University Press. Evanston, Illinois, USA. 1970

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Matter of fact is that upon which science proceeds, by generalization, to form theory, for the purpose of philosophy, or the knowledge of all natural causes; and it is by the companion of these matters of fact with any theory, that such a theory will be tried. But, in judging of matter of fact, let us be cautious of deceiving ourselves, by substituting speculative reasoning in place of actual events.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter III (p. 301)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Aldous** 1894–1963

English writer and critic

Facts do not cease to exist because they are ignored.

*Proper Studies*

A Note on Dogma (p. 205)

Chatto & Windus. London, England. 1957

Facts are ventriloquists’ dummies. Sitting on a wise man’s knee they may be made to utter words of wisdom; elsewhere they say nothing or talk nonsense...

*Time Must Have a Stop*

Chapter XXX (p. 301)

The Sun Dial Press. Garden City, New York, USA. 1944

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

To speculate without facts is to attempt to enter a house of which one has not the key, by wandering aimlessly round and round, searching the walls and now and then peeping through the windows. Facts are the key.

*Essays in Popular Science*

Heredity, the Behavior of the Chromosomes (pp. 1–2)

Chatto & Windus. London, England. 1926

...facts are too bulky to be lugged about conveniently except on the wheels of theory.

*Essays of a Biologist*

Progress, Biological and Other (p. 32)

Alfred P. Knopf. New York, New York, USA. 1929

**Huxley, Thomas Henry** 1825–95

English biologist

Sit down before fact as a little child... follow humbly and to whatever abysses Nature leads, or you shall learn nothing.

In Leonard Huxley (ed.)  
*Life and Letters of Thomas Henry Huxley* (Volume 1)  
 Huxley to Kingsley, September 23, 1860 (p. 235)  
 D. Appleton & Company. New York, New York, USA. 1901

The great danger which besets all men of large speculative faculty, is the temptation to deal with the accepted statements of facts in natural science, as if they were not only correct, but exhaustive; as if they might be dealt with deductively, in the same was a proposition in Euclid may be dealt with.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 The Monograph of the Cirripedia (pp. 315–316)  
 D. Appleton & Company. New York, New York, USA. 1896

Spencer's idea of a tragedy is a deduction killed by a fact.

In William Irvine  
*Apes, Angels, and Victorians*  
 Chapter III (p. 30)  
 McGraw-Hill Book Company, Inc., New York, New York, USA, 1955

God give me the strength to face a fact though it slay me.

In George Seldes  
*The Great Quotations* (p. 344)  
 Citadel Press. Secaucus, New Jersey, USA. 1996

Men of science do not pledge themselves to creeds; they are bound by articles of no sort; there is not a single belief that it is not a bounden duty with them to hold with a light hand and to part with cheerfully, the moment it is really proved to be contrary to any fact, great or small.

*Collected Essays* (Volume 2)  
*Darwiniana*  
 On Our Knowledge of the Causes of the Phenomena of Organic Nature,  
 Lecture VI (pp. 468–469)  
 Macmillan & Company Ltd. London, England. 1904

If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere; but if you are absolutely and thoroughly and persistently wrong, you must, some of these days, have the extreme good fortune of knocking your head against a fact, and that sets you straight again.

*Science and Education*  
 On Science and Art in Relation to Education (p. 100)  
 Kessinger Publishing. Whitefish, Montana, USA. 2004

...those who refuse to go beyond fact rarely get as far as fact...

*Collected Essays* (Volume 1)  
*Method and Result*  
 The Progress of Science (p. 26)  
 Macmillan & Company Ltd. London, England. 1904

...he had one eye upon fact, and the other on Genesis.

*Collected Essays* (Volume 1)  
*Method and Result*  
 The Progress of Science (p. 127)  
 Macmillan & Company Ltd. London, England. 1904

### Ichheiser, Gustav

No biographical data available

Nothing evades our attention so persistently as that which is taken for granted... Obvious facts tend to remain *invisible*.

*Misunderstandings in Human Relations*  
 Chapter I (p. 1)  
 University of Chicago Press. Chicago, Illinois, USA. 1949

### Jacks, L. P. 1860–1955

English educator, philosopher, and Unitarian minister

Facts are popularly regarded as antidotes to mysteries. And yet, in sober earnest, there is nothing so mysterious as a fact.

Is There a Foolproof Science?  
*The Atlantic Monthly*, Volume 133, Number 2, February, 1924 (p. 229)

### James, Henry

American-born British author and literary critic

The fatal futility of Fact.

*The Spoils of Poynton*  
 Preface  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

### James, William 1842–1910

American philosopher and psychologist

"Facts" are the bounds of human knowledge, set for it, not by it.

*The Will to Believe and Other Essays in Popular Philosophy and Human Immortality*  
 On Some Hegelisms (p. 202)  
 Dover Publications, Inc. New York, New York, USA. 1956

I have to forge every sentence in the teeth of irreducible and stubborn facts.

Letter to brother Henry James

Facts are there only for those who have a mental affinity with them. When once they are indisputably ascertained and admitted, the academic and critical minds are by far the best fitted ones to interpret and discuss them, – for surely to pass from mystical to scientific speculations is like passing from lunacy to sanity ...

*The Will to Believe and Other Essays in Popular Philosophy*  
 What Psychological Research Has Accomplished (p. 301)  
 Longmans, Green & Co. New York, New York, USA. 1899

The scientific-academic mind and the feminine-mystical mind shy from each other's facts, just as they fly from each other's temper and spirit. Facts are there only for those who have a mental affinity with them.

*The Will to Believe and Other Essays in Popular Philosophy*  
 What Psychological Research Has Accomplished (p. 301)  
 Longmans, Green & Co. New York, New York, USA. 1905

### Jeffreys, Sir Harold 1891–1989

English astronomer and geophysicist

There are some current "theories" that, when divested of begged questions, reduce to the non-controversial statement, "Here are some facts and there may be some relation between them."

*Theory of Probability*

Chapter VIII, Section 8.5 (p. 419)  
Clarendon Press. Oxford, England. 1961

**Jerrold, Douglas William** 1803–57

English playwright, journalist, and humorist

Talk to him of Jacob's ladder, and he would ask the number of the steps.

*Specimens of Douglas Jerrold's Wit*

A Matter-Of-Fact Man  
Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Jevons, William Stanley** 1835–82

English economist and logician

Just as, in the map of a half-explored country, we see detached bits of rivers, isolated mountains, and undefined plains, not connected into any complete plan, so a new branch of knowledge consists of groups of facts, each group standing apart, so as not to allow us to reason from one to another.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXIV (p. 526)  
Macmillan & Co Ltd. London, England. 1887

**Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

Theories there are in plenty, but there is no agreement among the theorists. The position at the moment seems to be that the facts (if facts they be) discovered by the physicists are outrunning the capacity of human schematization to embrace them, while conceptions of the physical universe are following one another with a rapidity which has overtaxed the accommodation provided by philosophers for their reception.

*Philosophical Aspects of Modern Science*

Introduction (p. 10)  
G. Allen & Unwin Ltd. London, England. 1932

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

We should never over-estimate our own accomplishments because it is more than possible that new facts obtained from studies of nature can modify and improve many of our own well-established theories.

*Short Stories of Science and Invention: A Collection of Radio Talks by C.F. Kettering*

Underwater Powerhouse (p. 109)  
General Motors, Detroit, Michigan, USA. 1955

**Keynes, John Maynard** 1883–1946

British economist

When the facts change, I change my mind. What do you do, sir?

*The Economist*, December 18, 1999 (p. 47)

**Kingsley, Charles** 1819–75

English clergyman and author

The fact is novel, and I am more obliged to any one who gives me that, than if he gave me a bank-note. The money gets spent and done with; but I cannot spend the fact: it remains for life as permanent capital, returning interest and compound interest ad infinitum.

*Alton Locke, Taylor and Poet*

Chapter XVII (p. 139)  
Macmillan & Company Ltd. London, England. 1911

**Kipling, Rudyard** 1865–1936

British writer and poet

Just statin' evidential facts beyon' all argument.

*Rudyard Kipling's Verse*

McAndrew's Verse  
Hodder & Stroughton. London, England. 1919

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Artists treat facts as stimuli for the imagination, while scientists use their imagination to coordinate facts.

*Insight and Outlook: An Inquiry into the Common Foundations of Science, Art and Social Ethics*

Preface (p. vii)  
University of Nebraska Press. Lincoln, Nebraska, USA. 1949

**Kough, A.**

No biographical data available

Facts are necessary, of course, but unless fertilized by ideas, correlated with other facts, illuminated by thought, I consider them as only material for science.

*The Progress of Physiology*

*Science*, Volume 70, Number 1809, August 30, 1929 (p. 203)

**Kratovil, Robert** 1920–

Attorney

An impartial and reliable research substitutes facts for hunches.

*Real Estate Law* (4th edition) (p. 419)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1952

**Kuhn, Thomas S.** 1922–96

American historian of science

Scientific fact and theory are not categorically separable, except perhaps within a single tradition of normal-scientific practice. That is why the unexpected discovery is not simply factual in its import and why the scientist's world is qualitatively transformed as well as quantitatively enriched by fundamental novelties of either fact or theory.

*The Structure of Scientific Revolutions*

Chapter I (p. 7)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

**Langer, Susanne Katherina Knauth** 1895–1985

American philosopher

Our world "divides into facts" because we so divide it.



*Philosophy in a New Key*  
Chapter X (p. 273)  
Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

Had man restricted himself to a mere compilation of facts, the sciences would present nothing but a barren nomenclature, and a knowledge of the great laws of nature would never have been attained.

*System of the World* (Volume 1)  
Book I, Chapter XI (p. 72)  
Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

**Le Sage, Alan Rene**  
No biographical data available

Facts are stubborn things.

Translated by T. Smollett  
*The Adventure of Gil Blas of Santillana*  
Second Book, Chapter VIII, Section 2 (p. 46)  
Cunningham. London, England. 1826

**Latham, Peter Mere** 1789–1875  
English physician

People in general have no notion of the sort and amount of evidence often needed to prove the simplest fact.  
*The Collected Works of Dr. P.M. Latham* (Volume 2) (p. 525)  
The New Sydenham Society. London, England. 1876078

Bear in mind then, that abstractions are not facts; and next bear in mind that opinions are not facts.

In William B. Bean  
*Aphorisms from Latham* (p. 36)  
Prairie Press. Iowa City, Iowa, USA. 1962

...as long as you live, you will be evermore conversant with facts; learning and collecting them, arranging and combining and separating them, tracing their relations, and through them arriving at general principles.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture V (p. 114)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

Bear in mind...that abstractions are not facts; and next bear in mind that opinions are not facts.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture V (p. 116)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

All facts are not of equal value: some are trivial and accidental, some important and essential to the subject.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture V (p. 118)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

A premature desire to generalize, an eagerness to arrive at conclusions, and a readiness to rest in them, are very common infirmities, and they offer very serious hindrances to the right acquisition of facts.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture V (p. 121)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

The more you exercise yourselves in the observation of medical facts, the more you will understand the sources of error to be avoided in the reception of them. Time and diligence, and constant intercourse with the sick, if you have but an impartial and honest mind, will enable you to lay up a large and useful store of genuine facts, and to draw from it as the treasury of your future knowledge.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture V (p. 129)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Latour, Bruno** 1947–  
French sociologist of science

...a fact is what is collectively stabilised from the midst of controversies when the activity of later papers does not consist only of criticism or deformation but also of confirmation.

*Science in Action: How to Follow Scientists and Engineers Through Society*  
Literature (p. 42)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

**Laut, Agnes C.** 1871–1936  
Canadian journalist

The ultimate umpire of all things in Life is – Fact.  
*The Conquest of the Great Northwest*  
Part III, Chapter XX (p. 391)  
The Outing Publishing Company. New York, New York, USA. 1908

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

We must trust to nothing but facts: These are presented to us by Nature, and cannot deceive.

*Elements of Chemistry in a New Systematic Order*  
Preface of the Author (p. xviii)  
Printed for William Creech. Edinburgh, Scotland. 1790

**Lukasiewicz, J.**  
No biographical data available

Facts whose effects have disappeared altogether, and which even an omniscient mind could not infer from those now occurring, belong to the realm of possibility. One cannot say about them that they took place, but only that they were possible.

In L. Borkowski (ed.)  
*Selected Works*  
On Determinism (p. 128)  
North-Holland Publishing Company. Amsterdam, Netherlands. 1970

**MacDonald, George** 1824–1905  
Scottish novelist and poet



Facts are certainly stubborn things, as people say. But it is equally certain that they are the most slippery things to get a hold of. And even when you have got a hold of them, they can be used with such different designs – after such varying fashions, that no more unlike buildings can be constructed of the same bricks or hewn stones, than conclusions arrived at from precisely the same facts. And this because all the facts round about the known facts, and which keep those facts in their places, compelling them to combine after a certain fashion, are not known, or perhaps are all unknown.

*Guild Court*

Chapter LVI (p. 317)

Sampson Low, Marston, Searle & Rivington. London, England. 1881

Facts are like faces – capable of a thousand expressions and meanings.

*Guild Court*

Chapter LVI (p. 317)

Sampson Low, Marston, Searle & Rivington. London, England. 1881

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

One can never lose one's footing, or come into collision with facts, if one always keeps in view the path by which one has come.

Translated by Philip E.B. Jourdain

*History and Root of the Principle of Conservation of the Energy* (p. 17)

The Open Court Publishing Co. Chicago, Illinois, USA. 1911

The ultimate unintelligibilities on which science is founded must be facts, or, if they are hypotheses, must be capable of becoming facts. If the hypotheses are so chosen that their subject ... can never appeal to the senses and therefore also can never be tested, as is the case with the mechanical molecular theory, the investigator has done more than science, whose aim is facts, requires of him – and this work of supererogation is an evil.

Translated by Philip E.B. Jourdain

*History and Root of the Principle of the Conservation of Energy*

Chapter III (p. 57)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

As long as the pursuit of the facts of a given province of phenomena is in the hands of a few isolated investigators, as long as every experiment can be easily repeated, the fixing of the collected facts by provisional description is ordinarily sufficient. But the case is different when the whole world must make use of the results reached by many, as happens when the science acquires broader foundations and scope, and so particularly so when it begins to supply intellectual nourishment to an important branch of the practical arts, and to draw from that province in return stupendous empirical results.

*Popular Scientific Lectures*

On the Fundamental. Concepts of Electrostatics (pp. 107–108)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Maier, N. R. F.**

American psychologist

The method of how psychologists as scientists dispose of facts is of special interest. One of the most common is to give the facts a new name. In this way they are given a special compartment and therefore cease to infringe on the privacy of the theory.

Maier's Law

*The American Psychologist*, March, 1960 (p. 208)

If the facts do not conform to the theory, they must be disposed of.

Maier's Law

*The American Psychologist*, March, 1960 (p. 208)

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

My facts shall be as accurate as though they appeared in a practical manual or scientific monograph, but I shall relate them in a somewhat livelier fashion than such works would allow, shall group them more harmoniously together, and blend them with freer and more mature reflections.

Translated by Alfred Sutro

*The Life of the Bee*

Chapter I (p. 5)

Dodd, Mead & Co. New York, New York, USA. 1929

**Margenau, Henry** 1901–97

American physicist

A forest of facts unordered by concepts and constructive relations may be cherished for its existential appeal, its vividness, or its nausea; yet it is meaningless and cognitively unavailing unless it be organized by reason.

*Open Vistas Philosophical Perspectives of Modern Science*

Chapter 2 (pp. 28–29)

Yale University Press. New Haven, Connecticut, USA. 1961

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

A fact is a fact; an idea is merely an idea. Facts and ideas move on prescribed planes from which they cannot escape.

*Prefaces*

Preface to a Book of Statistics (p. 183)

D. Appleton & Co. New York, New York, USA. 1919

**Marshall, Alfred** 1842–1924

English economist

...facts by themselves are silent. Observation discovers nothing directly of the actions of causes, but only of sequences in time.

In A.C. Pigou (ed.)

*Memorials of Alfred Marshall*

Chapter VI (p. 166)

Macmillan & Company Ltd. London, England. 1925

**Marshall, Arthur Milnes** 1852–93  
English zoologist

Scientific facts accumulate rapidly, and give rise to theories with almost equal rapidity. These theories are often wonderfully enticing, and one is apt to pass from one to another, from theory to theory, without taking care to establish each before passing on to the next, without assuring oneself that the foundation on which one is building is secure. Then comes the crash; the last theory breaks down utterly, and on attempting to retrace our steps to firm ground and start anew, we may find too late that one of the cards, possibly at the very foundation of the pagoda, is either faultily placed or in itself defective, and that this blemish easily remedied if detected in time has, neglected, caused the collapse of the whole structure on whose erection so much skill and perseverance have been spent.

*Biological Lectures and Addresses, Delivered by the Late Arthur Milnes Marshall*

Chapter I (pp. 1–2)

Nutt. London, England. 1894

**Maurycy, Matthew Fontaine** 1806–73  
American hydrographer and naval officer

Physical facts are the language of Nature, and every expression uttered by her is worthy of our most attentive consideration.

*The Physical Geography of the Sea*

Chapter IX (p. 180)

Harper & Brothers. New York, New York, USA. 1855

**Mayo, William J.** 1861–1939  
American physician

The man of science in searching for the truth must ever be guided by the cold logic of facts, and be animated by scientific imagination.

Perception

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 20, 1928

**McArthur, Peter** 1866–1924  
Canadian poet

The golden rule of science is: Make sure of your facts and then lie strenuously about your modesty.

*To Be Taken with Salt: An Essay on Teaching One's Grandmother to Suck Eggs* (p. 150)

Limpus, Bacon London, England. 1903

**McCarthy, Mary** 1912–89  
American writer

...in science, all facts, no matter how trivial or banal, enjoy democratic equality.

*On the Contrary*

The Fact in Fiction (p. 266)

Farrar, Straus & Cudahy. New York, New York, USA, 1961

**Mellor, Joseph William** 1863–1938  
Chemist

Theories perish, facts remain.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

Chapter I (p. 72)

Longman, Green & Co. London, England. 1922

Without facts, science can do nothing ...

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 6)

Longman, Green & Co. London, England. 1922

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and social critic

The common view of science is that it is a sort of machine for increasing the race's store of dependable facts. It is that only in part; in even larger part it is a machine for upsetting undependable facts.

In Will Durant

*Living Philosophies*

Chapter XII (p. 187)

Simon & Schuster. New York, New York, USA. 1931

Science, at bottom, is really anti-intellectual. It always distrusts pure reason, and demands the production of objective fact.

*Minority Report: H.L. Mencken's Notebooks*

No. 412 (p. 277)

Alfred A. Knopf. New York, New York, USA. 1956

**Mendeleev, Dmitry Ivanovich** 1834–1907  
Russian chemist

If statements of fact themselves depend upon the person who observes them, how much more distinct is the reflection of the personality of him who gives an account of methods and of philosophical speculations which form the essence of science!

Translated by George Kamensky

In Thomas Atkinson Lawson

*The Principles of Chemistry* (Volume I)

Author's Preface (p. vii)

Longmans, Green & Co. London, England. 1891

**Miall, L. C.**  
English entomologist

Natural history is encumbered by multitudes of facts which are recorded only because they are easy to record.

In Marston Bates

*The Natural History of Mosquitoes*

Introduction (p. 1)

The Macmillan Company. New York, New York, USA. 1949

**Millay, Edna St. Vincent** 1892–1950  
American poet

Upon this gifted age, in its dark hour,

Rains from the sky a meteoric shower  
Of facts...they lie unquestioned, uncombined,  
Wisdom enough to leach us of our ill  
Is daily spun; but there exists no loom  
To weave it into fabric ...

*Collected Sonnets*

Three Sonnets in Tetrameter, Sonnet III (p. 697)  
Harper & Row, Publishers. New York, New York, USA. 1950

**Moulton, Forest Ray** 1872–1952

American astronomer

How greatly fact often transcends fancy!

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 23)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

It may be so, there is no arguing against facts and experiments.

In David Brewster

*Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*  
(Volume 2)

Chapter XXVII (p. 407)

Hamilton, Adams & Company. London, England. 1855

**Nightingale, Florence** 1820–1910

British nursing pioneer and statistician

What you want are facts, not opinions –

*Notes on Nursing: What It Is and What It Is Not*

Chapter XIII (p. 59)

Harrison. London, England. 1859

**Obruchev, Vladimir** 1863–1956

Russian geologist and geographer

Facts are the bricks of human experience, your implement in creation. Search for facts tirelessly, collect them in nature and in books, and read good textbooks from cover to cover.

Translated by Vic Schneiereson

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Progress Publishers. Moscow, Russia. 1979

**O'Malley, Austin** 1858–1932

American physician and humorist

Facts are carpet-tacks under the pneumatic tires of theory.

*Keystones of Thought*

The Devin Adair Company. New York, New York, USA. 1918

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

...when technical people talk they always emphasize the facts [of which] they are not sure.

The Tree of Knowledge

*Harper's Magazine*, Volume 217, October, 1958 (p. 57)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Fed on the dry husks of facts, the human heart has a hidden want which science cannot supply...

*Science and Immortality*

The Teresians (p. 41)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1905

**Ozick, Cynthia** 1928–

American novelist and short story writer

I'm not afraid of facts. I welcome facts – but a congeries of facts is not equivalent to an idea. This is the essential fallacy of the so-called “scientific” mind. People who mistake facts for ideas are incomplete thinkers; they are gossips.

Quoted in Francis Klagsbrun

*The First Ms. Reader*

We are the Crazy Lady and Other Feisty Feminist Fables (p. 67)

Warner Paperback Library. New York, New York, USA. 1973

**Pallister, William Hales** 1877–1946

Canadian physician

Facts are hard, stubborn things; so relative, so rare.

They limit all we know. Let us, my friend, beware!

*Poems of Science*

De Ipsa Natura, The Law of Logic (p. 235)

Playford Press. New York, New York, USA. 1931

**Pancoast, Seth**

No biographical data available

Facts are ascertained, demonstrated, taught, learned and forgotten; Theories, vague and uncertain even in the minds of their weavers, are accepted for Science! then, lo! the old-forgotten Facts spring again to view and the Theories flee to be forgotten in their turn, only with this difference that there is no resurrection for them!

*The Kabbala: Or, The True Science of Light*

Introduction (p. 10)

Publisher undetermined

1883

**Parsons, Talcott** 1902–79

American sociologist

...a fact is not itself a phenomenon at all, but a proposition about one or more phenomena.

*The Structure of Social Action*

Part I, Chapter I (p. 41)

The Free Press. Glencoe, Illinois, USA. 1949

**Pasteur, Louis** 1822–95

French chemist

When I am in my laboratory...I begin by shutting the door on materialism and on spiritualism; I observe facts alone; I seek but the scientific conditions under which life manifests itself.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 11)  
Macmillan & Company Ltd. London, England. 1918

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

Facts are the air of a scientist. Without them you never can fly. Without them your “theories” are vain efforts.  
Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Do not become the archivist of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.  
Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Learn, compare, collect facts!  
Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

But learning, experimenting, observing, try not to stay on the surface of the facts. Do not become the archivist of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.  
Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Perfect as is the wing of a bird, it never could raise the bird up without resting on air. Facts are the air of scientists. Without them you never can fly. Without them your *theories* are vain efforts.  
Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

The physiologist who succeeds in penetrating deeper and deeper into the digestive canal becomes convinced that it consists of a number of chemical laboratories equipped with various mechanical devices.  
*Nobel Lectures, Physiology or Medicine 1901–1921*  
Physiology of Digestion  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

...the chief function which it [the digestive tract] has to perform in the living organism, maybe compared to a chemical factory, where the raw materials the food-stuffs are submitted to an essentially chemical process. In this factory the foods are brought into a condition in which they are capable of being absorbed into the body fluids and made use of for the maintenance of the processes of life. The factory consists of a series of compartments, in each of which the food, according to its properties, is either retained for a time or at once sent on to the next; and each single compartment is provided with suitable reagents. These reagents are either prepared in adjoining little workshops, burrowed into the walls of the laboratory itself, or else in distant and separate organs, connected, as in other large chemical factories, with the main workshop by a system of transmitting tubes. These latter

are the so-called secreting glands with their excretory ducts. Each of the workshops furnishes a special fluid, its own particular product, endowed with definite chemical properties which enable it to act on certain /portions of the food, this latter being ordinarily formed of a complex mixture of different ingredients.  
Translated by William Henry Thompson  
*The Work of the Digestive Glands*  
Lecture I (p. 2)  
Charles Griffin & Co., Ltd. London, England. 1902

**Pearson, Karl** 1857–1936  
English mathematician

The classification of facts, the recognition of their sequence and relative significance is the function of science, and the habit of forming a judgment upon these facts unbiased by personal feeling is characteristic of what may be termed the scientific frame of mind.  
*The Grammar of Science*  
Introductory, Section 2 (p. 8)  
Charles Scribner’s Sons. London, England. 1892

...facts may belong to the past history of mankind, to the social statistics of our great cities, to the atmosphere of the most distant stars, to the digestive organs of a worm, or to the life of a scarcely visible bacillus. It is not the facts themselves which form science, but the method in which they are dealt with.  
*The Grammar of Science* (2nd edition)  
Chapter I (p. 12)  
Adam & Charles Black. London, England. 1900

The smallest group of facts, if properly classified and logically dealt with, will form a stone which has its proper place in the great building of knowledge, wholly independent of the individual workman who has shaped it.  
*The Grammar of Science*  
Introductory, Section 5 (p. 16)  
Charles Scribner’s Sons. London, England. 1892

**Peers, John**  
No biographical data available

Gross’s Postulate. Facts are not all equal. There are good facts and bad facts. Science consists of using good facts.  
*1001 Logical Laws, Accurate Axioms, Profound Principles, Trusty Truisms, Homey Homilies, Colorful Corollaries, Quotable Quotes, and Rambunctious Ruminations for All Walks of Life* (p. 35)  
Doubleday & Company, Inc. Garden City, New York, USA. 1979

**Peirce, Benjamin** 1809–80  
American mathematician

What is this which we call fact? It is not a sound; it is not a star. It is sound heard by the ear; it is a star seen by the eye.  
*Ideality in the Physical Sciences*  
Lecture I (p. 12)  
Little, Brown & Co. Boston, Massachusetts, USA. 1881

**Pirandello, Luigi** 1867–1936  
Italian author

PRODUCER: Let's get to the point, let's get to the point.  
This is all chat.

FATHER: Right then! But a fact is like a sack – it won't stand up if it's empty. To make it stand up, first you have to put in it all the reasons and feelings that caused it in the first place.

Translated by John Linstrum

*Six Characters in Search of an Author*

Act One (p. 21)

Eyre Methuen. London, England. 1979

**Pisarev, Dmitry**

No biographical data available

For one man to discover a fruitful fact a hundred must burn up their lives in unsuccessful search and sad error.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierston

Progress Publishers. Moscow, Russia. 1979

**Planck, Max** 1858–1947

German physicist

Nothing is more interesting to the true theorist than a fact which directly contradicts a theory generally accepted up to that time, for this is his particular work.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

New Paths of Physical Knowledge (p. 46)

Methuen & Company Ltd. London, England. 1925

The more fruitful a thinker's imagination is, the more careful he should be never to forget that the different facts invariably form the foundation without which science cannot exist; and the more carefully must he ask himself whether he is treating them with due respect.

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter IV (p. 125)

W.W. Norton & Co. New York, New York, USA. 1936

**Plautus** ca. 254 BCE–184 BCE

Roman playwright

*Res ipsa testit.*

Facts speak for themselves.

*Aulularia*

I, 421

B.G. Trubner. Stuttgart, Germany. 1983

**Playfair, Lyon** 1818–98

Scottish scientist and Parliamentarian

...the accumulation of facts is indispensable to the growth of science, a thousand facts are of less value to human progress than is a single one when it is scientifically comprehended, for it then becomes generalised in all similar cases.

Inaugural Address

*Nature*, Volume 32, September 10, 1885 (p. 443)

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

It is because simplicity and vastness are both beautiful that we seek by preference simple facts and vast facts; that we take delight, now in following the giant courses of stars, now in scrutinizing with a microscope that prodigious smallness which is also a vastness, and now in seeking in geological ages the traces of a past that attracts us because of its remoteness.

*Science and Method*

The Selection (p. 23)

Dover Publications. Mineola, New York, USA. 2003

...the most interesting facts are those which may serve many times; these are the facts which have a chance of coming up again. We have been so fortunate as to be born in a world where there are such.

*The Foundations of Science*

*Science and Method*, Book I

Chapter I (p. 363)

The Science Press. New York, New York, USA. 1913

The historian, the physicist, even, must make a choice among facts; the head of the scientist, which is only a corner of the universe, could never contain the universe entire; so that among the innumerable facts nature offers, some will be passed by, others retained.

*The Foundations of Science*

*Science and Method*, Book I

Chapter II (p. 369)

The Science Press. New York, New York, USA. 1913

Well, this is one of the characteristics by which we recognize the facts which yield great results. They are those which allow of these happy innovations of language. The crude fact then is often of no great interest; we may point it out many times without having rendered great services to science. It takes value only when a wiser thinker perceives the relation for which it stands, and symbolizes it by a word.

*The Foundations of Science*

*Science and Method*, Book I

Chapter II (p. 375)

The Science Press. New York, New York, USA. 1913

The facts of greatest outcome are those we think simple; may be they really are so, because they are influenced only by a small number of well-defined circumstances, may be they take on an appearance of simplicity because the various circumstances upon which they depend obey the laws of chance and so come to mutually compensate.

*The Foundations of Science*

*Science and Method*, Book IV

General Conclusion (pp. 544–545)

The Science Press. New York, New York, USA. 1913

There are facts common to several sciences, which seem the common source of streams diverging in all directions and which are comparable to that knoll of Saint Gothard whence spring waters which fertilize four different valleys.



Translated by George Bruce Halsted  
*The Foundations of Science*  
*Science and Method*  
 Book IV, General Conclusions (p. 546)  
 The Science Press. New York, New York, USA. 1921

Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house.

*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
 Chapter IX (p. 127)  
 The Science Press. New York, New York, USA. 1913

A fact is a fact.

*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
 Chapter IX (p. 128)  
 The Science Press. New York, New York, USA. 1913

An isolated fact can be observed by all eyes; by those of the ordinary person as well as of the wise. But it is the true physicist alone who may see the bond which unites several facts among which the relationship is important though obscure.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
 The Future of Mathematics (p. 124)  
 Government Printing Office. Washington, D.C. 1910

Facts are sterile until there are minds capable of choosing between them and discerning those which conceal something and recognizing that which is concealed; minds which under the bare fact see the soul of the fact.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
 The Future of Mathematics (pp. 124–125)  
 Government Printing Office. Washington, D.C. 1910

The importance of a fact is known by its fruits, that is to say, by the amount of thought which it enables us to economize.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
 The Future of Mathematics (p. 125)  
 Government Printing Office. Washington, D.C. 1910

The mere fact is oftentimes without interest; it has been noted many times, but has rendered no service to science; it becomes of value only on that day when some happily advised thinker perceives a relationship which he indicates and symbolizes by a word.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
 The Future of Mathematics (p. 128)  
 Government Printing Office. Washington, D.C. 1910

...scientists believe there is a hierarchy of facts and that among them may be made a judicious choice. They are right, since otherwise there would be no science, yet science exists. One need only open the eyes to see that the conquests of industry which have enriched so many

practical men would never have seen the light, if these practical men alone had existed and if they had not been preceded by unselfish devotees who died poor, who never thought of utility, and yet had a guide far [sic] other than caprice. As Mach says, these devotees have spared their successors the trouble of thinking.

Translated by George Bruce Halsted  
*The Value of Science*  
 Author's Essay Prefatory to the Translation (pp. 4–5)  
 The Science Press. New York, New York, USA. 1907

We can not know all facts and it is necessary to choose those which are worthy of being known.

Translated by George Bruce Halsted  
*The Value of Science*  
 Science and Reality (p. 142)  
 The Science Press. New York, New York, USA. 1907

The scientific fact is only the crude fact translated into a convenient language.

*The Foundations of Science*  
*The Value of Science*, Part III  
 Chapter X (p. 330)  
 The Science Press. New York, New York, USA. 1913

**Poincaré, Lucien** 1862–1920  
 French physicist

The facts which our theories enable us to discover, subsist and are linked together long after these theories have disappeared. Out of the materials of former edifices overthrown, new dwellings are constantly being reconstructed.

*The New Physics and Its Evolution*  
 Chapter I (p. 6)  
 D. Appleton & Co. New York, New York, USA. 1908

**Polanyi, Michael** 1891–1976  
 Hungarian-born English scientist philosopher and social scientist

Just as the eye sees details that are not there if they fit in with the sense of the picture, or overlooks them if they make no sense, so also very little inherent certainty will suffice to secure the highest scientific value to an alleged fact, if only it fits in with a great scientific generalization, while the most stubborn facts will be set aside if there is no place for them in the established framework of science.

*Personal Knowledge*  
 Chapter 6, Section 2 (p. 138)  
 Harper & Row, Publishers. New York, New York, USA. 1962

**Potest, William Louis** 1856–1938  
 American educator

Before the dull eye of the ordinary man facts pass one after another in long procession, but pass without effect, awakening nothing. In the eye of the man of genius, be he poet or man of science, the same facts light up an illumination, in the one of beauty, in the other of truth.

*Science and Culture*  
*The South Atlantic Quarterly*, Volume 2, Number 1, January, 1903 (p. 73)



**Potts, William**

No biographical data available

Facts are like mosquitoes: they don't amount to much, but sometimes they are very annoying.

*More Notes from Underledge*

Chapter III (p. 23)

Dodd, Mead & Co. New York, New York, USA. 1904

**Preston, Thomas** 1860–1900

Irish scientist

Facts are independent of taste and fashion, and are subject to no code of criticism. They are perhaps more useful when they contradict than when they support received doctrines, for our theories at best are only imperfect approximations to the real knowledge of things, and in all physical research doubt is usually an incentive to new labours, and tends continually to the development of truth.

*The Theory of Heat* (2nd edition)

Introduction (p. 8)

Macmillan & Co Ltd. London, England. 1904

**Queneau, Raymond** 1903–76

French poet, novelist, and publisher

I beg to advise you of the following facts of which I happen to be the equally impartial and horrified witness.

*Exercises in Style*

Official Letter (p. 54)

New Direction Publishing Corporation. New York, New York, USA. 1981

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

Without facts we have no science. Facts are to the scientist what words are to the poet. The scientist has a love of facts, even isolated facts, similar to a poet's love of words. But a collection of facts is not a science any more than a dictionary is poetry. Around his facts the scientist weaves a logical pattern or theory which gives the facts meaning, order and significance.

Faith in Science

*Atlantic Monthly*, Volume 187, January, 1951

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

Hypotheses pass, but facts remain. Theories desert us, facts defend us.

*Advice for a Young Investigator*

Chapter 5 (p. 86)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rhodes, Frank H. T.**

No biographical data available

**Stone, Richard O.**

No biographical data available

Science, it is generally asserted, is concerned with facts. But ultimately there is nothing in Nature labeled "fact."

Facts represent human abstractions, and our recognition and understanding of facts are based upon individual perception and experience.

*Language of the Earth*

Chapter 2 (p. 45)

Pergamon Press. New York, New York, USA. 1981

**Ritchie, Arthur David** 1891–1967

Scottish philosopher and science history writer

The facts of the external world stand to our scientific knowledge. Or to our commonsense knowledge there is no difference in principle between them so much in the same relation as a library of books stands to the catalogue.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter V (p. 112)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

With solid facts on hand one may have only one undisputed explanation; with no facts, there can be a dozen argumentative ones.

*Encyclopedia of Thoughts*

Aphorisms 2411

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970

British philosopher, logician, and social reformer

A fact, in science, is not a mere fact, but an instance.

*The Scientific Outlook*

Chapter II (p. 59)

George Allen & Unwin Ltd. London, England. 1931

**Sayers, Dorothy L.** 1893–1957

English novelist and essayist

To suppress a fact is to publish a falsehood.

*Gaudy Night*

Chapter XVII (p. 257)

Victor Gollancz Ltd. London, England. 1949

... a false statement of fact, made deliberately, is the most serious crime a scientist can commit...

*Gaudy Night*

Chapter XVII (p. 259)

Victor Gollancz Ltd. London, England. 1949

Yes, my lord. My old mother...always says...that facts are like cows. If you look them in the face hard enough they generally run away. She is a very courageous woman, my lord.

*Clouds of Witness*

Chapter IV (p. 86)

Harper & Row, Publishers. New York, New York, USA. 1955

"Must have facts," said Lord Peter, "facts. When I was a small boy I always hated facts. Thought of 'em as nasty, hard things, all knobs. Uncompromising."

*Clouds of Witness*

Chapter IV (p. 86)

Harper & Row, Publishers. New York, New York, USA. 1955

**Schneer, Cecil J.** 1923–

American science historian and mineralogist

...science crossed the divide from the tidy, cultivated garden of classical thought to a new thicket of stubborn, irreducible fact.

*Mind and Matter: Man's Changing Concepts of the Material World*  
Chapter 13 (p. 220)  
Grove Press. New York, New York, USA. 1969

**Schuchert, C.**

No biographical data available

Facts are facts and it is from facts that we make our generalizations, from the little to the great, and it is wrong for a stranger to the facts he handles to generalize from them to other generalizations.

In W.A.J.M. Waterschoot van der Gracht, et. al.(eds.)  
*Theory of Continental Drift: A Symposium on The Origin and Movement of Land Masses...*  
The Hypothesis of Continental Displacement (p. 139)  
The American Association of Petroleum Geologists. Tulsa, Oklahoma, USA. 1928

**Shamos, Morris H.**

No biographical data available

Perhaps the greatest injustice that can be done to science is to regard it merely as a collection of facts, and the practice of science as little more than the routine accumulation of minutiae. It is true that science deals with hard, inflexible facts, but it has also to do with very general ideas and abstract principles; and it is the co-ordination of these ideas and observed facts that is the essence of modern science. Facts alone do not constitute a science. Nature Study is not the same as the study of nature.

*Rethinking Science Education*  
Science and the Humanities (p. 5)  
National Society for the Study of Education. 1960

**Shapere, Dudley**

No biographical data available

One of the chief motivations behind the attempt to defend a distinction between theoretical and observational terms has been the desire to explain how a theory can be tested against the data of experience, and how one theory can be said to “account for the facts” better than another; that is, to give a precise characterization of the idea, almost universally accepted in modern times, that the sciences are “based on experience,” that they are “empirical.”

*Philosophical Problems of Natural Science*  
Introduction, Section VI (p. 15)  
The Macmillan Company. New York, New York, USA. 1965

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

PATIOKIM: In Russia we face facts.

EDSTATON: In England, sir, a gentleman never faces any fact if they are unpleasant facts.

PATIOKIM: In real life, all facts are unpleasant.

*Complete Plays with Prefaces* (Volume 4)

*Great Catherine*, Scene I

Dodd, Mead. New York, New York, USA. 1963

Facts mean nothing by themselves. All the people at present crowding the Strand are facts. Nobody can possibly know the facts. Naturalists collect a few. Men of genius select a fewer few, and lo! a drama or a hypothesis. Genius is a sense of values and significances (the same thing). Without this sense facts are useless mentally. With it a Goethe can do more with ten facts than an encyclopedia compiler with ten thousand.

In J. Percy Smith (ed.)  
*Selected Correspondence of Bernard Shaw*  
Letter to H.G. Wells, 2 August, 1929 (pp. 152–153)  
University of Toronto Press. Toronto, Ontario, Canada. 1995

But an Englishman was not daunted by facts. To explain why all the lines in his rectilinear universe were bent, he invented a force called gravitation and thus erected a complete British universe and established it as a religion which was devoutly believed in for 300 years. The book of this Newtonian religion was not that oriental magic thing, the Bible. It was that British and matter-of-fact thing, a Bradshaw [a British railway timetable]. It gives the stations of all the heavenly bodies, their distances, the rates at which they are traveling, and the hour at which they reach eclipsing points or crash into the earth like Sirius. Every time is precise, ascertained, absolute and English.

In B. Patch  
*Thirty Years with G.B.S.*  
Chapter Twelve (p. 235)  
Dodd, Mead & Company. New York, New York, USA. 1951

A mere fact will never stop an Englishman.

Speech  
October 28, 1930

**Siegel, Eli** 1902–78

American philosopher, poet, critic and founder of Aesthetic Realism

Facts are always whispering, uttering, and shouting advice.

*Damned Welcome*  
Aesthetic Realism, Maxims, Part Two, #387 (p. 152)  
Definition Press. New York, New York, USA. 1972

The facts never give up.

*Damned Welcome*  
Aesthetic Realism, Maxims, Part Two, #418 (p. 156)  
Definition Press. New York, New York, USA. 1972

**Simpson, James Young** 1873–1934

No biographical data available

Facts are the premises of knowledge: according to their importance they are the bedrock upon which, or the bricks out of which, the superstructure – the Temple of Knowledge – is built.

*Spiritual Interpretation of Nature*  
Chapter I (p. 12)  
Hodder and Stoughton. London, England. 1912

**Slossin, Edwin Emery** 1865–1919  
Chemist and author

The scientific man, especially the scientific investigator, holds his theories with a light hand, but keeps a firm grip on his facts.

*Major Prophets of To-day*

Henri Poincaré (p. 119)

Little, Brown & Co. Boston, Massachusetts, USA. 1916

Facts and figures that the lecturer cannot keep in his own head for fifty minutes are not likely to get into the heads of the students.

Great American Universities – XV

*The Independent*, Volume LXVIII, Number 3196, March 3, 1910 (p. 462)

**Smedley, F. E.**

No biographical data available

...the facts, the stubborn, immovable facts.

*Frank Fairleigh or, Scenes from the Life of a Private Pupil*

Chapter 49

A. Hall. London, England. 1850

**Smith, George Otis** 1871–1944

American geologist

...statistics need to be much more than the output of a battery of adding machines. The ideal collection of facts is the man who has spent years as a specialist in the work and in this way knows the reality behind the words and figures. Only the personal touch that comes from intimate familiarity with facts at their source can give life to statistics.

What are the Facts?

*Civil Engineering*, Volume 2, Number 3, March, 1932 (p. 154)

Facts that have aged in the course of their collection and preparation for consumption are likely to be too stale for practical use. Dating an egg doesn't keep it good.

What are the Facts?

*Civil Engineering*, Volume 2, Number 3, March, 1932 (p. 155)

In this partnership of engineer and economist, it will be the engineer's part to furnish most of the facts. The engineer calls them "plain" facts, because they do not lend themselves to display as readily as theoretical phrases. He uses facts, not pieces on a chessboard to be moved back and forth in a contest of wits, but rather as foundation stones to be assembled in orderly fashion to hold up the superstructure of conclusions.

What are the Facts?

*Civil Engineering*, Volume 2, Number 3, March, 1932 (p. 155)

**Smollett, Tobias George** 1721–71

Scottish novelist

Facts are facts, as the saying is.

*The Life and Adventures of Sir Launcelot Greaves*

Chapter III (p. 20)

Oxford University Press, Inc. London, England. 1973

**Snow, Charles Percy** 1905–80

English novelist and scientist

I saw a medley of haphazard facts fall into line and order... "But it's true," I said to myself. "It's very beautiful. And it's true."

*The Search* (p. 27)

Charles Scribner's Sons. New York, New York, USA. 1958

A fact is a fact is a fact.

*The Two Cultures: And a Second Look*

Chapter 4 (p. 45)

At The University Press. Cambridge, England. 1964

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

...you have your little handful of facts, little bits of a puzzle, and you sit and think, and fit 'em together this way and that, and get up and throw 'em down, and say damn, and go out for a walk.

*The Letters of Robert Louis Stevenson*

Chapter XII

Letter to Edmund Gosse

June 10, 1893 (p. 211)

Charles Scribner's Sons. New York, New York, USA. 1917

**Stoppard, Tom** 1937–

Czech-born English playwright

Comment is free but facts are an expense.

*Night and Day*

Act 2

Faber & Faber Ltd. London, England. 1978

**Streatfield, Mr. Justice Geoffrey**

No biographical data available

Facts speak louder than statistics.

Sayings of the Week

*The Observer*, 19 March, 1950

**Szilard, Leo** 1898–1964

Hungarian-born American nuclear physicist

"I don't intend to publish it; I am merely going to record the facts for the information of God."

"Don't you think God knows the facts?" Bethe asked.

"Yes," said Szilard. "He knows the facts, but He does not know this version of the facts."

*The Collected Works of Leo Szilard: Scientific Papers* (Volume 1)

Preface (p. xix)

MIT Press. Cambridge, Massachusetts, USA. 1972

**Tansley, A. G.** 1917–

English ecologist

We must never conceal from ourselves that our concepts are creations of the human mind which we impose on the facts of nature, that they are derived from incomplete knowledge, and therefore will never exactly fit the facts, and will require constant revision as knowledge increases.

The Classification of Vegetation and the Concept of Development  
*Journal of Ecology*, Volume 8, Number 2, June, 1920 (p. 120)

**Taylor, Alfred Edward** 1869–1945  
English philosopher

All knowledge, we admit, is in the last resort “empirical,” in the sense that it arises out of *facts*, that is, out of experiences which we cannot altogether fashion as we please to suit our own convenience, or our own sense of what is fitting or desirable, but have largely to accept as they come to us.

*The Problem of Conduct: A Study in the Phenomenology of Ethics*  
Introductory (p. 7)  
Macmillan & Co Ltd. London, England. 1901

**Teall, J. J. Harris** 1849–1924  
British geologist

Armchair philosophy, apart from actual work in the field, the laboratory, and the museum, is by no means to be commended. But the worship of fact, as fact, may easily be overdone. The number of discoverable facts is practically infinite, and it is therefore possible to get into such a condition as not to be able to see the wood for the trees, to lose the due sense of proportion, and to become mere machines for tabulating interminable trivialities.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1902

The Evolution of Petrological Ideas (p. 289)  
Government Printing Office. Washington, D.C. 1903

**Temple, William F.** 1914–89  
English science fiction writer

Facts are the children of imagination. It's only through the eye of the imagination that you see the true picture of this strange universe. If imagination is strong and pure, unsullied by doubt, its truth is the only truth. Facts are simply what they're imagined to be.

The Legend of Ernie Deacon  
*Astounding Science Fiction*, March, 1965

**Terence** 190 BCE–158 BCE  
Roman comic dramatist

Let us look at the facts.

*Adelphoe*, I. 796  
Cambridge University Press. Cambridge, England. 1976

**Thompson, Elihu** 1853–1937  
American electrical engineer

Scientific facts are of little value in themselves. Their significance is their bearing upon other facts, enabling us to generalize and so to discover principles, just as the accurate measurement of the position of a star may be without value in itself, but in relation to other similar measurement of other stars may become the means of discovering their proper motions. We refine our instruments; we render more trustworthy our means

of observation; we extend our range of experimental inquiry, and thus lay the foundation for the future work, with the full knowledge that, although our researches can not extend beyond certain limits, the field itself is, even within those limits, inexhaustible.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1899

The Field of Experimental Research (p. 130)  
Government Printing Office. Washington, D.C. 1901

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Conventionalities are at length as bad as impurities. Even the facts of science may dust the mind by their dryness, unless they are in a sense effaced each morning, or rather rendered fertile by the dews of fresh and living truth.

*The Writings of Henry David Thoreau* (Volume 4)  
*Life Without Principle* (p. 475)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Let us not underrate the value of a fact; it will one day flower in a truth. It is astonishing how few facts of importance are added in a century to the natural history of any animal. The natural history of man himself is still being gradually written.

*The Writings of Henry David Thoreau* (Volume 9)  
*Natural History of Massachusetts* (p. 161)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Trousseau, Armand** 1801–67  
French internist

...facts bear a certain analogy to the thread of Theseus and the blind man's staff; and though, assuredly, if we have no other aid, we are walking in darkness and running towards the unknown, we are, nevertheless, not without a guide; and even if we find the road shut up, we shall have well merited the gratitude of our successors for showing them that the way was not open, and so sparing them laborious research in a wrong direction.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)  
Introduction (p. 39)  
Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

**Tuttle, Hudson** 1836–1910  
Fruit farmer and horse breeder

We must have facts, and a positive philosophy based on nature and reason.

*Arcana of Nature: Or, The History and Laws of Creation* (Volume 1)  
Part I, Chapter III (p. 71)  
William White & Co. Boston, Massachusetts, USA. 1870

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

For a forgotten fact is news when it comes again.

*Following the Equator* (Volume 2)  
Chapter XXII (p. 259)  
Harper & Brothers Publishers. New York, New York, USA. 1899

Get your facts first and...then you can distort them as much as you please.

In Rudyard Kipling

*From Sea to Sea*

An Interview with Mark Twain (p. 180)

Doubleday, Page & Company. Garden City, New York, USA. 1912

The mere knowledge of a fact is pale; but when you come to realize your fact, it takes on color. It is all the difference between hearing of a man being stabbed to the heart, and seeing it done.

*A Connecticut Yankee in King Arthur's Court*

Chapter VI (p. 42)

Harper & Brothers Publishers. New York, New York, USA. 1899

How empty is theory in the presence of fact!

*A Connecticut Yankee in King Arthur's Court*

Chapter XLIII (p. 396)

Harper & Brothers. New York, New York, USA. 1899

In the space of one hundred and seventy six years, the Lower Mississippi has shortened itself two hundred and forty two miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oolitic Silurian Period, just a million years ago next November, the Lower Mississippi river was upwards of one million three hundred miles long, and stuck out over the Gulf of Mexico like a fishing rod. And by the same token any person can see that seven hundred forty two years from now the Lower Mississippi will be only a mile and three quarters long, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of aldermen. There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

*Life on the Mississippi*

Chapter XVII (p. 156)

Harper & Row, Publishers. New York, New York, USA. 1951

...always dress a fact in tights, never in an ulster...

*Life on the Mississippi*

Chapter XXXIV (pp. 294–295)

Harper & Row, Publishers. New York, New York, USA. 1951

Pardon, once more; if you are going to load any thing more on to that statement, you want to get a couple of lighters and tow the rest, because it's drawing all the water there is in the river already; stick to facts – just stick to the cold facts...

*Life on the Mississippi*

Chapter XXXIV (p. 259)

Harper & Brothers Publishers. New York, New York, USA. 1901

...if you are going to find out the facts of a thing, what's the sense in guessing out what ain't the facts and wasting ammunition? I didn't lose no sleep.

*Tom Sawyer Abroad; Tom Sawyer, Detective and Other Stories, etc., etc.*

*Tom Sawyer, Detective*

Chapter II (p. 123)

Harper & Brothers. New York, New York, USA. 1902

**Tyndall, John** 1820–93

Irish-born English physicist

Facts looked at directly are vital; when they pass into words half the sap is taken out of them.

*Fragments of Science for Unscientific People*

Chapter XIII (p. 360)

D. Appleton & Co. New York, New York, USA. 1875

It is as fatal as it is cowardly to blink facts because they are not to our taste.

*Fragments of Science* (Volume 2)

Chapter XIV (p. 378)

P.F. Collier & Son. New York, New York, USA. 1902

It is by a kind of inspiration that we rise from the wise and sedulous contemplation of facts to the principles on which they depend.

*Fragments of Science* (Volume 2)

Chapter II (p. 24)

D. Appleton & Co. New York, New York, USA. 1892

...the brightest flashes in the world of thought are incomplete until they have been proved to have their counterparts in the world of facts.

*Fragments of Science* (Volume 2)

Chapter VI (p. 84)

P.F. Collier & Son. New York, New York, USA. 1902

No fact is to him [Man] either original or final. He cannot limit himself to the contemplation of it alone, but endeavors to ascertain its position in a series to which uniform experience assures him it must belong. He regards all that he witnesses in the present as the efflux and sequence of something that has gone before, and as the source of a system of events which is to follow.

*Fragments of Science*

Part One

A Lecture to School Masters (p. 362)

P.F. Collier & Son. New York, New York, USA. 1901

We observe facts and store them up; imagination broods upon these memories, and by the aid of reason tries to discern their interdependence. The theoretic principle flashes, or slowly dawns upon the mind, and then the deductive faculty interposes to carry out the principle to its logical consequences.

*Fragments of Science for Unscientific People*

Chapter XIII (p. 366)

D. Appleton & Co. New York, New York, USA. 1875

**Valéry, Paul** 1871–1945

French poet and critic

A faultily observed fact is more treacherous than a faulty train of reasoning.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)



Moralities, Analects (p. 191)  
Princeton University Press. Princeton, New Jersey, USA. 1971

Small unexplained facts always contain grounds for upsetting all explanations of “big” facts.

Translated by Stuart Gilbert  
*The Collected Works of Paul Valery* (Volume 14)  
*Analects*  
Odds and Ends (p. 35)  
Princeton University Press. Princeton, New Jersey, USA. 1979

**Virchow, Rudolf Ludwig Karl** 1821–1902  
German pathologist and archaeologist

The naked facts are doubtful weapons.

Translated by Lelland J. Rather  
*Disease, Life, and Man*  
Scientific Method and Therapeutic Standpoints (p. 45)  
Stanford University Press. Stanford, California, USA. 1958

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

When we find facts within our knowledge exhibited by some new method, or even, it may be, described in a foreign language, they receive a peculiar charm of novelty and wear a fresh air.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
#526 (p. 186)  
The Macmillan Co. New York, New York, USA. 1906

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

It is not enough to be acquainted with the facts; scientific knowledge begins only when their laws and their causes are unveiled.

*Popular Lectures on Scientific Subjects*  
Lecture I  
Volume 2, 1846 (p. 13)  
D. Appleton & Company. New York, New York, USA. 1885

Isolated facts and experiments have in themselves no value, however great their number may be. They only become valuable in a theoretical or practical point of view when they make us acquainted with the law of a series of uniformly recurring phenomena.

*Popular Lectures on Scientific Subjects*  
Lecture VIII (p. 368)  
D. Appleton & Company. New York, New York, USA. 1885

Each individual fact, taken by itself, can indeed arouse our curiosity or our astonishment, or be useful to us in its practical applications.

Translated by E. Atkinson  
*Popular Lectures on Scientific Subjects* First Series  
On the Conservation of Force (p. 319)  
D. Appleton & Co. New York, New York, USA. 1897

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

With the simplest statements of scientific facts there must ever mingle a certain eloquence. Nature herself is sublimely eloquent. The stars as they sparkle in the firmament fill us with delight and ecstasy, and yet they all move in orbits marked out with mathematical precision. In Julius Löwenberg, Robert Avé-Lallemant, Alfred Wilhelm Dove (ed.)  
*Life of Alexander von Humboldt: Compiled in Commemoration of the Centenary of His Birth* (Volume 2)  
Letter 28 April, 1841 Varnhagen von Ense  
Longman's, Green & Company, New York, New York, USA; 1873

**von Liebig, Justus** 1803–73  
German organic chemist

Facts by the million cannot be bequeathed; but scientific principles which are expressions for these facts, may be so, because they are immutable in their nature.

In John Blyth  
*Letters on Modern Agriculture*  
Letter XIII (p. 232)  
Walton & Maberly. London, England. 1859

*Facts* are like *grains of sand* which are moved by the wind, but principles are these same grains cemented into *rocks*.

In John Blyth  
*Letters on Modern Agriculture*  
Letter XII (p. 233)  
Walton & Maberly. London, England. 1859

The attaching too high a value to the mere facts is often a sign of want of ideas. It is not fertility, but poverty, of ideas which clothes itself with a mass of coverings of all sorts, or wears old, tattered, -threadbare, and ill-fitting garments.

In John Blyth (ed.)  
*Familiar Letters on Chemistry*  
Letter III (p. 57)  
Walton & Maberly. London, England. 1859

We value facts because of their permanence and immutability, and because they supply the grounds for ideas; but a fact acquires its true and full value only through the idea which is developed from it.

*Familiar Letters on Chemistry*  
Letter III (p. 58)  
Walton & Maberly. London, England. 1859

**Webb, Jack** 1920–82  
American actor and television producer

Just the facts, Ma'm.

*Dragnet*  
Television program

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian and sociologist

Facts are the raw materials and not the substance of science.  
*The Discovery of the Future* (p. 35)  
B.W. Huebsch. New York, New York, USA. 1913



**West, Jessamyn** 1902–84  
American writer

We want the facts to fit the preconceptions. When they don't, it is easier to ignore the facts than change the preconceptions.

*The Quaker Reader*  
Introduction (p. 2)  
The Viking Press. New York, New York, USA. 1962

**Whately, Richard** 1787–1863  
English theologian

No matter of fact can be mathematically demonstrated, though it may be proved in such a manner as to leave no doubt on the mind.

*The Elements of Logic*  
IV  
John W. Parker & Son. London, England. 1853

**Whewell, William** 1794–1866  
English philosopher and historian

When we inquire what Facts are to be made the materials of Science, perhaps the answer which we should most commonly receive would be, that they must be True Facts, as distinguished from any mere inferences or opinions of our own.

*Novum Organon Renovatum*  
Chapter III (pp. 50–51)  
John W. Parker & Son. London, England. 1858

...in order that the facts obtained by observation and experiment may be capable of being used in furtherance of our exact and solid knowledge, they must be apprehended and analysed according to some Conception which, applied for this purpose, gives distinct and definite results, such as can be steadily taken hold of and reasoned from...

*The Philosophy of the Inductive Sciences Founded Upon their History*  
(Volume 2)  
Book XI, Chapter III (p. 39)  
John W. Parker. London, England. 1847

Facts are the materials of science, but all Facts involve Ideas. Since, in observing Facts, we cannot exclude Ideas, we must, for the purposes of science, take care that the Ideas are clear and rigorously applied.

*The Philosophy of the Inductive Sciences: Founded Upon Their History*  
(Volume 2) (2nd edition)  
Aphorisms Concerning Ideas (p. 467)  
John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

They remain "stubborn fact"...

*Adventures of Ideas*  
Chapter XV (p. 405)  
The Macmillan Company. New York, New York, USA. 1956

There is nothing in the real world which is merely an inert fact...

*Process and Reality: An Essay in Cosmology*  
Part IV, Part IV, Section I (p. 472)  
The Macmillan Company. New York, New York, USA. 1929

...irreducible and stubborn facts...

*Science and the Modern World*  
Chapter I (p. 4)  
The Macmillan Company. New York, New York, USA. 1929

A chain of facts is like a barrier reef. On one side there is wreckage, and beyond it harborage and safety.

*Process and Reality: An Essay in Cosmology*  
Part III, Chapter I, Section IV (p. 341)  
The Macmillan Company. New York, New York, USA. 1929

**Whyte, Lancelot Law** 1896–1972  
Scottish Physicist

The true aim of science is to discover a simple theory which is necessary and sufficient to cover the facts, when they have been purified of traditional prejudices.

*Accent on Form: An Anticipation of the Science of Tomorrow*  
Chapter IV (p. 59)  
Harper & Brothers Publishers. New York, New York, USA. 1954

Science does not begin with facts; one of its tasks is to uncover the facts by removing misconceptions.

*Accent on Form: An Anticipation of the Science of Tomorrow*  
Chapter IV (p. 60)  
Harper & Brothers. New York, New York, USA. 1954

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Facts fled before philosophy like frightened forest things.

*The Picture of Dorian Gray*  
Chapter 3 (p. 47)  
The Modern Library. New York, New York, USA. 1992

Facts are not merely finding a footing-place in history, but they are usurping the domain of Fancy, and having invaded the kingdom of Romance. Their chilling touch is over everything. They are vulgarizing mankind.

*The Works of Oscar Wilde* (Volume 10)  
*Intentions*  
The Decay of Lying (p. 27)  
AMS Press. New York, New York, USA. 1909

**Winchell, Alexander** 1824–91  
American geologist

It is not for its facts, but for the significance of the facts, that science is valuable.

*Sketches of Creation*  
Preface (p. vii)  
Harper & Brothers Publishers. New York, New York, USA. 1870

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The world is the totality of facts, not of things.

Translated by D.F. Pears & B.F. McGuinness  
*Tractatus Logico-Philosophicus*  
1. 1 (p. 7)  
Routledge & Kegan Paul. London, England. 1961

The world divides into facts.

Translated by D.F. Pears & B.F. McGuinness

*Tractatus Logico-Philosophicus*

1.2 (p. 7)

Routledge & Kegan Paul. London, England. 1961

**Wright, Chauncey** 1830–75

American philosopher of science

True science deals with nothing but questions of facts...

In James Bradley Thayer

*Letters of Chauncey Wright, with Some Account of His Life*

Letter of August 13, 1867 to F.E. Abbot (p. 113)

Press of John Wilson & Son. Cambridge, England. 1878

**Wright, Jonathan**

No biographical data available

Coat it [a fact] over with the incrustations of criticism, the mould of age, and it must be fresh hewed to the point of losing its identity – its susceptibility of identification, I mean, – before it can be appreciated as a part of “the solid ground of nature – made solid of course by eyes, not really myopic or hypermetropic when they have their errors of refraction properly corrected, made solid in a word by the unfailing, unerring use of sense – a veritable fact, not an old fact, of course, but a new one.

The Evanescence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 181)

It unfortunately has come to look a little suspicious in the secular press, but a new fact, really approved by the hierarchy of science, unsmirched by any touch of the imagination and free of any suspicion of deductive birth, is a thing of beauty if not a joy forever. The old facts, though they continue to sing:

*Duhast uns gepflanzt; Zu Tausenden kommen Wir, Vater, getanzt.*

are, I must confess, a pretty “poor run of shad.” It is true it does not seem just the way a fact should behave. Its vintage should improve with age. It is undeniable, however, that in really choice circles of science, the old facts are not looked on with favor.

The Evanescence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 181)

They [facts] seem just a little tarnished; the mind is not tempted to gild them over or rub them up, the imagination refuses to endow them with those winged words which carry newly quarried facts bright and shining to the work table of the appreciative student, unhaunted by any shade of historical perspective. Evidently the time to work a fact into the masonry of science, “the solid ground of nature” upon which her trusting and unsuspecting, non-historical, scientific children love to build, is when it is fresh and when the mortar will cling to it.

The Evanescence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 181)

The imagery of Shakespeare, the flowers of eloquence in Demosthenes, need no burnishing, no drapery to hide their age, but the atoms of Democritus and the spheres of Ptolemy need considerable correction, and the cloud of insect facts which swarm up from my old yellow sheets, if not simply disgusting, are at least uninspiring.

The Evanescence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 181)

A fact, it is true, should lack nothing. It should stand alone unshamed in its nakedness – for is it not the truth? Is not the truth divine?

The Evanescence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 181)

When the fact comes to be builded into a structure of any use to mankind, of course the “light of Heaven” must be employed, but not for a fact alone. That shines by its own effulgence.

The Evanescence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 183)

## FACTS, EXPERIMENTAL

**Tyndall, John** 1820–93

Irish-born English physicist

...experimental facts alone cannot satisfy the mind: we desire to know the cause of the fact; we search after the principle by the operation of which the phenomena are produced.

*Heat A Mode of Motion* (6th edition)

Lecture II (p. 36)

D. Appleton & Co. New York, New York, USA. 1915

## FACTS, WORLD OF

**Huxley, Thomas Henry** 1825–95

English biologist

...a world of facts lies outside and f beyond the world of words.

*Lay Sermons, Addresses and Reviews*

Essay III (p. 53)

D. Appleton & Co. New York, New York, USA. 1910

## FACTOR

**Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children’s writer, and playwright

...and then, as Pooh seemed disappointed, he added quickly, “but it’s grander than Factors.”

*The Complete Tales & Poems of Winnie-the-Pooh*

*The House at Pooh Corner* (p. 175)

Dutton Children’s Books. New York, New York, USA. 2001

Suddenly Christopher Robin began to tell Pooh about some of the things: People called Kings and Queens and something called Factors...

*The Complete Tales & Poems of Winnie-the-Pooh*

*The House at Pooh Corner* (p. 337)

Dutton Children's Books. New York, New York, USA. 2001

## FACULTY MEETING

**Mitchell, Maria** 1818–89

American astronomer and educator

Our faculty meetings always try me in this respect: we do things that other colleges have done before. We wait and ask for precedent. If the earth had waited for a precedent, it never would have turned on its axis!

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 174)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

## FAILURE

### Author undetermined

What is the opposite of 'Eureka'?

Source undetermined

**Dewey, John** 1859–1952

American philosopher and educator

Failure is instructive. The person who really thinks learns quite as much from his failures as from his successes.

In Larry H. Hickman and Thomas M. Alexander (eds.)

*Essential Dewey* (Volume 2) (p. 142)

Indiana University Press. Bloomington, Indiana, USA. 1998

**Huxley, Thomas Henry** 1825–95

English biologist

...there is the greatest practical benefit in making a few failures early in life.

*Collected Essays* (Volume 3)

*Science and Education*

On Medical Education (p. 306)

Macmillan & Company Ltd. London, England. 1904

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years, and that word is failure.

Lord Kelvin's Jubilee

*Nature*, Volume 54 173181 1896

**Rossman, Joseph**

Inventor

One seldom perfects an idea without many failures...

*Industrial Creativity: The Psychology of the Inventor*

Chapter IV (p. 45)

University Books. New Hyde Park, New York, USA. 1964

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Failure is less attributable to either insufficiency of means or impatience of labours than to a confused understanding of the thing actually to be done.

In Henry Attwell

*Thoughts from Ruskin*

17 (p. 12)

Longman's, Green & Company, New York, New York, USA; 1901

**Starling, Ernest Henry** 1866–1927

English physiologist

Every discovery, however important and apparently epoch-making, is but the natural and inevitable outcome of a vast mass of work, involving many failures, by a host of different observers, so that if it is not made by Brown this year it will fall into the lap of Jones, or of Jones and Robinson simultaneously, next year or the year after.

Discovery and Research

*Nature*, Volume 113, Number 2843, April, 1924 (p. 606)

## FAITH

**Haeckel, Ernst Heinrich Philipp August** 1834–1919

German biologist and philosopher

Where faith commences, science ends.

Translated by Edwin Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its*

*Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)

Chapter II (p. 9)

D. Appleton & Co. New York, New York, USA. 1892

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

There are no inscrutables in Nature. By Faith only can we go beyond – as far and where we please.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 11)

D. van Nostrand Co. New York, New York, USA. 1893

**Mellor, Joseph William** 1863–1938

Chemist

Faith without facts availeth nothing.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

Chapter I (p. 16)

Longman, Green & Co. London, England. 1922

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The eye of faith is no better than the eye of science ...

*The Eye of Faith is No Better Than the Eye of Science*

The Moth (p. 151)

Harper & Brothers Publishers. New York, New York, USA. 1897

**Winchell, Alexander** 1824–91  
American geologist

It appears from a cursory acquaintance with the facts, that faith and science have lived in perpetual strife. Faith has been wont to appropriate whatever has fallen within her reach, and science has declared, from time to time, that certain of her claims were indefensible; and she has been compelled to recede.

*Reconciliation of Science and Religion*

Chapter I (p. 31)

Harper & Brothers Publishers. New York, New York, USA. 1877

## FAITH OF SCIENCE

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Reasoning leads us from premises to conclusion; it cannot start without premises.... [W]e...must believe that we have an inner sense of values which guides us as to what is to be heeded, otherwise we cannot start on our survey even of the physical world.... At the very beginning there is something which might be described as an act of faith – a belief that what our eyes have to show us is significant.

*Science and the Unseen World*

Chapter VI (pp. 73–74)

The Macmillan Company. New York, New York, USA. 1929

**Ferris, Timothy** 1944–  
American science writer

To say that nature is comprehensible to us, that science is not deluding itself, is an assertion of faith – ‘reason is one of the articles of faith,’ said Eddington – but there is nothing wrong with that. After all, we are part of the universe. And the faith of science – that the seamless wave of nature will reveal itself to our reasoned inquiry – that faith is part of the universe too.

*The Red Limit: The Search for the Edge of the Universe*

Chapter 10 (p. 245)

William Morrow & Company, Inc. New York, New York, USA. 1977

**Planck, Max** 1858–1947  
German physicist

Science demands also the believing spirit. Anybody who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: Ye must have faith. It is the quality which the scientist cannot dispense with.

*Where Is Science Going?*

Epilogue (p. 214)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

...if we did not have faith but could solve puzzle in life by an application of the human reason, what an unbearable burden life would be.

*Where Is Science Going?*

Epilogue (p. 218)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Virchow, Rudolf Ludwig Karl** 1821–1902  
German pathologist and archaeologist

There cannot be any issue between faith and science, for science and faith mutually exclude one another; not in the sense that the one renders the other impossible, or vice versa, but rather that so far as science extends faith does not exist, and faith begins where science leaves off.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 52)

Macmillan & Company Ltd. London, England. 1918

**Wiener, Norbert** 1894–1964  
American mathematician

A faith which we follow upon orders imposed from outside is no faith, and a community which puts its dependence upon such a pseudo-faith is ultimately bound to ruin itself because of the paralysis which the lack of a healthily growing science imposes upon it.

*The Human Use of Human Beings*

Chapter XI (p. 193)

Da Capo Press. New York, New York, USA. 1988

## FALLACY

**Goddard, Robert H.** 1882–1945  
American physicist

The only antidote for fallacies is – in a word – to take nothing for granted.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted (p. 64)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Huxley, Thomas Henry** 1825–95  
English biologist

There are men (and I think Priestley was one of them) to whom the satisfaction of throwing down a triumphant fallacy is as great as that which attends the discovery of a new truth; who feel better satisfied with the government of the world, when they have been helping Providence by knocking an imposture on the head; and who care even more for freedom of thought than for mere advance of knowledge. These men are the Carnots who organise

victory for truth, and they are, at least, as important as the generals who visibly fight her battles in the field.

*Collected Essays* (Volume 3)

*Science and Education*

Joseph Priestley (p. 13)

Macmillan & Company Ltd. London, England. 1904

## FALLING

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Let us draw a lesson from nature, which always works by short ways. When the fruit is ripe, it falls. When the fruit is despatched, the leaf falls. The circuit of the waters is mere falling. The walking of man and all animals is a falling forward. All our manual labor and works of strength, as prying, splitting, digging, rowing, and so forth, are done by dint of continual falling, and the globe, earth, moon, comet, sun, star, fall forever and ever.

*Essays*

Essay IV (p. 112)

James Munroe & Co. Boston, Massachusetts, USA. 1841

## FALSEHOOD

**Latham, Peter Mere** 1789–1875

English physician

...it takes as much time and trouble to pull down a falsehood as to build up a truth.

In Robert Martin

*The Collected Works of Dr. P. M. Latham* (Volume 2)

General Remarks on the Practice of Medicine, VI (p. 398)

The New Sydenham Society. London, England. 1878

## FALSITY

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

Falsity in intellectual action is intellectual immorality.

The Ethical Functions of Scientific Study

*The Journal of Geology*, Volume 2, Number 6, December, 1888 (p. 380)

## FAME

**Rubin, Vera** 1928–

American astronomer

Fame is fleeting. My numbers mean more to me than my name. If astronomers are still using my data years from now, that's my greatest compliment.

*Discover*, October, 1990

## FANTASY

**Sagan, Carl** 1934–96

American astronomer and author

If some good evidence for life after death were announced, I'd be eager to examine it; but it would have to be real scientific data, not mere anecdote. As with the face on Mars and alien abductions, better the hard truth, I say, than the comforting fantasy.

*Demon-Haunted World: Science As a Candle in the Dark*

Chapter 12 (p. 204)

Random House, Inc. New York, New York, USA. 1995

## FART

**Maxwell, Gavin** 1914–69

Scottish naturalist

Then it came again, thunderous, earthshaking, the longest, loudest and most superbly stupendous fart that I have ever heard in my life, a sound of such magnificent and prolonged volume as to appear utterly beyond human capability.

*Raven Seek Thy Brother* (p. 38)

E.P. Dutton & Company. New York, New York, USA. 1969

## FATE

**Charlie Chan (Fictional character)**

Wheel of fate has many spokes.

*Charlie Chan's Secret*

Film (1936)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Fate then is a name for facts not yet passed under the fire of thought; for causes which are unpenetrated.

*The Complete Works of Ralph Waldo Emerson* Volume 6

*The Conduct of Life*

Fate (p. 31)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

## FAULT

**The Bible (King James Version)**

...and the mount of Olives shall cleave in the midst thereof toward the east and toward the west, and there shall be a very great valley; and half of the mountain shall remove toward the north, and half of it toward the south.

Zechariah 14:4

## FAUNIST

**White, Gilbert** 1720–93

English naturalist and cleric

Faunists, as you observe, are too apt to acquiesce in bare descriptions, and a few synonyms: the reason is plain: because all that may be done at home in a man's study;

but the investigation of the life and conversation of animals is a concern of much more trouble and difficulty, and is not to be attained but by the active and inquisitive, and by those that reside much in the country.

*The Natural History and Antiquities of Selborne: In the County of Southampton*

Letter X (p. 236)

Printed for J. & A. Arch. London, England. 1837

## FEAR

**Morehouse, George Wilkinson** 1840–?

American naturalist

Fear, crouching in a quagmire of bare possibility that things may turn out in a supernatural way, attempts to pull down the proud figure of Truth, standing on the solid rock of scientific and mathematical deduction through the law of probabilities.

*The Wilderness of Worlds*

Chapter VII (p. 54)

Peter Eckler, Publisher. New York, New York, USA. 1898

## FEE

**da Costa, J. Chalmers** 1863–1933

American physician

A fashionable surgeon, like a pelican, can be recognized by the size of his bill.

*The Trials and Triumphs of the Surgeon*

Chapter 1 (p. 38)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**de Mondeville, Henri** 1260–1320

French pioneer surgeon

Never dine with a patient who is in your debt, but get your dinner at an inn, otherwise he will deduct his hospitality from your fee.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 307)

The S.E. Massengill Company, Bristol, Tennessee, USA. 1943

**Dunne, Finley Peter** 1867–1936

American journalist and humorist

I wondher why ye can always read a doctor's bill an' ye niver can read his purscription?

*Mr. Dooley Says*

Drugs (pp. 93–94)

Charles Scribner's Sons. New York, New York, USA. 1910

**Fielding, Henry** 1707–54

English novelist, playwright, and barrister

So little then did our doctors delight in death that they discharged the corpse after a single fee.

*The History of Tom Jones: A Foundling* (Volume 1)

Book II, Chapter 9 (p. 86)

P.F. Collier & Son Company. New York, New York, USA. 1917

**Graves, Richard**

No biographical data available

Three doctors, met in consultation,  
Proceed with great deliberation;  
The case was desperate, all agreed,  
But what of that? they must be fee'd.  
They write then (as't was fit thay shou'd)  
But for their own, not patients' good.  
Consulting wisely (don't mistake, sir)  
Not what to give, but what to take, sir.

In William Davenport Adams

*English Epigrams*

The Consultation, cclxxxii

G. Routledge. London, England. 1878

**Hazlitt, William Carew** 1834–1913

English bibliographer

One asked a man whether he had swallowed a Doctor of Phisicke's bill, because hee spoke such hard words.

*Shakespeare Jest Books* (Volume 3)

Conceit, Clichés, Flashes and Whimzies, Number 9

Willis & Sotheran. London, England. 1864

A Physitian demanded money of another for one of his patients that was dead long before. He was answered that it was a worke of chairty to visit the sick; but if he was so earnest for money, the only way was for him to visit the dead, and then he would never want money more.

*Shakespeare Jest Books* (Volume 3)

Conceit, Clichés, Flashes and Whimzies, Number 176

Willis & Sotheran. London, England. 1864

**Hood, Thomas** 1582–98

English poet and editor

The doctor look'd and saw the case

Plain as the nose not on his face.

“O! hum – ha – yes – I understand.”

But then arose a long demur,

For not a finger would he stir

Till he was paid his fee in hand;

That matter settled, there they were,

With Hunks well strapp'd upon his chair.

*The Complete Poetical Works of Thomas Hood*

A True Story, Stanza 12

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**McElwee, Tom**

No biographical data available

Cardiologist's Fee – Heart-earned money.

*Quote, the Weekly Digest*, June 2, 1968 (p. 437)

**Morris, Robert Tuttle** 1857–1945

American abdominal surgeon

One must not count upon all of his patients being willing to steal in order to pay doctor's bills.

*Doctors versus Folks*

Chapter 3

Doubleday, Page & Company. Garden City, New York, USA. 1915



**Syminges, John**

No biographical data available

Before you meddle with him, make your bargain wisely, now he is in pain, for he is but a bad pay-master, and therefore follow this rule: Get your money while he's ill, for when he's well you never will.

*John Donne and the Ancient Catholic Nobility*

Part I, Chapter 4 (p. 75)

Indiana University Press. Bloomington, Indiana, USA. 1995

**FEEDBACK****Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

...an essential element in all mechanisms of self-organization is feedback.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 5 (p. 69)

Simon & Schuster. New York, New York, USA. 1988

**FEEDING BEHAVIOR****James, William** 1842–1910

American philosopher and psychologist

Not one man in a billion, when taking his dinner, ever thinks of utility. He eats because the food tastes good and makes him want more. If you ask him *why* he should want to eat more of what tastes like that, instead of revering you as a philosopher he will probably laugh at you for a fool.

*The Principles of Psychology* Volume 2

Chapter XXIV (p. 386)

Henry Holt & Co. New York, New York, USA. 1918

**FERMAT'S THEOREM****de Fermat, Pierre** 1601–65

French mathematician

But it is impossible to divide a cube into two cubes, or a fourth power into two fourth powers, or generally any power beyond the square into two like powers; of this I have found a remarkable demonstration. This margin is too narrow to contain it.

*Oeuvres* (Volume 1) (p. 291)

Gauthier-Villars et Fils. Paris. 1891

**Guy, Richard K.** 1916–

Mathematics professor

Mathematics often owes more to those who ask questions than to those who answer them. The solution of a problem may stifle interest in the area around it. But "Fermat's Last Theorem", because it is not yet a theorem, has generated a great deal of "good" mathematics, whether goodness is judged by beauty, by depth or by

applicability.

*Unsolved Problems in Number Theory*

Preface to the First Edition (p. ix)

Springer-Verlag. New York, New York, USA. 2004

**Wiles, Andrew** 1953–

English-born American mathematician

I had this very rare privilege of being able to pursue in my adult life what had been my childhood dream. I know it's a rare privilege, but if you can tackle something in adult life that means that much to you, then it's more rewarding, than anything imaginable. Having solved this problem there's certainly a sense of loss, but at the same time there is this tremendous sense of freedom. I was so obsessed by this problem that for eight years I was thinking about it all the time – when I woke up in the morning to when I went to sleep at night. That's a long time to think about one thing. That particular odyssey is not over. My mind is at rest.

In Simon Singh

*Fermat's Enigma*

Epilogue (p. 285)

Walker & Company. New York, New York, USA. 1997

**FERMENT****Feynman, Richard P.** 1918–88

American theoretical physicist

There in wine is found the great generalization: all life is fermentation.

*The Feynman Lectures in Physics* (Volume 1)

Chapter 3 (p. 3–10) 1965

**FERMENT BANDS****Warburg, Otto** 1883–1970

German physiologist

Physics brings the ferment bands into existence but organic chemistry is necessary for the identification or creation of these bands.... Indeed, the ferment substance – though being so near to us – is, like the substance of the stars, inaccessible for us.

*Nobel Lectures, Physiology or Medicine 1922–1941*

The Oxygen-Transferring Ferment of Respiration

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**FERMENTATION****Boorse, Christopher**

Philosopher

...the actual function in fermentation is to produce enzymes which catalyze the conversion of sugar to carbon dioxide and alcohol. Presumably, then, that has always been the function of yeast in brewing devices. It did not suddenly acquire this function with the advent



to settle the question of whether machines can think, a question of which we now know that it is about as relevant as the question of whether submarines can swim.

ACN South Central Regional Conference  
Austin, Texas, 16–18 November, 1984

## FIELD WORK

**Woolley, Sir Charles Leonard** 1880–1960

English archaeologist

All about one as one digs there is the atmosphere of the historic past and of the still living world wherein that history took shape; and if out of all this a man cannot reap a harvest for the widening and the delight of his own soul he must be a purblind creature and poorly suited to his task – for him and through him there can be no stirring and murmur of new life in the valley of dry bones where he works.

*Dead Towns and Living Men: Being Pages from an Antiquary's Notebook*

Introduction (p. 10)

Philosophical Library. New York, New York, USA. 1956

## FIELDS

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

One could say that gravitational forces, like electromagnetic forces, are long range, in that they fall off slowly with distance, and that this suggests one make a theory of gravitation, which is a natural analogue of the intuitive pictures of Faraday and the equations of Maxwell which describe electromagnetism, electromagnetic waves, and the fields around magnets and charges. The principle point of difference for which one must allow from the beginning is this: that two like charges repel each other, whereas all masses attract each other.

*The Flying Trapeze: Three Crises for Physics*

Space and Time (p. 26)

Oxford University Press, Inc. London, England. 1964

## FIGURE

**Carlyle, Thomas** 1795–1881

English historian and essayist

A witty statesman said you might prove anything by figures.

*English and Other Critical Essays*

Chartism, Chapter II (p. 170)

J. M. Dent & sons Ltd. London, England. 1950

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

Grown-ups love figures. When you tell them that you have made a new friend, they never ask you any questions about

essential matters. They never say to you, “What does his voice sound like? What games does he love best? Does he collect butterflies?” Instead, they demand: “How old is he? How many brothers has he? How much does he weigh? How much money does his father make?” Only from these figures do they think they have learned anything about him.

Translated by Katherine Woods

*The Little Prince*

Chapter IV (p. 17)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Findlay, Alexander**

No biographical data available

Probably one of the first difficulties which confronts a beginner [of physical chemistry] is to decide how many figures are to be employed; for it is just as easy, and apparently more natural, to make the mistake of using too many as of using too few figures.

*Practical Physical Chemistry*

Chapter I (p. 1)

Longmans, Green & Co. London, England. 1920

**Hopkins, Harry**

No biographical data available

Figures are faceless and incestuous.

*The Numbers Game: The Bland Totalitarianism*

Chapter I (p. 15)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Huxley, Aldous** 1894–1963

English writer and critic

“Give them a few figures, Mr. Foster,” said the Director, who was tired of talking.

*Brave New World*

Chapter One (p. 11)

Harper & Brothers. New York, New York, USA. 1950

**Le Fèvre, Nicaise** 1610–69

Chemist and alchemist

[Fire is] the most potent Agent that Nature hath furnished us withal under Heaven, to perform the Anatomy of Mixt Bodies.

*A Compleat Body of Chemistry*

Part I (p. 75)

Printed for O. Pullyn. London, England. 1640

**Sage, M.**

No biographical data available

...battalions of figures are like battalions of men, not always as strong as is supposed.

Translated by Noraile Robertson

*Mrs. Piper and the Society for Psychological Research*

Chapter XV (p. 151)

Scott-Thaw Company. New York, New York, USA. 1904

**Stanley, Ferdinando (Lord Derby)** 1559–94

English literary patron

It is hardly possible to overrate the value of figures, partly by checking that universal tendency to exaggeration – not wilful, but a kind of mental illusion – which operates wherever we are deeply interested; partly as giving definiteness and precision to ideas which otherwise would remain floating in our minds in a vague, and therefore comparatively useless, form.

In Albert Leffingwell

*Illegitimacy, and The Influence of Seasons Upon Conduct*

Appendix II (p. 146)

Swan Sonnenschein & Co. London, England. 1892

**Tarbell, Ida** 1857–1944

American historian, journalist, and reformer

There is no more effective medicine to apply to feverish public sentiment than figures. To be sure, they must be properly proposed, must cover the case, must confine themselves to a quarter of it, and they must be gathered for their own sake, not for the sake of a theory.

*The Ways of Woman*

Chapter I (p. 3)

The Macmillan Company. New York, New York, USA. 1915

**Verne, Jules** 1828–1903

French novelist

“Thus, my friends,” said Barbicane, “all motion suddenly stopped produces heat. And this theory allows us to infer that the heat of the solar disc is fed by a hail of meteors falling incessantly on its surface. They have even calculated –”

“Oh, dear !” murmured Michel, “the figures are coming.”

*From the Earth to the Moon*

Chapter VI (p. 196)

Charles Scribner’s Sons. New York, New York, USA. 1905

## FIGURES

**Bürgel, Bruno Hans** 1875–1948

German astronomer

It is, however, impossible to attain the pure heights of astronomical science without having passed through a chaos of figures and formulae, without having thrown a fleeting glance at the labyrinth of mathematical findings in which the calculators are engaged, to convey a correct idea of the structure and wonders of the universe. And deeper penetration into these dry figures shows them possessed of a peculiar and wondrous charm, for they are the keepers of the key that unlocks infinity to us.

Translated by Stella Bloch

*Astronomy for All*

Chapter IX (p. 105)

Cassell & Co., Ltd. London, England. 1911

**Cutting, Mary Stewart** 1851–1924

Author

It was popularly supposed that figures couldn't lie, but they did; they lied like the dickens.

*The Suburban Whirl and Other Stories of Married Life*

Chapter I (p. 29)

The McClure Co. New York, New York, USA. 1907

**Disraeli, Benjamin, 1st Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Figures are not party men. You may cross the House, yet you cannot convert 15,000 tons into 20,000 tons.

*The Parliamentary Debates* Volume 88

Speech in House of Commons, 1846 (p. 154)

Printed by G. Woodfall & Son. London, England. 1846

**Peirce, Benjamin** 1809–80

American mathematician

It would not be unjust in you to demand an apology of your lecturer for the seeming inconsistency between his customary labors and the subject of his lectures. Enter his workshop; open either of the worn volumes on his table. It is filled with figures. From the beginning to the end it is a mass of figures. Inspect his manuscript. Figures everywhere! nothing but figures! Where is the ideality in this monotonous repetition of the nine digits?

*Ideality in the Physical Sciences*

Lecture I (p. 9)

Little, Brown & Co. Boston, Massachusetts, USA. 1881

**Surtees, Robert Smith**

...if you will allow a man to use figures, he may undertake to prove any thing ...

*Plain or Ringlets?*

Chapter XCIV (p. 390)

Bradbury & Evans. London, England. 1860

## FILTER

**Aristotle** 384 BCE–322 BCE

Greek philosopher

Make a vessel of wax and put it in the sea, fastening its mouth in such a way as to prevent any water getting in. Then the water that percolates through the wax sides of the vessel is sweet, the earth stuff, the admixture of which makes the water salt, being separated off as it were by a filter.

In *Great Books of the Western World* (Volume 8)

*Meteorology*

Book II, Chapter 3, 359a [35]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FINITE

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

Whatsoever we imagine is “finite.”

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (2nd edition)  
Chapter III (p. 22)  
George Routledge & Sons. London, England. 1886

**Morris, Robert Tuttle** 1857–1945  
American surgeon

Like children who are not permitted to do certain things, we are not permitted by nature to think in terms of infinity. We may think in terms of the universe, transcendent minds do that. We may think in terms of the world, the noble mind finds itself so engaged. One may think in terms of his country, a great mind does that. It is fine to think in terms of the state, commendable to think in terms of the town, and one may think in terms of himself if that is his best outlook, but we are not allowed by nature to think in terms of the finite.

*Microbes and Men*  
Chapter I (p. 17)  
Doubleday Page & Co. Garden City, New York, USA. 1916

## FINITE SET

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

God created infinity, and man, unable to understand infinity, had to invent finite sets.

*Discrete Thoughts: Essays on Mathematics, Science and, Philosophy* (2nd ed.)  
Chapter Six (p. 62)  
Birkhäuser. Boston, Massachusetts, USA. 2008

## FIRE

**Adams, George** 1750–95  
English instrument maker

When the spark or atom of fire lies hid in primary matter, it is dark, deformed, and in no ways promising such a fair contexture and life as it will be clothed with when it has built its house or body, in which it seems dormant awhile.

In this sense it was *Vulcan deformis*.  
*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture IX (p. 417)  
Printed by R. Hindmarsh. London, England. 1794

**Dickinson, Emily** 1830–86  
American lyric poet

Fire exists the first in light,  
And then consolidates –  
Only the chemist can disclose  
Into what carbonates.

*The Complete Poems of Emily Dickinson*  
No. 1063 (p. 484)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Gissing, George** –1903  
English novelist

A fire is a delightful thing, a companion and an inspiration. If my room were kept warm by some wretched modern contrivance of water-pipes or heated air, would it be the same to me as that beautiful core of glowing fuel, which, if I sit and gaze into it, becomes a world of wonders? Let science warm the heaven-forsaken inhabitants of flats and hotels as effectually and economically as it may; if the choice were forced upon me, I had rather sit, like an Italian, wrapped in my mantle, softly stirring with a key the silver-grey surface of the brasier's charcoal.

*The Private Papers of Henry Ryecroft* (p. 214)  
E.P. Dutton & Co. New York, New York, USA. 1903

**Hunt, Leigh** 1784–1859  
English author, poet, and editor

...the most intangible of all visible mysteries – fire.  
*Table-talk: To Which Are Added Imaginary Conversations of Pope and Swift*  
Wax and Honey (p. 149)  
Smith, Elder, & Co. London, England. 1902

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Fire is beautiful; some day it will be useful, I think.  
*Eve's Diary*  
Tuesday (p. 65)  
Harper & Brothers. New York, New York, USA. 1906

## FIRMAMENT

**van Gogh, Vincent Willem** 1853–90  
Dutch painter

...the stars always makes me dream, as simply as I dream over the black dots representing towns and villages on a map. Why, I ask myself, shouldn't the shinning dots of the sky be as accessible as the black dots on the map of France?

*The Complete Letters of Vincent van Gogh with Reproductions of all the Drawings in the Correspondence* (Volume 2)  
Letter 506 (p. 605)  
New York Graphic Society. Greenwich, Connecticut, USA. 1958

## FISSION

**Cowan, George A.**  
American physical chemist

...in the design of fission reactors man was not an innovator but an unwitting imitator of nature.

A Natural Fission Reactor  
*Scientific American*, Volume 235, Number 1, July 1976 (p. 47)

**Fermi, Laura** 1907–77  
Italian-born American writer

The counters stepped up; the pen started its upward rise. It showed no tendency to level off. A chain reaction was taking place in the pile. In the back of everyone's mind was one avoidable question, "When do we become scared?"

*Atoms in the Family*

Part I, Chapter 13 (p. 118)

The University of Chicago Press. Chicago, Illinois, USA. 1954

**Lovelock, James Ephraim** 1919–  
English scientist

In the current fashionable denigration of technology, it is easy to forget that nuclear fission is a natural process. If something as intricate as life can assemble by accident, we need not marvel at the fission reactor, a relatively simple contraption, doing likewise.

*Gaia: A New Look at Life on Earth*

Chapter 2 (p. 15)

Oxford University Press, Inc. Oxford, England. 2000

**Teller, Edward** 1908–2003  
Hungarian-born American nuclear physicist

**Teller, Wendy**  
No biographical data available

F stands for fission  
That is what things do  
When they get wobbly and big  
And must split in two.  
And just to complete  
The atomic confusion,  
What fission has done  
Can be undone by fusion.

*Conversations on the Dark Secrets of Physics*

Epilogue (p. 215)

Plenum Press. New York, New York, USA. 1991

## FLAME

### Donald 'Shadow' Rimgale (Fictional character)

It's a living thing, Brian. It breathes, it eats, and it hates. The only way to beat it is to think like it. To know that this flame will spread this way across the door and up across the ceiling, not because of the physics of flammable liquids, but because it wants to. Some guys on this job, the fire owns them, makes 'em fight it on it's level, but the only way to truly kill it is to love it a little.

*Backdraft*

Film (1991)

## FLATLAND

**Abbott, Edwin A.** 1838–1926  
English schoolmaster and theologian

I call our world Flatland, not because we call it so, but to make its nature clearer to you, my happy readers, who are privileged to live in Space.

*Flatland: A Romance of Many Dimensions*

Part I, Section 1 (p. 11)

Little, Brown & Co. Boston, Massachusetts, USA. 1899

## FLATULENCE

**Aristophanes** 448 BCE–380 BCE  
Greek playwright

My wind exploded like a thunder-clap.  
...Iaso blushed a rosy red  
And Panacea turned away her head  
Holding her nose: my wind's not frankincense.

*Plutus*

699

At The University Press. Cambridge, England. 1913

**Sagan, Carl** 1934–96  
American astronomer and author

...bovine flatulence – the intimate intestinal activities of cows, reindeer, elephants, and elk – is detectable over interplanetary distances, while the bulk of the activities of mankind are invisible. We would not ordinarily consider the flatulence of cattle as a dominant manifestation of life on Earth, but there it is.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 22 (p. 150)

Dell Publishing, Inc. New York, New York, USA. 1975

## FLIGHT

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The human bird shall take his first flight, filling the world with amazement, all writings with his fame, and bringing eternal glory to the nest whence he sprang.

Quoted in Dmitry Sergeyeovich Merezhkovsky

*The Romance of Leonardo da Vinci: The Forerunner*

Chapter XI (p. 300)

G.P. Putnam's Sons. New York, New York, USA. 1903

**Merezhkovsky, Dmitry Sergeyeich** 1865–1941  
Russian novelist and critic

There shall be wings!...if the accomplishment be not for me, tis for some other. It shall be done. The spirit cannot



lie; and Man, who shall know all and who shall have wings, shall indeed be as a god.

Translated by Herbert Trench

*The Romance of Leonardo da Vinci: The Forerunner*

Chapter XI (p. 318)

G.P. Putnam's Sons. New York, New York, USA. 1903

**Wilkins, Bishop John** 1614–72

Co-founder of the Royal Society

There are four several ways whereby this flying in the air hath been or may be attempted. Two of them by the strength of other things, and two of them by our own strength: (1) By spirits, or angels. (2) By the help of fowls. (3) By wings fastened immediately to the body. (4) By a flying chariot.

In Charles Balchford Mansfield

*Aerial Navigation*

Part the Second, Chapter II (p. 191)

Macmillan & Company Ltd. London, England. 1877

## FLORA

**Damon, William E.**

No biographical data available

...no fairy-land could exceed in beauty many of the gorgeous bowers formed by the combined productions of the marine flora and the animated dwellers in the submarine depths of the tropical seas.

*Ocean Wonders:*

*Companion for the Seaside*

Chapter I (p. 5)

D. Appleton & Co. New York, New York, USA. 1879

**Kirby, William** 1759–1850

English entomologist

**Spence, William** 1783–1860

English entomologist

Flora with a liberal hand has scattered around us, her charming productions, they every where meet and allure us, enchanting us by their beauty, regaling us by their fragrance, and interesting us as much by their subservience to our luxuries and comfort, as to the necessary support and well-being of our life.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects*

Introductory Letter (pp. 2–3)

Printed for Longman, Hurst, Rees, Orme & Brown. London, England. 1818

## FLORAL

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

He who only does not appreciate floral beauty la to be pitied like any other man who is born imperfect. It is a misfortune not unlike blindness.

*Star Papers*

Experiences of Nature, I (p. 94)

J.B. Ford & Co. New York, New York, USA. 1873

## FLOWER NAME

**Gannett, William Channing**

The flower-names are often little poems in themselves. Those long, uncouth names, dreaded in botany, hide Nature-meanings in them. Heliotrope is “she who turns to the sun”; mesembryanthemum is “flower of the mid-day”; nasturtium carries its meaning of “bent-nose” in its face; geranium is “crane's-bill,” – let the seed-vessel grow and it will tell the reason why; saxifrage is – rock-cleaver, – named so from its birthplace in the clefts; anemone is – wind-flower.” These, you see, were but simple heart and eye names to the Greeks or Romans, just as we call the pets heart's-ease, day's-eye, morning-glory, honeysuckle, mignonette. Each people has its own. Other flower-names come down to us impearled with myth and story, – the hyacinth, narcissus, Solomon's-seal, arethusa, the passion-flower.

*A Year of Miracle*

Chapter 3 (p. 78)

Geo. H. Ellis. Boston, Massachusetts, USA. 1882

## FLUID

**Lamb, Sir Horace** 1848–1934

English applied mathematician

I am an old man now, and when I die and go to Heaven there are two matters on which I hope for enlightenment. One is quantum electrodynamics and the other is the turbulent motion of fluids. And about the former I am rather more optimistic.

In Anderson, Tannehill, and Pletcher

*Computational Fluid Mechanics and Heat Transfer* (p. 197)

## FLUORESCENCE

**Stokes, Sir George** 1819–1903

English mathematician and physicist

I am almost inclined to coin a word and call the appearance *fluorescence*, from fluor-spar, as the analogous term *opalescence* is derived from the name of a mineral.

*Mathematical and Physical Papers* (Volume 3)

On the Change of Refrangibility of Light fn (p. 289)

At the University Press. Cambridge, England. 1901

## FLUOROCHEMISTRY

**de Ment, J.**

No biographical data available

With the increasing number of researches and publications devoted to the applications of fluorescence to

chemistry, a need is rapidly arising to identify this new branch of science as distinct and apart from related and often confused fields. Therefore, it seems expedient to propose the name fluorochemistry as described in this branch of science. The term fluorochemistry is in order with other terms created to identify highly specialized fields which are still within the boundaries of chemistry and/or physics.

Discussion

*Science*, Volume 95, Number 2468, 17 April, 1943 (p. 407)

## FLUXION

**Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

But he who can digest a second or third Fluxion, a second or third Difference, need not, methinks, be squeamish about any Point in Divinity.

*The Works of George Berkeley (Volume 3)*

*The Analyst*

Chapter V (p. 261)

At the Clarendon Press. Oxford England. 1871

## FOCUS

**MacLeod, G. Preston**

No biographical data available

It is a great thing to be able to come to the point.

*The Interpreter's Bible* (p. 187)

Abingdon-Cokesbury Press. New York, New York, USA. 1951–57

## FOLLY

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The greatest piece of folly is that every man thinks himself compelled to hand down what people think they have known.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#563 (p. 196)

The Macmillan Co. New York, New York, USA. 1906

## FOOD

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

...from the least to the greatest in the zoological progression, the stomach sways the world; the data supplied by food are chief among all the documents of life.

Translated by Alexander Teixeira de Mattos and Bernard Miall

*The Wonders of Instinct*

Chapter XIII (p. 269)

The Century Co. New York, New York, USA. 1918

**Stevens, Wallace** 1879–1955

American Modernist poet

Frogs Eat Butterflies. Snakes Eat Frogs.

Hogs Eat Snakes. Men Eat Hogs.

Title of poem

## FOOL

**Abbott, Francis Elingwood** 1836–1903

American scientific realist

Science is universally verified knowledge of a real universe which includes countless individuals; and the very definition of a fool is one who conceives himself wiser than science.

In Brooklyn Ethical Association

*Evolution in Science, Philosophy, and Art:*

*The Scientific Method* (p. 67)

D. Appleton & Co. New York, New York, USA. 1891

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

Of all fools, a floral fool deserves the eminence.

*Star Papers*

*Experiences of Nature*, I (p. 93)

J.B. Ford & Co. New York, New York, USA. 1873

**Feynman, Richard P.** 1918–88

American theoretical physicist

The first principle is that you must not fool yourself – and you are the easiest person to fool. So you have to be very careful about that. After you've not fooled yourself, it's easy not to fool other scientists. You just have to be honest in a conventional way after that.

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

(Caltech commencement address, 1974) *Cargo Cult Science* (p. 343)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

In talking about the impact of ideas in one field on ideas in another field, one is always apt to make a fool of oneself. In these days of specialization there are too few people who have such a deep understanding of two departments of our knowledge that they do not make fools of themselves in one or the other.

*The Meaning of It All*

Chapter I (p. 3)

Addison-Wesley. Reading, Massachusetts, USA. 1998

## FOOTPRINT

**Bird, R. T.**

No biographical data available

We left the woodlot, climbed a fence, and started for the bend in the river. Ryals told a lengthy tale of his experience in quarrying tracks.

“I’ve had a heap o’ fun at it,” he said. “Don’t put much food on the table, but then, what does? Hereabouts, ‘bout the only money-makin’ jobs is cuttin’ cedar posts, boot-leggin’, and quarryin’ dinosaur footprints. And the other two is hot, hard work.”

*Bones for Barnum Brown: Adventures of a Dinosaur Hunter*  
Chapter 29 (p. 147)  
Texas Christian University Press. Ft. Worth, Texas, USA. 1985

**Buckland, William** 1784–1856

English geologist and palaeontologist

The Historian or the Antiquary may have traversed the fields of ancient or of modern battles; and may have pursued the line of march of triumphant Conquerors, whose armies trampled down the most mighty kingdoms of the world. The winds and storms have utterly obliterated the ephemeral impressions of their course. Not a track remains of a single foot, or a single hoof, of all the countless millions of men and beasts whose progress spread desolation over the earth. But the Reptiles, that crawled upon the half-finished surface of our infant planet, have left memorials of their passage, enduring and indelible. No history has recorded their creation or destruction; their very bones are found no more among the fossil relics of a former world. Centuries, and thousands of years, may have rolled away, between the time in which these footsteps were impressed by Tortoises upon the sands of their native Scotland, and the hour when they are again laid bare, and exposed to our curious and admiring eyes. Yet we behold them, stamped upon the rock, distinct as the track of the passing animal upon the recent snow; as if to show that thousands of years are but as nothing amidst Eternity – and, as it were, in mockery of the fleeting perishable course of the mightiest potentates among mankind.

*Geology and Mineralogy Considered With Reference to Natural Theology* (Volume 1)  
Chapter XII (p. 201)  
Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1841

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There is no branch of detective science which is so important and so much neglected as the art of tracing footsteps.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 14 (p. 232)  
Wings Books. New York, New York, USA. 1967

**Hitchcock, Edward** 1793–1864

American geologist

Foot-marks on stone!  
How plain and yet how strange!  
A bird track truly though of giant bulk,  
Yet of the monster every vestige else  
Has vanished. Bird, a problem thou hast solved

Man never has: to leave his trace on earth  
To deep for time and fate to wear away.

The Sandstone Bird  
*American Midland Naturalist*, Volume 10, 1927

**Lowell, Percival** 1855–1916

American astronomer

For animals and plants, too perishable to endure, have left their stamp behind, and even footprints of past reptiles confront us, legible still on the hardened sands of time, as if made yesterday in the spots they traversed hundreds of centuries ago.

*Mars As the Abode of Life*  
Part I, Chapter II (pp. 44–45)  
The Macmillan Co. New York, New York, USA. 1908

**Miller, Hugh** 1802–56

Scottish geologist and theologian

They are fraught with strange meaning, these footprints of Connecticut.

*The Testimony of the Rocks*  
Lecture Second (p. 116)  
Gould & Lincoln. Boston, Massachusetts, USA. 1858

**Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children’s writer, and playwright

“Tracks,” said Piglet. “Paw-marks.” He gave a little squeak of excitement. “Oh, Pooh! Do you think it’s a – a – a Woozle?”

“It may be,” said Pooh. “sometimes it is, and sometimes it isn’t. You can never tell with paw-marks.”

*The Complete Tales & Poems of Winnie-the-Pooh*  
*Winnie-the-Pooh, Pooh and Piglet Go Hunting and Nearly Catch a Woozle* (p. 34)  
Dutton Children’s Books. New York, New York, USA. 2001

**Nixon, Richard M.** 1913–94

37th president of the United States

...the most important thing about man’s first footsteps on the Moon is what they promise for the future.

Statement on the Space Program

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932

Latvian-born German chemist

The mere fact that the footprints of a previous wanderer can be recognized is sufficient to cause the later wanderer to keep in the same path, although he might possibly find another more convenient way if he made himself independent.

*Individuality and Immortality*  
Individuality and Immortality (p. 11)  
Houghton, Mifflin & Co. Boston, Massachusetts, USA.

**Winchell, Alexander** 1824–91

American geologist

It is a solemn and impressive thought that the footprints of these dumb and senseless creatures have been preserved

in all their perfection for thousands of ages, while so many of the works of man which date but a century back have been obliterated from the records of time. Kings and conquerors have marched at the head of armies across continents, and piled up aggregates of human suffering and experience to the heavens, and all the physical traces of their march have totally disappeared; but the solitary biped which stalked along the margins of a New England inlet before the human race was born, pressed footprints in the soft and shifting sand which the rising and sinking of the continent could not wipe out.

*Sketches of Creation*

Chapter XVI (pp. 186–187)

Harper & Brothers Publishers. New York, New York, USA. 1870

## FORBIDDEN

### Gilmore, Robert

No biographical data available

Everything that is not forbidden is compulsory.

*Alice in Quantum Land*

Chapter 3 (p. 44)

Springer-Verlag. New York, New York, USA. 1955

## FORCE

### Buchner, Ludwig 1824–99

German physician and philosopher

Force can as little exist without a substance, as seeing without a visual apparatus, or thinking without an organ of thought.

*Force and Matter*

Chapter I (p. 4)

Trübner & Co. London, England. 1864

### Carlyle, Thomas 1795–1881

English historian and essayist

Force, Force, everywhere Force; we ourselves a mysterious Force in the centre of that. “There is not a leaf rotting on the highway but has Force in it; how else could it rot?”

*On Heroes and Hero Worship*

Lecture I (p. 12)

John B. Alden, Publisher. New York, New York, USA. 1887

### Carpenter, William Benjamin 1813–85

English physiologist and naturalist

Should we not think it absurd on the part of any one who possesses in the use of his hands the means of detecting the error of his visual perceptions, if he were to base a superstructure of reasoning – still more... a whole system of philosophy – upon the latter alone? Yet such appears to me to be the position of those who deny our direct cognition of force.

*The Force Behind Nature*

*Popular Science Monthly*, Volume 16, 1880 (p. 620)

### Clifford, William Kingdon 1845–79

English philosopher and mathematician

Force is not a fact at all, but an idea embodying what is approximately the fact.

*The Common Sense of the Exact Sciences*

Preface (p. ix, fn 2)

B.J. Holdsworth. London, England. 1823

### Dallinger, William Henry 1839–1909

English minister in the Wesleyan Methodist Church

...force is as absolutely inscrutable as mind. Force can never be known in itself; it is known by its manifestations. It is not a phenomenon; it produces phenomena. We cannot know it; but we know nothing without it.

*The Creator*

*The Creator, and What We May Know of the Method of Creation* (p. 4)

T. Woolmer. London, England. 1867

### DuBois-Reymond, Emil 1818–96

German physiologist

Fundamentally considered, there are neither forces nor matter. Both are merely abstractions, assumed from different points of view, of things as they are. They supplement and presuppose each other. Separately they do not exist. Matter is not like a carriage, to which the force, like horses, can be put or again removed from. A particle of iron is, and remains, the same, whether it crosses the horizon in the meteoric stone, rushes along in the wheel of the steam-engine, or circulates in the blood through the temples of the poet. These qualities are eternal, inalienable, and untransferable.

In Ludwig Buchner

*Force and Matter*

Chapter I (p. 1)

Trubner & Company. London, England. 1864

### Faraday, Michael 1791–1867

English physicist and chemist

I do not perceive in any part of space, whether (to use the common phrase) vacant or filled with matter, anything but forces and the lines in which they are exerted.

In Robert K. Adair

*The Great Design* (p. 49)

Oxford University Press, Inc. New York, New York, USA. 1987

I have long held an opinion, almost amounting to conviction, in common I believe with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or, in other words, are so directly related and mutually dependent, that they are convertible, as it were, one into another, and possess equivalents of power in their action.

*Experimental Researches in Electricity* (Volume 3)

Nineteenth series (p. 1)

Bernard Quaritch. London, England. 1855

The long and constant persuasion that all the forces of nature are mutually dependent, having one common

origin, or rather being different manifestations of one fundamental power, has made me often think upon the possibility of establishing, by experiment, a connexion between gravity and electricity, and so introducing the former into the group, the chain of which, including also magnetism, chemical force and heat, binds so many and such varied exhibitions of force together by common relations.

*Experimental Researches in Electricity* (Volume 3)

Twenty-fourth series (p. 161)

Bernard Quaritch. London, England. 1855

...the highest law in physical science which our faculties permit us to perceive...the "conservation of force".

*The Correlation and Conservation of Forces*

Some Thoughts on the Conservation of Force (p. 364)

D. Appleton & Co. New York, New York, USA. 1865

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

...in dealing with force the tacit assumption is always made that the force is equal to zero unless some physical body is present.... One of the most important characteristics of force is that it has a material origin, and this is not just a definition.... If you insist upon a precise definition of force, you will never get it.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 12–1 (p. 12–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Graham, L. A.**

No biographical data available

Hey diddle, diddle,  
The cat and the fiddle,  
The cow jumped into the blue;  
Her leap into action  
Took plenty of traction,

The product of Force times mew.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 8

Dover Publications, Inc. New York, New York, USA. 1959

Humpty Dumpty sat on a wall,  
Wondering how hard he would fall.  
Force times time, you will agree,  
Is equal to mass times velocity.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 15

Dover Publications, Inc. New York, New York, USA. 1959

**Gross, David J.** 1941–

American particle physicist

One of the best of the many Pauli jokes tells of Pauli's arriving in Heaven and being given, as befits a theoretical physicist, an appointment with God. When granted the customary free wish, he requests that God explain to him why the value of the fine-structure constant,  $\alpha = e^2/(4\pi\epsilon_0\hbar c)$ , which measures the strength of the electric force, is 0.00729735.... God goes to the blackboards and starts to write furiously. Pauli watches with pleasure but soon starts shaking his head violently...

On the Calculation of the Fine-Structure Constant

*Physics Today*, Volume 142, Number 13, December, 1989 (p. 9)

**Henry, John**

No biographical data available

...had Newton not been steeped in alchemical and other magical learning, he would never have proposed forces of attraction and repulsion between bodies as the major feature of his physical system.

In John Fauvel, Raymond Flood, Michael Shortland and Robin Wilson (eds.) *Let Newton Be!*

Chapter Six (p. 144)

Oxford University Press, Inc. Oxford, England. 1988

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Whatever attempts have been made by metaphysical writers to reason away the connection of cause and effect, and fritter it down into the unsatisfactory relation of habitual sequence, it is certain that the conception of some more real and intimate connection is quite as strongly impressed upon the human mind as that of the existence of an external world, the vindication of whose reality has, strange to say, been regarded as an achievement of no common merit in the annals of this branch of philosophy. It is our own immediate consciousness of effort, when we exert a force to put matter in motion or to oppose and neutralize force, which gives us this internal conviction of power and causation, so far as it relates to the material world.

*Lardner's Cabinet Cyclopaedia*

Treatise on Astronomy, Volume 3 (p. 232)

London, England. 1830–1832

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

For whenever bodies fall through water and thin air, they must quicken their descents in proportion to their weights, because the body of water and subtle nature of air cannot retard everything in equal degree, but more readily give way, overpowered by the heavier: on the other hand empty void cannot offer resistance to anything in any direction at any time, but must, as its nature craves, continually give way; and for this reason all things must be moved and borne along with equal velocity though of unequal weights through the unresisting void.



*De Rerum Natura*

Book II (p. 33)

George Bell & Sons. London, England. 1903

**Maxwell, James Clerk** 1831–79

Scottish physicist

An inextensible heavy chain  
Lies on a smooth horizontal plane,  
An impulsive force is applied at A,  
Required the initial motion of K.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

A Problem in Dynamics (p. 625)

Macmillan & Company Ltd. London, England. 1882

Gin a body meet a body

Flyin' through the air,

Gin a body hit a body,

Will it fly? and where?

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

In memory of Edward Wilson (p. 630)

Macmillan & Company Ltd. London, England. 1882

Force, then is Force, but mark you! not a thing,

Only a Vector.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

Report on Tait's Lecture on Force (p. 647)

Macmillan & Company Ltd. London, England. 1882

**Michener, James A.** 1907?–97

American novelist

The Luna broke away to start its descent to what Tucker Thompson had told his readers was “the dark and dangerous chasm in which unknown forces threaten the life of any trespasser.” Dr. Mott, reading the report in Folks, growled, “The basic forces are identical with those which govern Brooklyn. Only the landscape is different.”

*Space*

Chapter IX (p. 480)

Random House, Inc. New York, New York, USA. 1982

**Moleschott, Jacob** 1822–93

Dutch scientist, physiologist, and philosopher

Force is not an impelling God, not an essence separate from the material substratum of things. A force not united to matter, but floating freely above it, is an idle conception. Nitrogen, carbon, hydrogen, oxygen, sulphur, and phosphorus, possess their inherent qualities from eternity.

In Ludwig Buechner

*Force and Matter*

Chapter I (p. 1)

Truth Seeker. New York, New York, USA. 1950

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The parts of all homogeneous hard bodies which fully touch one another stick together very strongly. And for explaining how this may be, some have invented hooked atoms, which is begging the question; and others tell us that bodies are glued together by rest...and others, that they stick together by conspiring motions.... I had rather infer from their cohesion that their particles attract one another by some force, which in immediate contact is exceedingly strong, at small distances performs the chemical operations above mentioned, and reaches not far from the particle with any sensible effect.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book Three, Chapter I (3/4 way through chapter)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...nor could the moon without some such force be retained in its orbit. If this force was too small, it would not sufficiently turn the moon out of a rectilinear course; if it were too great, it would turn it too much, and draw down the moon from its orbit towards the earth.

*Mathematical Principles of Natural Philosophy*

Definitions, Definition V

E.P. Dutton & Company. New York, New York, USA. 1922

**Pisko, F. J.**

No biographical data available

And if the inscription on the ancient pyramid of Sais says, "I am all that is, that was, and that will be; no mortal man has yet raised my veil," it might be replied thereto: "Modern science has removed the veil and has discovered that Force and Matter were, are and will be."

In Ludwig Buechner

*Force and Matter: Or, Principles of the Natural Order of the Universe* (p. ii)

Asher & Co. London, England. 1884

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

If nature in her subterraneous abodes is provided with a force that could burst asunder the massy pavement of the globe, and place the fragments upright upon their edges, could she not, by the same effort, raise them from the greatest depths of the sea, to the highest elevation of the land?

*The Works of John Playfair* (Volume 1)

*Illustrations of the Huttonian Theory*, Paragraph 46 (p. 68)

Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**Robb, Alfred Arthur** 1873–1936

English physicist

Here's a health to Professor J.J.!

May he hunt for ions for many a day,



And take observations

And find the relations

Which forces obey.

Postprandial Proceedings of Cavendish Society

The Don of the Day

*The American Physics Teacher*, Volume 7, Number 3, June, 1939

**Slossin, Edwin Emery** 1865–1919

Chemist and author

The forces of the infinitesimal are infinite.

*Creative Chemistry*

Chapter XII (p. 219)

The Century Co. New York, New York, USA. 1921

**Smoot, George** 1945–

American astrophysicist

Using the forces we now know, you can't make the universe we know now.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 32)

Random House, Inc. New York, New York, USA. 1991

**Soddy, Frederick** 1877–1956

English chemist

Forces are not conserved, they have no physical existence, but they still survive even in scientific parlance, mainly because of the poverty of the language, which hardly allows effects to be expressed, without some causal inference.

*Matter and Energy*

Chapter I (pp. 20–21)

Henry Holt & Co. New York, New York, USA. 1912

**Stone, Samuel John** 1839–1900

Anglican clergyman and hymnist

All things are molded by some plastic force

Out of some atoms somewhere up in space.

Soliloquy of a Rationalistic Chicken

*Harper's Monthly*, September, 1875

**Tolstoy, Leo** 1828–1910

Russian writer

A countless number of free forces (for nowhere is man freer than during a battle, where it is a question of life and death) influence the course taken by the fight, and that course never can be known in advance and never coincides with the direction of any one force. If many simultaneously and variously directed forces act on a given body, the direction of its motion cannot coincide with any one of those forces, but will always be a mean – what in mechanics is represented by the diagonal of a parallelogram of forces. If in the descriptions given by historians, especially French ones, we find their wars and battles carried out in accordance with previously formed plans, the only conclusion to be drawn is that those descriptions are false.

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Book Thirteen, Chapter VII (p. 570)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

A moving body whose motion was not retarded by any resisting force would continue to move to all eternity.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects* First Series

On the Conservation of Force (p. 346)

D. Appleton & Co. New York, New York, USA. 1897

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Forces, whose silent operations in elementary nature, and in the delicate cells of organic tissues, still escape our senses, will, when recognized, employed, and awakened to higher activity...enter within the sphere of the endless chain of means which enable man to...control separate domains of nature, and to approximate to a more animated recognition of the Universe as a Whole.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)

General Retrospect (p. 356)

Harper & Brothers. New York, New York, USA. 1869

**Weil, Simone** 1909–43

French philosopher and mystic

Two forces rule the universe: light and gravity.

*Gravity and Grace*

Gravity and Grace (p. 1)

Routledge & Kegan Paul. London, England. 1952

**Whewell, William** 1794–1866

English philosopher and historian

Time, inexhaustible and ever accumulating his efficacy, can undoubtedly do much in geology: – but Force, whose limits we cannot measure, and whose nature we cannot fathom, is also a power never to be slighted: and to call in the one to protect us from the other is equally presumptuous to which ever side out superstition leans.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 3)

Chapter VIII, Section 2 (p. 616)

John W. Parker. London, England. 1837

There is no force, however great,

Can stretch a cord, however fine

Into a horizontal line

Which is accurately straight.

In Charles Carroll Bombaugh

*Gleaning for the Curious From the Harvest-field of Literature*

Metric Prose (p. 228)

A. D. Worthington & Company. Hartford, Connecticut, USA. 1875

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

You unseen force, centripetal, centrifugal, through space's spread,

Rapport of sun, moon, earth, and all the constellations,  
What are the messages by you from distant stars to us?

*Complete Poetry and Collected Prose*

Fancies at Navesink

The Library of America. New York, New York, USA. 1982

### Winsor, Frederick

No biographical data available

Little Miss Muffet

Sits on her tuffet

In a nonchalant sort of way.

With her force field around her

The spider, the bounder,

Is not in the picture today.

*The Space Child's Mother Goose*

Simon & Schuster. New York, New York, USA. 1958

## FORCES

### Faraday, Michael 1791–1867

English physicist and chemist

I do not perceive in any part of space, whether (to use the common phrase) vacant or filled with matter, anything but forces and the lines in which they are exerted.

*Experimental Researches in Electricity* (Volume 3)

Thoughts on Ray-vibrations (p. 450)

Bernard Quaritch. London, England. 1855

## FORECAST

### Aron, Raymond 1905–83

French sociologist and historian

Foreknowledge of the future makes it possible to manipulate both enemies and supporters.

*The Opium of the Intellectuals*

Chapter IX (p. 284)

Secker & Warburg. London, England. 1957

### Cicero (Marcus Tullius Cicero) 106 BCE–43 BCE

Roman orator, politician, and philosopher

I wonder...that a soothsayer doesn't laugh when he sees another soothsayer.

Translated by William Armistead Falconer

*Cicero: De Senectute, De Amicitia, De Divinatione*

De Divinatione, II, XXIV (p. 429)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

### Clarke, Arthur C. 1917–

English science and science fiction writer

Prophecy is a dangerous and thankless business, frequently fatal to those who practice it.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 2)

Harper & Brothers. New York, New York, USA. 1959

### de Jouvenel, Bertrand 1903–87

French man of letters

Forecasting in economics is an activity fully licensed in the City of Action and the City of Intellect. Sought and subsidized by executives in government and business, it is also recognized and accredited by the universities. For it to attain so remarkable a status, two suspicions had to be overcome: that of men of action "the speculative views of intellectuals who lack any experience of reality"; and that, even stronger, of men of learning about "intellectual adventurism which discredits science by going beyond the established facts."

Translated by Nikita Lary

*The Art of Conjecture*

Chapter 16 (p. 179)

Basic Books, Inc. New York, New York, USA. 1967

### Fiedler, Edgar R. 1916–2003

American economist

When you know absolutely nothing about the topic, make your forecast by asking a carefully selected probability sample of 300 others who don't know the answer either.

...

The herd instinct among forecasters makes sheep look like independent thinkers.

...

Forecasting is very difficult, especially about the future.

...

The moment you forecast, you know you're going to be wrong, you just don't know when and in which direction.

...

If you have to forecast, forecast often.

...

He who lives by the crystal ball soon learns to eat ground glass.

The Three R's of Economic Forecasting – Irrational, Irrelevant and Irreverent

*Across the Board*, Volume 14, June, 1977

### Harris, Ralph

No biographical data available

All forecasting is in an important sense backward-looking – vividly compared to steering a ship by its wake.

*Economic Forecasting – Models or Markets?: An Introduction to the Role of Econometrics in Economic Policy* (p. 86)

Institute of Economic Affairs. London, England. 1977

### Heilbroner, Robert 1919–2005

American economist

Rather than projecting the shadow of Tomorrow's unknowable realities, I propose to ask whether it is imaginable – I stress this crucial word – to exercise effective control over the future-shaping forces of Today. This rescues us from the impossible attempt to predict the shape

of Tomorrow, and leaves us with the somewhat less futile effort of inquiring into the possibilities of changing or controlling the trends of the present... Can this intrusion of science and technology be bounded, confined to its needed applications, and kept from sucking the life out of our engagement with nature and with one another? I find that difficult to imagine.

*Visions of the Future: The Distant Past, Yesterday, Today, Tomorrow*  
Chapter 5 (pp. 95, 99)  
Oxford University Press, Inc. New York, New York, USA. 1995

**Henry, Patrick** 1736–1799  
American revolutionary and governor of Virginia

I know of no way of judging the future but by the past.  
Speech  
Second Virginia Convention, March 23, 1775

**Mellor, Joseph William** 1863–1938  
Chemist

Nearly every inference we make with respect to any future event is more or less doubtful. If the circumstances are favorable, a forecast may be made with a greater degree of confidence than if the conditions are not so disposed.  
*Higher Mathematics for Students of Chemistry and Physics*  
Probability and Theory of Errors (p. 498)  
Dover Publications. New York, New York, USA. 1955

**Nicks, Oran W.**  
No biographical data available

Forecasting the future is a chancy thing, but we can nonetheless make out dim shapes of what may lie ahead.  
*This Island Earth*  
Chapter 7 (p. 168)  
National Aeronautics and Space Administration. Washington, D.C. 1970

**Penjer, Michael**  
No biographical data available

We are making forecasts with bad numbers, but bad numbers are all we've got.  
*The New York Times*, September 1, 1989

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

It is far better to foresee even without certainty than not to foresee at all.  
*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
Chapter IX (p. 129)  
The Science Press. New York, New York, USA. 1913

**Strong, Lydia**  
No biographical data available

Two plus two is four? Not to this forecaster. He knows the sales manager (who hired him) wants a different answer.  
...

Will he ever be able to correlate all these facts into one forecast that makes sense? What does it matter? He's just obtained a new and exclusive figure on discretionary consumer income in Hudson N.Y. – and he's sublimely happy.  
...

Why fool around with market research? Why try to correlate economic indicators? The correct prediction will strike suddenly – like a bolt from the blue.  
...

The charts rustle as the wind murmurs through the sacred grove. The high priest interprets the prophecy to the waiting supplicant. Business will improve, he says... unless it takes a turn for the worse.  
...

His forecasts could have been presented at the deadline date – but he's held it up six weeks waiting for information which will clear up one "crucial" point – crucial only to him.  
...

He's fed in enough data for a dozen forecasts – let the electronic brains do the rest. While the THINK machines grind out prophecies, he can relax and contemplate the cosmos.  
...

A forecast is a forecast is a forecast. What if an important new trend developed? All the possibilities were considered three months ago, and it's too late to discuss any further changes in this year's projections.  
*Sales Forecasting: Problems and Prospects*  
*Management Review*, September, 1956

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

It is said that the present is pregnant with the future.  
*The Portable Voltaire*  
Philosophical Dictionary, Concatenation of Events (p. 99)  
The Viking Press. New York, New York, USA. 1959

**Walker, Marshall John**  
American physicist

Men have always valued the ability to predict future events, for those who can predict events can guard against them.  
*The Nature of Scientific Thought*  
Chapter I (p. 2)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Until a scientific theory yields confident forecasts you know it is unsound and tentative; it is mere theorizing, as evanescent as art talk or the phantoms politicians talk about.

*Annual Report of the Board of Regents of the Smithsonian Institution (1902)*  
The Discovery of the Future (p. 384)  
Government Printing Office, Washington, D.C. 1903

## FORESIGHT

**Meyerson, Emile** 1859–1933  
Polish-born French chemist

...foresight is indispensable for action. Now action for any organism of the animal kingdom is an absolute necessity. Surrounded by hostile nature it must act, it must foresee, if it wishes to live. "All life, all action," says Fouillée, "is a conscious or an unconscious divining. Divine or you will be devoured."

Translated by Kate Loewenberg

*Identity & Reality*

Chapter I (p. 22)

George Allen & Unwin Ltd. London, England. 1930

**Shewhart, Walter Andrew** 1891–1967  
American statistician

Hindsight supplements foresight: A view backward often adds materially to a view forward.

*Statistical Method from the Viewpoint of Quality Control*

Epilogue (p. 149)

The Graduate School. The Department of Agriculture. Washington, USA. 1939

## FOREST

**Cather, Willa** 1873–1947  
American writer

...the forest stretched no living man knew how far.

*Shadows on the Rock*

The Apothecary (p. 11)

Alfred A. Knopf. New York, New York, USA. 1931

**Cooper, Susan Fenimore** 1813–94  
American writer and amateur naturalist

What a noble gift to man are the forests ! What a debt of gratitude and admiration we owe for their utility and their beauty !

*Rural Hours*

Saturday, 28th (p. 202)

George W. Putnam. New York, New York, USA. 1850

**Howes, Paul Griswold** 1918–85  
Naturalist

Where man has felled the primitive forest, obliterating nature's labors of half a thousand years, he leaves a wound that is long in healing. Just as a wound in the flesh leaves a scar that stands out distinct from its surroundings, so the forest heals its injury with a new vegetation, distinct from itself, but a mask nevertheless to the ghastly

wound lying beneath.

*Insect Behavior*

Chapter II (p. 27)

R.G. Badger. Boston, Massachusetts, USA. 1919

**Leopold, Aldo** 1886–1948  
American naturalist

When the pioneer hewed a path for progress through the American wilderness, there was bred into the American people the idea that civilization and forests were two mutually exclusive propositions. Development and forest destruction went hand in hand; we therefore adopted the fallacy that they were synonymous. A stump was our symbol of progress.

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

The Popular Wilderness Fallacy: An Idea That Is Fast Exploding (p. 49)

The University of Wisconsin Press

Madison, Wisconsin, USA. 1991

**Marsh, George Perkins** 1801–82  
American diplomat, scholar and conservationist

...when we consider the immense collateral advantages derived from the presence of the forest, the terrible evils necessarily resulting from its destruction, we can not but admit that the preservation of existing woods, and the more costly extension and creation of them where they have been unduly reduced or have never existed, are among the plainest dictates of self-interest and most obvious of the duties which this age owes to those that are to come after it.

*The Earth as Modified by Human Action: A Last Revision of "Man and Nature"* (pp. 381–382)

Charles Scribner's Sons. New York, New York, USA. 1885

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

A forest is in all Mythologies a sacred place, as the oak among the Druids, and the grove of Egeria – And what is Robin Hood – without his Barnsdale and Sherwood – It is the life that is lived in the unexplored scenery of the wood that charms us.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848 (Volume 2)* (p. 37)

Princeton University Press. Princeton, New Jersey, USA. 1984

## FORESTER

**Leopold, Aldo** 1886–1948  
American naturalist

We are entrusted with the protection and development, through wise use and constructive study, of the Timber, water, forage, farm, recreative, game, fish, and esthetic resources of the areas under our jurisdiction. I will call these resources, for short, "The Forest."

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
 To the Forest Officers of the Carson (p. 43)  
 The University of Wisconsin Press  
 Madison, Wisconsin, USA. 1991

The technical education of the American forester aims principally to teach him how to raise and use timber. This is obviously proper. Handling timber lands is his major function.

But when the forester begins actual work on a forest he is called upon to solve a much broader problem. He is charged with the duty of putting land to its highest use.

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
 Forestry and Game Conservation (p. 53)  
 The University of Wisconsin Press  
 Madison, Wisconsin, USA. 1991

## FORESTRY

**Leopold, Aldo** 1886–1948  
 American naturalist

Isaiah (41–9) seems to have had some knowledge of forest types and the ecological relations of species. He quotes Jehovah in this manner: “I will plant in the wilderness the cedar, the Shittah-tree [Hebrew for acacia tree], and the myrtle, and the oil tree; I will set in the desert the fir tree, the pine, and the box tree together.”

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
 Forestry and Game Conservation (pp. 76–77)  
 The University of Wisconsin Press  
 Madison, Wisconsin, USA. 1991

## FORETHOUGHT

**Bronowski, Jacob** 1908–74  
 Polish-born British mathematician and polymath

We are all aware, although we rarely think about it, that all human forethought depends on our recognizing or putting some kind of order into the world. As much as book-keeping, government, and doing the week-end shopping...science is an activity of putting order into our experience... Science is to get rid of angels, blue fairies, and other agents whose intervention would reduce the explanation of physical events to other than physical terms... We must use science as it is, and that is an assembly of observations so ordered that they tell us what we may expect in the future. Science is not only rational; it is also empirical. Science is experiment, that is, orderly and reasoned activity. The essence of experiment and of all science is that it is active. It does not watch the world, it tackles it.

*The Common Sense of Science*  
 Chapter VII, Section 2 (p. 100)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1953

## FORM

**Narby, Jeremy**  
 Swiss anthropologist and author

Nature talks in signs and, to understand its language, one has to pay attention to similarities in form.

*The Cosmic Serpent: DNA and the Origins of Knowledge*  
 Chapter 7 (pp. 96–97)  
 Tarcher/Putnam. New York, New York, USA. 1998

**Sullivan, Louis Henry** 1856–1924  
 American architect

*...form ever follows function ...*  
*Lippincott's Magazine*  
 The Tall Office Building Artistically Considered  
 March, 1896

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
 Scottish zoologist and classical scholar

...our own study of organic form, which we call by Goethe's name of Morphology, is but a portion of that wider still Science of Form which deals with the forms assumed by matter under all aspects and conditions, and, in a still wider sense, with forms which are theoretically imaginable.

*On Growth and Form* (Volume 2)  
 Chapter XVII (p. 1026)  
 At The University Press. Cambridge, England. 1951

...we rise from the conception of form to an understanding of the forces which gave rise to it... in the representation of form we see a diagram of forces in equilibrium, and in the comparison of kindred forms we discern the magnitude and the direction of the forces which have sufficed to convert the one form into the other.

*On Growth and Form* (Volume 2)  
 Chapter XVII (p. 1027)  
 At The University Press. Cambridge, England. 1951

## FORMULA

**Agnew, Ralph Palmer**  
 American mathematician

One who feels that these formulas are complicated need not be disturbed; automobiles are much more complicated and we use them.

*Differential Equations*  
 Chapter 1, Problem 1.391 (p. 11)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

## Author undetermined

for[M-u/l]<sup>a</sup>  
 Source undetermined

**Barr, H. F.**  
 No biographical data available

The young engineer, for example, soon finds that a problem is not always clear or easily defined and that the solution does not involve merely substituting known values into a standard formula.

Typical Problems in Engineering

*General Motors Engineering Journal*, Forward, Set 1, Number 1

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The pursuit of pretty formulas and neat theorems can no doubt quickly degenerate into a silly vice, but so can the quest for austere generalities which are so very general indeed that they are incapable of application to any particular.

*Men of Mathematics* (p. 590)

Simon & Schuster. New York, New York, USA. 1986

**Carlyle, Thomas** 1795–1881

English historian and essayist

When we can drain the Ocean into our mill-ponds, and bottle up the Force of Gravity, to be sold by retail, in our gas-jars; then may we hope to comprehend the infinitudes of man's soul under formulas of Profit and Loss; and rule over this too, as over a patent engine, by checks, and valves, and balances.

*Signs of the Times* (p. 192)

Phillips, Sampson & Co. Boston, Massachusetts, USA. 1858

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

...from the time of Kepler to that of Newton, and from Newton to Hartley, not only all things in external nature, but the subtlest mysteries of life and organization, and even of the intellect and moral being, were conjured within the magic circle of mathematical formulae.

*The Theory of Life*

On the Definitions of Life Hitherto Received (p. 375)

George Ball & Sons. London, England. 1892

**Dudley, Underwood** 1937–

American mathematician

Formulas should be useful. If not they should be astounding, elegant, enlightening, simple, or have some other redeeming value.

Formulas for Primes

*Mathematics Magazine*, Volume 56, Number 1, January, 1983 (p. 22)

Authors who discover formulas should not rush into print. Even as in business and marriage, in mathematics not all that is true needs to be published.

Formulas for Primes

*Mathematics Magazine*, Volume 56, Number 1, January, 1983 (p. 22)

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Books on physics are full of complicated mathematical formulae. But thought and ideas, not formulas, are the beginning of every physical theory.

*The Evolution of Physics*

The Waves of Matter (p. 277)

Simon & Schuster. New York, New York, USA. 1961

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The formulas of science are like the papers in your pocketbook, of no value to any but their owner.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Beauty (p. 1100)

The Library of America. New York, New York, USA. 1983

**Everett, Edward** 1794–1865

Whig Party politician

Although with the majority of those who study and practice in these capacities [engineers, builders, surveyors, geographers, navigators, hydrographers, astronomers], second-hand acquirements, trite formulas, and appropriate tables are sufficient for ordinary purposes, yet these trite formulas and familiar rules were originally or gradually deduced from the profound investigations of the most gifted minds, from the dawn of science to the present day.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 90)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Flammarion, Camille** 1842–1925

French astronomer and writer

We cannot be indifferent to it [astronomy], for it alone teaches us where we are and what we are; and, moreover, it need not bristle with figures, as some severe *savants* would wish us to believe. The algebraical formulae are merely scaffoldings analogous to those which are used to construct an admirably designed palace. The figures drop off, and the palace of Urania shines in the azure, displaying to our wondering eyes all its grandeur and all its magnificence.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter I (p. 1)

Chatto & Windus. London, England. 1894

**Fort, Charles** 1874–1932

American writer

Formulas are against us.

*The Book of the Damned*

Chapter XIV (p. 190)

Boni & Liveright. New York, New York, USA. 1919



**Guyau, Jean-Marie**

No biographical data available

Mathematicians fancy that their formulas are infallible because they are drawn from mathematics, and they have a formula for everything: everything is classed, ticketed, and in such a way as to preclude discussion. How can one dispute with a formula?

*Education and Heredity: A Study In Sociology*

Chapter VI (p. 245)

Walter Scott. London, England. 1891

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The mathematical formulas indeed no longer portray nature, but rather our knowledge of nature.

The Representation of Nature in Contemporary Physics  
*Daedalus*, Volume 87, Number 3, Summer, 1958 (p. 105)

**Hodnett, Edward** 1901–84

Illustration historian

A formula is like a basket. Try to pick up a dozen apples from the ground and carry them in your hands. It is well-nigh impossible. With a basket you can carry as many as you can lift.

*The Art of Problem Solving*

Part II, Chapter 12 (p. 86)

Harper & Brothers. New York, New York, USA. 1955

What you do to a situation when you use a formula approach is to schematize it. You impose a pattern on it...

*The Art of Problem Solving*

Part II, Chapter 12 (p. 89)

Harper & Brothers. New York, New York, USA. 1955

**Hofmann, A. W.**

No biographical data available

...symbolic formulae...would deserve to rank among the chemist's most powerful instruments of research.

*Introduction to Modern Chemistry*

Lecture V (p. 87)

Walton & Maberly. London, England. 1866

**Huxley, Thomas Henry** 1825–95

English biologist

...as the grandest mill in the world will not extract wheat-flour from peascods, so pages of formulae will not get a definite result out of loose data.

*Lay Sermons, Addresses and Reviews*

Chapter XI (p. 249)

D. Appleton & Company. New York, New York, USA. 1871

...there can be little doubt that the further science advances, the more extensively and consistently will all the phenomena of Nature be represented by materialistic formulae and symbols.

*Collected Essays* (Volume 1)

*Method and Result*

On the Physical Basis of Life (p. 164)

Macmillan & Company Ltd. London, England. 1904

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

There is a famous formula – perhaps the most compact and famous of all formulas – developed by Euler from a discovery of the French mathematician de Moivre:  $e^{i\pi} + 1 = 0$ ... It appeals equally to the mystic, the scientist, the philosopher, the mathematician.

*Mathematics and the Imagination*

Transcendental and Imaginary (p. 103)

Simon & Schuster. New York, New York, USA. 1940

**Kipling, Rudyard** 1865–1936

British writer and poet

No proposition Euclid wrote

No formulae the text-books know,

Will turn the bullet from your coat,

Or ward the tulwar's downward blow.

Strike hard who cares – shoot straight who can –

The odds are on the cheaper man.

*Rudyard Kipling's Verse*

Arithmetic on the Frontier (p. 45)

Hodder & Stroughton. London, England. 1919

**London, Jack** 1876–1916

American author

He found books on trigonometry in the mathematics section, and ran the pages, and stared at the meaningless formulas and figures.

*Martin Eden*

Chapter V (p. 43)

The Review of Review's Co. New York, New York, USA. 1916

**Merz, John Theodore** 1840–1922

German-born British chemist, historian, and, industrialist

The mathematical formula is the point through which effect of "all the light gained by science passes in order to be of use to practice; it is also the point in which all knowledge gained by practice, experiment, and observation must be concentrated before it can be scientifically grasped. The more distinct and marked the point, the more concentrated will be the light coming from it, the more unmistakable the insight conveyed.

*A History of European Thought in the Nineteenth Century* (Volume 1)

Part I, Chapter IV (p. 332)

William Blackwood & Sons. Edinburgh, Scotland. 1907

**Mitchell, Margaret** 1900–49

American author

...she knew only that if she did or said thus-and-so, men would unerringly respond with the complimentary

thus-and-so. It was like a mathematical formula and no more difficult, for mathematics was the one subject that had come easy to Scarlett in her schooldays.

*Gone With the Wind* (p. 60)

The Macmillan Co. New York, New York, USA. 1936

**Mitchell, Maria** 1818–89

American astronomer and educator

Every formula which expresses a law of nature is a hymn to praise of God.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 185)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Pearson, Karl** 1857–1936

English mathematician

There is an insatiable desire in the human breast to resume in some short formula, some brief statement, the facts of human experience. It leads the savage to “account” for all natural phenomena by deifying the wind and the stream and the tree. It leads civilised man, on the other hand, to express his emotional experience in works of art, and his physical and mental experience in the formulas or so-called laws of science.

*The Grammar of Science* (2nd edition)

Chapter I (p. 36)

Adam & Charles Black. London, England. 1900

**Peirce, Benjamin** 1809–80

American mathematician

The arithmetical formula, considered as an end, is the embodiment of fact, and isolated fact is as worthless as the idle gossip of the parlor or the club; whereas facts combined into formulae and formulae organized into theory penetrate the whole domain of physical science, and ascend to the very throne of ideality.

*Ideality in the Physical Sciences*

Lecture I (pp. 10–11)

Little, Brown & Co. Boston, Massachusetts, USA. 1881

**Planck, Max** 1858–1947

German physicist

Ever since the observation of nature has existed, it has held a vague notion of its ultimate goal as the composition of the colorful multiplicity of phenomena in a uniform system, where possible, in a single formula.

Translated by Elizabeth Oehlkers

In Ernest Peter Fischer

*Beauty and the Beast*

Chapter 2 (p. 47)

Plenum Trade. New York, New York, USA. 1999

...even if the radiation formula should prove itself to be absolutely accurate, it would after all be only an interpolation...it would still only have, within the significance of a happily chosen interpolation formula, a strictly limited value. For this reason, I busied myself, from then on,

that is, from the day of its establishment, with the task of elucidating a true physical character for the formula...

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1918

The Genesis and Present State of Development of the Quantum Theory (p. 411)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

As long as Natural Philosophy exists, its ultimate highest aim will always be the correlating of various physical observations into a unified system, and, where possible, into a single formula.

Translated by R. Jones and D.H. Williams

*A Survey of Physical Theory*

The Unity of the Physical Universe (p. 1)

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Thanks to the formula, a single algebraic demonstration spares us the pains of going over the same ground time after time for each new calculation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 126)

Government Printing Office. Washington, D.C. 1910

**Royce, Josiah** 1855–1916

American philosopher

The mathematical formulas are conceptions. They constitute admirable and, for their purpose, invaluable ledger entries in our accounts with Nature. For they help us to compute, to predict, to describe, and to classify phenomena. But they do not as literally express the directly observable behavior of any independent facts of Nature as does many a much humbler empirical observation ...

*The World and the Individual*

Lecture V (p. 225)

The Macmillan Co. New York, New York, USA. 1923

**Saint Augustine of Hippo** 354–430

Theologian and doctor of the Church

If I am given a formula, and I am ignorant of its meaning, it cannot teach me anything, but if I already know it what does the formula teach me?

*De Magistro*

Chapter X, 23

Hackett Publishing Company. Indianapolis, Indiana, USA. 1995

**Stoppard, Tom** 1937–

Czech-born English playwright

THOMASINA: If you could stop every atom in its position and direction, and if your mind could comprehend all the actions thus suspended, then if you were really, really, good at algebra you could write the formula for all the future; and although nobody can be so clever to do it, the formula must exist just as if one could.

*Arcadia*

Act I, Scene One (p. 5)

Faber & Faber Ltd. London, England. 1993

**Williamson, Alexander William** 1824–1904  
English chemist of Scottish descent

Not one of them [formulae] can be shown to have any existence, so that the formula of one of the simplest of organic bodies is confused by the introduction of unexplained symbols for imaginary differences in the mode of combination of its elements.... It would be just as reasonable to describe an oak tree as composed of blocks and chips and shavings to which it may be reduced by the hatchet, as by Dr Kolbe's formula to describe acetic acid as containing the products which may be obtained from it by destructive influences. A Kolbe botanist would say that half the chips are united with some of the blocks by the force *parenthesis*; the other half joined to this group in a different way, described by a *buckle*; shavings stuck on to these in a third manner, *comma*; and finally, a compound of shavings and blocks united together by a fourth force, *juxtaposition*, is joined to the main body by a fifth force, *full stop*.

On Dr. Kolb's Additive Formula

*The Quarterly Journal of the Chemical Society of London*, Volume 7  
1855 (p. 133, 134)

## FOSSIL

### Author undetermined

Every little fossil has a meaning all its own –  
Meaning that is clear to me, yes, clear to me alone;  
For every species or variation  
I have found in its own formation –  
Will assist my determination  
Of the stratigraphic zone.

More or Less

*The Pick and Hammer Club*, November 17–18, 1950 (p. 10)

Child of an ancient world! O'er whom the storms  
That shatter'd empires silently have roll'd,  
What awful mysteries could'st thou unfold  
Of Chance and Change in all their various forms!  
Thy frond-like leaves were blooming when in glory,  
Proud Rome and Egypt each beheld its prime,  
And doubtless thou could'st tell us many a story  
Of mighty victors of the olden time.  
Geology, with microscopic eye,  
Regards thee as a phantom metaphoric;  
While Chemistry, whose flight is always high,  
Claims thee as a production meteoric;  
But sister Poesy seems half afraid,  
And wisely keeps her learning in the shade.

*The Museum of Foreign Literature and Science*, Volume 29, 1836 (p. 572)

**Blumenbach, Johann Friedrich** 1752–1840  
German naturalist and anthropologist

If one looks at fossils from the grand viewpoint that they are the most infallible documents in Nature's archives,

demonstrating that our planet has gone through several upheavals, showing even the manner and to some extent the times of these major changes, thus making it possible to determine the relative ages of the various major formations – it is obvious that their history must be regarded as one of the most important and instructive parts of all natural history, and especially of scientific mineralogy.

In Andrew Cunningham and Nicholas Jardine (ed.)

*Romanticism and the Sciences*

In Nicholas A. Rupke

*Caves, Fossils and the History of the Earth* (p. 248)

Cambridge University Press. Cambridge, England. 1990

### Bucher, W. H.

No biographical data available

Since those who know where to find fossils are unwilling to look, and most of those who look at metamorphic rocks do not know what to look for and where, much valuable material must remain undiscovered.

Fossils in Metamorphic Rocks, A Review

*Bulletin of the Geological Society of America*, Volume 64, Number 3,  
March, 1953 (p. 293)

### Callaway, Jack M.

No biographical data available

### Nicholls, Elizabeth L.

No biographical data available

Good index fossils have two key distributional attributes – they are widespread (geography) and they represent short-lived taxa (stratigraphy).

*Ancient Marine Reptiles*

Chapter 14 (p. 427)

Academic Press. San Diego, California, USA. 1997

### Carson, Hampton

 1914–2004

American biologist

The fossil record says eloquently that profuse evolution had indeed occurred over millions of years, but the data just aren't sensitive enough to analyze evolutionary kinetics. This is the province of the evolutionary geneticist who works with descent and change in populations of present-day organisms.

Letters

*Science*, Volume 211, Number 4484, February 20, 1981 (p. 773)

### Committee on Guidelines for Paleontological Collecting

... fossils are very different from human artifacts, but past attempts at regulation have tended to confuse the two. This has led to uncritical and often unfortunate transfers of standards and procedures from archaeology to paleontology.

*Paleontological Collecting*

Executive Summary (p. 2)

National Academy Press. Washington, D.C. 1987

**Conrad, Timothy** 1803–77  
American geologist and malacologist

Methinks I see thee gazing from the stone  
With those great eyes, and smiling in scorn  
Of notions and of systems which have grown  
From relics of the time when thou wert born.  
Ode to a Trilobite  
*Rocks and Minerals*, Volume 8, 1926 (p. 413)

**Cook, James H.** 1857–1942  
No biographical data available

The early fossil hunters surely had to endure hardships in the days when West meant West. I can well remember how most of my western friends regarded the early fossil hunters and naturalists who came to do collecting. They were usually spoken of as bone- or bug-hunting idiots. For anyone to go chasing over the West hunting for petrified bones, or even bugs, was conclusive evidence of his lack of good horse sense, especially in sections of the West where Indians were still wild enough to want to stick their arrows into anything wearing a white skin.  
*Fifty Years on the Old Frontier*  
Supplementary Chapter, *The Agate Springs Fossil Beds* (pp. 280–281)  
University of Oklahoma Press, Norman, Oklahoma, USA. 1992

**Cuppy, Will** 1884–1929  
American humorist and critic

If this egg is really 100,000,000 years old, that would make it older than the dinosaur eggs found by Roy Chapman Andrews in the Gobi Desert and therefore one of the oldest fossil eggs known to man, but that doesn't matter to me. In order to appeal to me...an egg has to have more than mere age. There is such a thing as sentiment. Some of us feel a real affection for Mr. Andrew's dinosaur eggs, and I, for one, am not going to switch to ophiacodon's eggs all of a sudden.  
*How to Get from January to December*  
April 6 (p. 75)  
Henry Holt & Company, New York, New York, USA. 1951

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

The attention of naturalists was early directed to the investigation of the fossil organic remains so generally and abundantly distributed throughout the strata of which the crust of the earth is composed. It is not, as some writers now imagine, entirely a modern study; for even so early as the time of Leibnitz, we find that philosopher drawing and *Essay On the Theory of the Earth*  
Preface (p. v)  
Printed by James Ballantyne & Co. Edinburgh, Scotland. 1817

Life, therefore, has often been disturbed on this earth by terrible events. Numberless living beings have been the victims of these catastrophes; some, which inhabited the dry land, have been swallowed up by inundations; others, which peopled the waters, have been laid dry, from the bottom of the sea having been suddenly raised; their very

remains have been extinguished for ever, and have left no other memorial of their existence than some fragments, which the naturalist can scarcely recognize.  
*Essay on the Theory of the Earth* (5th edition)  
Proofs That These Revolutions Have Been Sudden (p. 15)  
William Blackwood, Edinburgh, Scotland. 1827

It is my object, in the following work, to travel over ground which has as yet been little explored, and to make my reader acquainted with a species of Remains, which, though absolutely necessary for understanding the history of the globe, have been hitherto almost uniformly neglected.  
*An Essay on the Theory of the Earth*  
Section 1 (p. 25)  
Kirk & Mercein. New York, New York, USA. 1818

The importance of investigating the relations of extraneous fossils with the strata in which they are contained is quite obvious. It is to them alone that we owe the commencement even of the Theory of the Earth; as, but for them, we could never have even suspected that there had existed any successive epochs in the formation of our earth, and a series of different and consecutive operations in reducing it to its present state.  
*An Essay on the Theory of the Earth*  
Section 23 (p. 69)  
Kirk & Mercein. New York, New York, USA. 1818

It is also owing to these extraneous fossils, slight as is the knowledge we have hitherto acquired respecting them, that we have yet been enabled to discover the little that we yet know concerning the revolutions of our globe. From them we have learned that the strata, or at least those which contain their remains, have been quietly deposited in a fluid; that the variations of the several strata must have corresponded with the variations in the nature of the fluid; that they have been left bare by the transportation of this fluid to some other place; and that his fact must have happened more than once. Nothing of all this could have been known with certainty, without the aid of extraneous fossils.  
*An Essay on the Theory of the Earth*  
Section 23 (pp. 69–70)  
Kirk & Mercein. New York, New York, USA. 1818

We are ignorant even of the agents which may have held some of these substances in a state of solution; and it is still disputed respecting several of them, whether they have owed their origin to the agency of water or fire. After all, philosophers are only agreed on one point, which is, that the sea has changed its place; and this could have never been certainly known, but for the existence of extraneous fossils. These fossils, then, which have given rise to the theory of the earth, have at the same time furnished its principal illustrations – the only ones, indeed, that have as yet been generally received and acknowledged.  
*An Essay on the Theory of the Earth*  
Section 23 (pp. 70–71)  
Kirk & Mercein. New York, New York, USA. 1818

**Darwin, Charles Robert** 1809–82

English naturalist

Now let us turn to our richest geological museums and what a paltry display we behold! That our collections are imperfect is admitted by everyone. Many fossil species are known from single and often broken specimens. Only a small portion of the earth has been geologically explored, and no part with sufficient care. Shells and bones decay and disappear when left of the bottom of the sea where sediment is not accumulating. We err when we assume that sediment is being deposited over the whole bed of the sea sufficiently quickly to embed fossil remains.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter X (p. 55)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The pleasure of the first day's hunting cannot be compared to finding a fine group of fossil bones, which tell their story of former times with almost a living tongue.

*The Correspondence of Charles Darwin* (Volume 1)

Letter to Sister Catherine, April 6, 1834 (p. 379)

Cambridge University Press. Cambridge, England. 1985

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Fifty million years lay under my feet, fifty million years of bellowing monsters moving in a green world now gone so utterly that its very light was traveling on the far edge of space. The chemicals of all that vanished age lay about me in the ground. The iron did not remember the blood it had once moved within, the phosphorus had forgotten the savage brain...

*The Immense Journey* (p. 171)

Victor Gollancz Ltd. London, England. 1958

**George, T. N.**

No biographical data available

There is no need to apologize any longer for the poverty of the fossil record. In some ways it has become almost unmanageably rich, and discovery is outpacing integration.

Fossils in Evolutionary Perspective

*Science Progress*, Volume 48, 1960 (p. 1)

**Harte, Francis Bret** 1839–1902

American author and poet

Speak, O man, less recent! Fragmentary fossil!  
Primal pioneer of Pliocene formation,  
Hid in lowest drifts below the earliest stratum  
Of volcanic tufa!

In John Burroughs (ed.)

*Songs of Nature*

To the Pliocene Skull, Stanza I

Doubleday, Page & Company. Garden City, New York, USA. 1912

I'll show thee the sinuous track  
By the slow-moving annelid made,  
Or the trilobite, that, farther back,  
In the old Potsdam sandstone was laid.  
Thou shalt see, in his Jurassic tomb,  
The plesiosaurus embalmed;  
In his oolitic prime and his bloom,  
Iguanodon, safe and unharmed!

In John Burroughs (ed.)

*Songs of Nature*

A Geological Madrical, Stanza II

Doubleday, Page & Company. Garden City, New York, USA. 1912

**Hitchcock, Edward** 1793–1864

American geologist

"Not a track remains," says Dr Buckland, "or a single hoof, of all the countless millions of men and beasts whose progress spread desolation over the Earth. But the reptiles that crawled upon the half finished surface of our planet, have left memorials of their passage enduring and indelible." And we may add, that the proudest monuments of human art will moulder down and disappear; but while there are eyes to behold them, the sandstone of the Connecticut valley will never cease to remind the observer of the gigantic races that passed over it while yet in an incipient state.

Rejoinder to the "Discovery of Fossil Footmarks"

*American Journal of Science*, Volume 47, 1844 (p. 321)

**Hitching, Francis**

English writer

...the curious thing is that there is a consistency about the fossil gaps; the fossils are missing in all the important places.

*The Neck of the Giraffe: Where Darwin Went Wrong*

Part One, Chapter One (p. 19)

Ticknor & Fields. New Haven, Connecticut, USA. 1982

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Cuvier, with one eye on Genesis and the other on nature, was striving to please the bigoted reaction by placing fossils in harmony with texts, and letting Moses be flattered by the Mastodons.

*Les Misérables*

Volume I, Book III, Chapter 1 (p. 117)

The Heritage Press. New York, New York, USA. 1938

**Huxley, Thomas Henry** 1825–95

English biologist

Every fossil which takes an intermediate place between forms of life already known, may be said, so far as it is intermediate, to be evidence in favour of evolution, inasmuch as it shows a possible road by which evolution may have taken place. But the mere discovery of such a form does not, in itself, prove that evolution took place by and



through it, nor does it constitute more than presumptive evidence in favour of evolution in general.

*Critiques and Addresses*

Paleontology and the Doctrine of Evolution (p. 187)  
Macmillan & Company Ltd. London, England. 1873

**Ingelow, Jean** 1820–97

English poet and novelist

And delving in the outworks of this world, And little crevices that it [early science] could reach, Discovered certain bones laid up, and furred Under an ancient beach ...

*Poems*

13th Honours (p. 26)  
Longmans, Green & Co. London, England. 1867

**Leakey, Richard Erskine** 1944–

Kenyan paleoanthropologist and politician

I just find the fossils. I'll leave it to the experts to name them.

In Donald C. Johanson and Maitland A. Edey

*Lucy: The Beginnings of Humankind*

Chapter 6 (p. 136)  
Simon & Schuster. New York, New York, USA. 1981

**Leakey, Richard Erskine** 1944–

Kenyan paleoanthropologist and politician

**Lewin, Roger Amos**

Anthropologist

When out fossil hunting, it is very easy to forget that rather than telling you how the creatures lived, the remains you find indicate only where they became fossilized.

*Origins: What New Discoveries Reveal About the Emergence of Our Species and Its Possible Future*

Chapter 5 (p. 96)  
E.P. Dutton. New York, New York, USA. 1977

**Levi-Setti, Riccardo**

No biographical data available

All fossils are, in a way, time capsules that can transport our imagination to unseen shores, lost in the sea of eons that preceded us.

*Trilobites*

Preface (p. vii)  
University of Chicago Press. Chicago, Illinois, USA. 1993

**Lucas, Frederic Augustus** 1852–1929

American naturalist and zoologist

...collecting [fossils] is a lottery, differing from most lotteries, however, in that while some of the returns may be pretty small, there are few absolute blanks and some remarkably large prizes, and every collector hopes that it may fall to his lot to win one of these, and is willing to work long and arduously for the chance of obtaining it.

*Animals of the Past: an Account of Some of the Creatures of the Ancient World* (6th edition)

Chapter VIII (p. 98)

American Museum Of Natural History New York, New York, USA. 1922

**Lyell, Sir Charles** 1797–1875

English geologist

A fossil shell may interest a conchologist, though he be ignorant of the locality from which it came; but it will be of more value when he learns with what other species it was associated, whether they were marine or fresh-water, whether the strata containing them were at a certain elevation above the sea, and what relative position they held in regard to other groups of strata ...

*Principles of Geology* (Volume 1)

Chapter I (p. 3)  
John Murray. London, England. 1830

Then might those genera of animals return, of which the memorials are preserved in the ancient rocks of our continents. The huge iguanodon might reappear in the woods, and the ichthyosaurs in the sea, while the pterodactyl might flit again through umbrageous groves of tree-ferns.

*Principles of Geology* (Volume 1)

Chapter VII (p. 123)  
John Murray. London, England. 1830

Our acquaintance with the living creation of given periods of the past must depend in a great measure on what we commonly term chance; and the casual discovery of new localities, rich in peculiar fossils, may modify or entirely overthrow all our generalisations which are based on the supposed non-existence at former epochs of the fossil representatives of large families or classes of plants and animals.

Anniversary Address

*The Quarterly Journal of the Geological Society of London*, Volume VII 1851 (p. lxxviii)

**Mantell, Gideon Algernon** 1780–1852

English obstetrician, geologist and paleontologist

...the study of those Medals of Creation – those electrotypes of nature – the mineralized remains of the plants and animals which successively flourished in the earlier ages of our planet, in periods incalculably remote, and long antecedent to all human history and tradition.

*The Medals of Creation* (Volume I)

Preface (p. viii)  
Henry G. Bohn. London, England. 1844

**Marsh, O. C.**

No biographical data available

[Fossils are] the stepping stones by which the evolutionist of today leads the doubting brother across the shallow remnant of the gulf, once thought impassable.

Introduction and Succession of Vertebrate Life in North America  
*Nature*, Volume 16, 1877



**McMenamin, Mark**

No biographable data available

**McMenamin, Dianna**

No biographable data available

The worst problem in the search for the oldest animal fossils is mistaken identity.

*The Emergence of Animals: The Cambrian Breakthrough*

Chapter III (p. 31)

Columbia University Press. New York, New York, USA. 1990

**Melville, Herman** 1819–91

American novelist

“Hold!” cried Media, “yonder is a curious rock. It looks black as a whale’s hump in blue water, when the sun shines.”

“That must be the Isle of Fossils,” said Mohi. “Ay, my lord, it is.”

“Let us land, then,” said Babbalanja.

*Typee, Omoo, Mardi*

Mardi

Chapter 132 (p. 1070)

The Library of America. New York, New York, USA. 1982

**Miller, Hugh** 1802–56

Scottish geologist and theologian

There is scarce an architectural ornament of the Gothic or Grecian styles which may not be found existing as fossils in the rocks.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two*

*Theologies, Natural and Revealed*

Lecture Sixth (p. 255)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

The different degrees of entireness in which, the geologist finds his organic remains depend much less on their age than on the nature of the rock in which they occur ...

*The Old Red Sandstone*

Chapter IX (p. 151)

John B. Alden, Publisher. New York, New York, USA. 1892

The older fossils, therefore, like the mummies of Egypt, can be described well nigh as minutely as the existences of the present creation: the newer, like the comparatively modern remains of our churchyards, exist, except in a few rare cases, as mere fragments ...

*The Old Red Sandstone*

Chapter IX (p. 152)

John B. Alden, Publisher. New York, New York, USA. 1892

**Morris, Henry** 1918–2006

American creationist

Never are fossils of creatures found with incipient eyes, with half-way wings, with half-scales turning into feathers, with partially-evolved forelimbs, or with any other nascent or transitional characters. Yet there must have been innumerable individuals which possessed such

features, if the neo-Darwinian model of evolutionary history is correct.

*The Troubled Waters of Evolution*

Chapter IV (pp. 91–92)

Creation-Life Publishers. San Diego, California, USA. 1974

**Nicholson, Norman** 1914–87

English poet

In the bones of the rock

The fossils are living,

Crinoid and ammonite;

In the red of the rock

(Sandstone and hematite)

The fossils are moving,

Coiling, crawling,

Aching for the sea.

In Neil Curry (ed.)

*Norman Nicholson Collected Poems*

Fossils (p. 216)

Faber & Faber Ltd. London, England. 1994

**Osborn, Henry Fairfield** 1857–1935

American paleontologist and geologist

The hunter of wild game is always bringing live animals nearer to death and extinction, whereas the fossil hunter is always seeking to bring extinct animals to life.

In Robert West Howard

*The Dawnseekers: The First History of American Paleontology*

Chapter 17 (p. 238)

Harcourt Brace Jovanovich. New York, New York, USA. 1975

**Parkinson, James** 1755–1824

English physician and paleontologist

The study of fossil organized remains has hitherto been directed too exclusively to the consideration of the specimens themselves; and hence has been considered rather as an appendix to botany and zoology, than as (what it really is) a very important branch of geological inquiry.

Observations on Some of the Strata in the Neighborhood of London, and on the Fossil Remains Contained in Them

*Geological Society of London Transactions*, Volume 1, 1811 (p. 324)

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist and author

...every fossil on a museum shelf is a three-fold miracle. First, the plant had to die under the most exceptional conditions remote from the normal course of events, which is swift decay, dissolution, and reworking of the mold into new forms of life. Then, by a wildly fortuitous set of circumstances, the fossilized evidence must not be washed into the sea, or buried several miles under sedimentary rocks, but had to come to light, be bared by erosion, or deprived of its Stygian privacy in the course of mining or excavating. And then, as the most unlikely chance of all, a paleobotanist (a very rare fellow even in a densely packed congress of botanists) had to pass by

and collect the specimen before it was burned for coal, ground up for cement, washed away or otherwise hopelessly obliterated.

*Flowering Earth*

Chapter 7 (pp. 79–80)

G.P. Putnam's Sons. New York, New York, USA. 1939

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

A very little attention to the phenomena of the mineral kingdom is sufficient to convince us that the conditions of the earth's surface has not been the same at all times that it is at the present moment. When we observe the impressions of plants in the heart of the hardest rocks; when we discover trees converted into flint, and entire beds of limestone or of marble composed of shells and corals; we see the same individual in two states, the most widely different from one another; and, in the latter instance, we have clear proof, that the present land was once deep immersed under the waters of the ocean.

*Illustrations of the Huttonian Theory of the Earth*

Illustrations, &c. (p. 1)

Dover Publications, Inc. New York, New York, USA. 1964

The series of changes which fossil bodies are defined to undergo does not cease with their elevation above the level of the sea; it assumes, however, a new direction, and from the moment that they are raised up to the surface, is constantly exerted in reducing them again under the dominion of the ocean. The solidity is now destroyed which was acquired in the bowels of the earth; and as the bottom of the sea is the great laboratory, where loose materials are mineralized and formed into stone, the atmosphere is the region where stones are decomposed, and again resolved into earth.

*Illustrations of the Huttonian Theory of the Earth*

Section III, 92 (p. 97)

Dover Publications, Inc. New York, New York, USA. 1964

**Robertson, Percival**

No biographical data available

The greatest interest lies in the study of fossils in the field, but even if I were located where it was impossible to study fossils in the field, I still think that fossils should be the central theme of historical geology – not pictures of fossils, not drawings of fossils, not lantern slides of fossils, but the little “bugs” themselves.

Holding Student Interest in Historical Geology

*Journal of Geological Education*, Volume 1, Number 3, April, 1952 (pp. 34–35)

**Rolt-Wheeler, Francis** 1876–1960

No biographical data available

If every youngster in the United States would look around for fossils when he got the chance, we'd probably find more new species in a year than we find now in ten years.

*The Monster-hunters*

Chapter IX (p. 274)

Lothrop, Lee & Shepard Co. Boston, Massachusetts, USA. 1916

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

DON JUAN: You forget that brainless magnificence of body has been tried. Things immeasurably greater than man in every respect but brains have existed and perished. The megatherium, the ichthyosaurus have paced the earth with seven-league steps and hidden the day with cloud vast wings. Where are they now? Fossils in museums, and so few and imperfect at that, that a knuckle bone or a tooth of one of them is prized beyond the lives of a thousand soldiers.

*Man and Superman: A Comedy and a Philosophy*

Act III (p. 83)

The Heritage Press. New York, New York, USA. No date

**Simpson, George Gaylord** 1902–84

American paleontologist

The history of life ceases to be hypothesis and inference and becomes direct knowledge when fossils are available.

*Life: An Introduction to Biology*

Chapter 29 (p. 756)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

Fossil hunting is by far the most fascinating of all sports. It has some danger, enough to give it zest and probably about as much as in the average modern engineered big-game hunt, and danger is wholly to the hunter. It has uncertainty and excitement and all the thrill of gambling with not of its vicious features. The hunter never knows what his bag may be, perhaps nothing, perhaps a creature never before seen by human eyes. It requires knowledge, skill, and some degree of hardihood. And its results are so much more important, more worthwhile than those of any other sport! The fossil hunter does not kill, he resurrects. And the result of this sport is to add to the sum of human pleasure and to the treasure of human knowledge.

*Attending Marvels: A Patagonian Journal*

Chapter IV (p. 83)

The Macmillan Company. New York, New York, USA. 1934

**Skwara, T.**

No biographical data available

Fossils in isolation are antiquarian objects; in the absence of context and concepts they are mute. But with conceptual models and technical tools at our disposal, a rich and luxurious tapestry – the history of life on earth – emerges. Fossils, time, and change are the foundations of that history.

*Old Bones and Serpent Stones: A Guide to Interpreted Fossil Localities in Canada and the United States*

Section I (p. 9)

McDonald & Woodward. Blacksburg, Virginia, USA. 1992

**Smith, William**

No biographical data available

Rural amusements to those who can enjoy them, are the most healthful; and the search for a fossil may be considered at least as rational as the pursuit of a hare.

*Stratigraphical System of Organized Fossils*

Preface (p. vi)

Printed for E. William. London, England. 1817

Fossils have long been studied as great Curiosities collected with great pains treasured up with great Care and at great Expense and shown and admired with as much pleasure as a Child's rattle or his Hobbyhorse is shown and admired by himself and his playfellows – because it is pretty. And this has been done by Thousands who have never paid the least regard to that wonderful order & regularity with which Nature has disposed of these singular productions and assigned to each Class its peculiar Stratum.

In John G.C.M. Fuller

The Industrial Basis of Stratigraphy: John Strachey and William Smith

*American Association of Petroleum Geologists Bulletin*, Volume 53, 1968

**Sonneberg, Walter**

No biographical data available

Fossils tell a tale which the veriest child might build into a novel.

*Social Eccentricities*

Social Eccentricities (p. 9)

Broadway Publishing Co. New York, New York, USA. 1906

**Spencer, Herbert** 1820–1903

English social philosopher

Whoever has not sought for fossils, has little idea of the poetical associations that surround the places where imbedded treasures were found.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 72)

A.L. Fowle. New York, New York, USA. 1860

**Tennyson, Alfred (Lord)** 1809–92

English poet

And, below, stuck out

The bones of some vast bulk that lived and roared Before man was.

*The Works of Alfred Lord Tennyson, Poet Laureate*

The Princess (p. 24)

The Macmillan Co. New York, New York, USA. 1898

Huge Ammonites, and the first bones of Time.

*The Works of Alfred Lord Tennyson, Poet Laureate*

The Princess: Prologue (p. 24)

The Macmillan Co. New York, New York, USA. 1898

**Watson, Lyall**

No biographical data available

The fossils that decorate our family tree are so scarce that there are still more scientists than specimens. The remarkable fact is that all the physical evidence we have for human evolution can still be placed, with room to spare, inside a single coffin!

The Water People

*Science Digest*, Volume 90, May, 1982 (p. 44)

**FOSSIL COLLECTOR****Hutchinson, Henry Neville**

No biographical data available

Every fossil-collector is delighted when he comes across a fossil fish; one gets rather tired of everlasting mollusca, and a fish cropping up now and then is a great encouragement to a geologist.

*Creatures of Other Days*

Chapter II (p. 23)

Chapman & Hall. London, England. 1894

**FOSSIL HUNTER****Leakey, Richard Erskine** 1944–

Kenyan paleoanthropologist and politician

**Lewin, Roger**

English anthropologist

A fossil hunter needs sharp eyes and a keen search image, a mental template that subconsciously evaluates everything he sees in his search for telltale clues. A kind of mental radar works even if he isn't concentrating hard. A fossil mollusk expert has a mollusk search image. A fossil antelope expert has an antelope search image.... Yet even when one has a good internal radar, the search is incredibly more difficult than it sounds.

*Origins Reconsidered: In Search of What Makes Us Human*

Chapter 2 (p. 26)

Doubleday. New York, New York, USA. 1992

**FOSSIL INDEX****Shaw, Alan B.**

No biographical data available

It would be difficult to estimate how many nascent geologists have been turned aside from paleontology by being forced during the course of some dismal semester to learn hundreds of index fossils and the formations of which they are the index. Many geologists' sole memory of the whole discipline of paleontology is the unerasable fact that "*Spirifer frimesi* is the index fossil of the Burlington Limestone" or some such tidbit.

*Time in Stratigraphy*  
Chapter 13 (p. 90)  
McGraw-Hill Book Company. New York, New York, USA. 1964

## FOSSIL, COSMIC

**Gaarder, Jostein** 1952–  
Norwegian intellectual

Everything we see in the sky is a cosmic fossil from thousands and millions of years ago.

*Sophie's World: A Novel about the History of Philosophy*  
The Big Bang (p. 392)  
Farrar, Straus & Giroux New York, New York, USA. 1994

## FRACTAL

**Krantz, Steven** 1951–  
Mathematician

There is not even a universally accepted definition of the term “fractal.” It seems that if one does not prove theorems (as, evidently, fractal geometers do not), then one does not need definitions. One notable difference between fractal geometry and calculus is that fractal geometry has not solved any problems. It is not even clear that it has created any new ones.

Fractal Geometry  
*The Mathematical Intelligencer*, Volume 11, Number 4, Fall, 1989 (pp. 13–14)

**Mandelbrot, Benoit B.** 1924–  
French mathematician

I coined *fractal* from the Latin adjective *fractus*. The corresponding Latin verb *frangere* means “to break:” to create irregular fragments...how appropriate for our needs!

*The Fractal Geometry of Nature*  
Introduction (p. 4)  
W.H. Freeman & Co. San Francisco, California, USA. 1983

**Paulos, John Allen** 1945–  
American mathematician

...the simple equations that generate the convoluted Mandelbrot fractal have been called the wittiest remarks ever made.

*Once Upon a Number: The Hidden Mathematical Logic of Stories*  
Appendix: Humor and Computation (pp. 130–131)  
Basic Books. New York, New York, USA. 1998

## FRACTAL GEOMETRY

**Barnsley, Michael F.**  
No biographical data available

Fractal geometry will make you see everything differently. There is danger in reading further. You risk the loss of your childhood vision of clouds, forests, flowers, galaxies, leaves, feathers, rocks, mountains, torrents

of water, carpets, bricks, and much else besides. Never again will your interpretation of these things be quite the same.

*Fractals Everywhere*  
Chapter 1 (p. 1)  
Academic Press, Inc. San Diego, California, USA. 1993

## FRACTION

**Alcott, Louisa May** 1832–88  
American author

As Rose stood by him watching the ease with which he quickly brought order out of chaos, she privately resolved to hunt up her old arithmetic and perfect herself in the four first rules, with a good tug at fractions, before she read any more fairy tales.

*Eight Cousins*  
Chapter 8 (p. 72)  
Little, Brown & Co. Boston, Massachusetts, USA. 1996

**Beckmann, Petr** 1924–93  
Physicist

Continued fractions are part of the “lost mathematics,” the mathematics now considered too advanced for high school and too elementary for college.

*A History of Pi*  
Chapter 12 (p. 129)  
St. Martin's Press. New York, New York, USA. 1974

**Benson, Donald C.**  
No biographical data available

Getting fractions right is the first slippery step in the mathematical education of many schoolchildren, a place where many fall.

*A Smoother Pebble*  
Part I, Chapter 1 (p. 5)  
Oxford University Press. Oxford, England. 2003

**Burr, Lehigh**  
No biographical data available

“My daughter,” and his voice was stern,  
“You must set this matter right;  
What time did the Sophomore leave,  
Who sent in his card last night?”  
“His work was pressing, father dear,  
And his love for it was great;  
He took his leave and went away  
Before a quarter of eight.”  
Then a twinkle came to her bright blue eye,  
And her dimple deeper grew.  
“Tis surely no sin to tell him that,  
For a quarter of eight is two.

In R.L. Paget  
*Poetry of American Wit and Humor*  
Applied Mathematics (p. 302)  
Page. Boston, Massachusetts, USA. 1899

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

Is a woman a thinking unit at all, or a fraction always wanting its integer?

*Jude the Obscure*

Part V, Chapter III (p. 430)

The Modern Library. New York, New York, USA. 1923

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

Some of the unmathematical believe that the mathematician is merely engaged in counting or in doing long sums; this probably arises from reminiscences of their schooldays, when they were flogged over fractions.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 10)

D. van Nostrand Co. New York, New York, USA. 1893

**Weaver, Jefferson Hane**  
American science author

Gulp! A fraction! Well, sometimes we simply have to face our fears squarely and march forward.

*Conquering Calculus: The Easy Road to Understanding Mathematics*

Chapter 4 (p. 96)

Plenum Press. New York, New York, USA. 1998

## FRACTURE

**Hippocrates** 460 BCE–377 BCE  
Greek physician

In treating fractures and dislocations, the physician must make the extension as straight as possible, for this is the most natural direction. But if it inclines to either side, it should rather turn to that of pronation, for there is thus less harm than if it be towards supination.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On Fractures, 1 (p. 74)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FRAGMENT

**Merriam, John C.** 1869–1945  
American paleontologist

The story of life as it comes to us through the ages must in many cases be built upon fragments. This does not signify that it is therefore untrustworthy. Nor should it be assumed that it is always fragmentary. A clear understanding of the record requires appreciation of the nature of the evidence, especially if it rest upon interpretation of limited information.

*The Living Past*

Chapter 1 (p. 3)

C. Scribner's Sons. New York, New York, USA. 1930

## FREEDOM

**Hoagland, Hudson** 1899–1982  
American physiologist

All scientists must be heretics and dissenters against accepted views in science if science itself is to advance. Freedom is thus essential to a scientific society, one in evolution. It is merely a nuisance to be discouraged in a static, authoritarian society.

Science and the New Humanism

*Science*, Volume 143, Number 3062, 10 January, 1964 (pp. 112–113)

## FRICTION

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

On the ice rink I am communing with the fundamental laws of physics. At the instant of creation we believe that the Universe was symmetrical, it was pure, it was elegant. Without friction Newtonian laws are laid bare, simple, elegant and beautiful, pure, noble, elemental, just like it was at the beginning of time.

Parallel Universes

BBC broadcast February 14, 2002

**Whately, Richard** 1787–1863  
English theologian

The closer two bodies act together, the more they will want oiling to prevent friction.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D.*

Apothegm 5 (p. 1)

Longman, Green, Longman, Roberts & Green. London, England. 1865

## FUNCTION

**Agnew, Ralph Palmer**  
American mathematician

Just as a lass may walk through the grass and, seeing no snakes, believe that there are no snakes, so also a student, may pass through elementary calculus and, seeing only elementary functions may for integrals, believe that each elementary function necessarily has an elementary function for an integral.

*Differential Equations*

Chapter 13 (p. 432)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

One should not forget that the functions, like all mathematical constructions, are only our own creation, and that when the definition with which one begins ceases to



make sense, one should not ask, what is, but what is convenient to assume in order that it [remain] significant.

In Bryan H. Bunch

*Mathematical Fallacies and Paradoxes*

Chapter 1 (p. 1)

van Nostrand Reinhold Company. New York, New York, USA. 1982

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Every one is familiar with the ordinary notion of a function – with the notion, that is, of the lawful dependence of one or more variable things upon other variable things, as the area of a rectangle upon the lengths of its sides, as the distance traveled upon the rate of going, as the volume of a gas upon the temperature and pressure, as the prosperity of a throat specialist upon the moisture of the climate, as the attraction of material particles upon the distance asunder, as the rate of chemical change upon the amount or the mass of the substance involved, as the turbulence of labor upon the lust of capital, and so on and on without end.

*Mathematical Philosophy: A Study of Fate and Freedom*

Lecture III (pp. 49–50)

E.P. Dutton & Company. New York, New York, USA. 1922

The connections shown by these particular examples hold in general: given a transformation, you have a function and a relation; given a function, you have a relation and a transformation; given a relation, you have a transformation and a function: one thing – three aspects; and the fact is exceedingly interesting and weighty.

*Mathematical Philosophy: A Study of Fate and Freedom*

Lecture X (pp. 167–168)

E.P. Dutton & Company. New York, New York, USA. 1922

**McCormack, Thomas J.**

No biographical data available

That flower of modern mathematical thought – the notion of a function.

On the Nature of Scientific Law and Scientific Explanation

*Monist*, Volume 10, 1899–1900 (p. 555)

**Merz, John Theodore** 1840–1922

German-born British chemist, historian, and industrialist

Nature herself exhibits to us measurable and observable quantities in definite mathematical dependence; the conception of a function is suggested by all the processes of nature where we observe natural phenomena varying according to distance or to time. Nearly all the “known” functions have presented themselves in the attempt to solve geometrical, mechanical, or physical problems.

*A History of European Thought in the Nineteenth Century* (Volume 2)

Chapter XIII (p. 696)

William Blackwood & Sons. Edinburgh, Scotland. 1903

**Montel, Paul** 1876–1975

French mathematician

Functions, just like living beings are characterized by their singularities.

Quoted in Vladimir Igorevich Arnold

*Catastrophe Theory*

Preface to the Third Russian Edition (p. vii)

Springer-Verlag. Berlin. Germany. 1986

**Rankine, William John Macquorn** 1820–72

Scottish engineer and physicist

Let x denote beauty, y manners well-bred,  
z fortune (this last is essential),

Let L stand for love – our philosopher said –

Then L is a function of x, y and z

Of the kind that is known as potential.

*Songs and Fables*

The Mathematician in Love, Verse 6

J. Maclehoose, Glasgow, Scotland. 1874

**Roe, Jr., E. D.**

No biographical data available

The continuous function is the only workable and usable function. It alone is subject to law and the laws of calculation. It is a loyal subject of the mathematical kingdom. Other so-called or miscalled functions are freaks, anarchists, disturbers of the peace, malformed curiosities which one and all are of no use to anyone, least of all to the loyal and burden-bearing subjects who by keeping the laws maintain the kingdom and make its advance possible...scholarship lies in the direction of paying deference to the loyal continuous function rather than to the outlaws of mathematical society.

A Generalized Definition of Limit

*The Mathematics Teacher*, Volume III, Number 1, September, 1910 (p. 4)

## FUNDING

**Dunlap, Knight**

No biographical data available

It is easier for a man to get funds for what he proposes to do than for what he is doing.

The Outlook for Psychology

*Science*, Volume 69, Number 1782, February 22, 1929 (p. 206)

**Loehle, Craig**

Mathematical ecologist

What would have happened if Darwin and Einstein as young men had needed to apply for government support? Their probability of getting past the grant reviewers would be similar to a snowball surviving in Hell.

A Guide to Increased Creativity in Research – Inspiration or Perspiration?

*BioScience*, Volume 40, Number 2, February, 1990 (p. 125)



## FUSION

### Macaulay, Robert B.

No biographical data available

Fission is like kissing your wife. Fusion is like kissing your mistress.

*Globe and Mail*, Toronto, June 8, 1983

### Pauli, Wolfgang 1900–58

Austrian-born physicist

Let no man join together what God hath put asunder.

In Robert P. Crease and Charles C. Mann

How the Universe Works

*The Atlantic Monthly*, August, 1984 (p. 68)

### Winsor, Frederick

No biographical data available

The Hydrogen Dog and the Cobalt Cat

Side by side in the Armory sat.

Nobody thought about fusion or fission,

Everyone spoke of their peacetime mission,

Till somebody came and opened the door,

There they were, in a neutron fog,

The Codrogen Cat and the Hybalt Dog;

They mushroomed up with a terrible roar –

And Nobody Never was there – No more.

*The Space Child's Mother Goose*

Simon & Schuster. New York, New York, USA. 1958

## FUTURE

### Adams, Henry Brooks 1838–1919

American man of letters

Man has mounted science, and is now run away with. I firmly believe that before many centuries more, science will be the master of man. The engines he will have invented will be beyond his strength to control. Some day science may have the existence of mankind in its power, and the human race commit suicide by blowing up the world. Not only shall we be able to cruize in space, but I see no reason why some future generation shouldn't walk off like a beetle with the world on its back, or give it another rotary motion so that every zone should receive in turn its due portion of heat and light.

In Worthington Chauncey Ford

*A Cycle of Adams Letters, 1861–1865* (Volume 1)

Letter to Charles Francis Adams (p. 135)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1920

### Bernal, John Desmond 1901–71

Irish-born physicist and x-ray crystallographer

There are two futures, the future of desire and the future of fate, and man's reason has never learnt to separate them.

*The World, the Flesh & the Devil*

The Future

Dutton. New York, New York, USA. 1929

We care less about the more distant future, but to approach it at all we must divest ourselves of so many customary forms, that even the more enlightened prophets lets their imagination stop in some static Utopia in despite of all evidence pointing to ever increasing acceleration of change.

*The World, the Flesh & the Devil*

The Future

Dutton. New York, New York, USA. 1929

### Boulding, Kenneth E. 1910–93

English economist and social scientist

There are only two things we know about the future. One is where and when eclipses will take place and the other is that a kitten will never grow up into a rhinoceros.

The Dodo Didn't Make It: Survival and Betterment

*Bulletin of the Atomic Scientists*, Volume XXVIII, Number 5, May, 1971 (p. 20)

### Brewster, David 1781–1868

Scottish scientist, inventor and writer

Interesting as has been the past history of our race, – engrossing as must ever be the present, – the future, more exciting still, mingles itself with every thought and sentiment, and casts its beams of hope, or its shadows of fear, over the stage both of active and contemplative life.

*More Worlds Than One: The Creed of the Philosopher and the Hope of the Christian*

Chapter I (p. 8)

Chatto & Windus. London, England. 1876

### Davy, Sir Humphry 1778–1829

English chemist

The future is composed merely of images of the past, connected in new arrangements by analogy, and modified by the circumstances and feelings of the moment...

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 18)

Press of the Royal Institution of Great Britain. London. 1802

### Einstein, Albert 1879–1955

German-born physicist

The scientist is possessed by the sense of universal causation. The future, to him, is every whit as necessary and determined as the past.

*Ideas and Opinions*

The Religious Spirit of Science (p. 40)

Crown Publishers, Inc. New York, New York, USA. 1954

### Eiseley, Loren C. 1907–77

American anthropologist, educator, and author

In the extravagant pursuit of a future projected by science, we have left the present to shift for itself. We have regarded science as a kind of twentieth-century substitute for magic, instead of as a new and burgeoning social institution whose ways are just as worthy of objective study as our political or economic structures. In short, the future has become our primary obsession. We constantly treat our scientists as sooth-sayers and project

upon them questions involving the destiny of man over prospective millions of years.

*The Invisible Pyramid*

Chapter Four (p. 105)

University of Nebraska Press. Lincoln, Nebraska, USA.

**Flammarion, Camille** 1842–1925

French astronomer and writer

Like the eagle which rises higher and higher in the upper regions where the atmosphere itself loses its density, so we sail ourselves over-looking the mysterious horizons of the future.

Translated by John Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book III, Chapter VI (p. 313)

Chatto & Windus. London, England. 1907

**Fromm, Erich** 1900–80

German psychoanalyst

The danger of the past was that men became slaves. The danger of the future is that we may become robots.

*The Dogma of Christ: And Other Essays on Religion, Psychology and Culture*

The Present Human Condition (p. 101)

Henry Holt & Co. New York, New York, USA. 1963

**Hilbert, David** 1862–1943

German mathematician

Who of us would not be glad to lift the veil behind which the future lies hidden; to cast a glance at the next advances of our science and at the secrets of its development during future centuries?

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902 (p. 437)

**Igor Dmitriyevich Novikov** 1935–

Russian theoretical astrophysicist and cosmologist

This possibility of visiting the future is quite awesome to anyone who learns about it for the first time ...

Translated by Vitaly Kisin

*The River of Time*

Chapter 5 (p. 73)

Cambridge University Press. Cambridge, England. 2001

**Kapitza, Pyetr Leonidovich** 1894–1984

Russian physicist

...only by having a clear perspective of the future can we rightly direct our work in the present.

*The Collected Papers of P.L. Kapitza* (Volume 3)

Chapter 26 (p. 190)

Pergamon Press. Oxford, England. 1967

**Lawrence Ernest O.** 1901–58

American physicist

In a discussion bearing on the future, the scientist is always in something of a dilemma. On the one hand, he

is cautioned to make only very limited prognostications, for he has learned the limited region of applicability of existing knowledge and the likelihood of error in speculation. On the other hand, he faces the future with eager excitement and curiosity about what is beyond the present frontiers of knowledge, and he is naturally tempted to speculate and indeed to indulge in day dreams.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1941*

The New Frontiers in the Atom (p. 163)

Government Printing Office. Washington, D.C. 1942

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

When the time is run, and that future become history, it will be clear how little of it we today foresaw or could foresee.

*The Open Mind*

Chapter III (p. 53)

Simon & Schuster. New York, New York, USA. 1955

**Poincaré, Lucien** 1862–1920

French physicist

It would doubtless be exceedingly rash, and certainly very presumptuous, to seek to predict the future which may be reserved for physics. The role of prophet is not a scientific one, and the most firmly established precisions of to-day may be overthrown by the reality of tomorrow.

*The New Physics and Its Evolution*

Chapter XI (p. 322)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Tennyson, Alfred (Lord)** 1809–92

English poet

When I dipt into the Future, far as human eye could see;  
Saw the vision of the world, and all the wonder that would be.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 8

Oxford University Press, Inc. London, England. 1953

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Man has acquired the habit of going to the past because it was the line of least resistance for his mind. While a certain variable portion of the past is serviceable matter for knowledge in the case of everyone, the future is, to a mind without an imagination trained in scientific habits of thought, non-existent.

*The Discovery of the Future* (p. 21)

B.W. Huebsch. New York, New York, USA. 1913

On the whole there is something sympathetic for the dupe of the fortune-teller in the spirit of modern science; it is one of the persuasions that come into one's mind, as

one assimilates the broad conception of science, that the adequacy of causation is universal; that in absolute fact – if not in that little bubble of relative fact which constitutes the individual life – in absolute fact the future is just as fixed and determinate, just as settled and inevitable, just as possible a matter of knowledge as the past.

*The Discovery of the Future* (pp. 22–23)

B.W. Huebsch. New York, New York, USA. 1913

The man of science comes to believe at last that the events of the year A.D. 4000 are as fixed, settled, and unchangeable as the events of the year 1600. Only about the latter he has some material for belief and about the former practically none.

*The Discovery of the Future* (pp. 23–24)

B.W. Huebsch. New York, New York, USA. 1913

You can no more know about the future, I was recently assured by a friend, than you can know which way a kitten will jump next.

*Annual Report of the Board of Regents of the Smithsonian Institution (1902)*

*The Discovery of the Future* (p. 380)

Government Printing Office. Washington, D.C. 1903

All this world is heavy with the promise of greater things, and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

*The Discovery of the Future* (p. 392)

Government Printing Office. Washington, D.C. 1903

### **Whewell, William** 1794–1866

English philosopher and historian

If our knowledge of the earth and of the heavens, of animals and of man, of the past condition and present laws of the world, is quite barren of all suggestion of what may or may not hereafter be the lot of man, such knowledge will lose the charm which would have made it most precious and attractive in the eyes of mankind in general.

*The Plurality of Worlds*

Chapter XIII (p. 294)

Gould & Lincoln. Boston, Massachusetts, USA. 1854

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

What our students should learn is how to face the future with the aid of the past.

*Essays in Science and Philosophy*

Education (p. 202)

Philosophical Library. New York, New York, USA. 1947

### **Wiener, Norbert** 1894–1964

American mathematician

The future offers very little hope for those who expect that our new mechanical slaves will offer us a world in which we may rest from thinking. Help us they may, but at the cost of supreme demands upon our honesty and intelligence. The world of the future will be an ever more demanding struggle against the limitations of our intelligence, not a comfortable hammock in which we can lay down to be waited upon by our robot slaves.

*God and Golem, Inc.: A Comment on Certain Points Where Cybernetics*

*Impinges on Religion*

Chapter V (p. 69)

The MIT Press. Cambridge, Massachusetts, USA. 1964

### **Whyte, A. Gowans**

Scottish writer

Knowledge is advancing in geometrical progression, and with each new conquest we gain more mastery over the problems that confront us. More assuredly than ever before, the future rests with science.

*The Triumph of Physics*

*The Rationalist Annual*, 1931 (p. 34)

### **Young, Charles Augustus** 1834–1908

American astronomer

The germs of the future are now present in various stages of development, and many of them so far advanced that we can already form some idea of what the product is to be.

In George Iles

*Little Masterpieces of Science*

*The Astronomical Outlook* (p. 53)

Doubleday, Page & Co. New York, New York, USA. 1902

...as we try to penetrate the future of our science, a small portion of what lies nearest appears reasonably distinct, and we feel confident that sturdy persistence in following certain paths in which astronomers are now treading will carry them well forward into regions now visible but dimly, if at all.

In George Iles

*Little Masterpieces of Science*

*The Astronomical Outlook* (p. 54)

Doubleday, Page & Co. New York, New York, USA. 1902

## G

### GADGET

#### Gray, George W.

Freelance science writer

The future of science does not mean the future of gadgets – though the gadgets will come, for better or for worse, you can bank on that.

*The Advancing Front of Science*

Chapter 1 (p. 10)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1937

### GAIA

#### da Vinci, Leonardo 1452–1519

Italian High Renaissance painter and inventor

...man has within him the lake of the blood where the lungs rise and fall in breathing, so likewise the body of the earth has its oceans which also rise and fall in consequence of the world's breathing.

In Osvald Sirén

*Leonardo da Vinci, the Artist and the Man*

Chapter XV (p. 224)

Yale University Press. New Haven, Connecticut, USA. 1916

#### Joseph, Lawrence E.

No biographical data available

The Gaia hypothesis is the first comprehensive scientific expression of the profoundly ancient belief that the planet Earth is a living creature.

*GALA, the Growth of an Idea*

Introduction (p. 1)

St. Martin's Press. New York, New York, USA. 1990

#### Lovelock, James Ephraim 1919–

English scientist

When I first introduced Gaia [an ecological theory], I had vague hopes that it might be denounced from the pulpit and thus made acceptable to my scientific colleagues. As it was, Gaia was embraced by theologians and by a wide range of New Age writers and thinkers but denounced by biologists.

*Earthwatch*

Rethinking Life on Earth: The Sum: Gaia Takes Flight

September/October, 1992

The Gaia hypothesis is for those who like to walk or simply stand and stare, to wonder about the Earth and the life it bears, and to speculate about the consequences of our own presence here.

*Gaia: A New Look at Life on Earth*

Introductory (p. 11)

Oxford University Press, Inc. Oxford, England. 2000

The clues to Gaia's existence are as transient as our sand-castle. If her partners in life were not there, continually repairing and recreating, as children build fresh castles on the beach, all Gaia's traces would soon vanish....

*Gaia: A New Look at Life on Earth*

Chapter 3 (p. 31)

Oxford University Press, Inc. Oxford, England. 2000

#### Murchie, Guy 1907–97

American biologist

...the physical essence of Earth life may be termed a spherical biofilm rotating in gravitational, electromagnetic, and nuclear fields – a sort of gyrating bubble of evolving potency, a cosmic node of ferment.

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*

Part One, Chapter 1 (p. 15)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

If a germ cannot be presumed aware of the living state of the body it dwells in, how can man's somewhat similarly circumscribed view afford him much more comprehension of the total aliveness of his planet today....

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*

Part Three, Chapter 14 (p. 389)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

### GALAPAGOS

#### Darwin, Charles Robert 1809–82

English naturalist

Considering the small size of these islands, we feel the more astonished at the number of their aboriginal beings and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period, geologically recent, the unbroken ocean was here spread out. Hence, both in space and time, we seem to be brought somewhat near to that great fact – that mystery of mysteries – the first appearance of new beings on this earth....

*The Voyage of The Beagle*

Chapter XVII (pp. 377–378)

Heron Books. Sheridan, Oregon, USA. 1968

### GALAXIES, SUPER-SYSTEM OF

#### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The super-system of the galaxies is dispersing as a puff of smoke disperses. Sometimes I wonder whether there may not be a greater scale of existence of things, in which it is no more than a puff of smoke.

*The Expanding Universe*

Chapter 1 (p. 13)

Cambridge University Press. Cambridge, England. 1987

## GALAXY

**Arp, Halton Christian** 1927–  
American astronomer

...not all galaxies fit the schematic idealization of the Hubble sequence of nebular forms. In fact, when looked at closely enough, every galaxy is peculiar. Appreciation of these peculiarities is important in order to build a realistic picture of what galaxies are really like.

*Atlas of Peculiar Galaxies*

Preface

California Institute of Technology. Pasadena, California, USA. 1966

**Buta, R.**

No biographical data available

Galaxies are majestically beautiful objects, and anyone who has seen a galaxy through a telescope, or even our own Milky Way Galaxy with the unaided eye, cannot help but wonder at the nature of these remote star systems and what they have to say about our universe and ourselves.

In Paul Murdin

*Encyclopedia of Astronomy and Astrophysics* (Volume 1)

Galaxies: Classification (p. 861)

Nature Publishing Group. London, England. 2001

**Chaisson, Eric J.** 1946–

Astrophysicist

Silently and majestically, galaxies twirl in the faraway tracts of the Universe – vast pinwheels of energy, matter, and perhaps life – imparting a feeling simultaneously for the immensity of the Universe and for the mediocrity of our position in it.

*The Life Era: Cosmic Selection and Conscious Evolution*

Chapter 1 (p. 18)

The Atlantic Monthly Press. New York, New York, USA. 1987

**Crommelin, Andrew Claude de la**

**Cherois** 1865–1939

Astronomer

Whether true or false, the hypothesis of external galaxies is certainly a sublime and magnificent one. Instead of a single star-system it presents us with thousands of them.... Our conclusions of Science must be based on evidence, and not on sentiment. But we may express the hope that this sublime conception may stand the test of further examination.

Are the Spiral Nebulae External Galaxies?

*The Journal of the Royal Astronomical Society of Canada*, Volume XII, Number 2, February, 1918 (p. 376)

**Denton, Michael J.** 1943–

British-Australian molecular biologist

Ironically, our relatively peripheral position on the spiral arm of a rather ordinary galaxy is indeed rather fortunate. If we had been stationed in a more central position – say,

near the galactic hub – it is likely that our knowledge of the universe of other galaxies, for example, might not have been as extensive. Perhaps in such a position the light from surrounding stars could well have blocked our view of intergalactic space. Perhaps astronomy and cosmology as we know these subjects would never have developed.

*Nature's Destiny: How the Laws of Biology Reveal Purpose in the Universe*

Conclusion (p. 372)

The Free Press, New York, New York, USA. 1998

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Let us first understand what a galaxy is. The following is a recipe for making galaxies: Take about ten thousand million stars. Spread them so that on the average light takes three or four years to pass from one to the next. Add about the same amount of matter in the form of diffuse gas between the stars. Roll it all out flat. Set it spinning in its own plane. Then you will obtain an object which, viewed from a sufficient distance, will probably look more or less like a spiral nebula.

*New Pathways in Science*

Chapter X, Section I (p. 206)

The Macmillan Company. New York, New York, USA. 1935

The running away of the galaxies does not mean that they have a kind of aversion from us.

*New Pathways in Science*

Chapter X, Section II (p. 210)

The Macmillan Company. New York, New York, USA. 1935

**Ferris, Timothy** 1944–

American science writer

...here we are, without eyes and our minds and our curiosity, six billion passengers aboard a tiny blue boat, bobbing and wheeling our way around one vast Catherine wheel among many. Time now to leave the Milky Way and explore the realms of the galaxies.

*Seeing in the Dark*

Chapter 16 (p. 245)

Simon & Schuster. New York, New York, USA. 2002

Galaxies are so big that once you get up to their scale, the universe starts to take on an almost country-cottage intimacy.

*Seeing In the Dark*

Chapter 17 (p. 253)

Simon & Schuster. New York, New York, USA. 2002

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Think of the stars as ordinary household specks of dust. Then we must think of a galaxy as a collection of specks a few miles apart from each other, the whole distribution filling a volume about equal to the Earth. Evidently one such collection of specks could pass almost freely through another.



*Frontiers of Astronomy*

Chapter Sixteen (p. 278)

Harper & Row, Publishers. New York, New York, USA. 1955

**Jeffers, Robinson** 1887–1962

American poet

Galaxy on galaxy, innumerable swirls of innumerable stars, endured as it were forever and humanity  
Came into being, its two or three million years are a moment, in a moment it will certainly cease out from being.

*The Selected Poetry of Robinson Jeffers*

Margrave

Random House, Inc. New York, New York, USA. 1938

**Keel, William C.**

No biographical data available

Galaxies are rightly called the “atoms of astronomy,” for they are the fundamental building blocks of matter on a cosmic scale.

*Crashing Galaxies, Cosmic Fireworks*

*Sky and Telescope*, Volume 77, Number 1, January, 1989 (p. 18)

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

We find that the galaxy has a much larger mass than the sum of all the stars, dust, and other things we “see.” The shortfall is not just a few percentage points, but most of the mass of our galaxy seems to have been left unaccounted.

*Blind Watchers of the Sky*

Chapter Eleven (pp. 292–293)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

...I leave it undecided whether the Milky Way visible to us still belongs to uncounted others and forms with these a whole system. Perhaps the light of this so immeasurably distant Milky Way is so weak that we are unable to see it.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Tenth Letter (p. 111)

Science History Publications. New York, New York, USA. 1976

**Panagia, Nino**

Astronomer

In order to understand what are the earliest building blocks of galaxies like our own, one must detect and identify “first light” sources, i.e., emission from the first objects in the Universe to undergo star formation.

*Detecting Primordial Stars*

*astro-ph/04100235*, Volume 1, October 6, 2004 (p. 2)

**Sagan, Carl** 1934–96

American astronomer and science writer

The study of the galaxies reveals a universal order and beauty. It also shows us chaotic violence on a scale hitherto undreamed of. That we live in a universe which permits life is remarkable. That we live in one which destroys galaxies and stars and worlds is also remarkable. The universe seems neither benign nor hostile, merely indifferent to the concerns of such puny creatures as we.

*Cosmos*

Chapter X (p. 250)

Random House, Inc. New York, New York, USA. 1980

**Sandage, Allan** 1926–

American astronomer

They are to astronomy what atoms are to physics. Each galaxy is a stellar system somewhat like our Milky Way, and isolated from its neighbors by nearly empty space. In popular terms, each galaxy is a separate universe unto itself.

*The Hubble Atlas of Galaxies* (p. 1)

Carnegie Institution of Washington. Washington, D. C. 1961

**Saslaw, William C.**

Astronomer

If galaxies did not exist we would have no difficulty in explaining the fact.

*Gravitational Physics of Stellar and Galactic Systems*

Chapter 21 (p. 157)

Cambridge University Press. London, England. 1985

**Tennyson, Alfred (Lord)** 1809–92

English poet

The fires that arch this dusty dot –

Yon myriad worlded-ways –

“The vast sun-cluster” gathered blaze,

World-isles in lonely skies,

Whole heavens within themselves amaze

Our brief Humanities.

*Alfred Tennyson's Poetical Works*

Epilogue, I, 51–56

Oxford University Press, Inc. London, England. 1953

**Updike, John** 1932–

American novelist, short story writer, and poet

And beyond our galaxy are other galaxies, in the universe all told at least a hundred billion, each containing a hundred billion stars. Do these figures mean anything to you?

*The Centaur*

Chapter I (p. 37)

Alfred A. Knopf. New York, New York, USA. 1995

**Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer



Stars, like little lost children seeking shelter on a cold night, tend to cluster, via gravitationally induced starlight, into galaxies.

*Parallel Universes*

Chapter 6 (p. 71)

Simon & Schuster. New York, New York, USA. 1988

### **Wright, Thomas** 1711–86

English cosmologist

Since as the Creation is, so is the Creator also magnified, we may conclude in consequence of an infinity, and an infinite all-active power, that as the visible creation is supposed to be full of sidereal systems and planetary worlds, so on, in like similar manner, the endless immensity is an unlimited plenum of creations not unlike the known.... That this in all probability may be the real case, is in some degree made evident by the many cloudy spots, just perceivable by us, as far without our starry Regions, in which tho' visibly luminous spaces, no one star or particular constituent body can possibly be distinguished; those in all likelihood may be external creation, bordering upon the known one, too remote for even our telescopes to reach.

*An Original Theory or New Hypothesis of the Universe*

Letter the Ninth (p. 83)

Printed for the Author. London, England. 1750

## IRAS

### **Vadar, J. Patricia**

No biographical data available

### **Simon, M.**

No biographical data available

IRAS [infrared astronomical satellite] galaxies are all chocolate chip flavored rather than vanilla flavored as heretofore supposed. This no doubt accounts for their diversity and appeal.

The Optical Luminosity Function of a 60-micron Flux-limited Sample of IRAS Galaxies

*The Astronomical Journal*, Volume 94, Number 4, October, 1987 (p. 865)

## MILKY WAY

### **Alighieri, Dante** 1265–1321

Italian poet and writer

...distinct with less and greater lights, the Galaxy so whitens between the poles of the world that it makes even the wise to question...

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Paradise, Canto XIV, l. 97–100

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...pricked out with less and greater lights, between the poles of the universe, the Milky Way so gleameth white as to set very sages questioning...

*The Paradiso of Dante Alighieri* (6th edition)

Canto XIV (p. 175)

J.M. Dent & Co. London, England. 1908

### **Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The human race cannot hope to check the accuracy of its calculations on the Milky Way. The cosmic clock ticks in millions of years, and our kind will have vanished before the galaxy touches its noon. But ours is only one galaxy in hundreds of millions. The wrecks of others, dissipated like wisps of foam, may yet be visible in the unfathomable deep. These derelicts of eternity shall be our check.

*The Handmaiden of the Sciences*

Chapter I (p. 16)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

### **Chaucer, Geoffrey** 1343–1400

English poet

See yonder, lo, the Galaxy  
Which men clepeth the Milky Wey,  
For hit is whyt.

*The House of Fame*

Book II

Chatto & Windus. London, England. 1908

### **de Fontenelle, Bernard le Bovier** 1657–1757

French author

...you see that whiteness in the sky, which some call the milky-way; can you imagine what that is? Why, it is nothing but infinity of small stars, not to be seen by our eyes, because they are so very little; and they are sown so thick, one by another, that they seem to be one continued whiteness: I wish you had a glass to see this ant's nest of stars...

*Conversations on the Plurality of Worlds*

The Fifth Evening (pp. 159–160)

Printed for Peter Wilson. Dublin, Ireland. 1761

### **de Morgan, Augustus** 1806–71

English mathematician and logician

I have often had the notion that all the nebula we see, including our own, which we call the Milky Way, may be particles of snuff in the box of a giant of a proportionately larger universe. Of course the minimum time – a million of years or whatever the geologists make it – which our little affair has lasted, is but a very small fraction of a second to the great creature in whose nose we shall all be in a few tens of thousands of millions of millions of millions of years.

*A Budget of Paradoxes*

Are Atoms Worlds (p. 377)  
Longmans, Green & Company. London, England. 1872

**Donne, John** 1572–1631  
English poet and divine

In that glistering circle in the firmament, which we call the Galaxie, the milkie way, there is not one starre of any of the six great magnitudes, which Astronomers proceed upon, belonging to that circle: it is a glorious circle, and possesseth a great part of heaven, and yet is all of so little starres, as have no name, no knowledge taken of them...

*Donne's Sermons*  
Little Stars, Sermon 144 (p. 221)  
Clarendon Press. Oxford, England. 1942

**Hearn, Lafcadio** 1850–1904  
Greek-born American writer

In the silence of the transparent night, before the rising of the moon, the charm of the ancient tale sometimes descends upon me out of the scintillant sky, to make me forget the monstrous facts of science and the stupendous horror of space. Then I no longer behold the Milky Way, as that awful Ring of Cosmos, whose hundred million suns are powerless to lighten the abyss, but as the very Amanogwa itself – the river Celestial. I see the thrill of its shining stream, the mists that hover along the verge, and the watergrasses that bend in the winds of autumn. White Orihimé I see at her starry loom and the Ox that grazes on the farther shore – and I know that the falling dew is the spray of the Herdsman's oar.

*The Writings of Lafcadio Hearn* (Volume VIII)  
*The Romance of the Milky Way* (p. 257)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1922

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

This remarkable belt [Milky Way] has maintained, from the earliest ages, the same relative situation among the stars; and, when examined through powerful telescope, is found (wonderful to relate!) to consist entirely of stars scattered by millions, like glittering dust, on the black ground of the general heavens.

*Outlines of Astronomy*  
Part I, Chapter V (p. 166)  
Sheldon & Co. New York, New York, USA. 1869

The Milky Way is like sand, not strewn evenly as with a sieve, but as if flung down by handfuls (and both hands at once), leaving dark spaces in between ...

In Mary Procter  
The Silver River of Heaven  
*The Chautauquan*, Volume 21, Number 4, July, 1895 (p. 459)

**Huggins, Sir William** 1824–1910  
English astronomer

The heavens are richly but very irregularly inwrought with stars. The brighter stars cluster into well-known

groups upon a background formed of an enlacement of streams and convoluted windings and intertwined spirals of fainter stars, which becomes richer and more intricate in the irregularly rifted zone of the Milky Way.

*Report of the Sixty-first Meeting of the British Association for the Advancement of Science*  
Address by William Huggins (p. 35)  
John Murray. London, England. 1892

**Joyce, James** 1882–1941  
Irish-born author

Bloom was pointing out all the stars and the comets in the heavens to Chris Callinan and the jarvey: the great bear and Hercules and the dragon, and the whole jingbang lot. But, by God, I was lost, so to speak, in the milky way.

*Ulysses* (p. 231)  
Random House, Inc. New York, New York, USA. 1946

**Kilmer, Joyce** 1886–1918  
American poet

God be thanked for the Milky Way that runs across the sky.  
That's the path that my feet would tread whenever I have to die.

Some folks call it a Silver Sword, and some a Pearly Crown.  
But the only thing I think it is, is Main Street, Heaven-town.

*Main Street and Other Poems*  
Main Street  
George H. Doran Company. New York, New York, USA. 1917

**Lambert, Johann Heinrich** 1728–77  
Swiss-German mathematician and astronomer

I am undecided whether or not the visible Milky Way is but one of countless others all of which form an entire system. Perhaps the light from these infinitely distant galaxies is so faint that we cannot see them.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 217)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Showed the broad, white road in heaven,  
Pathway of the ghosts, the shadows,  
Running straight across the heavens,  
Crowded with the ghosts, the shadows.

*The Poetical Works of Henry Wadsworth Longfellow*  
The Song of Hiawatha, Hiawatha's Childhood  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Milton, John** 1608–74  
English poet

A broad and ample road, whose dust is Gold,  
And pavement Stars, as Stars to thee appear  
Seen in the galaxy, that Milkie way...

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
 Book VII, l. 577–579  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ovid** 43 BCE–17 AD  
 Roman poet

There is a high way, easily seen when the sky is clear.  
 'Tis called the Milky Way, famed for its shining whiteness.

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 1)  
 Book I, l. 168 (p. 15)  
 William Heinemann. London, England. 1916

**Pasternak, Boris** 1890–1960  
 Russian poet and novelist

With an awful, dreadful list  
 Towards other galaxies unknown  
 Ponderously turns the Milky Way...

*Poems*  
 Night  
 University of Michigan Press. Ann Arbor, Michigan, USA. 1959

And there, with frightful listing  
 Through emptiness, away  
 Through unknown solar systems  
 Revolves the Milky Way.

*Fifty Poems*  
 Night  
 George Allen & Unwin Ltd. London, England. 1963

## Plutarch

It is a cloudy circle, which continually appears in the air,  
 and by reason of the whiteness of its colors is called the  
 galaxy, or the milky way.

*Plutarch's Morals* (Volume 3)  
 Book III, Chapter I (p. 148)  
 Little, Brown & Co. Boston, Massachusetts, USA. 1871

**Poincaré, Jules Henri** 1854–1912  
 French mathematician and theoretical astronomer

Consider now the Milky Way; there also we see an innumerable dust; only the grains of this dust are not atoms, they are stars; these grains move also with high velocities; they act at a distance one upon another, but this action is so slight at great distance that their trajectories are straight; and yet, from time to time, two of them may approach near enough to be deviated from their path, like a comet which had passed too near Jupiter. In a world, to the eyes of a giant for whom our suns would be as for us our atoms, the Milky Way would seem only a bubble of gas.

*The Foundations of Science*  
*Science and Method*, Book IV  
 Chapter I (p. 524)  
 The Science Press. New York, New York, USA. 1913

**Proctor, Mary** 1862–1957  
 American popularizer of astronomy

Come, let us speed on the wings of thought, across the unfathomable depths of space which extend between us and that distant shore, and wander for awhile by the Silver River of Heaven [Milky Way].

The Silver River of Heaven  
*The Chautauquan*, Volume 21, Number 4, July, 1895 (p. 459)

**Rich, Adrienne** 1929–  
 American poet

Driving at night I feel the Milky Way

Streaming above me like the graph of a cry.

*Leaflets, Poems 1965–1968*  
 Ghazals 7/24/68: ii  
 W.W. Norton & Company, Inc. New York, New York, USA. 1969

**Serviss, Garrett Putman** 1851–1921  
 American science fiction writer

Judged by the eye alone, the Milky Way is one of the most delicately beautiful phenomena in the entire realm of nature – a shimmer of silvery gauze stretched across the sky; but studied in the light of its revelations, it is the most stupendous object presented to human ken.

*Curiosities of the Sky*  
 Chapter II (p. 17)  
 Harper & Brothers Publishers. New York, New York, USA. 1909

The great galactic system, driving through space like a flat shining raft, built up of hundreds of millions of stars –

our little sun being lost among them – and drawing in from either side, and from distances of hundreds of quadrillions of miles, vast stellar organisms, of a globular shape, on which it feeds and grows, while from before it, like frightened flocks of strange winged creatures, hatched in the midst of the mysterious and boundless ether, flee the spiral nebulae, speeding madly on – on – on.

The Latest Marvels of Astronomy  
*The Mentor*, Volume 9, Number 9, October, 1921 (p. 12)

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

This whole earth which we inhabit is but a point in space. How far apart, think you, dwell the two most distant inhabitants of yonder star, the breadth of whose disk cannot be appreciated by our instruments? Why should I feel lonely? is not our planet in the Milky Way?

*The Writings of Henry David Thoreau* (Volume 2)  
*Walden*  
 Chapter V (p. 208)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Why should I feel lonely? Is not our planet in the Milky Way?

*Walden*

Solitude (p. 118)

George Routledge &amp; Sons. London, England. 1904

**Updike, John** 1932–

American novelist, short story writer, and poet

The Milky Way, which used to be thought of as the path by which the souls of the dead traveled to Heaven, is an optical illusion; you could never reach it. Like fog, it would always thin out around you. It's a mist of stars we make by looking the long way through the galaxy...

*The Centaur*

Chapter I (p. 37)

Alfred A. Knopf. New York, New York, USA. 1995

**Wright, Thomas** 1711–86

English cosmologist

This is the great Order of Nature which I shall now endeavor to prove, and thereby solve the Phaenomena of the Via Lactea; and in order thereto, I want nothing to be granted but what may easily be allowed, namely, that the Milky Way is formed of an infinite Number of small Stars.

*An Original Theory or New Hypothesis of the Universe*

Letter the Seventh (p. 62)

Printed for the Author. London, England. 1750

**GALE****Conrad, Joseph** 1857–1924

Polish-born English novelist

Gales have their personalities, and, after all, perhaps it is not strange; for, when all is said and done, they are adversaries whose wiles you must defeat, whose violence you must resist, and yet with whom you must live in the intimacies of nights and days.

*The Mirror of the Sea*

Chapter XXII (p. 71)

Doubleday, Page &amp; Co. Garden City, New York, USA. 1924

**GAMBLING****Chambers, Robert William** 1865–1933

American artist and writer

Take one of my favourite experiments, for example. I see a little ball rattling around in a wheel. Where will that ball stop? You, being less intellectual than I, don't care where it stops I do. Instantly my scientific curiosity is aroused; I reason logically; I evolve an opinion; I back that opinion; and I remain busy and poor.

*The Firing Line*

Chapter XIII (p. 203)

D. Appleton &amp; Co. New York, New York, USA. 1908

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

In moderation, gambling possesses undeniable virtues. Yet it presents a curious spectacle replete with contradictions. While indulgence in its pleasures has always lain beyond the pale of fear of Hell's fires, the great laboratories and respectable insurance palaces stand as monuments to a science originally born of the dice cup.

*Mathematics and the Imagination*

Chance and Chanceability (p. 239)

Simon &amp; Schuster. New York, New York, USA. 1940

**Pompidou, Georges** 1911–1974

19th president and longest serving prime minister of France

There are three roads to ruin; women, gambling and technicians. The most pleasant is with women, the quickest is with gambling, but the surest is with technicians.

*Sunday Telegraph*, 26 May, 1968**Puzo, Mario** 1920–99

American novelist and screenwriter

He felt the table was having a run of bad luck, but he knew. Gronevelt would never accept that explanation. Gronevelt believed that the house could not lose over the long run, that the laws of percentage were not subject to chance. As gamblers believed mystically in their luck so Gronevelt believed in percentages.

*Fools Die: A Novel*

Chapter 17 (pp. 187–188)

G.P. Putnam's Sons. New York, New York, USA. 1978

**GAME MANAGEMENT****Leopold, Aldo** 1886–1948

American naturalist

Game management lubricates the engine we call "Nature," rather than building a substitute engine in the form of a propagating plant. The motive power is that natural force implied in the biblical injunction, "Go forth and replenish the earth," and which professors define impersonally as "the tendency of any species to increase to the capacity of its environment."

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

Grand-Opera Game (p. 169)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**GARDEN****Addison, Joseph** 1672–1719

English essayist, poet, and statesman

I think there are as many kinds of gardening as of poetry: your makers of parterres and flower-gardens are epigrammatists and sonneteers in this art: contrivers of

bowers and grottos, treillages and cascades, are romance writers.

*The Spectator* (Volume 9)

Saturday, September 6, 1712 (p. 13)

Crissy & Markley. Philadelphia, Pennsylvania, USA. 1853

**Armstrong, Martin D.** 1882–1974

No biographical data available

A garden is the attempt of Man and Nature to materialize their dreams of the original Paradise. Man is its father and Nature its mother, so that all gardens which deserve the name are half-human, can appeal to us with a personality of their own.

Two Italian Gardens

*The Atlantic Monthly*, Volume cx, September, 1912 (p. 360)

**Austin, Alfred** 1835–1913

English poet

...exclusiveness in a garden is a mistake as great as it is in society ...

*The Garden That I Love*

Chapter 10 (pp. -102)

Adam & Charles Black. London, England. 1906

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

God Almighty first planted a garden.

*The Essays or Counsels Civil of Francis Bacon*

Of Gardens (p. 195)

J.M. Dent & Sons Ltd. London, England. 1900

**Bailey, Liberty Hyde** 1858–1954

American horticulturist and botanist

If I were to write a motto over the gate of a garden, I should choose the remark which Socrates made as he saw the luxuries in the market, "How much there is in the world that I do not want!"

*Garden-making* (8th edition)

Section I (p. 2)

The Macmillan Co. New York, New York, USA. 1904

## GAS

### Author undetermined

Sir James Dewar

Is cleverer than you are

None of you asses

Can condense gases.

In Abraham Pais

*Inward Bound*

Chapter 7 (p. 137)

Clarendon Press. Oxford, England. 1986

Sulfurated hydrogen is a gas of pugnacious odor.

Classroom Emanations, Volume 2, Number 7, July 1925 (p. 611)

A gas is a dry liquid.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

In my opinion it would be a great tragedy for science if the theory of gases were temporarily thrown into oblivion because of a momentary hostile attitude toward it, as for example was the wave theory because of Newton's authority.

I am conscious of being only one individual struggling weakly against the stream of time. But it still remains in my power to contribute in such a way that, when the theory of gases is again revived, not too much will have to be rediscovered.

Translated by Stephen G. Brush

*Lectures on Gas Theory*

Part II, Forward to Part II (p. 216)

University of California Press. Berkeley, California, USA. 1964

**Dalton, John** 1766–1844

English chemist and physicist

At the time I formed the theory of mixed gases I had a confused idea, as many have, I suppose, at this time, that the particles of elastic fluids are all of the same size; that a given volume of oxygenous gas contains just as many particles as the same volume of hydrogenous.... But...I became convinced that different gases have not their particles of the same size: and that the following may be adopted as a maxim, till some reason appears to the contrary: namely – [t]hat every species of pure elastic fluid has its particles globular and all of a size; but that no two species agree in the size of their particles, the pressure and temperature being the same.

*A New System of Chemical Philosophy*

John Day. New York, New York, USA. 1966

The greatest difficulty attending the mechanical hypothesis, arises from the different gases observing different laws. Why does water not admit its bulk of every kind of gas alike? – This question I have duly considered, and though I am not able yet to satisfy myself completely, I am nearly persuaded that the circumstance depends upon the weight and number of the ultimate particles of the several gases: those whose particles are lightest and single being least absorbable, and the others more according as they increase in weight and complexity.[5] An enquiry into the relative weights of the ultimate particles of bodies is a subject, as far as I know, entirely new: I have lately been prosecuting this enquiry with remarkable success. The principle cannot be entered upon in this paper; but I shall just subjoin the results, as far as they appear to be ascertained by my experiments.



On the Absorption of Gases by Water and Other Liquids  
*Memoirs of the Literary and Philosophical Society of Manchester*, 2nd Series, (Volume 1) 1805

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

...chemistry, which is the analysis of matter, has taught us that we eat gas, drink gas, tread on gas, and are gas.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)  
 Lectures and Biographical Sketches  
 Chapter XII (p. 329)  
 Houghton, Mifflin and Company. Boston, Massachusetts, USA. 1904

**Maxwell, James Clerk** 1831–79  
 Scottish physicist

So many of the properties of matter, especially when in the gaseous form, can be deduced from the hypothesis that their minute parts are in rapid motion, the velocity increasing with the temperature, that the precise nature of this motion becomes a subject of rational curiosity. Daniel Bernoulli, Herapath, Joule, Krönig, Clausius, etc. have shown that the relations between pressure, temperature, and density in a perfect gas can be explained by supposing the particles to move with uniform velocity in straight lines, striking against the sides of the containing vessel and thus producing pressure.

In W.D. Niven (ed.)  
*The Scientific Papers of James Clerk Maxwell* (Volume 1)  
 Illustrations of the Dynamical Theory of Gases (p. 377)  
 At The University Press. Cambridge, England. 1890

**Silver, Brian L.**  
 Israeli professor of physical chemistry

In general, chemical experience suggests that each gas is unique, which is true, and has very little, if anything, in common with most other gases, which is not true. That which is common to all gases is the way in which their molecules move.

*The Ascent of Science*  
 Part I, Chapter 1 (p. 5)  
 Solomon Press Book. New York, New York, USA. 1998

**Smith, Alexander** 1865–1922  
 American chemist and author

It is not the gas which “diverges” from our statement or “disobeys” our law, but our statement which is proved by the behavior of the gas to be inaccurate. Our procedure, in such cases, is always more logical than our language, for we never attempt to cure the gas of its error, but always the law itself by suitable modification in its phraseology.

*Introduction to General Inorganic Chemistry*  
 Chapter 1 (p. 8)  
 The Century Co. New York, New York, USA. 1907

## The X-Files

SCULLY: And you know, there’s a marsh over there. The lights the driver saw may have been swamp gas.

MULDER: Swamp gas?

SCULLY: It’s a natural phenomenon in which phosphine and methane rising from decaying organic matter ignite, creating globes of blue flame.

*E.B.E.*  
 Television program  
 Season 1 (1993)

**van Helmont, Jean-Baptista** 1579–1644  
 Flemish chemist

Charcoal and, in general, bodies which are not immediately resolved into water, necessarily disengage (when purest), *spiritum syhestrem*. Sixty-two pounds of oak charcoal yield one pound of cinders. Therefore the rest, amounting to sixty-one pounds, is this *spiritus sylvestris*. This spirit, hitherto unknown, which can neither be contained in vessels nor reduced to a visible body, I call by a new name, *gas* (*hunc spiritum incognitum, hactenus, novo nomine gas voco*). There are bodies which enclose that spirit, and can be resolved almost wholly into it; therein it is as fixed or solidified, from which state it may be driven forth, as is seen in the fermentation of wine, bread, etc.

Quoted in Matthew Moncrieff Pattison Muir  
*A History of Chemical Theories and Laws*  
 Part I, Chapter 1 (p. 23)  
 John Wiley & Sons. New York, New York, USA. 1907

...for want of a name, I have called that vapour *Gas*, being not far severed from the *chaos* of the aunts. In the meantime it is sufficient for me to know that gas is a far more subtle or fine thing than a vapour, mist, or distilled oyliness, although, as yet, it may be many times thicker than air.

In George F. Kodwell  
 On the Supposed Nature of Air Prior to the Discovery of Oxygen  
*The Chemical News and Journal of Physical Science*, Volume X, October 24, 1864 (p. 196)

## GASTRULATION

**Wolpert, Lewis** 1929–  
 American biologist

It is not birth, marriage, or death, but gastrulation which is truly the most important time in your life.

In J.M.W. Slack (ed.)  
*From Egg to Embryo: Determinative Events in Early Development* (p. 1)  
 Cambridge University Press. Cambridge, England. 1991

## GAUGE FIELD THEORY

**Salam, Abdus** 1926–96  
 Pakistani theoretical physicist

From time immemorial, man has desired to comprehend the complexity of nature in terms of as few elementary concepts as possible. Among his quests – in Feynman’s words – has been the one for “wheels within wheels”



– the task of natural philosophy being to discover the innermost wheels if any such exist. A second quest has concerned itself with the fundamental forces which make the wheels go round and enmesh with one another. The greatness of...of gauge field theories – is that they reduce these two quests to just one.

*Nobel Lectures, Physics 1971–1980*

Gauge Unification of Fundamental Forces (p. 515)

World Scientific Publishing Co. Singapore, Malaysia. 1992

## GAUGE SYMMETRY

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

This [gauge] invariance is, of course, an artificial one, similar to that which we could obtain by introducing into our equations the location of a ghost. The equations must then be invariant with respect to changes in the coordinate of that ghost. One does not see, in fact, what good the introduction of the coordinate of the ghost does.

*Philosophical Reflections and Syntheses*

On the Law of Conservation of Heavy Particles (p. 305)

Springer-Verlag, Berlin, Germany. 1995

## GEIGER COUNTER

**Blaine, Ralph**

American songwriter

I tic, tic, tic and my heart beats quick

How can anything go wrong?

When I'm listening to that Geiger counter song

I tic, tic all day long

*Tic, Tic, Tic*

Sung by Doris Day

Rhino R2 75543, 1949

## GEM

**King, Charles William** 1818–88

English writer

These works of Nature [gemstones], by their beauty and the wonderful symmetry of their primary forms, have from the very dawn of science aroused the speculations of inquiring minds, which discovered in them the special manifestation of the creative energy of some higher power.

*The Natural History, Ancient and Modern, of Precious Stones and Gems, and of the Precious Metals*

Preface (p. ix)

Bell & Daldy, London, England. 1867

**Simonin, Louis** 1830–86

French mineralogist

Most gems have been produced, like metallic ores, from aqueous solutions and hot vapours. Time, repose, and

the means being favourable, sparkling crystallizations are the result, true tears of nature, and the gem slowly appears, crystallizing itself out from the surrounding rock in which it originated.

Translated by H.R. Bristow

*Underground Life: or, Mines and Miners*

Mines of Precious Stones, Chapter I (p. 490)

Chapman & Hall, London, England. 1869

**Streeter, Edwin William**

No biographical data available

Among the infinitely diversified products of Inorganic Nature, there are certain mineral substances which form a small class by themselves – standing apart from all others by the possession of such exceptional characters that they have always attracted the attention of persons endowed with taste and refinement.

*Precious Stones and Gems: Their History, Sources and Characteristics* (6th edition)

Section I, Chapter I (p. 1)

George Bell & Sons, London, England. 1898

## GEMATRIA

**Clawson, Calvin C.**

No biographical data available

While it may be interesting to study the relationships between the numbers associated with words and the various ideas expressed within the Bible, gematria does not give us a strong tool for making meaningful predictions about the world we live in.

*Mathematical Mysteries: The Beauty and Magic of Numbers*

Chapter 2 (p. 51)

Perseus Books, Cambridge, Massachusetts, USA. 1996

**Goodwin, David**

No biographical data available

...the ceremonial magician who disdains the use of cabala and gematria is like a carpenter who tries to build a house without a hammer.

*Godwin's Cabalistic Encyclopedia: A Complete Guide to Cabalistic Magick* (3rd edition)

Introduction (p. xli)

Llewellyn Publications, St. Paul, Minnesota, USA. 1994

## GENE

**Arbib, Michael A.** 1940–

Neuroscientist and computer scientist

In the beginning was the word

WORD

WORE

GORE

GONE

GENE

and by the mutations came the gene.

*Towards a Theoretical Biology: In IUBS Symposium (Volume 2)*  
(p. 323) 1968

**Beadle, George Wells** 1903–89  
American geneticist

**Tatum, Edward** 1909–75  
American biochemist

One gene – one enzyme.

In Francis Crick  
*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (p. 33)  
Basic Books, Inc. New York, New York, USA. 1988

**Benzer, Seymour** 1921–  
American molecular biologist

The genes are the atoms of heredity...

*The Harvey Lectures*  
Genetic Fine Structure, Series 56, (p. 1)  
Academic Press. New York, New York, USA. 1960–61

**Boulding, Kenneth E.** 1910–93  
English economist and social scientist

The gene is a wonderful teacher. It is, however, a very poor learner.

*The Image*  
Chapter 3 (p. 37)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1956

**Danforth, Charles Haskell** 1883–1969  
American anatomist

One might say that the gene is to some of the biological sciences what the atom is to the physical sciences...

Genetics and Anthropology  
*Science*, Volume 79, Number 2045, Friday March 9, 1934 (p. 216)

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

We are survival machines – robot vehicles blindly programmed to preserve the selfish molecules known as genes... They swarm in huge colonies, safe inside gigantic lumbering robots... they are in you and me; they created us, body and mind; and their preservation is the ultimate rationale for our existence.

*The Selfish Gene*  
Preface to the 1976 Edition (p. ix)  
Oxford University Press, Inc. Oxford, England. 1976

The genes are master programmers, and they are programming for their lives.

*The Selfish Gene*  
Chapter 4 (pp. 66–67)  
Oxford University Press, Inc. Oxford, England. 1976

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

...we must remember that heredity, development, and evolution are essentially epigenetic and not preformistic not.

We do not inherit from our ancestors, close or remote, separate characters, functional or vestigial. What we do inherit is, instead, genes which determine the pattern of developmental processes...

*Evolution, Genetics, and Man*  
Chapter 10 (p. 242)  
John Wiley & Son. New York, New York, USA. 1955

**Heinlein, Robert A.** 1907–88  
American science fiction writer

No man owns his genes; he's merely their custodian. They are passed to him willy-nilly in the meiotic dance; he passes them along to others through the same blind chances.

*Time Enough for Love*  
Chapter X (p. 253)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Lote, Christopher J.**  
No biographical data available

The human genome project will sooner or later identify the gene or genes responsible for religious belief. Perhaps we can contemplate (with tongue only slightly in cheek!) a brave new world in which genetic engineering can free humanity from the scourge of religion and allow us to look forward to a bright rationalist future.

Correspondence  
*Nature*, Volume 363, Number 6428, 3 June, 1993 (p. 390)

**Midgley, Mary** 1919–  
English philosopher

Genes cannot be selfish or unselfish, any more than atoms can be jealous, elephants abstract or biscuits teleological.

Gene-juggling  
*Philosophy*, Volume 54, Number 210, 1979 (p. 439)

**Murchie, Guy** 1907–97  
American biologist

A gene is one step in the secret recipe for growing up, for living. It is a wave of the unseen wand that turns a tadpole into a frog, a caterpillar into a butterfly. It is a basic unit of heredity.

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*  
Part One, Chapter 6 (p. 152)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

**Sagan, Carl** 1934–96  
American astronomer and science writer

...organisms die but their genes pass on – often mutated and redistributed, it is true, but genes nevertheless; and it is difficult, therefore, to escape the conclusion that the design of the organism is merely to provide for gene multiplication and survival...

Radiation and the Origin of the Gene  
*Evolution*, January, 1957

**Tatum, Edward** 1909–75  
American geneticist

...I have great faith in the versatility of the gene and of living organisms in providing the material with which to meet the challenges of life at any level. Selection, survival, and evolution take place in response to environmental pressures of all kinds, including sociological and intellectual. In the larger view, the dangerous and often poorly understood and controlled forces of modern civilization, including atomic energy and its attendant hazards, are but more complex and sophisticated environmental challenges of life. If man cannot meet those challenges, in a biological sense he is not fit to survive.

*Nobel Lectures, Physiology or Medicine 1942–1962*

A Case History in Biological Research

Elsevier Publishing Co. Amsterdam, The Netherlands. 1964

**Watson, James D.** 1928–  
American geneticist and biophysicist

We used to think our fate was in our stars. Now we know, in large measure, our fate is in our genes.

In L. Jaroff

The Gene Hunt

*Time*, March 20, 1989(p. 67)

## GENE POOL

**Mayr, Ernst** 1904–2005  
German-born American biologist

The genes within a gene pool form a harmonious whole which can evolve only as a whole. The first step, then, in the multiplication of species, is a physical separation of a portion of the species, permitting it to go its own way genetically. What happens after this isolation depends on the genetic contents of the isolated population, on the totality of selection forces working on it and on numerous chance phenomena (mutation, recombination, etc.).

Isolation as an Evolutionary Factor

*Proceedings of the American Philosophical Society*, Volume 103, 1959 (p. 226)

## GENERA

**Darwin, Charles Robert** 1809–82  
English naturalist

Please observe the question is not whether there are more or fewer varieties in larger or smaller genera, but whether there is a stronger or weaker tendency in the minds of botanists to record such in large or small genera.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to Asa Gray, February 21, 1859 (p. 464)

D. Appleton & Company. New York, New York, USA. 1896

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist and explorer

By a botanist I mean one who understands how to observe the genera of Nature. I judge unworthy of the name of botanist the meddlesome person who is indifferent to genera.

*Critica Botanica*

Generic Names (p. 3)

The Ray Society. London, England. 1938

## GENERAL PRACTICE

**Bashford, Sir Henry Howarth** 1880–1961  
English physician

General practice is at least as difficult, if it is to be carried on well and successfully, as any special practice can be, and probably more so; for the G.P. has to live continually, as it were, with the results of his handiwork.

*The Corner of Harley Street*

Chapter 26 (p. 233)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

## GENERAL PRACTITIONER

**Hubbard, Kin** 1868–1930  
American Democratic newspaper editor

Th' thing I like about general practitioners is that you don't have t' let 'em know a week ahead when you're goin' t' be sick.

*Abe Martin: Hoss Sense and Nonsense* (p. 94)

The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1926

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

For the general practitioner a well-used library is one of the few correctives of the premature senility which is so apt to overtake him. Self-centered, self-taught, he leads a solitary life, and unless his every-day experience is controlled by careful reading or by the attrition of a medical society it soon ceases to be of the slightest value and becomes a mere accretion of isolated facts, without correlation. It is astonishing with how little reading a doctor can practise medicine, but it is not astonishing how badly he may do it.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Books and Men (pp. 210–211)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

## GENERAL RELATIVITY

**Besso, Michele** 1873–1955  
Physicist

...the devil has gotten into my friends in the Physical Society and they want a talk from me on your [Einstein's] latest papers: even though there are at least three people here – Abraham, Grossmann, and Weyl – who

know a hundred times more about the topic than I do. I feel like someone for whom Beethoven has whistled his symphony and who now on the basis of that has to whistle after him – someone with the score in front of his eyes, but only being able to read it the way I read sheet music...

*Collected Papers of Albert Einstein* (Volume 8)

Letter, Besso to Einstein (Document 229)

June 28, 1916

Princeton University Press. Princeton, New Jersey, USA. 1987

**Einstein, Albert** 1879–1955

German-born physicist

My faith in the reliability of the theory still fluctuates.... Thus, if not all systems of equations of the theory...admit transformations other than linear ones, then the theory contradicts its own starting point and all is up in the air.

*Collected Papers of Albert Einstein* (Volume 5)

Letter, Einstein to Lorentz (Document 467)

August 14, 1913

Princeton University Press. Princeton, New Jersey, USA. 1987

## GENERALIST

**Bailey, Liberty Hyde** 1858–1954

American horticulturist and botanist

The youth is by nature a generalist. He should not be forced to be a specialist.

*Botany*

Paragraphs for the Teacher (p. vii)

The Macmillan Co. New York, New York, USA. 1909

## GENERALITY

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Generalization is always a new influx of divinity into the mind. Hence the thrill that attends it.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

Circles (p. 407)

The Library of America. New York, New York, USA. 1983

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

In the natural sciences, and particularly in chemistry, generalities must come after the detailed knowledge of each fact and not before it. It is really only after having acquired this knowledge that one may see if the facts have anything in common...and only after that is it permissible to consider them in a general manner.

*Annales de Chimie et de Physique*, Volume 11, 1819 (p. 297)

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

Science is nothing without generalisations.... The suggestion of a new idea, or the detection of a law, supersedes much that had previously been a burden upon the memory, and by introducing order and coherence facilitates the retention of the remainder in an available form.

In William C. McC. Lewis

*A System of Physical Chemistry* (Volume 1) (p. iv)

Longmans, Green and Company. London, England. 1918

## Whitehead, Alfred North

We think in generalities, but we live in details.

*Essays in Science and Philosophy*

The Education of an Englishman (p. 29)

Philosophical Library. New York, New York, USA. 1947

## GENERALIZATION

**Bernard, Claude** 1813–78

French physiologist

...particular facts are never scientific; only generalization can establish science.

Translated by Henry Copley Green

*An Introduction to the Study of Experimental Medicine*

Part II, Chapter II (p. 91)

Henry Schuman, Inc. New York, New York, USA. 1949

**Bloom, Orly Castel** 1960–

Israeli writer

What is a generalization? Who said that one should not generalize?...To say that one should not generalize is not a generalization?

*Human Parts* (p. 150)

Kinneret. Tel Aviv, Israel. 2002

**de La Beche, Henry Thomas** 1796–1855

English geologist

...generalizations would be excellent things if we could be persuaded to part with them as easily as we formed them. They might then be used like the shifting hypotheses in certain operations of exact science, by help of which we may gradually approximate nearer and nearer to the truth.

Quoted in Henry Thomas de La Beche

*Sections & Views, Illustrative of Geological Phaenomena*

Preface (p. vii)

Treuttel & Würtz. London, England. 1830

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

It is well to be explicit when a positive generalization is made from negative experimental evidence.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter IV (p. 76)

At The University Press. Cambridge, England. 1921

**Michener, James A.** 1907–97

American Pulitzer Prize novelist

When a man has studied the heavens for ten thousand nights, he is entitled to make certain generalizations. Space is without limit or definition. There is no east or west, no north or south, no down or up, no in or out. It is truly boundless and must be respected as such. It cannot be measured or comprehended. All we can do is behave in accordance with its laws as we dimly perceive them.

*Space*

Chapter VI (p. 333)

Random House, Inc. New York, New York, USA. 1982

**Macaulay, Thomas Babington** 1800–50

English historian and writer

Generalisation is necessary to the advancement of knowledge, but particularly in the creations of the imagination.

*Critical and Miscellaneous Essays* (Volume 1)

Milton (p. 21)

Carey &amp; Hart. Philadelphia, Pennsylvania, USA. 1843

**Mellor, Joseph William** 1863–1938

Chemist

Generalization is the golden thread which binds many facts into one simple description.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry* (Volume 1)

Chapter I (p. 10)

Longman, Green, &amp; Co. London, England. 1922

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Every age has ridiculed the one before it, and accused it of having generalized too quickly and too naively. Descartes pitied the Ionians; Descartes, in his turn, makes us smile. No doubt our children will someday laugh at us.

Translated by George Bruce Halsted

*Science and Hypothesis*

Part IV, Chapter IX (p. 101. )

The Science Press. New York, New York, USA. 1905

Let us notice first of all, that every generalization implies in some measure the belief in the unity and simplicity of nature. As to the unity there can be no difficulty. If the different parts of the universe were not like the members of one body, they would not act on one another, they would know nothing of each other; and we in particular would know only one of these parts. We do not ask, then, if nature is one, but how it is one.

Translated by George Bruce Halsted

*Science and Hypothesis*

Part IV, Chapter IX (p. 104)

The Science Press. New York, New York, USA. 1905

**GENESIS****Huxley, Thomas Henry** 1825–95

English biologist

...when the *peine forte et dure* is over, the antique sincerity of the venerable sufferer always reasserts itself. Genesis is honest to the core, and professes to be no more than it is, a repository of venerable traditions of unknown origin, claiming no scientific authority and possessing none.

In Francis Darwin

*The Life and Letters of Charles Darwin*

On the Reception of the Origin of Species (p. 535)

D. Appleton &amp; Co. New York, New York, USA. 1904

**GENETIC****Callahan, Daniel**

No biographical data available

That the emphasis has so far fallen most heavily on ridding mankind of genetic disease should not obscure the fact that the vision of genetic improvement has a lively life just below the surface, in the stirrings of a new eugenics movement.

*The Tyranny of Survival; and Other Pathologies of Civilized Life*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1973

**Campbell, J. H.**

No biographical data available

This new era of genetics is disclosing a remarkable new type of biological function. Some genetic structures do not adapt the organism to its environment. Instead, they have evolved to promote and direct the process of evolution. They function to enhance the capacity of the species to evolve.

In D.J. Depew and B.H. Weaver (eds.)

*Evolution at a Crossroads: The New Biology and the New Philosophy of Science*

An Organizational Interpretation of Evolution (p. 137)

MIT Press. Cambridge, Massachusetts, USA. 1985

**Dobzhansky, Theodosius** 1900–75

Russian American scientist

Genetics is the first biological science which got in the position in which physics has been in for many years. One can justifiably speak about such a thing as theoretical mathematical genetics, and experimental genetics, just as in physics. There are some mathematical geniuses who work out what to an ordinary person seems a fantastic kind of theory. This fantastic kind of theory nevertheless leads to experimentally verifiable prediction, which

an experimental physicist has to test the validity of. Since the times of Wright, Haldane, and Fisher, evolutionary genetics has been in a similar position.

In William B. Provine  
*Sewall Wright and Evolutionary Biology*  
Chapter 9 (p. 277)

Genetics, an important branch of biological science, has grown out of the humble peas planted by Mendel in a monastery garden.

The Mendel Centennial  
*The Rockefeller Institute Review*, Volume 2, 1964

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

In the 50 years since Mendel's Laws were so dramatically rediscovered, genetics has been transformed from a groping incertitude to a rigorous and many-sided discipline, the only branch of biology in which induction and deduction, theory and experiment, observation and comparison have come to interlock, in the same sort of way that they have for many years done in physics.

In L.C. Dunn (ed.)  
*Genetics in the 20th Century: Essays on the Progress of Genetics during the First 50 Years*  
Genetics, Evolution and Human Destiny (p. 591)  
The Macmillan Company. New York, New York, USA. 1951

**Koestler, Arthur** 1905–83

Hungarian-born English writer

...the genetic code [is] written in the four-letter alphabet, "A", "G", "C", "T." Here, then, floating in the nuclear sap, is the code which governs the skill of creating a six-foot drum major with a slight squint and dimpled cheeks out of an egg with a diameter of a few microns.

*The Act of Creation*  
Book Two, Chapter I (p. 417)  
The Macmillan Company. New York, New York, USA. 1964

**Sturtevant, A. H.**

No biographical data available

Man is one of the most unsatisfactory of all organisms for genetic study.

Social Implications of the Genetics of Man  
*Science*, Volume 120, Number 3115, September, 10, 1954 (p. 405)

**Thomas, Lewis** 1913–93

American physician and biologist

It is the very strangeness of nature that makes science engrossing. That ought to be at the center of science teaching. There are more than seven-times-seven types of ambiguity in science, awaiting analysis. The poetry of Wallace Stevens is crystal-clear alongside the genetic code.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*  
Humanities and Science (p. 150)  
Viking Press. New York, New York, USA. 1983

## GENETIC CODE

**Jacob, François** 1920–

French biologist

If the genetic code is universal, it is probably because every organism that has succeeded in living up till now is descended from one single ancestor. But it is impossible to measure the probability of an event that occurred only once.

*The Logic of Life: A History of Heredity* (p. 306)  
Pantheon Books. New York, New York, USA. 1974

## GENETIC THEORY

**Jeffers, Robinson** 1887–1962

American poet

He smiled in himself

Thinking about the scrap of Mendelian theory  
Picked up in high-school: blue eyes recessive, brown dominant:

Therefore blue-eyed parents cannot produce  
A dark-eyed child, the dark-eyed-producing element  
Lacking in them. If it were present in either,  
That one would be dark-eyed, for dark eyes are dominant.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Such Counsels You Gave to Me (p. 568)  
Stanford University Press. Stanford, California, USA. 1988

## GENETICS

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

I believe that no one who is familiar, either with mathematical advances in other fields, or with the range of special biological conditions to be considered, would ever conceive that everything could be summed up in a single mathematical formula, however complex.

The Evolutionary Modification of Genetic Phenomena  
*Proceedings of the 6th International Congress of Genetics*, Volume 1, 1932

**Shakespeare, William** 1564–1616

English poet, dramatist, and actor

But where the bull and cow are both milk-white,  
They never do beget a coal-black calf.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*Titus Andronicus*  
Act V, Scene i, l. 31–32

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sturtevant, A. H.**

No biographical data available



The possibilities of the genetic study of *Drosophila* were then just beginning to be apparent; we were at the right place at the right time.

*American Scientist*, Volume 53, Number 303, 1965

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

Where a cell arises, there a cell must have previously existed (*omnis cellula e cellula*), just as an animal can spring only from an animal, a plant only from a plant.

Translated by Frank Chase

*Cellular Pathology: As Based Upon Physiological and Pathological History*

Lecture II (p. 54)

Dover Publications, Inc. New York, New York, USA. 1971

## GENIUS

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

To do easily what is difficult for others is the mark of talent. To do what is impossible for talent is the mark of genius.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

December 17, 1856 (p. 76)

A.L. Burt Company, Publishers. New York, New York, USA. 1897

**Babbage, Charles** 1792–1871

English mathematician

This desire for extreme accuracy has called away the attention of experimenters from points of far greater importance, and it seems to have been too much overlooked in the present day, that genius marks its tract, not by the observation of quantities inappreciable to any but the acutest senses, but by placing Nature in such circumstances, that she is forced to record her minutest variations on so magnified a scale, that an observer, possessing ordinary faculties, shall find them legibly written.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter V (p. 169)

Printed for B. Fellowes. London, England. 1830

**Bartol, C. A.** 1813–1900

No biographical data available

As diamond cuts diamond, and one hone smooths a second, all the parts of intellect are whetstones to each other; and genius which is but the result of their mutual sharpening is character too.

*Radical Problems*

Individualism (p. 43)

Robert Brothers. Boston, Massachusetts, USA. 1872

**Beaumont, William** 1785–1853

American Army surgeon

The process of developing truth by patient and persevering investigation, experiment, and research, is incompatible with their notions of unrestrained genius. The drudgery of science they leave to humbler and more unpretending contributors. The flight of genius is, however, frequently erratic.

*Experiments and Observations on the Gastric Juice, and the Physiology of Digestion*

Chapter 6 (p. 92)

Maclachlan & Stewart. Edinburgh, Scotland. 1838

**Bester, Alfred** 1913–87

Science fiction author

A genius is someone who travels to truth by an unexpected path.

*Starlight: The Great Short Fiction of Alfred Bester*

The Man Who Murdered Mohammed (p. 90)

Nelson Doubleday, Inc. Garden City, New York, USA. 1976

**Blake, William** 1757–1827

English poet, painter, and engraver

He who can be bound down is no Genius. Genius cannot be Bound.

In Edwin John Ellis

*The Real Blake: A Portrait Biography*

Chapter XXXII (p. 391)

Chatto & Windus. London, England. 1907

**Bonnycastle, John** 1751–1821

Mathematician

A great and comprehensive genius excludes none of the sciences; they all contribute, by various means, to adorn and embellish life; and, for that reason, ought to be cultivated and improved. Happy is the mind that is not contracted by the study of philosophy, nor enervated by the charms of the Belles Lettres; that can be strengthened by Locke; instructed by Clarke and Newton; impassioned by Cicero and Demosthenes; and elevated by the powers of Homer and Virgil.

*An Introduction to Astronomy* (7th edition)

Letter I (p. 16)

Printed for J. Nunn. London, England. 1817

**Bromberger, Sylvain**

No biographical data available

A clear mark of scientific genius is the ability to see certain well-known facts as departures from general rules... and the germane ability to ask why-questions that occur to no one else.

In Robert G. Colodny (ed.)

*Mind and Cosmos*

Why-Questions (p. 103)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1966

**Carlyle, Thomas** 1795–1881

English historian and essayist

...genius is ever a secret to itself...

*Characteristics*, by Thomas Carlyle; *Favorite Poems*, by Percy Bysshe Shelley; *the Eve of St. Agnes, and Other Poems*, by John Keats  
Paragraph 6 (p. 11)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1882

### Ceild, J. M.

No biographical data available

That man is well on the way to becoming a genius who can take a second man's subject, apply to it a third man's method, and get more out of either than the originators.

In W.J. Greenstreet

*Isaac Newton*

*Newton and the Art of Discovery* (p. 129)

G. Bell & Sons Ltd. London, England. 1927

### Chargaff, Erwin 1905–2002

Austrian biochemist

Unappreciated geniuses in the natural sciences remain unrecognized; for them there is no posterity.

*Voices in the Labyrinth: Nature, Man and Science* (p. 19)

The Seabury Press. New York, New York, USA. 1977

### Chittenden, Newton W.

Mineral surveyor

Great genius is seldom marked by precocious development ...

Translated by Andrew Motte

In Isaac Newton

*Newton's Principia: The Mathematical Principles of Natural Philosophy*

Life of Sir Isaac Newton (p. 10)

Daniel Adee. New York, New York, USA. 1848

### Coleridge, Samuel Taylor 1772–1834

English lyrical poet, critic, and philosopher

To find no contradiction in the union of old and new; to contemplate the Ancient of Days and all His works with feelings as fresh as if all had then sprang forth at the first creative fiat; characterizes the mind that feels the riddle of the world, and may help to unravel it. To carry on the feelings of childhood into the powers of manhood; to combine the child's sense of wonder and novelty with the appearances which every day for perhaps forty years had rendered familiar...this is the character and privilege of genius, and one of the marks which distinguish genius from talents.

*Biographia literaria*

Chapter IV (p. 41)

George Bell & Sons. London, England. 1905

...it is the prime merit of genius, and its most unequivocal mode of manifestation, so to represent familiar objects, as to awaken in the minds of others a kindred feeling concerning them, and that freshness of sensation which is the constant accompaniment of mental, no less than of bodily, convalescence.

*Biographia literaria*

Chapter IV (p. 41)

George Bell & Sons. London, England. 1905

### Colton, Charles Caleb 1780–1832

English sportsman and writer

A harmless hilarity, and a buoyant cheerfulness are not infrequent concomitants of genius; and we are never more deceived, than when we mistake gravity for greatness, solemnity for science, and compositeness for erudition.

*Lacon: Or, Many Things in Few Words*

CCII (p. 109)

Longman, Rees, Orme, Brown & Green. London, England. 1826

### Davy, Sir Humphry 1778–1829

English chemist

Almost all great deeds arise from a plenitude of hope or desire. No man ever had genius who did not aim to execute more than he was able.

In John Davy

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter II (p. 122)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

Restlessness of thought, power superior even to will, ardent, but indefinite hope – these constitute the great elements of that feeling which always has something above the common habits of thought; has been, as it were, supernaturally infused into the mind, or self-born in it, – which though derived from the senses and the feelings, bears very little relation to them – which is, as it were, matter converted into mind, spirit animating thoughts and feelings, embodied in reasoning.

In John Davy

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 115)

John Churchill. London, England. 1858

The man who labours to produce effect, can never have the highest degree of genius. That polish of style, that smoothness of versification, and that harmony of periods, which demand labour, and labour only, are incompatible with the strong and rapid combinations of genius.

In John Davy

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 115)

John Churchill. London, England. 1858

### de La Bruyère, Jean 1645–96

French philosopher, moralist, and writer

Intelligence is to genius as the whole is in proportion to its part.

Translated by Henri van Laun

*The "Characters" of Jean de La Bruyère*

Of Opinions (p. 348)

John C. Nimmo. London, England. 1885

### Diderot, Denis 1713–84

French encyclopedist and philosopher of materialism

We have three principal means: observation of nature, reflection, and experiment. Observation gathers the facts reflection combines them, experiment verifies the result

of the combination. It is essential that the observation of nature be assiduous, that reflection be profound, and that experimentation be exact. Rarely does one see these abilities in combination. And so, creative geniuses are not common.

*Thoughts on the Interpretation of Nature*

Chapter XV

Clinamen Press Ltd. Manchester, England. 2000

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

They say that genius is an infinite capacity for taking pains, he remarked with a smile. It's a very bad definition, but it does apply to detective work.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Study in Scarlet*, Chapter 3 (p. 171)

Wings Books. New York, New York, USA. 1967

**Edison, Thomas Alva** 1847–1931

American inventor

Genius is 1 per cent inspiration and 99 per cent perspiration.

In Frank Lewis Dyer

*Edison His Life and Inventions* (Volume 2)

Chapter XXIV (p. 607)

Harper & Brothers. New York, New York, USA. 1929

**Egler, Frank E.** 1911–96

Ecologist

Genius knows no method, tho it leaves a spoor-method for drones to follow.

*The Way of Science*

Methodology and Logic (p. 44)

Hafner Publishing Company. New York, New York, USA. 1970

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

To believe your own thought, to believe that what is true for you in your private heart is true for all men – that is genius.

*Essays, Lectures, and Orations*

Self-Reliance (p. 23)

William S. Orr & Co. London, England. 1848

**Fitzgerald, F. Scott** 1896–1940

American novelist and short story writer

Genius is the ability to put into effect what is in your mind. There's no other definition of it.

*The Crack-Up*

The Note-Books, E (p. 123)

New Directions. New York, New York, USA. 1945

**Hazlitt, William Carew** 1834–1913

English bibliographer

Genius is a native to the soil where it grows – is fed by the air, and warmed by the sun; and is not a hothouse plant or an exotic.

In W. Carew Hazlitt (ed.)

*The Round Table; Northcotes Conversations; Characteristics*

Commonplaces, XXVII (p. 534)

George Bell & Sons. London, England. 1884

**Holland, Josiah Gilbert** 1819–81

American novelist and poet

Genius originates ideas and invents forms; talent adopts ideas and imitates forms. Talent is instructed; genius is inspired.

*Plain Talks on Familiar Subjects: A Series of Popular Lectures*

Chapter VIII (p. 274)

Charles Scribner & Co. New York, New York, USA. 1866

Nature is the master of talent; genius is the master of nature.

*Plain Talks on Familiar Subjects: A Series of Popular Lectures*

Chapter VIII (p. 274)

Charles Scribner & Co. New York, New York, USA. 1866

**Huxley, Thomas Henry** 1825–95

English biologist

...genius, as an explosive power, beats gunpowder hollow; and if knowledge, which should give that power guidance, is wanting, the chances are not small that the rocket will simply run a-muck among friends and foes.

*Method and Results: Essays*

Administrative Nihilism (p. 256)

D. Appleton & Co. New York, New York, USA. 1898

**Joyce, James** 1882–1941

Expatriate Irish writer and poet

A man of genius makes no mistakes. His errors are volitional and are the portals of discovery.

*Ulysses* (p. 188)

Random House, Inc. New York, New York, USA. 1946

**Kekule, August** 1829–96

German organic chemist

Someone has spoken of genius, and has designated the benzene theory as the product of genius. I have often asked myself the question, What is the work of genius? What is genius? Someone has said that genius perceives the truth without knowing the proof of the truth. It has also been said that genius thinks by leaps and bounds. Gentlemen, the expanding mind does not think by leaps. This is not possible.

In Harry Clary Jones

*A New Era in Chemistry*

Chapter I (p. 13)

D. van Nostrand Co. New York, New York, USA. 1913

**Lavater, Johann Caspar** 1741–1801

Swiss poet and physiognomist

Who in the same given time can produce more than many others, has *vigour*; who can produce more and better, has *talents*; who can produce what none else can, has *genius*.

*Aphorisms on Man* (2nd edition)

Number 23 (pp. 11–12)

Printed by T. Bensey. London, England. 1789

**Longfellow, Henry Wadsworth** 1807–82

American poet

All the means of action – the shapeless masses – the materials – lie everywhere about us. What we need is the celestial fire to change the flint into the transparent crystal, bright and clear. That fire is genius.

*The Poetical Works of Henry Wadsworth Longfellow*

*The Spanish Student*

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1882

Men of genius are often dull and inert in society; as the blazing meteor, when it descends to earth, is only a stone.

*The Prose Works of Henry Wadsworth Longfellow*

*Kavanagh*

XII (p. 329)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1845

**O'Brien, Fitz James** 1828–62

Author

Every great genius is mad upon the subject in which he is greatest. The unsuccessful madman is disgraced and called a lunatic.

In William Winter

*The Diamond Lens*

Chapter II (p. 8)

The Macmillan Company. New York, New York, USA. 1928

**Olmsted, Denison** 1791–1859

Physicist and astronomer

Happy is genius, when it lights on a profession entirely consonant to its powers, where the objects successively presented to it are so exactly suited to its nature, that it clings to them as the loadstone to its kindred metal among piles of foreign ores.

*Letters on Astronomy*

Letter XXIV (p. 301)

Harper & Brothers Publishers. New York, New York, USA. 1848

**O'Malley, Austin** 1858–1932

American physician and humorist

Talent apprehends, genius comprehends.

*Keystones of Thought* (p. 9)

The Devin-Adair Co. New York, New York, USA. 1915

**Peirce, Benjamin** 1809–80

American mathematician

If American genius is not fettered by the chains of necessity, and helplessly exposed to the assaults of envious mediocrity, but is generously nourished in the bosom of liberty, it will joyfully expand its free wings, and soar with the eagle to the conquest of the skies.

*Address of Professor Benjamin Peirce, President of the American Association for the Year 1853, on Retiring from the Duties of President* (p. 17)

Unknown publisher. 1853

**Phillips, Wendell**

No biographical data available

We measure genius by quality, not by quantity.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter VIII (p. 82)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

**Priestley, Joseph** 1733–1804

English theologian and scientist

It sometimes happens to men whose genius far transcends the level of their day, to be from that very circumstance neither understood nor believed by their contemporaries.

*Memoirs of Dr. Joseph Priestley* (Volume 1)

Appendix Number 1 (p. 225 fn)

J. Binns. Northumberland, Pennsylvania, USA. 1806

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In science the man of real genius is the man who invents a new method. The notable discoveries are often made by his successors, who can apply the method with fresh vigour, unimpaired by the previous labour of perfecting it; but the mental calibre of the thought required for their work, however brilliant, is not so great as that required by the first inventor of the method.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 41)

Longmans, Green & Co. London, England. 1919

**Spencer, Herbert** 1829–1903

English social philosopher

Unexpected though the assertion may be, it is nevertheless true, that the highest Art of every kind is based on Science – that without Science there can be neither perfect production nor full appreciation.... Only when Genius is married to Science can the highest results be produced.

*Education*

Chapter I (p. 61, 66)

Willard Small. Boston, Massachusetts, USA. 1890

**Swann, William Francis Gray** 1884–1962

English physicist

When an outstanding genius causes science to take a leap forward beyond the vision of his contemporaries, there usually follows a period of depression in which it seems that all that is worth doing has been done, and that the universe has not already revealed must forever defy the power of man to fathom.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

Three Centuries of Natural Philosophy (p. 237)

Government Printing Office. Washington, D.C. 1929

**Swift, Jonathan** 1667–1745

Irish-born English writer

When a true genius appears in this world, you may know him by this sign, that the dunces are all in confederacy against him.

*The Works of Jonathan Swift* (Volume 2)  
*Thoughts on Various Subjects* (p. 304)  
Henry G. Bohn. London, England. 1856

**Todd, Margaret Georgina** 1859–1918

Physician and writer

The scientific genius is so like the old Hebrew prophet. He singles out the essential from the mass of facts before him, and then – lifts up his eyes.

*The Way of Escape: A Novel*  
Part III, Chapter XXVII (p. 187)  
William Blackwood & Sons. Edinburgh, Scotland. 1902

**Trevor-Roper, Hugh Redwald Baron**

**Dacre of Glanton** 1914–2003

English historian

The function of genius is not to give new answers, but to pose new questions, which time and mediocrity can resolve.

*Men and Events: Historical Essays* (p. 238)  
Harper. New York, New York, USA. 1957

**Tyndall, John** 1820–93

Irish-born English physicist

There is, however, no genius so gifted as not to need control and verification. The profoundest minds know best that Nature's ways are not at all times their ways, and that the brightest flashes in the world of thought are incomplete until they have been proved to have their counterparts in the world of fact.

*Fragments of Science for Unscientific People*  
Chapter VI (p. 111)  
D. Appleton & Co. New York, New York, USA. 1875

**von Ebner-Eschenbach, Marie** 1830–1916

Austrian novelist

Genius points the way; talent pursues it.

Translated by Annis Lee Wister  
*Aphorisms*  
Number 273  
J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Men of genius, after all, are not immortal. What a comfort for mediocrity!

Translated by Otto Wenckstern  
*Goethe's Opinions on the World, Mankind, Literature, Science, and Art* (p. 29)  
John W. Parker & Son. London, England. 1853

**Westfall, Richard S.** 1924–96

Science historian

...geniuses...are more apt to indicate the line of march into the future than to reflect the consensus accepted in their own time.

In David C. Lindberg and Ronald L. Numbers  
*God and Nature: Historical Essays on the Encounter Between Christianity and Science*  
The Rise of Science and the Decline of Orthodox Christianity (p. 219)  
University of California Press. Berkeley, California, USA. 1986

**Whipple, Edwin Percy** 1819–86

American essayist

Talent repeats; Genius creates. Talent is a cistern; Genius is a fountain. Talent deals with the actual, with discovered and realized truths, analyzing, arranging, combining, applying positive knowledge, and in action looking to precedents; Genius deals with the possible, creates new combinations, discovers new laws, and acts from an insight into principles. Talent jogs to conclusions to which Genius takes giant leaps. Talent accumulates knowledge, and has it packed up in the memory; Genius assimilates it with its own substance, grows with every new accession, and converts knowledge into power. Talent gives out what it has taken in; Genius what has risen from its unsounded wells of living thought. Talent, in difficult situations, strives to untie knots, which Genius instantly cuts with one swift decision. Talent is full of thoughts, Genius [is] of thought; one has definite acquisitions, the other indefinite power.

*Literature and Life*  
Genius (p. 162)  
Ticknor, Reed and, Fields. Boston, Massachusetts, USA. 1850

**Wiggam, Albert Edward**

American lecturer and writer

Only genius can create science, but the humblest man can be taught its spirit. He can learn to face truth.

*The New Decalogue of Science* (p. 127)  
The Bobbs-Merrill Co. Indianapolis, Indiana, USA. 1923

**Willmott, Robert Eldridge Aris** 1809–63

English writer, poet

The idioms of Genius will always present obscurities to the uninformed; they are to be acquired, as a man learns to translate a dialect.

*Pleasures, Objects, and Advantages of Literature* (4th edition)  
Chapter XI (p. 53)  
G. Routledge & Co. London, England. 1855

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

There are no more lights in a genius than in any other honest man – but he has a particular kind of lens to concentrate this light into a burning point.

Translated by Peter Winch  
*Culture and Value* (p. 35e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980



**GENOME**

**Ridley, Matt** 1958–  
English science writer

The truth is that nobody is in charge. It is the hardest thing for human beings to get used to, but the world is full of intricate, cleverly designed and interconnected systems that do not have control centers. The economy is such a system. The illusion that economies run better if somebody is put in charge of them – and decides what gets manufactured where and by whom – has done devastating harm to the wealth and health of people all over the world, not just in the former Soviet Union, but in the west as well.... It is the same with the body. You are not a brain running a body by switching on hormones. Nor are you a body running a genome by switching on hormone receptors. Nor are you a genome running a brain by switching on genes that switch on hormones. You are all of these at once.

*Genome: The Autobiography of a Species in 23 Chapters*  
Chapter 10 (p. 151)  
HarperCollins Publishers. New York, New York, USA. 2000

This is the reality of genes for behavior. Do you see now how unthreatening it is to talk of genetic influences over behavior? How ridiculous to get carried away by one “personality gene” among 500? How absurd to think that, even in a future brave new world, some-body might abort a foetus because one of its personality genes is not up to scratch – and take the risk that on the next conception she would produce a foetus in which two or three other genes were of a kind she does not desire? Do you see now how futile it would be to practise eugenic selection for certain genetic personalities, even if somebody had the power to do so? You would have to check each of 500 genes one by one, deciding in each case to reject those with the “wrong” gene. At the end you would be left with nobody, not even if you started with a million candidates. We are all of us mutants. The best defense against designer babies is to find more genes and swamp people in too much knowledge.

*Genome: The Autobiography of a Species in 23 Chapters*  
Chapter 11 (p. 165)  
HarperCollins Publishers. New York, New York, USA. 2000

**GENUS**

**Wiley, E. O.**

No biographical data available

The genus is a mandatory category to which every species must belong if binomial nomenclature is to be preserved.

*Phylogenetics: The Theory and Practice of Phylogenetic Systematics*  
(p. 205)  
John Wiley & Sons, Inc. New York, New York, USA. 1981

**GEOGRAPHY**

**Fitz-Gerald, Charles Egerton**  
English physician

In reflecting on the physical structure of the earth, and on its repeated alterations of level, the mind is prone to be more impressed by the “Infinitely Great” forces of nature, the earthquakes, volcanoes, and floods, than by the “Infinitely Small” agencies which are nevertheless unceasingly at work, and do more to alter the physical geography of the globe, than the most furious convulsions of nature.

*Semi-scientific Lectures*  
On Coral (p. 9)  
J. English. Folkstone, England. 1880

**GEOGRAPHY, PHYSICAL**

**Maury, Matthew Fontaine** 1806–73

American astronomer, astrophysicist, historian and oceanographer

Physical geography invites you to consider the terrestrial machinery which makes day and night, seed-time and harvest; which lifts the vapor from the sea, forms clouds, and waters the earth; which clothes it with verdure and cheers it with warmth, or covers it with snow.

*Physical Geography*  
Introductory (p. 5)  
University Publishing Co. New York, New York, USA. 1894

**GEOLOGICAL**

**Miller, Hugh** 1802–56

Scottish geologist and theologian

...no man who enters the geological field in quest of the wonderful need pass, in pursuit of his object, from the true to the fictitious.

*The Old Red Sandstone*  
Chapter III (p. 41)  
John B. Alden, Publisher. New York, New York, USA. 1892

**Whewell, William** 1794–1866

English philosopher and historian

While so large a portion of the globe is geologically unexplored; – while all the general views which are to extend our classifications satisfactorily from one hemisphere to another, from one zone to another, are still unformed; while the organic fossils of the tropics are almost unknown, and their general relation to the existing state of things has not even been conjectured; – how can we expect to speculate rightly and securely, respecting the history of the whole of our globe? And if Geological Classification and Description are thus imperfect, the knowledge of Geological Causes is still more so.



*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 2) (3rd edition)  
Book XVIII, Chapter VIII (p. 596)  
D. Appleton & Co. New York, New York, USA. 1894

## GEOLOGICAL AGE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The tree is known by its fruits, and the fruits of chance are incoherence, incompleteness, unsteadiness, the stammering utterance of blind, unreasoning force. A coherence that binds all the geological ages in one chain, a stability of purpose that completes in the beings born to-day an intention expressed in the first creatures that swam in the Silurian ocean or crept upon its shores, a steadfastness of thought, practically recognized by man, if not acknowledged by him, whenever he traces the intelligent connection between the facts of Nature and combines them into what he is pleased to call his system of geology, or zoology, or botany these things are not the fruits of chance or of an unreasoning force, but the legitimate results of intellectual power.

*Geological Sketches*

Chapter I (p. 21)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1886

## GEOLOGICAL CHANGE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

When chemists have brought their knowledge out of their special laboratories into the laboratory of the world, where chemical combinations are and have been through all time going on in such vast proportions, – when physicists study the laws of moisture, of clouds and storms, in past periods as well as in the present, – when, in short, geologists and zoologists are chemists and physicists, and *vice versa*, – then we shall learn more of the changes the world has undergone than is possible now that they are separately studied.

*Geological Sketches*

The Fern Forests of the Carboniferous Period (p. 73)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1886

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

We now propose to examine those changes which still take place on our globe, investigating the causes which continue to operate on its surface.... This portion of the history of the earth is so much the more important, as it has been long considered possible to explain the more ancient revolutions on its surface by means of these still existing causes.... But we shall presently see that unfortunately this is not the case in physical history; the thread of operations is here broken, the march of nature

is changed, and none of the agents that she now employs were sufficient for the production of her *Essay on the Theory of the Earth* (4th edition)

Examination of the Causes which act at present on the Surface of our Globe (p. 24)

Printed for William Blackwood. Edinburgh, Scotland. 1822

**Lyell, Sir Charles** 1797–1875  
English geologist

When we are unable to explain the monuments of past changes, it is always more probable that the difference arises from our ignorance of all the existing agents, or all their possible effects in an indefinite lapse of time, than that some cause was formerly in operation which has ceased to act...

*Principles of Geology* (Volume 1) (2nd edition)

Chapter IX (p. 189)

John Murray. London, England. 1832

**Meech, L. W.**

No biographical data available

The causes of notable geological changes must be other than the relative position of the sun and earth, under their present laws of motion.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1856)

On The Relative Intensity of the Heat and Light of the Sun Upon Different Latitudes of the Earth (p. 344)

Government Printing Office. Washington, D.C. 1857

## GEOLOGICAL EVOLUTION

**Geikie, Sir Archibald** 1835–1924  
English geologist

What art effects upon the marble block, nature accomplishes upon the surface of the land. Her tools are many and varied – air, frost, rain, springs, torrents, rivers, avalanches, glaciers, and the sea – each producing its own characteristic traces in the sculpture. With these implements, out of the huge bulk of the land she cuts the valleys and ravines, scoops the lake-basins, hews with bold hand the colossal outlines of the mountains, carves out peak and crag, crest and cliff, chisels the courses of the torrents, splinters the sides of the precipices, spreads out the alluvium of the rivers, and piles up the moraines of the glaciers.

*Geological Sketches at Home and Abroad*

Chapter XIII (p. 294)

The Macmillan Co. New York, New York, USA. 1892

## GEOLOGICAL INQUIRER

**Paris, John Ayrton** 1785–1856  
English physician

To discover order and intelligence in scenes of apparent wildness and confusion, is the pleasing task of the geological enquirer ...

On A Recent Formation of Sandstone  
*Transactions of the Royal Geological Society of Cornwall*, Volume 1,  
 1818 (p. 19)

## GEOLOGICAL SCIENCE

**de La Beche, Henry Thomas** 1796–1855  
 English geologist

The advance of geological science has lately been so rapid, that it requires some exertion to keep pace with it. Hasty conclusions can no longer command attention, – there are too many observers in the field to permit errors to remain long uncontradicted, – and it is very desirable for the progress of science, that no deference for a name should cause them to remain uncontradicted. It surely can be no offence to state, that the progress of science has led to new views, and that the consequences that can be deduced from the knowledge of a hundred facts may be very different from those deducible from five. It is also possible that the facts first known may be the exceptions to a rule, and not the rule itself, and generalizations from these first-known facts, though useful at the time, may be highly mischievous, and impede the progress of the science if retained when it has made some advance.

*Sections & Views, Illustrative of Geological Phaenomena*  
 Preface (p. vii)  
 Treuttel & Würtz. London, England. 1830

## GEOLOGICAL TERMS

**McPhee, John** 1931–  
 American journalist and nonfiction writer

I used to sit in class and listen to the terms come floating down the room like paper airplanes. Geology was called a descriptive science, and with its pitted, outwash plains and drowned rivers, its hanging tributaries and starved coastlines, it was nothing if not descriptive.

*Basin and Range* (p. 24)  
 Farrar, Straus, Giroux. New York, New York, USA. 1981

Someone developed enough effrontery to call a piece of our earth an epieugeosyncline. There were those who said interflue when they meant between two streams, and a perfectly good word like Mesopotamian would do. A cactolith, according to the American Geological Institute Glossary of Geology and Related Sciences, was “quasi-horizontal chonolith composed of anastomosing ductoliths, whose distal ends curl like a harpolith, thin like a sphenolith, or bulge dscordantly like an akmolityh or ethmolith.”

*Basin and Range* (pp. 27–28)  
 Farrar, Straus, Giroux. New York, New York, USA. 1981

The enthusiasm geologists show for adding new words to their conversation is, if anything, exceeded by their

affection for the old. They are not about to drop granite. They say granodiorite when they are in church and granite the rest of the week.

*Basin and Range* (pp. 29–30)  
 Farrar, Straus, Giroux. New York, New York, USA. 1981

## GEOLOGICAL THOUGHT

**Kemp, James Furman** 1859–1926  
 American geologist

We feel ourselves as it were upon some mountain summit looking ever away and away into regions beyond. And just as when standing amid such surroundings we have felt the ecstatic thrill brought by the expanding prospect and have burned with eagerness to penetrate the new lands further on, so in the realm of geological thought we look back over the periods of the past, over the course which we have come, over the problems solved, the lower summits climbed, and then turning ahead to the future, to the yet unknown, we burn with eagerness to push forward in our day and generation the boundaries of knowledge another stage.

*Lectures on Science, Philosophy and Art, 1907–1908*  
 Geology (p. 35)  
 The Columbia University Press. New York, New York, USA. 1908

## GEOLOGICAL TIME

**Burroughs, John** 1837–1921  
 American naturalist and essayist

Geologic time! How the striking of the great clock, whose hours are millions of years, reverberates out of the abyss of the past! Mountains fall, and the foundations of the earth shift, as it beats out the moments of terrestrial history.

*The Writings of John Burroughs* (Volume 19)  
 Chapter II (p. 40)  
 Houghton, Mifflin. Boston, Massachusetts, USA. 1916

How geologic time looks out from the ledges and walls of gray rocks unmindful of us human ephemera that pass! It has seen the mountains decay and the hills grow old. The huge drift boulders rest on the margin of meadows and fields, or stand sentry to the woods, and though races and kingdoms pass, scarcely the change of a wrinkle disturbs their calm stone faces. Yet time gets the better of them also. The frowning ledge melts as inevitably as a snowbank.

*The Writings of John Burroughs* (Volume 19)  
 Chapter II (p. 58)  
 Houghton, Mifflin. Boston, Massachusetts, USA. 1916

Time, geologic time, looks out at us from the rocks as from no other objects in the landscape. Geologic time! How the striking of the great clock, whose hours are

millions of years, reverberates out of the abyss of the past! Mountains fall, and the foundations of the earth shift, as it beats out the moments of terrestrial history.

*Under the Apple-Trees*

Chapter II (p. 40)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

Geologic time is the most potent of the gods of change. He wields an invisible hammer beside which the hammer of Thor is a child's toy. Its slow, silent blows break in through granite rocks as big as a house.

*Under the Apple-Trees*

Chapter II (p. 58)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

### **Croll, James** 1821–90

Scottish scientist

...when we reflect that with such extreme slowness do these agents [rain, snow, ice, running water] perform their work that we might, if we could, watch their operations from year to year, and from century to century, without being able to perceive that they make any sensible impression, we are necessitated to conclude that geological periods must be enormous.

*Discussions on Climate and Cosmology*

Chapter XVII (p. 267)

Edward Stanford. London, England. 1889

### **Geikie, Sir Archibald** 1835–1924

English geologist

We speak of the firm earth, of the everlasting hills, of the imperishable mountains, as if, where all else is fleeting and mutable, these forms at least remain unchanged.

*Geology*

Part I, Chapter I (p. 1)

J.A. Hill & Co. New York, New York, USA. 1904

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

A great reform in geological speculation seems now to have become necessary. A very earnest effort was made by geologists, at the end of last century, to bring geology within the region of physical science, to emancipate it from the dictation of authority and from dogmatic hypotheses. The necessity for more time to account for geological phenomena than was then generally supposed to be necessary, became apparent to all who studied with candour and with accuracy the phenomena presented by the surface of the earth.

*Popular Lectures and Addresses* (Volume 2)

On Geological Time (p. 10)

Macmillan & Co Ltd. London, England. 1894

### **Lapworth, Charles** 1842–1920

English Geologist

...the geologist, who is blest with an assured conviction of the immensity of geological time, moves with an ease

and freedom from cause to effect wholly denied to those wanting in this conviction.

*The Relations of Geology*

*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1902 (p. 398)

### **Morton, Ron L.**

No biographical data available

Geologic time – we know the earth is very old, but it occurs to me that the millions, nay billions, of years of geologic time, which geologists constantly remind us of, and impress us with, are not what an understanding of earth history should really be about. The span of geologic time is almost impossible to equate with the daily life of any of us. It is like our budget deficit – difficult to imagine, hard to comprehend, and seemingly impossible to control. Geologic time is simply not relevant to most of us.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Introduction (p. 3)

Plenum Press. New York, New York, USA. 1996

### **Sollas, William Johnson** 1849–1936

Geologist

The human mind, dwelling on such considerations as these [evolution of the world], seems at times to have been affected by a sur-excitation of the imagination, and a consequent paralysis of the understanding, which led to a refusal to measure geological time by years at all, or to reckon by anything less than “eternities.”

*The Age of the Earth and Other Geological Studies*

Chapter I (p. 15)

T. Fisher Unwin. London, England. 1908

## **GEOLOGIST**

### **Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

The world is the geologist's great puzzle-box; he stands before it like the child to whom the separate pieces of his puzzle remain a mystery till he detects their relation and sees where they fit, and then his fragments grow at once into a connected picture beneath his hand.

*Geological Sketches*

Chapter I (p. 11)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1886

### **Author undetermined**

Over the ground

Passes a sound;

It is the pit-a-pat of footsteps in the sand.

See them advance,

Thicker than ants;

Survey geologists are swarming through the land!

Quo Vadse?

*The Pick and Hammer Club*, March 16, 1948 (p. 12)

A geologist is the only person who can talk to a woman and use the words 'dike' 'thrust' 'bed' 'orogeny' 'cleavage' and 'subduction' in the same sentence without facing a civil suit.

Source undetermined

### **Bassler, Ray Smith**

No biographical data available

Paradise to the geologist is not only the traditional far-away heaven with its gates of pearl and jasper and streets of gold, all precious minerals of interest to him, but it is also right here on earth where these minerals and many interesting earth problems are to be found.

*Annual Report of the Board of Regents of the Smithsonian Institution (1933)*

A Geologist's Paradise (p. 327)

Government Printing Office, Washington, D.C. 1934

### **Brande, William Thomas** 1788–1866

English chemist

Persons have been called Geologists who, gifted with prolific imaginations, have indulged in fanciful speculation concerning a former order of things, and have reared hypotheses respecting the origin of our planet upon foundations so flimsy and unsubstantial, as to deserve no other appellation than flighty excursions of a poetic mind. Others, by careful, diligent, and extended observations of the present state of the earth's surface, have endeavored, in the path of induction, to trace the nature of the agents which have once been active, to ascertain how far they are now operating, and to anticipate the results of their continuance. If they frame theories, they do so upon the results of actual research; if they indulge in speculation, they assign to it its proper place. These are really Geologists, and their aim is, not to imagine or suppose, but to discover the nature of all changes of the earth's surface and interior, and thence to arrive at the laws that regulate them.

*Outlines of Geology*

Lecture I (pp. 1–2)

John Murray. London, England. 1817

### **Chamberlain, Rollin T.**

American geologist

To the geologist the recognised geologic facts, which he can understand and appreciate, are vastly more convincing than mathematical interpretations based upon assumptions, some of which he does not understand, and others of which seem to him clearly at variance with actual earth conditions.

Isostasy from the Geological Point of View

*Journal of the Washington Academy of Science*, Volume 20, 1932 (pp. 1–2)

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

It is the natural and legitimate ambition of a properly constituted geologist to see a glacier, witness an eruption and feel an earthquake.

The Investigation of the San Francisco Earthquake

*Popular Science Monthly*, Volume 69, August, 1906 (p. 97)

### **Cloos, Hans** 1885–1951

German geologist

...I became a geologist forever by seeing with my own eyes: THE EARTH IS ALIVE.

*Conversation with the Earth*

Chapter I (p. 15)

Knopf. New York, New York, USA. 1953

### **Darwin, Charles Galton** 1809–82

English naturalist

I have long discovered that Geologists never read each other's works, and that the only object in writing a book is a proof of earnestness, and that you do not form your opinions without undergoing labour of some kind.

Letter to J.M. Herbert

### **de La Beche, Henry Thomas** 1796–1855

English geologist

The complacent manner in which geologists have produced their theories has been extremely amusing; for often, with knowledge (and that frequently inaccurate) not extending beyond a given province, they have described the formation of a world with all the detail and air of eye-witnesses. That much good ensues, and that the science is greatly advanced, by the collision of various theories, cannot be doubted. Each party is anxious to support opinions by facts. Thus, new countries are explored, and old districts re-examined; facts come to light that do not suit either party; new theories spring up; and, in the end, a greater insight into the real structure of the earth's surface is obtained.

*Sections & Views, Illustrative of Geological Phaenomena*

Preface (p. iii)

Treuttel & Wurtz. London, England. 1830

Generally speaking, geologists seem to have been much more intent on making little worlds of their own, than in examining the crust of that which they inhabit. It would be much more desirable that facts should be placed in the foreground and theories in the distance, than that theories should be brought forward at the expense of facts.

*Sections & Views, Illustrative of Geological Phaenomena*

Preface (p. iv)

Treuttel & Würtz. London, England. 1830

### **Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

What is the boasted communion which the vain poet holds with nature compared with conversation which the geologist perpetually carries on with the elemental world?

Gazing on the strata of the earth, he reads the fate of his species. In the undulations of the mountains is revealed to him the history of the past; and in the strength of rivers and the powers of the air he discovers the fortunes of the future. To him, indeed, that future, as well as the past and the present, are alike matter for meditation : for the geologist is the most satisfactory of antiquarians, the most interesting of philosophers, and the most inspired of prophets ; demonstrating that which has past by discovery, that which is occurring by observation, and that which is to come by induction.

*Vivian Grey*

Chapter IV (p. 316)

Longmans, Green, & Co. London, England. 1911

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“It is no doubt a curious formation,” said I “but I am not geologist enough to say that it is wonderful.”

*The Lost World*

Chapter IV (p. 42)

A.L. Burt Co. New York, New York, USA. 1912

**Hurley, Patrick M.** 1912–2000

American geologist

Geologists have a new game of chess to play, using a spherical board and strange new rules.

*Scientific American*, Volume 218 (p. 64)

**Hutchinson, Henry Neville**

No biographical data available

The geologist is he who interprets to his fellows the stony documents contained in Nature’s “ Record Office,” and he finds the key to the interpretation of her hieroglyphics in watching her daily actions at the present time.

*Creatures of Other Days*

Chapter I (p. 1)

Chapman & Hall. London, England. 1894

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

In examining things which actually exist, and which have proceeded in a certain order, it is natural to look for that which had been first; man desires to know what had been the beginning of those things which now appear. But when, in forming a theory of the earth, a geologist shall indulge his fancy in framing, without evidence, that which had preceded the present order of things, he then either misleads himself, or writes a fable for the amusement of his reader.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter III (p. 280)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Jukes, Joseph Beete** 1811–69

English geologist

No man...can be a thorough geologist without being acquainted, to some extent, with the general results of other sciences, and being able both to understand them when stated in plain untechnical language, and to appreciate their application to his own researches.

*The Student’s Manual of Geology* (3rd edition)

Chapter I (p. 3)

Adam & Charles Black. Edinburgh, Scotland. 1872

**Lane, Ferdinand C.**

No biographical data available

From the rocks the geologist deciphers much global history that we should know in studying mountain structure.

Like the sailor, however, who observes winds and waves and currents with little knowledge of what lies below, he is busied with surface indications.

*The Story of Mountains*

Chapter 14 (p. 62)

Doubleday & Co., Inc. Garden City, New York, USA. 1950

**Lindgren, Waldemar** 1860–1939

Swedish-born American economic geologist

The prime object of the geologist as a scientist is to find the truth. The prime object of the geologist as a practitioner is to find ore.

Discussion

*Transactions of the American Institute of Mining Engineers*, Volume 59, 1918 (p. 66)

**Melville, Herman** 1819–91

American novelist

...I present my credentials as a geologist, by stating that in my miscellaneous time I have been a stone-mason, and also a great digger of ditches, canals, and wells, wine-vaults, cellars, and cisterns of all sorts.

*Moby Dick*

Chapter CIV (p. 428)

L.C. Page & Co. Boston, Massachusetts, USA. 1892

**Miller, Hugh** 1802–56

Scottish geologist and theologian

There is surely something very wonderful in the fact, that in uniting the links of the chain of creation into an unbroken whole, we have in like manner to seek for them all along the scale of the geologist ...

*The Old Red Sandstone*

Chapter III (p. 41)

John B. Alden, Publisher. New York, New York, USA. 1892

**Milton, John Laws** 1820–98

English physician

The hammer of the geologist has conjured up many a picture of the farthest eld far more weird and wondrous than ever was fabled, and though of times far beyond the ken of history, yet supported on proofs for which we vainly hunt in tradition.



*The Stream of Life on Our Globe*

Chapter I (p. 2)

Robert Hardwicke. London, England. 1872

### **Nelson, Les**

American sheriff

Trying to pin down a geologist [is] like trying to corner a rat in a rain barrel.

In Dick Thompson

*Volcano Cowboys: The Rocky Evolution of a Dangerous Science*

Part I, Chapter 2 (p. 36)

St. Martin's Press. New York, New York, USA. 2000

### **Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

...the geologist sadly mistakes, both the object of his science and the limits of his understanding, who thinks it his business to explain the means employed by INFINITE WISDOM for establishing the laws which now govern the world.

*The Works of John Playfair* (Volume 1)

*Illustrations of the Huttonian Theory*, Paragraph 119 (p. 132)

Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

The geologist must not content himself with examining the insulated specimens of his cabinet, or with pursuing the nice subtleties of mineralogical arrangement; he must study the relations of fossils, as they actually exist; he must follow nature into her wildest and most inaccessible abodes; and must select, for the places of his observations, those points, from which the variety and gradation of her works can be most extensively and accurately explored.

*The Works of John Playfair* (Volume 1)

*Illustrations of the Huttonian Theory*, Paragraph 133 (p. 148)

Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

### **Proctor, Richard Anthony** 1837–88

English astronomer

The geologist has been able to turn back a few leaves of the earth's past history, and, though the pages have been defaced and mutilated by Time's unsparing hand, he is yet able to read in them of many strange vicissitudes to which the continents and oceans of our globe have been exposed.

*Other Worlds than Ours; The Plurality of Worlds Studies Under the*

*Light of Recent Scientific Researches*

Chapter I (p. 24)

D. Appleton & Co. New York, New York, USA. 1898

### **Watts, W. W.**

No biographical data available

...the reading of a good geological map to the geologist is like the reading of score to a musician.

*Report of the Seventy-third Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 647)

John Murray. London, England. 1904

## **GEOLOGIST'S TWENTY-THIRD PSALM**

### **Author undetermined**

Geology is my major, I shall not want another.

It maketh me to go down in dark places;

It leadeth me into the running waters.

It ruineth my soles –

It leadeth me on the paths of the outcrops

For its name's sake.

Yea, though I search through the valleys,

I find the rocks on the hills.

I fear great evil when on the cliffs:

The hammers and chisels discomfort me.

It preparast a bedding plane for me in the

Presence of my brunton, it anointest my

Body with mud, my collecting sack runneth over.

Surely to goodness if I follow this vocation all

The days of my life. I shall be buried in a

Landslide forever.

Source undetermined

## **GEOLOGIST'S WIFE**

### **Author undetermined**

then, my dear, to the highlands you go,

Geology calls you, you must not say no:

Alone in your absence I cannot but mourn.

And yet it were selfish to wish your return.

No, come not until you have searched through the gneiss,

And marked all the smoothings produced by the ice;

O'er granite-filled chinks felt Huttonian joy,

And measured the Parallel Roads of Glenroy.

Yet still, as from mountain to mountain you stride,

In visions I'll walk like a shade by your side;

Your bug and your hammer I'll carry with glee,

And climb the raised beaches, my own love, with thee.

Me, too, you'll remember, for love claims no less,

And all your proceedings a fondness confess;

Each level you take, be it not from the sea,

But above the dear place where your Susan may be.

Let everything mind you of tender relations –

Bee, even the hard rocks have their inclinations!

Oh, let me believe that, wherever you roam,

The axis of yours can be nowhere but – home!

Suppose that you find on the mountains of Lorn,

A boulder that long since from Nevis was torn,

'Twill seem like that fond one who left his own shore,

‘Perhaps to return to Lochaber no more.’

And if, in your wanderings, you chance to be led

To Ross-shire or Moray, to see the Old Rod,

Oh still, as its mail-covered fishes you view.

Remember the colour is love's proper hue.



Such being your feelings, I'll care not although  
 You're gone from my side – or a fortnight or so;  
 But know, if much longer you leave me alone,  
 You may find, coming back, you have two wives of  
 stone!

The Geologist's Wife

*Chambers's Journal*, Volume 6, September, 1846 (p. 256)

## GEOLOGY

**Adams, Henry Brooks** 1838–1918

American man of letters

...the easier study of geology...suited idle minds as well  
 as though it were history.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XV (p. 225)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Barrett-Browning, Elizabeth** 1806–61

English poet

Geology, ethnology, what not? –  
 (Greek endings, each the little passing bell  
 That signifies some faith's about to die.)

*The Poetical Works of Robert Browning*

Bishop Blougram's Apology

Smith, Elder & Co. London, England. 1886

**Berlinski, David** 1942–

Mathematician

To geology go the Rock and Riffs; entomology gets the  
 bugs.

Review of the Pleasures of Counting

*The Sciences*, Volume 37, Number 4, Jul/Aug 1997 (p. 37)

**Bice, James**

No biographical data available

The vital elements which make geology interesting eludes  
 us: The grandeur of scenes cannot be brought indoors  
 and the imposing vistas of time and change are beyond  
 our powers to exhibit. The rocks and minerals, torn from  
 their native habitat, lie naked and nearly meaningless on  
 the laboratory tables, and the topographic map does not  
 convey to the beginner an impression of the scenery it  
 represents.

Courses: An Observer Report

*Geology in General Education*, Volume 1, 1952 (p. 23)

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

GEOLOGY, n. The science of the earth's crust – to which,  
 doubtless, will be added that of its interior whenever a  
 man shall come up garrulous out of a well. The geological  
 formations of the globe already noted are catalogued thus:  
 the Primary, or lower one, consists of rocks, bones or mired

mules, gas pipes, miner's tools, antique statues minus the  
 nose, Spanish doubloons and ancestors. The Secondary is  
 largely made up of red worms and moles. The Tertiary  
 comprises railway tracks, patent pavements, grass, snakes,  
 moldy boots, beer bottles, tomato cans, intoxicated citi-  
 zens, garbage, anarchists, snap-dogs and fools.

*The Enlarged Devil's Dictionary* (p. 112)

Doubleday. Garden City, New York, USA. 1967

**Blackie, John Stuart** 1809–95

Scottish scholar

I'll sing you a ditty that needs no apology –  
 Attend, and keep watch in the gates of your ears! –

Of the famous new science which men call Geology,  
 And gods call the story of millions of years.

*Lays and Legends of Ancient Greece: With Other Poems*

A Song of Geology (p. 20)

Sutherland and Knox. Edinburgh, Scotland. 1857

**Bretz, J. Harlen** 1882–1981

American geologist

Geology does have a first authoritative book of facts – but  
 it is not in the library! It is in the rocks of the lithosphere.  
 No author's personal equation need be allowed for when  
 you read it; no emotional reactions warped the original  
 historian's selection of facts. Yet this unbiased book is  
 exceedingly difficult to read, for it is written in hiero-  
 glyphs and it is very fragmentary. Its deciphering is far  
 from complete, and many fragments previously unknown  
 are constantly being collected and pieced together.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Geological Processes and Earth's History (p. 70)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Brewster, David** 1781–1868

Scottish scientist, inventor and writer

In our daily walks we tread with heedless step upon the  
 apparently uninteresting objects of which it [geology]  
 treats; but could we rightly interrogate the rounded pebble  
 in our path, it would tell us of the convulsions by which it  
 was wrenched from its parent rock, and of the floods by  
 which it was abraded and placed beneath our feet.

*More Worlds Than One: The Creed of the Philosopher and the Hope of  
 the Christian*

Chapter III (p. 44)

Chatto & Windus. London, England. 1876

**Brewster, Edwin Tenney** 1866–1960

Educator

Geology is always the science of such rocks as the way-  
 faring man can look at for himself and understand.

*This Puzzling Planet*

Chapter XIX (p. 307)

The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1928

**Büchner, Georg** 1813–37  
German dramatist

1st GENTLEMAN: You were afraid?!  
2nd GENTLEMAN: Indeed I was. The crust of the earth is exceedingly thin: when I see such a hole I'm always afraid I might fall right through. We must tread very carefully, it could give way beneath us.

Translated by John Reddick  
*Complete Plays, Lenz and Other Writings*  
*Danton's Death*  
Act II, Scene II (p. 33)  
Penguin Books. London, England. 1993

**Buchner, Ludwig** 1824–99  
German physician and philosopher

The investigations of geology have thrown a highly interesting and important light on the history of the origin and gradual development of the earth. It was in the rocks and strata of the crust of the earth, and in the organic remains, that geologists read, as in an old chronicle, the history of the earth.

*Force and Matter*  
Chapter IX (p. 56)  
Trübner & Co. London, England. 1864

Like astronomy, which with mathematical certainty has measured the spaces of the heavens, so does modern geology, by taking a retrospective view of the millions of years which have passed, lift the veil which has so long concealed the history of the earth and has given rise to all kinds of religious and mysterious dreams.

*Force and Matter*  
Chapter IX (p. 57)  
Trübner & Co. London, England. 1864

**Buckland, William** 1784–1856  
English geologist and palaeontologist

...if we look to the great phenomena of physical geography, the grand distributions of the solids of the globe; the disposition of continents and islands above and amidst the waters; the depth and extent of seas, and lakes, and rivers; the elevation of hills and mountains; the extension of plains; and the excavation, depression, and fractures of valleys; we find them all originating in causes which it is the province of Geology to investigate.

*Geology and Mineralogy Considered With Reference to Natural Theology* (Volume 1)  
Introduction (p. 16)  
Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1841

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

The father of [geology] was he who seeing fossil shells on a mountain conceived the theory of the deluge.

*The Note-Books of Samuel Butler* (Volume 1)  
1874–1883 (p. 89)  
University Press of America, Inc. Lanham, Maryland, USA. 1984

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

In pioneer days, when the sciences were struggling for a place in the sun, it fell to geology to pull up and set back the stakes that man had struck to mark the beginning of the earth. This seemed to many a moving of sacred landmarks; to others it seemed a wanton use of the secrets of the cemetery of nature's dead.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1922*  
The Age of the Earth (p. 241)  
Government Printing Office. Washington, D.C. 1924

**Cloos, Hans** 1885–1951  
German geologist

...it was during my enchanted days of travel that the idea came to me which, through the years, has come into my thoughts again and again and again and always happily – the idea that geology is the music of the earth.

*Conversation with the Earth*  
Prologue (p. 3)  
Alfred A. Knopf. New York, New York, USA. 1953

**Cowper, William** 1731–1800  
English poet

...some drill and bore  
The solid earth, and from the strata there  
Extract a register, by which we learn  
That he who made it, and revel'd its date  
To Moses, was mistaken in its age.

*The Poetical Works of William Cowper*  
The Task  
Book iii, The Garden  
John W. Lovell Company. New York, New York, USA. n.d.

**Croll, James** 1821–90  
Scottish scientist

The only distinction between geology and heat, light, electricity, &c., is, that in geology the effects to be explained have almost, all occurred already, whereas in these other sciences effects actually taking place have to be explained.

*Climate and Time in Their Geological Relations*  
Chapter I (p. 4)  
Adam & Charles Black. Edinburgh, Scotland. 1885

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

If it be so interesting to us to follow, in the infancy of our species, the almost obliterated traces of extinct nations, why should it not also be so, to search, amid the darkness of the infancy of the Earth, for the traces of revolutions which have taken place anterior to the existence of all nations?

*Essay on the Theory of the Earth* (5th edition)  
Preliminary Observations (p. 3)  
William Blackwood. Edinburgh, Scotland. 1827

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

Geology has been charged with failure to measure up to the intellectual standard of the so-called “exact” sciences. The reproach is no longer merited. It originated during a century when the power of the experimental method in science was first clearly appreciated. As usually the case with great discoveries, this was soon given exaggerated importance by many students of the logic of science. Now that the intoxication of early, magnificent success in the use of experiment is succeeded by more sober second thought, it has become clearer that this method of research is only one of several that are quite essential and are of coordinate value in scientific thought.

*Igneous Rocks and Their Origin*

Introduction (p. xxi)

McGraw-Hill Book Co., Inc. London, England. 1914

**Dana, James Dwight** 1813–95

American geologist

Geology may seem to be audacious in its attempts to unveil the mysteries of creation. Yet what it reveals are only some of the methods by which the Creator has performed his will; and many deeper mysteries it leaves untouched.

*New Textbook of Geology Designed for Schools and Academies*

Concluding Remarks (p. 394)

Iverson, Blakeman, Taylor &amp; Co. New York, New York, USA. 1888

Geology is eminently an out-door science; for strata, rivers, oceans, mountains, valleys, volcanoes, cannot be taken into a recitation room. Sketches and sections serve a good purpose in illustrating the objects of which the science treats, but they do not set aside the necessity of seeing the objects themselves.

*The Geological Story Briefly Told*

Prefatory Suggestions (p. 6)

American Book Co. New York, New York, USA. 1895

**Darwin, Charles Robert** 1809–82

English naturalist

I am quite charmed with Geology, but like the wise animal between two bundles of hay, I do not know which to like the best; the old crystalline group of rocks, or the softer and fossiliferous beds.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VI (p. 221)

D. Appleton &amp; Company. New York, New York, USA. 1896

We continually overrate the perfection of the geological record and falsely infer, because certain genre or families have not been found below a certain stage, that they did not exist before that stage.

In *Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter X (p. 162)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...I look at the natural geological record as a history of the world imperfectly kept, and written in changing dialect; of this history we possess the last volume alone, relating to only two or three countries. Of this volume, only here and there a short chapter has been preserved; and of each page, only here and there a few lines.

In *Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter X (p. 166)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Davis, William Morris** 1850–1934

American geomorphologist

The movement of land waste is generally so slow that it is not noticed. But when one has learned that many land forms result from the removal of more or less rock waste, the reality and the importance of the movement are better understood. It is then possible to picture in the imagination a slow washing and creeping of the waste down the land slopes; not bodily or hastily, but grain by grain, inch by inch, yet so patiently that in the course of ages even mountains may be laid low.

*Physical Geography*

Chapter X (p. 263)

Ginn &amp; Company. Boston, Massachusetts, USA. 1898

The more clearly the immensely speculative nature of geological science is recognized, the easier it becomes to remodel our concepts of any inferred terrestrial conditions and processes in order to make outrages upon them not outrageous.

The Value of Outrageous Geological Hypotheses

*Science*, Volume 63, Number 1636, May 7, 1926 (p. 466)**Davy, Sir Humphry** 1778–1829

English chemist

Geology, perhaps more than any other department of natural philosophy, is a science of contemplation. It requires no experience or complicated apparatus, no minute processes upon the unknown properties of matter. It demands only an enquiring mind and senses alive to the facts almost everywhere presented in nature. And as it may be acquired without much difficulty, so it may be improved without much painful exertion.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Lecture One (p. 13)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**Dawkins, Boyd** 1837–1929

English geologist

Geology stands to engineering in the same relation as faith to works.... The success or failure of an undertaking depends largely upon the physical conditions which fall within the province of geology, and the “works” of the engineer should be based on the “faith” of the geologist.

On the Relation of Geology to Civil Engineering

*Institution of Civil Engineers, Minutes of Proceedings*, Volume 134,

1898 (pp. 254–255)

**Dawson, Sir John William** 1820–99  
Canadian geologist and educator

Geological reading, especially when of a strictly unitarian character and in warm weather, sometimes becomes monotonous...

*Some Salient Points in the Science of the Earth*  
Chapter II (p. 9)  
Hodder & Stroughton. London, England. 1893

The old rocks and the ancient lines of folding and the perished forms of life are not merely a scaffolding set up to be thrown down, but the foundation stones of a great and symmetrical structure.

*Some Salient Points in the Science of the Earth*  
Chapter II (p. 35)  
Hodder & Stroughton. London, England. 1893

**de Lunay, L.**

No biographical data available

Geology was made by the waters; it was made by the seas. If water, as it is passing away in other worlds, had not existed at the surface, this geology would be altogether different; and the day when active water shall have disappeared from the surface of the earth, which may happen, though perhaps only by congealing, the land will be dead; its geological history, as we understand it at least, will be ended.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
(1914)

Geology on the Bottom of the Seas (p. 330)  
Government Printing Office. Washington, D.C. 1915

**de Luc, Jean André** 1773–1817

Swiss naturalist

Of all the sciences, the most extensive and the most complex is that which was termed GEOLOGY, long before it was entitled to the name.

Translated by Henry de La Fite  
*An Elementary Treatise on Geology*  
Preliminary Discourse on Geology (p. 1)  
F.C. & J. Rivington. London, England. 1809

**Denton, William** 1823–83

English geologist

Destitute of astronomy, the heavens would be to us a sealed book, the moon no larger than a dinner-plate, and the stars but shining points in the revolving sky. But, with the light that this noble science sheds, we behold the rolling worlds around us, and view with mingled awe and delight the midnight vault that bends over us. And what astronomy does for the heavens, geology does for the earth, and much more. These pebbles we trample under foot are volumes that we may read with profit and pleasure: they are travellers who have wandered over many lands; and they have wonderful stories to tell us when we have learned their language.

*Our Planet, Its Past and Future*

Lecture I (pp. 14–15)  
William Denton. Boston, Massachusetts, USA. 1873

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

...it is all science; it is not like those books in which one says one thing and another the contrary, and both may be wrong. Everything is proved – by geology, you know. You see exactly how everything is made; how many worlds there have been; how long they lasted; what went before, what comes next. We are a link in the chain, as inferior animals were that preceded us: we in turn shall be inferior; all that will remain of us will be some relics in a new red sandstone.

*Tancred; or The New Crusade* (Volume 1)

Chapter IX (p. 226)  
Henry Colburn. London, England. 1847

Geology is indeed a magnificent study! What excites more the imagination? What exercises more the reason? Can you conceive anything sublimer than the gigantic shadows and the grim wreck of an antediluvian world? Can you devise any plan which will more brace our powers, and develop our mental energies, than the formation of a perfect chain of inductive reasoning to account for these phenomena?

*Vivian Grey*

Chapter IV (p. 316)  
Longmans, Green, & Co. London, England. 1911

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Knowledge of Geology – Practical, but limited. Tells at a glance different soils from each other. After walks has shown me splashes upon his trousers, and told me by their colour and consistence in what part of London he had received them.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 2 (p. 156)  
Wings Books. New York, New York, USA. 1967

**Eaton, Amos** 1776–1842

American botanist, geologist, and lawyer

Geology has its peculiar difficulties, from which all other sciences are exempt. Questions in chemistry may be settled in the laboratory by experiment. Mathematical and philosophical questions may be discussed, while the materials for discussion are ready furnished by our own intellectual reflections. Plants, animals and minerals, may be arranged in the museum, and all questions relating to their intrinsic principles may be discussed with facility. But the relative positions, the shades of difference, the peculiar complexions, whether continuous or in subordinate beds, are subjects of enquiry in settling the

characters of rocks, which can be judged of while they are in situ only.

*A Geological and Agricultural Survey of the District Adjoining the Erie Canal*

Introductory Report (p. 8)

Packard & van Benthuyssen. Albany, New York, USA. 1824

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Geology, a science of forty or fifty summers, has had the effect to throw an air of novelty and mushroom speed over entire history.

...Geology itself is only chemistry with the element of time added...

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

*Letters and Social Aims*

Chapter VII (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy...compelled a certain extension and uplifting of our views of the Deity and his Providence. This correction of our superstitions was confirmed by the new science of Geology...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Lectures and Biographical Sketches*

Chapter XII (p. 336)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

A cultivated man, wise to know and bold to perform, is the end to which nature works, and the education of the will is the flowering and result of all this geology and astronomy.

*The Conduct of Life*

Power (pp. 53–54)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1904

**Esar, Evan** 1899–1995

American humorist

[Geology] The subject that brings a student down to earth.

*Esar's Comic Dictionary*

Geology

Doubleday. Garden City, New York, USA. 1983

**Faul, Henry** 1920–

Geochronologist

**Faul, Carol**

No biographical data available

Geology began when early man first picked up a stone, considered its quantities, and decided that it was better than the stone he already had. Good stones were useful and they were collected, mined, and traded.

*It Began with a Stone*

Chapter One (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1983

**Fletcher, Robert Huntington**

No biographical data available

Geology and astronomy now gradually compelled all thinking people to realize the unthinkable duration of the cosmic processes and the comparative littleness of our earth in the vast extent of the universe.

*A History of English Literature*

Chapter XI, Period IX (p. 374)

Richard G. Badger. Boston, Massachusetts, USA. 1919

**Garrels, Robert M.** 1916–88

American geochemist

The greatest problem encountered by students in geology is the necessity for a complete reorganization of their concepts of space and time.

*A Textbook of Geology*

Chapter I (p. 1)

Harper Publishers. New York, New York, USA. 1951

**Geikie, Sir Archibald** 1835–1924

English geologist

...geology has been encumbered with many hypotheses and theories which, plausible as they might seem at the time of their promulgation, have one by one been dissipated before the advance of fuller and more accurate knowledge. Yet before their overthrow, it may often be hard to separate the actual ascertained core of fact within them from the mass of erroneous interpretation and unfounded inference that forms most of their substance.

*The Founders of Geology* (2nd edition)

Chapter I (p. 3)

Macmillan & Company Ltd. London, England. 1905

**Gerould, Katherine Fullerton** 1879–1944

American writer

The geologic ages are dealt with by pick and hammer and reduced to slides and the lore of the stars has become a pure matter of mathematical formulae.

The Extirpation of Culture

*The Atlantic Monthly*, October, 1915 (pp. 454–455)

**Gibson, William Sidney**

No biographical data available

The subjects of Geological inquiry are among the most magnificent that science has opened to the contemplation of the human mind, and their importance is admitted by all persons who are acquainted with their nature and results, and is sufficiently attested by the very exalted rank which Geology has attained in the circle of inductive science...

*The Certainties of Geology*

Chapter I (p. 1)

Smith, Elder & Company. London, England. 1840

...Geology has discovered upon our own planet, and has restored, to the wondering contemplation of man, the fossil monuments of systems of nature, which were created, and which passed away from the globe before his race were placed upon its surface; and the monuments of the



creation and extinction of successive races of animated forms, which “are as the stars for number,” and the fact of whose prior existence on our planet would have been unknown but for geological researches.

*The Certainties of Geology*

Chapter 1 (p. 2)

Smith, Elder & Co. London, England. 1840

### **Good, John Mason** 1764–1827

English physician and author

The direct object of geology is, to unfold the solid substance of the earth – to discover by what causes its several parts have been either arranged or disorganized – and from what operations have originated the general stratification of its materials, the inequalities of its surface, and the vast variety of bodies that enter into its make.

*The Book of Nature*

Series I, Lecture VI (p. 65)

Belknap and Hamersley, Hartford, Connecticut, USA. 1844

### **Granville, Peter**

No biographical data available

...if you call botany beautiful, and astronomy sublime... call Geology romantic, because it not only leads us to travel among the wildest scenery of nature, but carries the imagination back to the birth and infancy of our little planet...

*Conversations on Geology*

Conversation First (p. 7)

Printed for Samuel Maunder. London, England. 1828

### **Gray, Asa** 1810–88

American botanist

Among the questions which disquieted pious souls in my younger days, but which have ceased to disquiet any of us, are those respecting the age and gradual development of the earth and of the solar system, which came in with geology and modern astronomy. I remember the time when it was a mooted question whether geology and orthodox Christianity were compatible...

*Natural Science and Religion*

Two Lectures Delivered to the Theological School of Yale University (p. 6)

Charles Scribner's Sons. New York, New York, USA. 1880

### **Gregory, J. W.**

No biographical data available

A new geology was developing, and the Geological Society of London ushered in its birth. No more should observations be made through the distorting medium of preconceived fancies! No more should geology be inspired by that heedless spirit which cares not to distinguish between fancy and fact! With youthful vigor the new geology would have nothing to do with the search for cosmogonies and such like fancy foods, and the Geological Society of London should be nourished on unadulterated facts.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Geology of the Inner Earth – Igneous Ores (pp. 311–312)

Government Printing Office. Washington, D.C. 1908

### **Grinnell, George Bird** 1849–1938

American anthropologist

At the end of a long day's march, one of the soldiers, hot, thirsty and utterly weary, was heard to exclaim: “What did God Almighty make such a country for?” To which one of his companions made the reply that “God Almighty made the country good enough, but it's this infernal geology that the professor talks about that has spoiled it all.”

*An Old Time Bone Hunt*

*Natural History*, Volume 23, Number 4, July–August, 1923 (p. 332)

### **Hall, J.**

No biographical data available

To some minds geology scarcely assumes the rank of a science, except where treated from a physical point of view. They consider the simplest physical law adequate to the explanation of the most stupendous phenomena. To them, mountain chains rise and are abraded, and the entire crust of the earth is folded and plicated in obedience to certain laws. They see no difficulty in the way of imagining torrents of water moving onward and upward, carrying masses of rocks over heights far above their origin by some simply gyratory force. The entire earth becomes with equal ease to them, either a pliable, elastic, or compressible mass, or a non-elastic body; sudden cataclysms, according to the fancy of the expounder. No wizard's wand ever played so many pranks as the poor earth in the hands of these theorizing geologists.

*Contributions to the Geological History of the American Continent* (p. 34)

Printed at the Salem Press. Salem, Massachusetts. 1882

Geology, if we would let alone grand theorizing, is a simple and beautiful study, in which we see everything evolved naturally and harmoniously, without at any time great and sudden changes. We remark those changes as one who having viewed a city in its progress, should fall asleep for a century and afterwards behold the difference. But to one who could have seen stone laid upon stone, and each edifice completed singly, it would have had but the aspect of natural and quiet progress.

*Contributions to the Geological History of the American Continent* (p. 63)

Printed at the Salem Press. Salem, Massachusetts. 1882

### **Harris, Anita**

No biographical data available

Not by accident is geology called geology. It's named for Gaea, the daughter of Chaos.



In John McPhee

*Annals of the Former World*

Book 2, In Suspect Terrain (p. 213)

Farrar, Straus & Giroux. New York, New York, USA. 1998

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Geology, in the magnitude and sublimity of the objects of which it treats, undoubtedly ranks, in the scale of the sciences, next to astronomy; like astronomy, too, its progress depends on the continual accumulation of observations carried on for ages.

*Preliminary Discourse on the Study of Natural History*

Part III, Chapter III (p. 287)

Longman, Brown, Green & Longmans. London, England. 1845

**Hewitt, Philip C.**

No biographical data available

...don't believe that geology is only for geologists. It is, or should be for everyone.

Why Study Geology?

*Journal of Geological Education*, Volume XV, Number 1, February, 1969 (p. 10)

**Hillaby, John** 1917–96

Journalist

Fortunately for poets and those who like to walk about in the open air, the beauty of landscape is not something that can be reduced easily to basic geology or a few ready-wrapped phrases about what places are used for. Preference and prejudice creep in.

*A Walk Through Britain*

The Striding Dales (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1969

**Hobbs, William Herbert** 1864–1952

American geologist

The student of geology would, however, do well to take note of the early dominant influence of Werner or von Buch in Germany, of de Beaumont in France, of Murchison in England, or of Agassiz, the “Pope of American science.”

*Characteristics of Existing Glaciers*

Introduction (p. 2)

The Macmillan Co. New York, New York, USA. 1911

**Huxley, Thomas Henry** 1825–95

English biologist

Once more, an invariably-recurring lesson of geological history, at whatever point its study is taken up: the lesson of the almost infinite slowness of the modification of living forms. The lines of the pedigrees of living things break off almost before they begin to converge.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On the Formation of Coal (p. 158)

Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

Geology, economics, mechanics are humanities when taught with reference to the successive achievements of the geniuses to which these sciences owe their being. Not taught thus, literature remains grammar, art a catalogue, history a list of dates, and natural science a sheet of formulas and weights and measures.

*Memories and Studies*

The College-Bred (p. 313)

Longmans, Green & Company. New York, New York, USA. 1917

**Jukes, Joseph Beete** 1811–69

English geologist

It is not easy to give an accurate and comprehensive definition of the science of Geology; for its nature is so complex and various, that it is difficult in a few words either to specify its object or to assign its limits.

*The Student's Manual of Geology* (3rd edition)

Chapter I (p. 1)

Adam & Charles Black. Edinburgh, Scotland. 1872

**Kemp, James Furman** 1859–1926

American geologist

Mountains rise and disappear; sea and land repeatedly change places. Majestic forces in orderly succession perform their work, and development, whose course we may follow and whose processes understand, is made clear before our eyes.

*Lectures on Science, Philosophy and Art, 1907–1908*

Geology (p. 36)

The Columbia University Press. New York, New York, USA. 1908

**Kingsley, Charles** 1819–75

English clergyman and author

...geology...the science which explains to us the rind of the earth; of what it is made; how it has been made.

*Scientific Lectures and Essays*

Chapter I (p. 29)

Macmillan & Co Ltd. London, England. 1893

The most important facts of geology do not require, to discover them, any knowledge of mathematics or of chemical analysis; they may be studied in every bank, every grot, every quarry, every railway-cutting, by anyone who has eyes and common sense...

*Scientific Lectures and Essays*

Chapter I (p. 30)

Macmillan & Co Ltd. London, England. 1893

...thus geology is (or ought to be), in popular parlance, the people's science – the science by studying which, the man ignorant of Latin, Greek, mathematics, scientific chemistry, can yet become – as far as his brain enables him – a truly scientific man.

*Scientific Lectures and Essays* (Volume 19)

The Soil of the Field (pp. 30–31)

Macmillan & Co Ltd. London, England. 1880

Be sure, that wherever there is a river, or even a drain; and a stone quarry, or even a roadside bank; much more where there is a sea, or a tidal aestuary, there is geology enough to be learnt, to explain the greater part of the making of all the continents on the globe.

*Town Geology*

Chapter I (p. 35)

D. Appleton and Company. New York, New York, USA. 1873

**Knopf, Alfred A.** 1892–1984

American publisher

An urgent task for geology is to determine, in years, the length of the eras, periods, and “ages” (time spans of the stages) and, eventually of the zones. Not a single one of them – eras, periods, and ages, let alone zones – has yet been reliably determined. This statement is possibly surprising in view of the fact that almost any modern writer can produce a geologic timetable that gives precise datings and lengths of eras and systems and even of some of the smaller subdivisions....All other absolute ages have been derived from the three radioactive tie points by interpolation based on thickness of strata or by “reasoned guesses”...

Measuring Geologic Time

*Scientific Monthly*, Volume 85, 1957 (p. 227)

**Knopoff, L.**

No biographical data available

A century ago geology – under the impact of the theory of evolution, the statement of the principles of stratigraphy and widespread exploration – was perhaps the most exciting area of science. With passing years, geological activities were overshadowed by dramatic discoveries in chemistry, physics, biology, and astronomy. The recent new discoveries relating to the solid earth: i) put earth sciences once again in the forefront; ii) unified previously diverse fields of geology and geophysics; and iii) greatly enhanced the morale of geologists and geophysicists. The new excitement in the earth sciences is attracting many talented young people into this complex but highly important area of science.

Significance and Achievement of the Upper Mantle Project

*ICSU Bulletin*, Volume 27, September, 1972 (pp. 4–5)

**Lane, Rose Wilder** 1886–1968

American journalist, travel writer, novelist, and political theorist

...the difference between mining and geology is like that between the old-time bear-hunters and the city man.

*The Making of Herbert Hoover*

Chapter IV (pp. 181–182)

The Century Country. New York, New York, USA. 1920

**Lapworth, Charles** 1842–1920

English geologist

...it is not our self-esteem which prompts our work, or the applause of the world that cheers us in its pursuit.

Rather is it the delight in the work itself which animates our labours; and it is in the sympathy and the appreciation of our fellow-workers that we rejoice when our aim is achieved. To Geology and geologists do we stand or fall.

The Relations of Geology

*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1903 (p. 393)

In studying the solid elements of that structure, Geology shades through the science of Mineralogy into that of Chemistry. In the study of the changes which the parts of that structure have undergone and are now undergoing it shades through the science of Meteorology into that of Physics. In the study of the successive surfaces of that structure it grades into the science of Geography. In the study of the stony relics of the vanished beings that once dwelt upon those surfaces it joins hands with the sciences of Zoology and Botany. In studying the phenomena presented by the sequence and inter-relations of the rock formations which go to the building up of that structure, it finds the means of reading the past history of the earth and its living inhabitants – a glory reserved for Geology alone.

The Relations of Geology

*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1902 (pp. 398–399)

Astronomy concerns itself with the whole of the visible universe, of which our earth forms but a relatively insignificant part; while Geology deals with that earth regarded as an individual. Astronomy is the oldest of the sciences, while Geology is one of the newest. But the two sciences have this in common, that to both are granted a magnificence of outlook, and an immensity of grasp denied to all the rest.

*Proceedings of the Geological Society of London*, Volume 59, 1903

(p. lxviii)

**Le Conte, Joseph** 1823–1901

Physiologist and geologist

We have defined geology as the history of the evolution of the earth. *Evolution*, therefore, is the central idea of geology. It is this idea alone which makes geology a distinct science.

*Elements of Geology: A Text-book for Colleges and for the General*

*Reader* (5th edition) (p. 421)

D. Appleton & Co. New York, New York, USA. 1903

**Louderback, G. D.**

American mineralogist

Geology needs an independent time clock that runs at a uniform rate, just as we need it in our daily life, and the physicist needs it in his laboratory.

The Age of the Earth from Sedimentation

*Scientific Monthly*, Volume 42, 1936 (p. 245)

**Lt. Julian Bashir, M.D. (Fictional character)**

Baccarat and geology are my life.

*Star Trek: Deep Space Nine*

Television series (Season 4, episode 9 (1995))

**Lyll, Sir Charles** 1797–1875

English geologist

Geology is the science which investigates the successive changes that have taken place in the organic and inorganic kingdom of nature...

*Principles of Geology* (Volume 1)

Chapter I (p. 1)

John Murray. London, England. 1830

Geology is intimately related to almost all the physical sciences, as history is to the moral. An historian should, if possible, be at once profoundly acquainted with ethics, politics, jurisprudence, the military art, theology; in a word, with all branches of knowledge by which any insight into human affairs, or into the moral and intellectual nature of man, can be obtained. It would be no less desirable that a geologist should be well versed in chemistry, natural philosophy, mineralogy, zoology, comparative anatomy, botany; in short, in every science relating to organic and inorganic nature. With these accomplishments, the historian and geologist would rarely fail to draw correct and philosophical conclusions from the various monuments transmitted to them of former occurrences.

*Principles of Geology* (Volume 1)

Book I, Chapter I (p. 18)

James Kay, Jun, & Brother. Philadelphia, Pennsylvania, USA. 1837

...geology differs as widely from cosmogony, as speculations concerning the mode of the first creation of man differ from history.

*Principles of Geology* (Volume 1)

Book I, Chapter I (p. 20)

James Kay, Jun, & Brother. Philadelphia, Pennsylvania, USA. 1837

If it be true that delivery be the first, second, and third requisite in a popular orator, it is no less certain that travel is of first, second and third importance to those who desire to originate just and comprehensive views concerning the structure of our globe.

*Principles of Geology* (Volume 1)

Chapter IV (p. 69)

D. Appleton & Co. New York, New York, USA. 1873

The discovery of other systems in the boundless regions of space was the triumph of astronomy – to trace the same system through various transformations – to behold it at successive eras adorned with different hills and valleys, lakes and seas, and peopled with new inhabitants, was the delightful need of geological research.

*Principles of Geology* (Volume 3)

Chapter IV

John Murray. London, England. 1830

...we are apprehensive lest zoological periods in geology, like artificial divisions in other branches of natural history, should acquire too much importance, from being supposed to be founded on some great interruptions in the regular series of events in the organic world, whereas... we ought to regard them as invented for the convenience of systematic arrangement, always expecting to discover intermediate gradations between the boundary lines we have first drawn.

*Principles of Geology* (Volume 3)

Chapter V (p. 57)

John Murray. London, England. 1830

To assume that the evidence of the beginning or end of so vast a scheme lies within the reach of our philosophical inquiries, or even of our speculations, appears to us inconsistent with a just estimate of the relations which subsist between the finite powers of man and the attributes of an Infinite and Eternal Being.

*Principles of Geology* (Volume 3)

Concluding Remarks (p. 385)

John Murray. London, England. 1830

**Mantell, Gideon Algernon** 1780–1852

English obstetrician, geologist and paleontologist

To the medical philosopher Geology presents peculiar attractions for those hours of leisure and relaxation, which are indispensable to maintain a healthy state of mind; for it requires the cultivation and application of Chemistry, Botany, Comparative Anatomy, Zoology, and Physiology, sciences which form the very foundation of medical knowledge.

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Address to the Reader (p. xxii)

G.H. Bohn. London, England. 1857–58

Geology, beyond almost every other science, offers fields of research adapted to all capacities, and to every condition and circumstance in life in which we may be placed. For while some of its phenomena require the highest intellectual powers, and the greatest attainments in abstract science, for their successful investigation, many of its problems may be solved by the most ordinary intellect, and facts replete with the deepest interest may be gleaned by the most casual observer.

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Address to the Reader (p. xxii)

G.H. Bohn. London, England. 1857–58

Geology, in addition to its adherent dignity, puts forth strong claims to regard on the ground of positive utility. Everything reposes upon the mineral kingdom; it affords to man, directly or indirectly, all the materials of his physical comfort, all those of national wealth, and all the means of civilization.

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Introduction (p. 5)

G.H. Bohn. London, England. 1857–58

For every rock in the desert, every boulder on the plain, every pebble by the brook-side, every grain of sand on the sea-shore, is fraught with lessons of wisdom to the mind which is fitted to receive and comprehend their sublime import.

*Thoughts on a Pebble, or, A First Lesson in Geology*

More Thoughts on a Pebble (p. 55)

Reeve, Benham, & Reeve. London, England. 1849

### Merrill, William

No biographical data available

Whither goest we?

Whither goes geology?

The crystal ball

That tell us all

A little fuzzy be.

Purposes of Undergraduate Degree Programs in Geology

*Journal of Geological Education*, Volume XIII, Number 3, June, 1965 (p. 67)

### McPhee, John 1931–

American journalist and nonfiction writer

The far-out stuff was in the Far West of the country [United States] – wild, weirdsma, a leather-jacket geology in mirrored shades, with its welded tuffs and Franciscan melange (internally deformed, complex beyond analysis), its strike-slip faults and falling buildings, its boiling springs and fresh volcanics, its extensional disassembling of the earth.

*Basin and Range* (p. 24)

Farrar, Straus, Giroux. New York, New York, USA. 1981

### Miller, Hugh 1802–56

Scottish geologist and theologian

All geologic history is full of the beginning and the ends of species, – of their first and last days, but it exhibits no genealogies of development.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed* (p. 183)

Gould and Lincoln. Boston, Massachusetts, USA. 1857

The science of the geologist seems destined to exert a marked influence on that of the natural theologian. For not only does it greatly add to the materials on which the natural theologian finds his deductions, by adding to the organisms, plant and animal, of the present creation the extinct organisms of the creations of the past, with all their extraordinary display of adaptation and design; but it affords him, besides, materials peculiar to itself, in the history which it furnishes both of the appearance of these organisms in time, and of the

wonderful order in which they were chronologically arranged.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Fifth (p. 211)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

Nor can I doubt that [the Earth's] history throughout the long geologic age – its strange story of successive creations, each placed in advance of that which had gone before, and its succeeding organisms, vegetable and animal, ranged according to their appearance in time, on principles which our profounder students of natural science have but of late determined – will be found in an equal degree more worthy of its Divine Author than that which would huddle the whole into a few literal days, and convert the incalculably ancient universe which we inhabit into a hastily run-up erection of yesterday.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Gould and Lincoln. Boston, Massachusetts, USA. 1857

Geology is the most poetical of all sciences; and its various facts, as they present themselves to the human mind, possess a more overpowering immensity than even those of Astronomy itself. For while the Astronomer can carry about with him in his imagination a little portable Orrery of the whole solar system, the Geologist is oppressed by a weight of rocks and mountains, and of strata piled over strata which all his diligence in forming theories has not yet enabled him completely to arrange. He is no mere intellectual mechanic, who calculates and reasons on the movements of a piece of natural clockwork; the objects with which he is chiefly conversant have no ascertained forms, or known proportions, that he may conceive of them as abstract figures, or substitute a set of models in their places; his province, in at least all its outer skirts, is still a terra incognita, which he cannot conceive of as a whole; and the walks which intersect it are so involved and irregular that, like those of an artificial wilderness, they seem to double its extent. The operations of his latest eras, as his science exists in time, terminate long before history begins; while, as it exists in space, he has to grapple with the immense globe itself, with all its oceans, and all its continents.

*Scenes and Legends of the North of Scotland* (1st edition) (p. 48)

Adam and Charles Black. Edinburgh, Scotland. 1835

Geology, of all the sciences, addresses itself most powerfully to the imagination; and hence one main cause of the interest which it excites.

*The Old Red Sandstone*

Chapter II (p. 31)

John B. Alden, Publisher. New York, New York, USA. 1892

Geology, of all the sciences, addresses itself most powerfully to the imagination; and hence one main cause of the interest which it excites.

*The Old Red Sandstone*

Chapter II (p. 57)

J.M. Dent &amp; Sons Ltd. London, England. 1922

The wonders of geology exercise every faculty of the mind – reason, memory, imagination ...

*The Old Red Sandstone*

Chapter V (p. 93)

John B. Alden, Publisher. New York, New York, USA. 1892

The wonders of geology exercise every faculty of the mind, – reason, memory, imagination; and though we cannot put our fossils to the question, it is something to be so aroused as to be made to put questions to one's self.

*The Old Red Sandstone*

Chapter V (p. 119)

J.M. Dent &amp; Co. London, England. 1906

It is one of the great marvels of our day, that through the key furnished by geologic science we can now pursue the history of past creations more clearly, and arrive at a more thorough and certain knowledge of at least the structural peculiarities of the organisms, than we can read the early histories of the old dynasties of our own species, that flourished and decayed on the banks of the Euphrates or of the Nile, or ascertain the true character of the half-forgotten tyrants with whom they terminated, or from whom they began.

*The Old Red Sandstone*

Geological Evidences in Favour of Revealed Religion (pp. 275–276)

J.M. Dent &amp; Sons Ltd. London, England. 1922

He will find sermons in stones, and more of the suggestive and the sublime in a few broken scours of clay, a few fragmentary shell, and a few green reaches of the old coast line...

*Sketch-Book of Popular Geology*

Lecture Second (p. 80)

William P. Nimmo &amp; Co. Edinburgh, Scotland. 1880

...poets need be in no degree jealous of the geologists.

The stoney science, with buried creations for its domains, and half an eternity charged with its annals, possesses it realms of dim and shadowy fields, in which troops of fancies already walk like dismembered ghosts in the old fields of Elysium, and which bid fair to be quite dark and uncertain enough for all the purposes of poesy for centuries to come.

*Sketch-Book of Popular Geology*

Lecture Third (pp. 82–83)

William P. Nimmo &amp; Co. Edinburgh, Scotland. 1880

Nature is a vast tablet, inscribed with signs, each of which has its own significancy, and becomes poetry in the mind when read; and geology is simply the key by which myriads of these signs, hitherto indecipherable, can be unlocked and perused, and thus a new province added to the poetical domain.

*Sketch-Book of Popular Geology*

Lecture Third (p. 87)

William P. Nimmo &amp; Co. Edinburgh, Scotland. 1880

**Milner, Thomas**

No biographical data available

**Matell, Gideon Algernon** 1790–1852

English obstetrician, geologist and palaeontologist

Geology and Astronomy are, in truth, sciences whose discoveries have realized the wildest imaginings of the poet, and whose realities infinitely surpass, in grandeur and sublimity, the most imposing fictions of romance.

*Relics from the Wreck of a Former World*

Preface (p. 3)

W.H. Graham. New York, New York, USA. 1847

**Milton, John Laws** 1820–98

English physician

In the days when our little island [England] was young she was not a beauty, she was merely grand and interesting.

*The Stream of Life on Our Globe* (2nd edition)

Chapter I (p. 1)

Robert Hardwicke. London, England. 1872

**Montgomery, Arthur** 1909–99

American geologist

More than any other science, except perhaps astronomy, geology has inherent in it the capacity for capturing the quick interest of those who live upon the surface of the earth.

## Popular Geology

*Journal of Geological Education*, Volume 1, Number 2, October, 1951

(p. 9)

**More, Louis Trenchard** 1870–1944

English physicist and biographer of Isaac Newton

We can then be certain that geology cannot, and never will be able to, translate the thickness of any one stratum into an equivalent length of time and that it cannot, and never will be able to, establish real contemporaneity of time in different parts of the world.

*The Dogma of Evolution*

Chapter Four (p. 151)

Princeton University Press. Princeton, New Jersey, USA. 1925

**Muir, John** 1838–1914

American naturalist

...see how God writes history [in the earth]. No technical knowledge is required; only a calm day and a calm mind.

*Our National Parks*

Chapter II (p. 59)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901



**National Research Council (U.S.)**

Geology, as its name attests, differs from planet to planet.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 57)

National Academy of Sciences

Washington, D.C. 1972

**Newman, Joseph S.**

Poet

For several thousand endless ages  
It [earth] muddled thru its early stages  
Of heat, eruptions, floods, and quakes  
And other infant belly-aches.

Surviving all such pains and notions  
It settled down to land and oceans.  
In eras which are known as “glacials”  
The planet then got several facials.  
Four geological massages

In four successive Ice barrages  
Which filled its unbecoming dimples  
And leveled off some rocky pimples.

*Poems for Penguins and Other Lyrical Lapses*

Geology

Greenburg. New York, New York, USA. 1941

**Nye, Bill** 1850–96

American journalist

Geology is that branch of natural science which treats of the structures of the earth's crust and the mode of formation of its rocks. It is a pleasant and profitable study, and to the man who has married rich and does not need to work, the amusement of busting geology with the Bible, or busting the Bible with geology is indeed a great boon.

*Remarks*

About Geology (p. 201)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Page, David**

No biographical data available

Apart from its utilities, Geology will ever be a theme of intellectual interest and research, the problems of time, change, and progression it involves being amongst the most attractive that can engage the educated mind.

*Economic Geology; Or, Geology in Its Relations to the Arts and Manufactures*

Introduction (p. 1)

William Blackwood & Sons. Edinburgh, Scotland. 1874

The study of Geology presents itself in two great aspects – one purely scientific, and appealing to the intellect; another mainly practical, and appealing to the industrial necessities of life.

*Economic Geology; Or, Geology in Its Relations to the Arts and Manufactures*

Introduction (p. 1)

William Blackwood & Sons. Edinburgh, Scotland. 1874

**Palissy, Bernard** 1510–90

French Huguenot potter and writer

I have had no other book than the sky and the earth, which is known to all, and it is given to all to know and read in this beautiful book.... That is why a man who works in the art of the earth is always learning because of unknown natures, and diversity of earths.

Translated by Auréle La Rocque

*Admirable Discourses of Bernard Palissy* (p. 148, 186)

University of Illinois Press. Urbana, Illinois, USA. 1957

**Penn, Granville** 1761–1844

English scriptural geologist

EDWARD: Sea-shells, did you say, mother, in the heart of solid rocks, and far inland? There must surely be some mistake in this; at least it appears to me incredible.

MRS.R.: The history of the shells, my dear, and many other things no less wonderful, is contained in the science called geology, which treats of the first appearance of rocks, mountains, valleys, lakes, and rivers; and the changes they have undergone, from the Creation and the Deluge, till the present time.

*Conversations on Geology*

Conversation First (p. 1, 3)

Printed for Samuel Maunder. London, England. 1828

...philosophers, if they have much imagination, are apt to let it loose as well as other people, and in such cases are sometimes led to mistake a fancy for a fact. Geologists, in particular, have very frequently amused themselves in this way, and it is not a little amusing to follow them in their fancies and their waking dreams. Geology, indeed, in this view, may be called a romantic science.

*Conversations on Geology*

Conversation First (pp. 5–6)

Printed for Samuel Maunder. London, England. 1828

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

It is admitted, on all hands, that the Scriptures are not intended to resolve physical questions, or to explain matters in no way related to the morality of human actions; and if, in consequence of this principle, a considerable latitude of interpretation were not allowed, we should continue at this moment to believe that the earth is flat; that the sun moves around the earth; and that the circumference of a circle is not more than three times its diameter. It is but reasonable, therefore, that we should extend to the geologist the same liberty of speculation, which the astronomer and mathematicians are already in possession of; and this may be done, by supposing that the chronology of Moses relates only to the human race.

*Illustrations of the Huttonian Theory of the Earth*

Section 125 (pp. 126–127)

Dover Publications, Inc. New York, New York, USA. 1964



**Powell, Colin L.** 1937–  
American statesman

Last year, I amused and probably alarmed and shocked our good neighbors across the street at the National Academy of Sciences by revealing that I am a scientist. I have a Bachelor of Science degree in geology from the City College of New York, and my great contribution to the field of geology is that I never entered it upon graduation.

EARTH OBSERVATION

Address at the Earth Observation Summit, 31 July 2003

**Prichard, James Cowles** 1786–1846  
English physician and ethnologist

Geology is, like ethnology, a history of the past.

*Report of the Seventeenth Meeting of the British Association for the Advancement of Science*

On the Various Methods of Research (p. 231)

John Murray. London, England. 1848

**Proctor, Richard Anthony** 1837–88  
English astronomer

Astronomy and Geology owe much of their charm to the fact that they suggest thoughts of other forms of life than those with which we are familiar. Geology teaches us of days when this earth was peopled with strange creatures such as now are found upon its surface. We turn our thoughts to the epochs when those monsters thrived and multiplied, and picture to ourselves the appearance which our earth then presented.

*Other Worlds Than Ours*

Introduction (p. 17)

H.L. Fowle. New York, New York, USA. 1870

### Red (Fictional character)

Geology is the study of pressure and time. That's all it takes really...pressure, and time...that and a big goddamn poster.

*The Shawshank Redemption*

Film (1994)

### Robertson, Percival

...teachers of geology have a great privilege in opening the pages of the earth's own autobiography and helping the student to interpret its inspiring pages.

Holding Student Interest in Historical Geology

*Journal of Geological Education*, Volume 1, Number 3, April, 1952 (p. 40)

### Rudwick, Martin J. S.

Science historian

The emergence of a visual language for geological science...helps in a small way to counter the common but intellectually arrogant assumption that visual modes of communication are either a sop to the less intelligent or a way of pandering to a generation soaked in television.

*History of Science*, Volume 14, 1976

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

...geology does better in reclothing dry bones and revealing lost creations, than in tracing veins of lead and beds of iron ...

*The Works of John Ruskin* Volume 2

Part III, Section I, Chapter 1 (p. 9)

John Wiley & Sons. New York, New York, USA. 1889

**Scrope, George Poulett** 1797–1876  
English geologist and political economist

Geology has for its business a knowledge of the processes which are in continual or occasional operation within the limits of our planet, and the application of these laws to explain the appearances discovered by our Geognostical researches, so as from these materials to deduce conclusions as to the past history of the globe.

*Considerations on Volcanoes*

Preface (p. iv)

W. Phillips & George Yarp. London, England. 1825

If the business of Geology is the study of the structure of the accessible portion of the Earth, and of the changes it has undergone, there can be no more important branch of the science than that which examines the nature and mode of operation of the subterranean forces which have everywhere more or less broken up, disturbed, and altered the level of the superficial rocks, modified their internal texture and composition, and brought fresh material upon or towards the exterior of the globe.

*Volcanoes* (2nd edition)

Chapter I (p. 1)

Longman, Green, Longmans & Roberts. London, England. 1862

**Sedgwick, Adam** 1785–1873  
English geologist

I cannot promise to teach you all geology, I can only fire your imaginations.

In J. W. Clark and T. McHughes

*The Life and Letters of Adam Sedgwick* (Volume 2) (p. 489)

At the University Press. Cambridge, England. 1890

Geology, like every other science when well interpreted, lends its aid to natural religion. It tells us, out of its own records, that man has been but a few years a dweller on the earth; for traces of himself and his works are confined to the last monuments of its history. Independently of every written testimony, we therefore believe that man with all his powers and appetencies, his marvelous structure and fitness for the world was called into being a few thousand years of the days in which we live.

*Discourse on the Studies of the University of Cambridge* (pp. 22–23)

John W. Parker. London, England. 1850

But let us for a moment, suppose that there are some religious difficulties in the conclusions of Geology. How are we then to solve them? Not by making a world after a

pattern of our own – not by shifting and shuffling the solid strata of the earth, or dealing them out in such a way as to play the game of an ignorant and dishonest hypothesis – not by shutting our eyes to the facts, or denying the evidence of our senses: but by patient investigation carried on in the sincere love of truth and by learning to reject every consequence not warranted by direct physical evidence.

*Discourse on the Studies of the University of Cambridge*  
Appendix (p. 105)  
John W. Parker. London, England. 1850

We might expect...that as we come close upon living nature, the characters of our old records would grow legible and clear. But just where we begin to enter on the history of the physical changes going on before our eyes, and in which we ourselves bear a part, our chronicle seems to fail us; a leaf has been torn out from Nature's book, and the succession of events is almost hidden from our eyes.

*Sketch-Book of Popular Geology*  
Lecture First (p. 43)  
William P. Nimmo & Co. Edinburgh, Scotland. 1880

**Smith, George Otis** –1944  
American geologist

I am convinced that, at its best, science is simple – that the simplest arrangement of facts that sets forth the truth best deserves the term scientific. So the geology I plead for is that which states facts in plain words – in language understood by the many rather than only by the few. Plain geology needs little defining, and I may state my case best by trying to set forth the reasons why we have strayed so far away from the simple type.

Paper presented to the Society of Economic Geologists at the Amherst Meeting  
December 28, 1921

**Smith, Goldwin** 1823–1910  
English-Canadian historian

In my youth, geology was nervously striving to accommodate itself to Genesis. Now it is Genesis that is striving to accommodate itself to geology.

In Robert M. Hamilton  
*Canadian Quotations and Phrases*  
Lines of Religious Inquiry, Address, Toronto (p. 5)  
McClelland and Stewart. Toronto, Ontario, Canada. 1952

**Smith, John Pye** 1774–1851  
English Congregational theologian

If from the discoveries of Astronomy and Geology we infer that the created universe, including our own globe, has existed through an unknown but unspeakably long period of time past; and IF, from the records of revelation, we draw the conclusion that the work of creation, or at least so far as respects our planet, took place not quite

six thousand years ago; it is evident that the two positions cannot stand: one destroys the other. One of them must be an error; both may be wrong; only one can be right.

*The Relation Between the Holy Scriptures and Some Parts of Geological Science* (p. 15)  
H. G. Bohn. London, England. 1854

**Sollas, William Johnson** 1849–1936  
Geologist

The close of one century, the dawn of another, may naturally suggest some brief retrospective glance over the path along which our science has advanced, and some general survey of its present position from which we may gather hope of its future progress; but other connexion with geology the beginnings and endings of centuries have none. The great periods of movement have hitherto begun, as it were, in the early twilight hours, long before the dawn.

*The Age of the Earth and Other Geological Studies*  
Chapter I (p. 2)  
T. Fisher Unwin. London, England. 1905

Our science [geology] has become evolutionary, and in the transformation has grown more comprehensive: her petty parochial days are done, she is drawing her provinces closer around her, and is fusing them together into a united and single commonwealth – the science of the earth.

*The Age of the Earth and Other Geological Studies*  
Chapter I (p. 4)  
T. Fisher Unwin. London, England. 1905

**Tennyson, Alfred (Lord)** 1809–92  
English poet

What be these two shapes high over the sacred fountain,  
Taller than all the Muses, and higher than all the mountain?

On these two peaks they stand, ever spreading and heightening;  
Look in their deep double shadow, the crowned ones all disappearing!....

These are Astronomy and Geology – terrible Muses!

*The Works of Alfred Lord Tennyson, Poet Laureate*  
Parnassus  
The Macmillan Co. New York, New York, USA. 1894

**Toepffer, Rodolphe** 1799–1846  
Swiss teacher

But that is exactly what I like about this science of geology. It is infinite, ambiguous, like all poetry; like all poetry it has secrets, is permeated by them, lives within them, without being destroyed by them. It does not lift the veil, but only moves it, and through tiny holes in the fabric a few rays escape, which dazzle the eye.

In Ronald B. Parker  
*The Tenth Muse: The Pursuit of Earth Science* (p. xiii)  
Charles Scribner's Sons. New York, New York, USA. 1986

**Townsend, Joseph** 1739–1816

No biographical data available

The science of geology becomes of infinite importance when we consider it as connected with our immortal hopes. These depend on the truth of revelation, and the whole system of revealed religion is ultimately connected with the veracity of Moses. The divine legation of Christ and of the Jewish lawgiver must stand or fall together. If the Mosaic account of the creation and of the deluge is true, and consequently the promises recorded by him well founded, we may retain our hopes; but, should the former be given up as false, we must renounce the latter.

*The Character of Moses Established for Veracity as an Historian:*

*Recording Events from the Creation to the Deluge* (p. 430)

Printed by M. Gye. Bath, England. 1813

**Trefethen, Joseph M.**

No biographical data available

The relationship between civil engineering and geology is as old as the hills, manmade hills that is.

Geology for Civil Engineers

*Journal of Engineering Education*, Volume 39, Number 7, March, 1949 (p. 383)

**Tudor, John**

No biographical data available

Geology is like searching a charnel house, and expecting to find in the dust of the tombs a history of the living man...

*Sacred Geology*

Chapter VII (p. 425)

William Edward Painter. London, England. 1847

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Geology has revealed the fact that the crust of the earth is composed of five layers or strata. We exist on the surface of the fifth. Geology teaches, with scientific accuracy, that each of these layers was from ten thousand to two million years forming or cooling. (A disagreement as to a few hundred thousand years is a matter of little consequence to science.)

*Collected Tales, Sketches, Speeches, & Essays 1852–1890* (Volume 1)

A Brace of Brief Lectures on Science (p. 529)

The Library of America. New York, New York, USA. 1992

We now come to the geological part [of history]. This is the one where the evidence is not all in, yet. It is coming in, hourly, daily, coming in all the time, but naturally it comes with geological carefulness and deliberation, and we must not be impatient, we must not get excited, we must be calm, and wait. To lose our tranquility will not hurry geology; nothing hurries geology.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Was the World Made for Man? (p. 572)

The Library of America. New York, New York, USA. 1992

...most of Sir Dinadan's jokes were rotten and the rest were petrified. I said "petrified" was good; as I believed, myself, that the only right way to classify the majestic ages of some of those jokes was by geologic periods. But that neat idea hit the boy in a blank place, for geology hadn't been invented yet.

*A Connecticut Yankee*

Chapter IV (p. 30)

Harper & Brothers Publishers. New York, New York, USA. 1917

**Tyndall, John** 1820–93

Irish-born English physicist

Time and intensity are the main factors in geologic change, and they are in a certain sense the convertible. A feeble force acting through long periods, and an intense force acting through short ones, may produce approximately the same results.

*Fragments of Science*

Niagara, Section 6 (p. 192)

D. Appleton. New York, New York, USA. 1898

**Umbgrove, J. H. F.**

No biographical data available

Geology, the science of the history of the Earth and Life, reaches back into the infinitely remote ages and depths of the Universe and extends its speculations to the origin and meaning of all organisms and inorganic matter.

*The Pulse of the Earth*

Chapter I (p. 1)

Martinus Nijhoff. The Hague, Netherlands. 1947

...geology is a historical science. The history of the earth is a most absorbing one and its unknown elements – many of which, will perhaps elude us forever – challenge us.

*The Pulse of the Earth*

Chapter I (p. 2)

Martinus Nijhoff. The Hague, Netherlands. 1947

**van Hise, Charles R.** 1857–1918

American academic

It may be said that the history of events, as shown by the rocks and fossils, does not necessarily require physical or chemical treatment. There is some truth in these statements, but on the other side it may be held that the facts are the results accomplished by physical and chemical works. These facts become important and significant mainly as they are interpreted in physical and chemical terms. The objects of the earth, – the complex results of chemical and physical work – if described without reference to the manner in which the results came about, have comparatively little interest.

The Problems of Geology

*Journal of Geology*, Volume 12, 1904 (pp. 590–591)

Those geologists who have made the attempt to combine mathematical with their geological reasoning usually have shown marked deficiency in their mathematics. Upon the other hand, those mathematicians who have attempted to handle the problems of geology mathematically have usually been so deficient in a knowledge of geology that their work has been of comparatively little value.... [T]he time has come for co-operation between geologists and mathematicians in the advancement of the science of geology to a quantitative basis.

The Problems of Geology

*Journal of Geology*, Volume 12, 1904 (p. 603)

**Verne, Jules** 1828–1905

French novelist

His imagination is a perfect volcano, and to make discoveries in the interest of geology he would sacrifice his life.

*A Journey to the Center of the Earth*

Chapter 3 (pp. 18–19)

The Limited Editions Club. New York, New York, USA. 1966

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Of all the subjects to which the thought and imagination of man could turn, the question as to the origin of the world has, since remote antiquity, been the favorite arena of the wildest speculation.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

Second Series

On the Origin of the Planetary System (p. 139)

Longmans, Green & Co. London, England. 1903

**von Zittel, Karl Alfred** 1839–1904

German palaeontologist

It does not come within the domain of geology to investigate the origin of the universe and of solar and planetary systems. Yet such investigations are so closely associated with the origin and earliest history of the earth that the results attained by astronomical researches have at all times exerted an influence upon the views of geologists.

Translated by Maria M. Ogilvie-Gordon

*History of Geology and Paleontology*

Chapter I (p. 153)

W. Scott. London, England. 1901

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

...but geology alone can tell us nothing of lands which have disappeared beneath the ocean.

*The Malay Archipelago*

Chapter XXXIII (p. 291)

Macmillan & Company Ltd. London, England. 1869

**Whewell, William** 1794–1866

English philosopher and historian

Have the changes which lead us from one geological state to another been, on a long average, uniform in their intensity, or have they consisted of epochs of paroxysmal and catastrophic action, interposed between periods of comparative tranquility. These two opinions will probably for some time divide the geological world into two sects, which may perhaps be designated as the Uniformitarians and the Catastrophists.

Review of Lyell's *Principles of Geology*

*Quarterly Review*, 1832

...the study of Geology opens to us the spectacle of many groups of species which here, in the course of the earth's history, succeeded each other at vast intervals of time; one set of animals and plants disappearing, as it would seem, from the face of our planet, and others, which did not before exist, becoming the only occupants of the globe. And the dilemma then presents itself to us anew: – either we must accept the doctrine of the transmutation of species, and must suppose that the organized species of one geological epoch were transmuted into those of another by some long-continued agency of natural causes; or else, we must believe in many successive acts of creation and extinction of species, out of the common course of nature; acts which, therefore, we may properly call miraculous.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 2) (3rd edition)

Book XVIII, Chapter VI (p. 564)

D. Appleton & Co. New York, New York, USA. 1894

**Williams, G. H.**

No biographical data available

Geology has, for the earliest times, claimed the serious attention of mankind, by appealing to two entirely different sides of human character. In the first place, reverence for the mysterious in nature, which in untutored men amounts to worship, has always been excited by the secrets of the earth; while, in the second place, the cupidity of man has always led him to explore the rocks in quest of the mineral treasures which they contain.

Some Modern Aspects of Geology

*Popular Science Monthly*, Volume 35, 1889

**Winchell, Alexander** 1824–91

American geologist

The study of science is a virtue. Attention to geology is a human duty.

*Walks and Talks in the Geological Field*

Part I, Chapter VI (p. 36)

Chautauqua Press. New York, New York, USA. 1890

**Woodward, Robert Simpson** 1849–1924

American scientist and teacher

Geology illustrates better than any other science, probably, the wide ramifications and the close inter-relations

of physical phenomena. There is scarcely a process, a product, or a principle in the whole range of physical science, from physics and chemistry up to astronomy and astrophysics, which is not fully illustrated in its uniqueness and in its diversity by actual operations still in progress on the earth, or by actual records preserved in her crust. The earth is thus at once the grandest of laboratories and the grandest of museums available to man.

In J.A. Thomson

*Introduction to Science*

Chapter IV (pp. 109–110)

Williams & Norgate Ltd. London, England. 1916

**Zornlin, Rosina Maria** 1795–1859

No biographical data available

The difference between the sciences of astronomy and geology may be compared to that of the discoveries effected by the telescope and the microscope: – the one reveals to us objects of vast magnitude concealed from us by their immense distance; the other discloses objects hidden from us by their almost incomprehensible minuteness.

*Recreations in Geology*

Preliminary Discourse (p. xiv)

John W. Parker. London, England. 1839

## GEOLGY, THEORY OF

**Phillips, J.**

No biographical data available

The theory of geology is nothing less than the physical history of the globe – and this history is to be extorted from the archives of nature by question upon question after doubt upon doubt.

Anniversary Address of the President

*The Quarterly journal of the Geological Society of London*, Volume XV, 1859 (p. 295)

## GEOLOGICAL TIME

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

I have devoted my whole life to the study of Nature, and yet a single sentence may express all that I have done. I have shown that there is a correspondence between the succession of Fishes in geological time and the different stages of their growth in the egg – that is all.

*Methods of Study In Natural History*

Chapter II (p. 23)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Burroughs, John** 1837–1921

American naturalist and writer

Time, geologic time, looks out at us from the rocks as from no other objects in the landscape. Geologic time! How the

striking of the great clock, whose hours are millions of years, reverberates out of the abyss of the past!

*Under the Apple-Trees*

Chapter II (p. 40)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

Geologic time is the most potent of the gods of change. He wields an invisible hammer beside which the hammer of Thor is a child's toy. Its slow, silent blows break in through granite rocks as big as a house.

...

How geologic time looks out from the ledges and walls of gray rocks unmindful of us human ephemera that pass! It has seen the mountains decay and the hills grow old. The huge drift boulders rest on the margin of meadows and fields, or stand sentry to the woods, and through races and kingdoms pass, scarcely the change of a wrinkle disturbs their calm stone faces. Yet time gets the better of them also. The frowning ledge melts as inevitably as a snow bank.

*Under the Apple-Trees*

Chapter II (p. 58)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Coman, Dale Rex** 1906–

Writer and naturalist

A planet has no need to rush in the conduct of its affairs; its major schemes are plotted on a chart of eons.

*The Endless Adventure*

Along the Coast in April (p. 135)

Henry Regnery Company. Chicago, Illinois, USA. 1972

The rule is that no species prevails for long as measured in the units of eras by which our planet conducts its affairs.

*The Endless Adventure*

Once There Was a Planet (p. 181)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

As a microscope helps our minds to burrow through alien galleries of cell membranes, and as a telescope lifts us to far galaxies, another way of coming out of the anesthetic is to return, in our imaginations, through geological time.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter 1 (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Forbes, Edward** 1815–54

English naturalist

Palaeontological research exhibits, beyond question, the phenomenon of provinces in time, as well as provinces in space. Moreover, all our knowledge of organic remains teaches us that species have a definite existence, and a centralization in geological time as well as in geographical space, and that no species is repeated in time.



*The Natural History of the European Seas*  
Chapter I (p. 10)  
John van Voorst. London, England. 1859

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

We see, in the vastness of geologic time, events that bear superficial similarity to phenomena of local populations – and we assign a similar cause [to these events] without realizing that the extended time itself precludes such an application.

*The Promise of Paleobiology as a Nomothetic, Evolutionary Discipline*  
*Paleobiology*, Volume 5, 1980

The geologic time scale is a layer cake of odd names, learned by generations of grumbling students with mnemonics either too insipid or too salacious for publication: Cambrian, Ordovician, Silurian, Devonian.... Their ubiquity in all geological writing has led students to suspect that these names, like the rocks they represent, have been present from time immemorial (*et nunc, et semper, et in saecula saeculorum, amen*).

*An Urchin in the Storm: Essays About Books and Ideas*  
Chapter 5 (p. 76)  
W.W. Norton & Company, Inc. New York, New York, USA. 1987

**Hurley, Patrick M.**  
No biographical data available

...each grain of sand, each minute crystal in the rocks about us is a tiny clock, ticking off the years since it was formed. It is not always easy to read them, and we need complex instruments to do it, but they are true clocks or chronometers. The story they tell numbers the pages of earth history.

*How Old Is the Earth?*  
Introduction (p. 14)  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1959

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

...if the succession of worlds is established in the system of nature, it is in vain to look for anything in the origin of the earth. The result, therefore, of our present enquiry is, that we find no vestige of a beginning, – no prospect of an end.

*The Theory of the Earth* (Volume 1)  
Part I, Chapter I, Section IV (p. 200)  
Messrs. Cadwell, Junior, and Davies. London, England. 1795

**Knopf, Alfred A.** 1892–1984  
American publisher

If I were asked as a geologist what is the single greatest contribution of the science of geology to modern civilized thought, the answer would be the realization of the immense length of time. So vast is the span of time recorded in the history of the earth that it is generally distinguished from the more modest kinds of time by being

called “geologic time.”  
*Time and Its Mysteries*  
Series 3 (p. 33)  
New York University Press. New York, New York, USA. 1936

**Lambert, Johann Heinrich** 1728–77  
Swiss German mathematician and astronomer

Happy intelligences, how excellent must be the frame of your nature! Myriads of ages pass away with you, like so many days with the inhabitants of the Earth. Our largest measurements are your infinitely small quantities; our millions the elements of your arithmetic; we breathe but a moment; our lot is error and death; yours science and immortality.

Translated by James Jacque  
*The System of the World*  
Part I, Chapter IX (p. 58)  
Printed for Vernor and Hood. London, England. 1800

**McPhee, John** 1931–  
American journalist and nonfiction writer

With your arms spread wide...to represent all time on earth, look at one hand with its line of life. The Cambrian begins in the wrists, and the Permian extinction is at the outer end of the palm. All of the Cenozoic is in a fingerprint, and in a single stroke with a medium-grained nail file you could eradicate human history.

*Basin and Range* (p. 126)  
Farrar, Straus & Giroux. New York, New York, USA. 1981

**Morris, Henry**  
Creationist

The only way we can determine the true age of the earth is for God to tell us what it is. And since He has told us, very plainly, in the Holy Scriptures that it is several thousand years in age, and no more, that ought to settle all basic questions of terrestrial chronology.

*The Remarkable Birth of Planet Earth*  
Chapter VIII (p. 94)  
Creation-Life Publishers. San Diego, California, USA. 1972

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Geological time is not money. A pity too; for it would have abolished poverty from the earth.

In Albert Bigelow Paine (ed.)  
*Mark Twain's Notebook*  
Chapter XXXV (p. 393)  
Harper & Brothers. New York, New York, USA. 1899

**Walcott, Charles D.** 1850–1927  
Geologist

Few of us have a clear realization of the age of the earth. Under many deceptive aspects she carries with her the



secret of a long and busy life, one of such fascinating activity that it is not surprising that students are ever seeking to unravel the mysteries of the past. With all the evidences of youth there is to be felt, especially among the mountains, a sense of age and infinite power, and we are inspired with awe as we trace the base of worn-down rocks, miles in thickness, that formed the mountain ranges far back in geologic time.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1915*

Evidences of Primitive Life (p. 235)

Government Printing Office. Washington, D.C. 1916

### **Wald, George** 1906–97

American biologist and biochemist

Time is in fact the hero of the plot. The time with which we have to deal is of the order of two billion years. What we regard as impossible on the basis of human experience is meaningless here. Given so much time, the “impossible” becomes possible, the possible probable, and the probable virtually certain. One has only to wait: time itself performs the miracles.

*The Physics and Chemistry of Life*

The Origin of Life (p. 12)

Simon & Schuster. New York, New York, USA. 1955

## **GEOLOGIST**

### **Author undetermined**

Over the ground

Passes a sound;

It is the pit-a-pat of footsteps in the sand.

See them advance,

Thicker than ants;

Survey geologists are swarming through the land!

Quo Vadose?

*The Pick and Hammer Club*, March 16, 1948 (p. 12)

### **Bates, R. L.**

No biographical data available

I wonder who was the very first geologist to get it into his noodle

That an educated guess about something would sound better if he called it a model?

Petulant Questions

*Geotimes*, Volume 22, Number 6, 1977 (p. 46)

### **Bradley, W. H.**

No biographical data available

Again, because a geologist can see only parts of the features he studies and must forever deal with partial information (he constructs geologic maps primarily to bring large features down to a comprehensive scale at which he can integrate the parts and visualize the whole), it is most

essential that he be able to visualize, in three dimensions and with perspective, processes that may have gone on that will help to reconstruct events of the past.

In Claude C. Albritton

*The Fabric of Geology*

Geologic Laws (p. 16)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1963

### **Brown, H.**

No biographical data available

### **Monnett, J.**

No biographical data available

Whatever his method of approach, the geologist must take cognizance of the following facts...There is no place on the earth where a complete record of the rocks is present...To reconstruct the history of the earth, scattered bits of information from thousands of locations all over the world must be pieced together. The results will be at best only a very incomplete record. If the complete story of the earth is compared to an encyclopedia of thirty volumes, then we can seldom hope to find even one complete volume in a given area. Sometimes only a few chapters, perhaps only a paragraph or two, will be the total geological contribution of a region; indeed, we are often reduced to studying scattered bits of information more nearly comparable to a few words or characters.

*Introduction to Geology* (p. 11)

Ginn. Boston, Massachusetts, USA. 1958

### **Chalmers, Thomas** 1780–1847

Scottish theologian

There are prejudices...against the speculations of the geologist, which I am anxious to remove. It has been said that they nurture infidel propensities. It has been alleged that geology, by referring the origin of the globe to a higher antiquity than is assigned to it by the writings of Moses, undermines our faith in the inspiration of the Bible, and in all the animating prospects of the immortality which it unfolds. This is a false alarm. The writings of Moses do not fix the antiquity of the globe.

Quoted in Hugh Miller

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Third (p. 141)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

### **Chamberlin, Thomas Chrowder** 1843–1928

American geologist

The studies of the geologist are peculiarly complex. It is rare that his problem is a simple unitary phenomenon explicable by a single simple cause. Even when it happens to be so in a given instance, or at a given stage of work, the subject is quite sure, if pursued broadly, to

grade into some complications or undergo some transition. He must therefore ever be on the alert for mutations and for the insidious entrance of new factors. If, therefore, there are any advantages in any field in being armed with a full panoply of working hypotheses and in habitually employing them, it is doubtless the field of the geologist.

The Method of Multiple Working Hypotheses  
*Journal of Geology*, Volume 5, Number viii, November–December, 1897 (p. 848)

### Chapman, Clark R.

Astronomer and asteroid researcher

The geologist in the wilderness epitomizes man against nature. A tiny, transitory creature, whose life will be over in a mere second of geologic time, attempts to discern the life processes of Earth. Hammering at the rocks pregnant with data, the geologist is in physical contact and combat with the Earth, like a mosquito attacking Goliath. Ever so grudgingly, the Earth yields its life history.

*The Inner Planets: New Light on the Rocky Worlds of Mercury, Venus, Earth, the Moon, Mars, and the Asteroids*  
Chapter 1 (p. 10)  
Charles Scribner's Sons. New York, New York, USA. 1977

### Darwin, Charles Robert 1809–82

English naturalist

I have long discovered that geologists never read each other's works, and that the only object in writing a book is a proof of earnestness, and that you do not form your opinions without undergoing labour of some kind.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter IX (p. 303)  
D. Appleton & Company. New York, New York, USA. 1896

About thirty years ago there was much talk that geologists ought only to observe and not theorize; and I well remember someone saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colours. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
Letter 133, Darwin to Fawcett, 18 September, 1861 (p. 195)  
D. Appleton & Company. New York, New York, USA. 1903

### Dawson, Sir John William 1820–99

Canadian geologist and educator

The geologist, ascending from the oldest and lowest portions of the earth's crust, and dealing for millions of years with physical forces and the instinctive powers of animals alone, at length as he approaches the surface finds himself in contact with an entirely new agency, the free-will and conscious action of man.

*The Meeting-Place of Geology and History*  
Chapter I (p. 12)  
Fleming H. Revell Company. New York, New York, USA. 1894

### Dexter, William A.

No biographical data available

For every fossil or old rock the geologist can unearth, the astronomer can point his telescope toward an object whose light left the object when either the rock was formed or the fossil was alive.

The Bigness and the Smallness of Time  
*Journal of Geological Education*, Volume XV, Number 4, October, 1967 (p. 162)

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The time has gone by when the physicists prescribed dictatorially what theories the geologist might be permitted to consider.

The Borderland of Astronomy and Geology  
*Nature*, Volume 111, Number 2775, January 6, 1923 (p. 21)

### Esar, Evan 1899–1995

American humorist

[Geologist] A scientist whose life is less sedentary than sedimentary.

*Esar's Comic Dictionary*  
Geologist  
Doubleday. Garden City, New York, USA. 1983

[Geologist]. A faultfinder.

*Esar's Comic Dictionary*  
Geologist  
Doubleday. Garden City, New York, USA. 1983

### Gilbert, G. K. 1843–1918

American geologist

It is the natural and legitimate ambition of a properly constituted geologist to see a glacier, witness an eruption and feel an earthquake.

The Investigation of the San Francisco Earthquake  
*Popular Science Monthly*, Volume 69, 1906 (p. 97)

### Gould, Stephen Jay 1941–2002

American paleontologist and evolutionary biologist

No Geologist worth anything is permanently bound to a desk or laboratory, but the charming notion that true science can only be based on unbiased observation of nature in the raw is mythology.

*An Urchin in the Storm: Essays About Books and Ideas*  
Chapter 6 (p. 98)  
W.W. Norton & Company, Inc. New York, New York, USA. 1987

### Harrington, John W.

No biographical data available

Creative scientists work in an open-ended world of splendid uncertainty. Geologists are sometimes pitted,

for their world is the most uncertain of all. Theirs is a historical science, rooted in a past that defies experimental research methods.

*Dance of the Continents*

Chapter Two (p. 41)

J.P. Tarcher. Los Angeles, California, USA. 1983

### Langley, Samuel Pierpoint 1834–1906

American astronomer and aviation pioneer

We approach now the only planet in which man is certainly known to exist, and which ought to have an interest for us superior to any which we have yet seen, for it is our own. We are voyagers on it through space, it has been said, as passengers on a ship, and many of us have never thought of any part of the vessel but the cabin where we are quartered. Some curious passengers (these are the geographers) have visited the steerage, and some (the geologists) have looked under the hatches, and yet it remains true that those in one part of our vessel know little, even now, of their fellow-voyagers in another. How much less, then, do most of us know of the ship itself, for we were all born on it, and have never once been off it to view it from the outside!

*The New Astronomy*

### Lawson, Andrew C.

No biographical data available

By thought and dint of hammering  
Is the good work done whereof I sing,  
And a jollier crowd you'll rarely find,  
Than the men who chip at earth's old rind,  
And often wear a patched behind,  
By thought and dint of hammering.

*Mente et Malleo*

December 7, 1877

### Macaulay, Thomas Babington 1800–59

English historian and author

Bishop Watson compares a geologist to a gnat mounted on an elephant, and laying down theories as to the whole internal structure of the vast animal from the phenomena of the hide. The comparison is unjust to the geologist.

On History

*Edinburgh Review*, May, 1828

### McPhee, John 1931–

American journalist and nonfiction writer

A roadcut is to a geologist as a stethoscope is to a doctor.

*Basin and Range* (p. 11)

Farrar, Straus & Giroux. New York, New York, USA. 1981

I used to sit in class and listen to the terms come floating down the room like paper airplanes. Geology was called a descriptive science, and with its pitted outwash plains and drowned rivers, its hanging tributaries and starved coastlines, it was nothing if not descriptive. It was a fountain

of metaphors.... Geologists communicated in English; and they could name things in a manner that sent shivers through the bones.

*Basin and Range* (pp. 24, 25)

Farrar, Straus & Giroux. New York, New York, USA. 1981

Geologists, in their all but closed conversation, inhabit scenes that no one ever saw, scenes of global sweep, gone and gone again, including seas, mountains, rivers, forests, and archipelagoes of aching beauty rising in volcanic violence to settle down quietly and then forever disappear – almost disappear.

*Basin and Range* (p. 82)

Farrar, Straus & Giroux. New York, New York, USA. 1981

### Miller, Hugh 1802–56

Scottish geologist and theologian

There are few theologians worthy of the name who now hold that the deductions of the geologists regarding the earth's antiquity are at variance with the statements of Scripture respecting its first creation, and subsequent preparation for man.

*Sketch-Book of Popular Geology*

Lecture Second (p. 53)

William P. Nimmo & Co. Edinburgh, Scotland. 1880

The fact of the existence, throughout all the geological ages, of the great law of death, is a fact which must often press upon the geologist.

*Sketch-Book of Popular Geology*

Lecture Fifth (p. 158)

William P. Nimmo & Co. Edinburgh, Scotland. 1880

The geologist, as certainly as the theologian, has a province exclusively his own; and were the theologian ever to remember that the Scriptures could not possibly have been given to us as revelations of scientific truth, seeing that a single scientific truth they never yet revealed, and the geologist that it must be in vain to seek in science those truths which lead to salvation, seeing that in science these truths were never yet found, there would be little danger even of difference among them, and none of collision.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Sixth (pp. 280–281)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

The natural boundaries of the geographer are rarely described by right lines. Whenever these occur, however, the geologist may look for something remarkable.

*The Old Red Sandstone*

Chapter VI (p. 121)

J.M. Dent & Sons Ltd. London, England. 1922

### Nye, Bill 1850–96

American journalist

Geologists ascertain the age of the earth by looking at its teeth and counting the wrinkles on its horns. They have

learned that the earth is not only of great age, but that it is still adding to its age from year to year.

*Remarks*

About Geology (p. 201)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Pallister, William Hales** 1877–1946

Canadian physician

A torrid, turning sphere, cooling with crack and crash,  
Thick crust of lava-rock, and deep volcanic ash,  
Whose stratified formations now compose the book  
Of broken records where geologists may look.  
They classify the layers, by antiquity,

In five sections: Achaean, long o'er life could be;  
The Paleozoic, site of life, the primary;

Then Mesozoic, where the sequent life we see;  
Next comes the tertiary with creatures such as we,  
And, last of all, the recent-laid quaternary.

*Poems of Science*

Other Worlds and Ours, The Earth (p. 208)

Playford Press. New York, New York, USA. 1931

**Playfair, John** 1748–1819

Scottish geologist, physicist and mathematician

The geologist sadly mistakes both the object of his science and the limits of his understanding who thinks it his business to explain the means employed by INFINITE WISDOM for establishing the laws which now govern the world.

*Illustrations of the Huttonian Theory of the Earth*

Section 119 (p. 121)

Dover Publications, Inc. New York, New York, USA. 1964

The geologist must not content himself with examining the insulated specimens of his cabinet, or with pursuing the nice subtleties of mineralogical arrangement; he must study the relations of fossils, as they actually exist; he must follow nature into her wildest and most inaccessible abodes; and must select, for the places of his observations, those points, from which the variety and gradation of her works can be most extensively and accurately explored.

*Illustrations of the Huttonian Theory of the Earth*

Section 133 (p. 138)

Dover Publications, Inc. New York, New York, USA. 1964

...the outlines, at least, of geology have now been traced with tolerable truth, and are not susceptible of great variation...The mass of knowledge is in that state of termination from which the true theory may be expected to emerge.

*Illustrations of the Huttonian Theory of the Earth*

Section 449, 451 (pp. 515, 516)

Dover Publications, Inc. New York, New York, USA. 1964

**Prestwich, Joseph** 1812–96

English geologist and archaeologist

The geologist commences where the astronomer ends.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1875*

The Past and Future of Geology (p. 177)

Government Printing Office. Washington, D.C. 1876

**Pretorius, D. A.**

No biographical data available

It is the nature of the history of the earth that a geologist has available to him only partial information. Occasional lines from disconnected paragraphs in obscurantist chapters are what can be read. Violence in the handling of the book through time has caused many of these chapters to be ripped and reassembled out of context. That the gist of the early chapters can be deciphered at all is a credit to the perseverance and imagination not always associated with other sciences. The geologist operates at all times in an environment characterized by a high degree of uncertainty and ornamented with end-products which are the outcomes of the interactions of many complex variables. He sees only the end, and has to induce the processes and the responses that filled the time since the beginning.

In Stanley A. Schumm

*To Interpret the Earth*

Chapter 1 (p. 5)

Cambridge University Press. Cambridge, England. 1991

**Read, Herbert Harold** 1889–1970

Geologist

In these hurried days, geologists will take no harm from a quiet contemplation of the history of even this small part of their science.

*The Granite Controversy: Geological Addresses Illustrating the Evolution of a Disputant* (p. xiii)

Interscience Publishers. New York, New York, USA. 1957

**Redfern, Martin**

No biographical data available

Rocks and stones are not the most forthcoming storytellers. They have a tendency to sit there gathering moss, only rolling when pushed. But geologists have ways of making them talk. They can hit them and slice them; squeeze them, squash them, strain and stress them until they crack – sometimes quite literally. If you know how to look at them, rocks can tell you their history.

*The Earth: A Very Short Introduction*

Chapter 1 (p. 3)

Oxford University Press, Inc. Oxford, England. 2003

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

[geologists]...rin uphill and down dale, knapping the chunky stanes to pieces wi' hammers, like sae mony road-makers run daft, to see how the world was made.

*Saint Ronan's Well*

Section 3 (p. 30)

Maarcus Ward & Co. London, England. 1879

**Sollas, William Johnson** 1849–1936  
Geologist

A physicist studying geology is by definition a geologist.

*The Age of the Earth and Other Studies*  
Chapter I (p. 4)  
T. Fisher Unwin. London, England. 1905

**van Hise, Charles R.** 1857–1918  
American academic

No man has ever stated more than a small part of the facts with reference to any area. The geologist must select facts which he regards of sufficient note to record and describe. But such selection implies theories of their importance and significance. In a given case the problem is therefore reduced to selecting facts for record, with a broad and deep comprehension of the principles involved, a definite understanding of the rules of the game...

*The Problems of Geology*  
*Journal of Geology*, Volume 12, Number 7, 1904 (p. 612)

**Wordsworth, William** 1770–1850  
English poet

He who with pocket-hammer smites the edge  
Of luckless rock or prominent stone disfigured  
In weather-stain or crusted o'er by Nature  
With her first growths, detaching by the stroke  
A chip or splinter – to resolve his doubts;  
And, with that ready answer satisfied,  
The substance classes by some barbarous name,  
And hurries on; on from the fragments picks  
His specimen, if but haply intervened  
With sparkling mineral, or should crystal cube  
Lurk in its cells – and thinks himself enriched,  
Wealthier, and doubtless wiser than before.

*The Complete Poetical Works of William Wordsworth*  
The Excursion  
Crowell. New York, New York, USA. 1888

## GEOMETER

**Clifford, William Kingdon** 1845–79  
English mathematician

The geometer of to-day knows nothing about the nature of actually existing space at an infinite distance; he knows nothing about the properties of this present space in a past or a future eternity. He knows, indeed, that the laws assumed by Euclid are true with an accuracy that no direct experiment can approach, not only in this place where we are, but in places at a distance from us that no astronomer has conceived; but he knows this as of Here and Now; beyond his range is a There and Then of which he knows nothing at present, but may ultimately come to know more.

In Leslie Stephen and Frederick Pollock  
*Lectures and Essays, by the Late William Kingdon Clifford* (2nd edition)  
The Philosophy of the Pure Science (p. 213)  
Macmillan & Company Ltd. London, England. 1886

## du Hamel, Joannes Baptiste

No biographical data available

I do not find that geometers are mighty solicitous, whether their arguments be, in formula, compounded according to logical prescription; and yet there are none who demonstrate wither more precisely or with greater conviction. For they usually follow the guidance of nature; descending step by step, from the simpler and more general to the more complex, and defining every term, they leave no ambiguity in their language. Hence it is that they cannot err in the form of their syllogisms – for we seldom deviate from logical rules, except when we abuse the ambiguity of words, or attribute a different meaning to the middle term in the major and in the minor proposition. It is also the custom of geometers to prefix certain self-evident axioms or principles from which all that they are subsequently to demonstrate flow. Finally, their conclusions are deduced, either from definitions which cannot be called in question, or from those principles and propositions known by the light of nature, which are styled axioms, or from other already established conclusions, which now obtain the cogency of principles. They make not troublesome inquiry into the mood or figure of a syllogism, nor lavish attention on the rules of logic; for such attention, by averting their mind from more necessary objects, would be detrimental rather than advantageous.

*Edinburgh Review*, Volume 52, January, 1836 (p. 228)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The geometer shows us the true order in figures. ...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Lectures and Biographical Sketches*

Chapter III (p. 80)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Huxley, Aldous** 1894–1963

English writer and critic

How orderly philosophical is the landscape, are all the inhabitants of this World! It is the creation of a god who “ever plays the geometer.”

*Music at Night and Other Essays*

Music At Night (p. 45)

Doubleday Doran & Company, Inc. Garden City, New York, USA. 1931

## Scaliger, Joseph

No biographical data available

A dull and patient intellect such should be your geometers. A great genius cannot be a great mathematician.

*Edinburgh Review*, Volume 52, January, 1836 (p. 229)



**Sylvester, James Joseph** 1814–97  
English mathematician

It is the province of the metaphysician to inquire into the nature of space as it exists in itself, or with relation to the human mind. The less aspiring but more satisfactory business of the geometer is to deal with space as an objective reality, and to view it in its relation to matter, and as the substratum or the condition necessary to the existence of our conception of form.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
A Probationary Lecture on Geometry (p. 5)  
Cambridge University Press. Cambridge, England. 1908

## GEOMETRICAL FIGURE

**Jevons, William Stanley** 1835–82  
English economist and logician

There may exist in nature perfect straight lines, triangles, circles, and other regular geometrical figures; to our science it is a matter of indifference whether they do or do not exist, because in any case they must be beyond our powers of perception.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book IV, Chapter XXI (p. 458)  
Macmillan & Co Ltd. London, England. 1877

## GEOMETRICAL PROGRESSION

**Tolstoy, Leo** 1828–1910  
Russian writer

By adopting smaller and smaller elements of motion we only approach a solution of the problem, but never reach it. Only when we have admitted the conception of the infinitely small, and the resulting geometrical progression with a common ratio of one tenth, and have found the sum of this progression to infinity, do we reach a solution of the problem.

*Great Books of the Western World* (Volume 51)  
*War and Peace*  
Book XI, Chapter I (p. 469)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

## GEOMETRICAL RULE

**Sterne, Laurence** 1713–68  
English novelist and humorist

[My Uncle Toby] proceeded next to Galileo and Torricellius, wherein, by certain Geometrical rules, infallibly laid down, he found the precise part to be a “Parabola” – or else an “Hyperbola,” – and that the parameter, or “*latus rectum*,” of the conic section of the said path, was to the quantity and amplitude in a direct ration, as the whole line to the sine of double the angle of incidence, formed by the breech upon the horizontal line; – and that the

semiparameter, – stop! my dear uncle Toby – stop!

Quoted in James R. Newman  
*The World of Mathematics* (Volume 2)  
Mathematics of Motion (p. 734)  
Simon & Schuster. New York, New York, USA. 1956

## GEOMETRICIAN

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

Prudence and justice are virtues and excellencies of all times and of all places; we are perpetually moralists, but we are geometricians only by chance.

In Arthur Murphy  
*The Works of Samuel Johnson* (Volume 2)  
Milton (p. 25)  
Alexander van Blake, Publisher. New York, New York, USA. 1838

## GEOMETRY

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

This would appear to put at least part of the Theory of Demonstration in a category with the efforts of beginners in Geometry: To prove that A equals B: let A equal B; therefore A equals B.

*Debunking Science*  
University of Washington Book Store. Seattle, Washington, USA. 1930

The cowboys have a way of trussing up a steer or a pugnacious bronco which fixes the brute so that it can neither move nor think. This is the hog-tie, and it is what Euclid (B.C. 330–275) did to geometry.

*The Search for Truth*  
Chapter VII, Section 4 (p. 117)  
George Allen & Unwin Ltd. London, England. 1935

With a literature much vaster than those of algebra and arithmetic combined, and as least as extensive as that of analysis, geometry is a richer treasure house of more interesting and half-forgotten things, which a hurried generation has no leisure to enjoy, than any other division of mathematics

*The Development of Mathematics* (p. 320)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

...the only royal road to elementary geometry is ingenuity.

*The Development of Mathematics* (p. 322)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Berkeley, George** 1685–1753  
Irish prelate and metaphysical philosopher

The method of Fluxions [the calculus] is the general key by help whereof the modern mathematicians unlock the secrets of Geometry, and consequently of Nature.

In E.T. Bell  
*Men of Mathematics* (p. 90)  
Simon & Schuster. New York, New York, USA. 1937



**Bôcher, Maxime** 1867–1918  
Mathematician

We must, then, admit...that there is an independent science of geometry just as there is an independent science of physics, and that either of these may be treated by mathematical methods. Thus geometry becomes the simplest of the natural sciences, and its axioms are of the nature of physical laws, to be tested by experience and to be regarded as true only within the limits of the errors of observation.

The Fundamental Conceptions and Methods in Mathematics  
*Bulletin of the American Mathematical Society*, 2nd Series, Volume 11, 1904 (p. 124)

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

The goal of geometry is to study those properties of bodies which can be considered independent of their matter, but only with respect to their dimensions and their forms. Geometry measures the surface of a field without bothering to find out whether the soil is good or bad.  
Source undetermined

**Brown, Fredric** 1906–72  
Writer

“I’ve always been poor at geometry,” he began....  
“You’re telling me,” said the demon gleefully.  
Smiling flames, it came for him across the chalk lines of the useless hexagram Henry had drawn by mistake instead of the protecting pentagram.

*And the Gods Laughed: A Collection of Science Fiction and Fantasy*  
Naturally  
Phantasia Press. Bloomfield, Michigan, USA. 1987

**Butler, Nicholas Murray** 1862–1947  
American philosopher, diplomat, and educator

The elements of plane geometry should precede algebra for every reason known to sound educational theory. It is more fundamental, it is more concrete, and it deals with things and their relations rather than with symbols.

*The Meaning of Education, and Other Essays and Addresses*  
The Function of the Secondary School (p. 171)  
The Macmillan Co. New York, New York, USA. 1904

**Cedering, Siv** 1939–  
Poet, painter, author, and sculptor

As I picture each planet  
floating within the geometric perfections  
of space, I think geometry was implanted in man  
along with the image of God.  
Geometry indeed is God.

*Letters from the Floating World*  
Letters from the Astronomers, II. Johannes Kepler (p. 114)  
University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1984

**Charlie Chan (Fictional character)**

In phraseology of Euclid, X over Y equal proposition still unsolved.

*Dangerous Money*  
Film (1946)

**Chasles, Michel** 1793–1880  
French mathematician

The doctrines of pure geometry often, and in many questions, give a simple and natural way to penetrate to the origin of truths, to lay bare the mysterious chain which unites them, and to make them known individually, luminously and completely.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 834)  
Oxford University Press, Inc. New York, New York, USA. 1972

**Chern, Shiing-Shen** 1911–2004  
Chinese-American differential geometer

Physics and geometry are one family.  
Together and holding hands they roam to the limits of outer space...

Surprisingly, Math has earned its rightful place for man and in the sky;

Fondling flowers with a smile – just wish nothing is said!

Interview with Shiing Shen Chern  
*Notices of the American Mathematical Society*, Volume 45, Number 7, August, 1998 (p. 865)

**Clifford, William Kingdon** 1845–79  
English philosopher and mathematician

...for geometry, you know, is the gate of science, and the gate is so low and small that we can only enter it as a little child.

In Stephen F. Gull, Anthony N. Lasenby and Chris J.L. Doran  
Imaginary Numbers Are Not Real – The Geometric Algebra of Space-time  
*Foundations of Physics USA*, Volume 23, Number 9, September, 1993 (p. 1175)

**Comte, Auguste** 1798–1857  
French philosopher

...GEOMETRY is a true natural science; – only more simple, and therefore more perfect than any other. We must not suppose that, because it admits the application of mathematical analysis, it is therefore a purely logical science, independent of observation. Everybody studied by geometers presents some primitive phenomena which, not being discoverable by reasoning, must be due to observation alone.

*The Positive Philosophy of Auguste Comte* (Volume 1)  
Book I, Chapter III (p. 86)  
John Chapman. London, England. 1853

**Coolidge, Julian L.** 1873–1954  
American professor of mathematics

The present author humbly confesses that, to him, geometry is nothing at all, if not a branch of art...

*A Treatise on Algebraic Plane Curves*

Preface (p. x)

Dover Publications. New York, New York, USA. 1959

**Davies, Paul Charles William** 1946–  
Mathematical physicist

Geometry was the mid wife of science.

*Superforce: The Search for a Grand Unified Theory of Nature*

Chapter 10 (p. 165)

Simon & Schuster. New York, New York, USA. 1984

**de Morgan, Augustus** 1806–71  
English mathematician and logician

...there is no study which presents so simple a beginning as that of geometry, there is none in which difficulties grow more rapidly as we proceed, and what may appear at first rather paradoxical, the more acute the student the more serious will the impediments in the way of his progress appear.

*On the Study and Difficulties of Mathematics*

Chapter I (p. 6)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

Geometry, then, is the application of strict logic to those properties of space and figure which are self-evident, and which therefore cannot be disputed. But the rigor of this science is carried one step further; for no property, however evident it may be, is allowed to pass without demonstration, if that can be given. The question is therefore to demonstrate all geometrical truths with the smallest possible number of assumptions.

*On the Study and Difficulties of Mathematics*

Chapter XV (p. 231)

The Open Court Publishing Company. La Salle, Illinois, USA. 1943

**Dec, John** 1527–1609  
English mathematician and occultist

There is (gentle reader) nothing (the works of God only set apart) which so much beautifies and adorns the soul and mind of man as does knowledge of the good arts and sciences.... Many...arts there are which beautify the mind of man; but of all none do more garnish and beautify it than those arts which are called mathematical, unto the knowledge of which no man can attain, without perfect knowledge and instruction of the principles, grounds, and Elements of Geometry.

*Euclid*

Preface (p. 1)

Printed by Robert and William Leybourn. London, England. 1651

Many other arts also there are which beautifie the minde of man: but of all other none do more garnishe and beautifie it, than those artes which are called Mathematicall.

Unto the knowledge of which no man can attaine, without the perfect knowledge and instruction of the principles, groundes, and Elementes of Geometrie.

*Mathematicall Praeface to the Elements of Geometrie of Euclid of Megara*

The Translator to the Reader

Kessinger Publishing. Kila, Montana, USA. 1999

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

...we have sufficient evidence that the ancient Geometricians made use of a certain analysis which they extended to the resolution of all problems, though they grudged the secret to posterity.

*In Great Books of the Western World (Volume 31)*

*Rules for the Direction of the Mind*

Rule IV (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Dieudonné, Jean** 1906–92  
French mathematician and educator

...it has been said that the art of geometry is to reason well from false diagrams.

*Mathematics – The Music of Reason*

Chapter III, Section 4 (p. 37)

Springer-Verlag. Berlin, Germany. 1992

Modern algebraic geometry has deservedly been considered for a long time as an exceedingly complex part of mathematics, drawing practically on every other part to build up its concepts and methods and increasingly becoming an indispensable tool in many seemingly remote theories. It shares with number theory the distinction of having one of the longest and most intricate histories among all branches of our science, of having always attracted the efforts of the best mathematicians in each generation, and of still being one of the most active areas of research.

*The Historical Development of Algebraic Geometry*

*The American Mathematical Monthly*, Volume 79, Number 8, October, 1972 (p. 827)

**Duruy, Victor** 1811–94  
French historian

The point in geometry is like the unit in arithmetic and the molecule in matter ...

Translated by M.M. Ripley

*History of Greece, and of the Greek People, from the Earliest Times to the Roman Conquest (Volume 2) Section 1*

Chapter III, Section IV (p. 229)

Estes & Lauriat. Boston, Massachusetts, USA. 1892

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

We may climb into the thin and cold realm of pure geometry and lifeless science...

*The Complete Works of Ralph Waldo Emerson (Volume 3)*

*Essays: Second Series*

Chapter II (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Greek architecture is geometry. Its temples are diagrams in marble, and not appeals to the imagination, like the Gothic – they are powers of the square and cube.

*The Complete Works of Ralph Waldo Emerson: Lectures and Biographical Sketches* (Volume 10)

Notes (p. 545)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The astronomer discovers that geometry, a pure abstraction of the human mind, is the measure of planetary motion.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

The American Scholar

The Library of America. New York, New York, USA. 1983

Moon, planet, gas, crystal, are concrete geometry and numbers.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

Nature (p. 548)

The Library of America. New York, New York, USA. 1983

**Euripides** c. 480 BC–406 BC

Greek playwright

Mighty is geometry; joined with art, resistless.

In Stanley Gudder

*A Mathematical Journey* (p. 67)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

I find myself confronted with a subject which is not only highly interesting, but somewhat difficult: not that the subject is obscure; but it presupposes in the reader a certain knowledge of geometry: a strong meat too often neglected.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Appendix (p. 383)

Dodd, Mead & Co. Boston, Massachusetts, USA. 1917

Geometry, that is to say, the science of harmony in space, presides over everything. We find it in the arrangement of the scales of a fir-cone, as in the arrangement of an Epeira's limy web; we find it in the spiral of a Snail-shell, in the chaplet of a Spider's thread, as in the orbit of a planet; it is everywhere, as perfect in the world of atoms as in the world of immensities.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Appendix: The Geometry of the Eperia's Web (p. 399)

Dodd, Mead & Company. New York, New York, USA. 1913

True, it [geometry] does not bestow imagination, a delicate flower blossoming none knows how and unable to thrive on every soil; but it arranges what is confused, thins out the dense, calms the tumultuous, filters the

muddy and gives lucidity, a superior product to all the tropes of rhetoric.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 289)

Dodd, Mead & Co. New York, New York, USA. 1925

**Fontenelle, Bernard Le Bovier** 1657–1757

French author and scientist

A work of morality, politics, criticism will be more elegant, other things being equal, if it is shaped by the hand of geometry.

*l'Utilité des Mathématiques et de la Physique*

Preface

Publisher undetermined

**Forder, Henry G.** 1889–1981

English mathematician

Our Geometry is an abstract Geometry. The reasoning could be followed by a disembodied spirit who had no idea of a physical point, just as a man blind from birth could understand the Electromagnetic Theory of Light.

*The Foundations of Euclidean Geometry* (p. 43)

The University Press. Cambridge, England. 1927

**Frankland, William Barrett**

No biographical data available

There it will be seen that, whereas at the outset geometry is reported to have concerned herself with the measurement of muddy land, she now handles celestial as well as terrestrial problems: she has extended her domain to the furthest bounds of space.

*The Story of Euclid*

Chapter I (pp. 14–15)

George Newnes, Ltd. London, England. 1902

The history of geometry is, as it were, a drama enacted through the centuries: therein is beheld the growth of a science from helpless birth and stumbling childhood, through the strenuous but rash vigour of youth, to the perfect wisdom and disciplined strength of manhood. In the life of a science a human life is but an insignificant moment, and from this point of view the history of geometry assumes a grandeur scarcely short of majestic.

*The Story of Euclid*

Chapter I (p. 15)

George Newnes, Ltd. London, England. 1902

Geometry may be helpfully likened to a vast and intricate mountain region, in which each truth is a summit, unattainable without the putting forth of more or less effort. When once reached these summits furnish views which have in them something grand, although it may happen that their attainment conveys the greater reward. But each ascent is only the start of some fresh ascent of a loftier peak, and from no summit yet attained is it possible to

gaze all around with every truth of geometry below.

*The Story of Euclid*

Chapter VII (p. 60)

George Newnes, Ltd. London, England. 1902

**Freudenthal, Hans** 1905–90

German mathematician

Geometry is grasping space...that space in which the child lives, breathes and moves. The space that the child must learn to know, explore, conquer, in order to live, breathe and move better in it.

*Mathematics as an Educational Task*

Chapter XVI (p. 403)

Reidel. Dordrecht, Germany. 1973

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

SIMPLICIO: Indeed, I begin to understand that while logic is an excellent guide in discourse, it does not, as regards stimulation to discovery, compare with the power of sharp distinction which belongs to geometry.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Second Day (p. 190)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician

I am coming more and more to the conviction that the necessity of our geometry cannot be demonstrated, at least neither by, nor for, the human intellect. Perhaps in some other life we may arrive at other insights into the nature of space that are at present inaccessible to us. Until such time geometry should be ranked, not with arithmetic, which is purely aprioristic, but with mechanics.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part II, Chapter I (p. 133)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Halsted, George Bruce** 1853–1922

American mathematician

No mathematical exactness without explicit proof from assumed principles – such is the motto of the modern geometer.

In Henri Poincaré

*The Foundations of Science*

*The Value of Science*, Translator's Introduction (p. 202)

The Science Press. New York, New York, USA. 1913

Geometry is the science created to give understanding and mastery of the external relations of things; to make easy the explanation and description of such relations and the transmission of this mastery.

*Proceedings of the American Association for the Advancement of Science*

The Message of Non-Euclidean Geometry (p. 359)

December 1903-January 1904

Press of Gibson Brothers. Washington, D.C. 1904

Geometry is the most perfect of the sciences. It precedes experiment and is safe above all experimentation.

*Proceedings of the American Association for the Advancement of Science*

The Message of Non-Euclidean Geometry (p. 359)

December 1903-January 1904

Press of Gibson Brothers. Washington, D.C. 1904

It is something to know what proof is and what it is not; and where can this be better learned than in a science [geometry] which has never had to take one footstep backward?

*Proceedings of the American Association for the Advancement of Science*

The Message of Non-Euclidean Geometry (p. 371)

December 1903-January 1904

Press of Gibson Brothers. Washington, D.C. 1904

**Hamilton, Sir William Rowan** 1805–65

Irish mathematician

The mathematical process in the symbolical method (i.e., the algebraical) is like running a railroad through a tunneled mountain, ...in the ostensive (i.e., the geometrical) like crossing the mountain on foot. The former causes us, by a short and easy transit, to our destined point, but in miasma, darkness and torpidity, whereas the latter allows us to reach it only after time and trouble, but feasting us at each turn with glances of the earth and of the heavens, while we inhale the pleasant breeze, and gather new strength at every effort we put forth.

In Richard Olson

*Scottish Philosophy and British Physics: 1750–1880*

Chapter 1 (p. 22)

Princeton University Press. Princeton, New Jersey, USA. 1975

**Hamilton, William** 1788–1856

Scottish philosopher

The ostensive figures of Geometry are no abstractions – but concrete forms of imagination or sense; and the highest praise, accorded by the most philosophical mathematicians, to the symbolical notation of arithmetic and algebra, is, that it has relieved the mind of all intellectual effort, by substituting a sign for a notion, and a mechanical for a mental process.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 275)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Hempel, Carl G.** 1905–97

German philosopher of science

...to characterize the import of pure geometry, we might use the standard form of a movie-disclaimer: No portrayal of the characteristics of geometrical figures or of the spatial properties of relationships of actual bodies is intended, and any

similarities between the primitive concepts and their customary geometrical connotations are purely coincidental.

In James H. Fetzer

*The Philosophy of Carl G. Hempel*

Part I, Chapter 2 (p. 24)

Oxford University Press. Oxford, England. 2001

### **Hermite, Charles** 1822–1901

French mathematician

I cannot tell you the efforts to which I was condemned to understand something of the diagrams of Descriptive Geometry, which I detest.

In E.T. Bell

*Men of Mathematics* (p. 183)

Simon & Schuster. New York, New York, USA. 1937

### **Herodotus** 484 BC–432 BC

Greek historian

Sesostris also...made a division of the soil of Egypt among the inhabitants, assigning square plots of ground of equal size to all.... If the river carried away any portion of a man's lot, he appeared before the king, and related what has happened; upon which the king sent persons to examine, and determine by measurement the exact extent of the loss.... From this practice, I think, geometry first came to be known.

In *Great Books of the Western World* (Volume 6)

*The History of Herodotus*

The Second Book, Section 109 (p. 70)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hilbert, David** 1862–1943

German mathematician

Three-dimensional geometry becomes a chapter in four-dimensional physics.

In Constance Reid

*Hilbert – Courant*

Hilbert

Chapter XIV (p. 112)

Springer-Verlag. New York, New York, USA. 1986

### **Hobbes, Thomas** 1588–1679

English philosopher and political theorist

Geometry...the only Science that it hath pleased God hitherto to bestow on mankind....

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 4 (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...Geometry...is the Mother of all Natural Science...

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part IV, Chapter 46 (p. 268)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Holgate, Thomas F.**

No biographical data available

Modern pure geometry differs from the geometry of earlier times not so much in the subjects dealt with as in

the processes employed and the generality of the results obtained. Much of the material is old, but by utilizing the principle of projection and the theory of transversals, facts which were thought of as in no way related, prove to be simply different aspects of the same general truth. This generalizing tendency's the chief characteristic of modern geometry.

In J.W.A. Young (ed.)

*Monographs on the Topics of Modern Mathematics Relevant to the Elementary Field*

Modern Pure Geometry (p. 56)

Longmans, Green. New York, New York, USA. 1911

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Geometry itself is one kind of harmony.

*Notre-Dame de Paris*

Book III, Chapter 2 (p. 117)

J.M. Dent & Sons Ltd. London, England. 1910

### **Huxley, Aldous** 1894–1963

English writer and critic

...a world where beauty and logic, painting and analytic geometry, had become one.

*After Many a Summer Dies the Swan*

Part I, Chapter III (p. 44)

Ivan R. Dee, Publisher. Chicago, Illinois, USA. 1993

### **Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

As happens in all the sciences in which geometry is applied to matter, the demonstrations concerning Optics are founded on truths drawn from experience.

In *Great Books of the Western World* (Volume 34)

*Treatise on Light*

Chapter One, On Rays Propagated in Straight Lines (p. 553)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Ibn Khaldun** 1332–1406

Historiographer and historian

Geometry enlightens the intellect and sets one's mind right. All of its proofs are very clear and orderly. It is hardly possible for errors to enter into geometrical reasoning, because it is well arranged and orderly. Thus, the mind that constantly applies itself to geometry is not likely to fall into error. In this convenient way, the person who knows geometry acquires intelligence.

*The Muqaddimah: An Introduction to History*

The Various Kinds of Sciences, section 20

Pantheon Books. New York, New York, USA. 1958

### **Keller, Helen** 1880–1968

American author and lecturer

I am sure the daisies and buttercups have as little use for the science of Geometry as I, in spite of the fact that they so beautifully illustrate its principles.

*The Story of My Life*

Letter to Charles Dudley Warner



June 7, 1898 (p. 243)  
Grosset & Dunlap, Publishers. New York, New York, USA. 1905

**Kepler, Johannes** 1571–1630  
German astronomer

Why waste words? Geometry existed before the Creation, is co-eternal with the mind of God, is God himself (what exists in God that is not God himself?): geometry provided God with a model for the Creation and was implanted into man, together with God's own likeness – and not merely conveyed to his mind through the eyes.

In Arthur Koestler  
*The Sleepwalkers*  
Part Four, Chapter II, Section 3 (p. 262)  
The Macmillan Company. New York, New York, USA. 1966

Geometry has two great treasures: one is the Theorem of Pythagoras; the other, the division of a line into extreme and mean ratio. The first we may compare to a measure of gold; the second we may name a precious jewel.

In Carl B. Boyer  
*A History of Mathematics* (p. 55)  
John Wiley & Sons, Inc. New York, New York, USA. 1968

**Khaldun, Ibn** 1332–1406  
Arab Muslim polymath

Geometry enlightens the intellect and sets one's mind right. All of its proofs are very clear and orderly. It is hardly possible for errors to enter into geometrical reasoning, because it is well arranged and orderly. Thus, the mind that constantly applies itself to geometry is not likely to fall into error. In this convenient way, the person who knows geometry acquires intelligence.

Translated by Franz Rosenthal  
In N. J. Dawood  
*The Muqaddimah, an Introduction to History*  
Sixth Prefatory Discussion, Chapter 6 (p. 378)  
Princeton University Press. Princeton, New Jersey, USA. 1967

**Klein, Felix** 1849–1925  
German mathematician

Projective geometry has opened up for us with the greatest facility new territories in our science, and has rightly been called the royal road to its own particular field of knowledge.

In E.T. Bell  
*Men of Mathematics* (p. 206)  
Simon & Schuster. New York, New York, USA. 1937

There appears a fundamental principle which can serve to characterize all possible geometries.... Given any group of transformations in space which includes the principal group as a sub-group, then the invariant theory of this group gives a definite kind of geometry, and every possible geometry can be obtained in this way.

Translated by E.R. Hedrick and C.A. Noble  
*Elementary Mathematics from an Advanced Standpoint*  
Part Second, Chapter II, Section 6 (p. 133)  
Dover Publications. New York, New York, USA. 1939

**Kline, Morris** 1908–92  
American mathematics professor and writer

In the house of mathematics there are many mansions and of these the most elegant is projective geometry.

Projective Geometry  
*Scientific American*, Volume 192, Number 1, January, 1955 (p. 80)

...no branch of mathematics competes with projective geometry in originality of ideas, coordination of intuition in discovery and rigor in proof, purity of thought, logical finish, elegance of proofs and comprehensiveness of concepts. The science born of art proved to be an art.

Projective Geometry  
*Scientific America*, Volume 192, Number 1, 1955 (p. 86)

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

Those few things having been considered, the whole matter is reduced to pure geometry, which is the one aim of physics and mechanics.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 391)  
Oxford University Press, Inc. New York, New York, USA. 1972

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Just as without sensations of heat there would have been no theory of heat, so also without sensations of space there would be no geometry ...

Translated by Thomas J. McCormack  
*Space and Geometry in the Light of Physiological, Psychological and Physical*  
On the Psychology and Natural Development of Geometry (p. 38)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1960

**Manning, Henry Parker** 1859–1956  
American mathematician

Suspended o'er geometry,  
I am a fish-worm dangling –  
A creature too obtuse to see

What is acute in angling.  
In Francis A. Litz (ed.)  
*The Poetry of Father Tabb*  
Humorous Verse, A Problem in Mathematics  
Dodd, Mead. New York, New York, USA. 1928

...the greatest advantage to be derived from the study of geometry of more than three dimensions is a real understanding of the great science of geometry. Our plane and solid geometries are but the beginning of this science. The four-dimensional geometry is far more extensive than the three-dimensional, and all the higher geometries are more extensive than the lower.

*Geometry of Four Dimensions*  
Introduction (p. 13)  
Dover Publication, Inc. New York, New York, USA. 1914



**Marvell, Andrew** 1621–78  
English metaphysical poet

As lines, so loves oblique may well  
Themselves in every angle greet  
But ours, so truly parallel,  
Though infinite can never meet.

*The Poetical Works of Andrew Marvell*  
Definition of Love, Verse VII  
A. Murray. London, England. 1870

**Merezhkovsky, Dmitry Sergeyeovich** 1865–1941  
Russian novelist and critic

Geometry...being a part of mathematics, mother of all knowledge, is also the mother of drawing, which is the father of all the arts.,

*The Romance of Leonardo da Vinci: The Forerunner*  
Chapter XI (p. 312)  
G.P. Putnam's Sons. New York, New York, USA. 1903

**More, Louis Trenchard**  
American educator

Geometry is to be the ruler or at least the vicegerent, and no substance will be discussed except such as may be divided, figured, and moved according to the laws which geometers hold to govern quantity, nor will any proposition be considered proved unless it has been deduced with such evidence as would suffice for a mathematical demonstration.

*The Limitations of Science*  
Chapter III (p. 79)  
Henry Holt & Co. New York, New York, USA. 1915

**Morgan, Frank**  
No biographical data available

We are just beginning to understand how geometry rules the universe.

Review: The Parsimonious Universe  
*The American Mathematical Monthly*, Volume 104, Number 4, April, 1997 (p. 376)

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

...it is the glory of geometry that from so few principles, fetched from without, it is able to produce so many things.

*Mathematical Principles of Natural Philosophy*  
Preface to the First Edition  
E.P. Dutton & Company. New York, New York, USA. 1922

**O'Brien, Katharine**  
Mathematician

Now Einstein's Glee was plain to see at the sight of a cone with a sphere on top...

Einstein and the Ice-Cream Cone  
*The Mathematics Teacher*, April, 1968 (p. 404)

**Pasch, Moritz** 1843–1933  
German mathematician

If geometry is to be regarded as a science born of direct and exact observation of nature, a science that seeks by purely inductive means to win from immediately observed simple phenomena the laws of complicated phenomena, then one is indeed compelled to reject many a traditional idea; but if we do so, the material to be worked up will be brought back to its proper domain and the ground for a whole series of controversies will be eliminated. No matter how many sorts of speculation may still be associated with geometry, its fruitful application in the natural sciences and in practical life rests upon the fact that its concepts originally correspond to empirical objects. As long as one limits himself from first to last to this empirical core, geometry retains the character of a natural science, distinguished from the other parts of science by the fact that it needs to derive very few of its concepts and laws immediately from experience.

*Vorlesungen über neuere Geometrie*  
Band XXIII  
*Die Grundlehren der mathematischen Wissenschaften*  
Preface (p. v)  
Springer-Verlag. Berlin, Germany. 1926

**Philips, J. D.**  
No biographical data available

When school children study analytic geometry, they should be made aware that his seemingly trivial and esoteric subject exists to us only because of the heroic efforts of a succession of brilliant minds, culminating in the work of Descartes. Its depth, originality, and profundity are lost on students. It has been carefully polished and refined so exquisitely, presented so elegantly and simply, that students myopically receive it as a trifle.

The Humanistic Mathematics Network Journal  
*Mathematics as an Aesthetic Discipline*, Number 12, October, 1995

**Pirsig, Robert M.** 1928–  
American writer

One geometry cannot be more true than another; it can only be more convenient. Geometry is not true, it is advantageous.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part III, Chapter 22 (p. 264)  
William Morrow & Company, Inc. New York, New York, USA. 1974

**Plato** 428 BC–347 BC  
Greek philosopher

...we are concerned with that part of geometry which relates to war; for in pitching a camp, or taking up a position, or closing or extending the lines of an army, or any

other maneuver, whether in actual battle or on a march, it will make all the difference whether a general is or is not a geometrician.

In *Great Books of the Western World* (Volume 7)  
*The Republic*

Book VII, Section 526 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the knowledge at which geometry aims is knowledge of the eternal, and [naught of] perishing and transient.

In *Great Books of the Western World* (Volume 7)  
*The Republic*

Book VII, Section 527 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...geometry will draw the soul towards truth, and create the spirit of philosophy, and raise up that which is now unhappily allowed to fall down.

In *Great Books of the Western World* (Volume 7)  
*The Republic*

Book VII, Section 527 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

The truths of Geometry are all necessarily connected with one another, and the system of such truths can never be rightly explained, unless that connection be accurately traced, wherever it exists. It is upon this that the beauty and peculiar excellence of the mathematical sciences depend: it is this, which, by preventing any one truth from being single and insulated, connects the different parts so firmly, that they must all stand or all fall together.

*Elements of Geometry* (6th edition)

Preface (pp. 14–15)

Printed for Bell & Bradfute. Edinburgh, Scotland. 1822

### **Plotinus** 205–70

Egyptian-Roman philosopher

Geometry [is] the science of the Intellectual entities...

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Fifth Ennead IX. 11 (p. 250)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

That being so what ought one to think of this question: Is the Euclidean Geometry true? The question is nonsense. One might as well ask whether the metric system is true and the old measures false; whether Cartesian co-ordinates are true and polar co-ordinates false.

Non-Euclidean Geometry

*Nature*, Volume 45, Number 1165, February 25, 1892 (p. 407)

Common geometry has a great advantage in that the senses may come to the help of our reason and aid it in finding what path to follow, and many minds prefer to put their problems of analytical geometry in the ordinary geometrical form. Unfortunately our senses cannot lead

us so very far, and they fail us when we try to escape from the classical three dimensions.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
The Future of Mathematics (p. 138)

Government Printing Office. Washington, D.C. 1910

...the facts of geometry are naught else than the facts of algebra and analytical geometry expressed in another language.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
The Future of Mathematics (p. 138)

Government Printing Office. Washington, D.C. 1910

...if there were no solid bodies in nature, there would be no geometry.

*The Foundations of Science*

*Science and Hypothesis*, Part II

Chapter IV (p. 73)

The Science Press. New York, New York, USA. 1913

...geometry is not true, it is advantageous.

*The Foundations of Science*

*Science and Hypothesis*, Part II

Chapter V (p. 91)

The Science Press. New York, New York, USA. 1913

### **Pólya, George** 1887–1985

Hungarian mathematician

Geometry is the art of correct reasoning on incorrect figures.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The traditional mathematics professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

It was formerly supposed that Geometry was the study of the nature of the space in which we live, and accordingly it was urged, by those who held that what exists can only be known empirically, that Geometry should really be regarded as belonging to applied mathematics. But it has gradually appeared, by the increase of non-Euclidean systems, that Geometry throws no more light upon the nature of space than Arithmetic throws upon the population of the United States.

*Mysticism and Logic and Other Essays*

Chapter V (p. 92)

Longmans, Green & Company. London, England. 1925

Geometry, throughout the 17th and 18th centuries, remained, in the war against empiricism, an impregnable fortress of the idealists. Those who held – as was generally held on the Continent – that certain knowledge, independent of experience, was possible about the real world, had only to point to Geometry: none but a madman, they said, would throw doubt on its validity, and none but a fool would deny its objective reference.

*An Essay on the Foundations of Geometry*

Introduction (p. 1)

Dover Publications, Inc. New York, New York, USA. 1956

How can a certain line, or a certain surface, form an impassable barrier to space, or have any mobility different in kind from that of all other lines or surfaces? The notion cannot, in philosophy, be permitted for a moment, since it destroys that most fundamental of all the axioms, the homogeneity of space.

*An Essay on the Foundations of Geometry*

Chapter I, Section 45 (p. 49)

Dover Publications, Inc. New York, New York, USA. 1956

All points are qualitatively similar, and distinguished by the mere fact that they lie outside one another.

*An Essay on the Foundations of Geometry* (p. 52)

Dover Publications, Inc. New York, New York, USA. 1956

...Geometry has been, throughout, of supreme importance in the theory of knowledge.

*An Essay on the Foundations of Geometry*

Chapter Bisection 51 (p. 54)

Dover Publications, Inc. New York, New York, USA. 1956

All geometrical reasoning is, in the last resort, circular: if we start by assuming points, they can only be defined by the lines or planes which relate them; and if we start by assuming lines or planes, they can only be defined by the points through which they pass.

*An Essay on the Foundations of Geometry*

Chapter III, Section 108 (p. 120)

Dover Publications, Inc. New York, New York, USA. 1956

There is no logical implication of other entities in space. It does not follow, merely because there is space, that therefore there are things in it. If we are to believe this, we must believe it on new grounds, or rather on what is called the evidence of the senses. Thus we are taking an entirely new step.

*Principles of Mathematics* (2nd edition)

Chapter 53 (p. 465)

W.W. Norton & Company, Inc. New York, New York, USA. 1938

...it has gradually appeared, by the increase of non-Euclidean systems, that Geometry throws no more light upon the nature of space than Arithmetic throws upon the population of the United States.

*Mysticism and Logic: And Other Essays*

Chapter V (p. 92)

Longmans, Green & Co. London, England. 1919

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

A layer cake is geometry and layer cake.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #374 (p. 148)

Definition Press. New York, New York, USA. 1972

**Smith, David Eugene** 1860–1945

Mathematician

If “poetry is unfallen speech,” then geometry is undebased thought, and if “architecture is frozen music” then it is also the crystallized science of form.

Mathematics in the Training for Citizenship

*Teachers College Record*, Volume XVIII, Number 3, May, 1917 (p. 216)

**Smith, Henry John Stephen** 1826–83

Irish mathematician

One thing at least they have not forgotten, that geometry is nothing if it be not rigorous, and that the whole educational value of the study is lost, if strictness of demonstration be trifled with. The methods of Euclid are, by almost universal consent, unexceptionable in point of rigor.

Opening Address by the President, Section A

*Nature*, Volume 8, Number 204, September 25, 1873 (p. 450)

Next to the science of number, the science of space is that which is at once the most abstract, and admits of the most universal application to the study of natural phenomena. Everything that takes place takes place in space; and thus Geometry, or the science of space, necessarily intervenes in all exact observation of events.

*The Collected Mathematical Papers of Henry John Stephen Smith*

(Volume 2)

Appendix III (p. 698)

At The Clarendon Press. Oxford, England. 1894

**Stewart, Ian** 1945–

English mathematician

Don't judge geometries by first appearances.

*Flatterland*

Among the Looking-glass (p. 108)

Perseus Publishing. Cambridge, Massachusetts, USA. 2001

**Sylvester, James Joseph** 1814–97

English mathematician

Geometry may sometimes appear to take the lead over analysis but in fact precedes it only as a servant goes before the master to clear the path and light him on his way.

*Philosophic Magazine*, Volume 31, 1866 (p. 521)

He who would know what geometry is must venture boldly into its depths and learn to think and feel as a geometer. I believe that it is impossible to do this, and to study geometry as it admits of being studied and am conscious it can be taught, without finding the reason invigorated, the invention quickened, the sentiment of the orderly and beautiful awakened and enhanced, and reverence for truth, the foundation of all integrity of character, converted into a fixed principle of the mental and moral constitution, according to the old and expressive adage “*abeunt studia*” in mores.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry, Delivered before the Gresham Committee and the Members of the Common Council of the City of London, 4 December, 1854 (p. 9)

University Press. Cambridge, England. 1904–1912

The interval between the two [geometry and analysis] is as wide as between empiricism and science, as between the understanding and the reason; or as between the finite and the infinite.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
Astronomical Prousions (p. 521)  
At the University Press. Cambridge, England. 1902

Geometry formerly was the chief borrower from arithmetic and algebra, but it has since repaid its obligations with abundant usury ...

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
Address to the Mathematical and Physical (p. 659)  
At the University Press. Cambridge, England. 1908

**Thom, René** 1923–2002

French mathematician

...the spirit of geometry circulates almost everywhere in the immense body of mathematics, and it is a major pedagogical error to seek to eliminate it.

In A. G. Howson (ed.)  
*Developments in Mathematical Education: Proceedings of the Second International Congress on Mathematical Education*  
Modern Mathematics: Does It Exist (p. 208)  
At the University Press. Cambridge, England. 1973

**Veblen, Oswald** 1880–1960

American mathematician

The branch of physics which is called Elementary Geometry was long ago delivered into the hands of mathematicians for the purposes of instruction. But, while mathematicians are often quite competent in their knowledge of the abstract structure of the subject, they are rarely so in their grasp of its physical meaning.

Geometry and Physics  
*Science*, Volume 57, Number 1466, February 2, 1923 (p. 131)

At the same time it will not be forgotten that the physical reality of geometry cannot be put in evidence with full clarity unless there is an abstract theory also.... Thus, for example, while the term electron may have more than one physical meaning, it is by no means such a protean object as a point or a triangle.

Geometry and Physics  
*Science*, Volume 57, Number 1466, February 2, 1923 (p. 131)

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

Geometry, if we consider it in its true light, is a mere jest, and nothing more.

*The Best Known Works of Voltaire*  
Jeannot and Colin (p. 281)  
Blue Ribbon Books. New York, New York, USA. 1940

Did anyone ever so much as think of talking geometry in good company?

*The Best Known Works of Voltaire*  
Jeannot and Colin (p. 281)  
Blue Ribbon Books. New York, New York, USA. 1940

...the geometrician makes a hundred thousand curved lines pass between a circle and a right line that touches it, when, in reality, there is not room for a straw to pass there.

*The Best Known Works of Voltaire*  
Jeannot and Colin (p. 281)  
Blue Ribbon Books. New York, New York, USA. 1940

...but of all the sciences, the most absurd, and that which in my opinion, is most calculated to stifle genius of every kind, is geometry. The objects about which this ridiculous science is conversant are surfaces, lines, and points, that have no existence in nature.

*The Best Known Works of Voltaire*  
Jeannot and Colin (p. 281)  
Blue Ribbon Books. New York, New York, USA. 1940

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Of all branches of human knowledge, there is none which, like it [geometry], has sprung as a completely armed Minerva from the head of Jupiter; none before whose death-dealing Aegis doubt and inconsistency have so little dared to raise their eyes.

Translated by E. Atkinson  
*Popular Lectures on Scientific Subjects* 2nd series  
On the Origin and Significance of Geometrical Axioms (p. 27)  
Longmans, Green & Co. New York, New York, USA. 1908

It [geometry] escapes the tedious and troublesome task of collecting experimental facts, which is the province of the natural sciences in the strict sense of the word; the sole form of its scientific method is deduction.

Translated by Edmund Atkinson  
*Popular Lectures on Scientific Subjects* 2nd Series  
Lecture II (pp. 27–28)  
Longmans, Green & Co. London, England. 1903

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

Geometry would be best to begin with plain plane geometry, immutably plane. Surely if anything could minister to the mind diseased it would be the steadfast contemplation of a right angle, an existence that no mist of human tears could blur, no blow of fate deflect.

*Mr. Fortune's Maggot*  
Mr. Fortune's Maggot (p. 107)  
New York Review of Books. New York, New York, USA. 1927

**Warrain, Francis**

No biographical data available

Music is to time what geometry is to space.

In Matila Ghyka  
*The Geometry of Art and Life*  
Chapter I (p. 6, fn)  
Dover Publications Inc. New York, New York, USA. 1977

**Weyl, Hermann** 1885–1955

German mathematician

Geometry became one of the most powerful expressions of that sovereignty of the intellect that inspired the thought of those times. At a later epoch, when the

intellectual despotism of the church, which had been maintained through the middle ages, had crumbled, and a wave of skepticism threatened to sweep away all that had seemed most fixed, those who believed in truth clung to Geometry as to a rock, and it was the highest ideal of every scientist to carry on his science “more geometrico.”

Translated by Henry L. Brose

*Space – Time – Matter*

Introduction (p. 1)

Dover Publications, Inc. New York, New York, USA. 1922

### **Wharton, William** 1925–

American author

In Plane Geometry that afternoon, I got into an argument with Mr. Shull, the teacher, about parallel lines. I say they have to meet. I’m beginning to think everything comes together somewhere.

*Birdy* (p. 231)

Avon Books. New York, New York, USA. 1980

### **Whewell, William** 1794–1866

English philosopher and historian

Geometry in every proposition speaks a language which experience never dares to utter; and indeed of which she but half comprehends the meaning.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (Volume 1)

Part I, Book I, Chapter VII (p. 74)

John W. Parker. London, England. 1847

This science is one of indispensable use and constant reference, for every student of the laws of nature; for the relations of space and number are the alphabet in which those laws are written. But besides the interest and importance of this kind which geometry possesses, it has a great and peculiar value for all who wish to understand the foundations of human knowledge, and the methods by which it is acquired.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 1)

Part I, Book 2, Chapter 4, article 8 (pp. 99–100)

John W. Parker. London, England. 1847

This science, Geometry, is one of indispensable use and constant reference, for every student of the laws of nature; for the relations of space and number are the alphabet in which those laws are written. But besides the interest and importance of this kind which geometry possesses, it has a great and peculiar value for all who wish to understand the foundations of human knowledge, and the methods by which it is acquired. For the student of geometry acquires, with a degree of insight and clearness which the unmathematical reader can but feebly imagine, a conviction that there are necessary truths, many of them of a very complex and striking character; and that a few of the most simple and self-evident truths which

it is possible for the mind of man to apprehend, may, by systematic deduction, lead to the most remote and unexpected results.

*History of Scientific Ideas: Being the First Part of The Philosophy of the Inductive Sciences* (3rd edition)

Part I, Book II, Chapter IV (p. 105)

John W. Parker & Son. London, England. 1858

### **Wordsworth, William** 1770–1850

English poet

But who shall parcel out

His intellect by geometric rules,

Split like a province into round and square?

*The Complete Poetical Works of William Wordsworth*

The Prelude

School-Time (continued.) (p. 41)

Crowell. New York, New York, USA. 1888

## GEOMETRY, BOARDING-HOUSE

### **Leacock, Stephen** 1869–1944

Canadian humorist

All boarding-houses are the same boarding-house.

Boarders in the same boarding-house and on the same flat are equal to one another.

A single room is that which has no parts and no magnitude.

The landlady of a boarding-house is a parallelogram – that is, an oblong angular figure, which cannot be described, but which is equal to anything.

A wrangle is the disinclination of two boarders to each other that meet together but are not in the same line.

All the other rooms being taken, a single room is said to be a double room.

## POSTULATES AND PROPOSITIONS

A pie may be produced any number of times.

The landlady can be reduced to her lowest terms by a series of propositions.

A bee line may be made from any boarding-house to any other boarding-house.

The clothes of a boarding-house bed, though produced ever so far both ways, will not meet.

Any two meals at a boarding-house are together less than two square meals.

If from the opposite ends of a boarding-house a line be drawn passing through all the rooms in turn, then the stove-pipe which warms the boarders will lie within that line.

On the same bill and on the same side of it there should not be two charges for the same thing.

If there be two boarders on the same flat, and the amount of side of the one be equal to the amount of side of the other, each to each, and the wrangle between one boarder and the landlady be equal to the wrangle between the landlady and the other, then shall the weekly bills of the



two boarders be equal also, each to each.  
For if not, let one bill be the greater.  
Then the other bill is less than it might have been – which is absurd.

*Read this book Literary lapses*

Boarding House Geometry (pp. 26–27)

John Lane Co. New York, New York, USA. 1918

## GEOMORPHOLOGY

### Robinson, Geoffrey

No biographical data available

Geomorphology, the study of earth sculpture, may be engaged in as a science of its own right.

*A Consideration of the Relations of Geomorphology and Geography Professional Geographer*, Volume 15, 1963 (p. 13)

### Russell, Richard Joel

No biographical data available

The distinction between geological and geographical geomorphology lies chiefly in a contrast between conclusions of vertical and horizontal significance.

*Geographical Geomorphology*

*Annals of the Association of American Geographers*, Volume 39, 1949 (p. 4)

### Tinkler, Keith J.

No biographical data available

Geomorphology is, and always has been, the most accessible earth science to the ordinary person: we see scenery as we sit, walk, ride or fly. It is a part of our daily visual imagery, and we do not even have to stop or stoop to examine it, although our perceptions are usually better if we do.

*A Short History of Geomorphology*

Chapter Twelve (p. 239)

Barnes and Noble Books. Totowa, New Jersey, USA. 1985

## GEOPHYSICS

### Wegener, Alfred 1880–1930

German climatologist and geophysicist

It is a strange fact, characteristic of the incomplete state of our present knowledge, that totally opposing conclusions are drawn about prehistoric conditions on our planet, depending on whether the problem is approached from the biological or geophysical viewpoint.

*The Origin of Continents and Oceans*

Chapter 2 (p. 5)

Dover Publications, Inc. New York, New York, USA. 1966

## GERMINATION

### Aristotle 440 BCE–322 BCE

Greek philosopher

All living creatures, whether they swim, or walk, or fly, and whether they come into the world with the form of an animal or of an egg, are engendered in the same way.

*Great Books of the Western World* Volume 28 (p. 472)

Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

## GERM

### Marquis, Don 1878–1937

American newspaperman, poet, and playwright

germs are very  
objectionable to men  
but a germ  
thinks a man  
as only the swamp  
in which  
he has to live

*the lives and time of archy & mehitabel*

random thoughts by archy (p. 224)

Doubleday Doran & Co. Garden City, New York, USA. 1934

### Osborne, Oliver Thomas

Physician

Nature is a good mother, but she will do just as much to propagate a pathologic germ as she will do to promote the welfare of the human being infected by that germ.

*The Principles of Therapeutics*

Introduction (p. 20)

W.B. Saunders Co. Philadelphia, Pennsylvania, USA. 1921

### Shaw, George Bernard 1856–1950

Irish playwright

Just as men imitate each other, germs imitate each other.

*The Doctor's Dilemma*

Act I (p. 108)

Penguin Books. Baltimore, Maryland, USA. 1954

### Williams, Greer

No biographical data available

A chromium-plated typhoid germ looks like a washed-out breakfast sausage. And the staphylococcus germs are like dumplings floating in a dark gravy.

*Virus Hunters* (p. 114)

Knopf. New York, New York, USA. 1959

## GERM PLASM

### Hirsch, Nathaniel David

No biographical data available

The germ cells are like immortal princes confined in isolated castles that they themselves have built; in other castles princesses are confined and they no more than the princes are satisfied with their sister cells. So both princes and princesses ignite their castles by the flame of love; which although ultimately destructive of the existing



castle, builds mightier and higher ones from their very flames and ashes.

*Genius and Creative Intelligence* (p. 60)  
Sci-Art Publishers. Cambridge, Massachusetts, USA. 1931

The germ-plasm has lived millions of years at least; it is perpetually experiencing, for all life, as distinguished from inorganic matter, endures – lives with and through the past. In our own lives we are the total of all our past experiences... we are ever growing older like the universe of the immortal Bergson. So too the germ-plasm; it is literally the heir of all the ages of germ-plasm experience, and the germ-plasm is living, is experiencing as much as we and in like manner. The germ cells have sexual yearnings, pugnacious tendencies, and they create; mutations are their darlings...

*Genius and Creative Intelligence* (p. 61)  
Sci-Art Publishers. Cambridge, Massachusetts, USA. 1931

**Pauling, Linus** 1901–94  
American chemist

I like people. I like animals, too – Whales and quail, dinosaurs and dodos. But I like human beings especially, and I am unhappy that the pool of human germ plasm, which determines the nature of the human race, is deteriorating.

*New York Times*, October 13, 1963

## GEYSER

**Esar, Evan** 1899–1995  
American humorist

[Geysers] A well with the hiccups.

*Esar's Comic Dictionary*  
Geysers  
Doubleday. Garden City, New York, USA. 1983

**Morton, Ron L.**  
No biographical data available

Geysers are hot springs that simply can't contain themselves. Natural show-offs, they try to outdo each other by throwing columns of hissing water hundreds of feet into the air.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*  
Chapter 5 (p. 129)  
Plenum Press. New York, New York, USA. 1996

**Muir, John** 1838–1914  
American naturalist

...Nature seems to have gathered them from all the world as specimens of her rarest fountains, to show in one place what she can do.

*Our National Parks*  
Chapter II (p. 43)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

In the solemn gloom, the geysers, dimly visible, look like monstrous dancing ghosts, and their wild songs and the earthquake thunder replying to the storms overhead seem doubly terrible, as if divine government were at an end.

*Our National Parks*  
Chapter II (p. 45)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## GLACIAL DEBRIS

**Burns, Robert** 1759–96  
English author

Hillocks dropt in Nature's careless haste...

*The Complete Poetical Works of Robert Burns*  
Verses Written with a Pencil at the Inn at Kenmore  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

## GLACIAL SAPPING

**Johnson, Willard D.** 1861–1917  
American typographer

The glacier side of the crevasse presented the more clearly defined wall. The rock face, though hard and undecayed, was much riven, its fracture planes outlining sharply angular masses in all stages of displacement and dislodgment. Several blocks were tipped forward and rested against the opposite wall of ice; others, quite removed across the gap, were incorporated in the glacier mass at its base.

*The Profile of Maturity in Alpine Glacial Erosion*  
*The Journal of Geology*, October–November, 1904 (p. 574)

## GLACIATION

**Johnson, Willard D.** 1861–1917  
American typographer

The literature of glaciation has not escaped the blemish of too free generalization.

*The Profile of Maturity in Alpine Glacial Erosion*  
*The Journal of Geology*, October–November, 1904 (p. 569)

## GLACIER

**Adams, Henry Brooks** 1838–1918  
American man of letters

If the glacial period were uniformity, what was catastrophe?

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter XV (p. 227)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The glacier was God's great plough; and when the ice vanished from the face of the land, it left it prepared for the hand of the husbandman.

*Geological Sketches*

Ice period in America (p. 99)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1886

One naturally asks, What was the use of this great engine set at work ages ago to grind, furrow, and knead over, as it were, the surface of the earth? We have our answer in the fertile soil which spreads over the temperate regions of the globe. The glacier was God's great plough; and when the ice vanished from the face of the land, it left it prepared for the hand of the husbandman.

*Geological Sketches* 2nd Series

Ice-period in America (p. 99)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1875

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

The world of ice and of eternal snow...so stern, so solitary, so dangerous, it may be, has yet its own peculiar charms.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

Ice and Glaciers (p. 107)

D. Appleton & Co. New York, New York, USA. 1897

**Bradley, Jr., John Hodgdon** 1898–1962

Geologist

Like a scavenging beast the ice on the lower face of the crevasse swallows both the rocky products of disintegration and the ice that enters from the snowfield above.

*Autobiography of Earth*

Chapter V (p. 151)

Coward-McCann, Inc. New York, New York, USA. 1935

**Burroughs, John** 1837–1921

American naturalist and essayist

The vast ice-engine that we call a glacier is almost as silent as the slumbering rocks, and, to all but the eye of science, nearly as immobile, save where it discharges into the sea. It is noisy in its dying, but in the height of its power it is as still as the falling snow of which it is made.

*Under The Apple Tree*

The Still Small Voice (p. 109)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Daumal, René** 1908–44

French surrealist writer

The glacier is an organized being, with a head or névé through which it gulps snow and rock debris, a head well separated from the rest of its body by the rimaye; then an enormous stomach in which snow is transformed into ice, a stomach riddled with crevasses and internal passages for expelling excess water; and in its lower portions it

secretes its wastes in the form of moraine. Its life follows the cycle of the seasons. It sleeps in winter and comes to life in the spring with deep creakings and boomings. Certain glaciers even reproduce themselves, by means that are little more rudimentary than those of unicellular beings – either by conjunction and fusion or by division, which gives birth to what are called regenerate glaciers.

*Mount Analogue*

Which Is That of the Crossing (pp. 73–74)

Shambhala. Boston, Massachusetts, USA. 1986

**de Saussure, Horace-Bénédict** 1740–99

Swiss physicist and geologist

Its surface resembled that of a sea which has become suddenly frozen – not during a tempest, but at the instant when the wind has subsided, and the waves, although very high, have become blunted and rounded.

In Alexander Winchell

*Walks and Talks in the Geological Field*

Chapter IV (pp. 27–28)

Chautauqua Press. New York, New York, USA. 1890

**Dufferin, Frederick Temple Blackwood** 1826–1902

English statesman

The glaciers were quite an unexpected element of beauty. Imagine a mighty river of as great a volume as the Thames – started down the side of a mountain, – bursting over every impediment, – whirled into a thousand eddies, – tumbling and raging on from ledge to ledge in quivering cataracts of foam, – then suddenly struck rigid by a power so instantaneous in its action, that even the froth and fleeting wreaths of spray have stiffened to the immutability of sculpture.

*Letters from High Latitudes* (5th edition)

Letter VIII (p. 140)

John Murray. London, England. 1867

**Harrison, Will**

No biographical data available

Glaciers are delicate and individual things, like humans. Instability is built into them.

*Time*, 1 September, 1986

**Keeler, Charles**

No biographical data available

Out of the cloud-world sweeps thy awful form,  
Vast frozen river, fostered by the storm  
Up on the dear peak's snow-encumbered crest,  
Thy sides deep grinding in the mountain's breast  
As down its slopes thou plougest to the sea  
To leap into thy mother's arms, and be  
Cradled into nothingness.

In John Burroughs

*Songs of Nature*

To an Alaskan Glacier

Doubleday, Page & Company. Garden City, New York, USA. 1912

**Levinson, Leonard Louis**

GLACIER. Frozen geography.

*The Left Handed Dictionary*

Collier Books. New York, New York, USA. 1963

**Morton, Ron L.**

No biographical data available

Glaciers are really nothing more than great lumps of ice on land that have the ability to move under their own weight (just like poured pancake batter in the middle of a griddle).

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 7 (p. 177)

Plenum Press. New York, New York, USA. 1996

Glaciers scrape, scour, pluck, rip, grind, and crush; in short, they terrorize rocks of all sizes and shapes.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 7 (p. 184)

Plenum Press. New York, New York, USA. 1996

**Muir, John** 1838–1914

American naturalist

Not a peak, ridge, dome, canyon, lake basin, garden, forest, or stream but in some way explains the past existence and modes of action of flowing, grinding, sculpturing, soil making, scenery making ice.

*Our National Parks*

Chapter III (p. 84)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pallister, William Hales** 1877–1946

Canadian physician

The story of earth's evolution, told  
In rocks which held the pages stratified:  
In granites torn by glacier and tide,  
In limestone, coal-bed, river-clay and mould;  
The story of the past, now blurred, now bold,  
Which nature tells in signs on every side,  
The story of the species, all allied.

*Poems of Science*

Geology (p. 83)

Playford Press. New York, New York, USA. 1931

**Playfair, John** 1748–1819

Scottish geologist, physicist and mathematician

For the moving of large masses of rock, the most powerful engines without doubt which nature employs are the glaciers, those lakes or rivers of ice which are formed in the highest valleys of the Alps, and other mountains of the first order.

*Illustrations of the Huttonian Theory of the Earth*

Section 348 (p. 388)

Dover Publications, Inc. New York, New York, USA. 1964

**Shelley, Percy Bysshe** 1792–1822

English poet

The glaciers creep

Like snakes that watch their prey, from their far fountains.

*The Complete Poetical Works of Percy Bysshe Shelley*

Mont Blanc

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

...a man who keeps company with glaciers comes to feel tolerably insignificant by and by. The Alps and the glaciers together are able to take every bit of conceit out of a man and reduce his self-importance to zero if he will only remain within the influence of their sublime presence long enough to give it a fair and reasonable chance to do its work.

*A Tramp Abroad*

Chapter XL (p. 298)

Penguin Books. New York, New York, USA. 1997

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

The world of ice and of eternal snow, as unfolded to us on the summits of the neighbouring Alpine chain, so stern, so solitary, so dangerous, it may be, has yet its own peculiar charm.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

Ice and Glaciers (p. 107)

D. Appleton & Co. New York, New York, USA. 1897

**Wright, George Frederick** 1838–1921

American geologist

To the ordinary man of science, water is a mineral and ice a rock; but to the glacialist both are fluids. The apparent solidity of ice is an illusion due to the dullness of our senses. The reason why its viscous or semi-fluid character remained unsuspected until a comparatively recent period is due to the fact that the ordinary movement of accessible glaciers was so slow that we could not by observation readily note their rate of progress.

*The Ice Age in North America: And Its Bearings Upon the Antiquity of Man* (6th edition)

Chapter I (p. 1)

Bibliotheca Sacra Co. Oberlin, Ohio, USA. 1920

**GLASSWARE****Cullinane, N. M.**

No biographical data available

My sweet pipet,  
Can I forget

The day we met – Pipet?  
 The day was drear and wet, how wet!  
 Your price was half a dollar net,  
 But shall I ever repay the debt, Pipet?  
 I think of what you held for me,  
 E'en though 'twas only 10 cc.,  
 (or 20 as the case may be),  
 And how in vain I tried to check  
 The water running down your neck – pipet.

Ode to a Pipet

*Industrial and Engineering Chemistry: News Edition*, Volume 13, Number 19, 10 October, 1935 (p. 394)

**Glaser, Christophe** 1615–78

Swiss chemist

The shape and form of Chymical Vessels is almost infinite...

*The Compleat Chymist, or a New Treatise of Chymistry*

Chapter VII (p. 20)

Printed for John Starkey. London, England. 1677

**Smith, Miles**

No biographical data available

**Boundy, Cather**

No biographical data available

Now if by chance we are missing a flask  
 We go to our neighbor, and timidly ask,  
 “Can you give us the low down – who stole our glass?”  
 With innocent surprise or utter dismay  
 He tell us that he has not seen it today.

So we give up our search, but the suspicion is strong  
 That our chemical neighbor has done us the wrong.

Our Poetic Corner, A Wail of Analytiker Men

*Industrial and Engineering Chemistry: News Edition*, Volume 8, Number 2, 20 January, 1930

**GLEAM**

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Thought is only a gleam in the midst of a long night. But it is this gleam which is everything.

Translated by George Bruce Halsted

*The Value of Science*

*Science and Reality* (p. 142)

The Science Press. New York, New York, USA. 1907

**GLUONS**

**Feynman, Richard P.** 1918–88

American theoretical physicist

We call these quanta gluons, and say that besides quarks there must be gluons to hold the quarks together.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 6 (p. 251)

Simon & Schuster. New York, New York, USA. 1982

**GOAL**

**Browne, Sir Thomas** 1605–82

English author and physician

In this virtuous Voyage of thy Life, hull not about like the Ark without the use of Rudder, Mast, or Sail, and bound for no Port. Let not Disappointment cause Despondency, nor difficulty despair.

*The Prose of Sir Thomas Browne*

Christian Morals

Part I, Section 1 (p. 371)

**Farber, Eric A.**

No biographical data available

Everything worthwhile which has been achieved by an individual, a group, or humanity as a whole was done by striving toward a definite, clearly defined – although sometimes unattainable – goal.

The Teaching and Learning of Engineering

*Journal of Engineering Education*, Volume 45, Number 10, June, 1955 (p. 784)

**Fredrickson, A. G.** 1932–

No biographical data available

We must try to set up some definite goals that have the benefit of all mankind as their objective.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 148)

Only by setting up defined goals will it be possible to develop priorities and institutions that can guide the innovative genius of men onto paths that will be truly, as opposed to superficially, beneficial.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 148)

**Grew, Nehemiah** 1641–1712

Scientific writer and journalist

.... If but little thought be effected, yet to design more, can do us no harm: For although a Man shall never be able to hit Stars by shooting at them; yet he shall come much nearer to them than another that throws at Apples.

*The Anatomy of Plants*

An Idea of A Philosophical History of Plants (p. 24)

Printed by W. Rawlins. London, England. 1682

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

When schemes are laid in advance, it is surprising how often the circumstances fit in with them.

*Aequanimitas, With Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Internal Medicine as a Vocation (p. 138)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

## GOD

**Adams, George** 1750–95  
English instrument maker

God pervades infinity, and sees through eternity...  
*Lectures on Natural and Experimental Philosophy* (Volume 4)  
Chapter XXVII (p. 4)  
Printed by R. Hindmarsh. London, England. 1794

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

I will frankly tell you that my experience in prolonged scientific investigations convinces me in a belief in God. A God who is behind and within the chaos of vanishing point of human knowledge – adds a wonderful stimulus to the man who attempts to penetrate into the regions of the unknown.

In A. R. Hanes  
*Report of the Superintendent of Public Instruction*  
*The Study of Physics* (p. 200)  
Virginia Department of Public Instruction  
1889

...the resources of the Deity cannot be so meager, that, in order to create a human being endowed with reason, he must change a monkey into a man.

*Methods of Study in Natural History*  
Preface (p. iv)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

**Allen, Dave** 1936–2005  
Irish comic and satirist

If man has a sense of humor about God then surely God must have a sense of humor about man.

*Dave Allen at Large, BBC*  
Aired on Miami Channel 2, WPBT, October 18, 1984

**Allen, Ethan** 1738–89  
Hero of the American Revolution

As far as we understand nature, we are become acquainted with the character of God; for the knowledge of nature is the revelation of God.

*Reason the Only Oracle of Man*  
Chapter I, Section II (p. 30)  
Scholar's Facsimiles and Reprints. New York, New York, USA. 1940

**Aristotle** 384 BC–322 BC  
Greek philosopher

...God and nature create nothing that has not its use.

In *Great Books of the Western World* (Volume 8)  
*On the Heavens*  
Book I, Chapter 4 (p. 362)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Asimov, Isaac** 1920–92  
American author and biochemist

If we assume the existence of an omniscient and omnipotent being, one that knows and can do absolutely every-

thing, then to my own very limited self, it would seem that existence for it would be unbearable. Nothing to wonder about? Nothing to ponder over? Nothing to discover? Eternity in such a heaven would surely be indistinguishable from hell.

*"X" Stands for Unknown*  
Introduction (p. 11)  
Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Bentley, Richard** 1882–1742  
English clergyman

The Atoms or Particles, which now constitute Heaven and Earth, being once separate and diffused in the Mundane Space, like the supposed Chaos, could never without a God by their Mechanical affections have convened into the present Frame of Things or any other like it.

*A Confutation of Atheism from The Origin and Frame of the World* Part II  
A Sermon Preached at St Martin's in the Fields  
November the 7th, 1692 (p. 7)

**Blackie, John Stuart** 1809–95  
Scottish scholar

God hath made three beautiful things,  
Birds, and women, and flowers;  
And he on earth who happy would be  
Must look with love on all the three;  
But chiefly, in bright summer hours,  
He is wise who loves the flowers,  
And roams the fields with me.

*Musa Burschicosa: A Book of Songs for Students and University Men*  
The Botanist's Song, First stanza  
Edmonston and Douglas. Edinburgh, Scotland. 1869

**Bohm, David** 1917–92  
American physicist

I would put it another way: people had insight in the past about a form of intelligence that had organized the universe and they personalized it and called it "God."

Quoted by Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 21)  
Routledge & Kegan Paul. London, England. 1986

**Bonnor, William Bowen** 1920–  
English physicist

It seems to me highly improper to introduce God to solve our scientific problems.

In Charles-Albert Reichen  
*A History of Astronomy* (p. 100)  
Hawthorn Books. New York, New York, USA. 1963

**Born, Max** 1882–1970  
German-born English physicist

If God has made the world a perfect mechanism, He has at least conceded so much to our imperfect intellects that in order to predict little parts of it, we need not solve innumerable differential equations, but can use dice with fair success.

In Heinz R. Pagels  
*The Cosmic Code: Quantum Physics as the Language of Nature*  
 Part I, Chapter 4 (p. 73)  
 Simon & Schuster. New York, New York, USA. 1982

**Brecht, Bertolt** 1898–1956  
 German writer

BELLARMIN: Wouldn't you also think it possible that the Creator had a better idea of what he was making than those he has created?

Translated by John Willett  
*Life of Galileo*  
 Scene 7 (p. 19)  
 Arcade Publishing. New York, New York, USA. 1994

**Buber, Martin** 1878–1965  
 Austrian-Jewish philosopher

Nature is full of God's utterance, if one but hears it...  
*At the Turning: Three Addresses on Judaism*  
 Third Address, Chapter IV (p. 57)  
 Farrar, Straus & Young. New York, New York, USA. 1952

**Butler, Joseph** 1692–1752  
 English bishop and exponent of natural theology

...the Author of Nature appears deliberate throughout His operations, accomplishing His natural ends by slow successive steps. And there is a plan of things beforehand laid out, which, from the nature of it, requires various systems of means, as well as length of time, in order to the carrying on its several parts into execution.  
*The Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature*  
 Chapter II, Section 1 (p. 148)  
 Samuel G. Goodrich. Hartford, Connecticut, USA. 1819

**Card, Orson Scott** 1951–  
 Science fiction author

All the universe is just a dream in God's mind, and as long as he's asleep, he believes in it, and things stay real.  
*Seventh Son*  
 Chapter 10 (p. 126)  
 Tom Doherty Associates, Inc. New York, New York, USA. 1987

**Carlyle, Thomas** 1795–1881  
 English historian and essayist

[Nature] is a Volume written in celestial hieroglyphs, in a true Sacred-writing; of which even Prophets are happy that they can read here a line and there a line.  
*Sartor Resartus*  
 Book III, Chapter VIII (p. 234)  
 Ginn & Company. Boston, Massachusetts, USA. 1897

...Nature, which is the Time-vesture of God, and reveals Him to the wise, hides Him from the foolish.  
*Sartor Resartus*  
 Book III, Chapter VIII (p. 240)  
 Ginn & Company. Boston, Massachusetts, USA. 1897

**Carver, George Washington** 1864–1943  
 American agricultural chemist

God is going to reveal to us things He never revealed before if we put our hands in His. No books ever go into my laboratory. The thing I am to do and the way of doing it are revealed to me. I never have to grope for methods. The method is revealed to me the moment I am inspired to create something new. Without God to draw aside the curtain I would be helpless.  
 In Ethel Edwards  
*Carver of Tuskegee* (pp. 141–142)  
 Cincinnati, Ohio: Ethel Edwards & James T. Hardwick, a limited edition work compiled in part from over 300 personal letters written by Dr. Carver to James T. Hardwick. 1971

**Compton, Karl Taylor** 1887–1954  
 American educator and physicist

As the complexity of the structure of matter became revealed through research, its basic simplicity, unity, and dependability became equally evident. So we now see ourselves in a world governed by natural laws instead of by capricious deities and devils. This does not necessarily mean that God has been ruled out of the picture, but it does mean that the architect and engineer of the universe is a far different type of being from the gods assumed by the ancients, and that man lives and dies in a world of logical system and orderly performance.  
*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 3)  
 Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

**Cowper, William** 1731–1800  
 English poet

Nature is a name for an effect,  
 Whose cause is God.  
*The Poetical Works of William Cowper*  
 The Task, the Winter Walk at Noon  
 John W. Lovell Company. New York, New York, USA. n.d.

**Dawkins, Richard** 1941–  
 English ethologist, evolutionary biologist, and popular science writer

If God is a synonym for the deepest principles of physics, what word is left for a hypothetical being who answers prayers, intervenes to save cancer patients or helps evolution over difficult jumps, forgives sins or dies for them?  
 Snake Oil and Holy Water  
*Forbes ASAP*, October 4, 1999

**Dick, Thomas** 1600–80  
 Scottish theologian and philosopher

Here imagination must drop its wing, since it can penetrate no further into the dominions of Him who sits on the Throne of Immensity. Overwhelmed with a view of



the magnificence of the Universe, and the perfections of its Almighty Author, we can only fall prostrate in deep humility and exclaim, "Great and marvelous are Thy works, Lord God Almighty."

In Hector Macpherson

*A Century's Progress in Astronomy*

Chapter XIII (p. 288)

William Blackwood & Sons. Edinburgh, Scotland. 1909

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

It seems to me one of the fundamental features of nature that fundamental physical laws ...described in terms of mathematical theory of great beauty and power need quite a high standard of mathematics for one to understand .... You may wonder: Why is nature constructed on these lines? One can only answer that our present knowledge seems to show that nature is so constructed.... We simply have to accept it. One could perhaps describe the situation by saying that God is a mathematician of very high order and He used a very advanced mathematics in constructing the Universe...

The Evolution of the Physicist's Picture of Nature

*Scientific American*, Volume 208, Number 5, May, 1963 (p. 53)

**Dyson, Freeman J.** 1923–

American physicist and educator

Humanity looks to me like a magnificent beginning but not the last word. Small children often have a better grasp of these questions than grown-ups. It happened to me that I adopted a stepdaughter. I moved into her family when she was five years old. Before that, she had been living alone with her mother. Soon after I moved in, she saw me for the first time naked. "Did God really make you like that?" she asked with some astonishment. "Couldn't he have made you better?" That is a question that every scientific humanist should be confronted with, at least once in a lifetime. The only honest answer is, of course, yes.

*Infinite in All Directions*

Part One, Chapter One (p. 9)

HarperCollins Publishers. New York, New York, USA. 1988

**Einstein, Albert** 1879–1955

German-born physicist

To be sure, the doctrine of a personal God interfering with natural events could never be refuted, in the real sense, by science, for this doctrine can always take refuge in those domains in which scientific knowledge has not yet been able to set foot. But I am persuaded that such behavior on the part of the representatives of religion would not only be unworthy but also fatal. For a doctrine which is able to maintain itself not in clear light but only in the dark, will of necessity lose its effect on mankind, with incalculable harm to human progress. In their struggle for the ethical good, teachers of religion must have the stature to give up the doctrine of a personal God, that is, give up that

source of fear and hope which in the past placed such vast power in the hands of priests. In their labors they will have to avail themselves of those forces which are capable of cultivating the Good, the True, and the Beautiful in humanity itself. This is, to be sure, a more difficult but an incomparably more worthy task.

*Science, Philosophy, and Religion*

A 1934 Symposium, published by the Conference on Science, Philosophy and Religion in Their Relation to the Democratic Way of Life, Inc. New York, New York. 1941

What I'm really interested in is whether God could have made the world in a different way; that is, whether the necessity of logical simplicity leaves any freedom at all.

In A.P. French

*Einstein: A Centenary Volume*

Chapter 4 (p. 128)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

I cannot imagine a God who rewards and punishes the objects of his creation, whose purposes are modeled after our own – a God, in short, who is but a reflection of human frailty. Neither can I believe that the individual survives the death of his body, although feeble souls harbor such thoughts through fear or ridiculous egotisms.

*New York Times*, Obituary, 19 April, 1955

**Ellie Arroway (Fictional character)**

So what's more likely? That an all-powerful, mysterious God created the Universe, and decided not to give any proof of his existence? Or, that He simply doesn't exist at all, and that we created Him, so that we wouldn't have to feel so small and alone?

*Contact*

Film (1997)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Our globe seen by God is a transparent law, not a mass of facts.

*Essays*

Circles (p. 282)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1873

**Erath, Vinzenz** 1906–76

German storyteller

God is a child; and when he began to play, he cultivated mathematics. It is the most godly of man's games.

In Stanley Gudder

*A Mathematical Journey* (p. 269)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Erdős, Paul** 1913–96

Hungarian mathematician

God created two acts of folly. First, He created the Universe in a Big Bang. Second, He was negligent enough to leave behind evidence for this act, in the form of the

microwave radiation.

In John D. Barrow and Frank J. Tipler  
*The Anthropic Cosmological Principle*  
Chapter 6.7 (p. 401)  
Clarendon Press. Oxford, England. 1986

**Fernel, Jean** 1497–1558  
French physician

Nature embracing all things and entering into each, governs the courses and the revolutions of the sun and the moon, and of the other stars, and the succession of times, the change of the season, and the ocean's ebb and flow. Nature rules this immensity of things with an order assured and unvarying. How were it possible for Nature so to conduct and direct all this thus well but for the interposition of a divine Intelligence, which, having produced the world, preserves it?

In Sir Charles Sherrington  
*Man on His Nature*  
Chapter I (p. 21)  
Doubleday Anchor Books. Garden City, New York, USA. 1955

**Feynman, Richard P.** 1918–88  
American theoretical physicist

God was always invented to explain mystery. God is always invented to explain those things that you do not understand. Now when you finally discover how something works, you get some laws which you're taking away from God; you don't need him anymore. But you need him for the other mysteries. So therefore you leave him to create the universe because we haven't figured that out yet; you need him for understanding those things which you don't believe the laws will explain, such as consciousness, or why you only live to a certain length of time – life and death – stuff like that. God is always associated with those things that you do not understand. Therefore I don't think that the laws can be considered to be like God, because they have been figured out.

In P.C.W. Davies and J. Brown (eds.)  
*Superstrings: A Theory of Everything*  
Chapter 9 (pp. 208–209)  
Cambridge University Press. Cambridge, England. 1988

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

The next great awakening of human intellect may well produce a method of understanding the qualitative content of equations. Today we cannot. Today we cannot see that the water flow equations contain such things as the barber pole structure of turbulence that one sees between rotating cylinders. Today we cannot see whether

Schrödinger's equation contains frogs, musical composers, or morality – or whether it does not. We cannot say whether something beyond it like God is needed, or not. And so we can all hold strong opinions either way.

*The Feynman Lectures on Physics* (Volume 2)  
Chapter 41–6 (p. 41–12)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

But I do not feel obliged to believe that the same God who has endowed us with senses, reason, and intellect has intended to forgo their use and by some other means to give us knowledge which we can attain by them.

Translated by Stillman Drake  
*Discoveries and Opinions of Galileo*  
Letter to Madame Christina of Lorraine (p. 183)  
Doubleday. New York, New York, USA. 1957

**Goodspeed, Edgar J.** 1871–1962  
American scholar

...science is seen to be just one more of those great flights of altar stairs that lead through darkness up to God.

*The Four Pillars of Democracy*  
Chapter II (p. 55)  
Harper & Brothers. New York, New York, US. 1940

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Since creationist-bashing is a noble and necessary pursuit these days, readers may wonder why I am praising such an invocation of God's power to create immutable entities all at once – especially since Linnaeus substituted this idea for earlier notions of looser definition and mutability. But, as I [have] argued..., the history of science progresses in such a manner – from theory to theory along a complex surface with a slant toward greater empirical adequacy, not along a straight and narrow path pushed by a gathering snowball of factual accumulation. The conceptual change was surely enormous, but Darwin's invocation of natural selection in steps as a replacement for God all at once did not require any major overhaul in practice. Species are real whether created by God or constructed by natural selection – and Darwin's conceptual shift, the second unmasking, required little revision in Linnaean methods.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Eight, Chapter 32 (p. 423)  
Random House, Inc. New York, New York, USA. 1995

**Graham, Aelred**  
Benedictine monk

Broadly speaking, all nature, since it has no claim to existence, manifests the grace of God.

*Christian Thought in Action*  
Chapter Eight (p. 139)  
Collins. London, England. 1958

**Greenstein, George** 1940–  
American astronomer

As we survey all the evidence, the thought insistently arises that some supernatural agency – or, rather, Agency – must be involved. Is it possible that suddenly, without intending to, we have stumbled upon scientific proof of the existence of a Supreme Being? Was it God who stepped in and so providentially crafted the cosmos for our benefit?

*The Symbiotic Universe*

Prologue (p. 27)

William Morrow & Company, Inc. New York, New York, USA. 1988

**Grove, William Robert** 1811–96  
Judge and physical scientist

Causation is the will, Creation the act, of God.

In Edward Livingston Youmans

*The Correlation and Conservation of Forces*

Concluding Remarks (p. 199)

D. Appleton & Co. New York, New York, USA. 1885

**Haeckel, Ernst Heinrich Philipp August** 1834–1919  
German biologist and philosopher

...God is, in fact, nothing more than a gaseous vertebrate.

Translated by E. Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)

Chapter III (p. 71)

D. Appleton & Co. New York, New York, USA. 1892

**Haldane, J. S. (John Scott)** 1860–1936  
Scottish physiologist

The existence of God must be the central feature in future developments of philosophy.

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*

Lecture III, The Deeper Meaning of Berkeley's Reasoning (p. 120)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Hardin, Garrett** 1915–2003  
American ecologist and microbiologist

The god who is reputed to have created fleas to keep dogs from moping over their situation must have also created fundamentalists to keep rationalists from getting flabby. Let us be duly thankful for our blessings.

In Ashley Montagu

*Science and Creationism*

Introduction (p. 3)

Oxford University Press, Inc. New York, New York, USA. 1984

**Hawking, Stephen William** 1942–  
English theoretical physicist

We still believe that the universe should be logical and beautiful; we just dropped the word "God."

Quoted by Renée Weber

*Dialogues with Scientists and Sages: The Search For Unity* (p. 21)  
Routledge & Kegan Paul. London, England. 1986

Science seems to have uncovered a set of laws that, within the limits set by the uncertainty principle, tell us how the universe will develop with time, if we know its state at any one time. These laws may have originally been decreed by God, but it appears that he has since left the universe to evolve according to them and does not now intervene in it.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 8 (p. 122)

Bantam Books. Toronto, Ontario, Canada. 1988

The idea that space and time may form a closed surface without boundary also has profound implications for the role of God in the affairs of the universe. With the success of scientific theories in describing events, most people have come to believe that God allows the universe to evolve according to a set of laws and does not intervene in the universe to break these laws. However, the laws do not tell us what the universe should have looked like when it started – it would still be up to God to wind up the clockwork and choose how to start it off. So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place, then, for a creator?

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 8 (pp. 140–141)

Bantam Books. Toronto, Ontario, Canada. 1988

Up to now, most scientists have been too occupied with the development of new theories that describe what the universe is to ask the question why.... If we find the answer to that, it would be the ultimate triumph of human reason – for then we would know the mind of God.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 11 (p. 174–175)

Bantam Books. Toronto, Ontario, Canada. 1988

...but if he [God] had started it [the universe] off in such an incomprehensible way, why did he choose to let it evolve according to laws that we could understand?

*A Brief History of Time: The Updated Expanded Tenth Anniversary Edition*

Chapter 8 (p. 127)

Bantam Books. Toronto, Ontario, Canada. 1998

...you don't have to say that the way the universe began was the personal whim of God. But you still have the question: Why does the universe bother to exist? If you like, you can define God to be the answer to that question.

*Black Holes and Baby Universes and Other Essays*

Desert Island Discs (p. 173)

Bantam Books. New York, New York, USA. 1993

**Henry, O. (pseudonym for William Sydney Porter)** 1862–1910  
American writer

For, even the preachers have begun to tell us that God is rarium, or ether or some scientific compound, and that the worst we wicked ones may expect is a chemical reaction.

*The Four Million*

An Unfinished Story (p. 174)

Doubleday, Page & Co. New York, New York, USA. 1919

**Herrick, Robert** 1591–1674  
English poet

Science in God, is known to be  
A Substance, not a Qualitie.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

Science in God

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Hill, Thomas**

No biographical data available

The genuine spirit of Mathesis is devout. No intellectual pursuit more truly leads to profound impressions of the existence and attributes of a Creator, and to a deep sense of our filial relations to him, than the study of these abstract sciences. Who can understand so well how feeble are our conceptions of Almighty Power, as he who has calculated the attraction of the sun and the planets, and weighed in his balance the irresistible force of the lightning? Who can so well understand how confused is our estimate of the Eternal Wisdom, as he who has traced out the secret laws which guide the hosts of heaven, and combine the atoms on earth? Who can so well understand that man is made in the image of his Creator, as he who has sought to frame new laws and conditions to govern imaginary worlds, and found his own thoughts similar to those on which his Creator has acted?

The Imagination in Mathematics

*North American Review*, Volume 85, Number 176, July 1857  
(pp. 226–227)

**Hobbes, Thomas** 1588–1679  
English philosopher and political theorist

...it is impossible to make any profound inquiry into natural causes without being inclined thereby to believe there is one God eternal...

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 11 (p. 78)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hudson, Jay William**

No biographical data available

All that I insist upon as a scientist is that you do not foist upon me a God that is inconsistent with what science must regard as verifiable facts and laws.

*The Truths We Live by*

Part II, Chapter VIII (p. 168)

D. Appleton & Co. New York, New York, USA. 1921

**Huxley, Aldous** 1894–1963  
English writer and critic

About God. You know the formula: m over nought equals infinity, m being any positive number? Well, why not reduce the equation to a simpler form by multiplying both sides by nought? In which case, you have m equals infinity times nought. That is to say that a positive number is the product of zero and infinity. Doesn't that demonstrate the creation of the universe by an infinite power out of nothing? Doesn't it...

*Point Counter Point*

Chapter XI (p. 135)

Roberts Brothers. Boston, Massachusetts, USA. 1866

**Infeld, Leopold** 1898–1968  
Polish physicist

Einstein uses his concept of God more often than a Catholic priest.

*Quest – An Autobiography*

Book Three, Part IV (p. 268)

Chelsea Publishing Company. New York, New York, USA. 1980

**Jacobi, Karl Gustav Jacob** 1804–51  
German mathematician

God ever arithmetizes.

In E.T. Bell

*Men of Mathematics* (p. xxi)

Simon & Schuster. New York, New York, USA. 1937

**James, William** 1842–1910  
American philosopher and psychologist

The God whom science recognizes must be a God of universal laws exclusively, a God who does a wholesale, not a retail business. He cannot accommodate his processes to the convenience of individuals.

*The Varieties of Religious Experience*

Lecture XX (pp. 483–485)

The Modern Library. New York, New York, USA. 1967

**Jastrow, Robert** 1925–  
American space scientist

When an astronomer writes about God, his colleagues assume he is either over the hill or going bonkers.

*God and the Astronomers*

Chapter 1 (p. 11)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...in physics God made mathematics and man made the rest.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
(1934)

The New World-Picture of Modern Physics (p. 83)  
Government Printing Office. Washington, D.C. 1935

**Joule, James Prescott** 1818–89  
English physicist

...the phenomena of nature, whether mechanical, chemical, or vital, consist almost entirely in a continual conversion of attraction through space, living force, and heat into one another. Thus it is that order is maintained in the universe – nothing is deranged, nothing ever lost, but the entire machinery, complicated as it is, works smoothly and harmoniously. And though, as in the awful vision of Ezekiel, “wheel may be in the middle of wheel,” and everything may appear complicated and involved in the apparent confusion and intricacy of an almost endless variety of causes, effects, conversions, and arrangements, yet is the most perfect regularity preserved – the whole being governed by the sovereign will of God.

*The Scientific Papers of James Prescott Joule*  
On Matter, Living Forces and Heat (p. 273)  
Taylor & Francis. London, England. 1884

**Kant, Immanuel** 1724–1804  
German philosopher

...God has put a secret art into the forces of nature so as to enable it to fashion itself out of chaos into a perfect world system ...

Translated by W. Hastie  
*Kant's Cosmogony*  
Preface (p. 27)  
James Maclehose & Sons. Glasgow, Scotland. 1900

**Keill, John** 1671–1721  
Scottish mathematician and natural philosopher

Among all the Gifts and Benefits the most bountiful God has most plentifully bestowed on Mankind, those are in the first place Valuable which consist in the Improvements of the Mind by Arts and Sciences.

*An Introduction to the True Astronomy*  
The Preface (p. 1)  
Printed for Bernard Lintot. London, England. 1721

**Keillor, Garrison** 1942–  
American humorist and radio broadcaster

We wondered if there is a God or is the universe only one seed in one apple on a tree in another world where a million years of ours is only one of their moments and what we imagine as our civilization is only a tiny charge of static electricity and the great truth that our science is slowly grasping is the fact the apple in which we are part of one seed is falling, has been falling for a million years and in one one-millionth of a second it will hit hard-frozen ground in that other world and split open and lie on the ground and a bear will come along and gobble it up, everything, the Judeo-Christian heritage, science, democracy, the Renaissance, art,

music, sex, sweet corn – all disappear into that black hole of a bear.

Leaving Home  
*The Atlantic Monthly*, Volume 260, Number 3, September, 1987 (p. 48)

**Kepler, Johannes** 1571–1630  
German astronomer

The chief aim of all investigations of the external world should be to discover the rational order and harmony which has been imposed on it by God and which He revealed to us in the language of mathematics.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 231)  
Oxford University Press, Inc. New York, New York, USA. 1972

...if there are globes in the heaven similar to our Earth, do we vie with them over who occupies the better portion of the universe? For if their globes are nobler, we are not the noblest of rational creatures. Then how can all things be for man's sake? How can we be the master of God's handiwork?

*Conversations with Galileo's Sidereal Messenger*  
Translated by Edward Rosen  
Section VIII (p. 43)  
Johnson Reprint Corp. New York, New York, USA. 1965

**Kersh, Gerald** 1911–68  
English journalist and author

I can't believe in the God of my Fathers. If there is one Mind which understands all things, it will comprehend me in my unbelief.

I don't know whose hand hung Hesperus in the sky, and fixed the Dog Star, and scattered the shining dust of Heaven, and fired the sun, and froze the darkness between the lonely worlds that spin in space.

*Sergeant Nelson of the Guards* (p. 135)  
The John C. Winston Co. Philadelphia, Pennsylvania, USA. 1945

**Lalande, Jérôme** 1732–1807  
French astronomer

I have searched through the heavens, and nowhere have I found a trace of God.

In Ludwig Buchner  
*Force and Matter* (p. 105)  
Truth Seeker. New York, New York, USA. 1950

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

...if I find that nature herself works all the wonders...that she has created organisation, life and even feeling, that she has multiplied and diversified within unknown limits the organs and faculties of the organized bodies whose existence she subserves or propagates...should I not recognise in this power of nature, that is to say in the order of existing things, the execution of the will of her Sublime Author, who was able to will that she should have this power.



Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
 Chapter III (p. 41)  
 The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lambert, Johann Heinrich** 1728–77  
 Swiss German mathematician and astronomer

If we admit the existence of a Supreme Disposer, who brought order out of Chaos, and gave form to the universe, it will follow that the universe is a perfect work, the impression, the character, the reflected image of the perfections of its author.

Translated by James Jacque  
*The System of the World*  
 Part I, Chapter II (p. 9)  
 Printed for Vernor and Hood. London, England. 1800

**Lawrence, D. H. (David Herbert)** 1885–1930  
 English writer

The history of the cosmos  
 is the history of the struggle of becoming.  
 When the dim flux of unformed life  
 struggled, convulsed back and forth upon itself,  
 and broke at last into light and dark  
 and came into existence as light,  
 came into existence as cold shadow  
 then every atom of the cosmos trembled with delight.  
 Behold, God is born!  
 He is bright light!  
 He is pitch dark and cold.

*The Complete Poems of D.H. Lawrence*  
 God Is Born  
 Viking Press. New York, New York, USA. 1973

**Leibniz, Gottfried Wilhelm** 1646–1716  
 German philosopher and mathematician

As God calculates, so the world is made.  
 In Morris Kline  
*Mathematics and the Physical World*  
 Chapter 23 (p. 385)  
 Dover Publications, Inc. New York, New York, USA. 1981

**Macfie, Ronald Campbell** 1867–1931  
 Poet and physician

Little wonder that God can make souls when his clay is  
 star-clusters!  
*Science, Matter and Immortality*  
 Chapter XVI (p. 197)  
 William & Norgate. London, England. 1909

**Mencken, H. L. (Henry Louis)** 1880–1956  
 American journalist and literary critic

It is impossible to imagine the universe run by a wise,  
 just and omnipotent God, but it is quite easy to imagine  
 it run by a board of gods. If such a board actually exists

it operates precisely like the board of a corporation that  
 is losing money.

*Minority Report: H.L. Mencken's Notebooks*  
 No. 79 (p. 63)  
 Alfred A. Knopf. New York, New York, USA. 1956

**Michalson, Carl** 1915–65  
 No biographical data available

One may point to nature and say, "There is a God," but  
 one cannot point to nature and say, "There God is."

In P. Ramsey (ed.)  
*Faith and Ethics: The Theology of H. Richard Niebuhr*  
 Chapter IX (p. 257)  
 Harper & Brothers. New York, New York, USA. 1957

**Miller, Hugh** 1802–56  
 Scottish geologist and theologian

The perfection of the works of Deity is a perfection entire  
 in its components, and yet these are not contemporaneous,  
 but successive: it is a perfection which includes the  
 dead as well as the living, and bears relation, in its completeness,  
 not to time, but to eternity.

*The Old Red Sandstone*  
 Chapter III (p. 41)  
 John B. Alden, Publisher. New York, New York, USA. 1892

**Millikan, Robert Andrews** 1868–1953  
 American physicist

A fire mist and a planet,  
 A crystal and a cell,  
 A jelly fish and a saurian  
 And caves where cavemen dwell.  
 Then a sense of law and beauty,  
 And a face turned from the clod.  
 Some call it evolution  
 And others call it God.

*Science and the New Civilization*  
 Chapter I (p. 15)  
 Charles Scribner's Sons. New York, New York, USA. 1930

**Moynihan, Sir Berkeley** 1865–1936  
 English surgeon

...the God of Science is a greater and more glorious  
 Being than the God of the Theologians.

In Edward H. Cotton  
*Has Science Discovered God?*  
 The Scientific Argument for Personal Survival (p. 260)  
 Thomas Y. Crowell Company, Publishers. New York, New York, USA. 1931

**Newton, Sir Isaac** 1642–1727  
 English physicist and mathematician

A true, supreme or imaginary dominion makes a true,  
 supreme or imaginary God. And from his true dominion it  
 follows that the true God is a living, intelligent and powerful  
 Being.... We know him only by his most wise and excellent  
 contrivances of things, and final causes...but we reverence  
 and adore him on account of his dominion: for



we adore him as his servants; and a god without dominion, providence, and final causes, is nothing else but Fate and Nature.

Translated by Andrew Motte

*The Mathematical Principles of Natural Philosophy*

General Scholium (p. 505)

Daniel Adee. New York, New York, USA. 1848

**Nicholson, Jack** 1937–

American film actor

When God makes a mistake, they call it nature.

*The Witches of Eastwood*

Film (1987)

**Orgel, Irene** 1922–

English poet

“But before Man?” asked Jonah, shocked out of his wits. “Do you mean you understood nothing at all? Didn’t you exist?”

“Certainly,” said God patiently. “I have told you how I exploded in the stars. Then I drifted for aeons in clouds of inchoate gas. As matter stabilized, I acquired the knowledge of valency. When matter cooled, I lay sleeping in the insentient rocks. After that I floated fecund in the unconscious seaweed upon the faces of the deep. Later I existed in the stretching paw of the tiger and the blinking eye of the owl. Each form of knowledge led to the more developed next. Organic matter led to sentience which led to consciousness which led inevitably to my divinity.”

*The Odd Tales of Irene Orgel*

Jonah (pp. 17–18)

Eakins Press. New York, New York, USA. 1967

**Paley, William** 1743–1805

English theologian

In crossing a heath, suppose I pitched my foot against a stone, and were asked how the stone came to be there; I might possibly answer, that, for anything I knew to the contrary, it had lain there forever: nor would it perhaps be very easy to show the absurdity of this answer. But suppose I had found a watch upon the ground, and it should be inquired how the watch happened to be in that place; I should hardly think of the answer which I had before given, that, for anything I knew, the watch might have always been there. Yet why should not this answer serve for the watch as well as the stone?

*The Works of William Paley, D.D.*

Natural Theology

Chapter I (p. 17)

Ward, Lock and Co. London, England. n.d.

**Paré, Ambroise** 1510–90

French surgeon

*Je le pensay, et Dieu le guarit.*

I dressed his wound, and God healed it.

In Oliver Wendell Holmes

*Medical Essays*

The Medical Profession in Massachusetts (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Parker, Theodore** 1810–60

American Transcendentalist

The universe, broad, and deep, and high, is a handful of dust which God enchants. He is the mysterious magic which possesses the world.

In Lydia Maria Francis Child

*Aspirations of the World*

Pantheism (p. 222)

Roberts Brothers. Boston, Massachusetts, USA. 1887

**Pascal, Blaise** 1623–62

French mathematician and physicist

...I have a hundred times wished that if a God maintains Nature, she should testify to Him unequivocally, and that, if the signs she gives are deceptive, she should suppress them altogether.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 229

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Nature has some perfections to show that she is the image of God, and some defects, to show that she is only His image.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section VIII, 580

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pascual, Jordan** 1902–80

German physicist

And certainly this picture of the universe as exploding fireworks which went off ten billion years ago invites us to consider the remarkable question of Miguel de Unamuno, whether the whole world – and we with it – be not possibly only a dream of God; whether the prayer and ritual perhaps be nothing but attempts to make HIM more drowsy, so that HE does not awaken and stop our dreaming.

*Physics of the 20th Century*

Appendix I (p. 185)

Philosophical Library. New York, New York, USA. 1944

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

I cannot believe God is a weak left-hander.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Interlude C (p. 256)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Peacocke, Arthur** 1924–2006

English biochemist-turned-theologian

...the processes revealed by the sciences are in themselves God acting as Creator and God is not to be found as

some kind of additional factor added on to the processes of the world. God, to use the language usually applied to sacramental theology, is “in, with and under” all that-is and all-that-goes-on.

In Mark William Worthing

*God, Creation, and Contemporary Physics*

Chapter Four (p. 157)

Fortress Press. Minneapolis, Minnesota, USA. 1996

**Pierce, Benjamin** 1809–80

American mathematician

If, then, everything is governed by law, and if all the power is in the physical universe that ever was there, where is God? In the intention.

*Dickinson's Theological Quarterly*

The Conflict between Religion and Science

Volume 3 Number 4 October, 1877 (p. 611)

**Plato** 428 BCE–347 BCE

Greek philosopher

God ever geometrizes.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Polyakov, Alexander**

Russian physicist

We know that nature is described by the best of all possible mathematics because God created it.

In S. Gannes

Alexander Polyakov; 40: Probing the Forces of the Universe

*Fortune*, Volume 114, Number 8, October 13, 1986 (p. 57)

**Popper, Karl R.** 1902–94

Austro-Hungarian-born philosopher of science

The earlier, naturalistic, revolution against God replaced the name “God” by the name “Nature.” Almost everything else was left unchanged. Theology, the Science of God, was replaced by the Science of Nature; God’s laws by the laws of Nature; God’s will and power by the will and power of Nature (the natural forces); and later God’s design and God’s judgment by Natural Selection. Theological determinism was replaced by naturalistic determinism; that is, God’s omnipotence and omniscience were replaced by the omnipotence of Nature and the omniscience of Science.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 16, Section XII (p. 346)

Harper & Row, Publishers. New York, New York, USA. 1963

**Pratchett, Terry** 1948–

English author

**Gaiman, Neil**

No biographical data available

God does not play dice with the universe; He plays an ineffable game of His own devising, which might

be compared, from the perspective of any of the other players (i.e., everybody), to being involved in an obscure and complex version of poker in a pitch-dark room, with blank cards, for infinite stakes, with a Dealer who won’t tell you the rules, and who smiles all the time.

*Good Omens: The Nice and Accurate Prophecies of Agnes Nutter, Witch* (p. 1)

Victor Gollancz Ltd. London, England. 1990

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

God is reduced to a mere archivist turning the pages of a cosmic history book already written.

In Sara Nash (ed.)

*Science and Complexity*

The Rediscovery of Time (p. 23)

Science Reviews Ltd. London, England. 1985

**Proctor, Richard Anthony** 1837–88

English astronomer

...so far as Science is concerned, the idea of a personal God is inconceivable...

*Our Place Among the Infinities*

The Past and Future of Our Earth (pp. 2–3)

Chatto & Windus. London, England. 1879

**Reade, Winwood** 1838–75

Philosopher and historian

When we have ascertained, by means of Science, the methods of nature’s operations, we shall be able to take her place to perform them for ourselves...men will master the forces of nature; they will become themselves architects of systems, manufacturers of worlds. Man will then be perfect; he will be a creator; he will therefore be what the vulgar worship as God.

*The Martyrdom of Man*

Chapter IV (pp. 458, 460)

E.F. Dutton & Company. New York, New York, 1926

**Roberts, Mary** 1788–1864

English botanist and author

Who shall assign a limit to the wonders of creation! Where is the spot on earth, the animal, or plant, or the creature which mysteriously partakes of both their natures, which does not lay open to us unquestionable evidences of the wisdom and benevolence of God.

*The Sea-side Companion; or, Marine Natural History*

Letter I (p. 10)

Printed for Whittaker & Co. London, England. 1835

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

God and immortality, the central dogmas of the Christian religion, find no support in science.

*What I Believe*

Chapter I (p. 5)

E.P. Dutton & Company. New York, New York, USA. 1925

And God smiled; and when he saw that Man had become perfect in renunciation and worship, he sent another sun thru the sky, which crashed into Man's sun; and all returned again to nebula....

"Yes," he murmured, "it was a good play; I will have it performed again."

*Philosophical Essays*

The Free Man's Worship (p. 60)

Longmans, Green & Company. New York, New York, USA. 1910

**Sagan, Carl** 1934–96

American astronomer and science writer

God may be thought of as the cosmic watchmaker, the engineer who constructed the initial state and lit the fuse.

In Stephen W. Hawking

*A Brief History of Time: From The Big Bang to Black Holes*

Introduction (p. x)

Bantam Books. Toronto, Ontario, Canada. 1988

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

God then becomes a poetic symbol for the material tenderness and the paternal strictness of this wonderful world; the ways of God become the subject-matter of physics.

*The Realm of Matter*

Chapter X (p. 205)

Charles Scribner's Sons. New York, New York, USA. 1930

**Scripps, Edwin W.**

American newspaper magnate

[Scientists are] so blamed wise and so packed full of knowledge...that they cannot comprehend why God has made nearly all the rest of mankind so infernally stupid.

In Dorothy Nelkin

*Selling Science*

Chapter 6 (p. 81)

W.H. Freeman and Company. New York, New York, USA. 1995

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Science could stand a cruel and unjust god; for nature was full of suffering and injustice. But a disorderly [god] was impossible.

*Back to Methuselah*

Preface (p. xxxviii)

Constable & Company Ltd. London, England. 1921

KNELLER: To you the universe is nothing but a clock that an almighty clockmaker has wound up and set going for all eternity.

NEWTON: Shall I tell you a secret, Mr. Beautymonger? The clock does not keep time. If it did there would be no further need for the Clockmaker.... Can you, who know everything because you and God are both artists, tell me what is amiss with the perihelion of Mercury?

KNELLER: The what?

NEWTON: The perihelion of Mercury.

KNELLER: I do not know what it is.

NEWTON: I do. But I do not know what is amiss with it. Not until the world finds this out can it do without the Clockmaker in the heavens.

*In Good King Charles's Golden Days*

Act I

Constable and Company Ltd. London, England. 1946

**Smullyan, Raymond** 1919–

American mathematician and logician

It has always puzzled me that so many religious people have taken it for granted that God favors those who believe in him. Isn't it possible that the actual God is a scientific God who has little patience with beliefs founded on faith rather than evidence?

*5000 B.C. and Other Philosophical Fantasies*

Chapter 3 (p. 25)

St. Martin's Press. New York, New York, USA. 1983

**Smyth, William Henry** 1788–1865

English admiral and scientific writer

...the whole firmament, with its countless and glorious orbs, – which, though sustaining apparently independent positions, are but individual constituents of one Majesty of Creation, – in the absence of a larger comprehension, countenances the sagacity of the oft-cited ancient dogma, that "GOD WOEKS BY GEOMETRY."

*A Cycle of Celestial Objects, Observed, Reduced and Discussed* (p. 680)

At The Clarendon Press. London, England. 1881

**Stanhope, Charles** 1753–1818

British statesman and scientist

To suppose that the Omnipotent God made a world, found it a failure, and broke it up, and then made it again, and again broke it up, as the Geologists say, is all fiddle faddle. Describing Species of birds and shells, & c., is all fiddle faddle...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to C. Lyell, September 14, 1849 (p. 345)

D. Appleton & Company. New York, New York, USA. 1896

**Somerville, Mary** 1780–1872

American author and humorist

Nothing has afforded me so convincing a proof of the unity of the Deity as these purely mental conceptions of numerical and mathematical science which have been by slow degrees vouchsafed to man, and are still granted in these latter times by the Differential Calculus, now superseded by the Higher Algebra, all of which must have existed in that sublimely omniscient Mind from eternity.

In Martha Somerville (ed.)

*Personal Recollections, from Early Life to Old Age, of Mary Somerville*

Chapter IX (pp. 140–141)

Robert Brothers. Boston, Massachusetts, USA. 1874

The traces of extreme antiquity perpetually occurring to the geologist give that information of the origin of things which we in vain look for in the other parts of the universe. They date the beginning of time [and] show that creation is the work of Him with whom “a thousand years are as one day, and one day as a thousand years.”

*Mechanism of the Heavens*

Preliminary Dissertation (p. 36)

John Murray. London, England. 1831

**Steele, Joel Dorman** 1836–86

American educator and textbook writer

God has no idlers in his world. Each atom has its use. There is not an extra particle in the entire universe.

*A Fourteen Weeks Course in Chemistry*

Inorganic Chemistry, Oxygen (p. 27)

A.S. Barnes & Company. New York, New York, USA. 1870

**Stewart, Ian** 1945–

English mathematician and science writer

Perhaps God can play dice, and create a universe of complete law and order, in the same breath.

*Does God Play Dice: The New Mathematics of Chaos*

Prologue (p. xii)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

**Stoppard, Tom** 1937–

Czech-born English playwright

Mountains are not pyramids and trees are not cones. God must love gunnery and architecture if Euclid is his only Geometry.

*Arcadia*

Act II, Scene Seven (p. 84)

Faber & Faber Ltd. London, England. 1993

**Teller, Woolsey** 1890–1954

Essayist

And what must we think of this alleged intelligence in the skies, which after toiling for billions of years, produces nothing more imposing than the equivalent of six specks of dust in a great railroad terminal?

*The Atheism of Astronomy*

Chapter VI (p. 120)

Arno Press & The New York Times. New York, New York, USA. 1972

**Temple, Frederick** 1821–1902

Anglican prelate, archbishop of Canterbury

The fixed laws of science can supply natural religion with numberless illustrations of the wisdom, the beneficence, the order, the beauty that characterizes the workmanship of God; while they illustrate His infinity by the marvelous complexity of natural combinations, by the variety and order of His creatures, by the exquisite finish alike bestowed on the very greatest and on the very least of His works, as if size were absolutely nothing in His sight.

*Present Relations of Science to Religion* (p. 13)

J. H. and Jas. Parker. London, England. 1860

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The heavens are telling the glory of God.

*Concerning Evolution*

Chapter I, Section 6 (p. 12)

Yale University Press. New Haven, Connecticut, USA. 1925

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

If Nature is our mother, then God is our father.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimack Rivers*

Friday (p. 492)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

If I were going to construct a God I would furnish Him with some ways and qualities and characteristics which the Present (Bible) One lacks.... He would spend some of His eternities in trying to forgive Himself for making man unhappy when He could have made him happy with the same effort and He would spend the rest of them in studying astronomy.

In Albert Bigelow Paine (ed.)

*Mark Twain's Notebook*

Chapter XXVI (p. 301, 302)

Harper & Brothers Publishers. New York, New York, USA. 1935

**Updike, John** 1932–

American novelist, short story writer, and poet

The most miraculous thing is happening. The physicists are getting down to the nitty-gritty, they've really just about pared things down to the ultimate details, and the last thing they ever expected to happen is happening. God is showing through.

“Mr. Kohler, What kind of God is showing through, exactly?”

*Roger's Version*

Chapter I (p. 10)

Alfred A. Knopf. New York, New York, USA. 1986

And I'm not sure it isn't a bit heretical of you to toss the fact of God in with a lot of other facts. Even Aquinas, I think, didn't postulate a God Who could be hauled kicking and screaming out from some laboratory closet, over behind the blackboard.

*Roger's Version*

Chapter I (p. 21)

Alfred A. Knopf. New York, New York, USA. 1986

**von Braun, Wernher** 1912–77

German-American rocket scientist

The more we learn about God's creation, the more I am impressed with the orderliness and unerring perfection of the natural laws that govern it.

In Erik Bergaust  
*Wernher von Braun*  
 The Starry Sky Above Me (p. 113)  
 National Space Institute. Washington, D.C. 1976

**Weil, Simone** 1909–43  
 French philosopher and mystic

A science which does not bring us nearer to God is worthless.

*Gravity and Grace*  
 Illusions (p. 50)  
 Routledge & Kegan Paul. London, England. 1952

**Whitcomb, J.**  
 No biographical data available

**Morris, H. M.**  
 No biographical data available

The more we study the fascinating story of animal distribution around the earth, the more convinced we have become that this vast river of variegated life forms, moving ever outward from the Asiatic mainland, across the continents and seas, has not been a chance and haphazard phenomenon. Instead, we see the hand of God guiding and directing these creatures in ways that man, with all his ingenuity, has never been able to fathom, in order that the great commission to the postdiluvian animal kingdom might be carried out, and that they may breed abundantly in the earth, and be fruitful, and multiply upon the earth (Gen. 8:17).

*The Genesis Flood: The Biblical Record and It's Scientific Implications*  
 Chapter III (p. 86)  
 Presbyterian and Reformed Pub. Co. Philadelphia, Pennsylvania, USA. 1961

**Wilson, Edward O.** 1929–  
 American biologist and author

Today, thanks to the relentless advance of the science which Newton pioneered, God's immanence has been pushed to somewhere below the subatomic particles or beyond the farthest visible galaxy.

*On Human Nature*  
 Chapter 8 (p. 171)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1978

**Wood, William Hamilton**  
 No biographical data available

God is a term which symbolizes that which faith finds beyond where science ends. He is not the absolute. He does not properly belong to scientific investigation or teachings because the organs of science are observation,

experiment and reason. Science therefore finds no God, and, without speaking irreverently has little use for this symbol or hypothesis.

*The Religion of Science*  
 Chapter II (p. 31)  
 The Macmillan Co. New York, New York, USA. 1922

**Wright, Frank Lloyd** 1867–1959  
 American architect

Toward the end of the last century, many physicists felt that the mathematical description of physics was getting ever more complicated. Instead, the mathematics involved has become ever more abstract, rather than more complicated. The mind of God appears to be abstract but not complicated. He also appears to like group theory.

*Fearful Symmetry*  
 Chapter 9 (p. 132)  
 Macmillan Publishing Company. New York, New York, USA. 1986

**Zeldovich, Yakov Borisovich** 1914–87  
 Russian physicist

...almighty God throwing dice for every single proton or antiproton would soon get tired with the astronomical number of particles. He could not make the asymmetry large enough.

In Joseph Silk  
*Cosmic Enigmas*  
 Cosmologists and Their Myths (p. 7)  
 AIP Press. Woodbury, New York, USA. 1994

**Ziman, John M.** 1925–2005  
 English physicist

As has been said of some experiments in high-energy physics: the process to be observed has never occurred before in the history of the Universe; God himself is waiting to see what will happen!

*Reliable Knowledge*  
 Chapter 3 (fn 11, p. 62)  
 Cambridge University Press. Cambridge, England. 1978

## GOOD SENSE

**Descartes, René** 1596–1650  
 French philosopher, scientist, and mathematician

Good sense is, of all things among men, the most equally distributed; for everyone thinks himself so abundantly provided with it, that those even who are the most difficult to satisfy in everything else, do not usually desire a larger measure of this quality than they already possess.

*Discourse on the Method of Rightly Conducting the Reason, and Seeking Truth in the Sciences*  
 Part I (p. 45)  
 Sutherland and Knox. Edinburgh, Scotland. 1850

## GOVERNMENT

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

No government has the right to decide on the truth of scientific principles, nor to prescribe in any way the character of the questions investigated. Neither may a government determine the aesthetic value of artistic creations,



nor limit the forms of literacy or artistic expression. Nor should it pronounce on the validity of economic, historic, religious, or philosophical doctrines. Instead it has a duty to its citizens to maintain the freedom, to let those citizens contribute to the further adventure and the development of the human race.

*The Meaning of It All*

## GRADUALNESS

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

About this [gradualness] most important condition of fruitful scientific work I never can speak without emotion. Gradualness, gradualness and gradualness. From the very beginning of your work, school yourselves to serve gradualness in the accumulation of knowledge.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

## GRAIN

**Heiles, Carl**

Astronomer

...needle-like grains tend to spin end-over-end, like a well-kicked American football.

In D.J. Hollenbach and H.A. Thronson (eds.)

*Interstellar Processes: Proceedings of the Symposium on Interstellar Processes*

Section III (p. 171)

Dordrecht. Boston, Massachusetts, USA. 1987

**Seab, C. G.**

No biographical data available

Once the newly formed grains are injected into the interstellar medium, they are subject to a variety of indignities...

In M.E. Bailey and D.A. Williams (eds.)

*Dust in the Universe: The Proceedings of a Conference at the Department of Astronomy, University of Manchester, 14–18 December, 1987*

Chapter 32, Section 32. 1 (p. 304)

Cambridge University Press. Cambridge, England. 1988

## GRAPH

### Advertisement

One picture is worth ten thousand words.

Royal Baking Powder

*Printers Ink*, Volume 138, 10 March, 1927

Every picture tells a story.

*Doan's Backache Kidney Pills*

Slogan

**Crichton, Michael** 1942–

American novelist

I'll give you a graphic display," Gerhard said. He punched buttons, wiping the screen. After a moment, cross-hatching for a graph appeared and the points began to blink on...

*The Terminal Man*

Chapter 5 (p. 121)

Alfred A. Knopf. New York, New York, USA. 1972

You can draw a lot of curves through three graph points.

You can extrapolate it a lot of ways.

*The Terminal Man*

Chapter 5 (p. 155)

Alfred A. Knopf. New York, New York, USA. 1972

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The preliminary examination of most data is facilitated by the use of diagrams. Diagrams prove nothing, but bring outstanding features readily to the eye; they are therefore no substitutes for such critical tests as may be applied to the data, but are valuable in suggesting such tests, and in explaining the conclusions founded upon them.

*Statistical Methods for Research Workers*

Chapter II (p. 26)

Oliver & Boyd. Edinburgh, Scotland. 1938

**Malcolm, Andrew H.**

No biographical data available

...no nation ranks higher in its collective passion for statistics. In Japan, statistics are the subject of holidays, local and national conventions, award ceremonies and nationwide statistical collection and graph-drawing contests.

Data-Loving Japanese Rejoice on Statistics Day

*New York Times*, October 26, 1977. A-1

**Moroney, Michael Joseph** 1918–90

English statistician

It pays to keep wide awake in studying any graph. The thing looks so simple, so frank, and so appealing that the careless are easily fooled.

*Facts from Figures*

The Magic Lantern Technique (p. 27)

Penguin Books Ltd. Harmondsworth, England. 1951

**Pearl, Judea**

Computer scientist and statistician

Despite the prevailing use of graphs as metaphors for communicating and reasoning about dependencies, the task of capturing informational dependencies by graphs is not at all trivial.

*Probabilistic Reasoning in Intelligent Systems: Network of Plausible*

*Inference*

Chapter 3 (p. 81)

Morgan Kaufmann Publishers, Inc. San Mateo, California, USA. 1988

**Playfair, William** 1759–1823

Inventor of statistical graphs



As to the propriety and justness of representing sums of money, and time, by parts of space, tho' very readily agreed to by most men, yet a few seem to apprehend there may possibly be some deception in it, of which they are not aware...

*The Commercial and Political Atlas*

Printed for J. Debrett. London, England. 1786

**Rogers, Will** 1879–1935

American actor and humorist

You must never tell a thing. You must illustrate it. We learn through the eye and not the noggin.

*The Will Rogers Book*

June 25, 1933 (p. 121)

The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1961

**Shakespeare, William** 1564–1616

English poet, dramatist, and actor

Dost thou love pictures?

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Taming of the Shrew*

Introduction, Scene ii, l. 51

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tufte, Edward R.** 1942–

American artist and statistician

Excellence in statistical graphics consists of complex ideas communicated with clarity, precision, and efficiency. Graphical displays should show the data, induce the viewer to think about the substance rather than about the methodology, graphic design, the technology of graphic production, or something else, avoid distorting what the data have to say, present many numbers in a small space make large data sets coherent, encourage the eye to compare different pieces of data, reveal the data at several levels of detail, from a broad overview to the fine structure, serve a reasonable clear purpose: description, exploration, tabulation, or decoration [should] be closely integrated with the statistical and verbal descriptions of a data set.

*The Visual Display of Quantitative Information*

Part I, Chapter 1 (p. 13)

Graphic Press. Cheshire, Connecticut, USA. 1983

Of course statistical graphics, just like statistical calculations, are only as good as what goes into them. An ill-specified or preposterous model or a puny data set cannot be rescued by a graphic (or by calculation), no matter how clever or fancy. A silly theory means a silly graphic.

*The Visual Display of Quantitative Information*

Part I, Chapter 1 (p. 15)

Graphic Press. Cheshire, Connecticut, USA. 1983

Graphical integrity is more likely to result if these six principles are followed:

The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.

Show data variations, not design variations.

In time-series displays of money, deflated and standardized units of monetary measurements are nearly always better than nominal units.

The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.

Graphics must not quote data out of context.

*The Visual Display of Quantitative Information*

Part I, Chapter 2 (p. 77)

Graphic Press. Cheshire, Connecticut, USA. 1983

## GRAVITATION

**Rogers, Samuel** 1763–1855

English poet

That very law [gravitation] which moulds a tear, And bids it trickle from its source, That law preserves the earth a sphere, And guides the planets in their course.

*The Poetical Works of Rogers, Campbell, J. Montombery, Lamb, and Kirke White*

On A Tear

J. Grigg. Philadelphia, Pennsylvania, USA. 1836

## GRAVITATIONAL LENS

**Drake, Frank**

No biographical data available

**Sobel, Dava**

No biographical data available

“I know perfectly well that at this moment the whole universe is listening to us,” Jean Giraudoux wrote in *The Madwoman of Chaillot*, “and that every word we say echoes to the remotest star.” That poetic paranoia is a perfect description of what the Sun, as a gravitational lens, could do for the Search for Extraterrestrial Intelligence.

*Is Anyone Out There?: The Scientific Search for Extraterrestrial Intelligence*

Chapter 10 (p. 232)

Delacorte press. New York, New York, USA. 1992

**Einstein, Albert** 1879–1955

German-born physicist

...there is no great chance of observing this phenomenon.

Lens-like Action of a Star by the Deviation of Light in the Gravitational Field

*Science*, Volume 84, Number 2188, 1936 (p. 507)

**Zwicky, Fritz** 1898–1974

Swiss-American Astronomer

... the probability that nebulae which act as gravitational lenses will be found becomes practically a certainty.

On the Probability of Detecting Nebulae Which Act as Gravitational Lenses  
*Physical Review*, Volume 51, Number 8. 1937

## GRAVITY

**Arnott, Neil** 1788–1874  
 Scottish physician

Attraction, as gravitation, is the muscle and tendon of the universe, by which its mass is held together and its huge limbs are wielded. As cohesion and adhesion, it determines the multitude of physical features of its different parts. As chemical or interatomic action, it is the final source to which we trace all material changes.

In J. Dorman Steele  
*Popular Physics*  
 Chapter III (p. 41)  
 American Book Company. New York, New York, USA. 1896

**Bierce, Ambrose** 1842–1914  
 American newspaperman, wit, and satirist

GRAVITATION, n. The tendency of all bodies to approach one another with a strength proportioned to the quantity of matter they contain – the quantity of matter they contain being ascertained by the strength of their tendency to approach one another. This is a lovely and edifying illustration of how science, having made A the proof of B, makes B the proof of A.

*The Cynic's Word Book*  
 Gravity (p. 141)  
 Doubleday, Page & Co. New York, New York, USA. 1906

**Blake, William** 1757–1827  
 English poet, painter, and engraver

God keep me...from supposing Up and Down to be the same thing as all experimentalists must suppose.

*The Complete Poetry and Prose of William Blake*  
 Letter to George Cumberland, 12 April, 1827  
 University of California Press. Berkeley, California, USA. 1982

**Chittenden, Newton W.**  
 Mineral surveyor

Guided by the genius of Newton, we see sphere bound to sphere, body to body, particle to particle, atom to mass, the minutest part to the stupendous whole – each to each, each to all, and all to each – in the mysterious bonds of a ceaseless, reciprocal influence.

Translated by Andrew Motte  
 In Isaac Newton  
*Newton's Principia: The Mathematical Principles of Natural Philosophy*  
 Life of Sir Isaac Newton  
 Daniel Adee. New York, New York, USA. 1848

**Clarke, Arthur C.** 1917–  
 English science and science fiction writer

Gravity, like the air we breathe, is one of those natural phenomena we take for granted and never think about in the ordinary course of events. It is a major factor in the

lives of steeplejacks and mountaineers, but those of us who like more two-dimensional existences usually notice it only when we run upstairs in a hurry or sit on a chair which has unaccountably removed itself.

*The Exploration of Space*  
 Chapter 4 (p. 30)  
 Harper & Brothers Publishers. New York, New York, USA. 1951

**Clerke, Agnes Mary** 1842–1907  
 Irish astronomer

Gravity, however, is a force of the utmost generality in the way it affects matter. It takes no notice of distinctions of kind or quality. The substances acted upon may be hot or cold, dense or rare, elementary or compound; they may be of any imaginable chemical or mineralogical constitution; they may be in any state of aggregation; they may be organic or inorganic; no difference is perceptible; gravity is concerned solely with mass, and is measured strictly by movement; and from gravitational inquiries, accordingly, mass and movement can alone be learned.

*Problems in Astrophysics*  
 Chapter 1 (p. 2)  
 Adam & Charles Black. London, England. 1903

**Conduitt, John** 1688–1737  
 French philosopher

Whilst he [Newton] was musing in a garden it came into his thought that the power of gravity (which brought an apple from the tree to the ground) was not limited to a certain distance from the earth but that this power must extend much farther than was usually thought. Why not as high as the Moon said he to himself & if so that must influence her motion & perhaps retain her in her orbit, whereupon he fell a calculating.

*Never at Rest: A Biography of Isaac Newton*  
 Chapter 5 (p. 154)  
 Cambridge University Press. Cambridge, England. 1980

**Dürrenmatt, Friedrich** 1921–90  
 Swiss playwright and novelist

My mission is to devote myself to the problems of gravitation, not the physical requirements of a woman.

Translated by James Kirkup  
*The Physicists*  
 Act One (p. 19)  
 Grove Press, Inc. New York, New York, USA. 1964

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

One of our ancestors, taking arboreal exercise in the forest, failed to reach the bough intended and his hand closed on nothingness. The accident might well occasion philosophical reflections on the distinctions of substance and void – to say nothing of the phenomenon of gravity.

*The Nature of the Physical World*  
 Chapter XIII (p. 273)  
 The University Press. New York, New York, USA. 1929

**Einstein, Albert** 1879–1955  
German-born physicist

Falling in love is not at all the most stupid thing that people do – but gravitation cannot be held responsible for it.

In Helen Dukas and Banesh Hoffmann  
*Albert Einstein: The Human Side: New Glimpses from His Archives* (p. 56)  
Princeton University Press. Princeton, New Jersey, USA. 1979

I know that hardly any physicists believe that the gravitational forces can play any part in the constitution of matter. The physicists always argues that the forces are too small. This reminds me of a joke. An unmarried woman had a child and the family was greatly humiliated. So the midwife tried to console the mother by saying: “Don’t worry so much, it’s a very small child!”

In Leopold Infeld  
*Quest – An Autobiography*  
Book Three, Part IV (p. 266)  
Chelsea Publishing Company. New York, New York, USA. 1980

I shall conduct the reader over the road that I have myself traveled, rather a rough and winding road, because otherwise I cannot hope that he will take much interest in the result at the end of the journey. The conclusion I shall arrive at is that the field equations of gravitation which I have championed hitherto still need a slight modification.

Cosmological Considerations on the General Theory of Relativity  
*Proceedings of the Prussian Academy of Sciences*, Volume X, 1917 (p. 142)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The child amidst his baubles is learning the action of light, motion, gravity...

*Ralph Waldo Emerson: Essays and Lectures  
Nature: Addresses, and Lectures*  
The Divinity School Address (p. 76)  
The Library of America. New York, New York, USA. 1983

Let us draw a lesson from nature, which always works by short ways. When the fruit is ripe, it falls. When the fruit is dispatched, the leaf falls. The circuit of the waters is mere falling. The walking of man and all animals is a falling forward. All our manual labor and works of strength, as prying, splitting, digging, rowing, and so forth, are done by dint of continual falling, and the globe, earth, moon, comet, sun, star, fall forever and ever.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)  
*Essays: First Series*  
Spiritual Laws (p. 137)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Ennis, Jacob**  
No biographical data available

The origination of the solar system is like a lock of the most intricate mechanism, and gravity is the single and only key to fit that lock!

*The Origin of the Stars: And the Causes of Their Motions and Their Light* (2nd edition)  
Part III, Chapter XXII (p. 250)  
D. Appleton & Co. New York, New York, USA. 1868

**Everett, Edward** 1794–1865  
Whig Party politician

...the great frame of nature, from the infinitesimal molecule to the entire compacted universe, is held together by the law of gravity; every mote that floats in the sunbeam, every leaf that falls in the forest, every drop that distills from the clouds, every planet that encircles the sun, every sun which holds together its attendant system, and every system which swings in vast gyration through the infinite of space, obeys this mysterious power.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*  
Mr. Everett’s Inaugural Address on Academical Education (p. 99)  
Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Faraday, Michael** 1791–1867  
English physicist and chemist

I go with Newton when he speaks of the “physical lines of gravitating force”...

In Bence Jones  
*The Life and Letters of Faraday* (Volume 2)  
Chapter III (p. 367)  
J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1870

...we come into this world, we live, and depart from it, without our thoughts being called specifically to consider how all this takes place; and were it not for the exertions of some few inquiring minds, who have looked into these things and ascertained the very beautiful laws and conditions by which we *do* live and stand upon the earth, we should hardly be aware that there was anything wonderful in it.

In William Crookes  
*A Course of Six Lectures on the Various Forces of Matter and Their Relations to Each Other*  
Lecture 1 (p. 3)  
Richard Griffin & Co. London, England. 1860

**Feynman, Richard P.** 1918–88  
American theoretical physicist

But I would like not to underestimate the value of the world view which is the result of scientific effort. We have been led to imagine all sorts of things infinitely more marvelous than the imaginings of poets and dreamers of the past. It shows that the imagination of nature is far, far greater than the imagination of man. For instance, how much more remarkable it is for us all to be stuck – half of us upside down – by a mysterious attraction to a spinning ball that has been swinging in space for billions of years than to be carried on the back of an elephant supported on a tortoise swimming in a bottomless sea.

*What Do You Care What Other People Think?*

The Value of Science (p. 242)  
W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Fort, Charles** 1874–1932  
American writer

If the Law of Gravitation could be stated as a real utterance, it might be a real resistance to us. But we are told only that gravitation is gravitation.

*The Book of the Damned*  
Chapter X (p. 132)  
Boni & Liveright. New York, New York, USA. 1919

**Fuller, Thomas** 1608–61  
English clergyman and author

Gravity is the ballast of the soul, which keeps the mind steady.

*The Holy and Profane State*  
Book III, Chapter XXI (p. 199)  
Printed for Thomas Tegg. London, England. 1841

**Glashow, Sheldon L.** 1932–  
American physicist

I have often said from the podium that although it is gravity that holds my feet to the ground, it is the electromagnetic force that stops me from falling through the ground. Electromagnetism binds the atoms together and puts a solid floor beneath my feet.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*  
Chapter 4 (p. 73)  
Warner Books. New York, New York, USA. 1988

**Hamilton, Sir William Rowan** 1805–65  
Anglo-Irish mathematician, physicist, and astronomer

When a fact is generalised, our discontent is quieted, and we consider the generality itself as tantamount to an explanation. Why does this apple fall to the ground? Because all bodies gravitate towards each other. Arrived at this general fact, we inquire no more, although ignorant now as previously of the cause of gravitation; for gravitation is nothing more than a name for a general fact, the why of which we know not.

In Henry Longueville Mansel and John Veitch  
*Lectures on Metaphysics and Logic*  
Lecture IV (p. 71)  
William Blackwood & Sons. Edinburgh, Scotland. 1861

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

...an old idea that the speed of gravitation must be an enormous multiple of the speed of light...is only moonshine.

*Electromagnetic Theory* (Volume 3)  
Chapter X (p. 144)  
"The Electrician" printing and publishing company. London, England.  
1894–1912

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

All bodies with which we are acquainted, when raised into the air and quietly abandoned, descend to the earth's surface in lines perpendicular to it. They are therefore urged thereto by a force or effort, which it is but reasonable to regard as the direct or indirect result of a consciousness and a will existing somewhere, though beyond our power to trace, which force we term gravity...

*Outlines of Astronomy*  
Part 1, Chapter VIII (p. 368)  
American Home Library Co. New York, New York, USA. 1902

**Heyl, Paul R.**  
American scientist

Gravitation appears to be a function of nothing but the masses involved and their space coordinates. As to all other properties the evidence is negative, in most cases of a high degree of precision, reaching a few parts in a billion. The cause of gravitation is hidden in a protective armor on which there is not even a projection upon which to hang a hypothesis.

What is Gravitation?  
*Scientific Monthly*, Volume 47, August, 1938 (p. 117)

**King, Alexander** 1900–65  
No biographical data available

Newton saw an apple fall and discovered the Laws of Gravity.

Eve made an apple fall and discovered the Gravity of Law.

*I Should Have Kissed Her More* (p. 51)  
Simon & Schuster. New York, New York, USA. 1961

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

...we must suppose that the gravitating fluid has a velocity which is at least a hundred millions of times greater than that of light...

*Celestial Mechanics*, (Volume 4)(p. 645)  
Chelsea Publishing Company. New York, New York, USA. 1966

The law of universal gravitation has this inestimable advantage, that it may be reduced to calculation, and by a comparison of its results with observation, it presents the most certain method of verifying its existence. We shall see that this great law of nature represents all the celestial phenomena even in their minutest details, that there is not one single inequality of their motions which is not derived from it, with the most admirable precision, and that it explains the cause of several singular motions, just perceived by astronomers, and which were either too complicated or too slow for them to recognize their law.  
Translated by J. Pond

*The System of the World* (Volume 2)  
Book IV (pp. 2–3)  
Printed for Richard Phillips. London, England. 1809

### Lehman, Robert C.

No biographical data available

Archimedes in his bathtub  
Thinking of the king's new crown.  
Was it gold or baser metal?  
On Archy's brow there was a frown.  
Gravitation pulled him downward  
As the tub began to fill.  
Buoyant forces lifted upward  
Till the tub began to spill.

Eureka

*The Physics Teacher*, Volume 21, Number 2, February, 1983 (p. 87)

### Lockyer, Joseph Norman 1836–1920

English astronomer and physicist

The force of gravity on their surfaces must be very small. A man placed on one of them would spring with ease 60 feet high, and sustain no greater shock in his descent than he does on the Earth from leaping a yard. On such planets giants may exist; and those enormous animals which here require the buoyant power of water to counteract their weight, may there inhabit the land.

*Elements of Astronomy*

Chapter IX (p. 153)

D. Appleton and Company. New York, New York, USA. 1885

### Moore, Mary

No biographical data available

[A properly fitted corset] prevents gravity from pulling us to far forward or too far backward, which in so doing, makes us old before our time.

In Martin Gardner

*Fads and Fallacies in the Name of Science*

Chapter 8 (p. 96)

Dover Publications, Inc., New York, New York, USA; 1957

### Newton, Sir Isaac 1642–1727

English physicist and mathematician

To understand the motions of the planets under the influence of gravity without knowing the cause of gravity is as good a progress in philosophy as to understand the frame of a clock and the dependence of the wheels upon one another without knowing the cause of the gravity of the weight.

*Memoirs of Literature*

Chapter XVIII

Sold by R. Knaplock. London, England. 1722

You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider of it.

In Richard Bentley

*The Works of Richard Bentley*

Letters from Sir Isaac Newton, Letter I, Volume 3 (p. 210)

So far I have accounted for the phenomena presented to us by the heavens and the sea by means of the force of gravity, but I have as yet assigned no cause to this gravity....I have not been able to deduce from phenomena the *raison d'être* of the properties of gravity and I have not set up hypotheses.

In J. Arthur Thomson

*The System of Animate Nature* (Volume 1)

Lecture I (p. 9)

William & Norgate. London, England. 1920

Hitherto we have explained the phenomena of the heavens and of our sea by the power of gravity, but have not yet assigned the cause of this power. This is certain, that it must proceed from a cause that penetrates to the very centres of the sun and planets, without suffering the least diminution of its force; that operates not according to the quantity of the surfaces of the particles upon which it acts (as mechanical causes used to do), but according to the quantity of the solid matter which they contain, and propagates its virtue over all sides to immense distances, decreasing always as the inverse square of the distances.

In *Great Books of the Western World* (Volume 34)

*Mathematical Principles of Natural Philosophy*

Book III

General Scholium (p. 371)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...what hinders the fixed stars from falling upon one another?

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III, Part I, Query 28 (p. 529)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Noordung, Hermann 1892–1929

Slovene rocket engineer and pioneer of cosmonautics

Since the beginning of time, mankind has considered it as an expression of its Earthly weakness and inadequacy to be bound to the Earth, to be unable to free itself from the mysterious shackles of gravity.

In Ernest Stuhlinger, J.D. Henry and Jennifer Garland

*The Problem With Space Travel: The Rocket Motor*

(Noordung's) Introduction (p. 1)

Aeronautics and Space Administration. Washington, D.C. 1995

### Philip Morrison

No biographical data available

### Phylis Morrison

No biographical data available

Gravity is exigent; it reaches inside every candy box, no matter what the wrapping, to distinguish the full pound from the empty container.



*Powers of Ten*

Looking at the World: An Essay (p. 6)  
Scientific American Library. New York, New York, USA. 1982

**Ridley, B. K.**

No biographical data available

What a remarkable idea, that when you accelerate into a run, your muscles are fighting the influence of galaxies scarcely visible even with the most powerful telescopes!

*Time, Space and Things*

Chapter 8 (p. 148)

Cambridge University Press. Cambridge, England. 1984

**Shizuki, Tadao** 1760-1806

Japanese astronomer and translator

The cause of gravity is quite inscrutable. Even with advanced Western instruments and mathematics, the fundamental cause is indeterminable.

Quoted in Rekisho Shinsho

*New Treatise on Calendrical Phenomena*

1802

**Slossin, Edwin Emery** 1865-1919

Chemist and author

A warp in nature has been found, No line is straight, no circle round;

For Isaac Newton had unsound

Ideas of gravitation.

*Easy Lessons in Einstein*

Easy Lessons in Einstein (p. 1)

Harcourt, Brace & Howe. New York, New York, USA. 1920

**Soddy, Frederick** 1877-1956

English chemist

An ingenious theory of gravitation was put forward a century ago which, though not accepted, is very suggestive, and illustrates the difference between what science would consider a real cause and one that is fictitious, like the "force of gravity".

*Matter and Energy*

Chapter V (p. 112)

Henry Holt & Co. New York, New York, USA. 1912

**Thomson, James** 1700-48

Scottish poet

...by the blended power

Of gravitation and projection, saw

The whole in silent harmony revolve...

And ruled unerring by that single power

Which draws the stone projected to the ground.

*The Complete Poetical Works of James Thomson*

To the Memory of Newton, l. 40-42, l. 75-76

H. Frowde. London, England. 1908

**Tolstoy, Leo** 1828-1910

Russian writer

When Newton enunciated the law of gravity he did not say that the sun or the earth had a property of attraction;

he said that all bodies from the largest to the smallest have the property of attracting one another, that is, leaving aside the question of the cause of the movement of the bodies, he expressed the property common to all bodies from the infinitely large to the infinitely small.

*Great Books of the Western World* (Volume 51)

*Second Epilogue*, Chapter II (p. 695)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tyndall, John** 1820-93

Irish-born English physicist

In the falling of a rock from a mountain head, in the shoot of an avalanche, in the plunge of a cataract, we often see more impressive illustrations of the power of gravity than in the motions of the stars. When the intellect has to intervene, and calculation is necessary to the building up of the conception, the expansion of the feelings ceases to be proportional to the magnitude of the phenomena.

*Hours of Exercise in the Alps*

Chapter 20 (p. 251)

D. Appleton & Co. New York, New York, USA. 1895

**von Braun, Wernher** 1912-77

German-American rocket scientist

We can lick gravity, but sometimes the paperwork is overwhelming.

On Bureaucracy

*Chicago Sun Times*, 10 July 1958

**Wheeler, John Archibald** 1911-

American physicist and educator

...one feels that one has, at last in gravitational collapse, a phenomenon where general relativity dramatically comes into its own, and where its fiery marriage with quantum physics will be consummated.

*Relativity, Groups, and Topology*

Geometrodynamics and the Issue of the Final State

**Whewell, William** 1794-1866

English philosopher and historian

[The law of gravitation] is indisputably and incomparably the greatest scientific discovery ever made, whether we look at the advance which it involved, the extent of truth disclosed, or the fundamental and satisfactory nature of this truth.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 2)

Book 7, Chapter 2, article 5 (p. 180)

John W. Parker. London, England. 1837

**Whittaker, Sir Edmund** 1873-1956

English mathematician

Gravitation simply represents a continual effort of the universe to straighten itself out.

In Robert G. Colodny (ed.)

*From Quarks to Quasars: Philosophical Problems of Modern Physics*

Newtonian Gravity, Limits, and the Geometry of Space (p. 181)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA.



**Zee, Anthony**

American physicist

Of the fundamental forces of nature, we are most intimate with gravity. In the uttermost darkness of night, lost in our private thoughts and shut off from the world of light, we still feel the incessant tug of gravity. No sooner had we come into existence that we became aware of the downwards pull of gravity, balanced by the buoyancy of the fluid inside our mothers' wombs. Yet we do not know gravity.

*An Old Man's Toy: Gravity at Work and Play in Einstein's Universe*

Preface (p. ix)

The Macmillan Company. New York, New York, USA. 1989

**GREAT RED SPOT****Wilde, Henry**

No biographical data available

The great red spot on his surface is generally considered to be caused by luminous vapours at great depths within the globe, if not by the actual incandescent crust of that part of the planet. The great extent and permanency of this spot indicate it as the locus of one of the vents through which comets and cometary satellites have been ejected at different periods of the history of the planet.

*Celestial Ejectamenta* (p. 11)

At The Clarendon Press. Oxford, England. 1910

**GREATNESS****Greene, Edward L.**

No biographical data available

...a great man in whatsoever profession, a man of power in any branch of science, is greater than the science to which he devotes himself; that he himself personally is of more moment, and ought to be of deeper interest than his science; yes, than all the sciences that are or ever shall be.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Linnaean Memorial Address (p. 685)

Government Printing Office. Washington, D.C. 1908

**Longfellow, Henry Wadsworth** 1807–82

American poet

Lives of great men all remind us  
We can make our lives sublime,  
And, departing, leave behind us  
Footprints on the sands of time.

*The Poetical Works of Henry Wadsworth Longfellow*

A Psalm of Life, Stanza VII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**GREEK****Maine, Henry Sumner** 1822–88

English comparative jurist

Except the blind forces of Nature, nothing moves in this world which is not Greek in its origin.

*Village-communities in the East and West*

The Effects of Observation of India on Modern European Thought (p. 238)

Henry Holt & Co. New York, New York, USA. 1890

**GREENHOUSE WARMING****Wohlforth, Charles** 1963–

American author

It was certainly possible to argue that other, smaller effects would cancel greenhouse gas warming, but the burden of proof belonged on those who made such claims. Yet even as the evidence piled up on the side of the most reasonable assumption, the public repeatedly spun off in weird directions, with every “what if” given equal weight. It was as if a murder defendant caught with a bloody weapon in one hand and a written confession in the other were acquitted on the theory that an alien might have beamed him into that position.

*The Whale and the Supercomputer: On the Northern Front of Climate Change*

Chapter 6 (p. 168)

North Point Press. New York, New York, USA. 2004

**GROUP****Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Wherever groups disclosed themselves, or could be introduced, simplicity crystallized out of comparative chaos.

*Mathematics: Queen and Servant of Science*

Groups (p. 164)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**GROUP THEORY****Dyson, Freeman J.** 1923–

American physicist and educator

The trouble with group theory is that it leaves so much unexplained that one would like to explain. It isolates in a beautiful way those aspects of nature that can be understood in terms of abstract symmetry alone. It does not offer much hope of explaining the messier facts of life, the numerical values of particle lifetimes and interaction strengths – the great bulk of quantitative experimental data that is now waiting for explanation. The process of abstraction seems to have been too drastic, so that many

essential and concrete features of the real world have been left out of consideration. Altogether group theory succeeds just because its aims are modest. It does not try to explain everything, and it does not seem likely that it will grow into a complete or comprehensive theory of the physical world.

Mathematics in the Physical Sciences

*Scientific American*, Volume 211, Number 3, September, 1964 (p. 146)

**Newman, James Roy** 1907–66

Mathematician and mathematical historian

The Theory of Groups is a branch of mathematics in which one does something to something and then compares the result with the result obtained from doing the same thing to something else, or something else to the same thing.

*The World of Mathematics* Volume 3

*World of Mathematics*

Commentary on Certain Important Abstractions (p. 1534)

1956

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The theory of groups is an extensive subject upon which there is much to be said. There are many kinds of groups, and whatever classification may be adopted we will always find new groups which will not fit it.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 137)

Government Printing Office, Washington, D.C. 1910

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

Group theory, like lattice theory, is the whipping boy of mathematicians in need of concealing their feelings of insecurity.

*Indiscrete Thoughts*

Chapter XX (p. 221)

Birkhäuser, Boston, Massachusetts, USA. 1997

## GROUPS

**Bowen, Francis** 1811–90

American philosophical writer and educationalist

The first necessity, then, which is imposed upon us by the constitution of the mind itself, is to break up the infinite wealth of Nature into groups and classes of things, with reference to their resemblances and affinities, and thus to enlarge the grasp of our mental faculties, even at the expense of sacrificing the minuteness of information which can be acquired only by studying objects in detail.

*A Treatise on Logic*

Chapter X (p. 315)

Allyn & Bacon, Boston, Massachusetts, USA. 1895

## GROWTH

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist and author

...the everlasting command of living organizations is, "Forward!" Growth, true growth, is unique to life. The cell builds from the inside out, transmuting raw elements into stuff like itself. The crystal, the stalactite, the snowflake, are but chill and mathematical imitators of growing life, increasing only by superficial accretions of unchanged matter.

*Flowering Earth*

Chapter 4 (pp. 45–46)

G.P. Putnam's Sons, New York, New York, USA. 1939

## GROWTH STRATEGIES

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Another sect of ignorant persons declare that Nature or Heaven created them in these places by celestial influences, as if in these places we did not also find the bones of fishes which have taken a long time to grow; and as if, we could not count, in the shells of cockles and snails, the years and months of their life, as we do in the horns of bulls and oxen, and in the branches of plants that have never been cut in any part.

*The Notebooks of Leonardo da Vinci* (Volume II) 990

## GUESS

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

There never was a great scientist who did not make bold guesses, and there never was a bold man whose guesses were not sometimes wild.

*Science and Human Values*

The Sense of Human Dignity (p. 64)

Harper & Row, Publishers, New York, New York, USA. 1965

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

No, no: I never guess. It is a shocking habit, – destructive to the logical faculty.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Sign of the Four*, Chapter 1 (p. 614)

Wings Books, New York, New York, USA. 1967

**Feynman, Richard P.** 1918–88

American theoretical physicist

In general we look for a new law by the following process. First we guess it. Then we compute the conse-

quences of the guess to see what would be implied if this law that we guessed is right. Then we compare the results of the computation to nature, with experiment or experience, compare it directly with observation, to see if it works. If it disagrees with experiment it's wrong. In that simple statement is the key to science. It does not make any difference how beautiful your guess is. It does not make any difference how smart you are, who made the guess, or what his name is – if it disagrees with experiment it's wrong.

*The Character of Physical Law*

Chapter 7 (p. 156)

British Broadcasting Company. London, England. 1965

### **Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

I can understand such an attitude directed toward photographs of objects – through opportunities for subtle manipulation are legion even here. But many of our pictures are incarnations of concepts masquerading as neutral descriptions of nature. These are the most potent sources of conformity, since ideas passing as descriptions lead us to equate the tentative with the unambiguously factual. Suggestions for the organization of thought are transformed to established patterns in nature. Guesses and hunches become things.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter I (p. 28)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

To say that Einstein formulated a theory of relativity by guesswork is on all fours with saying that Wordsworth wrote rhymes and Mozart tuneful music. It is cheeky where something grave is called for.

Hypothesis and Imagination

*Times Literary Supplement*, 25 Oct 1963

### **Pólya, George** 1887–1985

Hungarian mathematician

Anything new that we learn about the world involves plausible reasoning, which is the only kind of reasoning for which we care in everyday affairs.... Certainly, let us learn proving, but also let us learn guessing.

*Mathematics and Plausible Reasoning* (Volume 1)

Induction and Analogy in Mathematics

Preface

Princeton University Press. Princeton, New Jersey, USA. 1954

### **Prior, Matthew** 1664–1721

English poet and diplomat

Forc'd by reflective Reason I confess,  
That human Science is uncertain Guess.

In A.R. Waller

*Poems on Several Occasions*

Knowledge, The First Book (p. 283)

At the University Press. Cambridge, England. 1905

### **Whewell, William** 1794–1866

English philosopher and historian

...advances in knowledge! are not commonly made without the previous exercise of some boldness and license in guessing.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 55)

John W. Parker. London, England. 1867

If many of the guesses of philosophers of bygone times now appear fanciful and absurd, because time and observation have refuted them, others, which were at the time equally gratuitous, have been confirmed in a manner which makes them appear marvellously sagacious.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 56)

John W. Parker. London, England. 1867

To try wrong guesses is apparently the only way to hit upon right ones.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book V, Chapter II (p. 284)

John W. Parker & Son. London, England. 1857

## **GULF STREAM**

### **Maury, Matthew Fontaine** 1806–73

American astronomer, astrophysicist, historian and oceanographer

There is a river in the ocean: in the severest droughts it never fails, and in the mightiest floods it never overflows; its banks and its bottom are of cold water, while its current is of warm; the Gulf of Mexico is its fountain, and its

*The Physical Geography of the Sea* (8th edition)

Chapter II (p. 19)

Harper & Brothers Publishers. New York, New York, USA. 1871

## **GUNPOWDER**

### **Bacon, Roger**

...the sound of thunder may be artificially produced in the air with greater resulting horror than if it had been produced by natural causes.

*Roger Bacon's Letter Concerning the Marvelous Power of Art and of Nature and Concerning the Nullity of Magic*

Gunpowder (p. 30)

## **GYNECOLOGIST**

### **Rivers, Joan** 1933–

American comedian

The gynecologist says, Relax, relax, I can't get my hand out, relax. I wonder why I'm not relaxed. My feet are in the stirrups, my knees are in my face, and the door is open facing me.... And my gynecologist does jokes. Dr. Schwartz at your cervix! I'm dilated to meet you! Say ahhh. There's Jimmy Hoffa! There's no way you can get back at that son of a bitch unless you learn to throw your voice.

In Roz Warren

*Glibquips* (p. 70)

Crossing Press, Freedom, California. USA. 1994

## GYROSCOPE

**Maxwell, James Clerk** 1831–79

Scottish physicist

To those who study the progress of exact science, the common spinning top is a symbol of the labours and the perplexities of men who had successfully threaded the mazes of planetary motions. The mathematicians of the last age, searching through nature for problems worthy of their analysis, found in this toy their youth ample occupation for their highest mathematical powers.

No illustration of astronomical precession can be devised more perfect than that presented by a properly balanced top, but yet the motion of rotation has intricacies far exceeding those of the theory of precession.

*The Scientific Papers of James Clerk Maxwell*

On a Dynamical Top (p. 248)

University Press. Cambridge, England. 1890

## H

### HAPPENING

#### **Kay, Marshall**

American geologist

Anything that has happened, can.

*Mapping Mars: Science, Imagination and the Birth of a World*

Mike Carr's Mars (p. 160)

Fourth Estate. London, England. 2002

#### **Leclerc, Georges-Louis, Comte de Buffon** 1707–88

French naturalist

To understand what has happened, and even what will happen we have only to examine what is happening.

In Frances Mason

*Creation by Evolution*

The Evolution of the Brain (p. 326)

The Macmillan Company. New York, New York, USA. 1928

### HAPPINESS

#### **Morley, Christopher** 1890–1957

American writer

...for after all, happiness (as the mathematicians might say) lies on a curve, and we approach it only by asymptote...

*The Haunted Bookshop*

Chapter XIII (p. 242)

Double, Page & Company. New York, New York, USA. 1923

### HARD WORK

#### **Jacobi, Karl Gustav Jacob** 1804–51

German mathematician

It must not be supposed that it is to a gift of nature that I owe such mathematical power as I possess. No, it has come by hard work, hard work. Not mere industry, but brain-splitting thinking – hard work; hard work that has often endangered my health.

Quoted by C.S. Peirce

In A.G. Sedgwick

*The 19th Century: A Review of Progress During the Past One Hundred Years in the Chief Departments of Human Activity*

The Century's Great Men in Science (p. 317)

G.P. Putnam's Sons. New York, New York, USA. 1901

### HARMONIC LAW

#### **Kepler, Johannes** 1571–1630

German astronomer

But now since the first light eight months ago, since broad day three months ago, and since the sun of my

wonderful speculation [relating to the law of planetary motion – harmonic law] has shone fully a very few days ago: nothing holds me back. I am free to give myself up to the sacred madness, I am free to taunt mortals with the frank confession that I am stealing the golden vessels of the Egyptians, in order to build of them a temple for my God, far from the territory of Egypt. If you pardon me, I shall rejoice; if you are enraged, I shall bear up. The die is cast, and I am writing the book – whether to be read by my contemporaries or by posterity matters not. Let it await its reader for a hundred years, if God Himself has been ready for His contemplator for six thousand years.

In *Great Books of the Western World* (Volume 16)

*Harmonies of the World*

Proem (p. 1010)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### HARMONY

#### **von Humboldt, Alexander** 1769–1859

German naturalist and explorer

The earnest and solemn thoughts awakened by a communion with Nature intuitively arise from a presentiment of the order and harmony pervading the whole universe, and from the contrast we draw between the narrow limits of our own existence and the image of infinity revealed on every side, whether we look upward to the starry vault of heaven, scan the far-stretching plain before us, or seek to trace the dim horizon across the vast expanse of ocean.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 25)

D. Appleton & Co. New York, New York, USA. 1850

### HAZARD

#### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The opinion that man has long been placed in the centre of the universe, considering himself the special object of the cares of nature, leads each individual to make himself the centre of a more or less extended sphere and to believe that hazard has preference for him.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter XVI (p. 164)

John Wiley & Sons. New York, New York, USA. 1902

### HEAL

#### **Eddy, Mary Baker** 1821–1910

Religious writer

...how do drugs, hygiene, and animal magnetism heal? It may be affirmed that they do not heal, but only

relieve suffering temporarily exchanging one disease for another.

*Science and Health, With Key to the Scriptures*

Chapter XIV (p. 143)

Allison V. Stewart. Boston, Massachusetts, USA. 1918

## HEALING

**Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

You know, my dear doctor, the art of healing is simply the art of lulling and calming the imagination.

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (p. 140)

Columbia University Press. New York, New York, USA. 1955

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Dogs with their tongues their wounds do heal,  
But men with hands, as thou shalt feel.

*The Poetical Works of Samuel Butler* (Volume 1)

Part I, canto ii, l. 773–774

Bell & Daldy. London, England. 1835

**Eddy, Mary Baker** 1821–1910

American religious writer

Here comes the question, How do drugs, hygiene and animal magnetism heal? It may be affirmed that they do not heal, but only relieve suffering temporarily, exchanging one disease for another.

*Science and Health with Key to the Scriptures*

Chapter XIV (p. 483)

Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Forssmann, Werner** 1904–79

German physician and physiologist

One may compare the art of healing with a work of art, which from different standpoints and under different lighting reveals ever new and surprising beauty.

*Nobel Lectures, Physiology or Medicine 1942–1962*

The Role of Heart Catheterization and Angiocardiography in the Development of Modern Medicine (p. 510)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

...it will never get well if you pick it.

What Is Going on in the World

*The American Mercury*, Volume XXX, Number 119, November, 1933 (p. 257)

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

What wound did ever heal but by degrees?

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Othello, The Moore of Venice*

Act II, Scene iii, l. 375

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Willan, Robert** 1757–1812

Scottish physician

The Art of Healing would seem to be of all Arts the most honourable, even tho' no better Reason could be given for it, than that it is the most difficult.

*An Essay on the King's-evil: By Robert Willan, M.D.*

To Dr. Mead (p. v)

Printed for J. & P. Knapton. London, England. 1746

## HEALTH

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

Health is the first of all liberties, and happiness gives us the energy which is the basis of health.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

April 3, 1865 (p. 132)

A.L. Burt Company, Publishers. New York, New York, USA. 1897

**Born-Volber, A. J.**

No biographical data available

All that influences health, influences disease.

In Albert Abrams

*Man and His Poisons*

Chapter X (p. 220)

E.B. Treat & Co. New York, New York, USA. 1906

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

It was a monotonous life, but it was very healthy; and one does not much mind anything when one is well.

*Erewhon and Erewhon Revisited*

Chapter I (p. 5)

The Modern Library. New York, New York, USA. 1955

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Strive to preserve your health; and in this you will the better succeed in proportion as you keep clear of the physicians, for their drugs are a kind of alchemy concerning which there are no fewer books than there are medicines.

*Leonardo da Vinci's Note Books* (p. 65)

Duckworth & Company. London, England. 1906

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

The beginning of health lies in knowing the disease and in the sick man's willingness to take the medicines which the physician prescribes...

In *Great Books of the Western World* (Volume 29)



*The History of Don Quixote de la Mancha*  
Part II, Chapter 60 (p. 392)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Donleavy, James Patrick** 1926–  
No biographical data available

...when you don't have any money, the problem is food.  
When you have money, it's sex. When you have both,  
it's health...

*The Ginger Man*  
Chapter 5 (p. 39)  
Delacorte Press. New York, New York, USA. 1974

**Eddy, Mary Baker** 1821–1910  
American religious writer

Health is not a condition of matter, but of Mind; nor can  
the material senses bear reliable testimony on the subject  
of health.

*Science and Health with Key to the Scriptures*  
Chapter VI (p. 120)  
Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

...the rich ate and drank freely, accepting gout and apo-  
plexy as things that ran mysteriously in respectable fami-  
lies...

*Silas Marner*  
Chapter III (pp. 28–29)  
Dodd, Mead & Company. New York, New York, USA. 1948

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

The sense of wellbeing! It's often with us  
When we are young, but then it's not noticed;  
And by the time one has grown to consciousness  
It comes less often.

*The Elder Statesman*  
Act II (p. 54)  
Farrar, Straus & Cudahy. New York, New York, USA. 1959

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The first wealth is health. Sickness is poor-spirited, and  
cannot serve anyone; it must husband its resources to  
live. But health or fullness answers its own ends and has  
to spare, runs over, and inundates the neighborhoods and  
creeks of other men's necessities.

*Ralph Waldo Emerson: Essays and Lectures*  
*The Conduct of Life*  
Power (p. 972)  
The Library of America. New York, New York, USA. 1983

**Gull, Sir William Withey** 1816–90  
English physician

What we call health, which looks so fixed and stable, is  
more changeable than the stability of the rainbow.

*A Collection of the Published Writings of William Withey Gull (Volume 2)*  
Notes and Aphorisms (p. lix)  
The New Sydenham Society. London, England. 1896

**Hawthorne, Nathaniel** 1804–64  
American novelist and short story writer

A bodily disease, which we look upon as whole and  
entire within itself, may, after all, be but a symptom of  
some ailment in the spiritual part.

*The Scarlet Letter*  
Chapter 10 (p. 122)  
Modern Library. New York, New York, USA. 2000

**Herophilus** 325 BCE–255 BCE  
Greek physician

To lose one's health renders science null, art inglori-  
ous, strength effortless, wealth useless and eloquence  
powerless.

In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the*  
*Massengill Family from the Fifteenth to the Twentieth Century* (p. 28)  
The S. E. Massengill Company. Bristol, Tennessee, USA. 1943

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

If you mean to keep as well as possible, the less you think  
about your health the better.

*Over the Teacups*  
Chapter VIII (p. 186)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

There are three wicks you know to the lamp of a man's  
life: brain, blood, and breath. Press the brain a little, its  
light goes out, followed by both the others. Stop the heart  
a minute, and out go all three of the wicks. Choke the air  
out of the lungs, and presently the fluid ceases to sup-  
ply the other centres of flame, and all is soon stagnation,  
cold, and darkness.

*The Professor at the Breakfast-Table*  
Chapter XI

**Jefferson, Thomas** 1743–1826  
3rd president of the USA

With your talents and industry, with science, and that  
steadfast honesty which eternally pursues right, regard-  
less of consequences, you may promise yourself every-  
thing – but health, without which there is no happiness.  
An attention to health then should take place of every  
other object. The time necessary to secure this by active  
exercises, should be devoted to it in preference to every  
other pursuit.

In Julian P. Boyd (ed.)  
*The Papers of Thomas Jefferson* (Volume 11)  
Letter to Thomas Mann Randolph, Jr., July 6, 1787 (p. 558)  
Princeton University Press. Princeton, New Jersey, USA. 1950

**Melville, Herman** 1819–91  
American novelist

I rejoice in my spine, as in the firm audacious staff of that flag which I fling half out to the world.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 80 (p. 258)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## Proverb

Health and sickness surely are men's double enemies.

In George Herbert

*Outlandish Proverbs*

#1011

Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ray, John** 1627–1705

English naturalist

Health without money is half a sickness.

*A Complete Collection of English Proverbs* (p. 12)

Printed for G. Cowie. London, England. 1813

Early to go to bed, and early to rise, makes a man healthy, wealthy, and wise.

*A Complete Collection of English Proverbs* (p. 33)

Printed for G. Cowie. London, England. 1813

Health is better than wealth.

*A Complete Collection of English Proverbs* (p. 120)

Printed for G. Cowie. London, England. 1813

**Romains, Jules** 1885–1972

French author

Healthy people are sick people who don't know it.

*Knock*

Act 1 (p. 12)

Barron's Educational Series. Great Neck, New York, USA. 1962

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

One who does not care about his own health, or life, will soon be either disabled or dead.

*Encyclopedia of Thoughts*

Aphorisms 1033

Heritage Books. Ithaca, New York, USA. 1975

**Sacks, Oliver W.** 1933–

American neurologist and author

Health is infinite and expansive in mode, and reaches out to be filled with the fullness of the world; whereas disease is finite and reductive in mode, and endeavors to reduce the world to itself.

*Awakenings*

Perspectives (p. 234)

Vintage Books. New York, New York, USA. 1990

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Use your health, even to the point of wearing it out. That is what it is for. Spend all you have before you die; and do not outlive yourself.

*The Doctor's Dilemma*

Preface on Doctors

The Latest Theories (p. xcii)

Brentano's. New York, New York, USA. 1920

Doctoring is not even the art of keeping people in health (no doctor seems able to advise you what to eat any better than his grandmother or the nearest quack): it is the art of curing illnesses.

*The Doctor's Dilemma*

Preface (p. 25)

Penguin Books. Baltimore, Maryland, USA. 1954

**Simmons, Charles** 1798–1856

American clergy and litterateur

He that wants health wants everything.

*Laconic Manual and Brief Remarker Containing Over a Thousand*

*Subjects Alphabetically and Systematically Arranged* (p. 234)

Robert Dick. Toronto, Ontario, Canada. 1853

A man too busy to take care of his health is like a mechanic too busy to take care of his tools.

*Laconic Manual and Brief Remarker Containing Over a Thousand*

*Subjects Alphabetically and Systematically Arranged* (p. 234)

Robert Dick. Toronto, Ontario, Canada. 1853

**Sterne, Laurence** 1713–68

English novelist and humorist

People who are always taking care of their health, are like misers, who are hoarding up treasure which they have never spirit enough to enjoy.

*The Works of Laurence Sterne: With a Life of the Author*

The Koran (p. 330)

William Durell & Co. New York, New York, USA. 1814

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

It is better to lose health like a spend thrift than to waste it like a miser.

*Virginibus Puerisque & Familiar Studies of Men & Books*

Aes Triplex (p. 68)

J.M. Dent & Sons Ltd. London, England. No date

**Thomson, James** 1700–48

Scottish poet

Health is the vital Principle of Bliss,  
And Exercise of Health.

*The Castle of Indolence*

Canto II, Stanza lviii

William Smith. London, England. 1842

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

There are people who strictly deprive themselves of each and every eatable, drinkable and smokable which has in any way acquired a shady reputation. They pay this price for health. And health is all they get for it. How strange it is. It is like paying out your whole fortune for a cow that has gone dry.

*Mark Twain's Autobiography* (Volume 1)  
Chapters Begun in Vienna (p. 98)  
Harper & Brothers. New York, New York, USA. 1924

He had much experience of physicians, and said “the only way to keep your health is to eat what you don’t want, drink what you don’t like, and do what you’d durther not.”

*Following the Equator* (Volume 2)  
Chapter XIII (p. 151)  
Harper & Brothers. New York, New York, USA. 1899

**Walton, Izaak** 1593–1683  
English writer

...look to your health: and if you have it, praise God, and value it next to a good conscience; for health is the second blessing that we mortals are capable of; a blessing that money cannot buy.

*The Complete Angler*  
The Fifth Day, Chapter XXI (pp. 225–226)  
T.N. Foulis. London, England. 1913

## HEART TRANSPLANT

**Maudsley, Henry** 1835–1918  
English physician

Were the heart of one man to be placed in the body of another it would probably make no difference in the circulation of the blood, but it might make a real difference in the temper of his mind. So close is the physiological sympathy of parts in the commonwealth of the body, that it is necessary in the physiological study of mind to regard it as a function of the whole organism, as comprehending the whole bodily life.

*Responsibility in Mental Disease*  
Introductory (pp. 18–19)  
D. Appleton & Co. New York, New York, USA. 1900

## HEAT

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...heat is a motion of expansion, not uniformly of the whole body together, but in the smaller parts of it; and at the same time checked, repelled, and beaten back, so that the body acquires a motion alternative, perpetually quivering, striving and struggling, and irritated by repercussion, whence springs the fury of fire and heat.

In James Spedding, Robert Leslie Ellis, Douglas Denon Heath and William Rawley  
*Works of Francis Bacon* (Volume 8)  
*Translation of the Novum Organum* (p. 215)  
Taggard & Thompson. Boston, Massachusetts, USA. 1863

**Baumel, Judith**  
No biographical data available

Think of the complexity of temperature, quantification of that elusive quality “heat.”

Tonight, for instance, your hands are colder than mine. Someone could measure more precisely than we the nature of this relationship.

*The Weight of Numbers*  
Fibonacci (p. 20)  
Wesleyan University Press, Middletown, Connecticut, USA; 1988

**Carnot, Sadi Nicolas Leonhard** 1796–1832  
French physicist and engineer

The phenomenon of the production of motion by heat has not been considered in a sufficiently general way.... It is necessary to establish proofs applicable not only to steam engines but to all other heat-engines, irrespective of the working substance and the manner in which it acts.

Translated by W.F. Maggie  
*The Second Law of Thermodynamics: Memoirs by Carnot, Clausius, and Thompson*  
Reflections on the Motive Power of Heat, and on Engines Suitable for Developing this Power (p. 6)  
Harper & Brothers. New York, New York, USA. 1899

**Clausius, Rudolph** 1822–88  
German physicist

Heat can never pass from a colder to a warmer body without some other change, connected therewith, occurring at the same time.

*The Mechanical Theory of Heat – With its Applications to the Steam Engine and to Physical Properties of Bodies*  
Fourth Memoir  
John van Voorst. London, England. 1867

**Dyson, Freeman J.** 1923–  
American physicist and educator

Heat is disordered energy. So with two words the nature of heat is explained.

What is Heat?  
*Scientific American*, Volume 191 Number 3, September, 1954 (p. 58)

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Heat is a great agent and a useful word, but considered as a means of explaining the universe, it requires an extensive knowledge of differences....

*Daniel Deronda*  
Book I, Chapter VII (p. 23)  
Harper & Brothers. New York, New York, USA. 1876

**Flanders, Michael** 1922–75  
English actor and singer

**Swann, Donald** 1923–94  
English composer, musician, and entertainer

You can't pass heat from a cooler to a hotter.  
 Try if you like, you far better notter,  
 cause the cold in the cooler will get hotter as a ruler,  
 'cause the hotter body's heat will pass to the cooler.

*At the Drop of Another Hat*

The First and Second Law

CD. Telarc. Cleveland, Ohio, USA. 1994

Heat is work and work's a curse  
 And all the heat in the universe  
 Is gonna cool down  
 Because it can't increase.

*At the Drop of Another Hat*

The First and Second Law

CD. Telarc. Cleveland, Ohio, USA. 1994

### **Fourier, (Jean Baptiste-) Joseph** 1768–1830

French mathematician and physicist

The effects of heat are subject to constant laws which cannot be discovered without the aid of mathematical analysis.

Translated by Alexander Freeman

*The Analytical Theory of Heat*

Chapter I (p. 14)

At The University Press. Cambridge, England. 1878

...a very extensive class of phenomena exists, not produced by mechanical forces, but resulting simply from the presence and accumulation of heat. This part of natural philosophy cannot be connected with dynamical theories, it has principles peculiar to itself, and is founded on a method similar to that of other exact sciences.

In *Great Books of the Western World* (Volume 45)

*The Analytical Theory of Heat* (p. 23)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Heat, like gravity, penetrates every substance of the universe, its rays occupy all parts of space. The object of our work is to set forth the mathematical laws which this element obeys. The theory of heat will hereafter form one of the most important branches of general physics.

In *Great Books of the Western World* (Volume 43)

*The Analytical Theory of Heat*

Preliminary Discourse (p. 169)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Frost, Robert** 1874–1963

American poet

Say something to us we can learn.  
 By heart and when alone repeat.  
 Say something! And it says, "I burn."  
 But say with what degree of heat.  
 Talk Fahrenheit, Talk Centigrade.  
 Use language we can comprehend.  
 Tell us what elements you blend.

*Complete Poems of Robert Frost*

Choose Something Like a Star, l. 9–15

Henry Holt & Company. New York, New York, USA. 1949

### **Hall, Thomas Wright**

No biographical data available

Heat is considered to be as closely kin to Electricity as is infancy to manhood, and thus to be all-worthy of scientific apotheosis.

*New Theory of Galvanism: The Electrothermology of Chemistry*

Preface (p. v)

Edmonston & Douglas. Edinburgh, Scotland. 1872

...in this perhaps presumptuous effort, Heat is viewed in entirely novel aspects. Heat is considered no longer exclusively a thing of thermometers and pyrometers, but as a great power in chemistry.

*New Theory of Galvanism: The Electrothermology of Chemistry*

Preface (p. v)

Edmonston & Douglas. Edinburgh, Scotland. 1872

### **Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

The word heat, in its common acceptation, denotes a certain sensation well known to every person. The cause of this sensation, to avoid ambiguity, ought to have been distinguished by a name different from that which is used to point out its effect. Various authors, indeed, who have treated on the subject of heat, have occasionally added certain terms to distinguish their conceptions, such as latent, absolute, specific, sensible heat, while others have adopted the new expressions of caloric and the matter of heat.

Experiments on the Solar and on the Terrestrial Bays that Occasion Heat

*Philosophical Transactions of the Royal Society of London,*

Volume 90, 1800 (p. 293)

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

### **Hoyle, Geoffrey** 1942–

English science fiction writer

The Yela can destroy the Earth by wrapping a blanket of hydrogen around our atmosphere. Then all it needs do to destroy us is just press a little of the hydrogen into the atmosphere itself. The hydrogen and the oxygen in our atmosphere combine together with an immense release of heat. The generation of heat causes the gas to rise and more hydrogen is sucked down. Within seconds the whole atmosphere is a raging inferno.

*Into Deepest Space*

Chapter I (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1974

### **Johnson, Frank H.**

American biologist

Without heat, all life processes cease. With a little too much heat, they cease just as surely.

Heat and Life

*Scientific American*, Volume 191 Number 3, September, 1954 (p. 65)

**Joule, James Prescott** 1818–89  
English physicist

I shall lose no time in repeating and extending these experiments, being satisfied that the grand agents of nature are by the Creator's fiat indestructible, and that whatever mechanical force is expended an exact equivalent of heat is always obtained.

In Osborne Reynolds  
*Memoir of James Prescott Joule*  
Chapter VI (p. 71)  
Manchester Literary and Philosophical Society. Manchester, England.  
1892

You see, therefore, that living force may be converted into heat, and that heat may be converted into living force, or its equivalent attraction through space. All, three, therefore – namely, heat, living force, and attraction through space (to which I might also add light, were it consistent with the scope of the present lecture) – are mutually convertible into one another. In these conversions nothing is ever lost. The same quantity of heat will always be converted into the same quantity of living force. We can therefore express the equivalency in definite language applicable at all times and under all circumstances.

*The Scientific Papers of James Prescott Joule*  
On Matter, Living Force and Heat (pp. 270–271)  
Taylor & Francis. London, England. 1884

...the grand agents of nature are, by the Creator's fiat, *indestructible*; and that wherever mechanical force is expended, an exact equivalent of heat is always obtained.

On the Calorific Effects of Magneto-Electricity, and on the Mechanical Effects of Heat  
*Philosophical Magazine*, Volume XXIII, Number CLIV, December, 1843 (p. 442)

**Joyce, James** 1882–1941  
Expatriate Irish writer and poet

Be a warm day I fancy. Specially in these black clothes feel it more. Black conducts, reflects (refracts is it?) the heat.

*Ulysses* (p. 57)  
Random House, Inc. New York, New York, USA. 1946

**Keane, Bill Joseph**  
No biographical data available

Heat makes things expand. That's why the days are longer in the summer.

*Cartoon caption*

**Locke, John** 1632–1704  
English philosopher and political theorist

Heat is a very brisk agitation of the insensible parts of the object, which produces in us that sensation, from whence

we denominate the object hot; so what in our sensation is heat, in the object is nothing but motion.

*The Works of John Locke In Nine Volumes* (Volume 2)  
*Elements of Natural Philosophy*  
Chapter XI  
Of the Five Senses, of Touch

**Lyell, Sir Charles** 1797–1875  
English geologist

It is a favourite dogma of some physicists that not only the earth, but the sun itself, is continually losing a portion of its heat, and that as there is no known source by which it can be restored we can foresee the time when all life will cease to exist on this planet, and on the other hand we can look back to a period when the heat was so intense as to be incompatible with the existence of any organic beings such as are known to us in the living or fossil world. ... A geologist in search of some renovating power by which the amount of heat may be made to continue unimpaired for millions of years, past and future, in the solid parts of the earth...has been compared by an eminent physicist to one who dreams he can discover a source of perpetual motion and invent a clock with a self-winding apparatus. But why should we despair of detecting proofs of such regenerating and self-sustaining

*Principles of Geology*  
Chapter XXXII (p. 213)  
J, Murray. London, England. 1868

**Maxwell, James Clerk** 1831–79  
Scottish physicist

The distinction between hot bodies and cold ones is familiar to all, and is associated in our minds with the difference of the sensations which we experience in touching various substances, according as they are hot or cold. The intensity of these sensations susceptible of degrees, so that we may estimate one body to be hotter or colder than another by touch. The words hot, warm, cool, cold are associated in our minds with a series of sensations which we suppose to indicate a corresponding series of states of an object with respect to heat.

*Theory of Heat*  
A Treatise on Heat  
Chapter I (p. 1)  
Longmans, Green & Company. London, England. 1871

**Mayer, Julius Robert von Joseph** 1904–83  
German physician and physicist

Concerning the intimate nature of heat, or of electricity, etc., I know nothing, anymore than I know the intimate nature of any matter whatsoever, or of anything else.

Quoted by Pierre Duhem  
*The Aim and Structure of Physical Theory*  
Part I, Chapter III (p. 52)  
Princeton University Press. Princeton, New Jersey, USA. 1954



**McNeil, I. Joseph**

No biographical data available

In the beginning God created the heaven and the earth are the opening words of the Bible, which goes on, in verse 3, and God said Let there be light: and there was light. It must be assumed that the Cosmic Illuminator had to abide by the laws of physics like the rest of us for, after all, He had created them. In the nature of things, sensible heat comes long before visible light in the spectrum of electromagnetic wavelengths. Thus, when God said Let there be light, he implied, Let there also be heat – and there was heat.

In R. Angus Buchanan

*Engineers and Engineering*

Blast: From Blowpipe to Blowing Engine (p. 79)

Bath University Press. Bath, England. 1996

**Metsler, William Joseph**

No biographical data available

The stove is hot, but that's no change  
Heat's what it's supposed to make  
Resistance generates the energy to bake  
So its always Ohm Ohm on the range.

The Cowboy's Lament

*The Physics Teacher*, Volume 15, Number 2, February, 1977 (p. 127)

**Mott-Smith, Morton Joseph**

People are always exaggerating temperatures. If the day is hot, they add on a few degrees; if it is cold they deduct a few. No one ever gives the air temperature to a fraction of a degree, but only to whole degrees. Now on the Fahrenheit scale, on account of the small size of its degree, these whoppers and inaccuracies are only about half as big as they are on the other scales.

*Heat and Its Workings* (p. 24)

D. Appleton & Company. New York, New York, USA. 1933

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Do not all fixed bodies, when heated beyond a certain degree, emit light and shine; and is not this emission performed by the vibrating motions of their parts?

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III, Part 1, Query 8

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Planck, Max** 1858–1947

German physicist

The concept of heat, like all other physical concepts, originates in a sense-perception, but it acquires its physical significance only on the basis of a complete separation of the events in the sense-organs from the external events which excite the sensation. So heat, regarded physically, has no more to do with the sense of hotness than colour,

in the physical sense, has to do with the perception of colour.

Translated by Henry L. Brose

*Theory of Heat*

Introduction (p. 1)

The Macmillan Company. New York, New York, USA. 1957

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

And a well-made language is no indifferent thing; not to go beyond physics, the unknown man who invented the word heat devoted many generations to error. Heat has been treated as a substance, simply because it was designated by a substance, and it has been thought indestructible.

*The Foundations of Science*

*The Value of Science*, Analysis and Physics (p. 289)

The Science Press. New York, New York, USA. 1913

**Primack, Joel**

Astronomer

**von Hippel, Frank**

Nuclear physicist

This heat [developed after fission stops in a reactor] is like the still thrashing tail of a dead dragon.

Nuclear Reactor Safety

*Bulletin of the Atomic Scientists*, Volume XXX, Number 8, October,

1974 (p. 7)

**Preston, Thomas** 1860–1900

Irish scientist

There is, perhaps, no scientific inquiry more full of human interest, than the study of the nature of heat, and the manner in which matter in general is affected by it. No branch of physical science is so intimately connected with the everyday occupations of life, and, consequently, none of them interests mankind more closely.

*The Theory of Heat* (2nd edition)

Introductory (p. 3)

Macmillan & Company Ltd. London, England. 1904

**Reeve, Sidney Armor**

No biographical data available

Heat is like an ant-colony. It lives in a hidden nest. We can see it go into and come out of its nest – matter – by several doors. But as to just whither those doors may lead, and what may be the form of structure which connects the several doors, is as yet pure surmise.

*Energy*

Chapter VII (p. 89)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1909

**Rothman, Tony** 1953–

American cosmologist

Like atoms, heat is so intangible that it was one of the last concepts in classical physics to be sorted out. In the



process, the science of thermodynamics was created. Pollyannas who believe anything is possible should be subjected to a course in thermodynamics.

*Instant Physics: From Aristotle to Einstein, and Beyond*  
Chapter 3 (p. 68)  
Ballentine Books. New York, New York, USA. 1995

## HEAVENLY BODIES

**Phelps, Almira Hart Lincoln** 1793–1884  
American educator and writer

The study of nature, in any of her forms, is highly interesting and useful. But the heavenly bodies are far distant from us – and were they – within our reach, are too mighty for us to grasp, our feeble minds seem overwhelmed in the contemplation of their immensity.

*Familiar Lectures on Botany, Practical, Elementary and Physiological*  
(5th edition)  
Lecture I (p. 15)  
F.J. Huntington & Co. New York, New York, USA. 1837

## HEAVENS

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

The ways of Heaven are dark and intricate,  
Puzzled in Mazes and perplex'd with errors:  
Our understanding traces 'em in vain,  
Lost and bewilder'd in the fruitless search;  
Nor sees with how much art the winding run,  
Nor where the regular confusion ends.

*Cato*  
Act One, Scene I  
J. Dicks. London, England. 1883

**Alighieri, Dante** 1265–1321  
Italian poet and writer

...Heaven calls you, and revolves around you, displaying to you its eternal beauties....

In *Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
Purgatory, Canto XIV, l. 47–48  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Author undetermined

He cannot but feel a sense of pleasure, and even, of power, when he tracks the course of the flashing comet, examines into the physical characteristics of the Sun and Moon, and records the various phases of the distant planets. But if such be his feeling, it is certainly tempered with awe and wonder as he contemplates the phenomena of the heavens – the beauty of the stars, the immensity of their orbits, the regularity with which each bright world performs its appointed course, the simplicity of the laws which govern its motions, and the mystery which attends its far-off existence.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I  
T. Nelson & Sons. London, England. 1889

There is no “behind the scenes” in the heavens whence new stars and comets may make their entrance and strut and fret their hour on the celestial stage; no lumber garret or property room into which they can retire and be stowed out of the way. The universe is an open, infinite somewhere, at every point of its extent as much a real somewhere as it is here, where we happen for the moment to be bowling through space.

In Charles Dickens  
Periodical Comets  
*All the Year Round: A Weekly Journal*, Volume 7, March 23, 1872 (p. 390)

**Ball, Sir Robert Stawell** 1840–1913  
Irish astronomer

“The Story of the Heavens” is...indeed a wondrous story to narrate; and could we tell it adequately, it would prove of boundless interest and of exquisite beauty. It leads to the contemplation of the mightiest efforts of nature and the greatest achievements of human genius.

*The Story of the Heavens*  
Introduction (p. 1)  
Cassell & Co., Ltd. London, England. 1890

**Brewster, David** 1781–1868  
Scottish scientist, inventor, and writer

In the stillness of night, when the moral world is asleep – when the aspen leaf has ceased to flutter, and no sound is heard save that of the remote waterfall, or the restless ocean, or the zephyr breath among the distant foliage, the silver Moon, the brilliant Planet, and the twinkling Star, are the beacon-lights which guide the eye through the brilliant expanse above.

*More Worlds Than One: The Creed of the Philosopher and the Hope of the Christian*  
Chapter II (p. 17)  
John Camden Hotten. London, England. 1870

**Browne, J. Stark**  
No biographical data available

Awe-inspiring in its grandeur is that wonderful panorama which, on clear dark nights, we see in the heavens above us – that jeweled canopy sparkling from east to west, and from north to south, with its myriad diamond points of light.

The Number and Distances of the Stars  
*The Rationalist Annual*, 1931 (p. 61)

**Browning, Robert** 1812–89  
English poet

Ah, but a man's reach should exceed his grasp,  
Or what's a heaven for?

*The Poems and Plays of Robert Browning*  
Andrea del Sarto, 97  
The Modern Library. New York, New York, USA. 1934

**Burke, Edmund** 1729–97  
English statesman and philosopher

The starry heaven, though it occurs so very frequently to our view, never fails to excite an idea of grandeur. This cannot be owing to anything in the stars themselves, separately considered. The number is certainly the cause. The apparent disorder augments the grandeur; for the appearance of care is highly contrary to our ideas of magnificence. Besides, the stars lie in such apparent confusion as makes it impossible, on ordinary occasions, to reckon them. This gives them the advantage of a sort of infinity. *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful*

Section XIV (pp. 98–99)  
Harper & Brothers Publishers. New York, New York, USA. 1844

Magnificence is likewise a source of the sublime. A great profusion of things, which are splendid or valuable in themselves, is magnificent. The starry heaven, though it occurs so very frequently to our view, never fails to excite an idea of grandeur. This cannot be owing to anything in the stars themselves, separately considered. The number is certainly the cause. The apparent disorder augments the grandeur, for the appearance of care is highly contrary to our ideas of magnificence. Besides, the stars lie in such apparent confusion, as makes it impossible, on ordinary occasions, to reckon them. This gives them the advantage of a sort of infinity.

*The Sublime and the Beautiful*  
Section XIV (p. 73)  
Printed by J.F. Dove. London, England. 1827

**Burnham, Jr., Robert Jr.** 1931–93  
American astronomer

Here, in the dark unknown immensity of the heavens, we shall meet the glories beyond description and witness scenes of inexpressible splendor. In the great black gulfs of space and in the realm of the innumerable stars, we shall find mysteries and wonders undreamed of.

*Burnham's Celestial Handbook*  
Chapter 2 (p. 13)  
Celestial Handbook Publications. Flagstaff, Arizona, USA.

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Oh with what prayers and fasting  
Shall mortal man deserve  
To see that glimpse of Heaven.

*The Coloured Lands*  
The Joys of Science (p. 209)  
Sheed & Ward. New York, New York, USA. 1938

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

If a man should ascend alone into heaven and behold clearly the structure of the universe and the beauty of the stars, there would be no pleasure for him in the

awe-inspiring sight, which would have filled him with delight if he had had someone to whom he could describe what he had seen.

Translated by William Armistead Falconer  
*De Amicitia*  
XXIII (p. 195)  
Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

...the heavens are immense in comparison with the Earth...  
In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Book One, Chapter 6 (p. 516)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

When the heavens were a little blue arch, stuck with stars, me thought the universe was too straight and close: I was almost stifled for want of air: but now it is enlarged in height and breadth, and a thousand vortices taken in. I begin to breathe with more freedom, and I think the universe to be incomparably more magnificent than it was before.

Translated by John Glanville  
*A Plurality of Worlds*  
The Fifth Evening (p. 129)  
Printed for R.W. London, England. 1702

**de Gubernatis, Giuseppe Angelo**  
No biographical data available

The immense vault of heaven which over-arches the earth, as the eternal storehouse of light and rain, as the power which causes the grass to grow, and therefore the animals which pasture upon it, assumes in the Vedic literature the name of Aditis, or the infinite, the inexhaustible, the fountain of ambrosia (*amritasya nabhis*).

*Zoological Mythology; or, The Legends of Animals*  
Section I (p. 5)  
Trübner & Co. London, England. 1872

**Dickinson, Emily** 1830–86  
American lyric poet

What once was "Heaven"  
is "Zenith" now –  
Where I proposed to go  
When Time's brief masquerade was done  
Is mapped, and charted too.

*The Complete Poems of Emily Dickinson*  
No. 70 (p. 37)  
Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Donne, John** 1572–1631  
English poet and divine

Man has weav'd out a net, and this net throwne  
Upon the Heavens, and now they are his owne.

*An Anatomy of the World*

The First Anniversary  
Presented for presentation to members of the Roxburge Club.  
Cambridge, England. 1951

And then that heaven, which spreads so farre, as that  
subtill men have, with some appearance of probabilitie,  
imagined, that in that heaven, in those manifold Sphere  
of the Planets and the Starres, there are many earths,  
many worlds, as big as this which we inhabit...

*Donne's Sermons*

The Heavens and Earth, Sermon 98 (p. 161)  
Clarendon Press. Oxford, England. 1942

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

Profounder, profounder,  
Man's spirit must dive;  
To his aye-rolling orbit  
No goal will arrive;  
The heavens that now draw him  
With sweetness untold,  
Once found – for new heavens  
He spurneth the old.

*The Works of Ralph Waldo Emerson* (Volume 5) (p. 81)  
Hearst's International Library Co. New York, New York, USA. 1914

### Flammarion, Camille 1842–1925

French astronomer and writer

The silence of the vast and starry Heavens may terrify us;  
its immensity may seem to overwhelm us. But our inquiring  
thought flies curiously on the wings of dream, toward  
the remotest regions of the visible. It rests on one star and  
another, like the butterfly on the flower. It seeks what will  
best respond to its aspirations: and thus a kind of communication  
is established, and, as it were, protected by  
all Nature in these silent appeals. Our sense of solitude  
has disappeared.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 12)

D. Appleton & Co. New York, New York, USA. 1915

Diamonds, turquoises, rubies, emeralds, all the precious  
stones with which women love to deck themselves, are to  
be found in greater perfection, more beautiful, and more  
splendid, set in the immensity of Heaven!

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 16)

D. Appleton & Co. New York, New York, USA. 1915

The Heavens afford us a perennial store of treasure,  
wherein the thinker, poet or artist can find inexhaustible  
subjects of contemplation.

*Astronomy for Amateurs*

Chapter III (p. 66)

D. Appleton & Co. New York, New York, USA. 1915

### Guilleimin, Amédée 1826–93

French journalist and scientific writer

What are the Heavens? Where the shores of that limitless  
ocean; where the bottom of that unfathomable abyss?

In Norman Lockyer and Richard Anthony Proctor

*The Heavens: An Illustrated Handbook of Popular Astronomy*

The Heavens (p. 1)

Richard Bentley & Son. London, England. 1878

### Gronchal, Florence Armstrong

American astronomer and photographer

To the true lover of the stars, one universe or a million  
makes not a whit of difference. The silent song of the  
heavens is as sweet today, its mystery as alluring, its  
delights more marvelous, than in the days of yore when  
planets rolled out heavenly notes and stars shone through  
the seven spheres of pure, translucent crystal.

*The Music of the Spheres: A Nature Lover's Astronomy*

Chapter IX (p. 200)

The Macmillan Company. New York, New York, USA. 1926

### Herschel, Friedrich Wilhelm

(Sir William) 1738–1822

English astronomer

*Coelorum perrupit claustra*

He broke through the barriers of the heavens

*Epitaph*

Upton Church

The subject of the Construction of the Heavens is of so  
extensive and important a nature, that we cannot exert  
too much attention in our endeavors to throw all possible  
light upon it.

On the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*, 1783

Hitherto the sidereal heavens have been represented by  
the concave surface of a sphere. In future we shall look  
upon those regions into which we may now penetrate as  
a naturalist regards a rich extent of ground containing  
strata variously inclined and directed as well as consist-  
ing of very different materials.

Account of Some Observations Tending to Investigate the Construction  
of the Heavens

*Philosophical Transactions of the Royal Society of London*,

Volume 74, 1784 (p. 438)

This method [disposition of the component parts] of  
viewing the heavens seems to throw them into a new  
kind of light. They are now seen to resemble a luxuriant  
garden which contains the greatest variety of productions  
in different flourishing beds; and one advantage we may  
at least reap from it is that we can, as it were, extend the  
range of our experience to an immense duration. For, is it  
not almost the same thing whether we live successively

to witness the germination, blooming, foliage, fecundity, fading, withering, and corruption of a plant, or whether a vast number of specimens, selected from every stage through which the plant passes in the course of its existence, be brought at once to our view?

Catalogue of a Second Thousand of New Nebula  
*Philosophical Transactions of the Royal Society of London*,  
Volume 79, 1789 (p. 226)

A knowledge of the construction of the heavens has always been the ultimate object of ray observations ...

In Edward Polehampton and John Mason Good  
*The Gallery of Nature and Art: Or, a Tour Through Creation and Science* (Volume 1) (2nd edition)

Chapter VII (p. 61)  
Crosby Lockwood & Son. New York, New York, USA. 1892

### Huggins, Sir William 1824–1910

English astronomer

We, who form part of the emblazonry, can only see the design distorted and confused; here crowded, there scattered, at another place superposed. The groupings due to our position are mixed up with those which are real.

*Report of the Sixty-first Meeting of the British Association for the Advancement of Science*

Address by William Huggins (p. 35)  
John Murray. London, England. 1892

### Jefferies, Richard 1848–87

English naturalist and author

The whole time in the open air, resting at mid-day, under the elms with the ripple of heat flowing through the shadow; at midnight between the ripe corn and the hawthorn hedge on the white wild camomile and the poppy pale in the duskiness, with face upturned to the thoughtful heaven.

*The Open Air*  
Goldenbrown (p. 26)  
Chatto & Windus. London, England. 1908

### Kant, Immanuel 1724–1804

German philosopher

Two things fill me with awe: the starry heavens and the sense of moral responsibility in man.

Quoted in John Tyndall  
*Fragments of Science for Unscientific People*  
Chapter VII (p. 163)  
D. Appleton & Co. New York, New York, USA. 1875

### Kepler, Johannes 1571–1630

German astronomer

My aim is to show that the heavenly machine is not a kind of divine, live being, but a kind of clockwork, insofar as nearly all the manifold motions are caused by a most simple, magnetic, and material force, just as all motions of the clock are caused by a simple weight. And I also show how these physical causes are to be given numerical and geometrical expression.

In Michael Polyani

*The Logic of Personal Knowledge*  
Letter to Herwart von Hohenburg, February 10, 1605 (p. 52)  
The Free Press. Glencoe, Illinois, USA. 1961

### Laplace, Pierre Simon 1749–1827

French mathematician, astronomer, and physicist

If in a fine night, and in a place where the horizon is uninterrupted, we follow with attention the appearance of the heavens, it will be seen to vary at every instant.

Translated by John Pond  
*The System of the World* (Volume 1)  
Chapter I (p. 3)  
Printed for Richard Phillips. London, England. 1809

### Mitchel, Ormsby MacKnight 1805–62

American astronomer

It is in the stillness of the midnight hour, when all nature is hushed in repose, when the hum of the world's ongoing is no longer heard, that the planets roll and shine, and the bright stars, trooping through the deep heavens, speak to the willing spirit that would learn their mysterious being.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Introductory Lecture (p. 1)  
T. Nelson & Sons. London, England. 1859

...in the stillness of the midnight hour, when all nature is hushed in repose, when the hum of the world's ongoing is no longer heard...the planets roll and shine, and the bright stars, trooping through the deep heavens, speak to the willing spirit that would learn their mysterious being.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Lecture I (p. 17)  
Baker & Scribner. New York, New York, USA. 1848

The starry heavens do not display their glittering constellations in the glare of day, while the rush and turmoil of business incapacitate man for the enjoyment of their solemn grandeur. It is in the stillness of the midnight hour, when all nature is hushed in repose, when the hum of the world's ongoing is no longer heard, that the planets roll and shine, and the bright stars, trooping through the deep heavens, speak to the willing spirit that would learn their mysterious being.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Introductory lecture (p. 17)  
Baker & Scribner. New York, New York, USA. 1848

Far away from the earth on which we dwell, in the blue ocean of space, thousands of bright orbs, in clusterings and configurations of exceeding beauty, invite the upward gaze of man, and tempt him to the examination of the wonderful sphere by which he is surrounded. The starry heavens do not display their glittering constellations in the glare of day, while the rush and turmoil of business incapacitate man for the enjoyment of their solemn grandeur.

*The Orbs of Heaven, or, The Planetary and Stellar Worlds*  
Lecture I (p. 1)  
Office of the National Illustrated Library. London, England. 1851

Music is here; but it is the deep and solemn harmony of the spheres. Poetry is here; but it must be read in the characters of light, written on the sable garments of night. Architecture is here; but it is the colossal structure of sun and system, of cluster and universe. Eloquence is here; but “there is neither speech nor language: its voice is not heard.”

*The Orbs of Heaven, or, The Planetary and Stellar Worlds*  
Lecture I (p. 4)  
Office of the National Illustrated Library. London, England. 1851

## Narrator

The Heavens. Once an object of superstition, awe and fear. Now a vast region for growing knowledge. The distance of Venus, the atmosphere of Mars, the size of Jupiter, and the speed of Mercury. All this and more we know. But their greatest mystery the heavens have kept a secret. What sort of life, if any, inhabits these other planets? Human life, like ours? Or life extremely lower in the scale. Or dangerously higher.

*Invaders from Mars*  
Film (1953)

## Nicholson, James

No biographical data available

Where is the man who, in the calm stillness of an autumn or winter night, can look up to and contemplate the vast blue canopy of the heavens, as it glows and sparkles from horizon to zenith with stars sown broadcast and countless as daisies in May, without experiencing that profound sense of awe and mystery that comes, dove like, descending out of the solemn stillness to take possession of his being and bend it in lowly adoration at the feet of the Great All-father?

*Nightly Wanderings in the Gardens of the Sky*  
Introduction (p. 10)  
Porteous Brothers. Glasgow, Scotland. 1881

## Nicks, Oran W.

Unless you are a sailor, a shepherd, or otherwise occupied outdoors at night, the great sweep of the heavens is almost surely less familiar to you than it was to your ancestors.

*Far Travelers*  
The Team Assembles (p. 6)  
NASA. Washington, D.C. 1985

## Pasteur, Louis

1822–95

French chemist

What is there beyond this starry vault? Other starry heavens. Well, and beyond? The human mind, urged by an invincible force, will never cease to ask itself: What is

there beyond? Suppose the mind stops somewhere in time or space? As the point where it stops is only of a finite greatness, greater only than all those which have come before it, the mind hardly begins to contemplate it before the implacable question returns, and returns again, without the mind being able to make its cry of curiosity cease.

In Frederick Morris Warren  
*Ten Frenchmen of the Nineteenth Century*  
Selections (p. 246)  
The Chautauqua Press. Chautauqua, New York, USA. 1904

## Proctor, Mary

1862–1957

American popularizer of astronomy

When we gaze at the starlit heavens, and admire the silvery radiance of the Milky Way, we would fain believe that there is absolute silence and rest, a perfect haven of repose.

The Silver River of Heaven  
*The Chautauquan*, Volume 21, Number 4, July, 1895 (p. 460)

## Proctor, Richard Anthony

1837–88

English astronomer

On a calm, clear night...the contemplation of the celestial vault raises in the least thoughtful mind vague suggestions of infinity, eternity, and omnipotence.

Shooting-Stars, Meteors and, Aerolites  
*The Eclectic Magazine*, Volume VII, Number 2, February, 1868 (p. 145)

## Seneca (Lucius Annaeus Seneca)

4 BCE–65 AD

Roman playwright

No man is so utterly dull and obtuse, with head so bent on Earth, as never to lift himself up and rise with all his soul to the contemplation of the starry heavens, especially when some fresh wonder shows a beacon-light in the sky.

*Physical Science In the Time of Nero, being a Translation of the Quaestiones Naturales of Seneca*  
Book VII, Chapter I (p. 271, 272)  
Macmillan & Company Ltd. London, England. 1910

## Shelley, Percy Bysshe

1792–1822

English poet

Heaven's ebon vault  
Studded with stars unutterably bright,  
Through which the moon's unclouded grandeur rolls,  
Seems like a canopy which love has spread  
To curtain her sleeping world.

*The Complete Poetical Works of Percy Bysshe Shelley*  
Queen Mab, IV  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## Sime, James

1843–95

No biographical data available

The prose of the heavens surpasses the brightest poetry of earth.



In James Sime

*William Herschel and His Work*

Star-Dust, Chapter V, Ocean of Ether (p. 153)

Charles Scribner's Sons. New York, New York, USA. 1900

**Somerville, Mary** 1780–1872

English mathematician

The heavens afford the most sublime subject of study which can be derived from science. The magnitude and splendor of the objects, the inconceivable rapidity with which they move, and the enormous distances between them, impress the mind with some notion of the energy that maintains them in their motions, with a durability to which we can see no limit.

*The Connexion of the Physical Sciences* (9th edition)

Introduction (p. 2)

John Murray. London, England. 1858

...however profoundly we may penetrate the depths of space, there still remain innumerable systems, compared with which, those which seem so mighty to us must dwindle into insignificance, or even become invisible....

*Mechanism of the Heavens*

Preliminary Dissertation (p. 2)

John Murray. London, England. 1831

**Spencer, Herbert** 1820–1903

English social philosopher

Sad, indeed is it to see how men occupy themselves with trivialities, and are indifferent to the grandest phenomena – care not to understand the architecture of the Heavens, but are deeply interested in some contemptible controversy about the intrigues of Mary Queen of Scots!

*Education: Intellectual, Moral and Physical*

A.L. Fowle. New York, New York, USA. 1860

**Steele, Joel Dorman** 1836–86

American educator

In the presence of such weird and wondrous beauty [the night heavens], the tenderest sentiments of the heart are aroused. A feeling of awe and reverence, of softened melancholy mingled with a thought of God, comes over us, and awakens the better nature within us.

*The Story of the Stars: New Descriptive Astronomy*

Introductory Remarks (p. 1)

American Book Co. Chicago, Illinois, USA. 1884

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...in the heavens there are rivers of stars and milky ways.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2) (p. 33)

Princeton University Press. Princeton, New Jersey, USA. 1984

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

The vault of heaven, studded with nebulae and stars, and the rich vegetable mantle that covers the soil in the climate of palms, cannot surely fail to produce on the minds of these laborious observers of nature an impression more imposing and more worthy of the majesty of creation than on those who are unaccustomed to investigate the great mutual relations of phenomena.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 39)

Harper & Brothers Publishers. New York, New York, USA. 1858

**Williams, Frederick Smeeton**

No biographical data available

...we cannot look upon the glittering bosom of the heavens without being beguiled into meditation on its wonders.

*The Wonders of the Heavens*

Chapter I (p. 10)

John Cassell. London, England. 1852

...the greater number of observers of the heavens see nothing but a vast canopy mantling the globe, sparkling with brilliant atoms. To them it is only a scene of gay and gorgeous confusion, in which no laws can be recognised – a fitting dome, perhaps, for so noble a temple as earth, or a pavement for heaven.

*The Wonders of the Heavens*

Chapter I (p. 10)

John Cassell. London, England. 1852

**HEAVENS, WONDERS OF**

**Flammarion, Camille** 1842–1925

French astronomer and writer

The most fairy-like transformations of our theaters, the most resplendent pageants of our military reviews, the most sumptuous marvels on which the human race can pride itself – all that we admire, all that we envy on the Earth – is as nothing compared with the unheard-of wonders scattered through Infinitude.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 16)

D. Appleton & Co. New York, New York, USA. 1915

**HEILIGENSCHIEIN**

**Matthews, L.**

No biographical data available

But whereas the sylvan shine on a tree is visible to anyone in the car or holding a torch, heiligenschein, the result of sunlight focused by dewdrops held above a leaf's surface by fine hairs, appears to each observer as a halo around the head of just his own shadow on the grass. In his *Memoirs* of 1562, Benvenuto Cellini, no expert on the laws of optics, interpreted this instead as a sign



of divine grace towards himself; and, says Fraser wryly, evidently none of those to whom Cellini vouchsafed his secret dared mention the halo about his own head.

Reflections on a Summer's Night

*Nature*, Volume 369, Number 6480, 9 June, 1994 (p. 441)

## HEMATOCRIT

### Wintrobe, Maxwell M.

Canadian-born physician

I...discovered that there were no reliable normal blood values. What was called "normal" was based on only a few counts that had been made in the nineteenth century. So I proceeded to collect normal blood values. Others elsewhere, also mindful of this deficiency, were beginning to do the same. A major problem, however, was methodology, and this was what led me to devise the hematocrit as a simple and accurate means of quantitating blood.

In A.B. Weisse

*Conversations in Medicine: The Story of Twentieth-Century American Medicine in the Words of Those Who Created It* (p. 83)

New York University Press. New York, New York, USA. 1984

## HEREDITY

### Bateson, William 1861–1926

English geneticist

An exact determination of the laws of heredity will probably work more change in a man's outlook on the world and in his power over nature than any other advance in natural knowledge that can be clearly foreseen.

*Annual Report of the Board of Regents of the Smithsonian Institution (1902)*

The Problems of Heredity and Their Solution (p. 559)

Government Printing Office. Washington, D.C. 1903

### Bateson, William 1861–1926

English biologist and geneticist

Evolution is a process of Variation and Heredity. The older writers, though they had some vague idea that it must be so, did not study Variation and Heredity. Darwin did, and so begot not a theory, but a science.

In A.C. Seward

*Heredity and Variation in Modern Lights*

Darwin and Modern Science Heredity and Variation in Modern Light

(p. 88)

### Caullery, Maurice 1868–1958

French biologist

...the biologist who studies heredity is very much like a mathematician who is studying a very complex function with the aid of partial differential equations and who tries to analyze the properties and the function about a point without being able as in the case of an elementary function to study it in itself, directly in all its respects.

*Annual Report of the Board of Regents of the Smithsonian Institution (1916)*

The Present State of the Problem of Evolution (p. 330)

Government Printing Office. Washington, D.C. 1917

### de Vilmorin, Henri L.

No biographical data available

Heredity is the lever by which the results of the study and care and perseverance of the raiser are fixed, so to say, into the most valuable of the plants grown for man's use or delight.

In Washington Atlee Burpee

*Selection in Seed Growing*

Pedigree or Grade Races in Horticulture (p. 10)

W. Atlee Burpee & Co. Philadelphia, Pennsylvania, USA. 1896

### Kingsley, Charles 1819–75

English clergyman and author

...a great man of science...knows everything about everything, except why a hen's egg don't turn into a crocodile, and two or three other little things.

*The Water-Babies*

Chapter VIII (p. 267)

Dodd, Mead & Company. New York, New York, USA. 1910

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

The past lives on in the present, that is what is meant by heredity.

*The System of Animate Nature: The Gifford Lectures Delivered in the*

*University of St. Andrews in the Years 1915 and 1916* Volume 2

Lecture XV (p. 495)

Henry Holt & Co. New York, New York, USA. 1920

## HERITAGE

### Hoyle, Sir Fred 1915–2001

English mathematician and astronomer

We humans carry with us the heritage of a long past, extending backward in time for hundreds of millions of years. Our society is built not on the joy and happiness of the past, but on the agonies experienced by the long line of our predecessors. Whether or not all the agonies and struggles of the past will emerge into a great future, or will vanish into nothing at all, is likely to be decided in the next few tens of human generations.

*Ten Faces of the Universe*

Everyman's Universe (p. 203)

W.H. Freeman & Company. San Francisco, California, USA. 1977

### Huxley, Thomas Henry 1825–95

English biologist

...the entire organism may be compared to a web of which the warp is derived from the female and the woof from the male.

*Science and Culture, and Other Essays*

Chapter XI (p. 296)

D. Appleton & Co. New York, New York, USA. 1890

**Salam, Abdus** 1926–  
Theoretical physicist

...scientific thought and its creation is the common and shared heritage of mankind.

*Nobel Lectures, Physics 1971–1980*

Nobel lecture for award received in 1979

Gauge Unification of Fundamental Forces (p. 513)

World Scientific Publishing Company, Singapore. 1992

## HERMETICALLY SEALED

**Compton, Karl Taylor** 1887–1954  
American physicist

Long, long ago, when gods mingled among men, the god Hermes established the first laboratory on this earth and discovered many new and interesting substances by subjecting various kinds and mixtures of earth and rocks to the influence of fire or water. Not being blessed with the protection of the US Patent Office, he kept his discoveries secret by putting his products into jars, which were carefully closed and sealed. Hence arose the term “hermetically sealed”, and the chemistry and metallurgy which thus sprang from the god Hermes was long known as the “hermetic art.”

*Annual Report of the Board of Regents of the Smithsonian Institution (1933)*

The Battle of the Alchemists (p. 268)

Government Printing Office. Washington, D.C.

## HETEROCHRONIC CHANGE

**Garstang, Walter** 1868–1949  
English embryologist and amateur poet

Ambystoma is a giant newt who rears in swampy waters,

As other newts are wont to do, a lot of fishy daughters:

These Axolotls, having gills, pursue a life aquatic,

But, when they should transform to newts, are naughty and erratic.

They change upon compulsion, if the water grows too foul,

For then they have to use their lungs, and go ashore to prowl:

But when a lake’s attractive, nicely aired, and full of food,

They cling to youth perpetual, and rear a tadpole brood.

And newts Perennibranchiate have gone from bad to worse:

They think aquatic life is bliss, terrestrial a curse.

They do not even contemplate a change to suit the weather,  
But live as tadpoles, breed as tadpoles, tadpoles alto-

gether!

*Larval Forms, and Other Zoological Verses*

The Axolotl and the Ammonoete

The University of Chicago Press. Chicago, Illinois, USA. 1985

## HETEROGENEITY

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

As among plants and animals, so among lifeless things there is extraordinary heterogeneity. There are over eighty different kinds of elements; the number of different minerals is legion; the multitude of the stars is untold.

*The System of Animate Nature* (Volume 1)

Lecture II (p. 64)

William & Norgate. London, England. 1920

## HEXAGON

**Pappas of Alexandria** 250–320  
Greek style geometer

Bees...by virtue of a certain geometrical forethought... know that the hexagon is greater than the square and the triangle, and will hold more honey for the same expenditure of material.

In Sanderson Smith

*Agnesi to Zeno: Over 100 Vignettes from the History of Math*

Bees as Mathematicians (p. 173)

Key Curriculum Press. Emeryville, California, USA. 1996

## HIDEOUS

**Landrin, Armand**  
No biographical data available

Those animals or plants which we designate hideous or shapeless are not *opposed*, are not *contrary*, to the great natural laws, which, by the way, are far from being thoroughly understood; they are simply *unlike* the types of plant life or animal life we are most accustomed to see. And, in this sense, so-called deformities are not always *anomalies*; they are merely unusual facts.

*The Monsters of the Deep: And Curiosities of Ocean Life*

Introduction (p. 9)

T. Nelson & Sons. London, England. 1875

## HIEROGLYPHICS

**Birmingham Brown (Fictional character)**

The higher glyphs is higher than the lower glyphs.

*The Feathered Serpent*

Film (1934)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

These hieroglyphics have evidently a meaning. If it is a purely arbitrary one, it may be impossible for us to solve it. If, on the other hand, it is systematic, I have no doubt that we shall get to the bottom of it.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of the Dancing Men* (pp. 530–531)  
 Wings Books. New York, New York, USA. 1967

**King, Thomas Starr** 1824–64  
 American Unitarian clergyman

Nature is hieroglyphic. Each prominent fact in it is like a type: its final use is to set up one letter of the infinite alphabet, and help us, by its connections, to read some statement or statute applicable to the conscious world.

*The White Hills: Their Legends, Landscape, and Poetry*  
 The Connecticut Valley (p. 394)  
 Estes & Lauret. Boston, Massachusetts, USA. 1887

## HILBERT

**Dirac, Paul Adrien Maurice** 1902–84  
 English theoretical physicist

Hilbert... was perhaps the most absent-minded man who ever lived. He was a great friend of the physicist James Franck. One day when Hilbert was walking in the street he met James Franck and he said, "James, is your wife as mean as mine?" Well, Franck was taken aback by this statement and didn't know quite what to say, and he said, "Well, what has your wife done?" And Hilbert said, "It was only this morning that I discovered quite by accident that my wife does not give me an egg for breakfast. Heaven knows how long this has been going on."

In T. Ferris (ed.)  
*The World Treasury of Physics, Astronomy and Mathematics*  
 Hilbert (p. 604)  
 Little Brown & Company. Boston, Massachusetts, USA. 1991

## HILBERT SPACE

**von Neumann, John** 1903–57  
 Hungarian-American mathematician

I would like to make a confession which may seem immoral: I do not believe in Hilbert space anymore.

Letter to G. Birkhoff dated 13 Nov (Birkhoff believes the year was 1935)  
*Proceedings of Symposia in Pure Mathematics*, Volume 2, 1961 (p. 158)

## HISTORIAN

**Birrell, Augustine** 1850–1933  
 English politician, academic, and writer

What have we a right to demand of an historian? First, surely stern veracity, which implies not merely knowledge but honesty. An historian stands in a fiduciary position towards his readers, and if he withholds from them important facts likely to influence their judgment, he is guilty of fraud, and, when justice is done in this world,

will be condemned to refund all moneys he has made by his false professions, with compound interest. This sort of fraud is unknown to the law, but to nobody else. "Let me know the facts!" may well be the agonized cry of the student who finds himself floating down what Arnold has called "the vast Mississippi of falsehood, History." Secondly comes a catholic temper and way of looking at things. The historian should be a gentleman and possess a moral breadth of temperament. There should be no bitter protesting spirit about him. He should remember the world he has taken upon himself to write about is a large place, and that nobody set him up over us. Thirdly, he must be a born story-teller. If he is not this, he has mistaken his vocation. He may be a great philosopher, a useful editor, a profound scholar, and anything else his friends like to call him, except a great historian.

*Obiter Dicta*  
 Carlyle (p. 14)  
 John B. Alden, Publisher. New York, New York, USA. 1885

**Buffon, George Louis Leclerc** 1707–88  
 French naturalist

...it is the business of the historian to describe not to invent ...

Translated by William Smellie  
*Natural History General and Particular* (Volume 1) (3rd edition)  
 The History and Theory of the Earth (p. 4)  
 Printed for A. Straman & T. Caldwell. London, England. 1791

**Butler, Samuel** 1835–1902  
 British writer

It has been said that though God cannot alter the past, historians can; it is perhaps because they can be useful to Him in this respect that He tolerates their existence.

*Erewhon Revisited Twenty Years Later*  
 Chapter XIV (p. 151)  
 E.P. Dutton & Co. New York, New York, USA. 1920

**Herschel, Sir John Frederick William** 1792–1871  
 English astronomer and chemist

No grand practical result of human industry, genius, or meditation, has sprung forth entire and complete from the master hand or mind of an individual designer working straight to its object, and foreseeing and providing for all details. As in the building of a great city, so in every such product, its historian has to record rude beginnings, circuitous and inadequate plans; frequent demolition, renewal and rectification; the perpetual removal of much cumbrous and unsightly material and scaffolding, and constant opening out of wider and grander conceptions; till at length a unity and a nobility is attained, little dreamed of in the imagination of the first projector.

*Outlines of Astronomy: By Sir John F. W. Herschel*  
 Introduction (pp. 30–31)  
 American Home Library Co. New York, New York, USA. 1902

**Joravsky, David**

No biographical data available

The most difficult job for the historian is to develop a double vision, seeing his subjects' choices both as they saw them and as he, the retrospective outsider, sees them, free of the pressures that made them gasp and rage. He does not increase wisdom by laughter at their folly, by indignation at their tyranny, or by sentimental substitutes for ridicule and anger. The historian's scorn, rage, or facile charity are really self-congratulation at bottom.

*The Lysenko Affair*

Chapter 9 (p. 271)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Marmery, J. Villin**

No biographical data available

Men, as a rule, accept the fact of today as it stands without troubling themselves about the gradual steps taken in the past to reach it. They have neither the leisure nor the inclination to probe the obscurity of past ages themselves. They leave this task to the historian. Nor have they the inclination and leisure, pressed onward as they are by their daily work, to follow the historian if his account is at all bulky. Time fails them.

*Progress of Science*

Preface (p. vii)

Chapman &amp; Hall, Ltd. London, England. 1895

**Robbins, Tom** 1936–

American novelist

Hardly a pure science, history is closer to animal husbandry than it is to mathematics, in that it involves selective breeding. The principal difference between the husbandryman and the historian is that the former breeds sheep or cows or such, and the latter breeds (assumed) facts. The husbandryman uses his skills to enrich the future; the historian uses his to enrich the past. Both are usually up to their ankles in bullshit.

*Another Roadside Attraction* (p. 114)

Bantam Books. New York, New York, USA. 1990

**Thorne, Kip S.** 1940–

American theoretical physicist

I do not aspire to a historian's standards of completeness, accuracy, or impartiality.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 19)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1994

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Anybody can make history. Only a great man can write it.

*Intentions*

The Critic As Artist (p. 127)

Brentano's. New York, New York, USA. 1905

**HISTORICAL METHOD****Viollet-le-Duc, Eugène Emmanuel** 1814–79

French architect and theorist

If we will consent to regard the works of the past as belonging to the past – as steps by which we must pass if we would attain to the knowledge of what is appropriate to our own social condition; if we proceed by way of analysis, and not by that of unreflecting imitation; if amid the accumulated remains of former ages we search for methods that are applicable, and if we know how to determine in what respects they are applicable; in short, if, abandoning effete doctrinal traditions, we rely on our own observation, we shall have opened the way and shall ourselves be able to pursue it.

*Lectures On Architecture*

Lecture XI (p. 1)

Samson Low, Marston, Searle &amp; Rivington. London, England. 1881

**HISTORY****Acton, John Emerich Edward Dalberg** 1834–1902

English historian

The great object, in trying to understand history, political, religious, literary or scientific, is to get behind men and to grasp ideas.

*Letters of Lord Acton to Mary Gladstone*

March 15, 1880 (p. 6)

George Allen. London, England. 1904

**Anderson, James H.**

No biographical data available

History is the narration of a succession of events, the causes and effects of fundamental principles, the rise, culmination and wane of various powers, and as such it is fraught with interest, but the history of the earth itself from the beginning until such time as it was rendered fit for the habitation of man is far more interesting than any monkish chronicle or mediaeval romance.

*Riddles of Prehistoric Times*

Chapter I (p. 7)

Broadway Publishing Co. New York, New York, USA. 1911

**Belloc, Hilaire** 1870–1953

French-born poet and historian

No one truly loves history who is not more exalted according to the greater age of the new things he finds.

*The Old Road*

On the Road and the Fascination of Antiquity (p. 10)

Constable &amp; Co. London, England. 1911

**Brunstein, Karl A.**

No biographical data available

History, like faith, has both its uses and abuses. Often the introduction of either one of them into a discussion

signals the abandonment of any further pursuit of rational understanding.

*Beyond the Four Dimensions*

Chapter Five (p. 81)

Walker & Co. New York, New York, USA. 1979

**Clarke, Arthur C.** 1917–

English science and science fiction writer

We must not let our pride in our achievements blind us to the lessons of history. Over the first cities of mankind, the desert sands now lie centuries deep. Could the builders of Ur and Babylon – once the wonders of the world – have pictured London or New York? Nor can we imagine the citadels that our descendants may build beneath the blinding Sun on Mercury, or under the stars of the cold Plutonian wastes. And beyond the planets, though ages still ahead of us in time, lies the unknown and infinite promise of the stellar universe.

*Interplanetary Flight: An Introduction to Astronautics*

Chapter 10 (p. 126)

Harper & Row, Publishers. New York, New York, USA. 1960

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

A history tells us...how we came to know it. It thus places facts before us in the natural order of their ascertainment, and narrates instead of enumerating. The story to be told leaves the marvels of imagination far behind, and requires no embellishment from literary art or high-flown phrases. Its best ornament is unvarnished truthfulness ...

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Preface to the first edition (p. ix)

Adam & Charles Black. London, England. 1893

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

All things are engaged in writing their history. The planet, the pebble, goes attended by its shadow. The rolling rock leaves its scratches on the mountain; the river its channel in the soil; the animal its bones in the stratum; the fern and leaf their modest epitaph in the coal. The falling drop makes its sculpture in the sand or the stone. Not a foot steps into the snow or along the ground, but prints, in characters more or less lasting, a map of its March.

*Representative Men: Seven Lectures*

Chapter VII (p. 261)

Houghton, Mifflin Co. Boston, Massachusetts, USA. 1903

**Ford, Henry** 1863–1947

American industrialist

History is more or less bunk. It's tradition. We want to live in the present and only the history that is worth a tinker's damn is the history we make today.

Interview with Charles Wheeler

*Chicago Tribune*, May 25, 1916

**Geikie, Sir Archibald** 1835–1924

English geologist

While eagerly pressing forward in the search after the secrets of Nature, we are apt to keep the eye too constantly fixed on the way that has to be traveled, and to lose sight and remembrance of the paths already trodden.

*The Founders of Geology*

Lecture I (p. 1)

Macmillan & Company Ltd. London, England. 1897

If all history is only an amplification of biography, the history of science may be most instructively read in the life and work of the men by whom the realms of Nature have been successively won.

*The Founders of Geology* (2nd edition)

Chapter I (p. 4)

Macmillan & Company Ltd. London, England. 1905

In the history of mankind no sharp line can be drawn between the events that are happening now or have happened within the last few generations, and those that took place long ago, and which are sometimes, though inaccurately, spoken of as historical. Every people is enacting its history today just as fully as it did many centuries ago.

*Geology*

Part I, Chapter II (p. 10)

J.A. Hill & Co. New York, New York, USA. 1904

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

History subverts the stereotype of science as a precise, heartless enterprise that strips the uniqueness from any complexity and reduces everything to timeless, repeatable, controlled experiments in a laboratory.

*The Flamingo's Smile*

Prologue (p. 18)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

I regard the failure to find a clear “vector of progress” in life's history as the most puzzling fact of the fossil record. But I also believe we are now on the verge of a solution, thanks to a better understanding of evolution in both normal and catastrophic times.

*The Flamingo's Smile*

Part 4, Chapter 15 (p. 241)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

**Hilbert, David** 1862–1943

German mathematician

History teaches the continuity of the development of science. We know that every age has its own problems, which the following age either solves or casts aside as profitless and replaces by new ones.

Translated by Mary Winston Newson (p. 437)

Mathematical Problems

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher



Let us not let go the guiding hand of history. History has made all; history can alter all.

*History and Root of the Principle of the Conservation of Energy*

Chapter I (p. 18)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

**Müller, Max** 1823–1900

German philologist and Orientalist

There is but one way to understand the continuous growth of the human mind and to gain a firm grasp of what it has achieved in any department of knowledge – that is to watch its historical development.

In Mayo Williamson Hazeltine

*Orations from Homer to William McKinley*

On Some Lessons of Antiquity (p. 8597)

P.F. Collier & Son. New York, New York, USA. 1902

**Nernst, Walther** 1864–1941

German physicist and chemist

It is often easy to write history, but it is always more difficult to learn anything from the history after it is written.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

Development of General and Physical Chemistry During the Last Forty Years (p. 253)

Government Printing Office. Washington, D.C. 1909

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

History is simply the biography of the mind of man; and our interest in history, and its educational value to us, is directly proportionate to the completeness of our study of the individuals through whom this mind has been manifested.

*An Alabama Student: And Other Biographical Essays*

Harvey and His Discovery (p. 296)

Oxford University Press, Inc. American Branch. New York, New York, USA. 1908

**Pais, Abraham** 1918–2000

Dutch-born physicist

History is highly subjective, however, since it is created after the fact, and after the date, by the inevitable process of the selection of events deemed relevant by one observer or another. Thus there are as many (overlapping) histories as there are historians.

*Inward Bound*

Chapter I (p. 3)

Clarendon Press. Oxford, England. 1986

**Palgrave, Francis** 1788–1861

English historian

History requires no less study than Law. We cannot dabble in its practical application. Would you take upon yourself to pay down your purchase-money for an acre of land, upon your knowledge of conveyancing derived from Blackstone's Commentaries?

*The History of Normandy and of England* (Volume 1)

Preface (p. xxxix)

John W. Parker & Son. London, England. 1851

History is only another aspect of Time; and Time never stands still.

*The History of Normandy and of England* (Volume 1)

Chapter I (p. 3)

John W. Parker & Son. London, England. 1851

**Plumb, Sir John H.** 1911–2001

English historian

History is Janus-faced, but the faces are far from being identical.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas of Today* 1974

*History and Tradition* (p. 63)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1975

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

It is with history, as it is with mathematics and natural philosophy; the field of it is immensely enlarged. The more easy it is to compile newspapers, the more difficult it is at the present day to write history.

*A Philosophical Dictionary* (Volume 2)

History (p. 21)

W. Dugdale. London, England. 1843

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

There is no longer any doubt in our day that the history of the world must from time to time be rewritten. However, such a necessity does not develop because many new events have been discovered, but because new perspectives are being expressed, ... the companion of a progressive era is being led to a position [from] which the past can be viewed and evaluated in a new way.

In Karl J. Fink

*Goethe's History of Science*

Chapter 4 (p. 57)

Cambridge University Press. Cambridge, England. 1991

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

He who can trace, through bygone times, the stream of our knowledge to its primitive source, will learn from history how, for thousands of years, man has labored, amid the ever-recurring changes of form, to recognize the invariability of natural laws; and has thus, by the force of mind, gradually subdued a great portion of the physical world to his dominion.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 23)

D. Appleton & Co. New York, New York, USA. 1850



In interrogating the history of the past, we trace the mysterious course of ideas yielding the first glimmering perception of the same image of a cosmos, or harmoniously ordered whole, which, dimly shadowed forth to the human mind in the primitive ages of the world, is now fully revealed to the maturer intellect of mankind as the result of long and laborious observation.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 23)

D. Appleton & Co. New York, New York, USA. 1850

## HISTORY, NATURAL

**Burroughs, John** 1837–1921

American naturalist and essayist

Natural history is a matter of observation; it is a harvest which you gather when and where you find it growing. Birds and squirrels and flowers are not always in season, but philosophy we have always with us. It is a crop which we can grow and reap at all times and in all places, and it has its own value and brings its own satisfaction.

*The Writings of John Burroughs* (Volume 19)

Preface (p. v)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

**Smellie, William** 1740–95

Scottish encyclopedist and naturalist

Natural history is the most extensive, and perhaps the most instructive and entertaining of all the sciences. It is the chief source from which human knowledge is derived. To recommend the study of it from motives of utility, were to affront the understanding of mankind.

Translated by William Smellie

In Georges Louis Leclerc Buffon

*Natural History, General and Particular* (Volume 1) (2nd edition)

Preface (p. ix)

Printed for W. Strahan & T. Cadell. London, England. 1785

Natural history has been exhibited in its most forbidding aspect, which has limited the study of it to a few, and these often not of the most brilliant talents; for it has been remarked, that the parade of learning, resulting from technical phrases and definitions, allure some men to become what is called great naturalists, whose chief knowledge of Nature is the knack of being able to name, with facility, a great number of her productions.

Translated by William Smellie

*Natural History, General and Particular* (Volume 1) (2nd edition)

Preface (p. xii)

Printed for W. Strahan & T. Cadell. London, England. 1785

## HOLISM

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Yet there is a growing dissatisfaction with sweeping reductionism, a feeling that the whole really is greater than the sum of its parts. Analysis and reduction will always have a central role to play in science, but many people cannot accept that it is an exclusive role. Especially in physics, the synthetic or holistic approach is becoming increasingly fashionable in tackling certain types of problem.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 1 (p. 8)

Simon & Schuster. New York, New York, USA. 1988

## HOLOTYPE

Holotypes, syntypes, lectotypes, and neotypes are the bearers of the scientific names of all animal taxa. They are the international standards of reference that provide objectivity in zoological nomenclature. They are held in trust for science by all zoologists and by persons responsible for their safe keeping.

*International Code of Zoological Nomenclature* (3rd edition)

Article 72(g)

Iowa State University Press. Ames, Iowa, USA. 1982

## HOMEOPATHY

**Darwin, Charles Robert** 1809–82

English naturalist

You speak about Homoeopathy, which is a subject which makes me more wrath even than does Clairvoyance. Clairvoyancy so transcends belief that one's ordinary faculties are put out of the question, but in homoeopathy common sense and common observation come into play, and both those must go to the dogs, if the infinitesimal doses have any effect whatever.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to Fox, September, 1850 (p. 341)

D. Appleton & Company. New York, New York, USA. 1896

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

If you want to be sure not to reach threescore and twenty, get a little box of homeopathic pellets and a little book of

homeopathic prescriptions. I had a poor friend who fell into that way. . . . The poor fellow had cultivated symptoms as other people cultivate roses or chrysanthemums. What a luxury of choice his imagination presented to him!

*Over the Teacups*

Chapter VIII (p. 187)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

## HOMO SAPIEN

**Huxley, Thomas Henry** 1825–95

English biologist

*Was the oldest *Homo sapiens* pliocene or miocene, or yet more ancient? In still older strata do the fossilized bones of an Ape more anthropoid, or a Man more pithecoïd, than any yet known await the researches of some unborn palaeontologist?*

*Evidence as to Man's Place in Nature*

Chapter III (p. 184)

D. Appleton & Company, New York, New York, USA. 1873

**Leakey, Richard Erskine** 1944–

Kenyan paleoanthropologist and politician

*...*Homo sapiens* is poised to become the greatest catastrophic agent since a giant asteroid collided with the Earth sixty-five million years ago wiping out half the world's species in a geological instant.*

*The Sixth Extinction*

Chapter 13 (p. 241)

Anchor Books. New York, New York, USA. 1996

**Margulis, Lynn** 1938–

American cell biologist and evolutionist

**Sagan, Dorion** 1959–

American science writer

The question then becomes: If we have been around painting cave walls and designing artifacts for some 30,000 years at least, how long will it be until *Homo sapiens* becomes something else? When will a future descendent species look back on us as their naive predecessors?

*Microcosmos*

Chapter 12 (p. 226)

Summit Books. New York, New York, USA. 1986

## HOMOLOGY

**Jordan, David Starr** 1851–1931

American scientist and university administrator

Homology in any form is simply the stamp of heredity. In other words, homology means blood-relationship. The simplest explanation is the truest and would long ago have been recognized had it not been for prejudices of various sorts – theological prejudices that saw the image of God in man only, and scientific prejudices

which arose from the surface study of surfaces. For it is the inside of an animal which tells the real history of its ancestry; its outside tells us only where its ancestors have been.

*Foot-notes to Evolution, a Series of Popular Addresses on the Evolution of Life*

Chapter I (pp. 3–4)

D. Appleton & Co. New York, New York, USA. 1907

## HONORS

**Davy, Sir Humphry** 1778–1829

English chemist

A man should be proud of his honours, not vain of them.

In Sir William Ramsay

*Essays Biographical and Chemical*

The Great London Chemists

Section II (p. 54)

Archibald Constable & Company Ltd. London, England. 1908

## HOPE

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

It is in our hands to see that the hope of the future is not lost, because we were too sure that we knew the answers, too sure that there was no hope.

*The Open Mind*

The Open Mind (p. 57)

Simon & Schuster. New York, New York, USA. 1955

## HORMONE

**Denckla, W. Donner**

American endocrinologist

Throughout the history of endocrinology, hormones and vitamins are almost always defined as being good for us, and here I'm getting up and saying that this hormone may actually be part of a self-destruct program.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Death Hormone (p. 237)

Ticknor & Fields. New York, New York, USA. 1984

## HORTICULTURE

**Burpee, W. Atlee** 1858–1915

American seedman

Horticulture, for its proper advancement and full development, seems necessarily to be as international in its character as are the finances of the world.

In Washington Atlee Burpee

*Selection in Seed Growing*

Seedsmen's Session (p. 9)

W. Atlee Burpee & Co. Philadelphia, Pennsylvania, USA. 1896

**Hawkins, J. C.**

No biographical data available

It may be that horticulturists, like poets, are born, not trained; or it may be that the science of horticulture is like the science of war, the science not at all like the art itself in practice; one may be theory and dress parade, the other down-right hard work; one red tape and the gaudy paraphernalia of pomp and splendor, with glory to him who fighting dies, and fame to him who dares and survives.

President's Annual Address

*The Minnesota Horticulturist*, Volume 27, Number 8, August, 1899 (p. 283)

**HORTICULTURIST****President of the 1893 Horticultural Congress**

There is no more charming art and occupation than the cultivation of flowers and fruit-bearing trees. There is no calling more innocent and conducive to human welfare than that of the horticulturist. The improvement and beautifying of public parks and grounds depend chiefly upon the gardener's art.

In Washington Atlee Burpee

*Selection in Seed Growing*

The Horticultural Congress (p. 7)

W. Atlee Burpee & Co. Philadelphia, Pennsylvania, USA. 1896

**HOSPITAL****Barrett-Browning, Elizabeth** 1806–61

English poet

I think it frets the saints in heaven to see  
How many desolate creatures on the earth  
Have learnt the simple dues of fellowship  
And social comfort, in a hospital.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book III, l. 1120–1123

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Beckett, Samuel** 1906–89

Irish playwright

What sky! What light! Ah in spite of all it is a blessed thing to be alive in such weather, and out of hospital.

*All That Fall* (p. 9)

Grove Press. New York, New York, USA. 1957

**Bernard, Claude** 1813–78

French physiologist

...I consider hospitals only as the entrance to scientific medicine; they are the first field of observation which a physician enters; but the true sanctuary of medical science is a laboratory; only there can he seek explanations of life in the normal and pathological states by means of experimental analysis.

Translated by Henry Copley Greene

*Experimental Medicine II*

Part II, Chapter II, Section X (p. 140)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bevan, Aneurin** 1897–1960

Welsh-born English politician

I would rather be kept alive in the efficient if cold altruism of a large hospital than expire in a gush of warm sympathy in a small one.

Speech

30 April 1946, House of Commons

**Browne, Sir Thomas** 1605–82

English author and physician

...for the world, I count it not an Inne, but an Hospital; and a place, not to live, but to die in.

*Religio Medici*

Part II, Section 11 (p. 95)

Elliot Stock. London, England. 1883

**Kerr, Jean** 1922–2003

American author and playwright

One of the most difficult things to contend with in a hospital is the assumption on the part of the staff that because you have lost your gall bladder you have also lost your mind.

*Please Don't Eat the Daisies*

Operation operation (p. 143)

Doubleday & Company, Inc. Garden City, New York, USA. 1957

**Kraus, Jack**

No biographical data available

Hospital: Ail House.

*Quote, the Weekly Digest*, April 2, 1967 (p. 277)

**Mayo, William J.** 1861–1939

American physician

The hospital should be a refuge to which the sick might go for relief as they went before our Savior...

The Teaching Hospital of the University of Michigan

*Journal of the Michigan Medical Society*, Volume 25, January, 1926

**Ray, John** 1627–1705

English naturalist

A suit of law and an urinal brings a man to the hospital.

*A Complete Collection of English Proverbs* (p. 14)

Printed for G. Cowie. London, England. 1813

**Southerne, Thomas**

Irish dramatist

...wee'r worn,

Hack'd, hewn with constant service, thrown aside

To rust in peace; or rot in Hospitals.

*The Loyal Brother*

Act I, Scene I

Printed for William Cademan. London, England. 1682

**Thomson, James** 1700–48

Scottish poet

...lo! A goodly Hospital ascends;  
In which they bade each human Aid be nigh,  
That could the Sick-Bed smoothe of that unhappy Fry.  
It was a worthy edifying Sight,  
And gives to Human-Kind peculiar Grace,  
To see kind Hands attending Day and Night,  
With tender Ministry, from Place to Place.  
Some prop the Head; some, from the pallid Face,  
Wipe off the faint cold Dews weak Nature sheds;  
Some reach the healing Draught: the whilst, to chase  
The Fear supreme, around their soften'd Beds,  
Some holy Man by Prayer all opening Heaven dispreeds.

*The Castle of Indolence*

Canto II, Stanza lxxiv–lxxv

William Smith. London, England. 1842

## HOT SPRINGS

**Morton, Ron L.**

No biographical data available

Hot springs are waters that issue onto the earth's surface at temperatures appreciably warmer than leftover pizza. These waters can flow, bubble, seep, or ooze. They can smell as sweet as freshly mown hay, or they can reek like 10-year-old eggs mixed with a wino's breath and served up with oodles of old, cooked cabbage.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 5 (p. 125)

Plenum Press. New York, New York, USA. 1996

Hot springs are defined as springs of water that issue onto the earth's surface at temperatures "appreciably" above the average temperature of the air at their exit point. This means that if you sat in one in Hawaii you might be boiled like a lobster, whereas in Minnesota you could be turned into a giant ice cube. Appreciably above – now that's real scientific and exact. Some references define "appreciably above" as 11–16°F (6–8°C), others as 15–20°F (8–11°C); the Dictionary of Geological Terms says the temperature has to be higher than that of a human body (they don't specify whether that's dead or alive). Now if we grant a warm body, "appreciably" is more than 98° F (36.6° C), which is "appreciably" greater than the average air temperature almost anywhere on earth! Now, as silly as all this seems, this is what helps make geology fun.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 5 (p. 125)

Plenum Press. New York, New York, USA. 1996

Hot springs the world over are of two general kinds: those that make you feel good and those that will kill you.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 5 (p. 126)

Plenum Press. New York, New York, USA. 1996

## HOUSE

**Fort, Charles** 1874–1932

American writer

A barn is a house, if one lives in it. If residence constitutes houseness, because style of architecture does not, then a bird's nest is a house: and human occupancy is not the standard to judge by, because we speak of dogs' houses; nor material, because we speak of snow houses of Eskimos – or a shell is a house to a hermit crab – or was to the mollusk that made it – or things seemingly so positively different as the White House at Washington and a shell on the seashore are seen to be continuous.

*The Book of the Damned*

Chapter I (p. 9)

Boni & Liveright. New York, New York, USA. 1919

## HOW

**Adair, Robert K.**

American physicist

Our condemnation of "how" pertains to the deep, fundamental, questions of physics. As a matter of common speech, physicists use "how" and "why" like everyone else – and without apology – in questions that refer uncertain inferences or observations to better establish constructs or observations.

*The Great Design: Particles, Fields, and Creation*

Chapter I (p. 4)

Oxford University Press. Oxford, England. 1989

## HUE

**Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Make thy lasting abode where fixed Eternity dwelleth!  
Come, ye varying hues, come and illuminate man!

*The Poems of Schiller*

Light and Colour (p. 314)

H. Holt & Co. New York, New York, USA. 1902

## HUGGERMUGGER

**Fitzgerald, George Francis** 1851–1901

Irish physicist

When a student is told, as an explanation of the word "mass," that it means "quantity of matter," there is an

appeal made from the obscure to the more obscure. It is a case of huggermugger.

*The Scientific Writings of the Late George Francis Fitzgerald*  
Dynamical Units (p. 452)  
Hodges, Figgis & Co. Dublin, Ireland. 1902

## HUMAN

**Nansen, Fridtjof** 1861–1930  
Norwegian explorer, scientist, and diplomat

The history of the human race is a continual struggle from darkness towards light. It is, therefore, to no purpose to discuss the use of knowledge; man wants to know, and when he ceases to do so, he is no longer man.

In Prescott Holmes  
*The Story of Exploration and Adventure in the Frozen Seas*  
Chapter XIII (p. 230)  
Henry Altemus. Philadelphia, Pennsylvania, USA. 1896

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

When the human mind first attempts to subject to its control the world of physical phenomena, and strives by meditative contemplation to penetrate the rich luxuriance of living nature, and the mingled web of free and restricted natural forces, man feels himself raised to a height from whence, as he embraces the vast horizon, individual blend together in varied groups, and appear as if shrouded in a vapoury veil.

Translated by E. C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 79)  
Harper & Brothers Publishers. New York, New York, USA. 1858

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

It is possible to believe that all the past is but the beginning of a beginning, and that all that is and has been is but the twilight of the dawn. It is possible to believe that all the human mind has ever accomplished is but the dream before the awakening. We cannot see, there is no need for us to see, what this world will be like when the day has finally come. We are creatures of the twilight.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1902)  
The Discovery of the Future (p. 392)  
Government Printing Office. Washington, D.C. 1903

## HUMAN ACTION

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Every human action goes back in some part to our animal origins; we should be cold and lonely creatures if we were cut off from that blood-stream of life.

*The Ascent of Man*  
Lower than the Angels (p. 31)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

## HUMAN ACTIVITY

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

In regard to every form of human activity it is necessary that the question should be asked from time to time, What is its purpose and ideal? In what way does it contribute to the beauty of human existence? As respects those pursuits which contribute only remotely, by providing the mechanism of life, it is well to be reminded that not the mere fact of living is to be desired, but the art of living in the contemplation of great things.

*Mysticism and Logic: And Other Essays*  
Chapter IV (p. 58)  
Longmans, Green & Co. London, England. 1919

## HUMAN BEINGS

**Delbrück, Max** 1906–81  
German-born American biologist

Human beings are organisms capable of manipulating internal representations of the world by means of concrete operations and can transcend the bounds of their biologically given perceptions. They can liberate themselves and construct a view of reality that conflicts with intuition, yet gives a true, more encompassing view.

*Mind from Matter*  
Twenty (p. 277)  
Blackwell Scientific Publications, Inc., Palo Alto, California, USA. 1986

**Hay, John**  
No biographical data available

The cosmic presence whose seas go rocking past is peopled by innumerable beginners in creation. We follow and learn how immensely wide it is, and how far we still have to go. This beach is our original ground, a center of the world. Here is the outward-facing place where human life, even when lost in fear, can declare an eternity, without knowing why.

*The Undiscovered Country*  
Coexistence (p. 192)  
W.W. Norton & Company, Inc. New York, New York, USA. 1981

**Sagan, Carl** 1934–96  
American astronomer and author

A human being is seriously inconvenienced if his body temperature is raised or lowered by a mere 20 degrees. Is this because we happen to live by accident on the one planet in the Solar System that has a surface at the right temperature for biology? Or is it that our chemistry is

delicately attuned to the temperature of the planet on which we have evolved? The latter is almost surely the case. Other temperatures, other biochemistries.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 6 (pp. 45–46)  
Dell Publishing, Inc. New York, New York, USA. 1975

We are like butterflies who flutter for a day and think it is forever.

*Cosmos*  
Chapter II (p. 30)  
Random House, Inc. New York, New York, USA. 1980

## HUMAN BODY

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English writer

The trouble about always trying to preserve the health of the body is that it is so difficult to do without destroying the health of the mind.

*Come to Think of It*  
On the Classics (p. 47)  
Methuen & Company Ltd. London, England. 1932

**Flaubert, Gustave** 1821–90  
French novelist

Body. If we knew how our body is made, we wouldn't dare move.

*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

**Heaney, Robert P.**  
American physician

It's just like remodeling an office.... The body tears out partitions, puts up dry walls and paints.

The Calcium Craze  
*Newsweek*, January 27, 1986 (p. 50)

**Henle, Jacob** 1809–85  
German physician

I know of no better food for the imagination than the beautiful formation of the human body, constructed of individual bones and muscles, which I know so well and can assemble accurately.

In R. Kagan (ed.)  
*Leaders of Medicine*  
Chapter I (p. 11)  
The Medico-Historical Press. Boston, Massachusetts, USA. 1941

**Heschel, Abraham J.** 1907–72  
Jewish theologian

The body is a sanctuary, the doctor is a priest.

*The Insecurity of Freedom*  
The Patient as a Person (p. 33)  
Farrar, Straus & Giroux. New York, New York, USA. 1966

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

The microscopic observers who have come after him [Bichat] have analyzed these [anatomical elements] into letters, as we may call them – the simple elements by the combination of which Nature spells out successively tissues, which are her syllables, organs which are her words, systems which are her chapters, and so goes on from the simple to the complex, until she binds up in one living whole that wondrous volume of power and wisdom which we call the human body.

*The Writings of Oliver Wendell Holmes* (Volume 9)  
*Medical Essays: 1842–1882*  
Chapter IV (p. 228)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

**Huxley, Thomas Henry** 1825–95  
English biologist

...the body is a machine of the nature of an army, not of that of a watch or of a hydraulic apparatus. Of this army each cell is a soldier, an organ a brigade, the central nervous system headquarters and field telegraph, the alimentary and circulatory system the commissariat. Losses are made good by recruits born in camp, and the life of the individual is a campaign, conducted successfully for a number of years, but with certain defeat in the long run.

*Science and Education: Essays*  
Biological Sciences and Math (p. 369)  
D. Appleton & Co. New York, New York, USA. 1896

It is because the body is a machine that education is possible. Education is the formation of habits, a superinducing of an artificial organisation upon the natural organisation of the body: so that acts, which at first required a conscious effort, eventually became unconscious and mechanical.

*Collected Essays* (Volume 1)  
*Method and Result*  
Descartes' Discourse on Method (p. 188)  
Macmillan & Company Ltd. London, England. 1904

**Latham, Peter Mere** 1789–1875  
English physician

This body must be your study, and your continual care – your active, willing, earnest care. Nothing must make you shrink from it. In its weakness and infirmities, in the dishonours of its corruption, you must still value it – still stay by it – to mark its hunger and thirst, its sleeping and waking, its heat and its cold; to hear its complaints, to register its groans.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture II (p. 37)  
Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836



**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

We touch heaven when we lay our hand on a human body.

In Robert Coope  
*The Quiet Art* (p. 117)  
E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Plato** 428 BCE–347 BCE  
Greek philosopher

...we are imprisoned in the body, like an oyster to his shell.

In *Great Books of the Western World* (Volume 7)  
*Phaedrus*  
Section 250 (p. 126)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

To man the human body is most sacred.

*Encyclopedia of Thoughts*  
Aphorisms 1538  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

...the living body is the theatre of many chemical and physical operations in a line with those of the inorganic domain.

*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* (Volume 1)  
Lecture I (p. 6)  
Henry Holt & Co. New York, New York, USA. 1920

## ABDOMEN

### Author undetermined

The part of the body responsible for converting processed food into processed tissue.

In Richard Iannelli (rd)  
*The Devil's New Dictionary*  
Abdomen  
Citadel Press. Secaucus, New Jersey, USA. 1983

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

ABDOMEN, *n.* The temple of the god Stomach, in whose worship, with sacrificial rights, all true men engage.

*The Collected Works of Ambrose Bierce*  
*The Devil's Dictionary* (pp. 11–12)  
The Neale Publishing Co. New York, New York, USA. 1911

## ADENOID

**Chapin, Charles Value** 1856–1941  
American physician and public health officer

[It is] more important to remove adenoids from the child than it is to remove ashes from the back yard.

*How to Avoid Infection* (p. 61)  
Harvard University Press. Cambridge, Massachusetts, USA. 2001

## ADRENAL GLAND

**Addison, Thomas** 1793–1860  
English physician

The functions of the supra-renal capsules...are almost or altogether unknown. The large supply of blood which they receive from three separate sources; their numerous nerves, derived immediately from the semilunar ganglia and solar plexus; their early development in the foetus; their unimpaired integrity to the latest period of life; and their peculiar gland-like structure; all point to the performance of some important office.

*On the Constitutional and Local Effects of Disease of the Supra-Renal Capsules* (p. 1)  
Samuel Highley. London, England. 1855

**Jeffers, Robinson** 1887–1962  
American poet

He saw clearly in his mind the little  
Adrenal glands perched on the red-brown kidneys,  
As if all his doomed tissues became transparent,  
Pouring in these passions their violent secretion  
Into his blood-stream, raising the tension unbearably.  
And the thyroids: tension, tension.

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Margrave (p. 163)  
Stanford University Press. Stanford, California, USA. 1988

...the leonine adrenal glands poured their blind fury  
Into his blood...

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 3)  
Hungerfield (p. 380)  
Stanford University Press. Stanford, California, USA. 1988

Howard felt a sudden increase of force and life in his mind, like a transfusion  
Of strong red blood, he thought "The faithful adrenals  
Have just heard how near death I am..."

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Such Counsels You Gave to Me (p. 575)  
Stanford University Press. Stanford, California, USA. 1988

## ARTERY

**Barnes, Djuna** 1892–1982  
American writer

But the great doctor, he's a divine idiot and a wise man. He closes one eye, the eye that he studied with, and putting his finger on the arteries of the body says: "God whose

roadway this is, has given me permission to travel on it also," which, Heaven help the patient, is true...

*Nightwood*

La Somnambule (p. 40)

Harcourt, Brace & Company. New York, New York, USA. 1937

## AUTONOMIC NERVOUS SYSTEM

**Langley, John Newport** 1852–1925

English physiologist

I propose to substitute the word "autonomic". The word implies a certain degree of independent action, but exercised under control of a higher power. The "autonomic" nervous system means the nervous system of the glands and of the involuntary muscle; it governs the "organic" functions of the body.

On the Union of Cranial Autonomic Visceral Fibers with the Nerve Cells of the Superior Cervical Ganglion

*The Journal of Physiology*, Volume 23, 1898–1899 (p. 241)

## BACK

**Hubbard, Elbert** 1856–1915

American editor, publisher, and writer

BACK: 2. A smooth surface composed of skin and bones which stretches between Land's End and John O'Groat's.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 15)

The Roycrofters. East Aurora, New York, USA. 1914

## BLOOD

**Armstrong, John** 1709–79

American civil engineer and soldier

The blood, the fountain whence the spirits flow,  
The generous stream that waters every part,  
And motion, vigor, and warm life conveys  
To every particle that moves or lives...

*The Art of Preserving Health*

Book II, l. 12–15 (p. 26)

Printed by Hosea Sprague. Boston, Massachusetts, USA. 1802

**du Bartas, Guillaume de Salluste** 1544–90

French poet

Even so the Blood (bred of good nourishment)  
By divers Pipes to all the body sent,  
Turns here to Bones there changes into Nerves;  
Here is made Marrow, there for Muscles serves.

*Du Bartas: His Divine Weekes and Workes*

First Week, Sixth Day (p. 55)

Printed by Robert Young. London, England. 1641

## Editor of the Louisville Journal

Doctor, what do you think is the cause of this frequent rush of blood to my head?

Oh, it is nothing but an effort of nature. Nature, you know, abhors a vacuum.

In George Denison Prentice

*Prenticeana* (p. 22)

Penguin Books. Baltimore 1957

**Harvey, William** 1578–1657

English physician

But what remains to be said upon the quantity and source of the blood which thus passes is of so novel and unheard-of character, that I do not only fear injury to myself from the envy of a few, but I tremble lest I have mankind at large for my enemies, so much doth wont and custom, that become as another nature, and doctrine once sown and that hath struck deep root, and respect for antiquity influence all men; still the die is cast, and my trust is in my love of truth, and the candor that inheres in cultivated minds.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Chapter 8 (p. 285)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

With purple fountains issuing from your veins.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*Romeo and Juliet*

Act I, Scene i, l. 92

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Blood is a quite peculiar juice.

In *Great Books of the Western World* (Volume 47)

*Faust*

The First Part

The Study (2), l. 1740

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## BONE

**Cuvier, Georges** 1769–1832

French zoologist and statesman

By thus employing the method of observation, where theory is no longer able to direct our views, we procure astonishing results. The smallest fragment of bone, even the most apparently insignificant apophysis, possesses a fixed and determinate character, relative to the class, order, genus, and species of the animal to which it belonged; insomuch, that, when we find merely the extremity of a well-preserved bone, we are able, by careful examination, assisted by analogy and exact comparison, to determine the species to which it once belonged, as certainly as if we had the entire animal before us.

*An Essay on the Theory of the Earth*

Section 27 (p. 103)

Kirk & Mercein. New York, New York, USA. 1818

**BRAIN**

**Ackerman, Diane** 1948–  
American writer

Imagine the brain, that shiny mound of being, that mouse-gray parliament of cells, that dream factory, that petit tyrant inside a ball of bone, that huddle of neurons calling all the plays, that little everywhere, that fickle pleasuredome, that wrinkled wardrobe of selves stuffed into the skull like too many clothes into a gym bag.

*An Alchemy of Mind. The Marvel and Mystery of the Brain*  
Chapter 1 (p. 3)  
Charles Scribner's Sons. New York, New York, USA. 2004

Shaped a little like a loaf of French country bread, our brain is a crowded chemistry lab, bustling with nonstop neural conversations.

*An Alchemy of Mind. The Marvel and Mystery of the Brain*  
Chapter 1 (p. 4)  
Charles Scribner's Sons. New York, New York, USA. 2004

**Allport, Susan** 1950–  
American naturalist and science writer

Most of us have spent some time wondering how our brain works. Brain scientists spend their entire lives pondering it, looking for a way to begin asking the question, How does the brain generate mind? The brain, after all, is so complex an organ and can be approached from so many different directions using so many different techniques and experimental animals that studying it is a little like entering a blizzard, the Casbah, a dense forest. It's easy enough to find a way in – an interesting phenomenon to study – but also very easy to get lost.

*Explorers of the Black Box: The Search for the Cellular Basis of Memory*  
Chapter One (pp. 17–18)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

The seat of the soul and the control of voluntary movement – in fact, of nervous functions in general – are to be sought in the heart. The brain is an organ of minor importance.

*In Great Books of the Western World (Volume 9)*  
*On the Motion of Animals*  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Armstrong, John** 1709–79  
American civil engineer and soldier

...the secret mazy channels of the brain.

*The Art of Preserving Health*  
Book I, l. 178 (p. 11)  
Printed by Hosea Sprague. Boston, Massachusetts, USA. 1802

**Asimov, Isaac** 1920–92  
American author and biochemist

The human brain is the most magnificently organized lump of material in the known universe...

*Asimov's New Guide to Science*  
Chapter 1 (p. 4)  
Basic Books, Inc. New York, New York, USA. 1984

**Bianchi, Leonardo** 1848–1927  
Italian psychiatry researcher

The brain is the great factory of thought. To it are directed all the forces of nature, forces which, for thousands of years, have been expending themselves upon it and impressing on it a slow and continuous motion of evolution.

Translated by James H. Macdonald  
*The Mechanism of the Brain and the Function of the Frontal Lobes*  
Chapter I (p. 1)  
William Wood & Company. New York, New York, USA. 1922

**Bush, George H. W.** 1924–  
41st president of the USA

I, George Bush, President of the USA, do hereby proclaim the decade beginning January 1, 1990, as the Decade of the Brain. I call upon all public officials and the people of the USA to observe that decade with appropriate programs, ceremonies, and activities.

Presidential Proclamation 6158  
July 17, 1990

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

My hand moves because certain forces – electric, magnetic, or whatever “nerve-force” may prove to be – are impressed on it by my brain. This nerve-force, stored in the brain, would probably be traceable, if Science were complete, to chemical forces supplied to the brain by the blood, and ultimately derived from the food I eat and the air I breathe.

*The Complete Works of Lewis Carroll*  
*Sylvie and Bruno*  
Chapter XXV (pp. 499–500)  
The Modern Library. New York, New York, USA. 1936

**Coveney, Peter** 1958–  
Theoretical chemist

It is unmatched in its ability to think, to communicate, and to reason. Most striking of all, it has a unique awareness of its identity and of its place in space and time. Welcome to the human brain, the cathedral of complexity.

*Frontiers of Complexity. The Search for Order in a Chaotic World* (p. 279)  
Fawcett Columbine. New York, New York, USA. 1995

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

It is essential to understand our brains in some detail if we are to assess correctly our place in this vast and complicated universe we see all around us.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 14 (p. 163)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Darwin, Charles Robert** 1809–82  
English naturalist

It is certain that there may be extraordinary mental activity with an extremely small absolute mass of nervous matter: thus the wonderfully diversified instincts, mental powers, and affections of ants are notorious, yet their cerebral ganglia are not so large as the quarter of a small pin's head. Under this point of view, the brain of an ant is one of the most marvelous atoms of matter in the world, perhaps more so than the brain of a man.

In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
Part I, Chapter II (p. 281)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Davis, Joel** 1948–  
No biographical data available

The human brain is the last, and greatest, scientific frontier. It is truly an internal cosmos that lies contained within our skulls. The more than 100 billion nerve cells and trillion supporting cells that make up your brain and mine constitute the most elaborate structure in the known universe.

*Mapping the Mind: The Secrets of the Human Brain and How It Works*  
Introduction: The Human Brain Project (p. 1)  
Carol Publishing Group. New York, New York, USA. 1997

**Day, Clarence S.** 1874–1935  
American writer

When the brain fails to act with the body, or, worse, works against it, the body will sicken no matter what cures doctors try.

*This Simian World*  
Chapter Ten (p. 59)  
Alfred A. Knopf. New York, New York, USA. 1941

**Diamond, Marian**  
American neuroscientist

The brain is a three-pound mass you can hold in your hand that can conceive of a universe a hundred-billion light years across.

In John D. Barrow  
*Impossibility*  
Chapter 4. Complexity Matching (p. 96)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

You see, he explained, I consider that a man's brain originally is like a little empty attic, and you have to stock it with such furniture as you choose. A fool takes in all the lumber of every sort that he comes across, so that the knowledge which might be useful to him gets crowded

out, or at best is jumbled up with a lot of other things so that he has a difficulty in laying his hands upon it. Now the skilful workman is very careful indeed as to what he takes into his brain-attic. He will have nothing but the tools which may help him in doing his work, but of these he has a large assortment, and all in the most perfect order. It is a mistake to think that that little room has elastic walls and can distend to any extent. Depend upon it there comes a time when for every addition of knowledge you forget something that you knew before. It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 2 (p. 154)  
Wings Books. New York, New York, USA. 1967

The human brain is capable of only one strong emotion at a time, and if it be filled with curiosity or scientific enthusiasm, there is no room for fear.

*Tales of Unease* (p. 7)  
Wordsworth Editions, Ltd. Herfordshire, England. 2000

**Fischbach, Gerald D.**  
American physician

The brain immediately confronts us with its great complexity. The human brain weighs only three to four pounds but contains about 100 billion neurons. Although that extraordinary number is of the same order of magnitude as the number of stars in the Milky Way, it cannot account for the complexity of the brain. The liver probably contains 100 million cells, but 1,000 livers do not add up to a rich inner life.

*Mind and Brain*  
*Scientific American*, Volume 267, Number 3, September, 1992 (p. 49)

**Havemann, Joel**  
American journalist

What seems astonishing is that a mere three-pound object, made of the same atoms that constitute everything else under the sun, is capable of directing virtually everything that humans have done: flying to the moon and hitting seventy home runs, writing Hamlet and building the Taj Mahal – even unlocking the secrets of the brain itself.

*A Life Shaken: My Encounter with Parkinson's Disease*  
Chapter Three (p. 45)  
The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Our brains are seventy-year clocks. The Angel of Life winds them up once for all, then closes the case, and gives the key into the hand of the Angel of the Resurrection.

*The Autocrat of the Breakfast-Table*  
Chapter VIII (p. 185)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hooper, Judith**

American biology writer

**Teresi, Dick**

American science writer and editor

The brain is a little saline pool that acts as a conductor, and it runs on electricity.

*The Three-Pound Universe*

Chapter 2 (p. 29)

Macmillan Publishing Company, New York, New York, USA. 1986

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

The brain alone is not responsible for mind, even though it is a necessary organ for its manifestation. Indeed an isolated brain is a piece of biological nonsense.

In Teilhard de Chardin

*The Phenomenon of Man*

Introduction (pp. 16–17)

Harper &amp; Row, Publishers, New York, New York, USA. 1959

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

There's one sort who knowing nothing of Geometry or Mathematics, will laugh at it as a whimsical and ridiculous undertaking. It's mere Conjunction to them to talk of measuring the Distance or Magnitude of the Stars: And for the Motion of the Earth, they count it, if not a false, at least a precarious Opinion; and no wonder then if they take what's built upon such a slippery Foundation for the Dreams of a fanciful Head and a distemper'd Brain.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the First, The Objections of ignorant Cavillers prevented (p. 5)

Printed for T. Childe, London, England. 1698

**Lowell, James Russell** 1819–91

American poet, critic, and editor

...most brains reflect but the crown of a hat.

*A Fable for Critics*

A Fabler for the Critics (p. 35)

G.P. Putnam, New York, New York, USA. 1848

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

As a rule, the human brain is too much, and wrongly, burdened with things which might be more conveniently and accurately preserved in books where they could be found at a moment's notice.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On Instruction in the Classics and the Mathematico-Physical Sciences (p. 343)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**McCormick, Leander Hamilton** 1859–1934

American author, inventor, and scientist

A profound brain is related to average brains as a giant is to average humanity.

*Characterology*

Chapter XXVI (p. 593)

Rand McNally &amp; Co. Chicago, Illinois, USA. 1920

The brain is the soil in which knowledge is implanted, and just as a gardener divides his ground into parcels for the cultivation of different plants, so the various districts of the brain are set apart for different kinds of thought and of knowledge.

*Characterology*

Chapter XXVI (p. 595)

Rand McNally &amp; Co. Chicago, Illinois, USA. 1920

The human brain is a vast business establishment compressed within a small space.

*Characterology*

Chapter XXVI (p. 600)

Rand McNally &amp; Co. Chicago, Illinois, USA. 1920

**McGinn, Colin** – 1950

English philosopher

Brains cause technology, society, art, science, soap operas, sin. A remarkable set of effects for such a small chunk of coagulated atoms.

*The Mysterious Flame: Conscious Minds in a Material World*

Chapter 1 (p. 15)

Basic Books, New York, New York, USA. 1999

**Montagu, Ashley** 1905–99

English-born American anthropologist

You certainly can't tell anything from the microscopic structure of the brain whether the person was an idiot or a genius.

In D. Brian

*Genius Talk: Conversations with Nobel Scientists and Other Luminaries*

Chapter 19 (p. 349)

Plenum Press, New York, New York, USA. 1995

**Mountcastle, Vernon B.** 1918–

American neurosurgeon

Each of us lives within the universe – the prison – of his own brain. Projecting from it are millions of fragile sensory nerve fibers, in groups uniquely adapted to sample the energetic states of the world around us; heat, light, force and chemical composition. That is all we ever know of it directly: all else is logical inference. Sensory stimuli reaching us are transduced peripheral nerve endings, and neural replicas of them dispatched brainward, to the gray mantle of the cerebral cortex. We use them to form dynamic and continually updated neural maps of our place and orientation in the external world, and of events within it. At the level of sensation, your images and my images are virtually the same, and readily identified one to another by verbal descriptions, or common reactions. Beyond that, each image is conjoined with genetic and



stored experimental information that makes each of us uniquely private. From that complex integral each constructs at a higher level of perceptual experience, on my view in brain regions like those of the parietal lobe, his own, very personal, view from within.

The Views from Within: Pathways to the Study of Perception  
*Johns Hopkins Medical Journal*, Volume 136, 1975 (p. 109)

**Oates, Joyce Carol** 1938–

American novelist

The brain is a muscle of busy hills, the struggle of unthought things with things eternally thought.

*Love and Its Derangements*

The Grave Dwellers

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1970

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

If we could look through the skull into the brain of a consciously thinking person, and if the place of optimal excitability were luminous, then we should see playing over the cerebral surface, a bright spot with fantastic, waving borders constantly fluctuating in size and form, surrounded by a darkness more or less deep, covering the rest of the hemisphere.

*Twenty-five Years of Objective Study of the Higher Nervous Activity of Animals* (p. 222)

Martin Lawrence. London, England. 1928

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The brain is as weak as the senses, and it would be lost in the complexities of the world were there not harmony in that complexity. After the manner of the short-sighted, we would see only detail after detail, losing sight of each detail before the examination of another, unable to bind them together.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 126)

Government Printing Office. Washington, D.C. 1910

**Posner, Michael I.** 1936–

American neuroscientist and psychology researcher

**Raichle, Marcus E.** 1937–

American professor of radiology and neurology

The microscope and telescope opened up unexpectedly vast domains of scientific discovery. A similar opportunity has now been created in the study of human cognition by the introduction of methods to visualize the brain systems involved as we think.

*Images of Mind*

Chapter Ten (p. 245)

Scientific American Library. New York, New York, USA. 1994

**Pugh, Emerson M.**

No biographical data available

Like the entomologist in pursuit of brightly coloured butterflies, my attention hunted, in the flower garden of the gray matter, cells with delicate and elegant forms, the mysterious butterflies of the soul, the beating of whose wings may someday – who knows? – clarify the secret of mental life.

In S. Ramón y Cajal

*Recollections of My Life*

Chapter VII (p. 363)

The MIT Press. Cambridge, Massachusetts, USA. 1989

**Riedl, Rupert J.M.**

No biographical data available

...as biologists, we do know that our large brain has developed exactly like these extreme organs which, so far, have brought all their owners to extinction. However, we also know that our extreme organ enjoys a certain advantage, which we may have to exploit: the organ can be aware of itself.

Translated by Paul Foulkes

*Biology of Knowledge: The Evolutionary Basis of Reason* (p. 153)

Wiley. New York, New York, USA. 1984

**Sagan, Carl** 1934–96

American astronomer and author

We are an intelligent species and the use of our intelligence quite properly gives us pleasure. In this respect the brain is like a muscle. When we think well, we feel good. Understanding is a kind of ecstasy.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 14)

Random House, Inc. New York, New York, USA. 1979

The human brain seems to be in a state of uneasy truce, with occasional skirmishes and rare battles. The existence of brain components with predispositions to certain behavior is not an invitation to fatalism or despair: we have substantial control over the relative importance of each component. Anatomy is not destiny, but it is not irrelevant either.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 8 (p. 199)

Random House, Inc. New York, New York, USA. 1977

**Vogt, Carl** 1817–95

German physician and naturalist

The brain...is simply an organ which excretes feeling as the kidneys excrete urine.

In Irving John Good (ed.)

*The Scientist Speculates*

Mind and Consciousness (p. 80)

BasicBooks. New York, New York, USA. 1962



**Young, John Zachary** 1907–97  
English zoologist

In order to understand what is meant by the word “brain” as it is used by neuroscientists, we must bear in mind the evidence that this organ contains in some recorded form the basis of one’s whole conscious life. It contains the record of all our aims and ambitions and is essential for the experience of all pleasures and pains, all loves and hates.

*Philosophy and the Brain*

Part I, Section 3 (p. 8)

Oxford University Press, Inc. Oxford, England. 1987

## CELL

**Anderson, Poul** 1926–2001  
American science fiction writer

The cell is a sea where molecules drift on thermal tides.

In Byron Preiss and William R. Alschuler (eds.)

*The Microverse*

Death Wish (p. 140)

Bantam Books. New York, New York, USA. 1989

### Bastin, Ted

No biographical data available

As far as one can judge at all, the cell cannot be understood in its behavior as the basis of events at the molecular level. One would judge this because the control processes of detailed cell physiology seem to proliferate endlessly in the sense that the more one understands a given chain of reactions and their associated background dynamics, the larger is the number of ancillary, trigger and other processes which it seems necessary to call in to achieve completeness of explanation and a self-contained causal scheme.

In A.R. Peacock

Reductionism: A Review of the Epistemological Issues and Their Relevance to Biology and the Problem of Consciousness

*Zygon*, Volume 11, Number 4, 4 December, 1976 (p. 327)

**Bateson, William** 1861–1926  
English biologist and geneticist

When I look at a dividing cell I feel as an astronomer might do if he beheld the formation of a double star: that an original act of creation is taking place before me.

*Problems of Genetics*

Chapter II (p. 41)

Yale University Press. New Haven Connecticut, USA. 1913

**Benchley, Robert** 1889–1945  
American humorist and critic

The scene is a plateau of primeval ooze. Things are in terrible shape. Nobody knows what to do because there is nobody. The Earth is practically new and nothing is alive except a lot of – what shall we say?

*20,000 Leagues Under the Sea or David Copperfield*

It Seems There Were a Couple of Cells (p. 176)

Blue Ribbon Books. New York, New York, USA. 1928

**Burroughs, John** 1837–1921  
American naturalist and essayist

The cell is an intelligent being; through the chemico-physical forces it builds up a man and fits him with a brain and all his wonderful organs and powers. It builds the flower, the seed, the leaf, the stalk, the root, and through the mystery of inheritance keeps up the succession of its kind.

*Under The Apple Tree*

The Primal Mind (p. 139)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

The cell is more than a chemical slum.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 5)

The Seabury Press. New York, New York, USA. 1977

**Claude, Albert** 1898–1983  
Belgian-American cytologist

We have entered the cell, the Mansion of our birth, and started the inventory of our acquired wealth.

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company. Singapore. 1992

For over two billion years, through the apparent fancy of her endless differentiations and metamorphosis, the Cell, as regards its basic physiological mechanisms, has remained one and the same. It is life itself, and our true and distant ancestor.

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company. Singapore. 1992

**Cudmore, Lorraine Lee**  
American cell biologist

Some cells are extremely visible – the egg of an ostrich, of a hen or puffin. But we cell biologists see these the way anyone would, as a large globe of yellow yolk surrounded by a transparent glutinous mass; interesting only by virtue of their behavior in soufflé or omelet.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 5)

New York Times Book Company. New York, New York, USA. 1977

Our cells, the ones we love, are repositories of such fantastic architectural flights – pleasure domes far beyond even the most opiated dreams of Coleridge, a Xanadu percolating with the directed chaos of those hundreds of thousands of simultaneous chemical reactions that are life.

*The Center of Life: A Natural History of the Cell*  
The Universal Cell (p. 5)  
New York Times Book Company. New York, New York, USA. 1977

Every living thing is made of cells, and everything a living thing does is done by the cells that make it up.

*The Center of Life: A Natural History of the Cell*  
The Universal Cell (p. 6)  
New York Times Book Company. New York, New York, USA. 1977

Cells have everything. Except visibility.

*The Center of Life: A Natural History of the Cell*  
The Universal Cell (p. 6)  
New York Times Book Company. New York, New York, USA. 1977

Cells let us walk, talk, think, make love and realize the bath water is cold.

*The Center of Life: A Natural History of the Cell*  
The Universal Cell (p. 6)  
New York Times Book Company. New York, New York, USA. 1977

We are made of cells. And of stars.

*The Center of Life: A Natural History of the Cell*  
Biochemical Evolution (p. 27)  
New York Times Book Company. New York, New York, USA. 1977

A cell always leaves the same first impression. It is incredibly crowded in there; a welter of structures crammed together like rush-hour riders in Tokyo or New York subways, with no apparent breathing space.

*The Center of Life: A Natural History of the Cell*  
Cellular Evolution (p. 50)  
New York Times Book Company. New York, New York, USA. 1977

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

The living cell is the most complex system of its size known to mankind. Its host of specialized molecules, many found nowhere else but within living material, are themselves already enormously complex. They execute a dance of exquisite fidelity, orchestrated with breathtaking precision. Vastly more elaborate than the most complicated ballet, the dance of life encompasses countless molecular performers in synergetic coordination. Yet this is a dance with no sign of a choreographer. No intelligent supervisor, no mystic force, no conscious controlling agency swings the molecules into place at the right time, chooses the appropriate players, closes the links, uncouples the partners, moves them on. The dance of life is spontaneous, self-sustaining, and self-creating.

*The Fifth Miracle: The Search for the Origin of Life*  
Chapter 1 (p. 29)  
Simon & Schuster. New York, New York, USA. 1996

**Delbrück, Max** 1906–81

German-born American biologist

The closer one looks at these performances of matter in living organisms, the more impressive the show becomes. The meanest living cell becomes a magic puzzle box full

of elaborate and changing molecules, and far outstrips all chemical laboratories of man in the skill of organic synthesis performed with expedition and good judgment of balance.... [A]ny living cell carries with it the experience of a billion years of experimentation by its ancestors. You cannot expect to explain so wise an old bird in a few simple words.

A Physicist Looks at Biology  
*Transactions of The Connecticut Academy of Sciences*, Volume 38, 1949 (p. 191)

No, any living cell carries with it the experiences of a billion years of experimentation by its ancestors. You cannot expect to explain so wise an old bird in a few simple words.

A Physicist Looks at Biology  
*Transactions of The Connecticut Academy of Sciences*, Volume 38, 1949

**Reichenbach, Hans** 1891–1953

German philosopher of science

The production of just one living cell from inorganic matter is the most urgent problem which concerns the biologist who wants to make the theory of evolution complete.... Presumably, biologists will someday construct synthetic albumen molecules of the gene type and of the protoplasm type, put them together, and thus produce an aggregate which possesses all the characteristics of a living cell. Should the experiment succeed, it would demonstrate conclusively that the origin of life can be traced back to inorganic matter.

*The Rise of Scientific Philosophy*  
Chapter 12 (p. 202)  
University of California Press. Berkeley, California, USA. 1951

**Rubin, Harry**

No biographical data available

...we cannot disrupt the cell to understand its living behavior because in doing so we destroy the very property we wish to understand...

Cancer as a Developmental Disorder  
*Cancer Research*, Volume 45, July 1985 (p. 2940)

**Sachs, Julius** 1832–97

German botanist

To many, the cell is always an independent living being, which sometimes exists for itself alone, and sometimes becomes joined with others – millions of its like in order to form a cell-colony, or, as Haeckel has named it for the plant particularly, a cell republic. To others again, to whom the author of this book also belongs, cell-formation is a phenomenon very general, it is true, in organic life, but still only of secondary significance.

Translated by H. Marshall Ward  
*Lectures on the Physiology of Plants*  
Lecture VI (p. 73)  
At The Clarendon Press. Oxford, England. 1887

**Sherrington, Sir Charles** 1857–1952  
English physiologist

Essential for any conception of the cell is that it is no static system. It is dynamic. It is energy-cycles, suites of oxidation and reduction, concatenated ferment-actions. It is like a magic hive the walls of whose chambered spongework are shifting veils of ordered molecules, and rend and renew as operations rise and cease. A world of surfaces and streams. We seem to watch battalions of specific catalysts, like Maxwell's "demons," lined up, each waiting, stop-watch in hand, for its moment to play the part assigned to it. Yet each step is understandable chemistry.

*Man on His Nature*

Chapter III (p. 80)

Doubleday Anchor Books. Garden City, New York, USA. 1955

**Szent-Györgyi, Albert** 1893–1986  
Hungarian-born American biochemist

The cell knows but one fuel – hydrogen.

In Kenneth Thimann

*The Life of Bacteria: Their Growth, Metabolism and Relationships*

Chapter V (p. 167)

The Macmillan Company. New York, New York, USA. 1963

**Thomas, Lewis** 1913–93  
American physician and biologist

The uniformity of earth's life, more astonishing than its diversity, is accountable by the high probability that we derived, originally, from some single cell, fertilized in a bolt of lightning as the earth cooled. It is from the progeny of this parent cell that we all take our looks; we still share genes around, and the resemblance of the enzymes of grasses to those of whales is in fact a family resemblance.

*The Lives of a Cell: Notes of a Biology Watcher*

The Lives of a Cell (p. 5)

The Viking Press. New York, New York, USA. 1974

**Verworn, Max** 1862–1921  
German physiologist

It is the cell to which the consideration of every bodily function sooner or later drives us. In the muscle-cell lies the riddle of the heart-beat, or of muscular contraction; in the gland-cell are the causes of secretion; in the epithelial-cell, in the white blood-cell, lie the problem of the absorption of food, and the secrets of the mind are slumbering in the ganglion-cell...

In Edmund Beecher Wilson

*The Cell in Development and Inheritance*

Introduction (p. 4)

The Macmillan Co. New York, New York, USA. 1896

## CHROMOSOME

**Conklin, Edwin Grant** 1863–1952  
American zoologist

What molecules and atoms and electrons are to the physicist and chemist, chromosomes and genes are to the biologist.

A Generation's Progress in the Study of Evolution

*Science*, Volume 80, Number 2068, August 17, 1934 (p. 151)

**Newman, Joseph S.** 1892–1960  
American poet

All living protoplasmic cells  
That make up frogs or pimpernels  
Or men or hippopotami  
Have portions known as nuclei.  
Within these microscopic homes  
There lurk our fateful chromosomes,  
Those strange hereditary factors  
That make us good or bad actors,  
That shape our lips and chins and eyebrows  
And predetermine fools and highbrows.

*Poems for Penguins, and Other Lyrical Lapses*

Heredity

Greenburg. New York, New York, USA. 1941

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

But the term code-script is, of course, too narrow. The chromosome structures are at the same time instrumental in bringing about the development they foreshadow. They are law-code and executive power – or, to use another simile, they are architect's plan and builder's craft – in one.

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*

Chapter II, Section 12 (p. 21)

At The University Press. Cambridge, England. 1945

**Stoller, Robert** 1925–91  
American psychoanalytic theorist and researcher

What to the unempathic scientist is a chromosome is the heavy hand of immutable destiny to the victims: on receiving the genetic information, the patient may feel transformed into a freak, no longer fully human. Those who feel this is an exaggeration have not treated people afflicted with depression, hopelessness, or psychosis as a result of learning such a truth.

In Michael A. Sperber and Lissy F. Jarvik

*Psychiatry and Genetics: Psychosocial, Ethical and Legal Considerations*

Genetics, Constitution, and Gender Disorder (p. 54)

Basic Books, Inc. New York, New York, USA. 1976

**CLITORIS****Culpeper, N.**

No biographical data available

The Clytorus is a sinewy and hard body, full of spongy and black matter within, as the side ligaments of the Yard are, in form it represents the Yard of a Man, and suffers erection and falling as doth that; this is that which causes lust in Women, and gives delight in copulation, for without this, a Woman neither desires copulation, or hath pleasure in it, or conceives by it.

*A Directory for Midwives, or a Guide for Women in Their Conception, Bearing, and Suckling Their Children* (p. 22)  
Peter & Edward Cole. London, England. 1660

**CRANIUM****McCormick, Leander Hamilton** 1859–1934

American author, inventor, and scientist

The cranium is a caldron in which thoughts are boiled down.

*Characterology*

Chapter XXVI (p. 591)

Rand McNally & Co. Chicago, Illinois, USA. 1920

**DIGESTION****Chesterton, G. K. (Gilbert Keith)** 1874–1936

English writer

...digestion exists for health, and health exists for life, and life exists for the love of music or beautiful things.

*Generally Speaking*

On Misunderstanding (p. 107)

Dodd, Mead & Company. New York, New York, USA. 1929

**Disraeli, Benjamin, First Earl**

1804–81

English prime minister, founder of Conservative Party, and novelist

A good eater must be a good man; for a good eater must have a good digestion, and a good digestion depends upon a good conscience.

*Novels and Tales* (Volume 2)

The Young Duke (p. 44)

Longmans, Green & Co. London, England. 1881

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

It is not accidental that all phenomena of human life are dominated by the search for daily bread – the oldest link connecting all living things, man included, with the surrounding nature.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Physiology of Digestion

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**DIGESTIVE CANAL****Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

The physiologist who succeeds in penetrating deeper and deeper into the digestive canal becomes convinced that it consists of a number of chemical laboratories equipped with various mechanical devices.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1904

Physiology of Digestion (p. 141)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**DIAPHRAGM****Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

DIAPHRAGM, n. A muscular partition separating disorders of the chest from disorders of the bowels.

*The Cynic's Word Book*

Diaphragm (p. 74)

Doubleday, Page & Co. New York, New York, USA. 1906

**Kitchen, Joseph Moses Ward**

No biographical data available

The vast majority of the human race live and die in absolute ignorance of the fact that there is such an organ as the diaphragm – one of the most important structures of the human body. A certain very small proportion of the race are aware of the existence of such a structure, but that is the limit of their information in regard to the diaphragm.

*The Diaphragm and Its Functions*

Introduction (p. 5)

Edgar S. Werner. Albany, New York, USA. 1885

**EAR****Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Students of evolution in the animal world tell us that the ear was the last of the sense-organs to arrive; it is beyond question the most intricate and the most wonderful.

*Science and Music*

Chapter VII (p. 252)

The Macmillan Co. New York, New York, USA. 1938

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

For a long time the structure of the organ of hearing has actively engaged the attention of anatomists. A considerable number of brilliant discoveries has been brought to light by their labors, and a splendid array of facts and truths established. But with these facts a host of new enigmas has been presented.

Translated by Thomas Joseph McCormack  
*Popular Scientific Lectures* (3rd edition)  
 The Fibres of Corti (p. 17)  
 The Open Court Publishing Co. Chicago, Illinois, USA. 1898

## ESOPHAGUS

**Bierce, Ambrose** 1842–1914  
 American newspaperman, wit, and satirist

ESOPHAGUS, n. That part of the alimentary canal that lies between pleasure and business.

*The Cynic's Word Book*  
 Esophagus (p. 99)  
 Doubleday, Page & Co. New York, New York, USA. 1906

## EYE

**Adams, George** 1750–95  
 English instrument maker

The eyes are placed in the most eminent part of the body, near the brain, the seat of sensation.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
 Lecture XVII (p. 273)  
 Printed by R. Hindmarsh. London, England. 1794

The black and the blue are the most beautiful colours, and give the most fire and vivacity of expression to the eye. In black eyes there is more force and impetuosity; but the blue excel in sweetness and delicacy.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
 Lecture XVII (pp. 279–280)  
 Printed by R. Hindmarsh. London, England. 1794

The eyes are a faithful guard to the whole man, and are placed as in a friendly watch-tower, to discern his danger, and give him friendly warning, while it is yet far off.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
 Lecture XVIII (p. 357)  
 Printed by R. Hindmarsh. London, England. 1794

**Carroll, Lewis (Charles Dodgson)** 1832–98  
 English writer and mathematician

“I see nobody on the road,” said Alice.  
 “I only wish I had such eyes,” the King remarked in a fretful tone. “To be able to see Nobody! And at that distance too! Why, it’s as much as I can do to see real people by this light!”

*The Complete Works of Lewis Carroll*  
 Through the Looking-Glass  
 Chapter VII (p. 223)  
 The Modern Library. New York, New York, USA. 1936

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

I have said that the science of the visible universe starts with a determination to use our eyes; but that does not mean that the primary use of the eye is for advancing science.

*Science and the Unseen World*

Chapter VIII (p. 79)  
 The Macmillan Company. New York, New York, USA. 1929

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

Eyes are bold as lions – roving, running, leaping, here and there, far and near. They speak all languages. They wait for no introduction; they are no Englishmen ; ask no leave of age, or rank; they respect neither poverty nor riches, neither learning nor power nor virtue nor sex; but intrude, and come again, and go through and through you in a moment of time. What inundation of life and thought is discharged from one soul into another, through them !

*The Conduct of Life*  
 Behavior (pp. 178–179)  
 Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Jenkins, Norburne B.**  
 No biographical data available

The eye is so lively, nervous, and sentient that it really is not comparable to any other function except itself or the mind.

The Spectacal and Eye-glass Habit  
*Medical Record*, Volume 58, September 15, 1900 (p. 431)

**Molyneux, William** 1656–98  
 Irish astronomer

Tis therefore contrived by the *Most Wise and Omnipotent Framer of the Eye*, That it should have a Power of adapting itself in some Measure to *Nigh and Distant* Objects. For they require different Conformations of the Eye But whether this variety of Conformation consist in the Crystallines approaching nigher to, or removing farther from the Retinas; Or in the Crystallines assuming a different Convexity, sometimes greater, sometimes less, according as is requisite, I leave to the scrutiny of others, and particularly of the curious Anatomist.

*Dioptrica Nova* (p. 104)  
 Printed for Benjamin Tooke  
 London, England. 1692

**von Helmholtz, Hermann** 1821–94  
 German scientist and philosopher

If an optician sent it [the eye] to me as an instrument, I would send it back with reproaches for the carelessness of his work and demand the return of my money.

In J.B. Bury  
*A History of Freedom of Thought*  
 Chapter VII (pp. 145–146)  
 Oxford University Press, Inc. London, England. 1952

## EYELID

**Adams, George** 1750–95  
 English instrument maker

When the eye is wearied with its daily service, and the night spreads a veil of darkness over this lower world,



the curtain that is hung before the eye falls down, and the eye-lids are shut with a close seal, till we have renewed our strength, and the morning restores the world to our view: the eye-lid not only affording refreshment and rest to the eye, but defending it from the secret perils and invisible dangers of the night.

*Lectures on Natural and Experimental Philosophy* (Volume 2)

Lecture XVIII (p. 356)

Printed by R. Hindmarsh. London, England. 1794

## FACE

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

The face is the soul of the body.

Translated by Peter Winch

*Culture and Value* (p. 23e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

## FINGER PRINT

**Grew, Nehemiah** 1641–1712

English vegetable anatomist and physiologist

...if anyone will but take the pains, with an indifferent glass, to surrey the palm of his hand very well washed with a ball, he may perceive innumerable little ridges, of equal size and distance, and every where running parallel to each other.

*Readings in Natural Philosophy; Or, A Popular Display of the Wonders of Nature*

Of the Pores in the Skin of the Hands and Feet (p. 77)

Printed for Horatio Phillips. London, England. 1828

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Every human being carries with him from his cradle to his grave certain physical marks which do not change their character, and by which he can always be identified – and that without shade of doubt or question. These marks are his signature, his physiological autograph, not be counterfeited, nor can he disguise it or hide it away, nor can it become illegible by the wear and mutations of time. This signature is not his face – age can change that beyond recognition; it is not his hair, for that can fall out; it is not his height, for duplicates of that exist; it is not his form, for duplicates of that exist also, whereas this signature is each man's very own – there is no duplicate of it among the swarming populations of the globe! [The audience were interested once more.]

This autograph consists of the delicate lines or corrugations with which Nature marks the insides of the hands and the soles of the feet.

*Pudd'nhead Wilson* (p. 286)

American Publishing Co. Hartford, Connecticut, USA. 1897

## GALL BLADDER

**Rogers, Will** 1879–1935

American actor and humorist

Then he turned and exclaimed with a practiced and well-subdued enthusiasm, "It's the Gall-Bladder – just what I was afraid of." Now you all know what the word "afraid of," when spoken by a doctor, leads to. It leads to more calls.

*The Autobiography of Will Rogers*

Chapter Twelve (p. 153)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

## GLAND

**Carrel, Alexis** 1873–1944

French surgeon and biologist

For the noblest aspirations of the soul to vanish it is sufficient that the blood plasma be deprived of certain chemical substances. When the thyroid gland, for example, ceases to secrete thyranin into the blood stream there is no longer either intelligence, sense of evil, sense of beauty or religious sense.

Furthermore, the pituitary, the thyroid, the sexual glands, the suppreanal gland, make possible love, hatred, enthusiasm and faith. The Christian virtues are more difficult to practice when our endocrine glands are deficient.

In Jean Rostand Larousse and Andrée Tétray

Translated by Delano Ames

*Larousse Science of Life: A Study of Biology, Sex, Genetics, Heredity and Evolution* (p. 19)

Hamlyn. London, England. 1971

## HAIR

**Montagna, William**

Dermatological researcher

Interest in hair today has grown to the proportion of a fetish. Think of the many loving ways in which advertisements refer to scalp hair – satiny, glowing, shimmering, breathing, living. Living indeed! It is as dead as rope.

*New York Herald Tribune*, August 11, 1963

## HAND

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

We have to understand that the world can only be grasped by action, not by contemplation. The hand is more important than the eye.... The hand is the cutting edge of the mind.

*The Ascent of Man*

Chapter 3 (pp. 115–116)

Little, Brown & Co. Boston, Massachusetts, USA. 1975



**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

It is indeed wonderful to think that the feeble and sprawling paddles on a newt, the ungainly flippers of a seal, and the long leathery wings of a bat, have all the same elements, bone for bone, with that human hand which is the supple instrument of man's contrivance, and is alive even to the finger-tips, with the power of expressing his intellect and his will.

*The Works of the Duke of Argyll*

Chapter IV (p. 123)

John B. Alden, Publisher. New York, New York, USA. 1884

**Radcliffe, Charles Bland** 1822–89

English physician

The hand of man is in no sense a peculiar organ. It is the foot ennobled: that is all.

*Proteus; or Unity in Nature*

Chapter II (p. 24)

Macmillan & Co Ltd. London, England. 1877

## HEAD

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

The head is more than a symbolic image of man: it is the seat of foresight and, in that respect, the spring which drives cultural evolution.

*The Ascent of Man*

Chapter I (p. 36)

Little, Brown & Co. Boston, Massachusetts, USA. 1975

## HEART

**Barnard, Christiaan N.** 1923–

South African heart surgeon

...it is infinitely better to transplant a heart "than to bury it so it can be devoured by worms."

People

*Time*, October 31, 1969 (p. 36)

**Barnes, Djuna** 1892–1982

American author

We are adhering to life now without last muscle – the heart.

*Nightwood*

La Somnambule (p. 50)

Harcourt, Brace & Company. New York, New York, USA. 1937

**de Bakey, Michael E.**

American cardiovascular surgeon

If you can think of how much love there would be in hundreds of hearts, then that is how much love there is in a plastic heart. When you grow up you will understand how very much love that is.

Heart of the Matter

*Newsweek*, June 6, 1966 (p. 56)

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

The heart, because it is human – say rather because it is not wholly not divine – lifts itself up in aspiration, and claims to mingle with the lights of heaven; and joyfully receives into itself the skyey influences, and feels that it is no stranger in the courts of the moon and the stars. Though between us and the nearest of those stars there be a great gulph fixed, yet beyond that mighty gulph (oh, far beyond!) fly, on illimitable pinions, the thoughts and affections of man, and tell us that there, too, are beings, akin to us – members of one great family – beings animated, thoughtful, loving – susceptible of joy and hope, of pain and fear – able to adore God, or to rebel against him – able to admire and speculate upon that goodly array of worlds with which they also are surrounded.

*Life of Sir William Rowan Hamilton*

Introductory Lecture on astronomy (pp. 640–641)

Hodges, Figgis & Co. Dublin, Ireland. 1882

**Harvey, William** 1578–1657

English physician

The heart, consequently, is the beginning of life; the sun of the microcosm, even as the sun in his turn might well be designated the heart of the world; for it is the heart by whose virtue and pulse the blood is moved, perfected, made apt to nourish, and is preserved from corruption and coagulation; it is the household divinity which, discharging its function, nourishes, cherishes, quickens the whole body, and is indeed the foundation of life, the source of all action. The heart of animals is the foundation of their life, the sovereign of everything within them, the sun of their microcosm, that upon which all growth depends, from which all power proceeds.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood In Animals*

Dedication (p. 267)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But of these things we shall speak more opportunely when we come to speculate upon the final cause of this motion of the heart.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Chapter 8 (p. 286)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hellerstein, Herman**

Physician

Coronary heart disease is a silent disease and the first manifestation frequently is sudden death.

Tests to Avoid Attack

*Newsweek*, August 6, 1984 (p. 64)

**Legrain, G.**

No biographical data available

The heart is a god...the stomach is its chapel.  
*Répertoire Généalogique et Onomastique du Musée du Caire*  
Statues et Statuettes, III, 42225, e, I, II (p. 60)

**INTESTINE****Dunne, Finley Peter** 1867–1936

American journalist and humorist

...though I have patches on me pantaloons, I've ne'er a wan on me intestines.

*Mr. Dooley's Opinions*

Thanksgiving (p. 127)

Harper. New York, New York, USA. 1906

**JAW****Maisey, John**

American paleontologist

It is hard to imagine life without jaws: giant killer sharks, carnivorous dinosaurs, saber-toothed tigers, and that talkative neighbor just would not be the same without them. The acquisition of jaws is perhaps the most profound and radical evolutionary step in craniate history, after the development of the head itself.

*Discovering Fossil Fishes*

Chapter 5 (p. 59)

Henry Holt & Company. New York, New York, USA. 1996

**LIVER****Aterman, Kurt** 1913–2002

Pathologist

The liver is still one of those subjects "about which we know more than is true."

In C. Rouiller (ed.)

*The Liver: Morphology, Biochemistry, Physiology*

The Structure of the Liver Sinusoids and the Sinusoidal Cells (p. 126)

Academic Press. New York, New York, USA. 1963

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

The liver is the lazaret of bile.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 215

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Jonson, Ben** 1573?–1637

English dramatist and poet

JUS: ...the lungs of the tobacconist are rotted, the liver spotted, the brain smoked like the backside of the pig-woman's booth, here, and the whole body within, black as her pan you saw e'en now, without.

*Bartholomew Fair*

Act II, Scene VI (p. 65)

Manchester University Press. Manchester, England. 1960

**Molière (Jean-Baptiste Poquelin)** 1622–1673

French playwright and actor

GERONTE: But there was one little thing that puzzled me: the heart and the liver...the side they're on. I think you got them back to front. The heart is on the left side, and the liver on the right.

SGANARELLE: Yes, that used to be the case. But we've changed all that, and currently in medicine we are following the modern method.

Translated by W. Hannan

*The Reluctant Doctor*

Act II (p. 21)

Heinemann Educational Books. London, England. 1963

**Selzer, Richard** 1928–

American physician and essayist

...the liver!...that great maroon snail.... No wave of emotion sweeps it. Neither music nor mathematics gives it pause in its appointed tasks.

*Mortal Lessons*

Liver (p. 64)

Simon & Schuster. New York, New York, USA. 1976

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Were my wife's liver

Infected as her life, she would not live

The running of one glass.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*The Winter's Tale*

Act I, Scene ii, l. 304–306

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If he were open'd, and you find so much blood in his liver as will clog the foot of a flea, I'll eat the rest of th' anatomy.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*The Twelfth Night*

Act III, Scene ii, l. 65–67

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**LUNG****Mayow, John** 1641–79

English chemist and physiologist

The lungs are placed in a recess so sacred and hidden that nature would seem to have specially withdrawn this part both from the eyes and from the intellect; for, beyond the wish, it has not yet been granted to anyone to fit a window to the breast and redeem from darkness the profounder secrets of nature. For of all the parts of the body, the lungs alone, as if shrinking from observation, cease

from their movement and collapse at once on the first entrance of light and self-revelation.... Still, let me draw near to the inmost vitals, and, concerning so obscure a matter, make at least a guess.

*Medico-Physical Works*

Second Treatise (p. 183)

The Alembic Club. Edinburgh, Scotland. 1907

### Ott, Susan

Physician

Roses are red

Violets are blue

Without your lungs

Your blood would be too.

A Pulmonologist's Valentine

*The New England Journal of Medicine*, Volume 304, Number 12, 1981 (p. 739)

### Servetus, Michael 1511–53

Spanish theologian and physician

It is in the lungs, consequently, that the mixture (of the inspired air with the blood) takes place, and it is in the lungs also, not in the heart, that the crimson colour of the blood is acquired.

In William Osler

*Michael Servetus*

Lord Baltimore Press. Baltimore, Maryland, USA. 1909

## NERVE

### Home, Everard 1756–1832

English physician

The nerves have been hitherto considered as chords that have no powers of contraction within themselves, but only serving as a medium, by means of which the influence of the brain may be communicated to the muscles, and the impressions made upon the different parts of the body conveyed to the brain.

On the Irritability of Nerves

*Philosophical Transactions of the Royal Society of London*, 1801 (p. 1)

### Tyndall, John 1820–93

Irish-born English physicist

Between the mind of man and the outer world are interposed the nerves of the human body, which translate, or enable the mind to translate, the impressions of that world into facts of consciousness and thought.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews*

Chapter II (p. 28)

D. Appleton & Co. New York, New York, USA. 1897

## SKELETON

### Selzer, Richard 1928–

American physician and essayist

What man does not ponder the whereabouts of his skeleton – the place where it will lie? Say what you will, all sanitary and pragmatic considerations aside, these jaunty saunterers that have held us upright, have stiffened us against the grate and grind of life, are dear to us. What stands closer to a man all his days than his bones?

*Mortal Lessons*

Bone (pp. 54–55)

Simon & Schuster. New York, New York, USA. 1976

## SKIN

### Levi, Primo 1919–87

Italian writer and chemist

I live in my house as I live inside my skin: I know more beautiful, more ample, more sturdy and more picturesque skins: but it would seem to me unnatural to exchange them for mine.

*Other People's Trades*

My House

Summit Books. New York, New York, USA. 1989

### Selzer, Richard 1928–

American physician and essayist

I sing of skin, layered fine as baklava, whose colors shame the dawn, at once the scabbard upon which is writ our only signature, and the instrument by which we are thrilled, protected, and kept constant in our natural place. Here is each man bagged and trussed in perfect amiability.

*Mortal Lessons*

Skin (p. 105)

Simon & Schuster. New York, New York, USA. 1976

## STOMACH

### Athenaeus ca. 200

Greek writer

Every investigation which is guided by principles of Nature fixes its ultimate aim entirely on gratifying the Stomach.

*The Deipnosophists*

VII

### Hunter, William

Physician

Some physiologists, gentlemen, will have it that the stomach is a mill; others, that it is a fermenting vat; others again, that it is a stewpan: but in my view of the matter, it is neither a mill, a fermenting vat, nor a stew-an, but a stomach, gentlemen, a stomach.

In Sir Gilbert Blane

*Elements of Medical Logik*

*The London Medical Repository*, Volume XI, Number 63, March, 1819 (p. 223)

**TEETH**

**Alison, Richard** fl. 1606  
English poet

Those cherries fairly do enclose  
Of orient pearl a double row,  
Which, when her lovely laughter shows,  
They look like rosebuds fill'd with snow.  
*An Howre's Recreation in Musike*

**Baxter, Richard**  
No biographical data available

An aching tooth is better out than in.  
To lose a rotten member is a gain.  
*Hypocrisy*

**Berry, James H.**  
No biographical data available

Brush them and floss them and take them to the dentist,  
Care for them and they will stay with you. Ignore them,  
and they'll go away.  
Special Advertising Section  
*Time*, February 11, 1985 (p. 21)

**Christie, Agatha** 1890–1976  
English author

Beastly things, teeth.... Give us trouble from the cradle  
to the grave.  
*At Bertram's Hotel*  
Chapter X (p. 93)  
Dodd, Mead & Company. New York, New York, USA. 1966

**de la Salle, St. Jean Baptiste** 1651–1719  
French educational reformer and priest

It is necessary to clean the teeth frequently, more especially after meals, but not on any account with a pin, or the point of a penknife, and it must never be done at table.  
*The Rules of Christian Manners and Civility*  
Chapter I

**Editor of the Louisville Journal**

Probably the reason why women's teeth decay sooner than men's is not the perpetual friction of their tongues upon the pearl, but rather the intense sweetness of their lips.  
In George Denison Prentice  
*Prenticeana* (p. 35)  
Derby & Jackson. New York, New York, USA. 1859

**Fischer, Martin H.** 1879–1962  
German-American scientist

I find that most men would rather have their bellies opened for five hundred dollars than have a tooth pulled for five.

In Howard Fabing and Ray Marr  
*Fischerisms*  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

Hot things, sharp things, sweet things, old things, all rot the teeth.  
*Poor Richard's Almanac*  
1734

**Hazlitt, William Carew** 1834–1913  
English bibliographer

One said a tooth drawer was a kind of unconscionable trade, because his trade was nothing else but to take away those things whereby every man gets his living.  
*Shakespeare Jest Books* (Volume 3)  
Conceit, Clichés, Flashes and Whimzies, Number 84  
Willis & Sotheran. London, England. 1864

**Herrick, Robert** 1591–1674  
English poet

Some ask'd how pearls did grow, and where,  
Then spoke I to my girle,  
To part her lips, and showed them there  
The quarelets of pearl.  
*The Works of Robert Herrick*  
The Rock of Rubies and the Quarry of Pearls  
Reprinted for W. & C. Tait. Edinburgh, Scotland. 1823

**Hood, Thomas** 1582–98  
English poet and editor

The best of friends fall out, and so  
His teeth had done some years ago.  
*The Complete Poetical Works of Thomas Hood*  
A True Story, Stanza 2  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Lamb, Charles** 1775–1834  
English essayist and critic

The fine lady, or fine gentleman, who show me their teeth, show me bones.  
*The Complete Works and Letters of Charles Lamb*  
The Praise of Chimney-Sweeps (p. 99)  
Modern Library. New York, New York, USA. 1935

**Martial (Marcus Valerius Martialis)** ca. 40–ca. 103  
Latin poet and epigrammatist

Thais has black, Laecania snowy teeth. What is the reason? One has those she purchased, the other her own.  
Translated by Walter C.A. Ker  
*Epigrams* (Volume 1)  
Book V, Epigram XLIII (p. 327)  
William Heinemann. London, England. 1930

**Mayo, Charles Horace** 1865–1939  
American physician

A crowned tooth is not a “crown of glory” and may cover a multitude of germs.

Problems of Infection

*Minnesota Medicine*, Volume 1, 1918

**O’Donoghue, Michael** 1940–94

American writer and performer

Tough teeth make tough soldiers.

*National Lampoon Tenth Anniversary Anthology*

Frontline Dentists (p. 111)

National Lampoon. New York, New York, USA. 1979

**Perelman, Sidney Joseph** 1904–79

American comic writer

I’ll dispose of my teeth as I see fit, and after they’ve gone, I’ll get along. I started off living on gruel, and by God, I can always go back to it again.

*Crazy Like a Fox*

Nothing But the Tooth (p. 72)

Random House, Inc. New York, New York, USA. 1944

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Last scene of all,

That ends this strange eventful history,

Is second childishness and mere oblivion,

Sans teeth, sans eyes, sans taste, sans everything.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*As You Like It*

Act II, Scene vii, l. 163–166

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Bid them wash their faces,

And keep their teeth clean.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Coriolanus*

Act II, Scene iii, l. 65–66

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Swift, Jonathan** 1667–1745

Irish-born English writer

...sweet Things are bad for the Teeth.

*The Prose Works of Jonathan Swift* (Volume 4)

*Polite Conversation*, Dialogue II (p. 181)

Printed at the Shakespeare Head Press. Oxford, England. 1939–1968

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Adam and Eve had many advantages, but the principal one was that they escaped teething.

*The Tragedy of Pudd’nhead Wilson*

Chapter IV (p. 39)

New American Library. New York, New York, USA. 1980

**Wheeler, Hugh** 1912–87

English-born playwright

To lose a lover or even a husband or two during the course of one’s life can be vexing. But to lose one’s teeth is a catastrophe.

*Four by Sondheim*

A Little Night Music

Act II, Scene I (p. 269)

Applause. New York, New York, USA. 2000

## TONGUE

**Lyly, John** 1554–1606

English dramatist

We may see the cunning and curious work of Nature, which hath barred and hedged nothing in so strongly as the tongue, with two rows of teeth, and therewith two lips; besides she hath placed it far from the heart, that it should not utter that which the heart hath conceived; this also should cause us to be silent, seeing those that use much talk, though they speak truly, are never believed.

*Euphues: The Anatomy of Wit*. (pp. 146–147)

A. Constable & Co. Westminster, England. 1900

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Nearly every other creature but a snake can do all sorts of mischief with its tongue. A woman worries with it, a chameleon catches flies with it, a snail files away fruit with it, a hummingbird steals honey with it, a cat steals milk with it, a pholas digs holes in rocks with it, and a gnat digs holes in us with it; but the poor snake cannot do any manner of harm with it whatsoever ...

*Deucalion* (Volume 2)

Chapter I, 22 (p. 16)

John Wiley & Sons. London, England. 1886

## HUMAN NATURE

**Einstein, Albert** 1879–1955

German-born physicist

Human nature always has tried to form for itself a simple and synoptic image of the surrounding world. In doing this it tries to construct a picture which will give some sort of tangible expression to what the human mind sees in nature.

Translated by James Murphy

In Max Planck

*Where Is Science Going?*

Prologue (p. 8)

Norton. New York, New York, USA. 1932

## HUMAN PAST

**Newton, Charles Thomas** 1816–94

English archaeologist

The record of the Human Past is not all contained in printed books. Man’s history has been graven on the rock

of Egypt, stamped on the brick of Assyria, enshrined in the marble of the Parthenon – it rises before us a majestic Presence in the piled-up arches of the Coliseum – it lurks an unsuspected treasure amid the oblivious dust of archives and monasteries – it is embodied in all the heirlooms of religions, of races, of families; in the relics which affection and gratitude, personal or national, pride of country or pride of lineage, have preserved for us – it lingers like an echo on the lips of the peasantry, surviving in their songs and traditions, renewed in their rude customs with the renewal of Nature's seasons ...

*Essays on Art and Archaeology*

On the Studyies of Archaeology (p. 1)

Macmillan & Company Ltd. London, England. 1880

## HUMAN PERCEPTION

**Tyndall, John** 1820–93

Irish-born English physicist

Our senses stand between these phenomena [human perceptions] and the reasoning mind. We observe the fact, but are not satisfied with the mere act of observation: the fact must be accounted for fitted into its position in the line of cause and effect. Taking our facts from Nature we transfer them to the domain of thought: look at them, compare them, observe their mutual relations and connexions, and bringing them ever clearer before the mental eye, finally alight upon the cause which unites them.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 1)

Chapter XI (p. 282)

D. Appleton & Co. New York, New York, USA. 1896

## HUMAN POWER

**Glass, H. Bentley** 1906–2005

American geneticist

Human power, which mounted slowly indeed through the eons of prehistory and somewhat more rapidly after the advent of the sword and pen, has gathered momentum with logarithmic sweep since the dawn of modern science. Today it seems to be rocketing into outer space with the incredible energy of atomic fission.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1955)

Genetics in the Service of Man (p. 299)

Government Printing Office. Washington, D.C. 1956

## HUMAN SPIRIT

**Hawking, Stephen William** 1942–

English theoretical physicist

To confine our attention to terrestrial matters would be to limit the human spirit.

In Lawrence M. Krauss

*The Physics of Star Trek*

Foreword (p. xiii)

Harp Perennial Publishers. New York, New York, USA. 1995

## HUMANITY

**Dewar, Redcote**

No biographical data available

...a humanity which will not accept its own science, uphold its own knowledge, trust to its own inferences, believe in its own creeds, and abide by the consequences of its own observations, experiences and experiments, in preference to the science, knowledge, logic, beliefs, observations, experiences and experiments of any past age whatsoever, is hopelessly imbecile.

*From Matter to Man: A New Theory of the Universe*

Chapter II (p. 15)

Chapman & Hall, Ltd. London, England. 1898

**Wilson, Edward O.** 1929–

American biologist and author

Humanity is exalted not because we are so far above other living creatures, but because knowing them well elevates the very concept of life.

*Biophilia*

Bernhardsdorp (p. 22)

Harvard University Press. Cambridge, Massachusetts, USA. 1984

## HUMANKIND

**Boas, Franz** 1858–1942

German-born American anthropologist

If the clear enunciation of the aims and methods of physical or biological science is not an easy matter, difficulties many times greater are encountered in an attempt to explain the present position of investigation dealing with mankind from the biological, geographical, and psychological points of view – subjects that seem to lack in unity, and that present a number of most divergent aspects.

*Lectures on Science, Philosophy and Art, 1907–1908*

Anthropology

The Columbia University Press. New York, New York, USA. 1908

**Shea, William R.**

No biographical data available

In order to survive and to progress, mankind cannot know too much. Salvation can hardly be thought of as the reward for ignorance. Mankind has been given its mind in order that it may find out where it is, what it is, and who it is, and how it may assume the responsibility for itself which is the chief obligation incurred in gaining knowledge.

*The History of Science and the Image of Science*

*Notes and Records of the Royal Society of London*, Volume 55, Number 1, January, 2001



**HUMILITY**

**Rowland, Henry Augustus** 1848–1901  
American physicist

Humility is indeed a distinctive quality of every scientific mind; not humility before man and man-made images, but before the marvellous universe in which the Earth is only a particle.

*Discovery, Or, The Spirit and Service of Science*  
Chapter III (p. 50)  
Macmillan & Co Ltd. London, England. 1916

**HYBRID**

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

In nature, hybrid species are usually sterile, but in science the reverse is often true. Hybrid subjects are often astonishingly fertile, whereas if a scientific discipline remains too pure it usually wilts.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 14 (p. 150)  
Basic Books, Inc. New York, New York, USA. 1978

**HYDROLOGY**

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

It is evident that if anyone tries to compute the volume of water constantly flowing each day and then to visualize a reservoir for it, he will see that to contain the whole yearly flow of water it will have to be as large as the earth in size, or at any rate not much smaller.

In *Great Books of the Western World* (Volume 8)  
*Meteorology*  
Book I, xiii  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**HYPERBOLA**

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

What mathematician has ever pondered over an hyperbola, mangling the unfortunate curve with lines of intersection here and there, in his efforts to prove some property that perhaps after all is a mere calumny, who has not fancied at last that the ill-used locus was spreading out its asymptotes as a silent rebuke, or winking one focus at him in contemptuous pity?

*The Complete Works of Lewis Carroll*  
*The Dynamics of a Particle* (p. 1130)  
The Modern Library. New York, New York, USA. 1936

**Ditton, Humphry** 1675–1715  
English mathematician

We behold indeed, in the motions of the celestial bodies, some effects of [the attraction] that may be call'd more August or pompous. But methinks these little hyperbolas, form'd by a fluid between two glass planes, are not a-whit less fine and curious than the spacious ellipses describ'd by the planets, in the bright expanse of Heaven.

*The New Law of Fluids: or, a Discourse Concerning the Ascent of Liquors, in Exact Geometrical Figures Between Two Nearly Contiguous Surfaces, to Which Is Added the True State of the Case About Matter's Thinking* (p. 41)  
Printed by J. Roberts for B. Cowse. London, England. 1713–14

**Frere, John Hookam** 1769–1846  
British diplomat and man of letters

**Canning, George** 1770–1827  
British statesman and prime minister

Not thus HYPERBOLA – with subtlest art  
The blue-eyed wanton plays her changeful part;  
Quick as her conjugated axes move  
Through every posture of luxurious love,  
Her supportive limbs with easiest grace expand....

In Charles Edmonds  
*Poetry of the Anti-Jacobin*  
The Loves of the Triangle, Canto II, l. 115–119  
Printed for J. Wright, by W. Bulmer & Company. London, England. 1801

**HYPERBOLIC CURVE**

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

Indeed, he seemed to approach the grave as a hyperbolic curve approaches a line – less directly as he got nearer, till it was doubtful if he would ever reach it at all.

*Far from the Madding Crowd*  
Chapter XV (p. 117)  
Harper & Brothers Publishers. New York, New York, USA. 1895

**HYPERSPACE****Hans Solo (Fictional character)**

Traveling through hyperspace ain't like dusting crops, boy.

*Star Wars*  
Film (1977)

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

Future historians of science may well record that one of the greatest conceptual revolutions in the twentieth-century science was the realization that hyperspace may be the key to unlock the deepest secrets of nature and Creation itself.

*Hyperspace : A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension*  
Chapter 1 (p. 9)  
Oxford University Press, Inc. New York, New York, USA. 1995

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Creation of hyperspaces is one of the ways by which the rational spirit secures release from limitation. In them it lives ever joyously, sustained by an unflinching sense of infinite freedom.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Mathematical Emancipations: Dimensionality and Hyperspace (p. 110)  
Columbia University Press. New York, New York, USA. 1925

## HYPOCHONDRIAC

**Ace, Goodman** 1899–1982  
American radio writer and performer

If you're a hypochondriac, first class, you awaken each morning with the firm resolve not to worry; everything is going to turn out all wrong.

*The Fine Art of Hypochondria*  
Who Am I (p. 13)  
Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Askey, Vincent**  
American physician

When it comes to your health, I recommend frequent doses of that rare commodity among Americans – common sense. We are rapidly becoming a land of Hypochondriacs, from the ulcer-and-martini executives in the big city to the patent medicine patrons in the sulphur-and-molasses belt.

*The Land of Hypochondriacs*  
Address, October 20, 1960, Bakersfield, California

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

Those hypochondriacs, who, like Herodius, give up their whole time and thoughts to the care of their health, sacrifice unto life, every noble purpose of living; striving to support a frail and feverish being here, they neglect an hereafter; they continue to patch up and repair their moldering tenement of clay, regardless of the immortal tenant that must survive it; agitated by greater fears than the apostle, and supported by none of his hopes, they “die daily.”

*Lacon; or Many Things in a Few Words*  
1. 139  
William Gowans. New York, New York, USA. 1849

Hypochondriacs squander large sums of time in search of nostrums by which they vainly hope they may get more time to squander.

*Lacon; or Many Things in a Few Words*  
2.70  
William Gowans. New York, New York, USA. 1849

**Cvikota, Clarence**  
No biographical data available

Hypochondriac: Pill collector.  
*Quote, the Weekly Digest*, April 7, 1968 (p. 277)

**Herold, Don** 1889–1966  
Cartoonist

Even a hypochondriac can have appendicitis.  
*The Happy Hypochondriac* (p. 16)  
Dodd, Mead & Company. New York, New York, USA. 1962

**Karch, Carroll S.**  
No biographical data available

Hypochondriac – Enjoying pill health.  
*Quote, the Weekly Digest*, September 15, 1968 (p. 217)

**Ogutsch, Edith** 1929–1990  
Fantasy poet

Hypochondriac: A person of ill repute.  
*Quote, the Weekly Digest*, May 7, 1967 (p. 377)

**Thomson, James** 1700–48  
Scottish poet

And moping here did Hypochondria sit,  
Mother of Spleen, in Robes of various Dye,  
Who vexed was full oft with ugly fit,  
And some her frantic deem'd, and some her deem'd a wit.  
A lady proud she was of ancient blood,  
Yet oft her fear her pride made crouchen low,  
She felt or fancy'd in her fluttering mood,  
All the diseases which at the spittles know,  
And sought all physic which the shops bestow,  
And still new leaches and new drugs would try,  
Her humour ever wavering to and fro,  
For sometimes she would laugh and sometimes cry,  
Then sudden waxed wroth, and all she knew not why.  
*The Castle of Indolence*  
Hypochondria, Stanza lxxv–lxxvi  
William Smith. London, England. 1842

## HYPODERMIC NEEDLE

**Battles, William Snowden**  
No biographical data available

For many hold 'twould be so hard  
Through Heaven's gate to wheedle  
A doctor as to drive a camel through  
A hypodermic needle.  
In Mary Lou McDonough  
*Poet Physician: An Anthology of Medical Poetry Written by Physicians*  
The Doctor's Dream (p. 81)  
C.C. Thomas. Springfield, Illinois, USA. 1945

**Kernan, F. C.**

No biographical data available

Hypodermic needle: Sick shooter.

*Quote, the Weekly Digest*, March 19, 1967 (p. 237)

**HYPOTHESES, SYSTEM OF****Popper, Karl R.** 1902–94

Austrian/British philosopher of science

I think that we shall have to get accustomed to the idea that we must not look upon science as a “body of knowledge”, but rather as a system of hypotheses; that is to say, as a system of guesses or anticipations which in principle cannot be justified, but with which we work as long as they stand up to tests, and of which we are never justified in saying that we know that they are “true” or “more or less certain” or even “probable.”

*The Logic of Scientific Discovery*

Appendix I, II (p. 317)

Basic Books. New York, New York, USA. 1959

**HYPOTHESIS****Adams, Henry Brooks** 1838–1918

American man of letters

A science cannot be played with. If an hypothesis is advanced that obviously brings into direct sequence of cause and effect all the phenomena of human history, we must accept it, and if we accept it, we must teach it.

*The Degradation of the Democratic Dogma*

The Tendency of History (p. 131)

The Macmillan Co. New York, New York, USA. 1919

**Amundson, Ronald**

No biographical data available

It is commonly held that scientists do not generate hypotheses randomly, but rather with the goal in mind of solving some scientific problem. Now, if a purposively generated hypothesis has a greater chance of scientific success than a randomly generated one (a supposition we must fervently hope is true) then Condition 2 fails fully to be met. There are degrees here, of course. Perhaps “insightful” hypotheses are only slightly more likely than random ones to be successful, and only a tiny bit of the success of science is to be explained by the insights of scientists. Selection would in this case retain much of its force. But if “insightful” hypotheses are much more likely to be successful, selection is much eroded.

In K. Hahlweg and C.A. Hooker (eds.)

*Issues in Evolutionary Epistemology*

The Trials and Tribulations of Selectionist Explanations (p. 427)

State University of New York Press. Albany, New York, USA. 1989

**Asquith, Herbert** 1881–1947

English statesman

*Jolie hypothese elle explique tant de chases.*

A pretty hypothesis which explains many things.

Speech

House of Commons, March 29, 1917

**Author undetermined**

Q: What is the difference between a hypothesis and a theory?

A: Think of a hypothesis as a card. A theory is a house made of hypotheses.

Source undetermined

**Ayala, Francisco J.** 1934–

Spanish American biologist

A hypothesis is empirical or scientific only if it can be tested by experience... A hypothesis or theory which cannot be, at least in principle, falsified by empirical observations and experiments does not belong to the realm of science.

Biological Evolution: Natural Selection or Random Walk

*American Scientist*, November/December, 1974 (p. 700)

**Baez, Joan** 1941–

American singer

...hypothetical questions get hypothetical answers.

*Daybreak*

What Would You Do If (p. 134)

The Dial Press, Inc. New York, New York, USA. 1968

**Baldwin, J. Mark** 1861–1934

Psychologist

If the working hypothesis fails in any essential particular he [the scientist] is ready to modify or discard it. For the truly inspired investigator, one undoubted fact weighs more in the balance than a thousand theories.

The Processes of Life Revealed by the Microscope: A Plea for Physiological Histology

*Science*, N.S. Volume 2, Number 34, August 23, 1895 (p. 210)

...for the truly scientific man, the hypothesis is destined solely to enable him to get the facts of nature in some definite order, an order which shall make apparent their connection with the great order and harmony which is believed to be present in the universe.

The Processes of Life Revealed by the Microscope: A Plea for Physiological Histology

*Science*, N.S. Volume 2, Number 34, August 23, 1895 (p. 210)

**Barfield, Owen** 1898–1997

British philosopher, critic, and anthroposophist

...“hypotheses” in the strict sense of the word, that is, [are] assumptions made for the purpose of a particular argument and by the same token not posited as true.

*Saving the Appearances: A Study in Idolatry*

Chapter VII (p. 49)

Faber & Faber. London, England. 1957

**Barrell, Joseph** 1869–1919  
American geologist

A hypothesis to gain scientific credence must emerge successful from the test of observed facts and mathematical theory.

*The Evolution of the Earth and Its Inhabitants*  
Chapter I (p. 12)

Yale University Press. New Haven, Connecticut, USA. 1919

**Barry, Frederick** 1876–1943  
Historian of science

Hypothesis, however, is an inference based on knowledge which is insufficient to prove its high probability.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge*  
The Elements of Theory (p. 164)

Columbia University Press. New York, New York, USA. 1927

**Bartlett, Elisha** 1804–55  
Physician

The restless and inquisitive mind, from its very constitution insatiable, and ever unsatisfied with its actual and absolute possessions, endeavors to imagine the phenomena, which it cannot demonstrate; it struggles to overleap the boundary, whose inexorable circumference cages it in; and, failing to do this, it fills the infinite and unknown regions, beyond and without it, with its own creations.

*An Essay on the Philosophy of Medical Science*  
Part I, Chapter 4 (p. 33)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

Without qualifying, in any degree, the doctrine which I have been endeavoring to elucidate, that all science is independent of hypothesis, I am quite willing to admit, that the hypothesis has often been of service to science, in suggesting, guiding and directing its researches. I am willing to go further than this – and to admit, at least the possibility – that the researches thus suggested and directed, may lead, ultimately, to the positive demonstration of the assumed phenomena, constituting the theory.

*An Essay on the Philosophy of Medical Science*  
Part I, Chapter 4 (p. 46)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

**Bernard, Claude** 1813–78  
French physiologist

An anticipative idea or an hypothesis is, then, the necessary starting point for all experimental reasoning. Without it, we could not make any investigation at all nor learn anything; we could only pile up sterile observations. If we experiment without a preconceived idea, we should move at random...

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter II, Section ii (p. 32)

Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

The hypothesis is the principal intellectual instrument in research. Its function is to indicate new experiments and observations and it therefore sometimes leads to discoveries even when not correct itself. We must resist the temptation to become too attached to our hypothesis, and strive to judge it objectively and modify it or discard it as soon as contrary evidence is brought to light. Vigilance is needed to prevent our observations and interpretations being biased in favor of the hypothesis. Suppositions can be used without being believed.

*The Art of Scientific Investigation*  
Chapter Four (p. 52)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

...neither the Theory of Gases nor any other physical theory can be quite a congruent account of facts.... Certainly, therefore, Hertz is right when he says: "The rigor of science requires, that we distinguish well the undraped figure of nature itself from the gay-coloured vesture with which we clothe it at our pleasure." But I think the predilection for nudity would be carried too far if we were to forego every hypothesis.

Translated by Stephen G. Brush

*Lectures on Gas Theory*

Translator's Introduction (p. 16)

University of California Press. Berkeley, California, USA. 1964

Every hypothesis must derive indubitable results from mechanically well-defined assumptions by mathematically correct methods.

Certain Questions of the Theory of Gasses

*Nature*, Volume 51, Number 1322, February 28, 1895 (p. 413)

I think the predilection for nudity [regarding the undraped figure of nature] would be carried too far if we were to forego every hypothesis. Only we must not demand too much from hypotheses.

Certain Questions of the Theory of Gasses

*Nature*, Volume 51, Number 1322, February 28, 1895 (p. 413)

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

The Requisites of a *good Hypothesis* are:  
That It be Intelligible. That It neither Assume nor Suppose anything Impossible, unintelligible, or demonstrably False.

That It be consistent with Itself.

That It be lit and sufficient to Explicate the Phaenomena, especially the chief.

That It be, at least, consistent, with the rest of the Phaenomena It particularly relates to, and do not contradict

any other known Phenomena of nature, or manifest Physical Truth.

In Michael Alexander Stewart

*Selected Philosophical Papers of Robert Boyle*

MS Notes on a Good and an Excellent Hypothesis (p. 119)

Hackett Publishing, Indianapolis, Indiana, USA. 1991

**Bruner, Jerome Seymour** 1915–

American psychologist

The shrewd guess, the fertile hypothesis, the courageous leap to a tentative conclusion – these are the most valuable coin of the thinker at work.

*The Process of Education*

Introduction (p. 14)

Harvard University Press, Cambridge, Massachusetts, USA. 1961

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“Would you tell me, please, which way I ought to go from here?”

“That depends a good deal on where you want to get to,” said the Cat.

“I don’t much care where –” said Alice.

“Then it doesn’t matter which way you go,” said the Cat.

*The Complete Works of Lewis Carroll*

*Alice’s Adventures in Wonderland*

Chapter VI (pp. 71–72)

The Modern Library, New York, New York, USA. 1936

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

Affection may as easily cling about a beloved intellectual child under the name of a working hypothesis as under any other, and may become a ruling passion.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

Volume 4

The Methods of the Earth-Sciences (p. 481)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

It is as foolish to cultivate sterile soil in science as in agriculture, and preliminary tests may show that given soils are necessarily sterile.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

Volume 4

The Methods of the Earth-Sciences (p. 482)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

It will be observed that the distinction [between hypothesis and theory] is not such as to prevent a working hypothesis from gliding with the utmost ease into a ruling theory. Affection may as easily cling about a beloved intellectual child when named as a hypothesis as if named a theory, and its establishment in the one guise may become a ruling passion very much as in the other.

Studies for Students. The Method of Multiple Working Hypotheses

*The Journal of Geology*, Volume 5, Number 8, 1897 (pp. 842–843)

**Cohen, Morris Raphael** 1880–1947

American philosopher

There is...no genuine progress in scientific insight through the Baconian method of accumulating empirical facts without hypotheses or anticipation of nature. Without some guiding idea we do not know what facts to gather...we cannot determine what is relevant and what is irrelevant.

*A Preface to Logic*

Chapter VII (p. 135)

Henry Holt & Company, New York, New York, USA. 1944

**Cort, David**

No biographical data available

But suspicion is a thing very few people can entertain without letting the hypothesis turn, in their minds, into fact...

*Social Astonishments*

ONE, Believing in Books (p. 27)

The Macmillan Company, New York, New York, USA. 1963

**Curtis, George Ticknor** 1812–94

American author, writer, historian, and lawyer

... what I mean by the rationality of a belief in any hypothesis is its fitness to be accepted and acted upon because it has in its favor the strongest probabilities of the case, so far as we can grasp those probabilities. I know of no other foundation for a belief in anything; for belief is the acceptance by the mind of some proposition, statement, or supposed fact, the truth of which depends upon evidence addressed to our senses, or to our intellectual perceptions, or to both.

*Creation Or Evolution?*

Chapter I (p. 3)

D. Appleton & Co. New York, New York, USA. 1887

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

The “facts” of today are the hypotheses of yesterday.

*Igneous Rocks and Their Origin*

Introduction (p. xxii)

McGraw-Hill Book Co., Inc. London, England. 1914

**Dampier-Whetham, William** 1867–1952

English scientific writer

A false hypothesis, if it serve as a guide for further enquiry, may, at the right stage of science, be as useful as, or more useful than, a truer one for which acceptable evidence is not yet at hand.

*Science and the Human Mind*

Science in the Ancient World (p. 39)

Longmans, Green & Company, New York, New York, USA. 1912

**Daniels, Farrington** 1889–1972

Physical chemist

A successful hypothesis is not necessarily a permanent hypothesis, but it is one which stimulates additional research, opens up new fields, or explains and coordinates previously unrelated facts.



*Outlines of Physical Chemistry*

Chapter I (p. 4)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1948

**Darwin, Charles Robert** 1809–82

English naturalist

An unverified hypothesis is of little or not value; but if anyone should hereafter be led to make observations by which some such hypothesis could be established, I shall have done good service, as an astonishing number of isolated facts can be thus connected together and rendered intelligible.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 75)

D. Appleton &amp; Company. New York, New York, USA. 1896

I suspect the first expedition I take, clinometer and hammer in hand, will send me back very little wiser and a good deal more puzzled than when I started. As yet I have only indulged in hypotheses, but they are such powerful ones that I suppose, if they were put into action for but one day, the world would come to an end.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter V (p. 164)

D. Appleton &amp; Company. New York, New York, USA. 1896

In scientific investigations, it is permitted to invent any hypothesis and, if it explains various large and independent classes of facts, it rises to the ranks of a well-grounded theory.

*The Variations of Animals and Plants Under Domestication* (Volume 1)

Introduction (p. 9)

D. Appleton &amp; Company. New York, New York, USA. 1896

**Davis, William Morris** 1850–1934

American geomorphologist

The sensible facts are discoverable by our senses, the insensible facts by our thoughts. The invention of hypotheses is therefore nothing more than a mental effort to bring insensible facts into causal relation with sensible facts, and such an effort of correlation is praiseworthy even if it is daring.

In H. Shapley, H. Wright, and S. Rapport (eds.)

*Readings in the Physical Sciences*

The Reasonableness of Science (p. 22)

Appleton-Century-Crofts. New York, New York, USA. 1948

**Davy, Sir Humphry** 1778–1829

English chemist

The only use of an hypothesis is, that it should lead to experiments; that it should be a guide to facts. In this application, conjectures are always of use. The destruction of an error hardly ever takes place without the discovery of truth.... Hypothesis should be considered merely an intellectual instrument of discovery, which at any time may be relinquished for a better instrument.

It should never be spoken of as truth; its highest praise is verisimilitude. Knowledge can only be acquired by the senses; nature has an archetype in the human imagination; her empire is given only to industry and action, guided and governed by experience.

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* (Volume 8) (pp. 346–347)

Smith, Elder &amp; Company. London, England. 1839–1840

Believing that our philosophical systems are exceedingly imperfect, I never attached much importance to this hypothesis [electro-chemical action]; but having formed it after a copious induction of facts, and having gained immediately by the application of it a number of practical results, and considering myself the author of it as I was of the decomposition of the alkalies, and having developed it in an elementary work, as far as the present state of chemistry seemed to allow. I have never criticised or examined the manner in which different authors have adopted or explained it – contented, if in the hands of others it assisted the arrangement of chemistry or mineralogy, or became an instrument of discovery.

The Bakerian Lecture: On the Relations of Electrical and Chemical Changes

*Philosophical Transactions of the Royal Society of London, B*, Volume 116, 1826 (p. 312)

[Hypotheses were] part of the scaffolding of the building of science [rather] than as belonging either to its foundations, materials, or ornaments.

*Fragmentary Remains*

Chapter VII (pp. 231–232)

John Churchill. London, England. 1858

**de Montaigne, Michel Eyquem** 1533–92

French Renaissance writer

Just as women for themselves make use of teeth of ivory where the natural are wanting, and instead of their true complexion make one of some foreign matter; legs of cloth or felt, and plumpness of cotton, and in the sight and knowledge of everyone paint, patch, and trick up themselves with false and borrowed beauty: so does science (and even our law itself has, they say, legal fictions whereon it builds of its truth its justice); she gives us, in presupposition and for current pay, things which she herself informs us were invented...

Translated by Charles Cotton

In *Great Books of the Western World* (Volume 25)*The Essays of Michel Eyquem de Montaigne*

Essays II, 12 (pp. 258–259)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Morgan, Augustus** 1806–71

English mathematician and logician

...wrong hypotheses, rightly worked from, have produced more useful results than unguided observation.

*A Budget of Paradoxes*

Francis Bacon (p. 55)

Longmans, Green &amp; Company. London, England. 1872



**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

I have devised seven separate explanations, each of which would cover the facts as far as we know them. But which of these is correct can only be determined by the fresh information which we shall no doubt find waiting for us.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of the Copper Beeches* (p. 122)

Wings Books. New York, New York, USA. 1967

If the fresh facts which come to our knowledge all fit themselves into the scheme, then our hypothesis may gradually become a solution.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of Wisteria Lodge* (p. 245)

Wings Books. New York, New York, USA. 1967

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

The man of science who cannot formulate a hypothesis is only an accountant of phenomena.

*The Road to Reason*

Chapter 3 (p. 77)

Longmans, Green & Company. London, England. 1949

**Duhem, Pierre-Maurice-Marie** 1861–1916  
French physicist and mathematician

In sum, the physicist can never subject an isolated hypothesis to experimental test, but only a whole group of hypotheses; when the experiment is in disagreement with his predictions, what he learns is that at least one of his hypotheses constituting this group is unacceptable and ought to be modified; but the experiment does not designate which one should be changed.

*The Aim and Structure of Physical Theory*

Part II, Chapter VI (p. 187)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

Hypotheses are the crutches of science to be thrown away at the proper time.

Quoted by G.B. Halsted

The Elements: Verified and Unverified

*Proceedings of the American Association for the Advancement of Science*, December 1903–January 1904 (p. 393)

Till now it has been usual to discard a hypothesis as soon as it leads to absurdities, but to some modern investigators this course seems too inconvenient.

In Ida Freund

*The Study of Chemical Composition*

Chapter VIII (p. 339)

At The University Press. Cambridge, England. 1904

**Dumont, Theron Q. (William Walker Atkinson)** 1862–1932

American attorney, merchant, publisher, and author

The verification of an hypothesis must be an ‘all around one,’ and there must be an agreement between the observed facts and the logical conclusions in the case – the hypothesis must fit the facts, and the facts must fit the hypothesis. The facts are like the glass slipper of the Cinderella legend. The several sisters of Cinderella were like imperfect hypotheses, for the slipper did not fit them, nor did they fit the slipper. When Cinderella’s foot was found to be the one foot upon which the glass slipper fitted, then the Cinderella hypothesis was considered to be verified – the glass slipper was hers, and the prince claimed his bride.

*The Master Mind: Or the Key to Mental Power, Development and Efficiency*

Chapter XIV (p. 214)

Advanced Thought Publishing Co. Chicago, Illinois, USA. 1918

## Editor

Hypotheses are like balloons, and if not anchored to the solid material of disease, they drift away.

The Latest Church Medical Movement

*American Medicine*, N.S. Volume III, Number 10, October, 1906 (p. 437)

**Evans, Bergen** 1904–78  
Author

We see what we want to see, and observation conforms to hypothesis.

*The Natural History of Nonsense*

Chapter 19 (p. 268)

Alfred A. Knopf. New York, New York, USA. 1947

An honorable man will not be bullied by a hypothesis.

*The Natural History of Nonsense*

Chapter 19 (p. 275)

Alfred A. Knopf. New York, New York, USA. 1947

**Fischer, Martin H.** 1879–1962  
German-American physician

Many confuse hypothesis and theory. An hypothesis is a possible explanation; a theory, the correct one.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 7)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Faraday, Michael** 1791–1867  
English physicist and chemist

Hypotheses, treated as mere poetic fancies in one age, scouted as scientific absurdities in the next – preparatory only to their being altogether forgotten – have often, when least expected, received confirmation from indirect channels, and, at length, become finally adopted as tenets,

deducible from the sober exercise of induction.

*The Subject Matter of a Course of Six Lectures on the Non-Metallic Elements*

Section I (p. 23)

Longman, Brown, Green, Longmans & Robert. London, England. 1853

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

In the complete absence of any theory of the instincts which would help us to find our bearings, we may be permitted, or rather, it is incumbent upon us, in the first place to work out any hypothesis to its logical conclusion, until it either fails or becomes confirmed.

*On Narcissism*

Chapter I

Yale University Press. New Haven, Connecticut, USA. 1991

**Friedman, Milton** 1912–2006

American laissez-faire economist

The construction of hypotheses is a creative act of inspiration, intuition, invention; its essence is the vision of something new in familiar material.

*Essays in Positive Economics*

Part I, Section VI (p. 43)

The University of Chicago Press. Chicago, Illinois, USA. 1953

**Geikie, John Cunningham** 1824–1906

American clergyman

...I cannot help thinking his hypotheses are like inverted pyramids – a great deal resting on very little.

*Hours With the Bible* (Volume 3)

Chapter XVII (p. 429)

James Pott & Co. New York, New York, USA. 1889

**Gibbs, J. Willard** 1839–1903

American mathematician

In the present state of science, it seems hardly possible to frame a dynamic theory of molecular action which shall embrace the phenomena of thermodynamics, of radiation, and of the electrical manifestations which accompany the union of atoms. Yet any theory is obviously inadequate which does not take into account...all these phenomena. Even if we confine our attention to the phenomena distinctly thermodynamic, we do not escape difficulties in as simple a matter as the number of degrees of freedom of a diatomic gas. It is well known that while theory would assign to the gas six degrees of freedom per molecule, in our experiments on specific heat we cannot account for more than five. Certainly, one is building on an insecure foundation, who rests his work on hypotheses concerning the constitution of matter.

*Elementary Principles in Statistical Mechanics: Developed with Especial Reference to the Rational Foundation of Thermodynamics*

Preface (pp. ix–xi)

Charles Scribner's Sons. New York, New York, USA. 1902

**Gilbert, G. K.** 1843–1918

American geologist

The man who produces but one [hypothesis] cherishes and champions that one as his own, and is blind to its faults. With such men, the testing of alternative hypotheses is accomplished only through controversy. Crucial observations are warped by prejudice, and the triumph of truth is delayed.

In William Hoyt

*Coon Mountain Controversies: Meteor Crater and the Development of Impact Theory*

Chapter Two (p. 38)

The University of Arizona Press. Tucson, Arizona, USA. 1987

**Goldenweiser, Alexander** 1880–1940

American anthropologist

Scientific hypotheses are intuitive leaps in the dark.

*Robots or Gods*

Chapter III (p. 46)

Alfred A. Knopf. New York, New York, USA. 1931

**Gore, George** 1826–1909

English electrochemist

Hypotheses are more varied than the truths of science; for every single new truth of science discovered by means of research, many hypotheses have been imagined.

*The Art of Scientific Discovery*

Chapter XXXVII (p. 366)

Longmans, Green & Co. London, England. 1878

**Gregg, Alan** 1890–1957

American medical educator and philosopher

A dream is a firstborn: an hypothesis should be an orphan.

In Wilder Penfield

*The Difficult Art of Giving: The Epic of Alan Gregg*

Chapter 22 (p. 318)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The hypothesis which represents an effort of imaginative power not founded upon a wide range of facts may pass as fiction, but it has no place in science.

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 161)

Macmillan & Company Ltd. London, England. 1918

**Huxley, Thomas Henry** 1825–95

English biologist

That which we were looking for, and could not find, was a hypothesis representing the origin of known organic forms which assumed the operation of no causes but such as could be proved to be actually at work. We wanted, not to pin our faith to that or any other speculation, but

to get hold of clear and definite conceptions which could be brought face to face with facts and have their validity tested.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XIII (p. 182)

D. Appleton & Company. New York, New York, USA. 1901

The great tragedy of Science – the slaying of a beautiful hypothesis by an ugly fact.

*Collected Essays* (Volume 8)

*Biogenesis and Abiogenesis* (p. 244)

Macmillan & Company Ltd. London, England. 1904

Every hypothesis is bound to explain, or, at any rate, not be inconsistent with, the whole of the facts which it professes to account for; and if there is a single one of these facts which can be shown to be inconsistent with (I do not merely mean inexplicable by, but contrary to) the hypothesis, the hypothesis falls to the ground – it is worth nothing.

*Collected Essays* (Volume 2)

*Darwiniana*

On Our Knowledge of the Causes of the Phenomena of Organic Nature,

Lecture VI (pp. 463)

Macmillan & Company Ltd. London, England. 1904

Anyone who has studied the history of science knows that almost every great step therein has been made by the “anticipation of Nature,” that is, by the invention of hypothesis, which, though verifiable, often had very little foundation to start with; and, not unfrequently, in spite of a long career of usefulness, turned out to be wholly erroneous in the long run.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

The Problems of the Deep Sea (p. 62)

Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

A good hypothesis in science must have other than those of the phenomenon it is immediately invoked to explain, otherwise it is not prolific enough.

*The Varieties of Religious Experience*

Lecture XX (p. 508)

The Modern Library. New York, New York, USA. 1967

**Jevons, William Stanley** 1835–82

English economist and logician

By deductive reasoning and calculation, we must endeavor to anticipate such new phenomena, especially those of a singular and exceptional nature, as would necessarily happen if the hypothesis be true.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter VI (p. 131)

The Macmillan Co. New York, New York, USA. 1874

I hold that in all cases of inductive inference we must invent hypotheses, until we fall upon some hypothesis which yields deductive results in accordance with experience. Such accordance renders the chosen hypothesis more or less probable, and we may then deduce with some degree of likelihood, the nature of our future experience, on the assumption that no arbitrary change takes place in the conditions of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book II, Chapter XI (p. 228)

Macmillan & Company Ltd. London, England. 1887

Perfect readiness to reject a theory inconsistent with fact is a primary requisite of the philosophic mind. But it, would be a mistake to suppose that this candour has anything akin to fickleness; on the contrary, readiness to reject a false theory may be combined with a peculiar pertinacity and courage in maintaining an hypothesis as long as its falsity is not actually apparent.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXVI (p. 586)

Macmillan & Co Ltd. London, England. 1887

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

A hypothesis will in the end become a truth when all phenomena let themselves be derived from it in a natural and in an obvious manner, when all these consequences are connected with one another and with the general reasons, in short, when that hypothesis is consistent in all its parts with itself.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Eleventh Letter (p. 120)

Science History Publications. New York, New York, USA. 1976

I wonder what an astronomy would look like which has been rigorously demonstrated in every respect. It seems as if one can get to the truth only through a series of hypotheses, and that one has to reject each previous one to espouse the next and to abandon it again.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Twentieth Letter (p. 191)

Science History Publications. New York, New York, USA. 1976

**Leclerc, Georges-Louis, Comte de Buffon** 1707–88

French naturalist

These hypotheses are all constructed on tottering foundations. The ideas they contain are indistinct, the facts are confounded, and the whole is a motely [sic] jumble of physics and fable. They, accordingly, have never been adopted but by men who embrace opinions without examination, and who, incapable of distinguishing the degree of probability, are more deeply impressed with marvelous chimeras than with the genuine force of truth.

Translated by William Smellie  
*Natural History General and Particular* (Volume 1) (3rd edition)  
 The History and Theory of the Earth (p. 3)  
 Printed for A. Straman & T. Caldwell. London, England. 1791

**Levi, Primo** 1919–87  
 Italian writer and chemist

But there is trouble in store for anyone who surrenders to the temptation of mistaking an elegant hypothesis for a certainty: the readers of detective stories know this quite well.

Translated by Raymond Rosenthal  
*The Periodic Table*  
 Chromium (p. 157)  
 Schocken Books. New York, New York, USA. 1984

**Lewis, Sir Thomas** 1881–1945  
 No biographical data available

Hypothesis is the heart which no man with right purpose wears willingly upon his sleeve.

*The Mechanism and Graphic Registration of the Heart Beat*  
 Preface (p. vii)  
 Shaw & Sons. London, England. 1920

The purity of a science is to be judged by the paucity of its recorded hypothesis.

*The Mechanism and Graphic Registration of the Heart Beat*  
 Preface (p. vii)  
 Shaw & Sons. London, England. 1920

Hypothesis has its right place, it forms a working basis; but it is an acknowledged makeshift, and, as a final expression of opinion, it is an open confession of either failure, or at the best of purpose unaccomplished.

*The Mechanism and Graphic Registration of the Heart Beat*  
 (p. vii)  
 Shaw & Sons. London, England. 1920

**Lorenz, Konrad** 1903–89  
 Austrian zoologist

It is a good morning exercise for a research scientist to discard a pet hypothesis every day before breakfast. It keeps him young.

Translated by Marjorie Kerr Wilson  
*On Aggression*  
 Chapter Two (p. 12)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1963

Truth, in science, can be defined as the working hypothesis best fitted to open the way to the next better one.

*On Aggression*  
 Chapter 14 (p. 279)  
 Routledge. London, England. 2002

**Mach, Ernst** 1838–1916  
 Austrian physicist and philosopher

The essential function of a hypothesis consists in the guidance it affords to new observations and experiments, by which our conjecture is either confirmed or refuted.

*Knowledge and Error: Sketches on the Psychology of Enquiry*  
 Chapter XIV (p. 176)  
 D. Reidel Publishing Company. Dordrecht, Netherlands. 1976

**Machover, Maurice**  
 No biographical data available

My name is A (known as c),  
 You have no upper bound for me.  
 I go as low as A1,  
 And then soar back restrained by none.  
 The hierarchies of steps I roam,  
 And almost every step, my home.  
 Of course J. König has ordained  
 That certain first steps can't be gained.  
 But Cohen and Gödel set me free,  
 AW I can be.  
 You cannot catch me in your net,  
 Discreteness hasn't trapped me yet.  
 So learn the moral of my tale,  
 I cannot fit into a scale.  
 For any scale you think will serve,  
 Might press me down, but then I'll swerve.  
 Ode to the Continuum Hypothesis  
*Mathematics Magazine*, Volume 50, Number 2, March, 1977 (p. 94)

**Maeterlinck, Maurice** 1862–1949  
 Belgian playwright and poet

Hypothesis follows on hypothesis; the theoretical rubbish-heap accumulates; and truth ever eludes us.

Translated by Maurice Maeterlinck  
 In Jean-Henri Fabre  
*The Life of the Spider*  
 Preface (p. 34)  
 Dodd, Mead & Co. New York, New York, USA. 1913

**Maine, Sir Henry** 1822–88  
 English jurist

...a modern satirist has called "Hypothetics" – the science of that which might have happened but did not...

*Popular Government: Four Essays*  
 Essay I (p. 32)  
 Liberty Classics. Indianapolis, Indiana, USA. 1976

**Marryat, Frederick** 1792–1848  
 English novelist

An hypothesis is only a habit – a habit of looking through a glass of one peculiar colour, which imparts its hue to all around it.

*The King's Own*  
 Chapter XXXV (p. 227)  
 George Routledge & Sons. London, England. 1873

**Medawar, Sir Peter Brian** 1915–87  
 Brazilian-born English zoologist

The formulation of a hypothesis carries with it an obligation to test it as rigorously as we can command skills to do so.

Hypothesis and Imagination  
*Times Literary Supplement*, 25 Oct 1963

The formulation of a natural law begins as an imaginative exploit and imagination is a faculty essential to the

scientist's task.... In a modern professional vocabulary a hypothesis is an imaginative preconception of what might be true in the form of a declaration with verifiable deductive consequences. It no longer tows "gratuitous," "mere," or "wild" behind it, and the pejorative usage ("Evolution is a mere hypothesis," "It is only a hypothesis that smoking causes lung cancer") is one of the outward signs of little learning.

Hypothesis and Imagination

*Times Literary Supplement*, 25 October, 1963

**Mellor, Joseph William** 1863–1938

Chemist

Without hypotheses, the experimental method may degenerate into empiricism; without experiments, hypotheses may degenerate into speculation.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

Chapter I (p. 16)

Longman, Green & Co. London, England. 1922

The mind unconsciously assimilates evidence in favour of a pet hypothesis; and a pet hypothesis is apt to grow from a favoured child to a tyrannical master.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

Chapter I (p. 57)

Longman, Green & Co. London, England. 1922

**Mill, John Stuart** 1806–73

English political philosopher and economist

An hypothesis is any supposition which we make (either without actual evidence, or upon evidence avowedly insufficient), in order to endeavor to deduce from it conclusions in accordance with facts which are known to be real; under the idea that if the conclusions to which the hypothesis leads are known truths, the hypothesis itself either must be, or at least is likely to be, true.

*A System of Logic, Ratiocinative and Inductive*

Book III, Chapter XIV (p. 290)

Harper & Brothers Publishers. New York, New York, USA. 1867

An hypothesis being a mere supposition, there are no other limits to hypotheses than those of the human imagination; we may, if we please, imagine, by way of accounting for an effect, some cause of a kind utterly unknown, and acting according to a law altogether fictitious.

*A System of Logic, Ratiocinative and Inductive*

Book III, Chapter XIV (p. 290)

Harper & Brothers Publishers. New York, New York, USA. 1867

It appears, then, to be a condition of a genuinely scientific hypothesis, that it be not destined always to remain an hypothesis, but be certain to be either proved or disproved by that comparison with observed facts which is termed Verification.

*A System of Logic, Ratiocinative and Inductive*

Book III, Chapter XIV (p. 293)

Harper & Brothers Publishers. New York, New York, USA. 1867

The hypothesis, by suggesting observations and experiments, puts us upon the road to that independent evidence if it be really attainable; and till it be attained, the hypothesis ought not to count for more than a suspicion.

*A System of Logic, Ratiocinative and Inductive*

Book III, Chapter XIV (p. 294)

Harper & Brothers Publishers. New York, New York, USA. 1867

**Mendeleyev, Dmitry Ivanovich** 1834–1907

Russian chemist

Hypotheses help and guide scientific work – the search for truth – as the tiller's plough helps the cultivation of useful plants.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**More, Louis Trenchard**

American educator

It seems rather futile, if such be the normal history of hypothetical models, to inflict on us the labor of learning abstruse hypotheses which continually revamp old metaphysical terms and merely dress them up in new transcendental symbols. It is a valuable exercise to strip hypotheses of their technical phraseology; to change those words which deceive our minds into believing that a clear idea has been conveyed, when, in fact, they have merely been wrenched from any real significance.

*The Limitations of Science*

Chapter IV (p. 109)

Henry Holt & Co. New York, New York, USA. 1915

**Müller, Johann Heinrich Jacob** 1809–75

Physicist

...hypotheses are like questions which we put to Nature, but the answers she gives are not simply "yes" and "no;" but it can be so, or it cannot.

*Principles of Physics and Meteorology*

Introduction (p. 4)

Hippolyte Bailliere. London, England. 1847

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

I frame no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy.

*Mathematical Principles of Natural Philosophy*

Book III, General Scholium

E.P. Dutton & Company. New York, New York, USA. 1922

In experimental philosophy we are to look upon propositions inferred by general induction from phenomena as accurately or very nearly true, notwithstanding any



contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.

*Mathematical Principles of Natural Philosophy*

Book III, Rule IV

E.P. Dutton & Company. New York, New York, USA. 1922

**Nordmann, Charles** 1881–1940

French astronomer

Hypotheses usually spring up like mushrooms in every dark corner of science. You get a score of them to explain the slightest obscurity.

Nordmann, Charles

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter II (p. 40)

T. Fisher Unwin Ltd. London, England. 1922

Hypotheses in science are a kind of soft cement which hardens rapidly in the open air, thus enabling us to join together the separate blocks of the structure and to fill up the breaches made in the walls by projectiles with artificial stuff which the superficial observer presently mistakes for stone. It is because hypotheses are something like that in science that the best scientific theories are those which include the least hypotheses.

Translated by Joseph McAbe

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter II (p. 40)

T. Fisher Unwin Ltd. London, England. 1922

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

Hypotheses are nets; only he will catch who casts his net.

Translated by F.V.M.T. & U.C.B.

*The Disciples at Saïs and Other Fragments*

Thoughts on Philosophy, Love and Religion (p. 68)

Methuen & Co. London, England. 1903

Was not America discovered through Hypothesis. Long live Hypothesis!

Translated by F.V.M.T. & U.C.B.

*The Disciples at Saïs and Other Fragments*

Thoughts on Philosophy, Love and Religion (p. 68)

Methuen & Co. London, England. 1903

**Osiander, Andrew** 1498–1552

Lutheran minister

...it is not necessary that these hypotheses should be true, or even probably; but it is enough if they provide a calculus which fits the observations...

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Introduction, to the Reader Concerning the Hypothesis of this Work

(p. 505)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pascal, Blaise** 1623–62

French mathematician and physicist

For sometimes an obvious absurdity follows from its negation, and then the hypothesis is true and certain; or an obvious absurdity follows from its affirmation, and then the hypothesis is considered false; and when we have not yet been able to draw an absurdity either from its negation or from its affirmation, the hypothesis remains doubtful. So that to establish the truth of an hypothesis it is not enough that all the phenomena should follow from it, whereas if there follows from it something opposed to a single phenomenon, that is enough to make certain its falsity.

In *Great Books of the Western World* (Volume 33)

*Scientific Treatises*

Concerning the Vacuum, Pascal's Answer to the Reverend Noel (p. 368)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95

French chemist

Hypotheses come into our laboratories in armfuls, they fill our registers with projected experiments, they stimulate us to research – and that is all.

In Emile Duclaux

*Pasteur: The History of a Mind*

Aphorisms and Ideals of Pasteur (p. 343)

W.B. Saunders Co. Philadelphia, Pennsylvania, USA. 1920

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The great difference between induction and hypothesis is that the former infers the existence of phenomena such as we have observed in cases which are similar, while hypothesis supposes something of a different kind from what we have directly observed, and frequently something which it would be impossible for us to observe directly.

*Chance, Love and Logic: Philosophical Essays*

Deduction, Induction, Hypothesis (p. 149)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

If hypotheses are to be tried haphazard, or simply because they will suit certain phenomena, it will occupy the mathematical physicists of the world say half a century on the average to bring each theory to the test, and since the number of possible theories may go up into the trillion, only one of which can be true, we have little prospect of making further solid additions to the subject in our time.

The Architecture of Theories

*The Monist*, Volume I, Number 2, January, 1891 (p. 164)

**Pirsig, Robert M.** 1928–

American writer

For every fact there is an *infinity* of hypotheses. The more you *look* the more you *see*.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* (p. 171)

William Morrow & Company, Inc

New York, New York, USA. 1974



**Planck, Max** 1858–1947  
German physicist

An indispensable hypothesis, even though still far from being a guarantee of success, is however the pursuit of a specific aim, whose lighted beacon, even by initial failures, is not betrayed.

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1918 (p. 407)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

The measure of the value of a new hypothesis in physics is not its obviousness but its utility.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Place of Modern Physics in the Mechanical View of Nature (p. 39)

Methuen & Company Ltd. London, England. 1925

...every hypothesis in physical science has to go through a period of difficult gestation and parturition before it can be brought out into the light of day and handed to others, ready-made in scientific form so that it will be, as it were, fool-proof in the hands of outsiders who wish to apply it.

*Where Is Science Going?*

Chapter VI (p. 178)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Plato** 428 BCE–347 BCE  
Greek philosopher

I think that you should...consider not only the consequences which flow from a given hypothesis; but also the consequences which flow from denying the hypothesis.

In *Great Books of the Western World* (Volume 7)

*Parmenides*

Section 135 (p. 491)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

The firm determination to submit to experiment is not enough; there are still dangerous hypotheses; first, and above all, those which are tacit and unconscious. Since we make them without knowing it, we are powerless to abandon them.

*The Foundations of Science*

*Science and Hypothesis*, Part IV

Chapter IX (p. 134)

The Science Press. New York, New York, USA. 1913

For a Latin, truth can be expressed only by equations; it must obey laws simple, logical, symmetric and fitted to satisfy minds in love with mathematical elegance. The Anglo-Saxon to depict a phenomenon will first be engrossed in making a model, and he will make it with common materials, such as our crude, unaided senses show us them.... He concludes from the body to the atom. Both therefore make hypotheses, and this indeed is necessary, since no scientist has ever been able to get on without them. The essential thing is never to make them unconsciously.

*The Foundations of Science*

Author's Preface to Translation (p. 6)

The Science Press. New York, New York, USA. 1913

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

The best we can say of a hypothesis is that up to now it has been able to show its worth, and that it has been more successful than other hypotheses although, in principle, it can never be justified, verified or even shown to be probable. The appraisal of the hypothesis relies solely upon deductive consequences (predictions) which may be drawn from the hypothesis: There is no need even to mention "induction."

*The Logic of Scientific Discovery*

New Appendices, Two Notes on Induction and Demarcation 1933–1934

(p. 315)

Basic Books, Inc. New York, New York, USA. 1959

**Poynting, John Henry** 1852–1914  
English physicist

The hypotheses of science are continually changing. Old hypotheses break down and new ones take their place. But the classification of known phenomena which a hypothesis has suggested, and the new discoveries of phenomena to which it has led, remain as positive and permanent additions to natural knowledge when the hypothesis itself has vanished from thought.

In J.A. Thomson

*Introduction to Science*

Chapter I (p. 27)

Williams & Norgate Ltd. London, England. 1916

This hypothesis [the atomic and molecular hypothesis of matter] arose so early in the history of science that we are almost tempted to suppose that it is a necessity of thought, and that it has a warrant of some higher order than any other hypothesis which could be imagined arose so early in the history of science that we are almost tempted to suppose that it is a necessity of thought, and that it has a warrant of some higher order than any other hypothesis which could be imagined.

Address to the Mathematical and Physical Section

*Science*, Volume 10, Number 247, September 22, 1899 (p. 389)

To use an old analogy – and here we can hardly go except upon analogy – while the building of Nature is growing spontaneously from within, the model of it, which we seek to construct in our descriptive science, can only be constructed by means of scaffolding from without, a scaffolding of hypotheses. While in the real building all is continuous, in our model there are detached parts which must be connected with the rest by temporary ladders and passages, or which must be supported till we can see how to fill in the understructure. To give the hypotheses equal validity with facts is to confuse the temporary scaffolding with the building itself.

Address to the Mathematical and Physical Section

*Science*, Volume 10, Number 247, September 22, 1899 (pp. 391–392)

**Priestley, Joseph** 1733–1804

English theologian and scientist

Hypotheses, while they are considered merely as such, lead persons to try a variety of experiments, in order to ascertain them. In these experiments, new facts generally arise. These new facts serve to correct the hypothesis which gave occasion to them. The theory, thus corrected, serves to discover more new facts, which, as before, bring the theory still nearer to the truth. In this progressive state, or method of approximation, things continue...

*The History and Present State of Electricity*

Part III, Section I (p. 445)

Printed for J. Dodsley. London, England. 1767

**Richet, Charles** 1850–1935

French physiologist

Be as bold in the conception of hypotheses as rigorous in their demonstration.

*The Natural History of a Savant*

Chapter X (p. 123)

J.M. Dent &amp; Sons Limited. London, England. 1927

**Sagan, Carl** 1934–96

American astronomer and author

There are many hypotheses in physics of almost comparable brilliance and elegance that have been rejected because they did not survive such a confrontation with experiment. In my view, the human condition would be greatly improved if such confrontations and willingness to reject hypotheses were a regular part of our social, political, economic, religious and cultural lives.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 184)

Random House, Inc. New York, New York, USA. 1977

Spin more than one hypothesis. If there's something to be explained, think of all the different ways in which it could be explained. Then think of tests by which you might systematically disprove each of the alternatives. What survives, the hypothesis that resists disproof in this Darwinian selection among "multiple working hypotheses," has a much better chance of being the right answer than if you had simply run with the first idea that caught your fancy.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 12 (p. 210)

Random House, Inc. New York, New York, USA. 1995

It seems to me what is called for is an exquisite balance between two conflicting needs: the most skeptical scrutiny of all hypotheses that are served up to us and at the same time a great openness to new ideas. If you are only skeptical, then no new ideas make it through to you. You never learn anything new. You become a crotchety old person convinced that nonsense is ruling the world. (There is, of course, much data to support you.) On the

other hand, if you are open to the point of gullibility and have not an ounce of skeptical sense in you, then you cannot distinguish useful ideas from worthless ones. If all ideas have equal validity then you are lost, because then, it seems to me, no ideas have any validity at all.

*The Burden of Skepticism*

Pasadena lecture, 1987

If you spend any time spinning hypotheses, checking to see whether they make sense, whether they conform to what else we know, thinking of tests you can pose to substantiate or deflate your hypotheses, you will find yourself doing science. And as you come to practice this habit of thought more and more you will get better and better at it. To penetrate into the heart of the thing – even a little thing, a blade of grass, as Walt Whitman said – is to experience a kind of exhilaration that, it may be, only human beings of all the beings on this planet can feel. We are an intelligent species and the use of our intelligence quite properly gives us pleasure. In this respect the brain is like a muscle. When we think well, we feel good.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 14)

Random House, Inc. New York, New York, USA. 1979

**Smith, Robertson**

No biographical data available

The very object of hypothesis is to inquire whether a real cause has not had a wider operation that there is any direct evidence for.

In R.A. Fisher

*The Genetical Theory of Natural Selection*

Chapter III (p. 52)

Dover Publications, Inc. New York, New York, USA. 1958

**Sonneberg, Walter**

No biographical data available

An hypothesis is a theory with a false label.

*Social Eccentricities*

Social Eccentricities (p. 33)

Broadway Publishing Co. New York, New York, USA. 1906

**Steinbeck, John** 1902–68

American novelist

There is one great difficulty with a good hypothesis. When it is completed and rounded, the corners smooth and the content cohesive and coherent, it is likely to become a thing in itself, a work of art. It is then like a finished sonnet or a painting completed. One hates to disturb it. Even if subsequent information should shoot a hole in it, one hates to tear it down because it once was beautiful and whole.

*Sea of Cortez*

Chapter 17 (p. 180)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

When a hypothesis is deeply accepted it becomes a growth which only a kind of surgery can amputate.

*Sea of Cortez*

Chapter 17 (p. 180)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Sterne, Laurence** 1713–68

English novelist and humorist

It is the nature of an hypothesis when once a man has conceived it, that it assimilates everything to itself, as proper nourishment, and from the first moment of your begetting it, it generally grows the stronger by everything you see, hear, read or understand.

*The Life and Opinions of Tristram Shandy, Gentleman and a Sentimental Journey Through France and Italy* (Volume 1)

Book II, Chapter XIX (p. 135)

Macmillan & Company Ltd. London, England. 1900

**Syngé, John L.** 1897–1995

Irish mathematician and physicist

Life is complicated enough...without inventing hypothetical complications.

*Kandelman's Krim*

Chapter Five (p. 89)

Jonathan Cape. London, England. 1957

**Tappan, Henry Philip** 1805–81

American philosopher, educator, and academic administrator

Observation and experiment, without a rational hypothesis, is like a man groping at objects at random with his eyes shut.

*Elements of Logic*

Book II, section VIII (p. 313)

D. Appleton & Co. New York, New York, USA. 1856

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

**Talley, Wilson**

No biographical data available

A fact is a simple statement that everyone believes. It is innocent, unless found guilty. A hypothesis is a novel suggestion that no one wants to believe. It is guilty, until found effective.

*Conversations on the Dark Secrets of Physics*

Chapter 5 (p. 69, fn)

Plenum Press. New York, New York, USA. 1991

**Timiryazev, K. A.**

No biographical data available

Should hypothesis, that is the guiding thought, be totally renounced, science will become an agglomeration of naked facts.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Tischner, August**

No biographical data available

Hypotheses have their time like fashions, and the same courage is needed to profess those the hour of which is passed, as those the hour of which is not come.

*The Fixed Idea of Astronomical Theory* (p. 37)

Gustav Fock. Leipzig, Germany. 1885

We may in thought pursue a train of hypotheses and suppositions, but they do not thereby acquire reality; still, in a normal condition of the human intellect, it is impossible to conceive that anything can exist and not exist at the same time.

*The Sun Changes Its Position in Space, Therefore it Cannot be Regarded as being "In a Condition of Rest"* (p. 16)

Gustav Fock. Leipzig, Germany. 1883

**Verworn, Max** 1862–1921

German physiologist

...without hypothesis there can be no progress in knowledge.

*Irritability*

Chapter IX (p. 259)

Yale University Press. New Haven, Connecticut, USA. 1913

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

No hypothesis can lay claim to any value unless it assembles many phenomena under one concept.

*Wisdom and Experience*

Science and Philosophy (p. 115)

Routledge & Kegan Paul Ltd. London, England. 1949

Hypotheses are the scaffolds which are erected in front of a building and removed when the building is completed. They are indispensable to the worker; but he must not mistake the scaffolding for the building.

*The Maxims and Reflections of Goethe*

Macmillan & Company Limited. London, England. 1908

Hypotheses are lullabies with which the teacher lulls his pupils to sleep. The thinking and faithful observer learns to know his limitation more and more; he sees that the further knowledge extends the more problems arise.

*Goethe's Poems and Aphorisms* (p. 197)

Oxford University Press, Inc. New York, New York, USA. 1932

**Weismann, August** 1834–1914

German biologist

...when we are confronted with facts which we see no possibility of understanding save on a single hypothesis, even though it be an undemonstratable one, we are naturally led to accept the hypothesis, at least until a better one can be found.

*The Evolution Theory* (Volume 1)

Lecture XII (p. 242)

Edward Arnold Publishers Ltd. London, England, 1904

**Watts, W. W.**

No biographical data available

...hypotheses are like steps in a staircase: each one must be mounted before the next one can be reached; and if you have no intention of coming back again that way, it does not matter if you destroy each step when you have made use of it.

*Report of the Seventy-third Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 645)

John Murray. London, England. 1904

**Whewell, William** 1794–1866

English philosopher and historian

To discover a Conception of the mind which will justly represent a train of observed facts is, in some measure, a process of conjecture...and the business of conjecture is commonly conducted by calling up before our minds several suppositions, selecting that one which most agrees with what we know of the observed facts. Hence he who has to discover the laws of nature may have to invent many suppositions before he hits upon the right one; and among the endowments which lead to his success, we must reckon that fertility of invention which ministers to him such imaginary schemes, till at last he finds the one which conforms to the true order of nature. A faculty in devising hypotheses, therefore, is so far from being a fault in the intellectual character of a discoverer, that it is, in truth, a faculty indispensable to his task....

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Part II, Book XI, Chapter V, Section II, Article 6 (p. 54)

John W. Parker. London, England. 1847

The framing of hypotheses is, for the inquirer after truth, not the end, but the beginning of his work.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2)

Book XI, Chapter V (p. 57)

John W. Parker. London, England. 1847

The hypothesis is like the captain, and the observations like the soldiers of an army: while he appears to command them, and in this way to work his own will, he does in fact derive all his power of conquest from their obedience, and becomes helpless and useless if they mutiny.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2)

Chapter V (p. 59)

John W. Parker. London, England. 1847

The hypotheses which we accept ought to explain phenomena which we have observed. But they ought to do more than this: our hypotheses ought to foretell phenomena which have not yet been observed.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Part II, Book XI, Chapter V, Section III, article 10 (p. 62)

John W. Parker. London, England. 1847

The hypotheses which we accept ought to explain phenomena which we have observed. But they ought to do more than this: our hypotheses ought to foretel phenomena which have not yet been observed ...

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2)

Part II, Book XI, Chapter V (p. 62)

John W. Parker. London, England. 1847

Hypotheses may be useful, though involving much that is superfluous, and even erroneous: for they may supply the true bond of connection of the facts; and the superfluity and error may afterwards be pared away.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, XI (p. 468)

John W. Parker. London, England. 1847

...he who has to discover the laws of nature may have to invent many suppositions before he hits upon the right one; and among the endowments which lead to his success, we must reckon that fertility of invention which ministers to him such imaginary schemes, till at last he finds the one which conforms to the true order of nature. A facility in devising hypotheses, therefore, is so far from being a fault in the intellectual character of a discoverer, that it is, in truth, a faculty indispensable to his task.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 54)

John W. Parker. London, England. 1867

...hypotheses may often be of service to science, when they involve a certain portion of incompleteness, and even of error.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 60)

John W. Parker. London, England. 1867

...hypotheses which we accept ought to explain phenomena which we have observed. But they ought to do more than this: our hypotheses ought to foretel phenomena which have not yet been observed ...

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 62)

John W. Parker. London, England. 1867

...when the hypothesis, of itself and without adjustment for the purpose, gives us the rule and reason of a class of facts not contemplated in its construction, we have a criterion of its reality, which has never yet been produced in favour of falsehood.

*The Philosophy of the Inductive Sciences: Founded Upon Their History*

Book XI, Chapter V (pp. 67–68)

John W. Parker. London, England. 1847

The truth of tentative hypotheses must be tested by their application to facts. The discoverer must be ready,

carefully to try his hypotheses in this manner, and to reject them if they will not bear the test, in spite of indolence and vanity.

*The Philosophy of the Inductive Sciences, Founded Upon Their History*  
(Volume 2) (2nd edition)

Aphorisms Concerning Science (p. 468)

John W. Parker. London, England. 1848

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

If science is not to degenerate into a medley of ad hoc hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations.

*Science and the Modern World*

Chapter I (p. 17)

The Macmillan Company. New York, New York, USA. 1929

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

It is an hypothesis that the sun will rise tomorrow: and this means that we do not know whether it will rise.

Translated by D.F. Pears & B.F. McGuinness

*Tractatus Logico-Philosophicus*

6.36311 (p. 143)

Routledge & Kegan Paul. London, England. 1961

## HYPOTHETICAL

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The students of physical science are but too prone to take each phenomenon for granted, and at once to jump to a conclusion. Hence then – knowledge is unsatisfactory and chiefly hypothetical.

Translated by Otto Wenckstern

*Goethe's Opinions on the World, Mankind, Literature, Science, and Art*  
(p. 66)

John W. Parker & Son. London, England. 1853

## HYPOTHETICAL SYSTEM

**More, Louis Trenchard**

American educator

If we are compelled to revert to old and supposedly discarded systems of thought when we attempt to make new hypothetical systems, we should inquire whether we are really advancing the theory of science by that method.

*The Limitations of Science*

Chapter IV (p. 107)

Henry Holt & Co. New York, New York, USA. 1915

# I

## ICE

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

And now there came both mist and snow,  
And it grew wondrous cold:  
And ice, mast high, came floating by,  
As green as emerald.  
And through the drifts the snowy clifts,  
Did send a dismal sheen:  
No shapes of men nor beast we ken –  
The ice was all between.  
The ice was here, the ice was there,  
The ice was all around:  
It crack'd and growl'd, and roar'd and howl'd,  
Like noises in a swound!

*The Rime of the Ancient Mariner and Other Poems*  
Rime of the Ancient Mariner, Part I, 1 (pp. 51–60)  
Little Leather Library Corporation. New York, New York, USA. 1915

**Faraday, Michael** 1791–1867  
English physicist and chemist

The world of ice and of eternal snow, as unfolded to us on the summits of the neighboring Alpine chain, so stern, so solitary, so dangerous, it may be, has yet its own peculiar charm. Not only does it enchain the attention of the natural philosopher, who finds in it the most wonderful disclosures as to the present and past history of the globe, but every summer it entices thousands of travelers of all conditions, who find there mental and bodily recreation.

In Hermann von Helmholtz  
Translated by Edmund Atkinson  
*Popular Lectures on Scientific Subjects*  
Ice and Glaciers (p. 107)  
D. Appleton & Company. New York, New York, USA. 1873

**Høeg, Peter** 1957–  
Danish writer

I have hydrophobia. But I know something about ice.

Translated by Tiina Nunnally  
*Smilla's Sense of Snow*  
The Sea (p. 363)  
Dell Publishing. New York, New York, USA. 1993

**Nansen, Fridtjof** 1861–1930  
Norwegian explorer, oceanographer, and statesman

Unseen and untrodden under this spotless mantle of ice the rigid polar regions slept profound sleep of death from the earliest dawn of time.

*Farthest North*  
Chapter I (p. 1)  
Harper & Brothers. New York, New York, USA. 1899

## Oz (Fictional Character)

Ice is cool. It's water, but it's not.  
*Buffy, the Vampire Slayer*  
TV series, Helpless, Episode 46 (1999)

**Tyndall, John** 1820–93  
Irish-born English physicist

To the eye of science these ice-crystals are as precious as the diamond – as purely formed, as delicately built. Where no disturbing causes intervene, there is no disorder in this crystalline architecture. By their own constructive power molecule builds itself on to molecule with a precision far greater than that attainable by the hands of man.

*Fragments of Science for Unscientific People*  
Chapter III (p. 83)  
D. Appleton & Co. New York, New York, USA. 1875

## ICEBERG

**Dana, Richard Henry** 1815–82  
American lawyer and author

No pencil has ever yet given anything like the true effect of an iceberg. In a picture, they are huge, uncouth masses, stuck in the sea, while their chief beauty and grandeur – their slow, stately motion; the whirling of the snow about their summits, and the fearful groaning and cracking of their parts – the picture cannot give. This is the large iceberg; while the small and distant islands, floating on the smooth sea, in the light of a clear day, look like little floating fairy isles of sapphire.

*Two Years Before the Mast*  
Chapter 32 (p. 303)  
Doubleday & Company, Inc. Garden City, New York, USA. 1949

**Esar, Evan** 1899–1995  
American humorist

[Iceberg] A permanent wave.

*Esar's Comic Dictionary*  
Iceberg  
Doubleday & Company, Inc. Garden City, New York, USA. 1983

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Nature sports want only amid every variety of form; and the motion of the great floating masses, cast into shapes with which we associate moveless solidity, adds to the magical effect of the scene. Here a flat-roofed temple, surrounded by colonnades of hoar and wasted columns, comes drifting past; there a cathedral, furnished with towers and spire, strikes heavily against the rocky bottom, many fathoms beneath, and its nodding pinnacles stoop at every blow. Yonder, already fast aground, there rests a ponderous castle, with its curtained towers, its arched gateway, and its multitudinous turrets, reflected on the calm



surface beneath; and pyramids and obelisks, buttressed ramparts, and embrasured watch-towers, with shapes still more fantastic – those of ships, and trees, and brute and human forms – crowd the retiring vista beyond.

*Popular Geology*

Lecture Second (p. 120)

Gould & Lincoln. Boston, Massachusetts, USA. 1860

**Muir, John** 1838–1914

American naturalist

On days like this, true sun-days, some of the bergs show a purplish tinge, though most are white from the disintegrating of their weathered surfaces. Now and then a new-born one is met that is pure blue crystal throughout, freshly broken from the fountain or recently exposed to the air by turning over.

*Travels in Alaska*

Chapter XIV (p. 232)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

When sunshine is sifting through the midst of the multitude of icebergs that fill the fiord and through the jets of radiant spray ever rising from the tremendous splashing of the falling and upspringing bergs, the effect is indescribably glorious. Glorious, too, are the shows they make in the night when the moon and stars are shining. The berg-thunder seems far louder than by day, and the projecting buttresses seem higher as they stand forward in the pale light, relieved by gloomy hollows, while the new-born bergs are dimly seen, crowned with faint lunar rainbows in the up-dashing spray.

*Travels in Alaska*

Chapter XVI (p. 269)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**Jones, William**

No biographical data available

Among the most imposing and grand of the many wonders of the ocean world, are the fixed and floating icebergs, the “palaces of nature,” which assume extraordinary and fantastic shapes, and more than realize the most sublime conceptions of the imagination.

*The Broad, Broad Ocean and Some of its Inhabitants*

Chapter III (p. 31)

Frederick Warne & Company. London, England. 1871

**Wright, George Frederick** 1838–1921

American geologist

**Upham, Warren** 1850–1934

American geologist

The ice of Greenland is incessantly travelling both by land and sea, and is ever ready to meet the tourist and the explorer far down toward the middle of the Atlantic.

*Greenland Icefields and Life in the North Atlantic*

Chapter I (p. 1)

D. Appleton & Co. New York, New York, USA. 1896

## ICHOLOGY

**Frey, Robert W.**

No biographical data available

In a sense, the field of ichnology is both old and new. Its guiding principles were known to a few workers many years ago, and these principles are now being rediscovered by scores of current workers. As is true in the development of any science, ichnologists have indeed gotten some occasional pebbles mixed in with their snowball; but they have also exposed many misconceptions and have made numerous positive gains. Ichnology today is rapidly approaching that plateau at which the sub-discipline will settle comfortably into the ever-growing accumulation of “standard” but highly useful methods or procedures in geology. Ichnology is not a new “magic wand,” to render sister subdisciplines obsolete, but neither can it be glibly ignored by anyone seriously interested in ancient life or environmental reconstructions.

*The Study of Trace Fossils*

Prologue (p. ix)

Springer-Verlag. New York, New York, USA. 1975

## ICHTHYOLOGIST

**Cuppy, Will** 1884–1929

American humorist and critic

...it is the chief function of the ichthyologists, or fish people, to keep pointing out, day after day, the perfect fitness of fish for existence in a liquid medium. And they’re right, at that. But I sometimes think that if fish were not well adapted for an aquatic life – if they were square, say – then it would be time to talk.

*How to Become Extinct*

Fish and Democracy (p. 2)

Dover Publications. New York, New York, USA. 1964

**Fishback, Margaret** 1904–85

No biographical data available

An ichthyologist is he,  
Well versed in anthropology  
To boot, so maybe he will know  
Why God or nature bothered so  
To give us beards and shiny noses  
While fish still live on beds of roses.

*I Take It Back*

Fish Course

E.P. Dutton & Company. New York, New York, USA. 1935

## ICHTHYOLOGY

**Roberts, Mary** 1788–1864

English botanist and author

I salute you from the land of the mountain and the flood;  
from amid scenes worthy the pen of Virgil, and the pencil

of Loraine; from the solitary village of Bethgellert, where the science of Ichthyology recently engaged the attention of your friend; that interesting science which includes the order, genera, and species of those animals which have either a naked, or scaly body; are furnished with fins and destitute of feet; belonging to the fourth division into which Linnaeus has divided the animal kingdom. Their natural history is necessarily involved in more obscurity than that of land animals, from the difficulty of ascertaining their habits, instincts, and specific differences; yet sufficient is already known to excite the curiosity, and reward the diligence of the naturalist.

*The Sea-side Companion; or, Marine Natural History*  
Letter VI (pp. 49–50)  
Printed for Whittaker & Co. London, England. 1835

## IDEA

**Abbey, Edward** 1927–89

American environmentalist and nature writer

I'd sooner exchange ideas with the birds on earth than learn to carry on intergalactic communications with some obscure race of humanoids on a satellite planet from the world of Betelgeuse.

*Desert Solitaire*  
The First Morning (p. 7)  
Ballantine Books. New York, New York, USA. 1968

**Acton, John Emerich Edward Dalberg** 1834–1902  
English historian

Ideas have a radiation and development, an ancestry and posterity of their own, in which men play the part of godfathers and godmothers more than that of legitimate parents.

In Gertrude Himmelfard  
*Darwin and the Darwinian Revolution*  
Chapter XVIII (p. 380)  
Doubleday & Co, Inc. Garden City, New York, USA. 1962

**Agnew, Ralph Palmer**

American mathematician

It is better to have ideas that are not quite right than to have no ideas at all.

*Differential Equations*  
Chapter 1, Problem 1.491 (p. 16)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Alcott, Amos Bronson** 1799–1888

American educational and social reformer

If the ancients left us ideas, to our credit be it spoken that we moderns are building houses for them – structures which neither Plato nor Archimedes had dreamed possible.

*Table-talk*  
Hippogrieffs (p. 35)  
Roberts Brothers. Boston, Massachusetts, USA. 1877

**Aristotle** 384 BCE–322 BCE

Greek philosopher

The same ideas, one must believe, recur in men's mind not once or twice but again and again.

In *Great Books of the Western World* (Volume 8)  
*On the Heavens*  
Book I, Chapter 3, 270b [20]  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bagehot, Walter** 1826–77

English journalist

One of the greatest pains to human nature is the pain of a new idea.

*Physics and Politics*  
Chapter 5 (p. 145)  
Ivan R. Dee, Publisher. Chicago, Illinois, USA. 1999

**Belinsky, Vissarion Grigorievich** 1811–48

Russian writer and literary critic

In science you must look for ideas. No ideas, no science. Knowledge of the facts is precious, because facts are laden with ideas. Facts without ideas are tripe for the brain and for the memory.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

**Benjamin, Walter** 1892–1940

German-Jewish Marxist literary critic and essayist

Ideas are to objects as constellations are to stars.

*The Origin of German Tragic Drama* (p. 34)  
Verso. London, England. 1998

**Bernard, Claude** 1813–78

French physiologist

It is impossible to devise an experiment without a preconceived idea; devising an experiment, we said, is putting a question; we never conceive a question without an idea which invites an answer. I consider it, therefore, an absolute principle that experiments must always be devised in view of a preconceived idea, no matter if the idea be not very clear nor very well defined. As for noting the results of the experiment, which is itself only an induced observation, I posit it similarly as a principle that we must here, as always, observe without a preconceived idea.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section vi (p. 23)  
Henry Schuman, Inc. New York, New York, USA. 1927

The experimental method, then, cannot give new and fruitful ideas to men who have none; it can serve only to guide the ideas of men who have them, to direct their ideas and to develop them so as to get the best possible results. The idea is a seed; the method is the earth furnishing the conditions in which it may develop, flourish, and give

the best fruit according to its nature. But as only what has been sown in the ground will ever grow in it, so nothing will be developed by the experimental method except the ideas submitted to it.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II, Section ii (p. 34)  
 Henry Schuman, Inc. New York, New York, USA. 1927

If an idea presents itself to us, we must not reject it simply because it does not agree with the logical deductions of a reigning theory.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II, Section iii (p. 36)  
 Henry Schuman, Inc. New York, New York, USA. 1927

Our ideas are only intellectual instruments which we use to break into phenomena; we must change them when they have served their purpose, as we change a blunt lancet that we have used long enough.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II, Section iv (p. 41)  
 Henry Schuman, Inc. New York, New York, USA. 1927

When one calls a new fact a discovery, the fact itself is not a discovery, but rather the new idea derived from it ...

*An Introduction to the Study of Experimental Medicine*  
 Part One, Chapter II (p. 53)  
 Henry Schuman, Inc. New York, New York, USA. 1927

There must be a general idea to verify; without that there is no scientist.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin  
*The Cahier Rouge of Claude Bernard* (p. 117)  
 Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

### **Blake, William** 1757–1827

English poet, painter, and engraver

I have heard many people say, “Give me the ideas, it is no matter what words you put them into.... Ideas cannot be given but in their minutely appropriate words,

*The Poems, With Specimens of the Prose Writings, of William Blake*  
 The True and False in Literature and Art (p. 273)  
 W. Scott, Ltd. London, England. 1885

### **Bly, Robert** 1926–

American poet

A great idea is a useful invention, like an eyeglass or a new fuel.

*The Winged Life. The Poetic Voice of Henry David Thoreau*  
 Part Two (p. 25)  
 Sierra Club Books. San Francisco, California, USA. 1986

### **Bott, Raoul** 1923–2005

Hungarian mathematician

In retrospect all great ideas take on a certain simplicity and inevitability, partly because they shape the whole subsequent development of the subject.

In Robert D. MacPherson (ed)  
*Collected Papers: Mathematics Related to Physics*  
 Marston Morse and His Mathematical Works (p. 76)  
 Birkhauser. Boston, Massachusetts, USA. 1995

### **Bragg, Sir William Lawrence** 1890–1971

Australian-born English physicist

It is not easy to be sure whether the crucial idea is really one’s own or has been unconsciously assimilated in talks with others.

In J. Watson  
*The Double Helix: A Personal Account of the Discovery of the Structure of DNA*

Forward by Sir Lawrence Bragg (p. viii)  
 Athenaeum. New York, New York, USA. 1985

### **Brewster, George**

No biographical data available

Ideas may have originality, and yet, at the same time, they may be either as simple as the babbling and nonsense of mere idiocy, or as unreal as the wildest and most incoherent ravings of stark madness; the likeness of nothing in the heaven above, or in the earth beneath, or in any locality within the whole wide regions of sober thought.

*A New Philosophy of Matter; Showing the Identity of All the Imponderables* (3rd edition)

Chapter I (p. 19)  
 Edward H. Fletcher. New York, New York, USA. 1858

...ideas may be both novel and important, and yet, if they are incorrect – if they lack the very essential support of incontrovertible fact, they are unworthy of credence. Without this, a theory may be both beautiful and grand, but must be as evanescent as it is beautiful, and as unsubstantial as it is grand.

*A New Philosophy of Matter; Showing the Identity of All the Imponderables* (3rd edition)

Chapter I (p. 19)  
 Edward H. Fletcher. New York, New York, USA. 1858

### **Briggs, Robin**

No biographical data available

The history of ideas is at once a fascinating and a difficult subject. Fascinating, since it can so often illuminate our own attitudes and problems by reference to the struggle of previous generations, and can also give a new dimension to past ages. Difficult, because ideas change their meaning and importance according to the context in which they appear, and vary in their significance for different thinkers and different periods.

*The Scientific Revolution of the Seventeenth Century*  
 Foreword (p. ix)

Longman Group Ltd. London, England. 1969

### **Buchanan, Scott** 1895–1968

American educator and philosopher

The clarification of any idea, however, simple or complex it may be, begins with its location on that translucent

phosphorescent surface of man's thought that Plato called opinion or belief.

*Poetry and Mathematics*

Chapter I

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Every idea has something of the pain and peril of child-birth about it; ideas are just as mortal and just as immortal as organized beings are.

*The Note-books of Samuel Butler* (p. 108)

A. C. Fifield. London, England. 1913

**Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

...we know, and what we really know, practical assent and simulated ignorance...allows us to live with ideas which, if we truly put them to the test, ought to upset our whole life.

Translated by Justin O'Brien

*The Myth of Sisyphus and Other Essays*

An Absurd Reasoning (p. 18)

Alfred A. Knopf. New York, New York, USA. 1961

**Charlie Chan (Fictional character)**

Ideas planted too soon often like seeds on winter ground quickly die.

*The Sky Dragon*

The film

**Cloud, Preston Ercelle** 1912–91

American biogeologist, paleontologist, and humanist

Acceptance of new ideas is usually contingent on three preconditions: (1) the world must be ready for them; (2) they must be convincingly advocated by a persuasive person or group; and (3) they must be perceived as clearly superior to (or, at least, not in serious conflict with) other widely held beliefs.

*Oasis in Space: Earth History from the Beginning*

Chapter Three (p. 49)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Cohen, I. Bernard** 1914–2003

American physicist and science historian

Scientific ideas change so rapidly that we would have to add the qualification: important to whom – to us? To our children? Or to our fathers?

*Franklin and Newton*

Chapter One (p. 13)

Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Cohen, David** 1942–2002

American mathematician

The most profound ideas are easily stated – but not easily understood.

*Calculus: The Language Of Change*

Chapter 12 (p. 815)

Jones and Bartlett Publishers. Sudbury, Massachusetts, USA. 2005

**Cole, K. C.**

Science writer

Right ideas are seeds that flower into righter ideas, whereas wrong ideas are often sterile and do not bear fruit.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter II (p. 42)

Harcourt Brace & Co. Orlando, Florida, USA. 1999

**Collins, Wilkie** 1824–89

English novelist

Habits of literary composition are perfectly familiar to me. One of the rarest of all the intellectual accomplishments that a man can possess is the grand faculty of arranging his ideas. Immense privilege! I possess it. Do you?

*The Woman in White*

The Story Concluded by Walter Hartright

Chapter VII (p. 538)

Everyman's Library. London, England. No date

**Crehore, Albert Cushing**

No biographical data available

In presenting new ideas on any subject it is natural to draw a close comparison between the new and the old, for the new conceptions would not be required if existing theories were entirely adequate and stood in complete harmony with the experimental facts as we know them.

*The Atom*

Chapter II (p. 21)

D. van Nostrand Co. New York, New York, USA. 1920

**Darwin, Charles Robert** 1809–82

English naturalist

...the force of impressions generally depends on preconceived ideas...

*The Voyage of The Beagle*

Chapter XXI (p. 503)

Heron Books. 1968

**Davy, Sir Humphry** 1778–1829

English chemist

One use of physical science is that it gives definite ideas.

In John Davy

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter II (p. 123)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**de Bono, Edward** 1933–

Maltese psychologist and writer

Pouncing on an idea as soon as it appears kills the idea. Too early and too enthusiastic logical attention either

freezes the idea or forces it into the old moulds. Concentration on an idea isolates it from its surroundings and arrests its growth. The glare of attention inhibits the fertile semi-conscious processes that go to develop an idea.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas* (p. 138)  
Avon Books. New York, New York, USA. 1971

An idea is far more fertile if seduced rather than raped.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas* (p. 139)  
Avon Books. New York, New York, USA. 1971

**Dennett, Daniel Clement** 1942–  
American philosopher

If I were to give an award for the single best idea anyone has ever had, I'd give it to Darwin, ahead of Newton and Einstein and everyone else. In a single stroke, the idea of evolution by natural selection unifies the realm of life, meaning, and purpose with the realm of space and time, cause and effect, mechanism and physical laws.

*Darwin's Dangerous Idea*  
Chapter One, Section 1 (p. 21)  
Simon & Schuster. New York, New York, USA. 1995

**Dewey, John** 1859–1952  
American philosopher and educator

Old ideas give way slowly, for they are more than abstract forms and categories. They are habits, predispositions, deeply engrained attitudes of aversion and preference. Moreover, the conviction persists – though history shows it to be a hallucination – that all the questions that the human mind has asked are questions that can be answered in terms of the alternatives that the questions themselves present. But in fact intellectual progress usually occurs through sheer abandonment of questions together with both of the alternatives they assume – an abandonment that results from their decreasing vitality and a change of urgent interest. We do not solve them: we get over them. Old questions are solved by disappearing, evaporating, while new questions corresponding to the changed attitudes of endeavor and preference take their place. Doubtless the greatest dissolvent in contemporary thought of old questions, the greatest precipitant of new methods, new intention, new problems, is the one effected by the scientific revolution that found its climax in the “Origin of Species.”

*The Influence of Darwin on Philosophy, and Other Essays in Contemporary Thought*  
The Influence of Darwinism on Philosophy, Section IV (p. 19)  
Henry Holt & Company. New York, New York, USA. 1910

To magnify thought and ideas for their own sake apart from what they do (except, once more, esthetically) is to refuse to learn the lesson of the most authentic kind of knowledge – the experimental – and it is to reject the idealism which involves responsibility. To praise think-

ing above action because there is so much ill-considered action in the world is to help maintain the kind of a world in which action occurs for narrow and transient purposes. To seek after ideas and to cling to them as means of conducting operations, as factors in practical arts, is to participate in creating a world in which the springs of thinking will be clear and ever-flowing.

*The Quest for Certainty*  
Chapter V (p. 138)  
Balch & Co. New York, New York, USA. 1929

**Dirac, Paul Adrien Maurice** 1902–84  
English theoretical physicist

It seems that some essentially new physical ideas are here needed.

*The Principles of Quantum Mechanics* (2nd edition)  
Chapter XIII, Section 81 (p. 297)  
At The Clarendon Press. Oxford, England. 1935

...it is a general rule that the originator of a new idea is not the most suitable person to develop it because his fears of something going wrong are really too strong and prevent his looking at the method from a purely detached point of view in the way that he ought to.

*The Development of Quantum Theory* (p. 24)  
Gordon & Breach Science. New York, New York, USA. 1971

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

Great ideas often seem simple and self-evident, but only after somebody has explained them to us. Then, how interesting they become! The act of insight is among the most exciting and pleasurable experiences a scientist can have, when he recognizes what all the time was there to be seen, and yet he did not see it.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas 1974*  
Advancement and Obsolescence in Science (p. 56)  
Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

A new idea is unforeseeable until it has been germinated in somebody's mind, and a new discovery is not guaranteed until at least a glimmer of it is seen.

In Robert M. Hutchins and Mortimer J. Adler  
*The Great Ideas of Today 1974*  
Advancement and Obsolescence in Science (p. 61)  
Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

One's ideas must be as broad as Nature if they are to interpret Nature.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 5 (p. 179)  
Wings Books. New York, New York, USA. 1967

**Drexler, K. Eric** 1955–  
American nanotechnology engineer and researcher, and futurist



Because of our superficial self-awareness, we often wonder where an idea in our heads came from. Some people imagine that these thoughts and feelings come directly from agencies outside their own minds; they incline towards a belief in haunted heads.

*Engines of Creation*

Chapter 5 (p. 67)

Anchor Press/Doubleday. Garden City, New York, USA. 1986

**Duckworth, Eleanor** 1935–

Psychologist

The having of wonderful ideas is what I consider to be the essence of intellectual development.

The Having of Wonderful Ideas

*Harvard Educational Review*, May, 1972 (p. 218)

Wonderful ideas cannot spring out of nothing. They build on a foundation of other ideas.

The Having of Wonderful Ideas

*Harvard Educational Review*, May, 1972 (pp. 222–223)

Wonderful ideas build on other wonderful ideas. They are not had without content...

The Having of Wonderful Ideas

*Harvard Educational Review*, May, 1972 (p. 224)

**Easton, William**

No biographical data available

A creative thinker evolves no new ideas. He actually evolves new combinations of ideas that are already in his mind.

In Alex F. Osborn

*Applied Imagination: Principles and Procedures of Creative Problem-Solving*

Chapter XIV (pp. 168–169)

Charles Scribner's Sons. New York, New York, USA. 1957

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Most of the fundamental ideas of science are essentially simple, and may, as a rule, be expressed in a language comprehensible to everyone.

In Albert Einstein and Leopold Infeld

*The Evolution of Physics*

The Riddle of Motion (p. 27)

Simon & Schuster. New York, New York, USA. 1938

**Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

Fine ideas, unless put into words, are like water in a jug which has no outlet.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Nine (p. 112)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Eisner, Thomas** 1929–2011

Father of chemical ecology

“Every single new idea in chemistry has come not from the minds of chemists but from nature ...

Quoted in Jane E. Brody

Bug Lover Explores Nature's Subtle Chemistry

*The New York Times*, June 10, 1989

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

The moment of finding a fellow-creature is often as full of mingled doubt and exultation as the moment of finding an idea.

*Daniel Deronda*

Book II, Chapter XVII

Harper & Brothers. New York, New York, USA. 1876

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

Between the idea

And the reality

Between the notion

And the act

Falls the shadow.

*The Collected Poems and Plays 1909–1950*

The Hollow Men, Part V, stanza 3 (p. 59)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

God screens us evermore from premature ideas.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Spiritual Laws (p. 313)

The Library of America. New York, New York, USA. 1983

...ideas must work through the brains and the arms of good and brave men, or they are no better than dreams.

*Poems and Essays*

Terminus (p. 88)

Houghton Mifflin & Co. New York, New York, USA. 1897

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The network of ideas remains and forms as it were a moving cobweb in which repose wriggles and tosses, incapable of finding a stable equilibrium.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 301)

Dodd, Mead & Co. New York, New York, USA. 1925

...hunting for ideas troubles the brain even more than hunting for the roots of an equation.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 308)

Dodd, Mead & Co. New York, New York, USA. 1925



**Faraday, Michael** 1791–1867

English physicist and chemist

Ideas and thoughts often spring up in my mind, and are again irrevocably lost for want of noting at the time.

In Bence Jones

*The Life and Letters of Faraday* (Volume I)

Chapter I (p. 28)

J.B. Lippincott &amp; Co. Philadelphia, Pennsylvania, USA. 1870

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

There is no idea, however, ancient and absurd, that is not capable of improving our knowledge.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 4 (p. 47)

Verso. London, England. 1978

**Feynman, Richard P.** 1918–88

American theoretical physicist

...there are great ideas developed in the history of man, and these ideas do not last unless they are passed purposely and clearly from generation to generation.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 4)

Perseus Books. Reading, Massachusetts, USA. 1998

There is no authority who decides what is a good idea. We have lost the need to go to an authority to find out whether an idea is true or not. We can read an authority and let him suggest something; we can try it out and find out if it is true or not. If it is not true, so much the worse – so the “authorities” lose some of their functions.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 21)

Perseus Books. Reading, Massachusetts, USA. 1998

...the idea [to get rid of the infinite self-energies in the classical theory] seemed so obvious to me and so elegant that I fell deeply in love with it. And, like falling in love with a woman, it is only possible if you do not know much about her, so you cannot see her faults.

*Nobel Lectures, Physics 1963–1970*The Development of the Space-Time View of Quantum Electrodynamics  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1972**Gaarder, Jostein** 1952–

Norwegian intellectual

The Idea is much too big for my little head.

Translated by Paulette Møller

*Sophie's World: A Novel about the History of Philosophy*

The Big Bang

Farrar, Straus &amp; Giroux New York, New York, USA. 1994

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

It is easy to dismiss a crazy theory with laughter that debars any attempt to understand a man's motivation – and the nummulosphere is a crazy theory. I find that few men

of imagination are not worth my attention. Their ideas may be wrong, even foolish, but their methods often repay a close study. Few honest passions are not based upon some valid perception of unity or some anomaly worthy of note. The different drummer often beats a fruitful tempo.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 22 (pp. 234–235)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1980

**Hadamard, Jacques** 1865–1963

French mathematician

The ideas chosen by my unconscious are those which reach my consciousness, and I see that they are those which agree with my aesthetic sense.

*The Psychology of Invention in the Mathematical Field* (p. 39)

Princeton University Press. Princeton, New Jersey, USA. 1945

**Hare, Augustus William** 1834–1903

English writer and raconteur

**Hare, Julius Charles** 1795–1855

English theological writer

Notions may be imported by books from abroad; ideas must be grown at home by thought.

*Guesses at Truth* (3rd edition) (p. 3)

Printed for Walton &amp; Maberly. London, England. 1855

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

Ideas, once born, seemingly have a life of their own. Like germs they breed, spread, mutate, and catch their invaded victims by surprise. When and where an idea originated is often unknown, and many a person believes the idea, as recounted by him, springs unprompted from the recesses of his own mind. A thought drifts as light as thistledown, and sensitive minds responding to its novel vibrations “independently” discover the new idea.

*Masks of the Universe*

Chapter 6 (p. 87)

Macmillan Publishing Company. New York, New York, USA. 1985

**Hayes, Brian**

American scientist, columnist, and author

The nature of the mathematical enterprise may raise the stakes even higher than they are elsewhere in the world of science and scholarship. In other fields, an idea that proves fruitful for a time but eventually has to be discarded is counted a partial success. In mathematics, a proof that turns out to have a serious flaw is nothing but an embarrassment.

Aftermath

*The Emissary*, Fall 1999 (p. 13)**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

... we see from these formulations how difficult it is when we try to push new ideas into an old system of concepts belonging to an earlier philosophy, or, to use an old metaphor, when we attempt to put new wine into old bottles. Such attempts are always distressing, for they mislead us into continually occupying with the inevitable cracks in the old bottles, instead of rejoicing over the new wine.

In Wolfgang Pauli (ed.)

*Niels Bohr and the Development of Physics*

The Development of the Interpretation of the Quantum Theory (p. 23)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1955

### **Henderson, John R.**

No biographical data available

Almost anybody can have an idea. Ideas are the small change of science: it is conviction – zany, indestructible belief – that is the real pot of gold.

Who Discovered Insulin?

*Guy's Hospital Gazette*, Volume 85, 1971

### **Hickok, Laurens Perseus** 1798–1888

No biographical data available

...the subjective idea alone is not complete science; and the fact as mere fact is not science; the first is only the knowledge of the possible, the last is only the knowledge of the empirical ...

*Rational Cosmology: Or, The Eternal Principles and the Necessary*

*Laws of the Universe*

Introduction (p. 20)

D. Appleton & Co. New York, New York, USA. 1858

### **Higgins, Lothrop Davis**

No biographical data available

It is important, in beginning a new study, to have some clear idea of what the study is to be.

*First Science Book; Physics and Chemistry*

Part I, Chapter I (p. 1)

Ginn & Co. Boston, Massachusetts, USA. 1905

### **Hoeffler, Don C.**

No biographical data available

Develop a honeybee mind, gathering ideas everywhere and associating them fully.

But You Don't Understand the Problem

*Electronic News*, July 17, 1967

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Man's claim to have progressed far beyond his fellow animals must be supported, not by his search for food, warmth, and shelter (however ingeniously conducted) but by his penetration into the very fabric of the Universe. It is in the world of ideas and in the relation of his brain to the Universe itself that the superiority of Man lies. The rise of Man may just be described as an adventure in ideas.

*Frontiers of Astronomy*

Chapter One (p. 1)

Harper & Row, Publishers. New York, New York, USA. 1955

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Man is not a circle with a single centre; he is an ellipse with two foci. Facts are one, ideas are the other.

*Les Miserables*

Volume 4, Book VII, Chapter 1 (p. 257)

The Heritage Press. New York, New York, USA. 1938

An idea is a meteor; at the moment of success, the accumulated meditations which have preceded it open a little, and a spark flashes forth from it...

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part I, Book Sixth, Chapter VI (p. 255)

The Heritage Press. New York, New York, USA. 1961

### **Huxley, Thomas Henry** 1825–95

English biologist

Men can intoxicate themselves with ideas as effectually as with alcohol or with bang, and produce, by dint of intense thinking, mental conditions hardly distinguishable from monomania.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

An Episcopal Trilogy (p. 136)

Macmillan & Company Ltd. London, England. 1904

...whatever practical people may say, this world is, after all, absolutely governed by ideas, and very often by the wildest and most hypothetical ideas.

*Collected Essays* (Volume 3)

*Science and Education*

On the Study of Biology (p. 273)

Macmillan & Company Ltd. London, England. 1904

### **Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

We have been warned against accepting ideas because they seem self-evident. However, there are some assumptions we can accept. The whole world of science and knowledge is built on a set of assumptions that seem self-evident but cannot be independently proved.

*Is It Really So?: A Guide to Clear Thinking*

Chapter 4 (p. 38)

The West Minster Press. Philadelphia, Pennsylvania, USA. 1976

### **James, William** 1842–1910

American philosopher and psychologist

An idea, to be suggestive, must come to the individual with the force of a revelation.

*The Varieties of Religious Experience*

Lectures IV & V (p. 112)

The Modern Library. New York, New York, USA. 1967

### **J Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...if an interpretation of the workings of nature is to mean anything to us, it must be in terms of ideas which are already in our minds – otherwise it will be incomprehensible to us, and cannot add to our knowledge.

*Physics and Philosophy*

Chapter I (p. 10)

Dover Publications. Mineola, New York, USA. 1981

### **Jevons, William Stanley** 1835–82

English economist and logician

The man of one idea has but a single chance of truth.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXVI (pp. 586–587)

Macmillan & Co Ltd. London, England. 1887

### **Kant, Immanuel** 1724–1804

German philosopher

...all human cognition begins with intuition, proceeds from thence to conceptions, and ends with ideas.

In Great Books of the Western World Volume 42

*Critique of Pure Reason*

Book II, Chapter III (p. 209)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Kekulé, Friedrich August** 1829–96

German chemist

Certain ideas at certain times are in the air; if one man does not enunciate them, another will do so soon afterwards.

In O. Theodor Benfey

*From Vital Force to Structural Formulas*

Epilogue (p. 98)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

### **Kepler, Johannes** 1571–1630

German astronomer

...some things will be said which time will prove, but many things will be refuted by time and experience as vain and worthless; as is customary with the people, the latter will be committed to the winds, and the former, entirely to memory.

*Concerning the More Certain Fundamentals of Astrology*

Thesis 2 (p. 3)

Clancy Publications, Inc. New York, New York, USA. 1942

### **Kettering, Charles Franklin** 1876–1958

American engineer and inventor

I have no objection to the standardizing of bolts and nuts and screws...but I do have a terrible obsession against the standardization of ideas.

In T.A. Boyd

*Professional Amateur*

Part III Chapter XIV (p. 137)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

### **Keynes, John Maynard** 1883–1946

British economist

The difficulty lies, not in the new ideas, but in escaping the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds.

In K. Eric Drexler

*Engines of Creation: The Coming Era of Nanotechnology* (p. 231)

Bantam Books. New York, New York, USA. 1987

### **Keyser, Cassius Jackson** 1862–1947

American mathematician

Like a child, an idea, once it is born, once it has come into the realm of spiritual light, possibly long before such birth, enters upon a career, a career, however, that, unlike the child's, seems to be immortal. In most cases and probably in all, an idea, on entering the world of consciousness, is vague, nebulous, formless, not at once betraying either what it is or what it is destined to become.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter I (p. 13)

Columbia University Press. New York, New York, USA. 1916

### **Knuth, Donald E.** 1938–

Creator of TeX

It's the idea that counts true; but we need a name for the idea, so we can apply it more easily next time.

*Surreal Numbers*

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1974

### **Krantz, David L.**

No biographical data available

### **Wiggins, Lynda**

No biographical data available

Scientific ideas compete in an open marketplace. Each offers the possibility of a plausible solution to what might be a potentially significant problem. In its promise, an idea will attract other scientists – fellow explorers who will articulate, criticize, and ultimately determine the idea's actuality. While these explorers can breathe life into an idea, their absence or defection leads to its death. Ideas without recruits become like Bishop Berkeley's proverbial unheard falling tree.

Personal and Impersonal Channels of Recruitment in the Growth of Theory  
*Human Development*, Volume 16, 1973 (p. 133)

### **Langer, Susanne Katherina Knauth** 1895–1985

American philosopher

The limits of thought are not so much set from outside, by the fullness or poverty of experiences that meet the mind, as from within, by the power of conceptions, the wealth of formulative notions with which the mind meets experience.... A new idea is a light that illuminates presences which simply had no form for us before the light fell on them.

*Philosophy in a New Key*

Chapter I (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Lavoisier, Antoine Laurent** 1743–94

French chemist

Like three impressions of the same seal, the word ought to produce the idea, and the idea to be a picture of the fact.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xiv)

Printed for William Creech. Edinburgh, Scotland. 1790

When we begin the study of any science, we are in a situation, respecting that science, similar to that of children; and the course by which we have to advance is precisely the same which Nature follows in the formation of their ideas. In a child, the idea is merely an effect produced by a sensation; and, in the same manner, in commencing the study of a physical science, we ought to form no idea but what is a necessary consequence, and immediate effect, of an experiment or observation.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xvi)

Printed for William Creech. Edinburgh, Scotland. 1790

**Lederman, Leon** 1922–

American high-energy physicist

If the basic idea is too complicated to fit on a T-shirt, it's probably wrong.

In Timothy Ferris (ed.)

*The Whole Shebang: A State-of-the-Universe's Report*

Quantum Weirdness (p. 272)

Simon & Schuster. New York, New York, USA. 1996

**Lepper, George Henry**

No biographical data available

On the theory of probabilities, the odds in every generation are a billion to one against the originator of an idea being right and the world wrong. This formidable preponderance of numbers against him has doubtless awed many a timid, but correct, thinker into silence, and cast many a stone in the path of human progress.

*From Nebula to Nebula*

Introduction (p. 15)

Privately printed. Pittsburgh, Pennsylvania, USA. 1917

**Ley, Willy**

American scientist

The study of an idea is, of necessity, the story of many things. Ideas, like large rivers, never have just one source. Just as the water of a river near its mouth, in its final form, is composed largely of many tributaries, so an idea, in its final form, is composed largely of later additions.

*Rockets, Missiles and Space Travel*

Chapter 1 (p. 3)

The Viking Press. New York, New York, USA. 1951

**Locke, John** 1632–1704

English philosopher and political theorist

...there seems to be a constant decay of all our ideas; even of those which are struck deepest, and in minds the

most retentive; so that if they be not sometimes renewed, by repeated exercises of the senses, or reflection on those kinds of objects which at first occasioned them, the print wears out, and at last there remains nothing to be seen.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter X, Section 5 (p. 143)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Ideas in mathematics are a sure ground of certainty; and yet everyone may not make so right an use of them, as to attain to certainty by them: but yet anyone's failing of certainty by them, is not the overturning of this truth, that certainty is to be had by them.

*The Works of John Locke*

A Letter to the Right Rev. Edward Lord Bishop of Worcester (p. 56)

Printed for Thomas Tegg. London, England. 1823

**Lowell, Percival** 1855–1916

American astronomer

Only the accustomed and the commonplace do men take kindly at once. The strange terrifies them. It is with ideas in men as with unfamiliar sights in beasts. Both shy at first at what they have never seen before. Scientists and layman alike are afraid to commit themselves to that upon which they have not been brought up.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 298)

University of Arizona Press. Tucson, Arizona, USA. 1976

An idea... is a mode of motion, not in any figurative sense but in an actual one, and as such possesses inertia. That is, it takes force to start it going; and once set going, force to make it stop. A new idea entering the field encounters, opposed to it, the momentum of those already there. It has got to overcome this before it can prevail. Then it in turn grows hard to oust. The ripple of yesterday has become the roller of today. The despised is not the despotic.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 300)

University of Arizona Press. Tucson, Arizona, USA. 1976

**Lyttleton, R. A.**

English astronomer

A new idea may be likened to a new-born babe: it is to be carefully nurtured and given every consideration rather than attacked with the choking diet of a multitude of so-called facts because it cannot prove at once that it will one day grow into a Samson.

In Ronald Duncan and Miranda Weston-Smith (eds.)

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Nature of Knowledge (p. 11)

Pergamon Press. Oxford, England. 1977

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Ideas are not all of life. They are only momentary efflorescences of light, designed to illuminate the paths of the will.

*Popular Scientific Lectures*

On Transformation and Adaptation in Scientific Thought (p. 233)  
The Open Court Publishing Company, Chicago, Illinois, USA. 1898

The grist and kernel of mechanical ideas has in almost every case grown up in the investigation of very simple and special cases of mechanical processes; and the analysis of the history of the discussions concerning these cases must ever remain the method at once the most effective and the most natural for laying this grist and kernel bare.

Translated by Thomas McCormack

*The Science of Mechanics: A Critical and Historical Account of Its Development of Mechanics* (4th edition)

Preface to the first edition (pp. ix–x)

The Open Court Publishing Co. Chicago, Illinois, USA. 1902

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

...the proof of an idea is not to be sought in the soundness of the man fathering it, but in the soundness of the idea itself. One asks of a pudding, not if the cook who offers it is a good woman, but if the pudding itself is good.

*The Philosophy of Friedrich Nietzsche*

Nietzsche the Prophet

Chapter II (p. 271)

Kennikat Press, Inc. Port Washington, New York, USA. 1913

**Michaelson, Albert Abraham** 1852–1931

Prussian-born American physicist

Scientific men are necessarily educated to economize expression so as to condense whole sentences into a single word and a whole chapter into a single sentence. These words and sentences come to be so familiar to the investigator as expressions of summarized work – it may be of years – that only by considerable effort can he remember that to others his ideas need constant explanation and elucidation which lead to inartistic and wearying repetition.

*Light Waves and Their Uses*

Lecture I (p. 1)

The University of Chicago Press. Cambridge, England. 1903

**Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children's writer, and playwright

When you are a Bear of Very Little Brain, and you Think of Things, you find sometimes that a Thing which seemed very Thingish inside you is quite different when it gets out into the open and has other people looking at it.

*The Complete Tales & Poems of Winnie-the-Pooh*

The House at Pooh Corner (p. 266)

Dutton Children's Books. New York, New York, USA. 2001

**Mullis, Kary B.**

No biographical data available

Sometimes a good idea comes to you when you are not

looking for it. Through an improbable combination of coincidence, naïveté and lucky mistakes.

The Unusual Origin of the Polymerase Chain Reaction

*Scientific American*, Volume 262, Number 4, April, 1990 (p. 445)

**Oliver, Mary**

No biographical data available

A fact: one picks it up and reads it, and puts it down, and there is an end to it. But an idea! That one may pick up, and reflect upon, and oppose, and expand, and so pass a delightful altogether.

*Blue Pastures*

Pen and Paper and a Breath of Air (p. 57)

Harcourt Brace & Company. New York, New York, USA. 1995

**Osborn, Henry Fairfield** 1857–1935

American paleontologist and geologist

...the all round liberally educated man, from Paleolithic times to the time when the earth shall become a cold cinder, will always be the same, namely, *the man who follows his standards of truth and beauty, who employs his learning and observation, his reason, his expression, for purposes of production, that is, to add something of his own to the stock of the world's ideas.*

*Huxley and Education* (pp. 38–39)

Charles Scribner's Sons. New York, New York, USA. 1910

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932

Latvian-born German chemist

...a scientist, whose task it is to analyze the facts of experience irrespective of any preconceived ideas, will not find his results in accordance with ideas which are handed down from generation to generation – ideas which have become venerable, not only because of their age, but also because of the influence which they have had upon the development of mankind.

Translated by Thomas Seltzer

*Individuality and Immortality*

Individuality and Immortality (pp. 1–2)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1906

**Papert, Seymour** 1928–

South African mathematician

What matters most is...one comes to appreciate how certain ideas can be used as tools to think with over a lifetime. One learns to enjoy and respect the power of powerful ideas. One learns that the most powerful idea of all is the idea of powerful ideas.

*Mindstorms: Children, Computers and Powerful Ideas*

Chapter 3 (p. 76)

Basic Books, Inc. New York, New York, USA. 1980

**Parkhurst, C. K.**

No biographical data available

No idea can pass as legal tender till it has been indorsed by experiment.



Work as an Educating Power  
*The Magazine of American History with Notes and Queries*, Volume 13,  
 Number 4, April, 1885 (p. 356)

**Perl, Martin L.** 1927  
 American physicist

My final remark to young women and men going into experimental science is that they should pay little attention to the speculative physics ideas of my generation. After all, if my generation has any really good speculative ideas, we will be carrying these ideas out ourselves.

*Nobel Lectures, Physics 1991–1995*  
 Nobel lecture for award received in 1995  
 Reflections on the Discovery of the Tau Lepton (p. 193)  
 World Scientific Publishing Company. Singapore. 1997

**Peirce, Charles Sanders** 1839–1914  
 American scientist, logician, and philosopher

It is terrible to see how a single unclear idea, a single formula without meaning, lurking in a young man's head, will sometimes act like an obstruction of inert matter in an artery, hindering the nutrition of the brain, and condemning its victim to pine away in the fullness of his intellectual vigor and in the midst of intellectual plenty.

*Chance, Love and Logic: Philosophical Essays*  
 Second Paper, Section I (p. 37)  
 Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

**Planck, Max** 1858–1947  
 German physicist

When a scientific idea first takes shape in the brain of a researcher its origin is always due to some concrete experience. This experience may be in the nature of a discovery or an observation. It is a verification of some sort or other, whether in relation to a measurement in physics or astronomy, a chemical or biological observation, some document that has been brought to light from historical archives or some monument that has been excavated from the ruins of a past civilisation.

The Origin and Effect of Scientific Ideas  
*Research and Progress*, Volume 1, Number 1, January, 1935 (p. 3)

**Poincaré, Lucien** 1862–1920  
 French physicist

The labour of our forerunners never wholly perishes. The ideas of yesterday prepare for those of tomorrow; they contain them, so to speak, in potentia.

*The New Physics and Its Evolution*  
 Chapter I (p. 6)  
 D. Appleton & Co. New York, New York, USA. 1908

**Polanyi, Michael** 1891–1976  
 Hungarian-born English scientist, turned philosopher, and social scientist

A vital judgment practiced in science is the assessment of plausibility. Only plausible ideas are taken up, discussed

and tested by scientists. Such a decision may later be proved right, but at the time that it is made, the assessment of plausibility is based on a broad exercise of intuition guided by many subtle indications, and thus it is altogether undemonstrable. It is tacit.

*Knowing and Being*  
 Part Two Chapter 5. The Growth of Science in Society (p. 76)  
 The University of Chicago Press. Chicago, Illinois, USA. 1969

**Pólya, George** 1887–1985  
 Hungarian mathematician

...it is hard to have a good idea if we have little knowledge of the subject, and impossible to have it if we have no knowledge. Good ideas are based on past experience and formerly acquired knowledge.

*How to Solve It: A New Aspect of Mathematical Method*  
 Part I, Section 9 (p. 9)  
 Princeton University Press. Princeton, New Jersey, USA. 1973

**Popper, Karl R.** 1902–94  
 Austrian/British philosopher of science

Bold ideas, unjustifiable anticipations, and speculative thought, are our only means for interpreting nature: our only organon, our only instrument, for grasping her.

*Logic of Scientific Discovery*  
 Part II Chapter 10 (p. 280)  
 Routledge. New York, New York, USA. 1992

**Priest, Graham** 1848–  
 English philosopher

Historians of ideas soon learn – to their dismay – that their subject appears to be mathematically dense: between any two people who wrote on the matter there appears to be another.

*Beyond the Limits of Thought*  
 Chapter 1 (p. 6)  
 University Press. Cambridge, England. 1995

**Proust, Marcel** 1871–1922  
 French novelist

A powerful idea communicates some of its strength to him who challenges it.

Translated by C.K. Scott Moncrieff  
*Within a Budding Grove*  
 Part I, Madame Swann at Home (p. 191)  
 The Modern Library. New York, New York, USA. 1951

**Sagan, Carl** 1934–96  
 American astronomer and author

Someone has to propose ideas at the boundaries of the plausible, in order to so annoy the experimentalists or observationalists that they'll be motivated to disprove the idea.

In J. Achenbach  
 The Final Frontier?  
*The Washington Post*, C1–C2, May 30, 1996



**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

In experimental science facts of the greatest importance are rarely discovered accidentally: more frequently new ideas point the way towards them.

Translated by James Murphy

*Science and the Human Temperament*

Chapter I (p. 32)

George Allen &amp; Unwin. London, England. 1935

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

An idea is an eddy, an island of the mind, connected with a vast mainland.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #432 (p. 157)

Definition Press. New York, New York, USA. 1972

**Spencer, Herbert** 1820–1903

English social philosopher

Early ideas are not usually true ideas.

*The Principles of Biology* (Volume 1)

Part III, Chapter II, Section 110 (p. 333)

D. Appleton &amp; Company. New York, New York, USA. 1897

Inquiring into the pedigree of an idea is not a bad means of roughly estimating its value. To have come of respectable ancestry, is *prima facie* evidence of worth in a belief as in a person; while to be descended from a discreditable stock is, in the one case as in the other, an unfavourable index.

*Essays, Scientific, Political, and Speculative* (Volume 1)

The Nebular Hypothesis (p. 108)

D. Appleton &amp; Co. New York, New York, USA. 1898

**Stewart, Ian** 1945–

English mathematician and science writer

Really good mathematical ideas are hard to come by. They result from the combined work of many people over long periods of time. Their discovery involves wrong turnings and intellectual dead ends. They cannot be proved at will: truly novel mathematics is not amenable to an industrial “Research and Development” approach. But they pay for all that effort by their durability and versatility.

*The Problems of Mathematics*

Chapter 1 (pp. 11–12)

Oxford University Press, Inc. Oxford, England. 1987

**Stinton, D.**

No biographical data available

One should never have too much reverence for ideas, no matter whose they are. Ideas are meant to be kicked around, stood upon their heads, and looked at backwards through mirrors. It is only in this way that they can grow up in the way that they should, without excessive self-importance. The ideas of one man are the food for thought of another.

*The Anatomy of the Aeroplane*

Preface (p. ix)

American Elsevier Publishing Company. New York, New York, USA. 1966

**Thagard, Paul**

No biographical data available

Because the variation, selection, and transmission of scientific ideas differ in such fundamental ways from their biological analogs, Darwinian natural selection provides a poor model for understanding the growth of science. It misleadingly suggests that variation in scientific ideas is blind, that their selection is by local criteria, and that their transmission is genetic. It ignores the pragmatic, problem-solving context of induction. Thus employment of the evolutionary analogy leads away from solutions to important problems about the growth of knowledge, not toward them. Hence, evolutionary epistemology, conceived as the application of the Darwinian model to scientific development, should be abandoned.

*Computational Philosophy of Science*

Chapter 6 (pp. 110–111)

MIT Press. Cambridge. 1988

**Thomson, James** 1700–48

Scottish poet

Ten thousand great ideas filled his mind;  
But with the clouds they fled, and left no trace behind.

*Castle of Indolence*

Canto I, stanza 59

William Smith. London, England. 1842

**Toulmin, Stephen** 1922–

Anglo-American English philosopher

**Goodfield, June**

Science writer and historian

New ideas are the tools of science, not its end-product. They do not *guarantee* deeper understanding, yet our grasp of Nature will be extended only if we are prepared to welcome them and give them a hearing. If at the outset exaggerated claims are made on their behalf, this need not matter. Enthusiasm and deep conviction are necessary if men are to explore all possibilities of any new idea, and later experience can be relied on either to confirm or to moderate the initial claims – for science flourishes on a double programme of speculative liberty and unsparing criticism.

*The Architecture of Matter*

Chapter 2 (p. 41)

The University of Chicago Press. Chicago, Illinois, USA. 1982

**Trotter, Wilfred** 1872–1939

Surgeon and sociologist

The mind likes a strange idea as little as the body likes a strange protein, and resists it with similar energy. It would

not be too fanciful to say that a new idea is the most quickly acting antigen known to science. If we watch ourselves honestly we shall often find that we have begun to argue against a new idea before it has been completely stated.

*Collected Papers*

Has the Intellect a Function?

Oxford University Press, Inc. Oxford, England. 1941

It is a mistake to suppose, as it is so easy to do, that science enjoins upon us the view that any given idea is true or false and there is an end of it; an idea may be neither demonstrably true nor false and yet be useful, interesting, and good exercise. Again, it is poverty rather than fertility of ideas that causes them to be used as a substitute for experiment, to be fought for with prejudice or decried with passion. When ideas are freely current they keep science fresh and living and are in no danger of ceasing to be the nimble and trusty servants of truth. We may perhaps allow ourselves to say that the body of science gets from the steady work of experiment and observation its proteins, its carbohydrates, and – sometimes too profusely – its fats, but that without its due modicum of the vitamin of ideas the whole organism is apt to become stunted and deformed, and above all to lose its resistance to the infection of orthodoxy.

Observation and Experiment and Their Use in the Medical Science  
*British Medical Journal*, July 26, 1930 (p. 132)

**Tucker, Abraham** 1705–74

English writer

...an idea, on being displaced by another, does not wholly vanish, but leaves a spice and tincture of itself behind, by which it operates with a kind of attraction upon the subsequent ideas, determining which of their associates they shall introduce, namely such as carry some conformity with itself.... This regular succession of ideas, all bearing a reference to some one purpose retained in view, is what we call a train; and daily experience testifies how readily they follow one another in this manner of themselves, without any pains or endeavor of ours to introduce them.

*The Light of Nature Pursued* (Volume 1)

Trains (p. 147)

Hilliard & Brown. Cambridge, England. 1831

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

His head was an hour-glass; it could stow an idea, but it had to do it a grain at a time, not the whole idea at once.

*A Connecticut Yankee in King Arthur's Court*

Chapter XXVIII (p. 255)

Harper & Brothers. New York, New York, USA. 1899

**von Bubnoff, S.**

No biographical data available

The logical continuity of science is only a pious wish; the progress of knowledge is erratic and irrational. Ideas die not because they are wrong but because they find no substance and are reborn and become capable of development when the substance is available.

In Jochen Helms

*Fossils: The Oldest Treasures That Ever Lived*

The Beginnings of Knowledge and Understanding (p. 32)

T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Happy ideas come unexpectedly without effort like an inspiration, as far as I am concerned. They have never come to me when my mind was fatigued or when I was at my working table.

*Radhakrishnan: An Idealist View of Life*

Chapter V, Section 1 (p. 142)

Unwin Paperbacks. London, England. 1980

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Undue conciseness often checks the flow of expression, whilst diffuseness is alike detrimental to a clear and precise exposition of our ideas.

*Cosmos* (Volume I)

Introduction (p. 1)

Henry G. Bohn. London, England. 1849

**von Liebig, Justus** 1803–73

German organic chemist

Numberless germs of intellectual life fill the universe, but it is only in a few rare minds that these germs find a soil in which they can be developed. In these chosen minds the idea, whose origin is unknown, shows its vitality in creative acts; in them, the mysterious laws of nature assume a form, efficient, active, and recognisable by all.

*Familiar Letters on Chemistry*

Letter IV (p. 63)

Walton & Maberly. London, England. 1859

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

...I have long since come to see that no one deserves either praise or blame for the ideas that come to him, but only for the actions resulting there from. Ideas and beliefs are certainly not voluntary acts. They come to us – we hardly know how or whence, and once they have got possession of us we cannot reject or change them at will. It is for the common good that the promulgation of ideas should be free – uninfluenced by either praise or blame, reward or punishment.

The Origin of the Theory of Natural Selection

*Popular Science Monthly*, Volume 74, 1909 (p. 400)

**Weber, Max** 1864–1920

German founder of modern sociology and economic thinker

Ideas come in their own good time, not when we want them. In fact, the best ideas occur to us while smoking a cigar on the sofa, as Ihering says, or during a walk up a gently rising street, as Helmholtz observes of himself with scientific precision, or in some such way. At any rate, ideas come when they are least expected, rather than while you are racking your brains at your desk.

Translated by Rodney Livingstone

*The Vocation Lectures*

Science as a Vocation (p. 9)

Hackett Publishing Company. Indianapolis, Indiana, USA. 2004

### Weidlein, Edward Ray

Chemical engineer

If one were asked to name the most dynamic force in the known universe, he might grope for some time before he made a hesitant choice, wavering between such imponderables as the power of the sun and the energy hidden within the atom. His reluctant choice in any event would probably be wrong – for the most powerful force known to man still is an idea.

Cooperation – A Responsibility of the Scientist

*American Scientist*, March, 1962 (p. 29)

### Weil, André 1906–98

French mathematician

...the ability to recognize mathematical ideas in obscure and inchoate form, and to trace them under the many disguises which they are apt to assume before coming out in full daylight, is most likely to be coupled with a better than average mathematical talent. More than that, it is an essential component of such talent, since in large part the art of discovery consists in getting a firm grasp on the vague ideas which are “in the air,” some of them flying all around us, some (to quote Plato) floating around in our own minds.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

History of Mathematics (p. 207)

Mathematical Association of America. Washington, D.C. 2004

In the future, as in the past, the great ideas [of mathematics] must be simplifying ideas, the creator must always be one who clarifies, for himself, and for others, the most complicated issues of formulas and concepts.

In Peter L. Duren, Richard Askey, Uta C. Merzbach and Harold M. Edwards (eds.)

*A Century of Mathematics in America* (Volume 3)

The Future of Mathematics (p. 334)

American Mathematical Society. Providence, Rhode Island, USA. 1989

### Weisskopf, Victor Frederick 1908–2002

Austrian-American physicist

...it is not surprising that, after a long period of searching and erring, some of the concepts and ideas in human thinking should have come gradually closer to the fundamental laws of this world...

*Knowledge and Wonder: The Natural World as Man Knows It*

Epilogue (p. 270)

Doubleday & Company. Garden City, New York, USA. 1966

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

...he had ideas about everything. He could no more help having ideas about everything than a dog can resist smelling at your heels.

*Mr. Britling Sees It Through*

Book I, Chapter I, Section 2 (p. 10)

The Macmillan Company. New York, New York, USA. 1917

### Wheeler, John Archibald 1911–

American physicist and educator

To my mind there must be, at the bottom of it all, not an equation, but an utterly simple idea. And to me that idea, when we finally discover it, will be so compelling, so inevitable, that we will say to one another, “Oh, how beautiful. How could it have been otherwise.”

In Timothy Ferris (ed.)

*Coming of Age in the Milky Way*

Chapter 17 (p. 346)

William Morrow & Company, Inc. New York, New York, USA. 1988

### Whewell, William 1794–1866

English philosopher and historian

With his ideas unfolded by education, sharpened by controversy, rectified by metaphysics, he [Man] may *understand* the natural world, but he cannot *invent* it.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (Volume 2)

Book XIII, Chapter IV (p. 379)

John W. Parker. London, England. 1847

The cultivation of ideas is to be conducted as having for its object the connexion of facts; never to be pursued as a mere exercise of the subtilty of the mind, striving to build up a world of its own, and neglecting that which exists about us.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (Volume 2)

Book XIII, Chapter IV (p. 379)

John W. Parker. London, England. 1847

Ideas are not transformed, but informed Sensations; for without ideas, sensations have no form.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2) (2nd edition)

Aphorisms Concerning Ideas (p. 444)

John W. Parker. London, England. 1847

Facts are the materials of science, but all Facts involve Ideas. Since, in observing Facts, we cannot exclude Ideas, we must, for the purposes of science, take care that the Ideas are clear and rigorously applied.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, IV (p. 467)

John W. Parker. London, England. 1847

Scientific Ideas can often be adequately exhibited for all the purposes of reasoning, by means of Definitions and Axioms; all attempts to reason by means of Definitions from common Notions, lead to empty forms or entire confusion.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Introduction (p. 13)

John W. Parker & Son. London, England. 1857

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

To talk sense is to talk quantities.

*The Aims of Education and Other Essays*

Chapter I (p. 11)

The Macmillan Company. New York, New York, USA. 1959

If you have had your attention directed to the novelties in thought in your own lifetime, you will have observed that almost all really new ideas have a certain aspect of foolishness when they are first produced.

*Science and the Modern World*

Chapter III (p. 70)

The Macmillan Company. New York, New York, USA. 1929

...traditional ideas are never static. They are either fading into meaningless formulae, or are gaining power by the new lights thrown by a more delicate apprehension. They are transformed by the urge of critical reason, by the vivid evidence of emotional experience, and by the cold certainties of scientific perception. One fact is certain, you cannot keep them still.

*Science and the Modern World*

Chapter XII (p. 269)

The Macmillan Company. New York, New York, USA. 1929

In the study of ideas, it is necessary to remember that insistence on hard-headed clarity issues from sentimental feeling, as it were a mist, cloaking the perplexities of fact. Insistence on clarity at all costs is based on sheer superstition as to the mode in which human intelligence functions. Our reasonings grasp at straws for premises and float on gossamers for deductions.

*Adventures of Ideas*

Chapter V (p. 91)

The Macmillan Company. New York, New York, USA. 1956

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

He played with the idea, and grew willful; tossed it into the air and transformed it; let it escape and recaptured it; made it iridescent with fancy, and winged it with paradox.

*The Picture of Dorian Gray*

Chapter 3 (p. 46)

The Modern Library. New York, New York, USA. 1992

**Wilson, Edward O.** 1929–

American biologist and author

These whispering denizens of the mind are sensed but rarely seen. They rustle the foliage, leave behind a pug mark filling with water and a scent, excite us for an instant and vanish. Most ideas are waking dreams that fade to an emotional residue.

*The Diversity of Life*

Chapter One (p. 8)

W.W. Norton & Company, Inc. New York, New York, USA. 1992

Keep in mind that new ideas are commonplace, and almost always wrong. Most flashes of insight lead nowhere; statistically, they have a half-life of hours or maybe days. Most experiments to follow up the surviving insights are tedious and consume large amounts of time, only to yield negative or (worse!) ambiguous results.

Scientists, Scholars, Knaves and Fools

*American Scientist*, Volume 86, January–February, 1998 (p. 6)

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Ideas too sometimes fall from the tree before they are ripe.

Translated by Peter Winch

*Culture and Value* (p. 27e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

Sometimes you see the idea in the way an astronomer sees stars in the far distance. (Or it seems like that anyway.)

Translated by Peter Winch

*Culture and Value* (p. 58e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wright, Thomas** 1711–86

English cosmologist

...the author having dug all his Ideas from the Mines of Nature, is surely entitled to every kind of Indulgence.

*An Original Theory or New Hypothesis of the Universe*

Preface (p. iv)

Printed for the Author. London, England. 1750

## IDEAS

**Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

Things remaining the same, our ideas vary, and which of them, or even whether any of them at all, represent the true quality really existing in the thing, it is out of our reach to determine. So that, for aught we know, all we see, hear, and feel, may be only phantom and vain chimera ...

In Alexander Campbell Fraser

*Selections from Berkeley* (3rd edition)

Principles of Human Knowledge: Part I (p. 96)

At The Clarendon Press. Oxford, England. 1884

**Bernard, Claude** 1813–78

French physiologist

Our feelings lead us at first to believe that absolute truth must lie within our realm; but study takes from us, little by little, these chimerical conceits.

Translated by Henry Copley Green

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter 3 (p. 82)

Henry Schuman, Inc. New York, New York, USA. 1949

**Burroughs, John** 1837–1921

American naturalist and essayist

Birds and squirrels come home to us all in a way that speculative ideas do not.

*The Writings of John Burroughs* (Volume 19)

Preface (p. v)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

## IDEOLOGY

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Biological determinism is, in its essence, a theory of limits. It takes the current status of groups as a measure of where they should and must be... We inhabit a world of human differences and predilections, but the extrapolation of these facts to theories of rigid limits is ideology.

*The Mismeasure of Man*

Chapter One (p. 60)

W.W. Norton & Company, Inc. New York, New York, USA. 1996

## IDLER

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Among those whom I never could persuade to rank themselves with Idlers, and who speak with indignation of my morning sleeps and nocturnal rambles; one passes the day in catching spiders, that he may count their eyes with a microscope; another erects his head, and exhibits the dust of a marigold separated from the flower with a dexterity worthy of Leuwenhoeck himself. Some turn the wheel of electricity; some suspend rings to a load-stone, and find that what they did yesterday they can do again today. Some register the changes of the wind, and die fully convinced that the wind is changeable.

*The Idler*

Number 17 (p. 58)

William Durell. New York, New York, USA. 1811

## IDOL

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...the doctrine of idols bears the same relation to the interpretation of nature, as that of confutation of sophisms does to common logic.... It is the peculiar and perpetual error of the human understanding to be more

moved and excited by affirmations than by negations; whereas it ought duly and regularly to be impartial; nay, in establishing any true axiom, the negative instance is the most powerful.

In *Great Books of the Western World* (Volume *Novum Organum*)

First Book (pp. 109, 110)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Morgan, Augustus** 1806–71

English mathematician and logician

The history of the intellectual world is the history of the worship of one idol after another.

*A Budget of Paradoxes* (Volume 1) (2nd edition)

Basis of Modern Discovery (p. 89)

The Open Court Publishing Co. Chicago, Illinois, USA. 1915

## IGNORANCE

**Adams, George** 1750–95

English instrument maker

The natural propensity of the human mind to know the cause of every effect often leads men into errors, and makes them satisfied with a word which does not remove their ignorance.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture I (p. 14)

Printed by R. Hindmarsh. London, England. 1794

**Ansted, David Thomas** 1814–80

English geologist

Ignorance is bold, and takes high but useless flights; true knowledge is modest, and limits her flight to what she knows she can accomplish safely.

*The Great Stone Book of Nature*

The Book of Nature (p. 5)

Macmillan & Co Ltd. London, England. 1864

Ignorance, having few facts, loses sight of all in her endeavors to generalize; knowledge, with many facts, finds it difficult so to arrange them as to obtain the conclusions they properly warrant.

*The Great Stone Book of Nature*

The Book of Nature (p. 23)

George W. Childs. Philadelphia, Pennsylvania, USA. 1863

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

Ignorance of science and technology is becoming the ultimate self-indulgent luxury.

*Cranks, Quarks, and the Cosmos: Writings on Science*

Chapter 16 (p. 202)

Basic Books. New York, New York, USA. 1993

**Berry, Arthur**

No biographical data available

The larger the sphere of our knowledge, the greater its contact with the infinity of our ignorance.

*A Short History of Astronomy*



Chapter XIII  
Volume 83, Number 1, January, 1978 (p. 354)  
John Murray. London, England. 1898

### Bertotti, Bruno

Physicist

The catalogue of our ignorance has two, not one, gates: there is the obvious exit gate, through which questions answered and settled by experimental and theoretical developments march out and disappear into the textbooks and the applications; but there is also a more important, albeit less perspicuous, entrance gate, through which new riddles come to life in the scientific world.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Riddles of Gravitation (p. 92)  
Pergamon Press. Oxford, England. 1977

### Brecht, Bertolt 1898–1956

German writer

GALILEO: Truth is born of the times, not of authority. Our ignorance is limitless: let us lop one cubic millimeter off it. Why try to be clever now that we at last have a chance of being just a little less stupid?

Translated by John Willett

*Life of Galileo*

Scene 4 (p. 42)

Arcade Publishing. New York, New York, USA. 1994

### Bruno, Giordano 1548–1600

Italian philosopher and pantheist

Ignorance is the most delightful science in the world because it is acquired without labor or pains and keeps the mind from melancholy.

In David Starr Jordan

*The Higher Foolishness, with Hints as to the Care & Culture of Aristocracy; Followed by Brief Sketches on Ecclesiasticism, Science & the Unfathomed Universe*

Title page

The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1927

### Cooper, James Fenimore 1789–1851

American writer

Ignorance and superstition ever bear a close, and even a mathematical relation to each other.

*Jack Tier Or the Florida Reef*

Chapter 3 (p. 368)

Hurd & Houghton. London, England. 1871

### Cuvier, Georges 1769–1832

French zoologist and statesman

The time is past for ignorance to assert that these remains of organized bodies are mere *lusus naturae* – productions generated in the womb of the earth by its own creative powers.

*An Essay on the Theory of the Earth*

Section 4 (p. 31)

Kirk & Mercein. New York, New York, USA. 1818

### Darwin, Charles Robert 1809–82

English naturalist

It has often and confidently been asserted that man's origin can never be known: but ignorance more frequently begets confidence than does knowledge: it is those who know little, and not those who know so much, who so positively assert that this or that problem will never be solved by science.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Introduction (p. 253)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Davy, Sir Humphry 1778–1829

English chemist

Man is formed for pure enjoyment; his duties are high, his destination is lofty; and he must, then, be most accused of ignorance and folly when he grovels in the dust, having wings which can carry him to the skies.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Introductory Lecture for the Courses of 1805 (p. 9)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

### de Luc, Jean André 1773–1817

Swiss naturalist

...a considerable obstruction to the real advancement of science, the progress of which is much less retarded by ignorance than by error.

Translated by Henry de La Fite

*An Elementary Treatise on Geology*

Preliminary Discourse on Geology (p. 1)

F.C. & J. Rivington. London, England. 1809

### Duke of Argyll (George Douglas

**Campbell) 1823–1900**

English statesman and writer on science, religion, and politics

Without a sense of ignorance there could be no desire of knowledge, and without his desire of knowledge man would not be man.

*The Unity of Nature*

Chapter 9 (p. 188)

G.P. Putnam's Sons. New York, New York, USA. 1885

### Duncan, Ronald

No biographical data available

### Weston-Smith, Miranda

No biographical data available

Compared to the pond of knowledge, our ignorance remains Atlantic.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

Editorial Preface (p. ix)

Pergamon Press. Oxford, England. 1977

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician



Nowadays whenever enthusiasts meet together to discuss theoretical physics the talk sooner or later turns in a certain direction. You leave them conversing on their special problems or the latest discoveries; but return after an hour and it is any odds that they will have reached an all-engrossing topic – the desperate state of their ignorance.

*The Nature of the Physical World*

Chapter IX (p. 179)

D. Appleton & Co. New York, New York, USA. 1900

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

In order to arrive at what you do not know

You must go by a way which is the way of ignorance.

*The Collected Poems and Plays 1909–1950*

East Coker, Part III, stanza 2 (p. 127)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Faraday, Michael** 1791–1867

English physicist and chemist

At present we are accustomed to admit action at sensible distances, as of one magnet upon another, or of the sun upon the earth, as if such admission were itself a perfect answer to any inquiry into the nature of the physical means which cause distant bodies to affect each other; and the man who hesitates to admit the sufficiency of the answer, or of the assumption on which it rests, and asks for a more satisfactory account, runs some risk of appearing ridiculous or ignorant before the world of science.

*Experimental Researches in Electricity* (Volume 3)

The Same – And on the Nature of Force (p. 570)

Bernard Quaritch. London, England. 1855

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The precise specification of our knowledge is, however, the same as the precise specification of our ignorance.

*Statistical Methods and Scientific Inference*

Chapter II (pp. 28–29)

Hafner Publishing Company. New York, New York, USA. 1959

**Franklin, Alfred**

No biographical data available

Men are enclosed in their own ignorance as in a prison with slowly receding walls. Unable to see beyond, they marvel at the vastness of their mansion without ever suspecting the existence of an infinite world outside.

In Charles Noël Martin

*The Role of Perception in Science*

Conclusion (p. 138)

Hutchinson of London. London, England. 1963

**Gilbert, G. K.** 1843–1918

American geologist

It is not altogether pleasant to deal with a subject in regard to which domain of our ignorance is so broad; but

if we are optimists we may be comforted by the reflection that the geologists of this generation, at least, will have no occasion like Alexander, to lament a dearth of worlds to conquer.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1895*

Continental Problems of Geology (p. 173)

Government Printing Office. Washington, D.C. 1896

**Gissing, George** 1857–1903

English novelist

It has long been observed that mathematics tend to narrow the mind, and that an exclusive devotion to Science leads to ignorance so complete that it precludes a consciousness of its own existence.

*The Private Papers of Henry Ryecroft*

Chapter VII (p. 44)

E.P. Dutton & Co. New York, New York, USA. 1903

**Gore, George** 1826–1909

English electrochemist

The difficulties of research arise largely from our ignorance.

*The Art of Scientific Discovery*

Part II, Chapter 14 (p. 210)

Longmans, Green & Co. London, England. 1878

**Gull, Sir William Withey** 1816–90

English physician

The greatest advance that can be made in practical Science is to a full and intimate recognition of our ignorance.

*A Collection of the Published Writings of William Withey Gull* (Volume 2)

Notes and Aphorisms (p. lvi)

The New Sydenham Society. London, England. 1896

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

There are two sorts of ignorance: we philosophize to escape ignorance, and the consummation of our philosophy is ignorance; we start from the one, we repose in the other; they are the goals from which, and to which, we tend: and the pursuit of knowledge is but a course between two ignorances, as human life is itself only a traveling from grave to grave.

*Discussions on Philosophy and Literature, Education and University Reform*

Appendix I, B (p. 591)

Harper & Brothers Publishers. New York, New York, USA. 1855

The highest reach of human science is the scientific recognition of human ignorance ...

*Discussions on Philosophy and Literature, Education and University Reform*

Appendix I, B (p. 591)

Harper & Brothers Publishers. New York, New York, USA. 1855

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

Consider the unlearned, unaware of their ignorance, who think they know everything! As knowledge increases, ignorance decreases, but this kind of ignorance – unlearned ignorance – is no more than the lack of knowledge. With knowledge comes awareness of ignorance – learned ignorance – and the more we know, the more aware we become of what we do not know.

*Masks of the Universe*

Chapter 17 (p. 273)

Macmillan Publishing Company. New York, New York, USA. 1985

### Hellman, C. Doris

Translator and editor

There are many things whose existence we allow, but whose character we are still in ignorance of.... Why should we be surprised, then, that comets, so rare a sight in the universe, are not embraced under definite laws, or that their return is at long intervals?...The day will yet come when the progress of research through long ages will reveal to sight the mysteries of nature that are now concealed.... The day will yet come when posterity will be amazed that we remained ignorant of things that will to them seem so plain.

*The Comet of 1577: Its Place in the History of Astronomy*

Chapter I (p. 33)

Columbia University Press. New York, New York, USA. 1944

### Herschel, Sir John Frederick William 1792–1871

English astronomer and chemist

No man can rise from ignorance to anything deserving to be called a complete grasp of any considerable branch of science without receiving and discarding in succession many crude and incomplete notions, which so far from injuring the truth in its ultimate reception, act as positive aids to its attainment by acquainting him with the symptoms of an insecure footing in his progress.

*Outlines of Astronomy: By Sir John F. W. Herschel*

Introduction (p. 31)

American Home Library Co. New York, New York, USA. 1902

### Hilbert, David 1862–1943

German mathematician

...in mathematics there is no ignorabimus.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902 (p. 445)

### Holbach, Paul Henri Thiry 1723–89

French philosopher

The source of man's unhappiness is his ignorance of Nature. The pertinacity with which he clings to blind opinions imbibed in his infancy, which interweave themselves with his existence, the consequent prejudice that warps his mind, that prevents its expansion, that renders him the slave of fiction, appears to doom him to continual error.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*

(Volume 1)

Author's Preface (p. 2)

J.P. Mendum

Boston, Massachusetts, USA. 1889

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

You cannot and need not expect to disturb the public in the possession of its medical superstitions. A man's ignorance is as much his private property, and as precious in his own eyes, as his family Bible.

*The Young Practitioner*

Speech

Bellevue Hospital College

March 2, 1871

Our task is only that of sending out a few pickets under the starry flag of science to the edge of that dark domain where the ensigns of the obstinate rebel, Ignorance, are flying undisputed.

*Medical Essays 1842–1882*

Chapter IV (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### Hutton, James 1726–97

Scottish geologist, chemist, and naturalist

Ignorance suspects not error ...

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter VIII, Section I (p. 559)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

### Huxley, Thomas Henry 1825–95

English biologist

Ignorance is visited as sharply as willful disobedience – incapacity meets with the same punishment as crime. Nature's discipline is not even a word and a blow, and the blow first; but the blow without the word. It is left to you to find out why your ears are boxed.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 85)

Macmillan & Company Limited. London, England. 1904

...there is perhaps no sight in the whole world more saddening and revolting than is offered by men sunk in ignorance of everything but what other men have written; seemingly devoid of moral belief or guidance; but with the sense of beauty so keen, and the power of expression so cultivated, that their sensual caterwauling may be almost mistaken for the music of the spheres.

*Science and Education*

Chapter V (pp. 116–117)

American Home Library Co. New York, New York, USA. 1902

### James, William 1842–1910

American philosopher and psychologist

Our science is a drop, our ignorance a sea. Whatever else be certain, this at least is certain – that the world of our

present natural knowledge is enveloped in a larger world of some sort whose residual properties [about which] we at present can frame no positive idea.

*The Will to Believe and Other Essays in Popular Philosophy*  
Is Life Worth Living? (p. 54)  
Dover Publications, Inc. New York, New York, USA. 1956

### **Kingdon, Clifford W.**

No biographical data available

A wise man only remembers his ignorance in order to destroy it.

Aims and Instruments of Scientific Thought  
*The Popular Science Monthly*, Volume 2, December, 1872 (p. 179)

### **Kingsley, Charles** 1819–75

English clergyman and author

I hope that my children, at least, if not I myself, will see the day, when ignorance of the primary laws and facts of science will be looked on as a defect, only second to ignorance of the primary laws of religion and morality.

*Scientific Lectures and Essays*  
Preface (p. 7)  
Macmillan & Co Ltd. London, England. 1893

### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

In ignorance of the ties which unite such events to the entire system of the universe, they have been made to depend upon final causes or upon hazard, according as they occur and are repeated with regularity, or appear without regard to order; but these imaginary causes have gradually receded with the widening bounds of knowledge and disappear entirely before sound philosophy, which sees in them only the expression of our ignorance of the true causes.

*A Philosophical Essay on Probabilities*  
Chapter II (p. 3)  
John Wiley & Sons. New York, New York, USA. 1902

### **Lodge, Sir Oliver** 1851–1940

English physicist

The ordinary run of men live among phenomena of which they know nothing and care less. They see bodies fall to the earth, they hear sounds, they kindle fires, they see the heavens roll above them, but of the causes and inner working of the whole they are ignorant, and with their ignorance they are content.

*Pioneers of Science and the Development of Their Scientific Theories*  
Lecture I (p. 5)  
Dover Publications, Inc. New York, New York, USA. 1926

In regions where our ignorance is great, occasional guesses are permissible.

On the Supposed Weight and Ultimate Fate of Radiation  
*Philosophical Magazine*, Volume 41, 1921

### **Lovecraft, H. P. (Howard Phillips)** 1890–1937

American writer of fantasy, horror, and science fiction

The most merciful thing in the world, I think, is the inability of the human mind to correlate all its contents. We live on a placid island of ignorance in the midst of black seas of infinity, and it was not meant that we should voyage far.

*The Dark Descent*  
The Call of Cthulhu (p. 86)  
The Macmillan Co. New York, New York, USA. 1997

We live on a placid island of ignorance in the midst of black seas of infinity, and it was not meant that we should voyage far.

In Joyce Carol Oates  
*Tales of H.P. Lovecraft: Major Works*  
*The Call of Cthulhu*  
Chapter I (p. 52)  
HarperCollins Books. New York, New York, USA. 1997

### **McCormick, Leander Hamilton** 1859–1934

American author, inventor, and scientist

The centre of the universe is knowledge; its circumference is ignorance.

*Characterology*  
Chapter XXVI (p. 602)  
Rand McNally & Co. Chicago, Illinois, USA. 1920

### **Oppenheimer, James Robert** 1904–67

American theoretical physicist

We are not today tempted to search for these keys that unlock the whole of human knowledge and man's experience. We know that we are ignorant; we are well taught it, and the more surely and deeply we know our own job the better able we are to appreciate the full measure of our pervasive ignorance.

*Science and the Common Understanding*  
Chapter 6 (pp. 89–90)  
Simon & Schuster. New York, New York, USA. 1954

### **Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Never think that you already know all. However highly you are appraised, always have the courage to say to yourself – I am ignorant.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

### **Playfair, Lyon** 1818–98

Scottish scientist and Parliamentarian

It is no mean task for intellect to leap over the barriers of ignorance; it is even more easy to go onward ill new and untrodden paths.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I  
The Study of Abstract Science (p. 28)  
Longman, Brown, Green & Longmans. London, England. 1852

### **Pratchett, Terry** 1948–

English author

But then...it used to be so simple, once upon a time. Because the universe was full of ignorance all around and the scientist panned through it like a prospector crouched over a mountain stream, looking for the gold of knowledge among the gravel of unreason, the sand of uncertainty and the little whiskery eight-legged swimming things of superstition. Occasionally he would straighten up and say things like "Hurrah, I've discovered Boyle's Third Law." And everyone knew where they stood. But the trouble was that ignorance became more interesting, especially big fascinating ignorance about huge and important things like matter and creation, and people stopped patiently building their little houses of rational sticks in the chaos of the universe and started getting interested in the chaos itself – partly because it was a lot easier to be an expert on chaos, but mostly because it made really good patterns that you could put on a t-shirt.

*Witches Abroad* (p. 7)

Victor Gollancz Ltd. London, England. 1991

**Recorde, Robert** 1510?–58

English mathematician and writer

...the greatest point of all ignorance, not to know the goosenes of ignorance, and not to understand the benefit of knowledge...

*The Castle of Knowledge*

The First Treatise (pp. 1–2)

Imprinted by R. Wolfe. London, England. 1556

**Ritchie, Arthur David** 1891–1967

Scottish philosopher and science history writer

The first thing the reasonable man must do is to be content with a very little knowledge and a very great deal of ignorance. The second thing he must do is to make the utmost possible use of the knowledge he has and not waste his energy crying for the moon. The third thing he must do is try and see clearly where his knowledge ends and his ignorance begins.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter VI (p. 177)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

**Rowan-Robinson, Michael**

English astronomer

In extragalactic astrophysics we suffer from three types of ignorance: ignorance in principle, ignorance due to observational limitations, and ignorance due to inadequacy of theory and observation.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

Galaxies, Quasars and the Universe (p. 58)

Pergamon Press. Oxford, England. 1977

To be a true scientist is only to have an inkling of the full extent of man's ignorance.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know*

*About the Unknown*

Galaxies, Quasars and the Universe (p. 62)

Pergamon Press. Oxford, England. 1977

**Sayadaw, Ledi** 1846–1923

Theravadin Buddhist monk

Ignorance is like an eclipse. When the sun is eclipsed there is no sunlight. When the moon is eclipsed there is no moonlight. Likewise, when the mind is shrouded by ignorance, no knowledge can arise.

*A Manual of the Excellent Man*

Chapter 9 (p. 99)

Buddhist Publication Society. Kandy, Sri Lanka. 2000

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

In an honest search for knowledge you quite often have to abide by ignorance for an indefinite period. Instead of filling a gap by guesswork, genuine science prefers to put up with it; and this, not so much from conscientious scruples above telling lies, as from the consideration that, however irksome the gap may be, its obliteration by a fake removes the urge to seek after a tenable answer.

*Nature and the Greeks*

Chapter I (p. 6)

At The University Press. Cambridge, England. 1954

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...there is no darkness but ignorance...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Twelfth Night*

Act IV, Scene ii

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shapley, Harlow** 1885–1972

American astronomer

...the most interesting feature of this science astronomy (and of all science) is our eager ignorance.

Astronomy

*Scientific American*, Volume 183, Number 3, September, 1950 (pp. 25–26)

**Sonneberg, Walter**

No biographical data available

Out of the mouths of the ignorant comes the most humorous wisdom.

*Social Eccentricities*

Social Eccentricities (p. 4)

Broadway Publishing Co. New York, New York, USA. 1906

**Stevenson, John J.**

No biographical data available

We simply reveled in ignorance; we learned by making mistakes and by occasionally discovering some of them. We did not know for what to look, but we looked at everything, for everything was a revelation.

General Methods in Earlier Days  
*The Popular Science Monthly* *The Popular Science Monthly*,  
 Volume 86, Number 1, 1915 (p. 29)

**Vonnegut, Kurt** 1922–2007  
 American author

Beware of the man who works hard to learn something, learns it, and finds himself no wiser than before.... He is full of murderous resentment of people who are ignorant without having come by their ignorance the hard way.

*Cat's Cradle* (p. 294)  
 Delta Trade Paperbacks. New York, New York, USA. 1998

**Walker, Kenneth** 1882–1966  
 Physician

And how small is the sum of our actual knowledge. With regards to all the more important things, to the questions which concern us more nearly, it amounts to little beyond a consciousness of our own ignorance.

*Meaning and Purpose*  
 Chapter XV (p. 168)  
 Jonathan Cape. London, England. 1944

**Watts, Alan Wilson** 1915–73  
 American philosopher

The greater the scientist, the more he is impressed with his ignorance of reality, and the more he realizes that his laws and labels, descriptions and definitions, are the products of his own thought.

*The Wisdom of Insecurity*  
 Chapter IX (p. 149)  
 Pantheon. New York, New York, USA. 1951

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

It is our ignorance of the future and our persuasion that that ignorance is absolutely incurable that alone gives the past its enormous predominance in our thoughts.

*Annual Report of the Board of Regents of the Smithsonian Institution (1902)*  
 The Discovery of the Future (p. 380)  
 Government Printing Office. Washington, D.C. 1903

**Whately, Richard** 1787–1863  
 English theologian

He that is not aware of his ignorance, will be only misled by his knowledge.

*Thoughts and Apophthegms*  
 Section VI (p. 164)  
 Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1856

## IGNORANT

**Horrocks, Jeremiah** 1618–41  
 English astronomer

It is much easier to teach the ignorant than those who will not learn.

In Arundell Blount Whatton  
*Memoir of the Life and Labors of the Rev. Jeremiah Horrox*  
 Chapter IV (p. 144)  
 Wertheim, MacIntosh & Hunt. London, England. 1859

**Mach, Ernst** 1838–1916  
 Austrian physicist and philosopher

We shall find here much that has evidently been brought forward only to impress the minds of the ignorant ...

*Popular Scientific Lectures*  
 On Instruction in the Classics and the Sciences (pp. 330–331)  
 The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Oppenheimer, James Robert** 1904–67  
 American theoretical physicist

I am over and over again appalled by how ignorant, how incredibly ignorant of the most rudimentary things about my subject are my fellows the historians, my acquaintances the statesmen, my friends the men of affairs. They have no notion of what cooks in physics; I think that they have very little notion of what cooks in other parts of the house called science than the one that I live in.

*The Open Mind*  
 The Scientist in Society (p. 125)  
 Simon & Schuster. New York, New York, USA. 1955

**Pavlov, Ivan Petrovich** 1849–1936  
 Russian physiologist

Never think that you already know all. However highly you are appraised, always have the courage to say of yourself – I am ignorant.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

## ILLNESS

**Bisch, Louis E.**  
 No biographical data available

“Like any other major experience, illness actually changes us. How? Well, for one thing we are temporarily relieved from the pressure of meeting the world head-on.... We enter a realm of introspection and self-analysis. We think soberly, perhaps for the first time, about our past and future.... Illness...gives us that rarest thing in the world – a *second chance*, not only at health but at life itself!”

Turn Your Sickness into an Asset  
*Reader's Digest*, November, 1937 (p. 2)

**Bond, J.**  
 No biographical data available

**Bond, S.**  
 No biographical data available

A simple distinction we need to make here is between illness and disease. Disease refers to a medical concept



of pathology, which is indicated by a group of signs and symptoms. The presence or absence of a disease, as indicated by signs and symptoms, is clinically defined by the medical profession. The doctor or his substitute, using a common body of knowledge, makes the decision as to whether or not a person has a disease. In contrast, illness is defined by the person who had the signs and symptoms' experience of "health" and "ill-health" and is indicated by the person's reactions to the symptoms.

*Sociology and Health Care: An Introduction for Nurses and Other Health Care Professionals*  
Chapter 8 (p. 200)  
Churchill Livingstone. Edinburgh, Scotland. 1986

### **Bonnett, O. T.**

No biographical data available

A little illness is truly a wonderful thing to have if you are afraid of life.

*Why Healing Happens* (p. 109)  
MacMurray & Beck, Aspen. 1996

### **Butler, Samuel** 1612–80

English novelist, essayist, and critic

...I reckon being ill as one of the great pleasures of life, provided one is not too ill and is not obliged to work till one is better.

*The Way of All Flesh*  
Chapter LXXX (p. 346)  
Rinehart & Company, Inc. New York, New York, USA. 1955

### **Cassell, Eric J.**

No biographical data available

Illness [stands] for what the patient feels when he goes to the doctor and disease for what he has on the way home from the doctor's office. Disease...is something an organ has; illness is something a man has.

*The Healer's Art: A New Approach to the Doctor-Patient Relationship* (p. 48)  
Lippincott. New York, New York, USA. 1976

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

If doctors prescribe too many remedies for an illness it probably means that the illness can't be cured at all.

Translated by Sir John Gielgud  
*The Cherry Orchard: A Comedy in Four Acts*  
Act 1 (p. 21)  
Heinemann Educational Books Ltd. London, England. 1963

### **Glasow, Arnold**

No biographical data available

Spring fever in some areas is double pneumonia.

*Quote, the Weekly Digest*, June 18, 1967 (p. 497)

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Nature is a benevolent old hypocrite; she cheats the sick and dying with illusions better than any anodynes.

### *Medical Essays*

The Young Practitioner (p. 388)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### **Jaspers, Karl** 1883–1969

German psychiatrist and philosopher

What "sick" in general may mean depends less on a doctor's judgment than on the judgment of the patient and the prevailing conceptions of the contemporary culture.... With psychic illnesses [this] is very much so. The same psychic state will bring the one individual to the psychiatrist as a sick person while it will take another to the confessional as one suffering from sin and guilt.

*General Psychopathology* (p. 780)  
The University of Chicago Press. Chicago, Illinois, USA. 1963

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Twice in my life I very nearly died as a result of cerebral vascular accidents, and I don't look forward a bit to making, in due course, a clean job of it. I neither cursed God for depriving me of the use of two limbs nor thanked and praised Him for sparing me the use of two others. On these two occasions I derived no comfort from religion or from the thought that God was looking after me.

*The Limits of Science*  
Chapter 7 (pp. 96–97)  
Harper & Row, Publishers. New York, New York, USA. 1984

### **Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

Similarity in affliction makes us brothers even to the unknown.

*The Caxtons* (Volume 1)  
Part IX, Chapter VII (p. 333)  
Little, Brown & Company. Boston, Massachusetts, USA. 1899

### **Moore, Anthony R.**

No biographical data available

The experiences of illness are protean. In some cases disease can dignify, in others it creates heroic capacities. It can lead to self-realization; it can level unequal men; it can be thought of as an agent of retribution.... Even patients who see disease as a despoiler often experience sentiments of greater complexity. They see illness as an ever-present reminder of the unexpected, and of man's fundamental vulnerability.

*The Missing Medical Text: Humane Patient Care* (p. 36)  
Melbourne University Press, Victoria. 1978

### **Sigerist, Henry E.** 1891–1957

Medical historian

Illness, in general, is not a good literary subject.

*Civilisation and Disease*  
Chapter IX (p. 182)  
Cornell University Press. Ithaca, New York, New York. 1943



**Södergran, Edith** 1892–1923  
Finland-Swedish poet

I lie all day and wait for night,  
I lie all night and wait for day.  
*We Women: Selected poems of Edith Södergran*  
Days of Sickness  
Oyez. Berkeley, California, USA. 1977

**Sontag, Susan** 1933–2004  
American critic and writer

Illness is the night-side of life, a more onerous citizenship. Everyone who is born holds dual citizenship, in the kingdom of the well and in the kingdom of the sick. Although we all prefer to use only the good passport, sooner or later each of us is obliged, at least for a spell, to identify ourselves as citizens of that other place.

*Illness as Metaphor*  
Chapter 1 (p. 3)  
Farrar, Straus & Giroux. New York, New York, USA. 1978

Fatal illness has always been viewed as a test of moral character, but in the nineteenth century there is a great reluctance to let anybody flunk the test.

*Illness as Metaphor*  
Chapter 5 (p. 41)  
Farrar, Straus & Giroux. New York, New York, USA. 1978

**Trilling, Lionel** 1905–75  
American critic, author, and teacher

We are all ill: but even a universal sickness implies an idea of health.

*The Liberal Imagination*  
Art and Neurosis (p. 179)  
Charles Scribner's Sons. New York, New York, USA. 1950

**von Ebner-Eschenbach, Marie** 1830–1916  
Austrian writer

It is not the mortal but the incurable illnesses which are the worst.

Translated by David Scrase and Wolfgang Mieder  
*Aphorisms* (p. 44)  
Aridne Press. Riverside, California, USA. 1994

Imaginary ills belong to the incurable.  
Translated by David Scrase and Wolfgang Mieder  
*Aphorisms* (p. 24)  
Aridne Press. Riverside, California, USA. 1994

**Welty, Eudora** 1909–2001  
American writer

He did not like illness, he distrusted it, as he distrusted the road without signposts.

*Selected Stories of Eudora Welty*  
Death of a Traveling Salesman (p. 232)  
Modern Library. New York, New York, USA. 1954

**Wilder, Thornton** 1897–1975  
American playwright and novelist

For what human ill does not dawn seem to be an alleviation?  
*The Bridge of San Luis Rey*  
Part 3 (p. 119)  
Albert & Charles Boni. New York, New York, USA. 1928

**Wiltshire, John**  
No biographical data available

Illness has from ancient times been conceived as punishment, as a derivative of sin (with venereal disease providing the obvious paradigm), and even when this nexus is broken or disavowed by the conscious mind, it is always creeping back in less conscious forms...as in the production of “asthmatic” or “cancer prone” personality types. Or it may take another form when a sudden “attack” of disease is connected – to all intents and purposes arbitrarily – with some personal guilt, and thereby given a form of explanation.

*Samuel Johnson in the Medical World: The Doctor and the Patient* (p. 6)  
Cambridge University Press. Cambridge, England. 1991

**Woolf, Virginia** 1882–1941  
English novelist and essayist

Considering how common illness is, how tremendous the spiritual change that it brings, how astonishing, when the lights of health go down, the undiscovered countries that are then disclosed, what wastes and deserts of the soul a slight attack of influenza brings to view, what precipices and lawns sprinkled with bright flowers a little rise of temperature reveals, what ancient and obdurate oaks are uprooted in us by the act of sickness...

*The Moment*  
On Being Ill (p. 9)  
Harcourt, Brace & Company. New York, New York, USA, 1948

There is, let us confess it (and illness is the great confessional), a childish outspokenness in illness; things are said, truths blurted out, which the cautious respectability of health conceals.

*The Moment*  
On Being Ill (p. 13)  
Harcourt, Brace & Company. New York, New York, USA, 1948

## ADDICTION

**Jung, Carl G.** 1875–1961  
Swiss psychologist and psychiatrist

Every form of addiction is bad, no matter whether the narcotic be alcohol or morphine or idealism.

*Memories, Dreams, Reflections*  
Retrospect (p. 329)  
Vintage Books. New York, New York, USA. 1970

**St. John, Nicholas**  
Writer

Dependency is a marvelous thing. It does more for the soul than any formulation of doctor or material.

*The Addiction*  
Film (1995)

## ALLERGY

**Mather, Increase** 1639–1723

American Puritan clergyman

Some men also have strange antipathies in their natures against that sort of food which others love and live upon. I have read of one that could not endure to eat either bread or flesh; of another that fell into a swooning fit at the smell of a rose...

*Remarkable Providences*

Chapter IV (p. 71)

Reeves &amp; Turner. London, England. 1890

**Pirquet von Cesenatico, C. P.** 1874–1929

Austrian pediatrician

For this general concept of the changed capacity for reaction, I propose the term “allergy”. “Allo” denotes the deviation from the original state, from the behavior of the normal, as in “allorhythmia”, “allotropy”.

Allergie

*Muenchener medizinische wochenschrift*, Volume 53, July 24, 1906**Welsh, Joan I.**

No biographical data available

Medical science has gone far;

On that we'll all agree –

What used to be called an itch

Today's an allergy.

*Quote, the Weekly Digest*, July 21, 1968 (p. 56)

## ANEMIA

**Whipple, George H.** 1878–1976

American pathologist

It is obvious to any student of anemia that a beginning has been made, but our knowledge of pigment metabolism and hemoglobin regeneration is inadequate in every respect. This is a stimulating outlook for the numerous investigators in this field and we may confidently expect much progress in the near future.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1934

Hemoglobin Regeneration as Influenced by Diet and Other Factors (p. 353)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## COLD

**Benchley, Robert** 1889–1945

American humorist and critic

If you think you have caught a cold, call a good doctor.

Call in three doctors and play bridge.

*Benchley – or Else!*

How to Avoid Colds (p. 166)

Harper. New York, New York, USA. 1947

**Chamfort, Nicolas** 1741–94

French ironist and maker of maxims

The threat of a neglected cold is for doctors what the threat of purgatory is for priests – a gold mine.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference* #1092 (p. 61)

Harper &amp; Row, Publishers. New York, New York, USA. 1969

**Crichton-Browne, Sir James** 1840–1938

English physician

At a meeting of a medical society, it was said of the common cold that it was three days coming, three days staying, and three days going. A French physician, quoted by Sir St. Clair Thompson, said that the common cold, if left to itself, ran for a fortnight, but if medically treated, lasted only fourteen days.

*The Doctor's After Thoughts* (p. 235)

E. Benn Ltd. London, England. 1932

**Simmons, Charles** 1798–1856

American clergy and litterateur

Zealously nurse a cold with warm weather, and light and scanty food, till well cured, or repentance will be upon you.

*Laconic Manual and Brief Remarker Containing Over a Thousand**Subjects Alphabetically and Systematically Arranged* (p. 87)

Robert Dick. Toronto, Ontario, Canada. 1853

The best way to cure a cold is, not to catch another.

*Laconic Manual and Brief Remarker Containing Over a Thousand**Subjects Alphabetically and Systematically Arranged* (p. 87)

Robert Dick. Toronto, Ontario, Canada. 1853

## CONSTIPATION

**Mather, Cotton** 1663–1728

American minister and religious writer

For Costiveness. Take stewed Prunes.

*The Angel of Bethesda*

Capsula LX (p. 281)

American Antiquarian Society and Barre Publishers. Barre, Massachusetts, USA. 1972

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

There has [never] lived a poet...ancient or modern, near or far, who ever managed to write good poetry...at a time when he was suffering from stenosis at any point along the thirty-foot via dolorosa running from the pylorus to the sigmoid flexure.... The more he tries, the more vividly he will be conscious of his impotence.

*Prejudices*

2nd Series (pp. 160–161)

Alfred A. Knopf. New York, New York, USA. 1920

**COUGH**

**Fry, Stephen** 1957–  
English novelist and actor

I have tried to say more, but the Cough had come upon me, as it does these days. It starts as the smallest tickle in the throat and can build, though I say so myself as shouldn't, into a not unimpressive display. Something between a vomiting donkey and an explosion at a custard factory.

*The Hippopotamus*

Chapter I (p. 24)

Soho Press. New York, New York, USA. 1994

**Griffiths, Trevor** 1935–  
No biographical data available

MCBRAIN: Cough and the world coughs with you. Fart and you stand alone.

*The Comedians*

Act I (p. 17)

The Viking Press. New York, New York, USA. 1966

**Ray, John** 1627–1705  
English naturalist

A dry cough is the trumpeter of death.

*A Complete Collection of English Proverbs* (p. 5)

Printed for G. Cowie. London, England. 1813

**Second World War Health Slogan**

Coughs and sneezes spread diseases. Trap the germs in your handkerchief.

Source undetermined

**Wodehouse, Sir Pelham Grenville** 1881–1975  
English writer

Jeeves coughed one soft, low, gentle cough like a sheep with a blade of grass stuck in its throat.

*The Inimitable Jeeves*

Chapter 13 (p. 139)

Herbert Jenkins, Ltd. London, England. 1923

**Wolcot, John** 1738–1819  
English writer

And, doctor, do you really think  
That ass's milk I ought to drink?  
'Twould quite remove my cough, you say,  
And drive my old complaints away.  
It cured yourself – I grant it true;  
But then – 't was mother's milk to you!

In William Davenport Adams

*English Epigrams*

To a Friend Who Recommended Ass's Milk, cclxxxvi

G. Routledge. London, England. 1878

**FEVER**

**Colman, George (The Younger)** 1762–1836  
English playwright

The doctor looked wise: – “A slow fever,” he said:  
Prescribed sudorifics – and going to bed.  
“Sudorifics in bed,” exclaim'd Will, “are humbugs!  
I've enough of them there, without paying for drugs!”

In Helen and Lewis Melville

*An Anthology of Humorous Verse*

Lodgings for Single Gentlemen

Dodd, Mead & Company New York, New York, USA. 1924

**Herold, Don** 1889–1966  
Cartoonist

The sweetest words of tongue or pen: The child is 98.6 again.

*The Happy Hypochondriac* (p. 12)

Dodd, Mead & Company. New York, New York, USA. 1962

**Kipling, Rudyard** 1865–1936  
British writer and poet

An' that blasted Henglish drizzle wakes the fever in my bones...

*The Sahib Edition of Rudyard Kipling: Poems and Ballads*

Mandalay (p. 133)

P.F. Collier & Son Company. New York, New York, USA. No date

**MacFadden, Bernard** 1868–1955  
American physical culturist

If you feed a cold, as often done, you frequently have to starve a fever.

When a Cold Is Needed

*Physical Culture*, February, 1934

**Milton, John** 1608–74  
English poet

Fever, the eternal reproach to the physicians.

*The Reason of Church-Government*

Preface

Printed by E.G. for John Rothwell. London, England. 1641

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Humanity has but three great enemies: fever, famine and war; of these by far the greatest, by far the most terrible, is fever.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XVI (p. 435)

Clarendon Press. Oxford, England. 1925

**Paulos, John Allen** 1945–  
American mathematician

Consider a precise number that is well known to generations of parents and doctors: the normal human body temperature of 98.6 Fahrenheit. Recent investigations involving millions of measurements reveal that this number is wrong; normal human body temperature is actually 98.2 Fahrenheit. The fault, however, lies not with Dr. Wunderlich's original measurements – they were averaged and sensibly rounded to the nearest degree: 37 degree celsius. When this temperature was converted to Fahrenheit, however, the rounding was forgotten and 98.6 was taken to be accurate to the nearest tenth of a degree. Had the original interval between 36.5 and 37.5 degree celsius been translated, the equivalent Fahrenheit temperatures would have ranged from 97.7 to 99.5. Apparently, dyscalculia can even cause fevers.

*A Mathematician Reads the Newspaper*

Ranking Health Risks: Experts and Laymen Differ (p. 139)  
Basic Books. New York, New York, USA. 1995

**Ransom, John Crowe** 1888–1974  
American poet

Here lies a lady of beauty and high degree.  
Of chills and fever she dies, of fever and chills,  
The delight of her husband, her aunts, an infant of three,  
And of medicos marveling sweetly on her ills.

*The Poetry of John Crowe Ransom*

Here Lies a Lady (p. 64)

Rutgers University Press. New Brunswick, New Jersey, USA. 1972

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

He had a fever when he was in Spain,  
And when the fit was on him, I did mark  
How he did shake....

*In Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*Julius Caesar*

Act I, Scene ii, l. 119–121

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FLU

**Beacock, Cal**

No biographical data available

A bunch of germs were whooping it up  
In the Bronchial Saloon.  
The bacillus handling the larynx  
Was jazzing a gig-time tune,  
While back of the tongue in a solo game  
Sat Dangerous Ah Kerchoo.  
And watching his luck was his light of his love  
The malady known as Flu.

The Pundit

*Reader's Digest*, January, 1986

## HEADACHE

**Ray, John** 1627–1705  
English naturalist

When the head aches all the body is the worse.  
*A Complete Collection of English Proverbs* (p. 12)  
Printed for G. Cowie. London, England. 1813

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Do not undervalue the headache. While it is as its sharpest it seems a bad investment; but when relief begins, the unexpired remainder is worth \$4 a minute.

*Following the Equator* (Volume 2)

Chapter XVII (p. 215)

Harper & Brothers. New York, New York, USA. 1899

## HERNIA

**Jonson, Ben** 1573?–1637  
English dramatist and poet

He has a rupture, he has sprung a leake.

*The Staple of News*

Act I, Scene ii

Henry Holt & Company. New York, New York, USA. 1905

## HIVES

**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

The Indian medicine man used weird chants and dances to mystify his tribe. The medicine man of today uses cryptic cabalas in his prescription, and long Latin words for simple diseases. This impresses the patient, who in turn relishes to regale his visitor with expressions they cannot understand and are ashamed to have explained to them.

After all, it does make a difference whether you suffer from angioneurotic edema or only have the hives.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Eleven (p. 135)

Duell, Sloan & Pearce. New York, New York, USA. 1947

## INDIGESTION

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Indigestion was sent into the world to read a lecture to our stomachs...

*Les Misérables* (Volume 1)

Book III, Chapter 7 (p. 132)

The Heritage Press. New York, New York, USA. 1938

**Ingersoll, Robert Green** 1833–99

American lawyer, public official, and orator

...many people think they have religion when they are troubled with dyspepsia.

*The Ghosts: and Other Lectures*

The Liberty of Man, Woman and Child (p. 122)

C.P. Farrell, Publishers. New York, New York, USA. 1892

**INFECTIO****Voorhees, Irving Wilson**

No biographical data available

Perpetual warfare ought to be waged against those who willfully cough and sneeze into the open without protecting the face with a handkerchief.

Colds: Their Cause and Cure

*American Medicine*, Volume 12, 1917

**MAL DE MAR****Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

The best of remedies is a beef-steak  
Against sea-sickness; try it, sir, before  
You sneer, and I assure you this is true,  
For I have found it answer – so may you.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 13

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Charlie Chan (Fictional character)**

Mention of food more painful than surgeon's knife without anesthetic.

*Charlie Chan on Broadway*

Film (1937)

**Farris, Jean**

No biographical data available

Mal de mar – An ocean-motion notion.

*Quote, the Weekly Digest*, August 4, 1968 (p. 97)

**Flaubert, Gustave** 1821–90

French novelist

Sea-sickness. To avoid, all you have to do is think of something else.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Jerome, Jerome K.** 1859–1927

English author

It is a curious fact, but nobody ever is seasick – on land. At sea, you come across plenty of people very bad indeed, whole boat-loads of them; but I never met a man

yet, on land, who had ever known at all what it was to be seasick.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter I (p. 10)

Time Incorporated. New York, New York, USA. 1964

**Sterne, Laurence** 1713–68

English novelist and humorist

...the cells are broke loose one into another, and the blood, and the lymph, and the nervous juices, with the fix'd and volatile salts, are all jumbled into one mass – good g – ! everything turns round in it like a thousand whirlpools...

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 2)

Book VII, Chapter II (p. 66)

Macmillan & Company Ltd. London, England. 1900

**SCIATICA****Shakespeare, William** 1564–1616

English poet, playwright, and actor

Thou cold sciatica,  
Cripple our senators that their limbs may halt  
As lamely as their manners!

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Timon of Athens*

Act IV, Scene i, l. 23–25

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Which of your hips has the most profound sciatica?

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Measure for Measure*

Act I, Scene ii, l. 58

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**ILLUSION****Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The distinction between horizontal and vertical is not an illusion; and the man who thinks it is likely to come to an untimely end. Yet we cannot arrive at a comprehensive view of nature unless we combine horizontal and vertical dimensions into three dimensional space.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 45)

At The University Press. Cambridge, England. 1921

**Enriques, Federigo** 1871–1946

Italian mathematician

Since truth and error enter our minds by the door which the senses open to knowledge, we are soon obliged to be on our guard against illusions.

Translated by Katharine Royce  
*Problems of Science*  
 Introduction (p. 10)  
 The Open Court Publishing Co. Chicago, Illinois, USA. 1914

**Laplace, Pierre Simon** 1749–1827  
 French mathematician, astronomer, and physicist

Our passions, our prejudices, and dominating opinions, by exaggerating the probabilities which are favorable to them and by attenuating the contrary probabilities, are the abundant sources of dangerous illusions.

Translated by Frederick Wilson Truscott and Frederick Lincoln  
*A Philosophical Essay on Probabilities*  
 Chapter XVI (p. 160)  
 John Wiley & Sons. New York, New York, USA. 1902

**Pólya, George** 1887–1985  
 Hungarian mathematician

In our personal life we often cling to illusions. That is, we do not dare to examine certain beliefs which could be easily contradicted by experience, because we are afraid of upsetting our emotional balance.

*Induction and Analogy in Mathematics* (Volume 1)  
 Chapter I (p. 7)  
 Princeton University Press. Princeton, New Jersey, USA. 1954

## ILLUSTRATION

**Downy, J. C.**  
 No biographical data available

**Kelly, J. L.**  
 No biographical data available

While skill at drawing, or a steady hand, may help a person create an illustration, his skill will be of little help if he lacks the quality of careful observation, of attention to every detail of the subject; accuracy is the most sought after virtue in biological illustration.

*Biological Illustration: Techniques and Exercises* (p. viii)  
 Iowa State University Press. Ames, Iowa, USA. 1982

**Miles, Alfred Henry**

Illustrations are like windows to the house of knowledge. They let light in upon the understanding and they facilitate the outlook upon truth and beauty. To illustrate is to help one sense by the use of another, to reason by analogy and to teach the unknown by the known.

*Natural History of the World*  
 Preface (p. v)  
 Dodd, Mead & Co. New York, New York, USA. 1895

## IMAGE

**Pythagoras of Samos** ca. 580 BCE–500 BCE  
 Greek mathematician, astronomer, and philosopher

Nothing perishes in this world; but things merely vary and change their form. To be born, means simply that a

thing begins to be something different from what it was before; and dying, is ceasing to be the same thing. Yet, although nothing retains long the same image, the sum of the whole remains constant.

Quoted in Charles Lyell  
*Principles of Geology*  
 Book I, Chapter II (p. 27)  
 James Kay, Jun., & Brother. Philadelphia, Pennsylvania, USA. 1837

## IMAGINATION

### Advertisement

The freely ranging imagination of an orderly mind in a stimulating intellectual climate has a way of dissolving artificial barriers.

Advertisement by Los Alamos Scientific Laboratory  
*Scientific American*, Volume 204, Number 4, April, 1961 (p. 195)

**Akenside, Mark** 1721–70  
 English poet and physician

There are certain powers in human nature which seem to hold a middle place between the organs of bodily sense and the faculties of moral perception: They have been Call'd by a very general name, THE POWERS OF IMAGINATION.

*The Poetical Works of Mark Akenside*  
 The Powers of Imagination  
 Associated University Presses. Cranbury, New Jersey, USA. 1996

**Atchity, Kenneth** 1944–  
 Writer

That's what imagination is for: to go in advance so action can follow.

*A Writer's Time: Making the Time to Write* (p. 34)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1995

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

We are not...to imagine or suppose, but to discover, what Nature does or may be made to do.

In Henry Hobhouse  
*Seeds of Change, Five Plants that Transformed Mankind*  
 Quinine and the White Man's Burden (p. 14)  
 Harper & Row, Publishers. New York, New York, USA. 1987

**Ball, Sir Robert Stawell** 1840–1913  
 Irish astronomer

We have reached a point where man's intellect begins to fail to yield him anymore light, and where his imagination has succumbed in the endeavor to realise even the knowledge he has gained.

*The Story of the Heavens*  
 Chapter XXIII (p. 471)  
 Cassell & Co., Ltd. London, England. 1890

**Barfield, Owen** 1898–1997  
 British philosopher, critic, and anthroposophist



Imagination is really thinking with a bit of will in it.  
*History, Guilt, and Habit*  
 Chapter 3 (p. 80)  
 Wesleyan University Press. Middletown, Connecticut, USA. 1979

**Beveridge, William Ian Beardmore** 1908–  
 Australian zoologist

The imagination merely enables us to wander into the darkness of the unknown where, by the dim light of the knowledge that we carry, we may glimpse something that seems of interest. But when we bring it out and examine it more closely it usually proves to be only trash whose glitter had caught our attention. Imagination is at once the source of all hope and inspiration but also of frustration. To forget this is to court despair.  
*The Art of Scientific Investigation* (p. 58)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Blake, William** 1757–1827  
 English poet, painter, and engraver

The tree which moves some to tears of joy is in the Eyes of others only a Green thing that stands in the way. Some see Nature all Ridicule & Deformity...& Some Scarce see Nature at all. But to the Eyes of the Man of Imagination, Nature is Imagination itself.  
*The Letters of William Blake*  
 Letter to Dr. Trusler, 23 August, 1799 (p. 34)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1968

...to the eyes of the man of imagination, Nature is Imagination itself.  
 In Frederick Tatham (ed.)  
*The Letters of William Blake*  
 To The Rev. Dr. Trusler (p. 62)  
 Charles Scribner's Sons. New York, New York, USA. 1906

Nature has no outline:  
 but Imagination has.  
 Nature has no tune:  
 but Imagination has!  
 Nature has no supernatural & dissolves:  
 Imagination is Eternity.  
*The Complete Poetry and Prose of William Blake*  
 The Ghost of Abel  
 University of California Press. Berkeley, California, USA. 1982

**Borland, Hal** 1900–78  
 American writer

Give any man a star on which he can fix his eye and he can reach as far as his imagination points the way.  
*An American Year*  
 June (p. 46)  
 Simon & Schuster. New York, New York, USA. 1946

**Born, Max** 1882–1970  
 German-born English physicist

Faith, imagination and intuition are decisive factors in the progress of science as in any other human activity.

*Natural Philosophy of Cause and Chance*  
 Appendix One, 36 (p. 209)  
 At The Clarendon Press. Oxford, England. 1949

**Brillouin, Léon** 1889–1969  
 French physicist

An artist's inspiration or a scientist's theory, reveal the unpredictable power of human imagination.  
*Scientific Uncertainty and Information*  
 Dedication  
 Academic Press. New York, New York, USA. 1964

**Brodie, Sir Benjamin Collins** 1817–80  
 English chemist

Lastly, physical investigation, more than anything besides, helps to teach us the actual value and right use of the Imagination – of that wondrous faculty, which, left to ramble uncontrolled, leads us astray into a wilderness of perplexities and errors, a land of mists and shadows; but which, properly controlled by experience and reflection, becomes the noblest attribute of man; the source of poetic genius, the instrument of discovery in Science, without the aid of which Newton would never have invented fluxions, nor Davy have composed the earths and alkalies, nor would Columbus have found another Continent.  
 In John Tyndall  
*Fragments of Science*  
 Address to the Royal Society, November 30, 1859, Scientific Use of the Imagination (p. 423)  
 D. Appleton & Company. New York, New York, USA. 1898

**Bronowski, Jacob** 1908–74  
 Polish-born British mathematician and polymath

Man is distinguished from other animals by his imaginative gifts. He makes plans, inventions, new discoveries, by putting different talents together; and his discoveries become more subtle and penetrating, as he learns to combine his talents in more complex and intimate ways. So the great discoveries of different ages and different cultures, in technique, in science, in the arts, express in their progression a richer and more intricate conjunction of human faculties, an ascending trellis of his gifts.  
*The Ascent of Man*  
 Lower than the Angels (p. 20)  
 Little, Brown & Co. Boston, Massachusetts, USA. 1973

**Brougham, Henry** 1778–1868  
 English statesman

A mere theory...is the unmanly and unfruitful pleasure of a boyish and prurient imagination, or the gratification of a corrupted and depraved appetite...  
 The Bakerian Lecture on the Theory of Light and Colours  
*Edinburgh Review*, Volume 1, 1801–3 (p. 450)

**Buckley, Arabella B.** 1840–1929  
 English naturalist and science writer

...we must have imagination. I do not mean mere fancy, which creates unreal images and impossible monsters, but imagination, the power of making pictures or images in our mind of that which is, though it is invisible to us.

*The Fairy-Land of Science*

Lecture I (p. 17)

D. Appleton & Company. New York, New York, USA. 1899

**Burroughs, John** 1837–1921

American naturalist and essayist

In the great sciences, like astronomy and geology, one gets wholes; the imagination has play-room. The cosmic laws launch him upon a shoreless sea. One is blown upon by a breeze from eternity. The same with biology in the light of evolution.

*Under the Apple-Trees*

Chapter XI (p. 178)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Unpredictable associations and the free play of imagination are no less important in science, that is, in real science, than they are in writing.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 166)

The Rockefeller University Press. New York, New York, USA. 1978

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Nobody can imagine how nothing could turn into something. Nobody can get an inch nearer to it by explaining how something could turn into something else. It is really far more logical to start by saying “In the beginning God created heaven and earth” even if you only mean “In the beginning some unthinkable power began some unthinkable process.” For God is by its nature a name of mystery, and nobody ever supposed that man could imagine how a world was created anymore than he could create one. But evolution really is mistaken for explanation. It has the fatal quality of leaving on many minds the impression that they do understand it and everything else; just as many of them live under a sort of illusion that they have read the Origin of Species.

*The Everlasting Man*

Chapter I (p. 3)

Dodd, Mead & Company. New York, New York, USA. 1925

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Across the seas of space lie the new raw materials of the imagination, without which all forms of art must eventually sicken and die. Strangeness, wonder, mystery, and magic – these things, which not long ago seemed lost forever, will soon return to the world. And with them,

perhaps will come again an age of sagas and epics such as Homer never knew.

*Greetings, Carbon-Based Biped!* (p. 229)

HarperCollins. London, England, 2000

**Cole, K. C.**

Science writer

Imagining the unseeable is hard, because imagining means having an image in your mind. And how can you have a mental image of something you have never seen? Like perception itself, the models of science are embedded inextricably in the current worldview we call culture.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter One (p. 18)

Harcourt Brace & Co. Orlando, Florida, USA. 1999

**Coleridge, Stephen** 1854–1936

English author, barrister, and opponent of vivisection

Not that there may not emerge here and there among men of letters one who by some misfortune has lost his imagination and has subsided into a mere man of maxims such as was Polonius, whose trite observations were rightly founded on experience and were therefore not to be gainsayed, but whose opinions on contemporary human affairs were foolish, and who was in actual society a bore.

*The Idolatry of Science*

Chapter IV (pp. 21–22)

John Lane Co. London, England. 1920

**D’Alembert, Jean Le Rond** 1717–83

French mathematician

Thus metaphysics and geometry are, of all the sciences belonging to reason, those in which imagination has the greatest to share. I ask pardon for this observation, from those men of taste who, little aware of the near affinity of geometry to their own pursuits, and still less suspecting that the only intermediate step between them is formed by metaphysics, are disposed to employ their wit in depreciating its value...to the geometer who invents imagination is not less essential than to the poet who creates.... Of all the great men of antiquity, Archimedes is perhaps he who is best entitled to be placed by the side of Homer.

In Robert Blakey

*History of the Philosophy of Mind: Embracing the Opinions of All*

*Writers on Mental Science from the Earlier Periods to the Present Time*

(Volume 3)

Chapter XI (p. 176)

Longman, Brown, Green & Longmans. London, England. 1850

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

At bottom each “exact” science is, and must be speculative, and its chief tool of research, too rarely used with both courage and judgment, is the regulated imagination.

*Igneous Rocks and Their Origin*

Introduction (p. xxi)

McGraw-Hill Book Co., Inc. London, England. 1914

What geology, like every other science, needs today is a frank recognition that imaginative thought is not dangerous to science but is the life blood of science.

*Igneous Rocks and Their Origin*

Introduction (p. xxii)

McGraw-Hill Book Co., Inc. London, England. 1914

**Darwin, Charles Robert** 1809–82

English naturalist

This sketch is *most* imperfect; but in so short a space I cannot make it better. Your imagination must fill up many wide blanks. Without some reflexion it will appear all rubbish; perhaps it will appear so after reflexion.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter To Asa Gray, September 5, 1857 (p. 481)

D. Appleton &amp; Company. New York, New York, USA. 1887

The value of the products of our imagination depends, of course, on the number, accuracy, and clearness of our impressions, on our judgment and taste in selecting or rejecting the involuntary combinations, and to a certain extent on our power of voluntary [combinations of] them...

In *Great Books of the Western World* (Volume 49)*The Descent of Man*

Part I, Chapter III (p. 292)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Disraeli, Benjamin, First Earl****of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

...imagination is too often accompanied by somewhat irregular logic.

*Wit and Wisdom*

Imagination (p. 168)

Longmans, Green, &amp; Co. London, England. 1881

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

And yet there should be no combination of events for which the wit of man cannot conceive an explanation. Simply as a mental exercise, without any assertion that it is true, let me indicate a possible line of thought. It is, I admit, mere imagination; but how often is imagination the mother of truth?

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)*The Valley of Fear*

Part I, Chapter 6 (p. 507)

Wings Books. New York, New York, USA. 1967

...for strange effects and extraordinary combinations we must go to life itself, which is always far more daring than any effort of the imagination.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)*The Red-Headed League* (p. 419)

Wings Books. New York, New York, USA. 1967

**Einstein, Albert** 1879–1955

German-born physicist

I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 117)

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

In imagination there exists the perfect mystery story. Such a story presents all the essential clues, and compels us to form our own theory of the case. If we follow the plot carefully we arrive at the complete solution for ourselves just before the author's disclosure at the end of the book. The solution itself, contrary to those of inferior mysteries, does not disappoint us; moreover, it appears at the very moment we expect it.

*The Evolution of Physics*

The Great Mystery Story (p. 3)

Simon &amp; Schuster. New York, New York, USA. 1961

Scientific imagination finds old concepts too confining, and replaces them by new ones.

*The Evolution of Physics*

Chapter I (p. 26)

Simon &amp; Schuster

New York, New York, USA. 1961

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Science does not know its debt to imagination.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)*Letters and Social Aims*

Chapter I (p. 10)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

If I could put my hand on the North Star, would it be as beautiful? The sea is lovely, but when we bathe in it the beauty forsakes all the near water. For the imagination and senses cannot be gratified at the same time.

*The Complete Works of Ralph Waldo Emerson* Volume 6*The Conduct of Life*

Beauty (p. 303)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Faraday, Michael** 1791–1867

English physicist and chemist

The world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and

secrecy by his own severe criticism and adverse examination; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized.

In Karl Pearson

*The Grammar of Science*

Introductory, Section 11 (p. 38)

Charles Scribner's Sons. London, England. 1892

...in the pursuit of physical science, the imagination should be taught to present the subject investigated in all possible and even impossible views...

*Experimental Researches in Chemistry and Physics*

On Mental Education (p. 480)

Richard Taylor & William Francis. London, England. 1859

The truth of science has ever had not merely the task of evolving herself from the dull and uniform mist of ignorance, but also that of the repressing and dissolving the phantoms of the imagination.

In Bence Jones

*The Life and Letters of Faraday* (Volume 2)

Chapter III (p. 285)

Longmans, Green & Company. London, England. 1870

Let us encourage ourselves by a little more imagination prior to experiment.

In Bence Jones

*The Life and Letters of Faraday* (Volume 2)

Chapter IV (p. 414)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

Let the imagination go, guarding it by judgment and principle, but holding it in and directing it by experiment.

In Bence Jones

*The Life and Letters of Faraday* (Volume 2)

15,809 (p. 415)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

### **Fersman, A. E.** 1883–1945

Geochemist and mineralogist

First of all, a scientist must be endowed with an imagination, for imagination plays no less important a part in science than it does in art. Imagination is as necessary as is painstaking work on collected material. Without imagination scientific work is just an assortment of facts and conclusions – empty, chaotic, and often barren.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierov

Progress Publishers. Moscow, Russia. 1979

### **Feynman, Richard P.** 1918–88

American theoretical physicist

...the imagination of nature is far, far greater than the imagination of man.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter 1 (p. 10)

Perseus Books. Reading, Massachusetts, USA. 1998

It is surprising that people do not believe that there is imagination in science. It is a very interesting kind of

imagination, unlike that of the artist. The great difficulty is in trying to imagine something that you have never seen, that is consistent in every detail with what has already been seen, and that is different from what has been thought of; furthermore, it must be definite and not a vague proposition. That is indeed difficult.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter 1 (pp. 22–23)

Perseus Books. Reading, Massachusetts, USA. 1998

It is only through refined measurements and careful experimentation that we can have a wider vision. And then we see unexpected things: we see things that are far from what we would guess – far from what we could have imagined. Our imagination is stretched to the utmost, not, as in fiction, to imagine things which are not really there, but just to comprehend those things which are there.

*The Character of Physical Law*

Chapter 6 (p. 127)

British Broadcasting Company. London, England. 1965

As usual, nature's imagination far surpasses our own, as we have seen from the other theories which are subtle and deep.

*The Character of Physical Law*

Chapter 7 (p. 162)

British Broadcasting Company. London, England. 1965

What we need is imagination, but imagination in a terrible strait-jacket.

*The Character of Physical Law*

Chapter 7 (p. 171)

British Broadcasting Company. London, England. 1965

Imagination reaches out repeatedly trying to achieve some higher level of understanding, until suddenly I find myself momentarily alone before one new corner of nature's pattern of beauty and true majesty revealed.

*Les Prix Nobel. The Nobel Prizes in 1965*

Nobel banquet speech for award received in 1965

Nobel Foundation. Stockholm, Sweden. 1966

Our imagination is stretched to the utmost, not, as in fiction, to imagine things which are not really there, but just to comprehend those things which are there.

In James Gleik

*Genius: The Life and Science of Richard Feynman*

Caltech (p. 325)

Random House. New York, New York, USA. 1993

### **Feynman, Richard P.** 1918–88

American theoretical physicist

### **Leighton, Robert B.** 1919–97

American physicist

### **Sands, Matthew L.** 1919–

American physicist

The whole question of imagination in science is often misunderstood by people in other disciplines...whatever we are allowed to imagine in science must be consistent with everything else we know: that the electric fields and

the waves we talk about are not just some happy thoughts which we are free to make as we wish, but ideas which must be consistent with all the laws of physics we know. We can't allow ourselves to seriously imagine things which are obviously in contradiction to the known laws of nature. And so our kind of imagination is quite a difficult game. One has to have the imagination to think of something that has never been seen before, never been heard of before. At the same time the thoughts are restricted in a strait jacket, so to speak, limited by the conditions that come from our knowledge of the way nature really is. The problem of creating something which is new, but which is consistent with everything which has been seen before, is one of extreme difficulty.

*The Feynman Lectures on Physics* (Volume 2)  
Chapter 20–3 (p. 20-10)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

### **Frye, Northrop** 1912–91

Canadian literary critic

Science begins with the world we have to live in, accepting its data and trying to explain its laws. From there, it moves toward the imagination: it becomes a mental construct, a model of a possible way of interpreting experience.

*The Educated Imagination*

The Motive for Metaphor (p. 23)

Indiana University Press. Bloomington, Indiana, USA. 1964

### **Giberne, Agnes** 1845–1939

English writer

On the Wings of Imagination...[w]onderful journeys may...be taken.

*Among the Stars; or, Wonderful Things In the Sky*

Chapter III (p. 24)

Robert Carter & Brothers. New York, New York, USA. 1885

### **Gies, William J.** 1872–1956

US biochemist and dentist

Without imagination research is like an ocean voyage without a compass – even though you may be always on the way, you may “get nowhere.”

Research in Dentistry

*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xciv)

### **Goldsmith, Oliver** 1728–74

Anglo-Irish writer, poet, and physician

A man of this disposition [curious] turns all nature into a magnificent theatre, replete with objects of wonder and surprise, and fitted up chiefly for his happiness and entertainment: he industriously examines all things, from the minutest insect to the most finished animal; and, when his limited organs can no longer make the disquisition, he sends out his imagination upon new inquiries.

*A History of the Earth and Animated Nature* (Volume 1)

Chapter I (p. 9)

Claxton, Remson & Haffelfinger. Philadelphia, Pennsylvania, USA. 1875

### **Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

I find that few men of imagination are not worth my attention. Their ideas may be wrong, even foolish, but their methods often repay a close study. Few honest passions are not based upon some valid perception of unity or some anomaly worthy of note. The different drummer often beats a fruitful tempo.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 22 (p. 234–235)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

### **Goya, Francisco Jose** 1746–1828

Spanish artist

Imagination deserted by reason creates monstrosities. United with reason, imagination gives birth to great marvels and true art.

*Caption to Caprichos*, Number 43

### **Haldane, John Burdon Sanderson** 1892–1964

English biologist

Science is vastly more stimulating to the imagination than the classics.

*Daedalus, or Science and the Future*

Paper read to the Heretics, Cambridge, England, February 4, 1923

### **Harding, Rosamund E. M.**

No biographical data available

Dreaming over a subject is simply...allowing the will to focus the mind passively on the subject so that it follows the trains of thought as they arise, stopping them only when unprofitable but in general allowing them to form and branch naturally until some useful and interesting results occur.

*An Anatomy of Inspiration*

Chapter I (p. 5)

W. Heffer & Sons Ltd. Cambridge, England. 1940

### **Harishchandra**

Mythical Hindu king

I have often pondered over the roles of knowledge or experience, on the one hand, and imagination or intuition, on the other, in the process of discovery. I believe that there is a certain fundamental conflict between the two, and knowledge, by advocating caution, tends to inhibit the flight of imagination. Therefore, a certain naiveté, unburdened by conventional wisdom, can sometimes be a positive asset.

In R. Langlands

*Biographical Memoirs of Fellows of the Royal Society*

Harish-Chandra, Volume 31, 1985 (p. 206)



**Hawking, Stephen William** 1942–  
English theoretical physicist

Science fiction like *Star Trek* is not only good fun but it also serves a serious purpose, that of expanding the human imagination.

In Lawrence M. Krauss  
*The Physics of Star Trek*

Forward (p. xi)

Harp Perennial Publishers. New York, New York, USA. 1995

**Herbart, Johann Friedrich** 1776–1841  
German philosopher and educator

The great science occupies itself at least just as much with the power of imagination as with the power of logical conclusion.

*Werke*

Pestalozzi's Idee eines ABC der Anschauung, Bd. 1 (p. 174)

Langensalza. 1890

**Herrick, Charles Judson** 1868–1960  
American neurologist

Human imagination is the source of the greatest triumphs of science, technology, art, and philosophy. We must be careful not to cripple its exercise by arbitrary restrictions. It gives us our preeminence over the brutes.

*The Evolution of Human Nature*

Epilogue: The Unknown God (p. 464)

University of Texas Press. Austin, Texas, USA. 1956

**Herschel, Friedrich Wilhelm**  
**(Sir William)** 1738–1822  
English astronomer

[I]f we would hope to make any progress in an investigation of this delicate nature, we ought to avoid two opposite extremes, of which I can hardly say which is the most dangerous. If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going wide from the path of truth and nature; but these will vanish like the Cartesian vortices, that soon gave way when better theories were offered.

On the other hand, if we add observation to observation, without attempting to draw not only certain conclusions, but also conjectural views from them, we offend against the very end for which only observations ought to be made. I will endeavor to keep a proper medium, but if I should deviate from that, I could wish not to fall into the latter error.

On the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*,

Volume 75, February 3, 1785 (p. 213)

**Hobbes, Thomas** 1588–1679  
English philosopher and political theorist

“Imagination,” therefore, is nothing but “decaying sense;” and is found in men, and many other living creatures, as well sleeping, as waking.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (2nd edition)

Chapter II (p. 17)

George Routledge & Sons. London, England. 1886

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

When we have one fact found us, we are very apt to supply the next out of our own imagination.

*The Professor at the Breakfast-table*

A Short Lecture on Phrenology (p. 284)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Huggins, Sir William** 1824–1910  
English astronomer

This creative use of the imagination is not only the fountain of all inspiration in poetry and art, but is also the source of discovery in science, and indeed supplies the initial impulse to all development and progress. It is this creative power of the imagination which has inspired and guided all the great discoveries in science.

In William H. George

*The Scientist in Action: A Scientific Study of His Methods*

The Scientific Theory (p. 226)

Williams & Norgate Ltd. London, England. 1936

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

No faculty of the mind penetrates and plunges deeper than imagination; it is the great diver. Science, reaching the lowest depths, meets imagination. In conic sections, in logarithms, in the differential and integral calculus, in the calculations of sonorous waves, in the application of algebra to geometry, the imagination is the coefficient of calculation, and mathematics becomes poetry.

Translated by Melville Best Anderson

*William Shakespeare*

Part Second, Book I, Chapter I (p. 199)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

Imagination is needed in science as much as in any other mental activity. But it must not take charge of the scientific mind. If it [were to] do, disaster may follow.

*Essays in Popular Science*

On the History of Science (p. 168)

Chatto & Windus. London, England. 1926

**Huxley, Thomas Henry** 1825–95  
English biologist

The rapid increase of natural knowledge, which is the chief characteristic of our age, is effected in various ways. The main army of science moves to the conquest of new worlds slowly and surely, nor ever cedes an inch of the territory gained. But the advance is covered and facilitated by the ceaseless activity of clouds of light troops



provided with a weapon – always efficient, if not always an arm of precision – the scientific imagination.

*Man's Place in Nature and other Anthropological Essays*

Chapter VI (p. 271)

D. Appleton & Company. New York, New York, USA. 1896

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...are there any limits at all to the extent of space? Even a generation ago, I think most scientists would have answered this question in the negative. They would have argued that space could be limited only by the presence of something which is not space. We, or rather our imaginations, could only be prevented from journeying forever through space by running against a wall of something different from space. And, hard though it may be to imagine space extending forever, it is far harder to imagine a barrier of something different from space which could prevent our imaginations from passing into a further space beyond.

*The Universe Around Us*

Chapter I (p. 68)

The Macmillan Company. New York, New York, USA. 1929

**Jefferies, Richard** 1848–87

English naturalist and author

There is so much beyond all that has ever yet been imagined.

*The Story of My Heart*

Chapter III (p. 54)

Longmans, Green & Co. London, England. 1901

**Kaempffert, Waldemar** 1877–1956

American science editor and museum director

It is hard even for science to quell the imagination and to confine an observer to facts.

*The Science-history of the Universe* (Volume 1)

Chapter VIII (p. 88)

The Current Literature Publishing Co. New York, New York, USA. 1909

**Keats, John** 1795–1821

English Romantic lyric poet

...what the imagination seizes as beauty must be truth – whether it existed before or not ...

In Horace Elisha Scudder

*The Complete Poetical Works and Letters of John Keats*

Letter 21 (p. 274)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1899

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

...the greatest tool of discovery is the human imagination.

*Blind Watchers of the Sky*

Preface (p. x)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

Although today we look harder and farther than we have ever looked, with all the instruments of modern science, and with all of the imagination and courage we can muster, we are still blind watchers of the sky.

*Blind Watchers of the Sky*

Chapter One (p. 9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

Imagination is one of the finest faculties of man: it ennobles and elevates his thoughts and relieves him from the domination of minute details; and when it reaches a very high development, it makes him superior to the great majority of other people.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VIII (p. 390)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lankester, Edwin Ray** 1847–1929

English zoologist

All true science deals with speculation and hypothesis, and acknowledges as its most valued servant – its indispensable ally and helpmeet – that which our German friends I call “Phantasie” and we “the Imagination.”

*The Advancement of Science*

Chapter I (p. 4)

Macmillan & Company Ltd. London, England. 1890

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The philosopher who is really useful to the cause of science, is he who, uniting to a fertile imagination, a rigid severity in investigation and observation, is at once tormented by the desire of ascertaining the cause of the phenomena, and by the fear of deceiving himself in that which he assigns.

*System of the World* (Volume 2)

Book V, Chapter IV (pp. 276–277)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

**Lavoisier, Antoine Laurent** 1743–94

French chemist

In the study and practice of the sciences [learning to reason justly] is quite different; the false judgments we form neither affect our existence nor our welfare; and we are not forced by any physical necessity to correct them. Imagination, on the contrary, which is ever wandering beyond the bounds of truth, joined to self-love and that self-confidence we are so apt to indulge, prompts us to draw conclusions which are not immediately derived from facts; so that we become in some measure interested in deceiving ourselves. Hence it is by no means to

be wondered, that, in the science of physics in general, men have often made suppositions, instead of forming conclusions. These suppositions, handed down from one age to another, acquire additional weight from the authorities by which they are supported, till at last they are received, even by men of genius, as fundamental truths.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xvii)

Printed for William Creech. Edinburgh, Scotland. 1790

**Leslie, Sir John** 1766–1832

Scottish physicist and mathematician

The gift of a lively fancy is an important requisite for every physical observer.

*Elements of Natural Philosophy*

Introduction (p. xiii)

Printed for W. & C. Tate. Edinburgh, Scotland. 1823

The imagination of the Philosopher differs from that of the Poet, only because it calls forth less vivid images; but it is equally creative, and equally sentient to the flitting scenes of Nature.

*Elements of Natural Philosophy: Including Mechanics and Hydrostatics* (Volume 1)

Introduction (p. xv)

Oliber & Boyd. Edinburgh, Scotland. 1829

**Lowell, Percival** 1855–1916

American astronomer

Imagination is the single source of the new...reason, like a balance wheel, only keeping the action regular. For reason...compares what we imagine with what we know, and gives us the answer in terms of the here and now, which we call the actual. But the actual...does not mark the limit of the possible.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 20)

University of Arizona Press. Tucson, Arizona, USA. 1976

A good education is indispensable, one as broad as it is long; without it he runs the risk of becoming a crank. Then enters the important quality of imagination. This word to the routine rabble of science is a red rag to a bull; partly because it is beyond their conception, partly because they do not comprehend how it is used. To their thinking to call a man imaginative is to damn him; when, did they but know it, it is admitting the very genius they would fain deny. For all great work imagination is vital; just as necessary in science and business as it is in novels and art.... The difference between the everyday and scientific use of it is in that in science every imagining must be tested to see whether it explains the facts. Imagination harnessed to reason is the force that pulls an idea through. Reason, too, of the most complete, uncompromising kind. Imagination supplies the motive power, reason the guiding rein.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 21)

University of Arizona Press. Tucson, Arizona, USA. 1976

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

After having reached an opinion for a special case, one gradually modifies the circumstances of this case in one's imagination as far as possible, and in doing so tries to stick to the original opinion as closely as one can. There is no procedure which leads more safely and with greater mental economy to the simplest interpretation of all natural events.

In Ephraim Avigdor Speiser

*Studies in the History of Science* (p. 105)

University of Pennsylvania Press. Philadelphia, Pennsylvania, USA. 1941

**Marett, Robert Randolph** 1866–1943

Social anthropologist

...imagination is the queen of those mental functions which meet in what we loosely term "thought"; and imagination is ever most active where, on the outer fringe of the mind's routine work, our inarticulate questionings radiate into the unknown.

*Anthropology*

Chapter I (p. 28)

Henry Holt & Co. New York, New York, USA. 1912

**Matthew, William Diller** 1871–1930

Canadian-American paleontologist

It has been well observed that the imagination of man does not really enable him to create anything new, but only to recombine or rearrange what he has seen.

*The Science-history of the Universe* (Volume 6)

Chapter I

The Current Literature Publishing Co. New York, New York, USA. 1909

**Mayo, William J.** 1861–1939

American physician

The sciences bring into play the imagination, the building of images in which the reality, of the past is blended with the ideals for the future, and from the picture there springs the prescience of genius.

Contributions of Pure Science to Progressive Medicine

*The Journal of the American Medical Association*, Volume 84,

Number 20, May 16, 1925 (p. 1466)

**McComb, Samuel**

No biographical data available

The astronomer's physical frame is confined by the walls of his observatory, but his mind sweeps the orbit of the earth, tracks the solar system as it sounds its way through boundless space. Nor does the Milky Way, the confines of the stellar universe, avail to stay the flight of his speculative imagination; he can pierce through it. Though his telescope may not, and wonder what lies beyond.

The Modern Attitude Towards Belief in a Future Life

*The Living Age*, Volume XXXV, Number 3279, May 11, 1907 (p. 366)

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

All advances of scientific understanding, at every level, begin with a speculative adventure, an imaginative pre-conception of what might be true.... [This] conjecture is then exposed to criticism to find out whether or not that imagined world is anything like the real one. Scientific reasoning is, therefore, at all levels an interaction between two episodes of thought – a dialogue between two voices, the one imaginative and the other critical...

*The Hope of Progress*

Science and Literature (p. 16)

Methuen &amp; Company Ltd. London, England. 1972

If the generative act in science is imaginative in character, only a failure of the imagination – a total inability to conceive what the solution of a problem might be – could bring scientific inquiry to a standstill. No such failure of the imagination – nor any failure of nerve that might be responsible for it – has yet occurred in science and there is not the slightest reason to suppose that it will ever do so.

*The Limits of Science* (p. 85)

Harper &amp; Row Publishers. New York, New York, USA. 1984

**Mellor, Joseph William** 1863–1938

Chemist

It is the sprite imagination which usually reveals the deeper meaning of facts which have been diligently garnered, and laboriously sifted.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 9)

Longman, Green &amp; Co. London, England. 1922

It cannot be doubted that science in its higher work, requires a supple and well-developed imagination.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 10)

Longman, Green, &amp; Co. London, England. 1922

It is now generally recognized that imagination, uncontrolled by facts, has produced all the palsying superstitions which have blinded and cursed the human race – past and present.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 16)

Longman, Green &amp; Co. London, England. 1922

**Miller, Hugh** 1802–56

Scottish geologist and theologian

It is said that modern science is averse to the exercise and development of the imaginative faculty. But is it really so?

*Sketch-Book of Popular Geology*

Lecture Second (p. 79)

William P. Nimmo &amp; Company. Edinburgh, Scotland. 1880

**Mitchell, Maria** 1818–89

American astronomer and educator

Not too much mechanical apparatus – let the imagination have some play; a cube maybe shown by a model, but let the drawing upon the blackboard represent the cube; and if possible let Nature be the blackboard; spread your triangles upon land and sky.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 180)

Lea &amp; Shepard Publishers. Boston, Massachusetts, USA. 1896

We especially need imagination in science. It is not all mathematics, nor all logic, but it is somewhat beauty and poetry.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 187)

Lee &amp; Shepard. Boston, Massachusetts, USA. 1896

**Moore, Benjamin** 1745–1816

Episcopal writer and professor of rhetoric

Imagination is as fundamentally important for a student of natural science as for a poet or a devotee of a religious belief. It is by the use of the imagination that science is led on from discovery to discovery ...

*The Origin and Nature of Life*

Chapter I

Henry Holt &amp; Co. New York, New York, USA.

**More, Louis Trenchard**

American educator

It is no small danger thus to confuse reality and imagination; a science, which becomes so hypothetical or so specialized as to be unintelligible to the educated man, is apt to become as sterile as a religion which is in the sole possession of a hierarchy.

*The Limitations of Science*

Chapter II (pp. 34–35)

Henry Holt &amp; Co. New York, New York, USA. 1915

**Pascal, Blaise** 1623–62

French mathematician and physicist

Let man then contemplate the whole of nature in her full and lofty majesty.... But if our eyes stop here, let our imagination pass beyond. It will sooner tire of conceiving things than nature of producing them. The whole visible world is only an imperceptible trace in the amplitude of nature. No idea approaches it. However much we may inflate our conceptions beyond these imaginable spaces, we give birth only to atoms with respect to the reality of things.

*Pensees*

Beginning (p. 50)

Hackett. Indianapolis, Indiana, USA. 2004

**Patten, William**

No biographical data available

Imagination opens the gates of the universe.

In Austin L. Porterfield

*Creative Factors in Scientific Research*

Chapter IV (p. 61)

Duke University Press. Durham, North Carolina, USA. 1941

**Payne-Gaposchkin, Cecilia** 1900–79

British-American astronomer

To realize one's limitations marks the awakening of intellectual integrity, without which imagination, integrity and assiduity are barren.

*An Autobiography and Other Recollections*

Chapter 7 (p. 123)

Cambridge University Press. Cambridge, England. 1984

**Pearson, Karl** 1857–1936

English mathematician

All great scientists have, in a certain sense, been great artists; the man with no imagination may collect facts, but he cannot make great discoveries.

*The Grammar of Science*

Introductory, Section 11 (p. 37)

Charles Scribner's Sons. London, England. 1892

Hundreds of men have allowed their imagination to solve the universe, but the men who have contributed to our real understanding of natural phenomena have been those who were unstinted in their application of criticism to the product of their imaginations.

*The Grammar of Science*

Introductory, Section 11 (p. 38)

Charles Scribner's Sons. London, England. 1892

**Peebles, Curtis**

American aerospace historian

Before a discovery can be made, human imagination must be opened to new possibilities.

*Asteroids: A History*

Chapter 1 (p. 3)

Smithsonian Institution Press. Washington, D.C. 2000

**Phelps, William Lyon** 1865–1943

American author, critic, and scholar

One reason why I was a dunce in Mathematics was because I could not get an imaginative hold of it. Propositions in Geometry interested me not in the least. Suppose ABC did equal DEF, what of it? Parallel lines do not meet – who cares? If I could only have seen them as two dear and intimate friends, doing their best to get together, struggling with all their might to touch each other, and yet in vain – with the empty assurance that they would meet in infinity, a kind of comfortless Nirvana!

*Teaching in School and College*

Imagination and Teaching (p. 52)

The Macmillan Co. New York, New York, USA. 1912

**Planck, Max** 1858–1947

German physicist

...when the pioneer in science sends for the groping feelers of his thoughts, he must have a vivid intuitive imagination, for new ideas are not generated by deduction, but by an artistically creative imagination. Nevertheless, the worth of a new idea is invariably determined, not by the degree of its intuitiveness – which, incidentally, is to a major extent a matter of experience and habit – but by the scope and accuracy of the individual laws to the discovery of which it eventually leads.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part III (p. 109)

Philosophical Library. New York, New York, USA. 1949

**Pouchet, Félix Archimède** 1800–72

French biologist

Our imagination...is equally confounded by what is infinitely great or infinitely small.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book I (p. 3)

Blackie & Son. London, England. 1870

**Proctor, Richard Anthony** 1837–88

English astronomer

I believe that no one who studies aright the teachings of the profoundest students of nature will fail to perceive that our Galileos, Keplers, and Newtons, our Priestleys, Faradays, and Tyndalls, have been moved in no small degree by poetic instincts, and that their best scientific work has owed as much to their imagination as to their reasoning and perceptive faculties.

*The Poetry of Astronomy*

Preface

Smith, Elder & Co. London, England. 1881

**Pulitzer, Joseph** 1847–1911

American journalist and publisher

I know what you mean by imagination! That it is necessarily inexact or irresponsible. I hope you will recover from that. Imagination isn't disorder or sloppiness or substituting misinformation for something that should have been definitely ascertained.... It isn't being lazy or indifferent or lacking personal or professional conscience. No. It is what the astronomer has when he says that right there, though no one has located it, must be a star. It is what Darwin had when, with the long orchid in his hand, he said that somewhere they would find the long-tongued moth who visited it.

In Austin L. Porterfield

*Creative Factors in Scientific Research*

Chapter IV (p. 61)

Duke University Press. Durham, North Carolina, USA. 1941

**Raymo, Chet** 1936–

American physicist and science writer, teacher, and naturalist

No more of the universe is visible to our unaided eyes than to the eyes of our Neanderthal ancestors. But science, the product of our imagination, has immensely extended the range of our imagination. Our inward eye can range beyond the dome of visible stars to the unseen realm of the nebulae and galaxies.

*365 Starry Nights*

Introduction (p. x)

Prentice Hall Press. New York, New York, USA. 1982

Science is not a collection of facts, nor is science something that happens in the laboratory. Science is something that happens in the head; it is a flight of imagination beyond the constraints of ordinary imagination.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter I (p. 3)

The Viking Press. New York, New York, USA. 1991

**Reade, T. M.**

No biographical data available

When it becomes necessary to invent imaginary conditions, to do imaginary work instead of rigorously reasoning out the probabilities of geological facts – all too few in many cases – I shall leave the seemingly congenial occupation to the poets and romancers of science, and confess myself entirely unfitted for the prosecution of scientific investigation.

Glacial Geology, Old and New

*Geological Magazine*, Volume X, Number 1, 1893 (p. 37)

**Reid, Thomas** 1710–96

Scottish philosopher

It is genius, and not the want of it, that adulterates philosophy, and fills it with error and false theory. A creative imagination disdains the mean offices of digging for a foundation, of removing rubbish, and carrying materials; leaving these servile employments to the drudges in science, it plans a design, and raises a fabric. Invention supplies materials where they are wanting, and fancy adds colouring and every befitting ornament. The work pleases the eye, and wants nothing but solidity and a good foundation.

*The Works of Thomas Reid* (Volume 1)

An Inquiry into the Human Mind, Chapter I, Section ii (p. 99)

James Thin. Edinburgh, Scotland. 1895

**Richards, Mary Caroline**

No biographical data available

The imagination equips us to perceive reality when it is not fully materialized.

*Centering in Pottery, Poetry, and the Person*

Chapter III (p. 74)

Wesleyan University Press. Middletown, Connecticut, USA. 1989

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...if you have a good scientific imagination you can think of all sorts of things that might be true, and that's the essence of science. You first think of something that might be true – then you look to see if it is, and it generally isn't.

*Bertrand Russell Speaks His Mind*

What Is Philosophy? (p. 13)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1960

**Sagan, Carl** 1934–96

American astronomer and author

Imagination will often carry us to worlds that never were.

But without it, we go nowhere.

*Cosmos*

Chapter I (p. 2)

Ballantine Books. New York, New York, USA. 1985

**Schopenhauer, Arthur** 1788–1860

German philosopher

Every man takes the limits of his own field of vision for the limits of the world.

*The Wisdom of Life, and Other Essays*

Studies in Pessimism

Psychological Observations (p. 255)

M. W. Dunne. New York, New York, USA. 1901

**Serling, Rod** 1924–75

American playwright

There is a fifth dimension beyond those known to man. It is a dimension vast as space and timeless as infinity. It is the middle ground between light and shadow, between the pit of his fears and the summit of his knowledge. This is the dimension of imagination. It is an area called the Twilight Zone.

*Twilight Zone*

Preamble

Television program (1959–1964)

**Serviss, Garrett Putman** 1851–1921

American science fiction writer

His imagination flashed like lightning over the subject of his talk, revealing it at the most unexpected angles, and often he roused us to real enthusiasm for things the very names of which we almost forgot amidst the next day's occupations.

*A Columbus of Space*

Chapter I (p. 2)

D. Appleton & Co. New York, New York, USA. 1911

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

DON JUAN: Stupidity has all the knowledge, and Imagination all the intelligence.



*Man and Superman: A Comedy and a Philosophy*

Act III (p. 83)

The Heritage Press. New York, New York, USA. No date

### Super, Charles W.

No biographical data available

When the imagination is kept within bounds by the intellect it discovers many general truths.

Science and Poetry

*Popular Science Monthly*, Volume LXXXVI, February, 1914 (p. 168)

### Teall, J. J. Harris 1849–1924

British geologist

...it is well to remember that there is a scientific, as well as an unscientific, use of the imagination.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

The Evolution of Petrological Ideas (p. 288)

Government Printing Office. Washington, D.C. 1903

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

The scientific imagination devises a possible solution – an hypothesis – and the investigator proceeds to test it. He makes intellectual keys and then tries whether they fit the lock. If the hypothesis does not fit, it is rejected and another is made. The scientific workshop is full of discarded keys.

*Introduction to Science*

Chapter III (p. 69)

Henry Holt & Co. New York, New York, USA. 1911

### Thomson, Sir George Paget 1892–1975

English physicist

Science, like all arts, needs imagination.

*The Inspiration of Science*

Chapter II (p. 8)

Oxford University Press, Inc. London, England. 1961

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

...the imagination, give it the least license, dives deeper and soars higher than Nature goes.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter XVI (p. 441)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Thorndike, Ashley Horace

No biographical data available

The sciences cannot advance very far without the imagination, and literature is a feeble thing if it loses hold on the reason.

*Literature in a Changing Age*

Chapter IX (p. 231)

The Macmillan Co. New York, New York, USA. 1920

### Tischner, August

No biographical data available

Infinite space and its content as the celestial mechanism are beyond the intellectual faculties of man to understand, and it is a matter of course that knowledge is replaced by imagination. Theoretical astronomy or what they have agreed to call explanatory science is but the fruit of imagination.

*The Fixed Idea of Astronomical Theory* (p. 32)

Gustav Fock. Leipzig, Germany. 1885

### Tombaugh, Clyde 1906–97

American astronomer

You have to have the imagination to recognize a discovery when you make one. When they examined Voyager images and saw for the first time the volcanic eruptions on Io, which called for some intuitive imagination. I would suggest that above everything else, in observing you have to be very alert to everything. You have to be able to recognize a discovery as such. There are so many people who don't seem to have that talent. A research astronomer cannot afford to be in such a rut. I might say that different types of personalities in astronomy make certain types of discoveries that are in line with their personalities.

In David H. Levy

*Clyde Tombaugh: Discoverer of Planet Pluto*

Chapter 5 (p. 61)

University of Arizona Press. Tucson, Arizona, USA. 1991

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

...you can't depend on your eyes when your imagination is out of focus.

*A Connecticut Yankee in King Arthur's Court*

Chapter XLIII (p. 439)

Harper & Brothers Publishers. New York, New York, USA. 1917

### Tyndall, John 1820–93

Irish-born English physicist

With accurate experiment and observation to work upon...imagination becomes the architect of physical theory.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 162)

Macmillan & Company Ltd. London, England. 1918

Bounded and conditioned by cooperant reason, imagination becomes the mightiest instrument of the physical discoverer.

*Scientific Addresses*

Scientific Use of the Imagination (p. 36)

Charles C. Charfield. New Haven, Connecticut, USA. 1870

The outward facts of nature are insufficient to satisfy the mind. We cannot be content with knowing that the light and heat of the sun illuminate and warm the world. We are led irresistibly to enquire, 'What is light, and what is



heat?’ and this question leads us at once out of the region of sense into that of imagination.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 1)  
Chapter II (p. 72)  
D. Appleton & Co. New York, New York, USA. 1915

Scientific men fight shy of the word [imagination] because of its ultrascientific connotations; but the fact is that without the exercise of this power our knowledge of Nature would be a mere tabulation of coexistences and sequences.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 2)  
Chapter VIII (p. 104)  
D. Appleton & Co. New York, New York, USA. 1896

...it behooves us, who are examining the power and function of the imagination, to keep constantly before us the physical images which underlie our terms.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 2)  
Chapter 8 (p. 120)  
D. Appleton & Co. New York, New York, USA. 1896

[The] conception of physical theory implies, as you perceive, the exercise of the imagination. Do not be afraid of this word, which seems to render so many respectable people, both in the ranks of science and out of them, uncomfortable. That men in the ranks of science should feel thus is, I think, a proof that they have suffered themselves to be misled by the popular definition of a great faculty instead of observing its operation in their own minds. Without imagination we cannot take a step beyond the bourne of the mere animal world, perhaps not even to the edge of this one.

*Six Lectures on Light Delivered in America in 1872–1873*  
3rd Edition  
Lecture II (p. 43)  
D. Appleton & Co. New York, New York, USA. 1901

...presented rightly to the mind, the discoveries and generalizations of modern science constitute a poem more sublime than has ever yet addressed the human imagination.

*Heat Considered as a Mode of Motion*  
Chapter XIV (p. 466)  
D. Appleton & Company. New York, New York, USA. 1875

**Velikovsky, Immanuel** 1895–1979  
Russian author

Imagination coupled with skepticism and an ability to wonder – if you possess these, bountiful nature will hand you some of the secrets out of her inexhaustible store. The pleasure you will experience in discovering truth will repay you for your work; don't expect other compensation, because it may not come.

*Earth in Upheaval*  
Supplement, Worlds in Collision in the Light of Recent Finds in Archaeology, Geology, and Astronomy, Address, Princeton University, October 14, 1953 (p. 279)  
Dell Publishing Company, Inc. New York, New York, USA. 1955

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

There is an astonishing imagination, even in the science of mathematics.... We repeat, there was far more imagination in the head of Archimedes than in that of Homer.

*The Works of Voltaire* (Volume 10)  
*Philosophical Dictionary* (Volume 10)  
Imagination (p. 170)  
The St. Hubert Guild. Akron, Ohio, USA. 1901

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

All that the senses can but imperfectly comprehend, all that is most awful in such romantic scenes of nature, may become a source of enjoyment to man, by opening a wide field to the creative powers of his imagination.

Translated by E. C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 26)  
Harper & Brothers Publishers. New York, New York, USA. 1858

**von Liebig, Justus** 1803–73  
German organic chemist

...the moment the imagination alone is taken for a guide, and is allowed to solve questions left undecided by researches, investigation ceases, truth remains unascertained, and there is not only this negative evil, but in error we create a Monster, envious, malignant, and obstinate, which, when at length truth endeavors to make its way, crosses its path, combats, and strives to annihilate it!

In John Blyth (ed.)  
*Familiar Letters on Chemistry*  
Letter I (p. 18)  
Walton & Maberly. London, England. 1859

If we do not succeed in discovering causes by our researches, we have no right to create them by the imagination; we must not allow mere fancy to proceed beyond the bounds of our knowledge.

In John Gardner  
*Familiar Letters on Chemistry*  
Second Series  
Letter I (p. 27)  
Taylor & Walton. London, England. 1844

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

All our minds are made of memories. In our memories each of us has something that without any special training whatever will go back into the past and grip firmly and convincingly all sorts of workable facts, sometimes more convincingly than firmly. But the imagination, unless it is strengthened by a very sound training in the laws of causation, wanders like a lost child in the blankness of things to come and returns empty.

*The Discovery of the Future* (p. 21)  
B.W. Huebsch. New York, New York, USA. 1913

**Wheeler, John Archibald** 1911–  
American physicist and educator

The vision of the Universe that is so vivid in our minds is framed by a few iron posts of true observation – themselves resting on theory for their meaning – but most of all the walls and towers in the vision are of papier-mâché, plastered in between those posts by an immense labor of imagination and theory.

In John Archibald Wheeler and Wojciech Hubert Zurek (eds.)  
*Quantum Theory and Measurement*  
Law Without Law (p. 203)  
Princeton University Press. Princeton, New Jersey, USA. 1983

**Whitrow, G. J.** 1912–2000  
English mathematician

Our idea of the universe as a whole remains a product of the imagination.

*The Structure and Evolution of the Universe: An Introduction to Cosmology*  
Chapter 8 (p. 197)  
Hutchinson. London, England. 1959

**Willan, Robert** 1757–1812  
Scottish physician

There seems to be some Bounds placed to all Physical Enquiries, beyond which we cannot go, except in Imagination, and sometimes even that will fail us.

*An Essay on the King's-evil. By Robert Willan, M.D.*  
An Essay on the King's-evil (p. 5)  
Printed for J. & P. Knapton. London, England. 1746

**Wilson, Edmund** 1895–1972  
American writer and literary critic

The great scientists have been occupied with values – it is only their vulgar followers who think they are not. If scientists like Descartes, Newton, Einstein, Darwin, and Freud don't "look deeply into experience," what do they do? They have imaginations as powerful as any poet's and some of them were first-rate writers as well. How do you draw the line between Walden and The Voyage of the Beagle? The product of the scientific imagination is a new vision of relations – like that of the artistic imagination.

In Elena Wilson (ed.)  
*Letters on Literature and Politics, 1912–1972*  
Letter to Allen Tate, July 20, 1931 (p. 212)  
Farrar, Straus & Giroux. New York, New York, USA. 1977

## IMAGINE

**Cole, K. C.**  
Science writer

Imagining the unseeable is hard, because *imagining* means having an image in your mind.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*  
Part I, Chapter 1 (p. 18)  
Harcourt Brace & Co. Orlando, Florida, USA. 1999

## IMBECILITY

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

I am more and more convinced that I suffer, not from a shiny or showy impertinence, but from a simplicity that verges upon imbecility.

*All Things Considered*  
Science and Religion (p. 188)  
John Lane Co. New York, New York, USA. 1910

## IMMENSITY

**Pouchet, Félix Archimède** 1800–72  
French biologist

Immensity is everywhere. It stands revealed in the azure dome of heaven, where glows a perfect dust of stars, and in the living atom which hides from us the marvels of its organization.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book I, The Invisible World (p. 3)  
Blackie & Son. London, England. 1870

## IMMORTALITY

**Bell, Alexander Graham** 1847–1920  
American scientist

To my mind, the "Evolutionary Hypothesis" tends to weaken belief in the "immortality of personal consciousness" by revealing a cause for the growth of such an idea quite independently of its truth.

In Samuel June Barrows  
*Science and Immortality: The Christian Register Symposium*  
XXVII (p. 94)  
Geo. H. Ellis. Boston, Massachusetts, USA. 1887

**Gray, Asa** 1810–88  
American botanist

...it is not science – certainly not physical and physiological science – that brings immortality to light, modern science does not really tend to put out that light. Yet, if that light were quenched, "I know not where," in modern science alone, "is that Promethean heat that can that light relume."

In Samuel June Barrows  
*Science and Immortality: The Christian Register Symposium*  
III (p. 14)  
Geo. H. Ellis. Boston, Massachusetts, USA. 1887

**Hall, Asaph** 1829–1907  
American astronomer

Science does not, I think, give a positive answer to questions concerning the immortality of the human soul ...

In Samuel June Barrows  
*Science and Immortality: The Christian Register Symposium*  
XVII (p. 62)  
Geo. H. Ellis. Boston, Massachusetts, USA. 1887

**Lesley, J. P.**

No biographical data available

The ideas of unchangeably and immortality are not only repugnant to physical science, but inconceivable by it ...

In Samuel June Barrows

*Science and Immortality: The Christian Register Symposium*  
VI (p. 20)

Geo. H. Ellis. Boston, Massachusetts, USA. 1887

The question of immortality can hardly be said to be affected at all by the methods and results of the physical sciences as pursued and reached by men of our day, who busy themselves solely with material forms, growths, changes, dissolutions, reproductions, weights, measures, attractions and repulsions – in a word, with what is called matter and what are called its forces, the life-force and the mind-force included.

In Samuel June Barrows

*Science and Immortality: The Christian Register Symposium*  
VI (p. 20)

Geo. H. Ellis. Boston, Massachusetts, USA. 1887

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

If we admit the hypothesis of immortality, it is difficult to see how we could ever reach any proof of it derived from experience.

In Samuel June Barrows

*Science and Immortality: The Christian Register Symposium*  
V (pp. 17–18)

Geo. H. Ellis. Boston, Massachusetts, USA. 1887

**Plato** 428 BCE–347 BCE

Greek philosopher

But he who has been earnest in the love of knowledge and of true wisdom, and has exercised his intellect more than any other part of him, must have thoughts immortal and divine, if he attain truth, and in so far as human nature is capable of sharing in immortality, he must altogether be immortal...

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 90 (p. 476)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Braun, Wernher** 1912–77

German-American rocket scientist

Nature does not know extinction: all it knows is transformation. Everything science has taught me, and continues to teach me, strengthens my belief in the continuity of our spiritual existence after death.

Immortality

*This Week Magazine*, January 24, 1960 (p. 2)

**IMMUNITY****Mechnikov, Ilya** 1845–1916

Russian microbiologist

There is no need to be a doctor or a scientist to wonder why the human body is capable of resisting so many harmful agents in the course of everyday life. It is often seen that in households where all members are exposed to the same danger, or again in schools or troops where everyone lives the same life, disease does not strike everyone indifferently. For some individuals who go down at the attack, there are others who have immunity to a greater or lesser extent.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1908

On the Present State of the Question of Immunity in Infectious Diseases (p. 281)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

Whenever the organism enjoys immunity, the introduction of infectious microbes is followed by the accumulation of mobile cells, of white corpuscles of the blood in particular which absorb the microbes and destroy them.

*Nobel Lectures, Physiology or Medicine 1901–1921*

On the Present State of the Question of Immunity in Infectious Diseases  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**IMMUNOLOGICAL DEFENSE****Chedd, Graham**

No biographical data available

[I]t is possible to divide [immunological defenses] into two general classes, representing approximately the infantry and the heavy armor. The infantry consists of the well-known soluble antibodies, sent out into the blood in response to invasion by the great majority of the microbes to which we are susceptible. The heavy armour is made up of the cytotoxic lymphocytes, the class of white blood cells that attack and destroy many parasitic organisms, that are largely responsible for rejecting grafts of foreign tissue, and whose main job may be to patrol the body on the continual lookout for cancer cells.

Immunological Engineering

*New Scientist and Science Journal*, May 13, 1971

**Thomas, Lewis** 1913–93

American physician and biologist

Our arsenals for fighting off bacteria are so powerful and involve so many defense mechanisms, that we are more in danger from these than from the invaders. We live in the midst of explosive devices. We are mined.

*New England Journal of Medicine*, September 14, 1972

## IMMUNOLOGICAL SELF-RECOGNITION

**Burnet, Sir Frank Macfarlane** 1899–1985  
Australian virologist

There is an insistent suggestion that immunological self-recognition is derived from the processes by which morphological and functional integrity is maintained in large and long-lived multicellular organisms. This may be a mere cobweb of phantasy but in my more optimistic moments I could hope that it might also function like Ariadne's thread to guide us effectively through part of that biological labyrinth, the process of differentiation.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Immunological Recognition of Self

Elsevier Publishing Co. Amsterdam, The Netherlands. 1964

## IMPENETRABILITY

**Bernal, John Desmond** 1901–71  
Irish-born physicist and X-ray crystallographer

...the key word in the structure of liquids is the one which Humpty Dumpty used in *Alice Through the Looking Glass*, 'impenetrability'.

*Proceedings of the Royal Society of London*, Volume 280 (p. 302)

## IMPERTURBABILITY

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Imperturbability means coolness and presence of mind under all circumstances, calmness amid storm, clearness of judgment in moments of grave peril, immobility, impassiveness, or, to use an old and expressive word, *phlegm*. It is the quality which is most appreciated by the laity though often misunderstood by them; and the physician who has the misfortune to be without it, who betrays indecision and worry, and who shows that he is flustered and flurried in ordinary emergencies, loses rapidly the confidence of his patients.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

*Aequanimitas* (p. 4)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1910

## IMPORTANCE

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Everything is important, but there are degrees of importance ...

In Denis Brian

*The Voice of Genius*

Chapter Four (p. 102)

Perseus Publishing, Cambridge, Massachusetts, USA. 1995

## IMPOSSIBILITY

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

It is impossible to import things into an infinite area, there being no outside to import things in from.

*The Original Hitchhiker Radio Script*

Fit the Fifth (p. 101)

Harmony Books. New York, New York, USA. 1983

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

In framing an ideal we may assume what we wish, but should avoid impossibilities.

In *Great Books of the Western World* (Volume 9)

*Politics*

Book II, Chapter 6, 1265a [15]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A likely impossibility is always preferable to an unconvincing possibility.

In *Great Books of the Western World* (Volume 8)

*On Poetics*

24, 1460a

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

To aim at such a distant object and hit it is of course impossible. But if one has the impudence to throw in that direction without aiming, and in addition to imagine something so absurd as that one might hit it, yes, then perhaps it can happen. The idea that something perhaps could happen can be stronger than practice and will.

In Timothy Ferris (ed.)

*The Whole Shebang: A State – of-the Universe's Report*

Quantum Weirdness (p. 273)

Simon & Schuster. New York, New York, USA. 1996

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

Events with a sufficiently small probability never occur, or at least we must act, in all circumstances, as if they were impossible.

Translated by Maurice Baudin

*Probabilities and Life*

Introduction (pp. 2–3)

Dover Publications. New York, New York, USA. 1962

**Braudel, Fernand** 1902–85  
French historian

...intellectuals are always fascinated by the impossible.

Translated by Sarah Matthews

*On History*

Part II, History and the Social Science (p. 35)

University of Chicago Press. Chicago, Illinois, USA. 1980

**Card, Orson Scott** 1951–  
Science fiction author

You can't rule out the impossible, because you never know which of your assumptions about what was possible might turn out in the real universe to be false.

*Ender's Shadow*

Chapter 22 (p. 348)

TOR. New York, New York, USA. 1999

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

Alice laughed. "There's no use trying," she said "one can't believe impossible things."

"I daresay you haven't had much practice," said the Queen. "When I was your age, I always did it for half-an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast..."

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter V (p. 200)

The Modern Library. New York, New York, USA. 1936

**Charlie Chan (Fictional character)**

The impossible sometimes permits itself the luxury of occurring.

*Charlie Chan's Chance*

Film (1932)

**Chestov, Leon** 1866–1938  
Russian philosopher

A round square or a wooden iron is an absurdity and consequently an impossibility...

Look Back and Struggle

*Forum Philosophicum*, Volume 1, Number 1, 1930 (p. 112)

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

The only way of finding the limits of the possible is by going beyond them into the impossible.

*The Lost Worlds of 2001*

Chapter 34 (p. 189)

New American Library. New York, New York, USA. 1972

**Cromer, Alan** 1935–  
American physicist and educator

Belief in impossibility is the starting point for logic, deductive mathematics, and natural science. It can originate in a mind that has freed itself from belief in its own omnipotence.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 4 (p. 78)

Oxford University Press, Inc. New York, New York, USA. 1993

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

"Holmes," I cried, "this is impossible."

"Admirable!" he said. "A most illuminating remark. It is

impossible as I state it, and therefore I must in some respect have stated it wrong."

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of Priory School* (p. 620)

Wings Books. New York, New York, USA. 1967

**Goddard, Robert H.** 1882–1945  
American physicist

Often a science in its infancy, because it is unable to distinguish between path and barrier, falsely judges many things to be possible and others to be impossible...

*The Papers of Robert H. Goddard* (Volume 1)

*On Taking Things for Granted*

Graduation oration (p. 66)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Goldwyn, Samuel** 1882–1974  
American film producer

I'll tell you in two words – impossible.

Quoted in his obituary

*New York Times*, February 1, 1974

**Huxley, Aldous** 1894–1963  
English writer and critic

Except under controlled conditions, or in circumstances where it is possible to ignore individuals and consider only large numbers and the law of averages, any kind of accurate foresight is impossible.

*Time Must Have a Stop*

Chapter XXX (p. 296)

The Sun Dial Press. Garden City, New York, USA. 1944

**Juster, Norton** 1929–  
American architect and author

...so many things are possible just as long as you don't know they're impossible.

*The Phantom Tollbooth*

Chapter 19 (p. 247)

Alfred A. Knopf. New York, New York, USA. 1989

**Rubinstein, Anton** 1829–94  
Russian pianist, composer, and conductor

Do not forget to dare the impossible in order to achieve the possible.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Well, I'll have her: and if it be a match, as nothing is impossible – .

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Two Gentlemen of Verona*

Act III, Scene ii, l. 379

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**Syngé, John L.** 1897–1995  
Irish mathematician and physicist

There is a fascination about the impossible...which is responsible for the dreams and fantasies with which we are all familiar. Everything which is possible becomes banal. Only the inaccessible is worthy of our passions.

*Kandelman's Krim*

Chapter Eight (p. 115)

Jonathan Cape. London, England. 1957

**Thurber, James** 1894–1961  
American writer and cartoonist

All things, as we know, are impossible in this most impossible of all impossible worlds.

*Lanterns and Lances*

The Last Clock (p. 43)

Time-Life Books, Inc. Alexandria, Virginia, USA. 1980

**von Braun, Wernher** 1912–77  
German-American rocket scientist

...the past few decades should have taught us to use the word "impossible" with utmost caution.

In Erik Bergaust

*Wernher von Braun*

Reaching for the Straws (p. 2)

National Space Institute. Washington, D.C. 1976

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Man can believe the impossible, but man can never believe the improbable.

*Epigrams: Phrases and Philosophies for the Use of the Young*

Sebastian Melmoth

A.R. Keller. London, England. 1907

## IMPOSSIBLE

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Given power and knowledge (wisdom is rather useful, too) nothing that does not infringe the laws of Nature need be regarded as impossible.

*The Exploration of Space*

Chapter 11 (p. 118)

Harper & Brothers Publishers. New York, New York, USA. 1951

It is really quite amazing by what margins competent but conservative scientists and engineers can miss the mark, when they start with the preconceived idea that what they are investigating is impossible. When this happens, the most well-informed men become blinded by their prejudices and are unable to see what lies directly ahead of them.

*Profiles of the Future*

Chapter I (p. 7)

Harper & Row. New York, New York, USA. 1973

## Dr. Hans Reinhardt (Fictional character)

The word "impossible"...is only found in the dictionary of fools.

*The Black Hole*

Film (1979)

**Flammarion, Camille** 1842–1925  
French astronomer and writer

Impossible to deny what I saw, impossible to admit it.

Translated by S.R. Crocker

*Stories of Infinity*

First Story (p. 28)

Robert Brothers. Boston, Massachusetts, USA. 1873

**James, William** 1842–1910  
American philosopher and psychologist

I believe there is no source of deception in the investigation of nature which can compare with a fixed belief that certain kinds of phenomena are *impossible*.

In Henry James

*The Letters of William James: Ed. by His Son, Henry James*

Letter to Carl Stumpf (p. 248)

The Atlantic Monthly Press. Boston, Massachusetts, USA. 1920

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

Few things are impossible to diligence and skill.

In Arthur Murphy

*The Works of Samuel Johnson, LL.D. Volume 2*

*Rasselas*

Chapter VII (p. 14)

Jones & Co. London, England. 1825

## IMPRESSION

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The human understanding is most excited by that which strikes and enters the mind at once and suddenly, and by which the imagination is immediately filled and inflated.

It then begins almost imperceptibly to conceive and suppose that everything is similar to the few objects which have taken impression on the mind.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Nine (p. 114)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Impressions change with the varying movements of the mind, and we are led by a happy illusion to believe that we receive from the external world that with which we have ourselves invested it.

*Cosmos (Volume I)*

Introduction (p. 5)

Henry G. Bohn. London, England. 1849



**IMPULSE**

**Tyndall, John** 1820–93  
Irish-born English physicist

Extraordinary effects are produced by the accumulation of small impulses.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 1)  
Chapter 22 (p. 444)  
D. Appleton & Co. New York, New York, USA. 1896

**IMPROBABILITY**

**Dawkins, Richard** 1941–  
English ethologist, evolutionary biologist, and popular science writer

To “tame” chance means to break down the very improbable into less improbable small components arranged in series. No matter how improbable it is that an X could have arisen from Y in a single step, it is always possible to conceive of a series of infinitesimal graded intermediates between them. However improbable a large scale change may be, smaller changes are less improbable. And provided we postulate a sufficient series of sufficiently finely graded intermediates, we shall be able to derive anything from anything else, without astronomical improbabilities.

*The Blind Watchmaker*  
Chapter 11 (pp. 317–318)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Physical theories must not introduce as many arbitrary constants as there are phenomena to be accounted for; they must establish connections among the various experimental facts and, above all, must lead to predictions.

In A. d’Abro  
*The Rise of the New Physics* (Volume One)  
Chapter IV (p. 33)  
Dover Publications, Inc. New York, New York, USA. 1951

**INADEQUACY**

**Cannon, Walter Bradford** 1871–1945  
American neurologist and physiologist

Training and practice may not lead to perfection, but they will surely compensate for early inadequacy.

*The Way of an Investigator: A Scientist’s Experiences in Medical Research*  
Chapter III (p. 43)  
W.W. Norton & Company, Inc. New York, New York, USA. 1945

**INCOMPLETE KNOWLEDGE**

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

An incomplete knowledge put into words forms a relatively firm prop for fleeting thoughts, from which the thoughts, seeking among facts, set out, and to which, modifying it by criticism and comparison, they continually return.

*The Science of Mechanics: A Critical and Historical Account of Its Development*  
Appendix of Additions and Alterations to the Seventh German Edition (p. 14)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1915

**INCOMPREHENSIBLE**

**Browne, Sir Thomas** 1605–82  
English author and physician

Have a glimpse of incomprehensibles; and thoughts of things, which thoughts but tenderly touch. Lodge immaterials in thy head; ascend unto invisibles ...

In Simon Wilkin  
*The Works of Sir Thomas Browne* (Volume 3)  
*Christian Morals* (p. 133)  
Henry B. Bohn. London, England. 1852

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Humanity has an enormous capacity to disregard the incomprehensible.

*Voices in the Labyrinth: Nature, Man and Science* (p. 31)  
The Seabury Press. New York, New York, USA. 1977

**Robinson, Abraham** 1918–74  
Mathematician

I cannot imagine that I shall ever return to the creed of the true Platonist, who sees the world of the actual infinite spread out before him and believes that he can comprehend the incomprehensible.

From A Formalist’s Point of View  
*Dialectica*, Volume 23 1969

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

A man must cling to the belief that the incomprehensible is comprehensible; otherwise he would not try to fathom it.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe #554* (p. 194)  
The Macmillan Co. New York, New York, USA. 1906

**INCONCEIVABILITY**

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Nothing that we can measure is inconceivably large or inconceivably small in physical science.

*Popular Lectures and Addresses* (Volume 1)  
Lecture, Royal Institution of Great Britain  
February 3, 1883 (p. 147)  
Macmillan & Company Ltd. London, England. 1894

**INCURABLE**

**von Ebner-Eschenbach, Marie** 1830–1916  
Austrian novelist

The incurable ills are the imaginary ills.

Translated by Annis Lee Wister

*Aphorisms*

Number 52

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

**INDEPENDENCE**

**Koerner, Jon**

No biographical data available

The problem is that, in many cases for many systems, there may simply be no such thing as a truly independent variable. Out here in the real world, the phrase “independent” may often be oxymoronic. The very notion of independence reflects the world of Platonic idealism, a pure world populated by separate discrete things each with its essence, floating suspended in a sea of laws, rules governing the relations between these autonomous entities.

*Nontriviality of Nonlinear Dynamics in Psychology of Learning*

Doctoral dissertation, University of Minnesota, 1989 (p. 118)

**INDEX**

**Binney, Charles Chauncey** 1855–1913

No biographical data available

One may recollect generally that certain thoughts or facts are to be found in a certain book; but without a good index such a recollection may hardly be more available than that of the cabin-boy who knew where the ship’s teakettle was, because he saw it fall overboard. In truth, a very large part of every man’s reading falls overboard; and unless he has good indexes, he will never find it again, how much so ever he may look for it.

*The Life of Horace Binney: With Selections From His Letters*

Letter, February 20, 1866 (p. 446)

J. Lippincott Co. Philadelphia, Pennsylvania, USA. 1903

**Busk, R. H.**

No biographical data available

Multitudes of desired items lie buried under one’s hand, lost and useless because the mind that indexed them thought of them under one category and the mind that wants to unearth them searches for them under another category.

Indexing Monumental Inscriptions

*Notes and Queries*, Seventh Series, I, May 1, 1886 (p. 353)

**INDIFFERENCE**

**Bartlett, Elisha** 1804–55

American physician

Closely allied to this [integrity] is what may be called scientific indifference to the results of our observations, a quality of mind of most rare and difficult attainment, but most essential to the trusty and true observer. He must see clearly that the scientific truth he seeks is in nature – not in his thoughts or wishes – and that his sole function is to find where and what it is. The various passions of the human heart may dread or may desire, this issue or another: – but science asks one only question. And that is – What is?

In William E. Stempsey

*Elisha Bartlett’s Philosophy of Medicine*

The Philosophy in Therapeutics (p. 203)

Springer-Verlag. Dordrecht, The Netherlands. 2005

**INDIVIDUAL**

**Einstein, Albert** 1879–1955

German-born physicist

The individual feels the nothingness of human desires and aims and the sublimity and marvelous order which reveal themselves both in Nature and in the world of thought. He looks upon individual existence as a sort of prison and wants to experience the universe as a single significant whole.

*The World as I See It* (p. 229)

Philosophical Library. New York, New York, USA. 1949

The harmony of the whole makes every creature what it is, and the human being is a human being as much by the form and nature of his upper jaw as by the form and nature of the last joint of his little toe. And so, again, every creature is but a tone, a shade of a great harmony, which must be studied in its entirety, otherwise no individual has any meaning.

In Peter Hume Brown

*Life of Goethe* (Volume 1)

Chapter XVIII (p. 275)

Henry Holt & Co. New York, New York, USA. 1920

**INDIVIDUALITY**

**Alexander, Samuel** 1859–1938

Australian-born British philosopher

Individuality is a pervasive character of things, but so also it would seem that there is nothing individual which has not in it a character recognisable by thought, and known as a universal.

*Space, Time, and Deity: The Gifford Lectures at Glasgow, 1916–1918*

(Volume 1)

Introduction (p. 2)

Macmillan & Co. Ltd. London, England. 1920

**Muir, John** 1838–1914

American naturalist

Indeed, every atom in creation may be said to be acquainted with and married to every other, but with

universal union there is a division sufficient in degree for the purposes of the most intense individuality.

*Steep Trails*

Chapter I (p. 12)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

...no matter, therefore, what may be the note which any creature forms in the song of existence, it is made first for itself, then more and more remotely for all the world and worlds.

*Steep Trails*

Chapter I (p. 12)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## INDUCTION

**Comte, Auguste** 1798–1857

French philosopher

Induction for deduction, with a view to construction.

In J.A. Thomson

*Introduction to Science*

Chapter III (p. 58)

Williams & Norgate Ltd. London, England. 1916

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

The humblest student of astronomy, or of any other physical science, if he is to profit at all by his study, must in some degree go over for himself, in his own mind, if not in part with the aid of his own observation and experiment, that process of induction which leads from familiar facts to obvious laws, then to the observation of facts more remote, and to the discovery of laws of higher orders.

*Report of the Fifth Meeting of the British Association for the Advancement of Science*

Address by Sir William Hamilton (p. xliii)

John Murray. London, England. 1836

**Jevons, William Stanley** 1835–82

English economist and logician

No inductive conclusions are more than probable ...

*The Principles of Science: A Treatise on Logic and Scientific Method*

Preface to the First Edition (p. ix)

Macmillan & Company Ltd. London, England. 1892

Our ultimate object in induction must be to obtain the complete relation between the conditions and the effect, but this relation will generally be so complex that we can only attack it in detail.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XX (p. 443)

Macmillan & Co Ltd. London, England. 1887

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Even in the mathematical sciences, our principal instruments to discover the truth are induction and analogy.

*Oeuvres complètes de Laplace*

Introduction, Volume 7 (p. v)

Gauthier-Villars. Paris, France. 1886

Analysis and natural philosophy owe their most important discoveries to this fruitful means, which is called induction. Newton was indebted to it for his theorem of the binomial and the principle of universal gravity.

*A Philosophical Essay on Probabilities*

Chapter XVII (p. 176)

Dover Publications, Inc. New York, New York, USA. 1951

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

This is called the inductive method. Hypothesis, my dear young friend, establishes itself by a cumulative process: or, to use popular language, if you make the same guess often enough it ceases to be a guess and becomes a Scientific Fact.

*The Pilgrim's Regress: An Allegorical Apology for Christianity, Reason and Romanticism*

Wm. B. Eerdsman, Publishers. Grand Rapids. Michigan, USA. 1996

**Mendeleyev, Dmitry Ivanovich** 1834–1907

Russian chemist

By investigating the universe by an inductive method (endeavoring from the much which is observable to arrive at a little which may be verified and is indubitable) the new science refuses to recognise dogma as truth, but through reason, by a slow and laborious method of investigation, strives for and attains to true deductions.

*Principles of Chemistry* (Volume 1)

Introduction (p. 2, fn 1)

Longmans, Green & Company. London, England. 1891

**Newman, Francis William** 1805–97

English scholar

To infer that iron may be melted, because brass may be melted, is analogy: or to infer the same, because lead, or because tin or silver, can be melted, is still analogy. But to reason that iron may be melted, because brass and copper and lead and tin and silver will all melt, is no longer analogy, but induction.

*Lectures on Logic*

Section IV (p. 94)

J.H. Parker. Oxford, England. 1838

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The method of the physical sciences is based upon the induction which leads us to expect the recurrence of a phenomenon when the circumstances which give rise to it are repeated. If all the circumstances could be simultaneously reproduced, this principle could be fearlessly applied; but this never happens; some of the circumstances will always be missing. Are we absolutely certain that they are unimportant? Evidently not! It may be

probable, but it cannot be rigorously certain. Hence the importance of the role that is played in the physical sciences by the law of probability. The calculus of probabilities is therefore not merely a recreation, or a guide to the baccarat player; and we must thoroughly examine the principles on which it is based.

*Science and Hypothesis*

Author's Preface (pp. xxvi–xxvii)

Courier Dover Publications. New York, New York, USA. 1952

**Sylvester, James Joseph** 1814–97

English mathematician

Induction and analogy are the special characteristics of modern mathematics, in which theorems have given place to theories, and no truth is regarded otherwise than as a link in an infinite chain. 'Omne exit in infinitum' is their favourite motto and accepted axiom.

*The Laws of Verse: Or Principles of Verification Exemplified in Metrical Translations*

Inaugural Address (p. 118)

Longmans, Green & Co. London, England. 1870

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Thinking by analogy is not to be despised. Analogy has this merit, that it does not settle things – does not pretend to be conclusive. On the other hand, that *induction* is pernicious which, with a preconceived end in view, and working right forward for only that, drags in its train a number of unsifted observations, both false and true.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 167)

William Blackwood & Sons. Edinburgh, Scotland. 1883

**Whewell, William** 1794–1866

English philosopher and historian

Newton's theory [of gravitation] is the circle of generalization which includes all the others [as Kepler's laws, Ptolemy's theory, etc.]; – the highest point of the inductive ascent; – the catastrophe of the philosophic drama to which Plato had prologized; – the point to which men's minds had been journeying for two thousand years.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book VII, Chapter II (p. 139)

John W. Parker & Son. London, England. 1857

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...the chief reason in favor of any theory on the principles of mathematics must always be inductive, i.e., it must lie in the fact that the theory in question enables us to deduce ordinary mathematics. In mathematics, the greatest degree of self-evidence is usually not to be found quite at the beginning, but at some later point; hence

the early deductions, until they reach this point, give reasons rather from them, than for believing the premises because true consequences follow from them, than for believing the consequences because they follow from the premises.

*Principia Mathematica* (Volume 1)

Preface (p. v)

At The University Press. Cambridge, England. 1950

There is a tradition of opposition between adherents of induction and of deduction. In my view, it would be just as sensible for the two ends of a worm to quarrel.

The Organization of Thought

*Science*, Volume 44, Number 1134, September 29, 1916 (p. 417)

## INDUCTIVE METHOD

**Mendeleyev, Dmitry Ivanovich** 1834–1907

Russian chemist

By investigating the universe by an inductive method (endeavoring from the much which is observable to arrive at a little which may be verified and is indubitable) the new science refuses to recognise dogma as truth, but through reason, by a slow and laborious method of investigation, strives for and attains to true deductions.

Translated by A. J. Greenaway and George Kamensky

*The Principles of Chemistry* 5th edition

INTRODUCTION (p. 2)

Longmans, Green & Co. London, England. 1891

## INERTIA

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

Then it was found that the rules of motions of particles were incorrect. The mechanical rules of inertia and forces are wrong – Newton's laws are wrong – in the world of atoms. Instead, it was discovered that things on a small scale behave nothing like things on a larger scale.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–3 (pp. 2–6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

It is one thing if something merely retains its state until some event happens to change it – a circumstance which may occur if the subject is completely indifferent with respect to either state; it is another thing and signifies

much more if the subject is not indifferent but possesses a power, an inclination as it were, to retain its state and to resist the cause of change.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part II, Chapter I (p. 105)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Rothman, Milton A.** 1919–

Experimental American nuclear physicist and science writer

There was once a government whose leaders decided that it would be nice to relieve the people of the effort of carrying their weight around. They reasoned that life would be much easier without the stresses and strains caused by the force of gravity. Therefore they convened their legislature and repealed the law of gravity. As soon as their president signed the bill, everything became weightless. Immediately all the air whizzed off into space. Likewise, all objects not tied down to the ground were flung away from the spinning earth – for, unfortunately, the legislature had forgotten to repeal the law of Inertia.

*The Laws of Physics*

Chapter I (p. 5)

Basic Books, Inc. New York, New York, USA. 1963

## INFALLIBLE

### Emperor Cartagia (Fictional character)

The trouble with being infallible is that you have to deal with everyone else making mistakes.

Babylon 5 (Television series)

## INFER

### Case, Thomas

No biographical data available

Beasts infer: man reasons.

In T.B. Strong

*Lectures on the Method of Science*

Lecture I (p. 2)

At The Clarendon Press. Oxford, England. 1906

### Clerke, Agnes Mary

 1842–1907

Irish astronomer

What is must be studied before what was can be inferred. Precedent states remain visionary unless they can be closely linked to actual and observable conditions.

*Modern Cosmogonies*

Chapter I (pp. 15–16)

Adam & Charles Black. London, England. 1905

## INFERENCE

### Deetz, James

 1930–2000

American archaeologist

At the inferential level, the archaeologist is at least providing the flesh for the bare bones of his data, and, if done with care and imagination, such a procedure makes possible the delineation and ultimate understanding of past cultures.

*Invitation to Archaeology*

Chapter I (p. 11)

The Natural History Press. Garden City, New York, USA. 1967

### Deming, William Edwards

 1900–93

American statistician, educator, and consultant

An inference, if it is to have scientific value, must constitute a prediction concerning future data. If the inference is to be made purely with the help of the distribution theory of statistics, the experiments that constitute evidence for the inference must arise from a state of statistical control; until that state is reached, there is no universe, normal or otherwise, and the statistician's calculations by themselves are an illusion if not a delusion. The fact is that when distribution theory is not applicable for lack of control, any inference, statistical or otherwise, is little better than a conjecture. The state of statistical control is therefore the goal of all experimentation.

*Statistical Method from the Viewpoint of Quality Control*

Foreword from the Editor (p. iii)

Washington: Department of Agriculture. 1939

### Priestley, Joseph

 1733–1804

English theologian and scientist

I can only repeat that it is not my opinions on which I would be understood to lay any stress. Let the new facts, from which I deduce them, be considered as my discoveries, and let other persons draw better inferences from them if they can.

In F.W. Gibbs

*Joseph Priestley: Adventurer in Science and Champion of Truth*

Chapter 9 (p. 117)

Thomas Nelson & Sons Ltd. London, England. 1965

### Wiley, Gordon R.

 1913–2002

American archaeologist and writer

Inference is the key or the methodological pivot of archaeology, for it is only through inference that inanimate objects are reassembled into the milieu of life. Inferences are drawn from analogies.

*An Introduction to American Archaeology* (Volume 1)

North and Middle America (p. 3)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1966

## INFINITE

### Anaxagoras

 ca. 500 BCE–428 BCE

Greek philosopher of nature

There is no smallest among the small and no largest among the large, But always something still smaller and something still larger.



In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 2)  
 Birkhäuser. Boston, Massachusetts, USA. 1987

### Author undetermined

[pi] vs e  
 [PI] goes on and on and on....  
 And e is just as cursed.  
 I wonder: Which is larger  
 When their digits are reversed?  
*Source undetermined*

**Bailey, Philip James** 1816–1902  
 English poet

God puts his finger in the other scale,  
 And up we bounce, a bubble. Nought is great  
 Nor small, with God; for none but he can make  
 The atom imperceptible, and none  
 But he can make a world; he counts the orbs,  
 He counts the atoms of the universe,  
 And makes both equal; both are infinite.  
*Festus: A Poem*  
 Scene IV (p. 83)  
 George Routledge & Sons, Limited. London, England. 1893

**Bartlett, Elizabeth** 1924–94  
 Because I longed

to comprehend the infinite  
 I drew a line  
 between the known and unknown.  
 In Ernest Robson and Jet Wimp  
*Against Infinity*  
 Because I Longed (p. 11)  
 Primary Press, Parker Ford, Pennsylvania, USA. 1979

**Berkeley, George** 1685–1753  
 Irish prelate and metaphysical philosopher

Of late the speculations about Infinities have run so high,  
 and grown to such strange notions, as have occasioned  
 no small scruples and disputes among the geometers of  
 the present age. Some there are of great note who, not  
 content with holding that finite lines may be divided into  
 an infinite number of parts, do yet farther maintain that  
 each of those infinitesimals is itself subdivisible into an  
 infinity of other parts or infinitesimals of a second order,  
 and so on ad infinitum. These, I say, assert there are infin-  
 itesimals of infinitesimals of infinitesimals, & c., without  
 ever coming to an end; so that according to them an inch  
 does not barely contain an infinite number of parts, but an  
 infinity of an infinity of an infinity ad infinitum of parts.  
*The Principles of Human Knowledge*  
 Section 130  
 Hull, A. Brown & Sons, Ltd. London, England. 1937

**Blake, William** 1757–1827  
 English poet, painter, and engraver

If the doors of perception were cleansed, everything  
 would appear to man as it is, infinite.  
*The Complete Poetry and Prose of William Blake*  
 The Marriage of Heaven and Hell  
 University of California Press. Berkeley, California, USA. 1982

**Borges, Jorge Luis** 1899–1986  
 Argentine writer

There is a concept which corrupts and upsets all others.  
 I refer not to Evil, whose limited realm is that of ethics;  
 I refer to the infinite.  
 In Donald A. Yates & James E. Irby (eds.)  
*Labyrinths: Short Stories & Other Writings*  
 Avatars of the Tortoise (p. 202)  
 A New Direction Book. New York, New York, USA. 1964

The ignorant suppose that infinite number of drawings  
 require an infinite amount of time; in reality it is quite  
 enough that time to be infinitely subdivisible, as is the  
 case in the famous parable of the Tortoise and the Hare.  
 This infinitude harmonizes in an admirable manner with  
 the sinuous numbers of Chance and of the Celestial  
 Archetype of the Lottery, adored by the Platonists.  
*Ficciones*  
 The Babylon Lottery (p. 70)  
 Grove Press. New York, New York, USA. 1962

**Burroughs, John** 1837–1921  
 American naturalist and essayist

What is size, what is time, distance, etc., to the Infinite?  
 Nothing. The Infinite knows no time, no space, no great,  
 no small, no beginning, no end.  
*Birds and Poets With Other Papers*  
 Touches of Nature (p. 65)  
 David Douglas Edinburgh, Scotland. 1884

**Camus, Albert** 1913–60  
 Algerian-French novelist, essayist, and playwright

Somebody has to have the last word. Otherwise, every  
 reason can be met with another one and there would  
 never be no end to it.  
*The Fall* (p. 45)  
 Alfred A. Knopf. New York, New York, USA. 1958

**Carlyle, Thomas** 1795–1881  
 English historian and essayist

The moment of discovery, “spontaneous illumination...”  
 The infinite is made to blend itself with the finite, to stand  
 visible, as it were, attainable there.  
 In Roger A MacGowan and Frederick I Ordway, III  
*Intelligence in the Universe* (p. 49)  
 Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1966

**da Vinci, Leonardo** 1452–1519  
 Italian High Renaissance painter and inventor

What is that thing which does not give itself, and which  
 if it were to give itself would not exist?



It is the infinite...

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Mathematics (p. 612)

George Braziller. New York, New York, USA. 1958

**de Morgan, Augustus** 1806–71

English mathematician and logician

Great fleas have little fleas upon their backs to bite 'em,  
And little fleas have lesser fleas, and so ad infinitum.  
And the great fleas themselves, in turn have greater fleas  
to go on;

While these again have greater still, and greater still, and  
so on.

*A Budget of Paradoxes*

Are Atoms Worlds (p. 377)

Longmans, Green & Company. London, England. 1872

I had expressed my wish to have a thermometer of probability,  
with impossibility at one end, as 2 plus 2 makes 5,  
and necessity at the other as 2 plus 2 make 4.

*A Budget of Paradoxes*

Dr. Whewell's Letter (p. 416)

Longmans, Green & Company. London, England. 1872

**Dell, J. H.**

No biographical data available

The wilder'd mind is tost and lost,  
O sea in thy eternal tide;  
The reeling brain essays in vain,  
O stars, to grasp the vastness wide!  
The terrible tremendous scheme  
That glimmers in each glancing light,  
O night, O stars, too rudely jars  
The finite with the infinite!

In Alfred R. Wallace

*Man's Place in the Universe: A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds* (p. x)

Chapman & Hall Ltd. London, England. 1903

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

We call infinite that thing whose limits we have not perceived,  
and so by that word we do not signify what we understand about a thing,  
but rather what we do not understand.

In P. Mancosu and E. Vailati

Torricelli's Infinitely Long Solid and Its Philosophical Reception in the Seventeenth Century

*Isis*, Volume 82, Number 311, 1991 (p. 62)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

For it is only the finite that has wrought and suffered; the infinite  
lies stretched in smiling repose.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

Spiritual Laws (p. 305)

The Library of America. New York, New York, USA. 1983

...and thus ever, behind the coarse effect, is a fine cause,  
which, being narrowly seen, is itself the effect of a finer cause.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Circles (p. 404)

The Library of America. New York, New York, USA. 1983

**Flammarion, Camille** 1842–1925

French astronomer and writer

The infinitely little is equal to the infinitely great.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Chapter XII (p. 319)

D. Appleton & Co. New York, New York, USA. 1915

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

The infinite is only a *façon de parler*.

In C.A.F. Peters

*Briefwechsel zwischen C. E. Gauss und H. C. Schumacher* (Volume 2)

Letter to Schumacher dated July 12, 1831 (p. 269)

Vandenhoeck & Ruprecht. Göttingen, Germany. 1987

**Hawking, Stephen William** 1942–

English theoretical physicist

In an infinite number universe, every point can be regarded as the center,  
because every point has an infinity of stars on each side of it.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 1 (p. 5)

Bantam Books. Toronto, Ontario, Canada. 1988

**Hilbert, David** 1862–1943

German mathematician

The infinite, like no other problem, has always deeply moved the soul of men.  
The infinite, like no other idea, has had a stimulating and fertile influence upon the mind.  
But the infinite is also more than any other concept, in need of clarification.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 66)

Princeton University Press. Princeton, New Jersey, USA. 1949

The infinite! No other question has ever moved so profoundly the spirit of man...

In E.T. Bell

*Men of Mathematics* (Address in memory of Weierstrass) (p. xxi)

Simon & Schuster. New York, New York, USA. 1937

From time immemorial the infinite has stirred men's emotions more than any other question.  
Hardly any other idea stimulated the mind so fruitfully. Yet no other concept needs clarification more than it does.

In H.B. Griffiths and A.G. Hawson

*Mathematics: Society and Curricula*  
Exercises (p. 111)  
Cambridge University Press. London, England. 1974

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

When we say anything is infinite, we signify only that we are not able to conceive the ends and bounds of the thing named.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 3 (p. 54)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

No man can have in his mind an image of infinite magnitude; nor conceive infinite swiftness, infinite time, or infinite force, or inmate power.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth,*

*Ecclesiastical and Civil* (2nd edition)

Chapter III (p. 22)

George Routledge & Sons. London, England. 1886

**Huxley, Thomas Henry** 1825–95

English biologist

Truly it has been said, that to a clear eye the smallest fact is a window through which the Infinite may be seen.

*Discourses Biological and Geological*

The Study of Zoology (p. 209)

D. Appleton & Company. New York, New York, USA. 1897

**Kant, Immanuel** 1724–1804

German philosopher

But the infinite is absolutely (not merely comparatively) great. In comparison with this all else (in the way of magnitudes of the same order) is small. But the point of capital importance is that the mere ability even to think it as a whole indicates a faculty of mind transcending every standard sense. For the latter would entail a comprehension yielding as unit a standard bearing to the infinite rati- on expressible in numbers, which is impossible.

*The Critique of Judgment*

First Part, The Mathematically Sublime, 26

Hafner Publishing Company. New York, New York, USA. 1951

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

The infinite in mathematics is always unruly unless it is properly treated.

*Mathematics and the Imagination*

Paradox Lost and Paradox Regained (p. 210)

Simon & Schuster. New York, New York, USA. 1940

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

I say *finitude* is incomprehensible, the infinite in the universe *is* comprehensible. Now apply a little logic to

this. Is the negation of infinitude comprehensible? What would you think of a universe in which you could travel one, ten, or a thousand miles, or even to California, and then find it come to an end? Even if you were to go millions and millions of miles, the idea of coming to an end is incomprehensible.

*Popular Lectures and Addresses* (Volume 1)

The Wave Theory of Light (pp. 314–315)

Macmillan & Company Ltd. London, England. 1894

**Keyser, Cassius Jackson** 1862–1947

American mathematician

[The] subject of the infinite, how it baffles approach! How immediate and how remote it seems, how it abides and yet eludes the grasp, how familiar it appears, mingling with the elemental simplicities of the heart, continuously weaving itself into the intimate texture of common life, and yet how austere and immense and majestic, outreaching the sublimest flights of the imagination, transcending the stellar depths, immeasurable by the beginningless, endless chain of the ages!

*The Human Worth of Rigorous Thinking: Essays and Addresses*

The Axiom of Infinity (p. 141)

Columbia University Press. New York, New York, USA. 1916

One fact at once is clear, namely, that, whatever ultimate justification the hypothesis may find, thought has never escaped the necessity of supposing the universe of things to be intrinsically somehow cleft asunder into the two Grand Divisions, or figured, if you will, under the two fundamental complementary all-inclusive Forms, which, from motives more or less distinctly felt and also just, as we shall see, though not quite justified, have been, from time immemorial, designated as the Finite and the Infinite.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter VII (p. 142)

Columbia University Press. New York, New York, USA. 1916

**Locke, John** 1632–1704

English philosopher and political theorist

...if a man had a positive idea of infinite – he could add two infinities together: nay, make one infinite infinitely bigger than another, absurdities too gross to be confuted.

*An Essay Concerning Human Understanding* (Volume 1)

Book II, Chapter XVII (p. 292)

At The Clarendon Press. Oxford, England. 1844

**Loomis, Elisha S.** 1852–1940

Teacher

In the use of this method (of infinities) the pupil must be awake and thinking, for when the infinite is employed in an argument by the unskilled, the conclusion is often most absurd.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 34)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

Again if for the moment all existing space be held to be bounded, supposing a man runs forward to its outside borders, and stands on the utmost verge and then throws a winged javelin, do you choose that when hurled with vigorous force it shall advance to the point to which it has been sent and fly to a distance, or do you decide that something can get in its way and stop it? for you must admit and adopt one of the two suppositions; either of which shuts you out from all escape and compels you to grant that the universe stretches without end.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book One, I. 968–980 (p. 13)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Maeterlinck, Maurice** 1862–1949  
Belgian playwright and poet

The infinite which our imagination seeks to embrace is nothing more than the indefinite.

Translated by Bernard Miall

*The Life of Space*

The Fourth Dimension, IV (p. 13)

Dodd, Mead & Company. New York, New York, USA. 1928

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

There are two great infinities – the infinite in space and the infinite in time.

*Sketch-Book of Popular Geology*

Lecture Third (p. 120)

William P. Nimmo & Company, Edinburgh, Scotland. 1880

**Mitchell, Maria** 1818–89  
American astronomer and educator

Do not forget the infinite in the infinitesimal.

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 164)

Macmillan & Company Ltd. New York, New York, USA. 1949

**Pascal, Blaise** 1623–62  
French mathematician and physicist

We know that there is an infinite, and we are ignorant of its nature.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 233

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95  
French chemist

He who proclaims the existence of the infinite – and no one can escape from it – accumulates in this affirmation more of the supernatural than exists in all the miracles of all religions.

In Frederick Morris Warren

*Ten Frenchmen of the Nineteenth Century*

Selections (p. 246)

The Chautauqua Press. Chautauqua, New York, USA. 1904

...the notion of the infinite...forces itself upon our mind and yet is incomprehensible. When this notion takes possession of the understanding we have only to bow before it. At this moment of keen anguish we must ask our reason to pardon us. All the springs of intellectual life threaten to relax. We feel ourselves on the point of being seized by Pascal's "sublime madness."

In Frederick Morris Warren

*Ten Frenchmen of the Nineteenth Century*

Selections (p. 246)

The Chautauqua Press. Chautauqua, New York, USA. 1904

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

...it is only the affirmation of the, power of the mind which knows itself capable of conceiving the indefinite repetition of the same act when once this act is possible.

Translated by George Bruce Halsted

*Science and Hypothesis*

Part I, Chapter 1 (p. 13)

The Science Press. New York, New York, USA. 1905

**Proctor, Richard Anthony** 1837–88  
English astronomer

Inconceivable, doubtless, are these infinities of time and space, of matter, of motion, and of life. Inconceivable that the whole universe can be for all time the scene of the operation of infinite power, omnipresent, all-knowing. Utterly incomprehensible how Infinite Purpose can be associated with endless material evolution. But it is no new thought, no modern discovery, that we are thus utterly powerless to conceive or comprehend the idea of an Infinite Being, Almighty, All-knowing, Omnipresent, and Eternal, of whose inscrutable purpose the material universe is the unexplained manifestation. Science is in presence of the old, old mystery; the old, old questions are asked of her – 'Canst thou by searching find out God? Canst thou find out the Almighty unto perfection? It is as high as heaven; what canst thou do? deeper than hell; what canst thou know?' And science answers these questions as they were answered of old – 'As touching the Almighty we cannot find Him out.'

In Alfred R. Wallace

*Man's Place in the Universe: A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds* (p. x)

Chapter XVI (p. 324)

Chapman & Hall Limited. London, England. 1903

**Proctor, Richard Anthony** 1837–88  
English astronomer

Science deals with the finite though it may carry our thoughts to the infinite.

*Our Place Among Infinities: A Series of Essays Contrasting Our Little Abode thoughts to the infinite.*  
The Past and Future of Our Earth (p. 1)  
D. Appleton & Co. New York, New York, USA. 1876

**Richardson, Lewis** 1881–1953  
English mathematician and physicist

Big whorls have little whorls  
Which feed on their velocity,  
And little whorls have lesser whorls,  
And so on to viscosity.

In Ian Stewart

*Does God Play Dice: The New Mathematics of Chaos*  
Chapter 10 (p. 184)  
Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

**Rowland, Henry Augustus** 1848–1901  
American physicist

It is a curious fact that, having minds tending to the infinite, with imaginations unlimited by time and space, the limits of our exact knowledge are very small indeed.

*The Physical Papers of Henry Augustus Rowland*  
The Highest Aims of the Physicist (p. 675)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Royce, Josiah** 1855–1916  
American philosopher

...let us suppose, if you please, that a portion of the surface of England is very perfectly leveled and smoothed, and is the devoted to the production of our precise map of England. That in general, then, should be found upon the surface of England, map constructions which more or less roughly represent the whole of England – all this has nothing puzzling about it.... But now suppose that this our resemblance is to be made absolutely exact.... A map of England, contained within England, is to represent, down to the minutest detail, every contour and marking, natural or artificial, that occurs upon the surface of England.... One who, with absolute exactness of perception, looked down upon the ideal map thus supposed to be constructed, would see lying upon the surface of England on as large of small a scale as you please.... This representation, which would repeat in the outer portions the details of the former, but upon a smaller space, would be seen to contain yet another England, and this another, and so on without limit.

*The World and the Individual*  
Supplementary Essay, Section III (p. 504)  
The Macmillan Company. New York, New York, USA. 1900

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...I could be bounded in a nutshell and count myself a king of infinite space...

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*  
Act II, Scene ii, l. 260–261  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Swift, Jonathan** 1667–1745  
Irish-born English writer

So, Naturalists observe, a Flea  
Hath smaller Fleas that on him prey,  
And these have smaller Fleas to bite 'em  
And so proceed, ad infinitum.

*The Portable Swift*

On Nature  
Penguin Books. New York, New York, USA. 1977

**Tolstoy, Leo** 1828–1910  
Russian writer

And so to imagine the action of a man entirely subject to the law of inevitability without any freedom, we must assume the knowledge of an infinite number of space relations, an infinitely long period of time, and an infinite series of causes.

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Second Epilogue, Chapter X (p. 693)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Arriving at infinitesimals, mathematics, the most exact of sciences, abandons the process of analysis and enters on the new process of the integration of unknown, infinitely small, quantities.

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Second Epilogue, Chapter XI (p. 695)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**van Gogh, Vincent Willem** 1853–90  
Dutch painter

If what one is doing looks out upon the infinite, and if one see that one's work has its *raison d'être* and continuance in the future, then one works with more serenity.

*The Complete Letters of Vincent van Gogh with Reproductions of all the Drawings in the Correspondence* (Volume Three)

Letter 538 (p. 39)

New York Graphic Society. Greenwich, Connecticut, USA. 1958

**von Haller, Albrecht** 1708–77  
Swiss biologist

Infinity! What measures thee? Before the worlds as days,  
and men as moments flee!

In W. Hastie (ed.)

*Kant's Cosmogony*

Seventh Chapter (p. 134)

Greenwood Publishing Corporation. New York, New York, USA. 1968

**von Leibniz, Gottfried Wilhelm**

I am so much in favor of the actual infinite that instead of admitting that nature abhors it, as is commonly said,

I hold that it affects it everywhere in order better to mark the perfections of its author.

*The Philosophical Works of Leibnitz*

Reply to the Extract from the Letter of M. Foucher (p. 65)

Tuttle, Morehouse & Taylor. New Haven, Connecticut, USA. 1890

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

From what science has discovered about the infinitely small and the infinitely vast, the size of our bodies is almost totally irrelevant. In this little mahogany stand... may be civilizations as complex and diversified in scale as our own; and up there, the heavens, with all their vastness, may be only a minute strand of tissue in the body of a being in the scale of which all our universes are as a trifle.

In Lucien Price

*Dialogues of Alfred North Whitehead as Recorded by Lucien Price*

Dialogue XLIII, November 11, 1947 (pp. 367–368)

Little, Brown & Company. Boston, Massachusetts, USA. 1954

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

“Ought the word “infinite” to be avoided in mathematics?” Yes; where it appears to confer a meaning upon the calculus; instead of getting one from it.

*Remarks on the Foundations of Mathematics*

Appendix II, 17 (p. 63e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Zebrowski, George** 1945–

Polish-American science fiction writer

Science, when it runs up against infinities, seeks to eliminate them, because a proliferation of entities is the enemy of explanation.

*Time Is Nothing But A Clock*

*OMNI Magazine*, Volume 17, Number 1, 1994 (p. 144)

## INFINITE SERIES

**Riemann, Bernhard** 1826–66

German mathematician

The recognition of the fact that infinite series fall into two classes (according to whether the limit is independent of the ordering of the terms or not) constitutes a turning-point in the conceptualization of the infinite in mathematics.

Quoted in Reinhold Remmert

*Theory of Complex Functions*

Part A, Chapter 0, section 4 (p. 30)

Springer-Verlag. New York, New York, USA. 1991

## INFINITE SET

**Cameron, Peter J.** 1959–

American novelist

Counting is a less precise tool for infinite sets than for finite ones. The shepherdess who can count her flock of a

hundred sheep will know if the wolf has taken one; but, if she has an infinite flock, she won't notice until almost all of her sheep have been lost.

*Combinatorics*

Chapter 19 (p. 307)

Cambridge University Press. Cambridge, England. 1994

## INFINITELY SMALL

**Tolstoy, Leo** 1828–1910

Russian writer

A modern branch of mathematics having achieved the art of dealing with the infinitely small can now yield solutions in other more complex problems of motion which used to appear insoluble.

This modern branch of mathematics, unknown to the ancients, when dealing with problems of motion admits the conception of the infinitely small, and so conforms to the chief condition of motion (absolute continuity) and thereby corrects the inevitable error which the human mind cannot avoid when it deals with separate elements of motion instead of examining continuous motion.

*Great Books of the Western World* (Volume 51)

*War and Peace*

Book XI, Chapter I (p. 469)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

Only by taking infinitesimally small units for observation (the differential of history, that is, the individual tendencies of men) and attaining to the art of integrating them (that is, finding the sum of these infinitesimals) can we hope to arrive at the laws of history.

*War and Peace*

Book Eleven, Chapter I

## INFINITESIMAL

### Author undetermined

A smart sprinkle of infinitesimals were disposed at advantageous points; logarithms bristled at every angle, and crowds of those diminutive figures which have so often carried distraction to the very cerebellum of a freshman, were scattered through the whole fortifications.

*The Symbol of Darkness*

*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 216)

**Bing, Ilse** 1899–1998

German-born avant-garde photographer

Infinitesimal is the nearest to zero

infinitesimal is so small

that it is no longer something

but it is not yet nothing.

In Ernest Robson and Jet Wimp

*Against Infinity*

Infinitesimal (p. 12)

Primary Press, Parker Ford, Pennsylvania, USA. 1979



**Boethius, Anicius Manlius Severinus** ca. 475–524  
Roman philosopher and statesman

Thou has learnt from astronomical proofs that the whole earth compared with the universe is not greater than a point, that is, compared with the sphere of the heavens, it may be thought of as having no size at all. Then, of this tiny corner, it is only one-quarter that, according to Ptolemy, is habitable to living things. Take away from this quarter the seas, marshes, and other desert places, and the space left for man hardly even deserves the name of infinitesimal.

Translated by W. V. Cooper  
*The Consolation of Philosophy*  
II, vii  
J.M. Dent. London, England. 1902

**Browning, Robert** 1812–89  
English poet

Oh! The little more, and how much it is!  
And the little less, and what world's away!

*The Poetical Works of Robert Browning*  
By the Fireside  
Stanza XXXIX  
The Macmillan Company. New York, New York, USA. 1888–94

**Carus, Paul** 1852–1919  
American philosopher

Infinity is the land of mathematical hocus pocus. There Zero the magician is king. When Zero divides any number he changes it without regard to its magnitude into the infinitely small: and inversely, when divided by any number he begets the infinitely great.

*The Nature of Logical and Mathematical Thought*  
*Monist*, Volume 20, Number 1, January, 1910 (p. 69)

**Dantzig, Tobias** 1884–1956  
Russian mathematician

They [the mathematicians of the Enlightenment] defined their terms vaguely and used their methods loosely, and the logic of their arguments was made to fit the dictates of their intuition. In short, they broke all the laws of rigor and of mathematical decorum. The veritable orgy which followed the introduction of the infinitesimals... was but a natural reaction. Intuition had too long been held imprisoned by the severe rigor of the Greeks. Now it broke loose, and there were no Euclids to keep its romantic flight in check.

In by W.M. Priestley  
*Calculus: A Liberal Art*  
Chapter 8 (p. 310)  
Springer-Verlag New York, Inc. New York, New York, USA. 1998

### Scott Cary (Fictional character)

I was continuing to shrink, to become...what? The infinitesimal? What was I? Still a human being? Or was I the man of the future? If there were other bursts of radiation,

other clouds drifting across seas and continents, would other beings follow me into this vast new world? So close – the infinitesimal and the infinite. But suddenly, I knew they were really the two ends of the same concept. The unbelievably small and the unbelievably vast eventually meet – like the closing of a gigantic circle. I looked up, as if somehow I would grasp the heavens. The universe, worlds beyond number, God's silver tapestry spread across the night. And in that moment, I knew the answer to the riddle of the infinite. I had thought in terms of man's own limited dimension. I had presumed upon nature.

Closing soliloquy narration  
*The Incredible Shrinking Man*  
Film (1957)

**Tolstoy, Leo** 1828–1910  
Russian writer

Arriving at infinitesimals, mathematics, the most exact of sciences, abandons the process of analysis and enters on the new process of the integration of unknown, infinitely small, quantities. Abandoning the conception of cause, mathematics seeks law, that is, the property common to all unknown, infinitely small, elements.

*Great Books of the Western World* (Volume 51)  
Second Epilogue, Chapter II (p. 695)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**van Orman Quine, Willard** 1908–2000  
American philosopher

An infinitesimal is supposed to go into 1 not just sixteen times, or a thousand times, but infinitely many times.

*The Ways of Paradox, and Other Essays*  
Chapter 3 (p. 23)  
Harvard University Press. Cambridge, Massachusetts, USA. 1976

## INFINITY

**Alexander, Archibald** 1772–1851  
American Presbyterian theologian

Immensity and infinity are not synonymous terms.

*Some Problems of Philosophy*  
Chapter XIV (p. 114)  
Charles Scribner's Sons. New York, New York, USA. 1886

**Archytas of Tarentum** 428 BCE–350 BCE  
Greek mathematician

If I am at the extremity of the heaven of the fixed stars, can I stretch outwards my hand or staff? It is absurd to suppose that I could not; and if I can, what is outside must be either body or space. We may then in the same way get to the outside of that again, and so on; and if there is always a new place to which the staff may be held out, this clearly involves extension without limit.



Quoted in

*Essays in Honor of Gilbert Murray*

The Invention of Space (p. 233)

George Allen & Unwin Ltd. London, England. 1936

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Infinity past and to come is a fathomless gulf, into which vanish all things.

In Gerald Henry Rendall

*Marcus Aurelius Antoninus to Himself*

Book V (pp. 55–56)

Macmillan & Company Ltd. London, England. 1901

**Beerbohm, Max** 1872–1956

English caricaturist and writer

The attempt to conceive Infinity had always been quite arduous enough for me.

*Mainly on the Air*

A Note on the Einstein Theory (p. 77)

Alfred A. Knopf, Inc. New York, New York, USA. 1947

**Bernard Jaffe (Fictional character)**

There is no remainder in the mathematics of infinity.

*I Heart Huckabees*

Film (2004)

**Blake, William** 1757–1827

English poet, painter, and engraver

Too see the world in a grain of sand,  
And a heaven in a wild flower:  
Hold infinity in the palm of your hand,  
And eternity in an hour.

*The Complete Poetry and Prose of William Blake*

The Pickering Manuscript, Auguries of Innocence, l. 1–4

University of California Press. Berkeley, California, USA. 1982

The nature of infinity is this:

That everything has its

Own Vortex, and when once a traveler thro' Eternity

Has pass'd that Vortex,

he perceives it roll backward behind

His path, into a globe itself unfolding like a sun;

Or like a moon, or like a universe of starry majesty,

While he keeps onwards in his wondrous journey on the earth,

Or like a human form, a friend (with) whom he lived benevolent.

*The Complete Poetry and Prose of William Blake*

Milton, l. 21–7

University of California Press. Berkeley, California, USA. 1982

**Borland, Hal** 1900–78

American writer

Lift your eyes to the nighttime heavens now if you would see the lights of infinity.

*An American Year: Country Life and Landscapes Through the Seasons*

August (p. 81)

Simon & Schuster. New York, New York, USA. 1946

**Box, George E. P.** 1919–

English statistician

It is a pity, therefore, that the authors have confined their attention to the relatively simple problem of determining the approximate distribution of arbitrary criteria and have failed to produce any sort of justification for the tests they propose. In addition to those functions studied there are an infinity of others, and unless some principle of selection is introduced we have nothing to look forward to but an infinity of test criteria and an infinity of papers in which they are described.

Discussion

*Journal of the Royal Statistical Society*, Ser. B., 18, 1956 (p. 29)

**Bruno, Giordano** 1548–1600

Italian philosopher and pantheist

All is filled with infinity, and beyond infinity there is nothing.

In I. Frith

*Life of Giordano Bruno*

Chapter IX (p. 223)

Trübner & Co. London, England. 1885

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

I saw, as one might see the transit of Venus... , a quantity passing through infinity and changing its sign from plus to minus. I saw exactly how it happened and why the tergiversation was inevitable.... But it was after dinner and I let it go!

*My Early Life: A Roving Commission*

A Roving Commission (p. 26)

Charles Scribner's Sons. New York, New York, USA. 1958

**Cohen, David** 1942–2002

American mathematician

**Henle, James M.**

American mathematician

At the heart of the calculus lies INFINITY – that strange region of mathematics that's part mystical, part magical; that's dangerous by reputation, and ultimately romantic.

*Calculus: The Language Of Change*

Chapter 9 (p. 573)

Jones and Bartlett Publishers. Sudbury, Massachusetts, USA. 2005

**Cousins, Norman** 1912–90

American editor and author

Infinity converts the possible into the inevitable.

Editor's Odyssey

*Saturday Review*, April 15, 1978 (p. 18)

**Crane, Hart** 1899–1932

American poet

But the star-glistened salver of infinity,  
The circle, blind crucible of endless space,

Is sluiced by motion – subjugated never.

*The Complete Poems and Selected Letters and Prose of Hart Crane*  
The Bridge, Cape Hatteras  
Anchor Books, Garden City, New York, USA. 1966

**de Morgan, Augustus** 1806–71

English mathematician and logician

Doubt about Taylor's theorem or the binomial theorem, and you may be listened to with attention. But do not dare to question his mathematician's notions of infinitely great or infinitely small, be they positive or negative. You may be simply wrong about Taylor or the binomial: but about infinity you are not merely wrong, but absurd; and not merely absurd, but manifestly and palpably absurd.

*Transactions of the Cambridge Philosophical Society*

On Infinity: and on the Sign of Equality (p. 145)

At The University Press, Cambridge, England. 1871

I am well aware of the position occupied by the subject [infinity] I am about to treat. I know the positive way in which opinions are held upon it. Those who teach that we know nothing are quite sure we know nothing: those who teach that we know a certain something are as sure both of the character and extent of the known region: those who halt between these opinions are perfectly satisfied that such halting is the only true position for a rational being.

*Transactions of the Cambridge Philosophical Society* (Volume 11)

On Infinity: and on the Sign of Equality (p. 145)

At The University Press, Cambridge, England. 1871

Infinity is a pertinacious meddler, who will not be turned out: we must find out what he wants, and give it him.

*Transactions of the Cambridge Philosophical Society*

On Infinity: and on the Sign of Equality (p. 156, fn 1)

At The University Press, Cambridge, England. 1871

**Dewar, Redcote**

No biographical data available

In infinity looms a world of shadow called the unknown, the unread, or the unlearned, an *incognita* daily vanishing as its wrung-out secrets are added to our stores of knowledge.

*From Matter to Man: A New Theory of the Universe*

Chapter II (p. 23)

Chapman & Hall, Ltd. London, England. 1898

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

But how can finite grasp Infinity?

*The Poetical Works of Dryden*

Hind and the Panther, I

The Riverside Press, Cambridge, Massachusetts, USA. 1949

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

You cannot escape one infinity, I told myself, by fleeing to another; you cannot escape the revelation of the identical by taking refuge in the illusion of the multiple.

Translated by William Weaver

*Foucault's Pendulum*

Chapter 1 (pp. 6–7)

Harcourt, Brace Jovanovich, Publishers. San Diego, California, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

That queer quantity “infinity” is the very mischief, and no rational physicist should have anything to do with it. Perhaps that is why mathematicians represent it by a sign like a love-knot.

*New Pathways in Science*

Chapter X, Section III (p. 217)

The Macmillan Company. New York, New York, USA. 1935

**Eldridge, Paul** 1888–1982

American educator

Truth must be judged in terms of time and space; superstition in terms of eternity and infinity.

*Maxims for a Modern Man*

2533

T. Yoseloff. New York, New York, USA. 1965

**Froude, James Anthony** 1818–94

English historian and biographer

Large forms resolve themselves into parts, down so far as we can see into infinity.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 16)

Charles Scribner's Sons. New York, New York, USA. 1890

**Gamow, George** 1904–68

Russian-born American physicist

*One, Two, Three – Infinity*

Title of Book

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

Infinity is only a figure of speech, meaning a limit to which certain ratios may approach as closely as desired, when others are permitted to increase indefinitely.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. ix)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Gleick, James** 1954–

American author, journalist, and essayist

In the mind's eye, a fractal is a way of seeing infinity.

*Chaos: Making a New Science*

A Geometry of Nature (p. 98)

The Viking Press. New York, New York, USA. 1987

**Greene, Brian** 1963–

American physicist

Calculations that merge the equations of general relativity and those of quantum mechanics typically yield one

and the same ridiculous answer: infinity. Like a sharp rap on the wrist from an old-time schoolteacher, an infinite answer is nature's way of telling us that we are doing something that is quite wrong.

*The Elegant Universe*

Chapter 5 (p. 129)

W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

Only a cosmic jester could perpetrate eternity and infinity...

*Masks of the Universe*

Part II, Chapter 12 (p. 230)

The Macmillan Company. New York, New York, USA. 1985

**Ionesco, Eugene** 1912–94

French playwright

PROFESSOR: You know how to count? How far can you count up to?

PUPIL: I can count to...to infinity.

PROFESSOR: That's not possible, miss.

PUPIL: Well then, let's say to sixteen.

PROFESSOR: That is enough. One must know one's limits.

Translated by Donald M. Allen

*Four Plays*

*The Lesson* (p. 53)

Grove Press, Inc. New York, New York, USA. 1958

**Jaki, Stanley L.** 1924

Benedictine priest and physicist

As soon as you have infinity in mathematics everything breaks down.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 9 (p. 386)

Time Books. New York, New York, USA. 1991

**James, Henry** 1811–82

No biographical data available

Does infinity mean endless space? Does eternity mean endless time?

*Lectures and Miscellanies*

The Law of Creation (p. 322)

Redfield. New York, New York, USA. 1852

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Only if we know that what truly matters is the infinite can we avoid fixing our interests on futilities. In the final analysis we count for something only because of the essential we embody, and if we do not embody that life is wasted.

*Memories, Dreams, Reflections*

Chapter XI (p. 325)

Vintage Books. New York, New York, USA. 1963

**Kaplan, Robert** 1946–

No biographical data available

**Kaplan, Ellen**

No biographical data available

Is it ourself, our mind or spirit, that is infinity's proper home? Or might the infinite be neither out there nor in here but only in language, a pretty conceit of poetry?

*The Art of the Infinite*

An Invitation (p. 1)

Oxford University Press, Inc. Oxford, England. 2003

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

With the Hottentots, infinity begins at three.

*Mathematics and the Imagination*

New Names for Old (p. 19)

Simon & Schuster. New York, New York, USA. 1940

**Keyser, Cassius Jackson** 1862–1947

American mathematician

...there are many infinites of many orders...infinites are surpassed by other infinites...infinites, like the stars, differ in glory. This is not rhetoric, it is naked fact.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

The Walls of the World (p. 98)

Columbia University Press. New York, New York, USA. 1916

**Locke, John** 1632–1704

English philosopher and political theorist

This further is observable in number, that it is that which the mind makes use of in measuring all things that by us are measurable, which principally are expansion and duration; and our idea of infinity, even when applied to those, seems to be nothing but the infinity of number. For what else are out ideas of Eternity and Immensity, but the repeated additions of certain ideas of imagined parts of duration and expansion, with the infinity of number; in which we can come to no end of addition.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter XVI, Section 8 (p. 167)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But of all other ideas, it is number, which I think furnishes us with the clearest and most distinct idea of infinity we are capable of.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter XVII, Section 9 (p. 170)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Maclaurin, Colin** 1838–1916

Scottish mathematician

The view of nature, which is the immediate object of sense, is very imperfect, and of small extent; but, by the

assistance of art, and the aid of reason, becomes enlarged, till it loses itself in infinity.

*An Account of Sir Isaac Newton's Philosophical Discoveries*

Chapter I Section 5

London, England. 1748

### Mathews, G. B.

No biographical data available

A great deal of misunderstanding is avoided if it be remembered that the term *infinity*, *infinite*, *zero*, *infinitesimal* must be interpreted in connexion with their context, and admit a variety of meanings according to the way in which they are defined.

*Theory of Numbers*

Part 1, Section 104 (p. 112)

Chelsea Publishing Company. New York, New York, USA. 1980

### Milton, John 1608–74

English poet

[Infinity is]...a dark  
Illimitable ocean, without bound,  
Without dimension; where length, breadth, and height,  
And time, and place, are lost ...

In Arthur Wilson Verity

*Paradise Lost*

Book II (p. 64)

Cambridge University Press. Cambridge, England. 1907

### Murray, David Ambrose

No biographical data available

Large and small are merely terms of comparison. Space has two infinities, infinitely larger and infinitely smaller, but there is no natural starting point for comparisons. Whatever size or length is taken it is capable of infinite subdivision and infinite multiplication, so that with respect to some other line or space it may be considered infinitely large or infinitely small.

*Atoms and Energies*

Chapter I (p. 24)

Barnes & Co. New York, New York, USA. 1901

### Murray, William John

No biographical data available

To seek aid of the finite in trying to fathom infinity is like dissecting a seed to discover the nature of the fruit.

*The Astor Lectures*

Creation (p. 116)

The Divine Science Publishing Association. New York, New York, USA. 1917

### Pascal, Blaise 1623–62

French mathematician and physicist

Unity joined to infinity adds nothing to it, no more than one foot to an infinite measure. The finite is annihilated in the presence of the infinite, and becomes a pure nothing.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 233

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Pierpont, James

No biographical data available

...the notion of infinity is our greatest friend; it is also the greatest enemy of our peace of mind...Weirstrass taught us to believe that we had at last thoroughly tamed and domesticated this unruly element. Such however is not the case; it has broken loose again. Hilbert and Brouwer have set out to tame it once more. For how long? We wonder.

Mathematical Rigor, Past and Present

*Bulletin of the American Mathematical Society*, Volume 34, January–February, 1928 (p. 47)

### Poe, Edgar Allan 1809–49

American short story writer

Let us begin, then, at once, with that merest of words, "Infinity." This, like "God," "spirit," and some other expressions of which the equivalents exist in all languages, is by no means the expression of an idea, but of an effort at one. It stands for the possible attempt at an impossible conception. Man needed a term by which to point out the direction of this effort – the cloud behind which lay, forever invisible, the object of this attempt.

*Poems and Essays of Edgar Allan Poe*

Eureka (p. 128)

W.J. Widdleton, Publisher. New York, New York, USA. 1881

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

...without mathematical infinity, there would be no science at all, because there would be nothing general.

In H.B. Griffiths & A.G. Hawson

*Mathematics: Society and Curricula*

Exercises (p. 111)

Cambridge University Press. London, England. 1974

### Poland, Carl V.

No biographical data available

Infinity is a possibility, not a thing.

Monism and the Antimonies

*The Monist*, (p. 628), Volume XXV, 1915

### Proctor, Richard Anthony 1837–88

English astronomer

It is not simply the vast in which men have learned to believe, not mere immensity, but the mystery of absolute infinity. On all sides our island home [Earth] is surrounded by a shoreless sea of space.

*Mysteries of Time and Space*

Newton and Darwin (p. 4)

R. Worthington

New York, New York, USA. 1883

**Rucker, Rudy** 1946–  
Science and science fiction author

The study of infinity is much more than a dry academic game. The intellectual pursuit of the Absolute Infinite is, as Georg Cantor realized, a form of the souls quest for God. Whether or not the goal is ever reached, an awareness of the process brings enlightenment.

*Infinity and the Mind*

Preface (p. ix)

Princeton University Press. Princeton, New Jersey, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

When algebra has been learnt, all goes smoothly until we reach those studies in which the notion of infinity is employed – the infinitesimal calculus and the whole of higher mathematics.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 64)

Longmans, Green & Co. London, England. 1919

If any philosopher had been asked for a definition of infinity, he might have produced some unintelligible rigmarole, but he would certainly not have been able to give a definition that had any meaning at all.

*Mysticism and Logic: And Other Essays*

Chapter V (p. 85)

Longmans, Green & Co. London, England. 1919

**Shelley, Percy Bysshe** 1792–1822  
English poet

...infinity within,  
Infinity without...

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab, l. 22–23

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Stillwell, John**

No biographical data available

Reasoning about infinity is one of the characteristic features of mathematics as well as its main source of conflict.

*Mathematics and Its History*

Chapter 4 (p. 51)

Springer-Verlag. New York, New York, USA. 1989

**Van-Anderson, Helen**

No biographical data available

There is no end to the study of Infinity.

*The Right Knock: A Story* (8th edition)

Chapter XXXVI (p. 305)

The New York Magazine of Mysteries. New York, New York, USA. 1903

**Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer

Infinity is always one more than now.

*Parallel Universes*

Chapter 6 (p. 69)

Simon & Schuster. New York, New York, USA. 1988

Some scientists are also bothered by infinities, which seem to crop up at embarrassing places in our theories of the universe. A black hole...has an infinity at its very center.

*Parallel Universes*

Chapter 6 (p. 69)

Simon & Schuster. New York, New York, USA. 1988

I like infinities. I believe that infinity is just another name for mother nature. Nature provides infinite possibility all the time.

*Parallel Universes*

Chapter 6 (p. 70)

Simon & Schuster. New York, New York, USA. 1988

I believe that the infinity of possibilities predicted to arise in quantum physics is the same infinity as the number of universe-possibilities predicted to arise in relativistic physics when, at the beginning of time, the universe, our home, and all of its sisters and brothers were created. As modest and troublesome as we often are, we too are never the less creatures of infinity.

*Parallel Universes*

Chapter 6 (p. 70)

Simon & Schuster. New York, New York, USA. 1988

...infinity is just another name for mother nature.

*Parallel Universes*

Chapter 6 (p. 70)

Simon & Schuster. New York, New York, USA. 1988

**Ya Vilenkin, N.**

No biographical data available

In the Middle Ages the problem of infinity was of interest mainly in connection with arguments about whether the set of angels who could sit on the head of a pin was infinite or not.

*Stories about Sets* (p. 2)

Academic Press. New York, New York, USA. 1968

**Zebrowski, George** 1945–

Science fiction author

Science, when it runs up against infinities, seeks to eliminate them, because a proliferation of entities is the enemy of explanation.

Time is Nothing but a Clock

*OMNI*, Volume 17, Number 1, October, 1984 (p. 144)

**Zeno of Elea**

But now the many things are necessarily just so many as they are; and if they are just so many as they are, then are they finite in number.... If there are many things, then must they be infinite in number, for there must ever be

other things between things, and again between these still others; and so they must be infinite in number.

Translated by Alexander J. W. Morrison

In August Heinrich Ritter

*The History of Ancient Philosophy* (Volume 1)

Zeno of Elea (p. 473)

D.A. Talboys. Oxford, England. 1838

## INFLAMMATION

**Dickens, Charles** 1812–70

English novelist

I was born with inflammation of the lungs, and of everything else, I believe, that was capable of inflammation.

*Hard Times* (Volume 1)

Book the First, Chapter IV (pp. 25–26)

At The Riverside Press. Cambridge, England. 1869

## INFORMATION

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

For information commences with the senses. But the whole business terminates in Works.... The chief cause of failure in operation (especially after natures have been diligently investigated) is the ill determination and measurement of the forces and actions of bodies. Now the forces and actions of bodies are circumscribed and measured, either by distances of space, or by moments of time, or by concentration of quantity, or by predominance of virtue; and unless these four things have been well and carefully weighed, we shall have sciences, fair perhaps in theory, but in practice inefficient. The four instances which are useful in this point of view I class under one head as Mathematical Instances and Instances of Measurement.

In James Spedding, Robert Leslie Ellis and Douglas Denon Heath

*The Works of Francis Bacon* (Volume 8)

*The New Organon*

Book II, XLIII

Taggard & Thompson. Boston, Massachusetts, USA. 1868

**Bateson, Gregory** 1904–80

English anthropologist, social scientist, linguist, and cyberneticist

Information is any difference that makes a difference.

*Mind and Nature: A Necessary Unity*

Glossary (p. 233)

E.P. Dutton & Co. New York, New York, USA.

**Bernal, John Desmond** 1901–71

Irish-born physicist and X-ray crystallographer

We should admit in theory what is already very largely a case in practice, that the main currency of scientific information is the secondary sources in the form of abstracts, reports, tables, etc., and that the primary sources are only for detailed reference by very few people. It is possible that the fate of most scientific papers will be not to be read by anyone who uses them, but

with luck they will furnish an item, a number, some facts or data to such reports which may, but usually will not, lead to the original paper being consulted. This is very sad but it is the inevitable consequence of the growth of science.

The Supply of Information to the Scientist: Some Problems of the Present Day

*Journal of Documentation*, Volume 13, 1957

**Brand, Stewart**

No biographical data available

Information wants to be free. Information also wants to be expensive.

*The Media Lab: Inventing the Future at MIT* (p. 202)

Penguin Books. New York, New York, USA. 1988

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

In other words, there is more to a message than merely its information content; there is also the value or quality of the information that has to be taken into account.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 6 (p. 77)

Simon & Schuster. New York, New York, USA. 1988

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

Where is the Life we have lost in living? Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?

*The Complete Poems and Play, 1900–1950*

*The Rock*

Choruses from "The Rock" I (p. 96)

Houghton, Mifflin, Harcourt. New York, New York, USA. 1952

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

I find a frank acknowledgment of one's ignorance is not only the easiest way to get rid of a difficulty, but the likeliest way to obtain information, and therefore I practice it: I think it an honest policy. Those who affect to be thought to know everything, and so undertake to explain everything, often remain long ignorant of many things that others could and would instruct them in, if they appeared less conceited.

*The Works of Benjamin Franklin* (Volume 1)

Electricity (p. 307)

Hillard, Gray & Company. Boston, Massachusetts, USA. 1836–40

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...the sparks of information from time to time struck out, instead of glimmering for a moment, and dying away in oblivion, began to accumulate into a genial glow, and the flame was at length kindled which was speedily to acquire the strength and rapid spread of a conflagration.



*A Preliminary Discourse on the Study of Natural Philosophy*  
Part III, Chapter VI, Section 383 (p. 348)  
Printed for Longman, Rees, Orme, Brown & Green. London, England.  
1831

**Hertz, Heinrich** 1857–94  
German physicist

...to get information for myself and for others direct from nature gives me so much more satisfaction than to be always learning it from others and for myself alone...

*Miscellaneous Papers*  
Introduction (p. xiii)  
Macmillan & Company Ltd. London, England. 1896

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

There may be thousands of relevant bits of information lying dormant in hundreds of technical journals on dusty library shelves which, if remembered, would act as Open Sesames.

*The Act of Creation*  
Book One, Part Two, Chapter X  
Notes (p. 254)  
The Macmillan Company. New York, New York, USA. 1964

**Lee, Stan** 1922–  
American writer and editor

Negative information is that which, immediately upon acquiring, causes the recipient to know less than he did before.

*Dunn's Conundrum*  
Trash Report: #85–10–9 (p. 156)  
Harper & Row, Publishers. New York, New York, USA. 1985

**Liebling, A. J.**  
No biographical data available

When information becomes unavailable, the expert comes into his own.

*New York Times Book Review*, November 23, 1997

**Mailer, Norman** 1923–  
American author

The only thing of which I could be certain was that everyone had information to offer, spoke in a voice that was full of authority, and contradicted what the last fellow had said.

*Ancient Evenings*  
Part IV, Chapter Seven (p. 312)  
Little, Brown & Company. Boston, Massachusetts, USA. 1983

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

The ballast of factual information, so far from being just about to sink us, is growing daily less. The factual burden of a science varies inversely with its degree of maturity. As a science advances, particular facts are comprehended

within, and therefore in a sense annihilated by, general statements of steadily increasing explanatory power and compass – whereupon the facts need no longer be known explicitly, that is, spelled out and kept in mind. In all sciences we are being progressively relieved of the burden of singular instances, the tyranny of the particular. We need no longer record the fall of every apple.

Two Conceptions of Science  
*Encounter*, 143, August, 1965

**Minot, George R.** 1885–1950  
American physician

As each bit of information is added to the sum of human knowledge it is evident that it is the little things that count; that give all the fertility and character; that give all the hope and happiness to human affairs. The concept of bigness is apt to be a delusion, and standardizing processes must not supplant creative impulses.

*Les Prix Nobel. The Nobel Prizes in 1934*  
Nobel banquet speech for award received in 1934  
Nobel Foundation. Stockholm, Sweden. 1935

### President's Science Advisory Committee

We shall cope with the information explosion, in the long run, only if some scientists and engineers are prepared to commit themselves deeply to the job of sifting, reviewing, and synthesizing information; i.e., to handling information with sophistication and meaning, not merely mechanically. Such scientists must create new science, not just shuffle documents: their activities of reviewing, writing books, criticizing, and synthesizing are as much a part of science as is traditional research.

*Science, Government and Information*  
Summary and Major Recommendations  
A. 1 (p. 2)  
The White House. Washington, D.C. January 10, 1963

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

The scientific picture of the real world around me is very deficient. It gives me a lot of factual information, puts all our experience in a magnificently consistent order, but is ghastly silent about all and sundry that is really dear to our heart, that really matters to us.

In Ken Wilbur (ed.)  
*Quantum Questions* (p. 81)  
New Science Library. Boulder, Colorado, USA. 1984

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

I think it is best to put up with information the way you get it; and seem satisfied with it, and surprised at it, and grateful for it, and say, "My word!" and never let on. It was a wide space; I could tell you how wide, in chains and perches and furlongs and things, but that would not help

you any. Those things sound well, but they are shadowy and indefinite, like troy weight and avoirdupois; nobody knows what they mean. When you buy a pound of a drug and the man asks you which you want, troy or avoirdupois, it is best to say "Yes," and shift the subject.

*Following the Equator* (Volume 1)

Chapter XXIII (p. 229)

Harper & Brothers. New York, New York, USA. 1899

**Wiener, Norbert** 1894–1964

American mathematician

...information is information, not matter or energy ...

*Cybernetics, or Control and Communication in the Animal and the Machine* (2nd edition) (p. 132)

The MIT Press. Cambridge, Massachusetts, USA. 1948

## INGENUITY

**Hertzberger, Herman** 1932–

Dutch architect

Ingenuity in finding new concepts is all too often seen as something exclusive, reserved for the few who are gifted in that respect.

*Space and the Architect: Lessons in Architecture 2*

Chapter 2 (p. 30)

Publishers. Rotterdam, The Netherlands. 2000

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

It may sometimes happen, that the greatest efforts of ingenuity have been exerted in trifles; yet the same principles and expedients may be applied to more valuable purposes, and the movements, which put into action machines of no use but to raise the wonder of ignorance, may be employed to drain fens or manufacture metals, to assist the architect or preserve the sailor.

*The Rambler* (Volume 2)

No. 83, January 1, 1751 (pp. 184–185)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

## INHERITANCE

**Ardrey, Robert** 1908–80

American anthropologist

...acquired characteristics cannot be inherited, and... within a species every member is born in the essential image of the first of its kind.

*African Genesis: A Personal Investigation into the Animal Origins and Nature of Man*

Chapter I, Section 2 (p. 12)

Athenaeum. New York, New York, USA. 1961

**Darwin, Charles Robert** 1809–82

English naturalist

As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it fol-

lows that any being, if it varies however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Introduction (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Any variation which is not inherited is unimportant for us.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter I (p. 11)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

The large do not always beget the large, nor the small the small, and yet the observed proportions between the large and the small in each degree of size and in every quality, hardly varies from one generation to another.

*Natural Inheritance*

Chapter I (p. 2)

Macmillan & Company Ltd. London, England. 1889

## INITIATIVE

**Little, Arthur D.** 1863–1935

American chemist

Initiative is one of the rarest mental qualities; yet without it progress is impossible. Its combination with the scientific imagination and command of fact is still rarer and more precious.

*The Fifth Estate* (p. 5)

The Franklin Institute. Philadelphia, Pennsylvania, USA. 1924

## INNOVATION

**Duncan, Robert Kennedy** 1919–88

American poet

There is nothing in the action of the present-day forces of Innovation that bears any of the symptoms of past history. For the first time in any known era these aspirational forces have gained control, not through the explosive violence of revolution, but through the processes of evolution. As a result we find ourselves saved from revolution, living in an age intensely dynamic, ignorant of where we are going, but on the way.

*Some Chemical Problems of Today*

Chapter I (p. 1)

Harper & Brothers Publishers. New York, New York, USA. 1911

**Fredrickson, G.** 1932–

No biographical data available

The point is simply that if a technological innovation has a good side (as it almost always does), it will more than likely have a bad side as well.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 144)

**Gardner, John W.** 1912–2002  
American administrator

We may learn something about the renewal of societies if we look at the kind of men who contribute most to that outcome – the innovators.

*Self-Renewal: The Individual and the Innovative Society*

Chapter 4 (p. 27)

Harper & Rowe, Publishers, New York, New York, USA. 1964

Many of the major changes in history have come about through successive small innovations, most of them anonymous.

*Self-Renewal: The Individual and the Innovative Society*

Chapter 4 (p. 31)

Harper & Rowe, Publishers, New York, New York, USA. 1964

### Thagard, Paul

Professor of philosophy

Whereas genetic variation in organisms is not induced by the environmental conditions in which the individual is struggling to survive, scientific innovations are designed by their creators to solve recognized problems; they therefore are correlated with solutions to problems... Scientists also commonly seek new hypotheses that will correct error in their previous trials...

*Computational Philosophy of Science*

Chapter 6 (p. 103)

The MIT Press. Cambridge, Massachusetts, USA. 1988

## INOCULATE

**Sagan, Carl** 1934–96  
American astronomer and author

If you want to save your child from polio, you can pray or you can inoculate.... Try science.

*Demon-Haunted World: Science As a Candle in the Dark*

Chapter 2 (p. 30)

Random House, Inc. New York, New York, USA. 1995

## INORGANIC

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

Another year's installment of flowers, leaves, nightingales, thrushes, finches, and such ephemeral creatures, took up their positions where only a year ago others had stood in their place when these were nothing more than germs and inorganic particles.

*Tess of the D'Urbervilles: A Pure Woman Faithfully Presented*

Chapter XX (p. 165)

Harper & Brothers Publishers. New York, New York, USA. 1920

### Shulman, Max

No biographical data available

Organic chemistry is the study of organs; inorganic chemistry is the study of the insides of organs.

In Evan Esar

*20,000 Quips and Quotes* (p. 127)

Doubleday. Garden City, New York, USA. 1968

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

In the concrete fullness of the world without, we distinguish by common consent the realm of organisms and the domain of the inorganic. Sun and stars, sky and sea, mountains and rivers, the air we breathe and the dust beneath our feet, crystals and precious stones, it seems like colour-blindness to sum this up in the negative and unattractive term "inorganic." But better that than use a question-begging word.

*The System of Animate Nature* (Volume 1)

Lecture II (p. 49)

William & Norgate. London, England. 1920

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

So far as we can see, inorganic entities are vehicles for receiving and storing in a napkin, and for restoring without gain or loss.

*Process and Reality* (p. 269)

Chapter VIII (p. 177)

The Free Press. New York, New York, USA. 1978

## INQUIRY

**Durant, William James** 1885–1981

American historian and essayist

### Durant, Ariel

No biographical data available

...inquiry is fatal to certainty.

*The Age of Napoleon: A History of European Civilization from 1789 to 1815* (p. 1045)

Simon & Schuster. New York, New York, USA. 1975

**Foster, Sir Michael** 1836–1907

English physiologist

Almost every [scientific] inquiry, certainly every prolonged inquiry, sooner or later goes wrong. The path, at first so straight and clear, grows crooked and gets blocked; the hope and enthusiasm, or even the jaunty ease, with which the inquirer set out, leave him, and he falls into a slough of despond.

The President's Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 130)

### Henry Frankenstein (Fictional character)

Where should we be if nobody treed to find out what lies beyond?

*Frankenstein*  
Film (1931)

**Tyndall, John** 1820–93  
Irish-born English physicist

The aspects of Nature provoke in man the spirit of inquiry. As the eye is formed to see, and the ear to hear, so the human mind is formed to explore and understand the basis and relationship of natural phenomena.

*Heat a Mode of Motion* (6th edition)  
Lecture I (p. 1)  
D. Appleton & Co. New York, New York, USA. 1915

## INQUISITION

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

If Galileo had said in verse that the world moved, the Inquisition might have let him alone.

In Thomas Hardy  
*Hardy: Selected Poems*  
Appendix (p. 200)  
Penguin Books. New York, New York, USA. 1998

## INQUISITIVE

**Gies, William J.** 1872–1956  
US biochemist and dentist

No man discovers, except by accident, who isn't *inquisitive*.

Research in Dentistry  
*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xciv)

## INSANITY

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

At bottom we discover nothing new and unknown in the mentally ill; rather, we encounter the substratum of our own natures.

*Memories, Dreams, Reflections*  
Chapter IV (p. 127)  
Vintage Books. New York, New York, USA. 1970

## INSCRIPTION

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

We have been looking abroad on the old geological burying-grounds, and deciphering the strange inscriptions on their tombs; but there are other burying-grounds, and other tombs – solitary church-yards among the hills, where the dust of the martyrs lies, and tombs that rise over the ashes of the wise and good; nor are there awant-

ing, on even the monuments of the perished races, frequent hieroglyphics, that while their burial-yards contain but the debris of the past, we are to regard the others as charged with the sown seed of the future.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Second (p. 140)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

## INSECT COLORING

**Kirby, William** 1759–1850  
English entomologist

**Spence, William** 1783–1860  
English entomologist

In fishes the lucid scales, of varied hue, that cover and defend them, are universally admired, and esteemed their peculiar ornament but place a butterfly's wing under a microscope, that avenue to unseen glories in new worlds, and you will discover that nature has endowed the most numerous of the insect tribes with the same privilege, multiplying in them the forms, and diversifying the colouring of this kind of clothing beyond all parallel.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th Edition)  
Letter 1 (p. 5)  
Longman, Brown, Green, Longmans & Robert. London, England. 1858

What numbers vie with the charming offspring of Flora in various beauties! some in the delicacy and variety of their colours, colours not like those of flowers evanescent and fugitive, but fixed and durable, surviving their subject, and adorning it as much after death as they did when it was alive; others, again, in the veining and texture of their *wings*; and others in the rich cottony down that clothes them.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)  
Letter 1 (pp. 5–6)  
Longman, Brown, Green, Longmans & Robert. London, England. 1858

## INSECT PEST

**Macleod, Norman** 1812–72  
Scottish clergyman

Experienced European travelers, when they hire a boat for a journey on the Nile, always stipulate that it shall be sunk for a certain number of days, in order to clear it of the various insect pests to which such vessels are liable, but which seem to cause no discomfort to the Oriental owners.

*Good Words*  
Only A Cockroach (p. 628)  
Isbister & Co. London, England. 1879

## INSECT VARIEGATION

**Kirby, William** 1759–1850  
English entomologist

**Spence, William** 1783–1860  
English entomologist

In variegation, insects certainly exceed every other class of animated beings. Nature, in her sportive mood, when painting them, sometimes imitates the clouds of heaven; at others, the meandering course of the rivers of the earth, or the undulations of their waters: many are veined like beautiful marbles; others have the semblance of a robe of the finest net-work thrown over them; some she blazons with heraldic insignia, giving them to bear in fields sable – azure – vert – gules – argent and or, fesses – bars – bends – crosses – crescents – stars, and even animals. On many, taking her rule and compasses, she draws with precision mathematical figures; points, lines, angles, triangles, squares, and circles.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter 1 (p. 5)

Longman, Brown, Green, Longmans & Robert. London, England. 1858

## INSIGHT

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

‘Twas a tiny grain at first, an insignificant ball rolling and increasing as it went. From one slope to the other of the theorems, it grew to a heavy mass; and the mass became a mighty projectile which, flung backwards and retracing its course, split the darkness and spread it into one vast sheet of light.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 315)

Dodd, Mead & Co. New York, New York, USA. 1925

**Merrell-Wolff, Franklin**

No biographical data available

The function of insight gives a transcendental content that, when reduced to an interpretive system, becomes subject to the relativity of all subject-object consciousness. Therefore, there can be no such thing as an infallible interpretation. Thus we must distinguish between insight and its formulation.

*Transformations in Consciousness*

Introception (p. 163)

State University of New York. Albany, New York, USA. 1995

**Standen, Anthony**

Anglo-American science writer

Insight is not the same as scientific deduction, but even at that it may be more reliable than statistics.

*Science Is a Sacred Cow*

Chapter V (p. 123)

E.P. Dutton & Company. New York, New York, USA. 1950

**Weaver, Warren** 1894–1978  
American mathematician

Sometimes when, for a time, we think hard about some subject and then “dismiss it from our minds,” this subject seems to reappear later, in an improved and expanded form, just as though it had descended to a subconscious level of the mind, and had there profited by association with an unrecognized mixture of other ideas in a sort of unconscious reverie.

*Lady Luck: A Theory of Probability*

Chapter 1 (p. 30)

Dover Publications, Inc. New York, New York, USA. 1963

## INSOMNIAC

**Crichton-Browne, Sir James** 1840–1938  
English physician

A lady of my acquaintance, after a slight operation, suffered from insomnia [that] drugs failed to relieve. Her doctor, however, was very resourceful and on visiting her on the Sunday forenoon said: “I see there’s a sermon on the wireless at eight this evening...” There is no soporific better than a dry sermon.

*From the Doctor’s Notebook*

Insomnia (p. 202)

Duckworth. London, England. 1937

## INSPIRATION

**Huggins, Sir William** 1824–1910  
English astronomer

A feeling as of inspiration seized me: I felt as if I had it now in my power to lift a veil which had never before been lifted; as if a key had been put into my hands which would unlock a door which had been regarded as forever closed to man – the veil and door behind which lay the unknown mystery of the true nature of the heavenly bodies.

*The New Astronomy: A Personal Retrospect*

*The Twentieth Century*, Volume XLI, June, 1897 (p. 911)

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

One must fill oneself with human science. Above all and in spite of all, be a man. Do not fear to surcharge yourself with humanity. Ballast your mind with reality and then throw yourself into the sea – the sea of inspiration.

Translated by L. O’Rourke

*Intellectual Autobiography* (pp. 124–125)

Funk & Wagnalls Company. London, England. 1907



**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

One need only open the eyes to see that the conquest of industry which have enriched so many practical men would never have seen the light, if these practical men alone had existed and if they had not been preceded by unselfish devotees who died poor, who never thought of utility, and yet had a guide far other than caprice.

*The Foundations of Science  
Science and Method*, Book I  
Chapter I (p. 363)  
The Science Press. New York, New York, USA. 1913

**Sand, George (Amantine-Lucile-Aurore Dupin)** 1804–76  
French novelist and feminist

We are of nature, in nature, by nature, and for nature. Talent, will, genius are natural phenomena like the lake, the volcano, the mountain, the wind, the star, the cloud.

Translated by A.L. McKenzie  
*The George Sand—Gustave Flaubert Letters*  
Letter CCLXXX (p. 323)  
Duckworth & Company Ltd. London, England. 1922

**Wallace Barnes (Fictional character)**

You know, there's such a very thin dividing line between inspiration and obsession that sometimes it's very hard to decide which side we're really on.

*The Dambusters*  
Film (1955)

## INSTINCT

**Barrett, C. L.**  
No biographical data available

If it be objected that the term instinct is meaningless, I can only reply that there are many things in nature to which we attach convenient labels, although they still remain beyond our understanding.

*Annual Report of the Board of Regents of the Smithsonian Institution (1909)*  
The Origin and Development of Parasitical Habits in the Cuculidae (p. 492)  
Government Printing Office. Washington, D.C. 1910

**Bridges, Robert Seymour** 1844–1930  
English poet

'Tis laughable that men should fondle such surprise  
at animal behavior, seeing some beetle or fly  
– whose very existence is so negligible and brief –  
act more intelligently than he might himself had he been  
there to advise with all his pros and cons,  
his cause, effects and means: Such conduct he will style  
“Marvels of Instinct”, but what sort of wisdom is this that  
mistaketh the exception for the general rule and the rule  
for the exception?

*The Testament of Beauty – A Poem in Four Books*  
Book I  
At The Clarendon Press. Oxford, England. 2007

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Instinct... is crystallized intelligence ...  
*The Writings of Oliver Wendell Holmes (Volume 9)*  
*Medical Essays: 1842–1882*  
Chapter IV (p. 247)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

...the more we observe and study, the wider we find the range of the automatic and instinctive principles in body, mind, and morals, and the narrower the limits of the self-determining conscious movement ...

*The Autocrat of the Breakfast-table*  
Chapter IV (p. 79)  
J.M. Dent & Co. London, England. 1907

**James, William** 1842–1910  
American philosopher and psychologist

The whole story of our dealings with the lower wild animals is the history of our taking advantage of the way in which they judge of everything by its mere label, as it were, so as to ensnare or kill them. Nature, in them, has left matters in this rough way, and made them act *always* in the manner which would be *oftenest* right. There are more worms unattached to hooks than impaled upon them; therefore, on the whole, says Nature to her fishy children, bite at every worm and take your chances. But as her children get higher, and their lives more precious, she reduces the risks. Since what seems to be the same object may be now a genuine food and now a bait; since in gregarious species each individual may prove to be either the friend or the rival, according to the circumstances, of another; since any entirely unknown object may be fraught with weal or woe, *Nature implants contrary impulses to act on many classes of things*, and leaves it to slight alterations in the conditions of the individual case to decide which impulse shall carry the day. Thus, greediness and suspicion, curiosity and timidity, coyness and desire, bashfulness and vanity, sociability and pugnacity, seem to shoot over into each other as quickly, and to remain in as unstable equilibrium, in the higher birds and mammals as in man.

*The Principles of Psychology* Volume 2  
Chapter XXIV (p. 392)  
Henry Holt & Co. New York, New York, USA. 1918

**May, Rollo** 1909–94  
American psychologist

An instinct, Freud emphasizes, has as its goal the restoring of an earlier state. He borrows here from the second law of thermodynamics that the energy of the universe is constantly running down. Since "...an instinct is an urge inherent in organic life to restore an earlier state of



things..." and "inanimate things existed before living ones," so our instincts push us back to the inanimate. The instincts move toward nirvana, which is complete absence of excitation. The "aim of all life is death." And here we find ourselves at Freud's most controversial theory termed the death instinct, or Thanatos.

*Love and Will*

Chapter Three (p. 85)

W.W. Norton & Company, Inc. New York, New York, USA. 1969

**Sterling, John** 1806–44

English author

...instinct is intelligence incapable of self-consciousness.

In Julius Charles Hare (ed.)

*Essays and Tales* Volume 2

Thoughts, Thoughts and Images (p. 146)

John W. Parker. London, England. 1848

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

...obeying the living hand of the past which is within them.

*The Outline of Science* (Volume 1)

Chapter VII (p. 220)

G.P. Putnam's Sons. New York, New York, USA. 1937

**White, Gilbert** 1720–93

English naturalist and cleric

To a thinking mind nothing is more wonderful than that early instinct which impresses young animals with the notion of the situation of their natural weapons, and of using them properly in their own defense, even before those weapons subsist or are formed.

*The Natural History of Selborne*

Letter XXXI (p. 178)

Robert M. McBride & Company. New York, New York, USA. 1925

They who write on natural history cannot too frequently advert to instinct, that wonderful limited faculty, which, in some instances, raises the brute creation as it were above reason, and in others leaves them so far below it.

*The Natural History of Selborne*

Letter LVI (p. 221)

Robert M. McBride & Company. New York, New York, USA. 1925

## INSTRUMENT

**Abbott, Donald Putnam** 1920–86

American marine biologist and professor

There's no substitute for fine forceps. None.

In Galen Howard Hilgard (ed.)

*Observing Marine Invertebrates: Drawings from the Laboratory*

Author's Preface (p. xvii)

Stanford University Press. Stanford, California, USA. 1987

### Author undetermined

Man cannot but feel a sense of pleasure, and even of power, when, through the instruments constructed by

his ingenuity, he finds himself brought within reach, as it were, of the innumerable orbs that roll through the domains of space.

*The Story of The Herschels: A Family of Astronomers*

Chapter I (p. 6)

T. Nelson & Sons. London, England. 1889

**Babbage, Charles** 1792–1871

English mathematician

The first step in the use of every instrument is to find the limits within which its employer can measure the *same object under the same circumstances*. It is only from knowledge of this that he can have confidence in his measures of the *same object under different circumstances*, and after that, of *different objects under different circumstances*.

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter V (p. 172)

Printed for B. Fellowes. London, England. 1830

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

The unassisted hand and the understanding left to itself possess but little power. Effects are produced by the means of instruments and helps, which the understanding requires no less than the hand; and as instruments either promote or regulate the motion of the hand, so those that are applied to the mind prompt or protect the understanding.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 2 (p. 107)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Baudrillard, Jean** 1929–

French cultural theorist

It is like the expanding universe. The more our instruments penetrate it, the further the limits recede.

Translated by Chris Turner

*Cool Memories*

October, 1983 (p. 145)

Verso. London, England. 1990

**Bridgman, Percy Williams** 1882–1961

American physicist

Not only do we use instruments to give us fineness of detail inaccessible to direct sense perception, but we also use them to extend qualitatively the range of our senses into regions where our senses no longer operate...

*The Way Things Are*

Chapter V (p. 149)

Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Burrard, Sidney Gerald** 1860–1943

No biographical data available

**Hayden, Horace H.** 179–1844

Geologist and botanist

All observations are liable to error; no telescope is perfect, no leveling instrument entirely trustworthy; no instrumental graduations are exact and no observer is infallible.

*A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*

Chapter 4 (p. 23)

Superintendent Government Printing. Calcutta, India. 1907–1908

**Carpenter, William Benjamin** 1813–85

English physiologist and naturalist

No one who attentively examines the progress of any department of Science, save such as are (like Mathematics or Metaphysics) of a purely abstract character, can fail to perceive how much it is dependent upon the perfection of its *instruments*.

*The Microscope and Its Revelations*

Introduction (p. 1)

John Churchill. London, England. 1866

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Men can construct a science with very few instruments, or with very plain instruments; but no one on earth could construct a science with unreliable instruments.

*Heretics*

Science and the Savages (p. 147)

Books for Libraries Press. Freeport, New York, USA. 1970

**Davy, Sir Humphry** 1778–1829

English chemist

...nothing tends so much to the advancement of knowledge as the application of a new instrument. The native intellectual powers of men in different times are not so much the causes of the different success of their labours, as the peculiar nature of the means and artificial resources in their possession.

In Thomas Hager

*Force of Nature: The Life of Linus Pauling*

Chapter 4 (p. 86)

Simon & Schuster. New York, New York, USA. 1995

In physical science the imperfections of our instruments of investigation, the fallacies to which we are liable from the modifications of impressions by the state of feeling, and the minute nature and the complicated relations of the objects of research, prevent us from attaining to that state of certainty afforded by the results of the science of quantity.

In John Davy

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter II (p. 123)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Egler, Frank E.** 1911–96

American botanist and ecologist

Dazed with this brightness of our technology, I wonder if some are not inclined to forget that the most important

instrument in science must always be the mind of man.

*The Way of Science*

Methodology and Instrumentation (p. 59)

Hafner Publishing Company. New York, New York, USA. 1970

**Eisenhart, Churchill** 1913–94

Statistician

Of wonders of science and feats of design

Has many a scribe writ the praise;

And if I now mention the subject again

It's distinctly a relative phase.

For while science and gadgets are fine in their ways

One worries at times 'bout their clutch,

Especially when science, design, and math'matics

Combine to get us in Dutch.

Operational Aspects of Instrument Design

*Science*, Volume 110, October 7, 1949 (p. 343)

**Enriques, Federigo** 1871–1946

Italian mathematician

...impossibility exists only in relation to the instruments specified.

*Problems of Science*

Introduction (p. 7)

The Open Court Publishing Co. La Salle, Indiana, USA. 1914

**Flexner, Abraham** 1866–1959

American educator

Science lies in the intellect, not in the instruments.

*Medical Education: A Comparative Study*

Chapter I (pp. 6–7)

The Macmillan Company. New York, New York, USA. 1925

**Foster, Bishop**

No biographical information available

Man, having one kind of an eye given him by his Maker, proceeds to construct two other kinds [of scopes]. He makes one that magnifies invisible objects thousands of times, so that a dull razor-edge appears as thick as three fingers, until the amazing beauty of color and form in infinitesimal objects is entrancingly apparent, and he knows that God's care of least things is infinite. Then he makes the other kind four or six feet in diameter, and penetrates the immensities of space thousands of times beyond where his natural eye can pierce, until he sees that God's immensities of worlds are infinite also.

In Henry Warren

*Recreations in Astronomy*

Chapter III (p. 43)

Chautauqua Press. New York, New York, USA. 1886

**Galison, Peter**

American physicist and historian

The modern history of instruments and the patterns of their use may lack the glamour of the history of our over arching theoretical constructs. Nonetheless, these

bubbling, sparking, clanking devices remain the weft and the warp of physics.

In Peter Achinstein and Owen Hannaway  
*Observation, Experiment and Hypothesis in Modern Physics*  
Bubble Chambers and the Experimental Workplace (p. 359)  
The MIT Press. Cambridge, Massachusetts, USA. 1985

### **Giere, Ronald**

American philosopher of science

The overwhelming presence of machines and instrumentation must be one of the most salient features of the modern scientific laboratory.... The development of science depends at least as much on new machinery as it does on new ideas.

*Explaining Science: A Cognitive Approach*  
Chapter 5 (p. 138)  
The University of Chicago Press. Chicago, Illinois, USA. 1988

### **Gogarty, Oliver St. John** 1878–1957

Irish author

The telescope, the microscope and the test-tube have made skeptics of us all. We have changed wisdom for an exact knowledge of stains, precipitants, reactions and refractions, and put it, for this generation at least, beyond recall.

*I Follow Saint Patrick*  
Chapter 15  
Reynal & Hitchcock. New York, New York, USA. 1938

### **Hale, George Ellery** 1868–1938

American astronomer

We need the ideas of men from all parts of the world; we need the contributions they can make; and we need them more than we need larger instrumental means than we now possess.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*  
Some Opportunities for Astronomical Work with Inexpensive Apparatus (p. 285)  
Government Printing Office. Washington, D.C. 1908

### **Hardy, Thomas** 1840–1928

English poet and regional novelist

Then, by means of the instrument at hand, they traveled together from the earth to Uranus and the mysterious outskirts of the solar system; from the solar system to “61 Cygni,” the nearest fixed star in the northern sky; from “61 Cygni” to remoter stars; thence to the remotest visible, till the ghastly chasm which they had bridged by a fragile line of sight was realized ...

*Two on a Tower*  
Chapter IV (p. 38)  
Henry Holt & Co. New York, New York, USA. 1882

### **Hooper, Wynnard**

No biographical data available

It is found convenient to speak of the science of Spectrum Analysis and of Microscopical Science, on the following

grounds: – All complicated scientific instruments require that those who use them should understand them thoroughly, and should be able to adjust them should they get out of order. Now the knowledge which enables the operator to use his instrument effectively, and to restore its efficiency when it is not in working order, is important enough to be termed “scientific.”

*The Method of Statistical Analysis*  
*Journal of the Royal Statistical Society*, Volume 44, March, 1881 (p. 47)

### **Kuhn, Thomas S.** 1922–96

American historian of science

...scientists see new and different things when looking with familiar instruments in places they have looked before.... It is as elementary prototypes for these transformations of the scientist’s world that the familiar demonstrations of a switch in visual gestalt prove so suggestive. What were ducks in the scientist’s world before the revolution are rabbits afterwards.

*The Structure of Scientific Revolutions*  
Chapter X (p. 111)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

### **Lavoisier, Antoine Laurent** 1743–94

French chemist

As the usefulness and accuracy of chemistry depend entirely upon the determination of the weights of the ingredients and products, too much precision cannot be employed in this part of the subject; and for this purpose, we must be provided with good instruments.

*Elements of Chemistry in a New Systematic Order*  
Part III, Chapter I (p. 88)  
Printed for William Creech. Edinburgh, Scotland. 1790

In the present advanced state of chemistry, very expensive and complicated instruments are become indispensably necessary for ascertaining the analysis and synthesis of bodies with the requisite precision as to quantity and proportion; it is certainly proper to endeavor to simplify these, and to render them less costly; but this ought by no means to be attempted at the expense of their convenience of application, and much less of their accuracy.

*Elements of Chemistry in a New Systematic Order*  
Part III, Chapter I, Section II (p. 319)  
W. Creech. Edinburgh, Scotland. 1790

### **Planck, Max** 1858–1947

German physicist

It goes without saying that the laws of nature are in themselves independent of the properties of the instruments with which they are measured. Therefore in every observation of natural phenomena we must remember the principle that the reliability of the measuring apparatus must always play an important role.

Translated by James Murphy  
*Where is Science Going?*  
Chapter I (pp. 63–64)  
George Allen & Unwin. London, England. 1933

**Proctor, Richard Anthony** 1837–88  
English astronomer

Larger and larger grew the universe... as men turned more and more powerful, more and more exact instruments to the survey of the heavens.

*Mysteries of Time and Space*

Newton and Darwin (p. 2)

R. Worthington. New York, New York, USA. 1883

**Rumford, Benjamin** 1743–1814  
American-British scientist

It frequently happens that in the ordinary affairs and occupations of life, opportunities present themselves of contemplating some of the most curious operations of Nature; and very interesting philosophical experiments might often be made, almost without trouble or expense, by means of machinery contrived for the mere mechanical purposes of the arts and manufactures.

*The Complete Works of Count Rumford* (Volume 1)

An Experimental Inquiry Concerning the Source of Heat Which is

Excited by Friction (p. 471)

American Academy of Arts & Sciences. Boston, Massachusetts, USA. 1870

**Serviss, Garrett Putnam** 1851–1921  
American science fiction writer

Perhaps one reason why the average educated man or woman knows so little of the starry heavens is because it is popularly supposed that only the most powerful telescopes and costly instruments of the observatory are capable of dealing with them. No greater mistake could be made. It does not require an optical instrument of any kind, nor much labor, as compared with that expended in the acquirement of some polished accomplishments regarded as indispensable, to give one an acquaintance with the stars and planets which will be not only pleasurable but useful.

*Astronomy With an Opera-glass*

Introduction (p. 3)

D. Appleton & Co. New York, New York, USA. 1888

**Singer, Ignatius**  
No biographical data available

**Berens, Lewis Henry**  
No biographical data available

The first duty of every inquirer into nature is to acquaint himself with the properties and peculiarities of the instruments by the aid of which he is about to make his observations.

*Some Unrecognized Laws of Nature*

Chapter II (p. 7)

D. Appleton & Co. New York, New York, USA. 1897

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Ye instruments, ye surely jeer at me,  
With handle, wheel and cogs and cylinder.  
I stood beside the gate, ye were to be the key.  
True, intricate your ward, but no bolts do ye stir.  
Inscrutable upon a sunlit day,  
Her veil will Nature never let you steal,  
And what she will not to your mind reveal,  
You will not wrest from her with levers and with screws.

In *Great Books of the Western World* (Volume 47)

*Faust*

The First Part

Night, Faust in his Study, l. 668–675

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The reason why we are on a higher imaginative level is not because we have finer imagination, but because we have better instruments.

*Science and the Modern World*

Chapter VII (p. 166)

The Macmillan Company. New York, New York, USA. 1929

## INSULIN

**Banting, Frederick G.** 1891–1941  
Canadian physiologist

Insulin is not a cure for diabetes; it is a treatment. It enables the diabetic to burn sufficient carbohydrates, so that proteins and fats may be added to the diet in sufficient quantities to provide energy for the economic burdens of life.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1923

Diabetes and Insulin (p. 68)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## INTEGER

**Hauffman, Paul**  
No biographical data available

The trouble with integers is that we have examined only the small ones. Maybe all the exciting stuff happens at really big numbers, ones we can't get our hand on or even begin to think about in any very definite way. So maybe all the action is really inaccessible and we're just fiddling around. Our brains have evolved to get us out of the rain, find where the berries are, and keep us from getting killed. Our brains did not evolve to help us grasp really large numbers or to look at things in a hundred thousand dimensions.

The Man Who Loves Only Numbers

*The Atlantic Magazine*, Volume 260, Number 5, November, 1987

**Minkowski, Hermann** 1864–09  
German mathematician

Integers are the fountainhead of all mathematics.

*Diophantische Approximationen: eine einführung in die zahlen Theorie,*  
 von Hermann Minkowski  
 Preface  
 Publisher undetermined

## INTEGRAL

**Kasner, Edward** 1878–1955  
 American mathematician

**Newman, James Roy** 1911–66  
 Mathematician and mathematical historian

...it is to the definite integral that structural engineers must render thanks for the Golden Gate Bridge, for it rests on this even more than on concrete and steel.

*Mathematics and the Imagination*  
 Chance and Chanceability – The Calculus (p. 340)  
 Simon & Schuster. New York, New York, USA. 1940

**McReynolds, J. W.**  
 No biographical information available

I am a mathematician to this extent: I can follow triple integrals if they are done slowly on a large blackboard by a personal friend.

George's Problem  
*Scripta Mathematica*, Volume 15, 1949

**McShane, E. J.**  
 No biographical information available

There are in this world optimists who feel that any symbol that starts off with an integral sign must necessarily denote something that will have every property that they should like an integral to possess.

This of course is quite annoying to us rigorous mathematicians; what is even more annoying is that by doing so they often come up with the right answer.

*Bulletin of the American Mathematical Society*, Volume 69, 1963 (p. 611)

**Sylvester, James Joseph** 1814–97  
 English mathematician

It seems to be expected of every pilgrim up the slopes of the mathematical Parnassus, that he will at some point or other of his journey sit down and invent a definite integral or two towards the increase of the common stock.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
 Notes to the Meditation on Poncelet's Theorem, Including a Valuation of the Two New Definite Integrals (p. 214, fn 2)  
 University Press. Cambridge, England. 1904–1912

## INTEGRATION

**Clarke, Arthur C.** 1917–  
 English science and science fiction writer

“But no-one expected he'd ever get very far, because I don't suppose he could even integrate e to the x.” “Is such ignorance possible?” gasped someone.

*Tales from the White Hart* (p. 5)  
 Publisher undetermined

**de Morgan, Augustus** 1806–71  
 English mathematician and logician

Common integration is only the memory of differentiation, the different artifices by which integration is effected are changes, not from the known to the unknown, but from forms in which memory will not serve us to those in which it will.

*Transactions of the Cambridge Philosophical Society*, Volume 8, 1844 (p. 188)

**Kettering, Charles Franklin** 1876–1958  
 American engineer and inventor

...the most highly satisfactory use of the reverse-curve sign of integration used in calculus is for those two S-openings in the top of a violin.

In T.A. Boyd  
*Professional Amateur* (p. 209)  
 E.P. Dutton & Company, Inc. New York, New York, USA. 1957

**Rankine, William John Macquorn** 1820–72  
 Scottish engineer and physicist

Now integrate L with respect to dt,  
 (t Standing for time and persuasion);  
 Then, between proper limits, 'tis easy to see,  
 The definite integral Marriage must be –  
 (A very concise demonstration).

*Songs and Fables*  
 The Mathematician in Love, Verse 7  
 J. Maclehose. Glasgow, Scotland. 1874

**Schenck, Jr., Hilbert**  
 No biographical data available

“Oh, hast thou solved the integral?  
 Here is a raise, my brainish boy!”  
 He threw his time cards in the air  
 And clapped his hands with joy.

Wockyjabber  
*The Magazine of Fantasy and Science Fiction*, May, 1960

## INTELLECT

**Bergson, Henri** 1859–1941  
 French philosopher

The history of the evolution of life, incomplete as it yet is, already reveals to us how the intellect has been formed, by an uninterrupted progress, along a line which ascends through the vertebrate series up to man. It shows us in the faculty of understanding an appendage of the faculty of acting, a more and more precise, more and more complex and supple adaptation of the consciousness of living beings to the conditions of existence that are made for them.

*Creative Evolution*  
 Introduction (p. xix)  
 The Modern Library. New York, New York, USA. 1944



**Bramah, Ernest** 1869–1942

Author

As the Book of Verses indicates, “The person who patiently awaits a sign from the clouds for many years, and fails to notice the earthquake at his feet, is devoid of intellect.”

*The Wallet of Kai Lung*

16

Grant Richards. London, England. 1911

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Intellect...sees an object as it stands in the light of science...

*The Complete Works of Ralph Waldo Emerson* (Volume 2)*Essays: First Series*

Chapter XI (p. 326)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Nature is good, but intellect is better ...

*Representative Men*

Chapter II (p. 66)

Bernhard Tauchnitz. Leipzig, Germany. 1917

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

We may insist as much as we like that the human intellect is weak in comparison with human instincts, and be right in doing so. But nevertheless there is something peculiar about this weakness. The voice of the intellect is a soft one, but it does not rest until it has gained a hearing. Ultimately, after endlessly repeated rebuffs, it succeeds. This is one of the few points in which one may be optimistic about the future of mankind.

In Jonathan Glover

*Humanity: A Moral History of the Twentieth Century*

The Future of An Illusion

Yale University Press. New Haven, Connecticut, USA. 2001

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

One-story intellects, two-story intellects, three-story intellects with skylights. All fact-collectors, who have no aim beyond their facts, are one-story men. Two-story men compare, reason, generalise, using the labours of the fact-collectors as well as their own. Three-story men idealise, imagine, predict; their best illumination comes from above, through the skylight.

*The Poet at the Breakfast-table* (p. 69)

David Douglas. Edinburgh, Scotland. 1884

**Jevons, William Stanley** 1835–82

English economist and logician

It is the prerogative of Intellect to discover what is uniform and unchanging in the phenomena around us.

*The Principles of Science: A Treatise on Logic and Scientific Method*

(2nd edition)

Chapter I (p. 3)

Macmillan &amp; Co Ltd. London, England. 1877

The dignity of intellect begins with the power of separating points of agreement from those of difference.

*The Principles of Science: A Treatise on Logic and Scientific Method*

(2nd edition)

Chapter II (p. 24)

Macmillan &amp; Co Ltd. London, England. 1877

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Only in the course of the nineteenth century, when spirit began to degenerate into intellect, did a reaction set in against the unbearable dominance of intellectualism, and this led to the unpardonable mistake of confusing intellect with spirit and blaming the latter for the misdeeds of the former.

Translated by R.F.C. Hull

*Alchemical Studies*

Difficulties Encountered by a European in Trying to Understand the East (p. 9)

Princeton University Press. Princeton, New Jersey, USA. 1967

**Mellor, Joseph William** 1863–1938

Chemist

...man has to apply a very weak intellect to a very complicated world; and the resources of the human intellect are too narrow, and the universe is too complex to leave any hope that it will ever be within man's power to carry scientific perfection to Tennyson's last degree of simplicity:

... One law, one element.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 10)

Longman, Green, &amp; Co. London, England. 1922

**Tischner, August**

No biographical data available

It is strange: even sound intellects yield to that mighty incubus, the spirit of the age!

*The Fixed Idea of Astronomical Theory* (p. 36)

Gustav Fock. Leipzig, Germany. 1885

**Tyndall, John** 1820–93

Irish-born English physicist

We cannot quench [the] desires of the intellect. They are stimulated by the phenomena which surround us in our present state of existence as the body is by oxygen; and in the presence of these phenomena man thirsts for knowledge as an Arab longs for water when he smells the Nile. In Royal Institute of Great Britain

*Lectures on Education: Delivered at the Royal Institute of Great Britain*

On the Importance of the Study of Physics (p. 175)

John W. Parker &amp; Son. London, England. 1854



Whether we see rightly or wrongly – whether our intellection be real or imaginary – it is of the utmost importance in science to aim at perfect clearness in the description of all that comes, or seems to come, within the range of the intellect.

*Fragments of Science for Unscientific People*  
Chapter X (p. 242)

D. Appleton & Co. New York, New York, USA. 1875

...there is in the human intellect a power of expansion – I might almost call it a power of creation – which is brought into play by the simple brooding upon facts.

*Scientific Addresses*

Scientific Use of the Imagination (p. 39)

Charles C. Chatfield. New Haven, Connecticut, USA. 1870

## INTELLECTUAL

**Hamerton, Philip Gilbert** 1834–94

English artist and art critic

The intellectual life is sometimes a fearfully solitary one. Unless he lives in a great capital the man devoted to that life is more than all other men liable to suffer from isolation, to feel utterly alone beneath the deafness of space and the silence of the stars.

*The Intellectual Life*

Part VII, Letter II (p. 237)

Little, Brown & Co. Boston, Massachusetts, USA. 1901

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

In the modern world the celibacy of the medieval learned class has been replaced by a celibacy of the intellectual which is divorced from the concrete contemplation of the complete facts.

*Science and the Modern World*

Chapter XIII (p. 283)

The Macmillan Company. New York, New York, USA. 1929

## INTELLECTUAL FACULTY

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The types of mind which result from training in mathematics and in biology certainly differ profoundly; but the difference does not seem to lie in the intellectual faculty.

*Genetical Theory of Natural Selection*

Preface (p. viii)

At The Clarendon Press. Oxford, England. 1930

## INTELLIGENCE

**Bradbury, Ray** 1920–

American writer

The universe is full of matter and force. Yet in all that force, amongst all the bulks and gravities, the rains of

cosmic light, the bombardment of energy – how little spirit, how small the decimal points of intelligence.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 133)

Harper & Row, Publishers. New York, New York, USA. 1973

**Grassé, Pierre P.** 1895–1985

French zoologist

Any living thing possesses an enormous amount of “intelligence....” Today, this “intelligence” is called “information,” but it is still the same thing.... This “intelligence” is the sine qua non of life. If absent, no living being is imaginable. Where does it come from? This is a problem which concerns both biologists and philosophers, and, at present, science seems incapable of solving it.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*

An Introduction to the Study of Evolution (p. 2)

Academic Press. New York, New York, USA. 1977

**Hinton, Charles Howard** 1853–1907

English mathematician

At the present time our actions are largely influenced by our theories. We have abandoned the simple and instinctive mode of life of the earlier civilisations for one regulated by the assumptions of our knowledge and supplemented by all the devices of intelligence.

*Scientific Romances: First Series*

What is the Fourth Dimension? Chapter I (p. 3)

Swan Sonnenschein, Lowrey & Co. London, England. 1886

**Lemon, Harvey Brace**

Physicist

In our recognition that order is universal, a fact confirmed by myriads of observations of patient, indefatigable, and devoted investigators, the old saying that “an irreverent astronomer is mad” can apply with equal force to the physicist. Man learns something of his own minute and colossal stature, and he comes to feel that his own intelligence, which enables him to make such sublime discoveries, is the supreme achievement of evolution.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Atomic Structure (p. 98)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Lilly, John**

No biographical data available

The highest intelligence on the planet probably exists in a sperm whale, who has a ten-thousand-gram brain, six times larger than ours.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Altered States (p. 165)

Ticknor & Fields. New York, New York, USA. 1984

**Morris, Robert Tuttle** 1857–1945  
American surgeon

Man is the only animal persistently engaged in bringing about his own destruction. He does this with what he calls his intelligence ...

*Microbes and Men*

Chapter I (p. 3)

Doubleday Page & Co. Garden City, New York, USA. 1916

**Simak, Clifford D.** 1904–88  
American writer

The emergence of intelligence, I am convinced, tends to unbalance the ecology. In other words intelligence is the great polluter. It is not until a creature begins to manage its environment that nature is thrown into disorder.

*Shakespeare's Planet* (p. 113)

Berkeley Publishers, Inc. New York, New York, USA. 1976

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

What, unless biological science is a mass of errors, is the cause of human intelligence and vigour? Hardship and freedom: conditions under which the active, strong, and subtle survive and the weaker go to the wall ...

*Seven Science Fiction Novels of H. G. Wells*

*The Time Machine*

Chapter 4 (p. 27)

Dover Publications, Inc. New York, New York, USA. 1934

Nature never appeals to intelligence until habit and instinct are useless. There is no intelligence where there is no change and no need of change.

*Seven Science Fiction Novels of H. G. Wells*

*The Time Machine*

Chapter 10 (p. 65)

Dover Publications, Inc. New York, New York, USA. 1934

## INTELLIGENT DESIGN

**Darwin, Charles Robert** 1809–82  
English naturalist

Your question what would convince me of Design is a poser. If I saw an angel come down to teach us good, and I was convinced from others seeing him that I was not mad, I should believe in design.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter III (p. 169)

Letter To Asa Gray, September 17, 1861

D. Appleton & Company. New York, New York, USA. 1887

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

I belong to the group of scientists who do not subscribe to a conventional religion but nevertheless deny that the universe is a purposeless accident.... [T]he physical

universe is put together with an ingenuity so astonishing that I cannot accept it merely as a brute fact. There must... be a deeper level of explanation.

*The Mind of God: The Scientific Basis for a Rational World*

Preface (p. 16)

Simon & Schuster. New York, New York, USA. 1992

**Dembski, William A.** 1960–  
American mathematician and philosopher

Scientists rightly resist invoking the supernatural in scientific explanations for fear of committing a god-of-the-gaps fallacy (the fallacy of using God as a stop-gap for ignorance). Yet without some restriction on the use of chance, scientists are in danger of committing a logically equivalent fallacy – one we may call the “chance-of-the-gaps fallacy.” Chance, like God, can become a stop-gap for ignorance.

*The Chance of the Gaps*

Paper presented at conference, Boulder, Colorado. Fall 2001

What has kept design outside the scientific mainstream these last 130 years is the absence of precise methods for distinguishing intelligently caused objects from unintelligently caused ones. For design to be a fruitful scientific theory, scientists have to be sure they can reliably determine whether something is designed.... This fear of falsely attributing something to design only to have it overturned later has prevented design from entering science proper....

*Mere Creation: Science, Faith and Intelligent Design*

Introduction (p. 16)

InterVarsity Press. Downers Grove, Illinois, USA. 1998

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

...overpoweringly strong proofs of intelligent and benevolent design lie all round us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler.

*Popular Lectures and Addresses* (Volume 2)

Presidential Address to the British Association, Edinburgh, 1871 (p. 205)

Macmillan & Company Ltd. London, England. 1894

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

You all know the argument from design: everything in the world is made just so that we can manage to live in the world, and if the world was ever so little different, we could not manage to live in it.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Why I Am Not a Christian (p. 9)

Watts. London, England. 1927

## INTERACTION

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Nothing, in fact, is small, and anyone who is affected by the profound penetration of nature is aware of this fact. Although no absolute satisfaction is granted to philosophy, and though it can no more circumscribe the cause than limit the effect, the contemplator falls into unfathomable ecstasy when he watches all the decomposition of forces which result in unity. Everything labors for everything.

*Les Misérables*

Volume 4, Book III, Chapter 3 (p. 67)  
The Heritage Press. New York, New York, USA. 1938

Algebra is applied to the clouds, the irradiation of the planet benefits the rose, and no thinker would dare to say that the perfume of the hawthorn is useless to the constellation.

*Les Misérables*

Volume 4, Book III, Chapter 3 (p. 67)  
The Heritage Press. New York, New York, USA. 1938

## INTERDEPENDENCE

**Muir, John** 1838–1914  
American naturalist

To the dwellers of the plain, dependent on irrigation, the Big Tree, leaving all its higher uses out of the count, is a tree of life, a never failing spring, sending living water to the lowlands all through the hot, rainless summer.

*Our National Parks*

Chapter IX (p. 329)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Plants, animals and stars are all kept in place, bridled along appointed way, with one another, and through the midst of one another killing and being killed, eating and being eaten, in harmonious proportions and quantities.

*Steep Trails*

Chapter I (p. 13)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

...consumption of one another... is a kind of culture varying with the degree of directness with which it is carried out, but we should be careful not to ascribe to such culture any improving qualities upon those on whom it is brought to bear.

*Steep Trails*

Chapter I (p. 13)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## INTERN

**Stone, John**  
No biographical data available

The old man asked, "Are you an Intern?" Hearing the young doctor's tired, "Yes," the old man followed with another question: "Do you know what it takes to be a good Intern? It takes the heart of a lion, the eye of an eagle, and the hand of a woman."

In D. Abse (ed.)

*My Medical School* (p. 196)  
Robson Books. London, England. 1978

## INTERNIST

**Findley, Thomas**  
Physician

An internist has been defined as a man who is totally unable to answer either yes or no to any question.... If there is such a thing as a typical internist, he is a sedentary individual, curious, skeptical, reflective. He is accustomed to look at the patient as a unit rather than as a collection of separate organs and, if he had the fundamental scientific training he should have had, he is eager to distinguish between a fact and someone's opinion.

The Obligations of an Internist to a General Surgeon

*Surgery*, Volume 16, 1944

Accustomed to legerdemain and quick results, [the surgeon] is apt to regard the diagnosis and treatment of a headache, for example, as a trivial matter, forgetting that the internist may require hours of probing before discovering that what the patient needs is not a new pair of glasses but a different mother-in-law.

The Obligations of an Internist to a General Surgeon

*Surgery*, Volume 16, 1944

## INTERPRET

**Burroughs, John** 1837–1921  
American naturalist and essayist

It is not in the act of seeing things or apprehending facts that we differ so much from one another, as in the act of interpreting what we see or apprehend.

*Under The Apple Tree*

Literature and Science (p. 176)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Gray, George W.**  
Freelance science writer

One of the imperative tasks of our day is to interpret the purposes, methods, and results of science in such wise that this greatest adventure of the human spirit may be "understood of the people." Science needs to be made use of, but understanding of it must precede complete utilization. It needs to be made use of, not only in those practical ways which lighten burdens, relieve pains, cure diseases, and increase the comforts

and conveniences of civilized life, but more – it needs to be made use of also in those higher outcomes of the new knowledge: the freeing of the individual from fear and superstition, the widening of intellectual horizons, the strengthening of the ties of mutual interest which alleviate man's inhumanity to man.

*The Advancing Front of Science*

Prologue (p. 5)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1937

## INTERPRETATION

**Leakey, Mary** 1913–96

English archaeologist

There is so much we do not know, and the more we do know, the more we realize that early interpretations were completely wrong. It is good mental exercise, but people get so hot and nasty about it, which I think is ridiculous.

Marguerite Holloway

*Scientific American*, October, 1994

**Shah, Idries** 1924–96

Persian author and teacher in the Sufi tradition

...for every person there is an interpretation.

*Thinkers of the East*

Reading (p. 105)

Jonathan Cape. London, England. 1971

## INTERSTELLAR MESSAGE

### Baron Munchausen (Fictional character)

I immediately perceived the true descent of this people, which does not appear of terrestrial origin, but descended from some of the inhabitants of the moon, because the principal language spoken there, and in the centre of Africa, is very nearly the same. Their alphabet and method of writing are pretty much the same, and show the extreme antiquity of this people, and their exalted origin. I here give you a specimen of their writing...

*The Surprising Adventures of Baron Munchausen*

Chapter XXV (p. 178)

Thomas Y. Crowell Company, Publishers. New York, New York, USA.

1902

**Thomas, Lewis** 1913–93

American physician and biologist

Perhaps the safest thing to do at the outset, if technology permits, is to send music...I would vote for Bach, all of Bach, streamed out into space, over and over again. We would be bragging, of course, but it is surely excusable for us to put the best possible face on at the beginning of such an acquaintance.

*The Lives of a Cell: Notes of a Biology Watcher*

Ceti (p. 45)

The Viking Press. New York, New York, USA. 1974

## INTIMIDATION

**Shaw, George Bernard** 1856–1950

Irish playwright

It's always the way with the inartistic professions: when they're beaten in argument they fall back on intimidation. I never knew a lawyer yet who didn't threaten to put me in prison sooner or later. I never knew a parson who didn't threaten me with damnation. And now you threaten me with death. With all your tall talk you've only one real trump in your hand, and that Intimidation.

*The Doctor's Dilemma*

Act III (p. 153)

Penguin Books. Baltimore, Maryland, USA. 1954

## INTRODUCTION

**Wiese, W. L.**

No biographical data available

**Smith, Melvin William**

No biographical data available

**Glennon, B. M.**

No biographical data available

After having written introductory remarks for 9.2 elements, we must confess that this becomes a rather cumbersome exercise in style. Since we expect that this introduction will share the fate of most introductions (namely be ignored) and since there is nothing new to say on this ion (for scientific content see F I) we might as well give the few readers of this introduction some good advice:

If there is no other data source,

Use the Coulomb approximation, of course. The results should certainly be fine

For any moderately or highly excited line.

*Atomic Transition Probabilities* (p. 117)

US Dept. of Commerce, National Bureau of Standards. Washington,

D.C. 1966

## INTUITION

**Bruner, Jerome Seymour** 1915–

American psychologist

Intuition implies the act of grasping the meaning or significance or structure of a problem without explicit reliance on the analytical apparatus of one's craft. It is the intuitive mode that yields hypotheses quickly, that produces interesting combinations of ideas before their worth is known. It precedes proof: indeed, it is what the techniques of analysis and proof are designed to test and check. It is founded on a kind of combinatorial playfulness that is only possible when the consequences of error are not overpowering or sinful. Above all, it is a form of

activity that depends upon confidence in the worthwhile-ness of the process of mathematical activity rather than upon the importance of right answers at all times.

On Learning Mathematics

*Mathematics Teacher*, Volume 53, December, 1960 (p. 613)

### Dahlke, Paul

Established the first German Buddhist monastery

As all vegetable growth demands an impulsion, a provocation, so also does that mental growth which science names "intuition." One does not arrive at an intuition by the paths of induction-deduction; one grows into it.

Translated by the Bhikkhau Silacara

*Buddhism & Science*

Chapter 6 (p. 83)

Macmillan & Co Ltd. London, England. 1913

### Dantzig, George Bernard 1914–2005

American mathematician

I had no experience at the time with problems in higher dimensions, and I didn't trust my geometrical intuition. For example, my intuition told me that the procedure would require too many steps wandering from one adjacent vertex to the next. In practice, it takes few steps. In brief, one's intuition in higher dimensional space is not worth a damn!

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 77)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

### Einstein, Albert 1879–1955

German-born physicist

To these elementary laws there leads no logical path, but only intuition, supported by being sympathetically in touch with experience.

In Gerald Holton

*Thematic Origins of Scientific Thought: Kepler to Einstein*

Chapter 10 (p. 357)

Harvard University Press. Cambridge, Massachusetts, USA. 1973

...there is no logical way to the discovery of these elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance...

In Max Planck

*Where Is Science Going?*

Prologue, (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

### Huxley, Aldous 1894–1963

English writer and critic

...experience is not a matter of having actually swum the Hellespont, or danced with the dervishes, or slept in a doss-house. It is a matter of sensibility an intuition, of seeing and hearing the significant things, of paying attention at the right moments, of understanding and coordinating. Experience is not what happens to a man; it is

what a man does with what happens to him.

*Texts and Pretexts: An Anthology with Commentaries*

Introduction (p. 5)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1933

### Klee, Paul 1879–1940

Swiss painter

When intuition joins exact research, the progress of understanding will be accelerated astoundingly.

In Rolf Huisgen

*The Adventure Playground of Mechanisms and Novel Reactions*

*Marginalia on Art and Science* (p. 211)

American Chemical Society. Washington, D.C. 1994

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Intuition... does not give us certainty.

Translated by George Bruce Halsted

*The Value of Science*

Part I, Chapter I (p. 18)

The Science Press. New York, New York, USA. 1907

...logic and intuition have each their necessary role. Each is, indispensable. Logic, which alone can give certainty, is the instrument of demonstration; intuition is the instrument of invention.

Translated by George Bruce Halsted

*The Value of Science*

Part I, Chapter I (p. 23)

The Science Press. New York, New York, USA. 1907

The chief end of mathematical instruction is to develop certain powers of the mind, and among these the intuition is not the least precious. By it the mathematical world comes in contact with the real world, and even if pure mathematics could do without it, it would always be necessary to turn to it to bridge the gulf between symbol and reality. The practitioner will always need it, and for one mathematician there are a hundred practitioners. However, for the mathematician himself the power is necessary, for while we demonstrate by logic, we create by intuition; and we have more to do than to criticize others' theorems, we must invent new ones, this art, intuition teaches us.

In James Byrnie Shaw

Henri Poincare as An Investigator

*Popular Science Monthly*, March, 1913 (p. 222)

### von Humboldt, Alexander 1769–1859

German naturalist and explorer

That which for a long time remains merely an object of vague intuition, by degrees acquires the certainty of positive truth; and man, as an immortal poet has said, in our own tongue – Amid ceaseless change seeks the unchanging pole.

*Cosmos* (Volume I)

Introduction (p. 16)

Henry G. Bohn. London, England. 1849



**INTUITIVE**

**Pascal, Blaise** 1623–62  
French mathematician and physicist

All mathematicians would...be intuitive if they had clear sight, for they do not reason incorrectly from principles known to them; and intuitive minds would be mathematical if they could turn their eyes to the principles of mathematics to which they are unused.

*Thoughts*

Section I (p. 7)

P.F. Collier & Son. New York, New York, USA. 1910

**INVALID**

**Tracy, Susan Edith** 1864–1926  
American nurse

Whoever succeeds in making an invalid happy and in maintaining this same state of happiness has gone a long way towards making him well. The secretory system has subtle connecting lines with his mental attitude, a temptingly arranged tray, a fine aroma, the sight of delicious fruit produce instant stimulation of digestive fluids; deeper breathing results from a sight of real grandeur, it is easy to take deep inspirations as we look out over a wide stretch of sea or up to towering mountains. May we not justly feel that wounds heal quicker where a tranquil mind exists, that the complex organism recognizes the atmosphere which dominates and settles down into comfort as naturally as a cat curls up before a fire on the

Some Profitable Occupations for Invalids

*The American Journal of Nursing* Volume 8

December, 1907 (pp. 172–173)

**Yourcenar, Marguerite** 1903–87  
French writer

Nothing seemed simpler: a man has the right to decide how long he may usefully live...sickness disgusts us with death, and we wish to get well, which is a way of wishing to live. But weakness and suffering, with manifold bodily woes, soon discourage the invalid from trying to regain ground: he tires of those respites which are but snares, of that faltering strength, those ardors cut short, and that perpetual lying in wait for the next attack.

*Memoirs of Hadrian*

Patientia (pp. 278, 279)

Farrar, Straus & Company. New York, New York, USA. 1963

**INVARIANCE**

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

It is now natural for us to try to derive the laws of nature and to test their validity by means of the laws of invari-

ance, rather than to derive the laws of invariance from what we believe to be the laws of nature.

*Symmetries and Reflections*

Chapter 1 (p. 5)

Ox Bow Press. Woodbridge, Connecticut, USA. 1979

**INVARIANTS**

**Sylvester, James Joseph** 1814–97  
English mathematician

As all roads are said to lead to Rome, so I find, in my own case at least, that all algebraic inquiries sooner or later end at the Capitol of Modern Algebra over whose shining portal is inscribed “Theory of Invariants.”

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

An Inquiry into Newton’s Rule for the Discovery of Imaginary Roots

(p. 380, fn 1)

University Press. Cambridge, England. 1904–1912

The theory [of invariants] I am about to expound, or whose birth I am about to announce, stands to this in the relation not of a younger sister, but of a brother, who, though of later birth, on the principle that the masculine is more worthy than the feminine, or at all events, according to the regulations of the Salic law, is entitled to take precedence over his elder sister, and exercise supreme sway over their united realms.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 4)

On the Method of Recipients (p. 281)

Cambridge University Press. Cambridge, England. 1908

**INVENT**

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

Science has always been too dignified to invent a good back-scratcher.

In Edward Anthony

*O Rare Don Marquis* (p. 354)

Doubleday & Co., Inc. Garden City, New York, USA. 1962

**Slossin, Edwin Emery** 1865–1919  
Chemist and author

...in the course of time man often finds that he can make something new which is better than anything in nature or naturally produced. The savage discovers. The barbarian improves. The civilized man invents. The first finds. The second fashions. The third fabricates.

*Creative Chemistry*

Chapter I (p. 4)

The Century Co. New York, New York, USA. 1921

**INVENTION**

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist



The human mind is often so awkward and ill-regulated in the career of invention that is at first diffident, and then despises itself. For it appears at first incredible that any such discovery should be made, and when it has been made, it appears incredible that it should so long have escaped men's research. All which affords good reason for the hope that a vast mass of inventions yet remains, which may be deduced not only from the investigation of new modes of operation, but also from transferring, comparing and applying those already known, by the methods of what we have termed literate experience.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 110 (p. 129)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Brecht, Bertolt** 1898–1956

German writer

The more we can squeeze out of nature by inventions and discoveries and improved organization of labour, the more uncertain our existence seems to be. It's not we who lord it over things, it seems, but things which lord it over us.

*The Messingkauf Dialogues*

The Second Night, the Philosopher's Speech About Our Period (p. 42)

Methuen. London, England. 1965

**Butler, Samuel** 1835–1902

British writer

All the inventions that the world contains,  
Were not by reason first found out, nor brains;  
But pass for theirs who had the luck to light Upon them  
by mistake or oversight.

*The Poetical Works of Samuel Butler* (Volume 2)

Miscellaneous Thoughts (p. 289)

William Pickering. London, England. 1835

**D'Israeli, Isaac** 1766–1848

English critic and historian

The golden hour of invention must terminate like other hours, and when the man of genius returns to the cares, the duties, the vexations, and the amusements of life, his companions behold him as one of themselves – the creature of habits and infirmities.

*Literary Character: Or, the History of Men of Genius*

Chapter XVI (p. 183)

Routledge, Warnes & Routledge. London, England. 1859

**Disraeli, Benjamin, First Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

...there is no fallacy so flagrant as to suppose that the modern ages have the peculiar privilege of scientific discovery, or that they are distinguished as the epochs of the most illustrious inventions.

*Lothair*

Introduction (p. xvii)

Longmans, Green & Co. London, England. 1879

**Drachmann, A. G.** 1810–92

Historian of technology

I should prefer not to seek for the cause of the failure of an invention in the social conditions till I was quite sure that it was to be found in the technical possibilities of the time.

*The Mechanical Technology of Greek and Roman Antiquity*

Survey of Results (p. 206)

Munksgaard. Copenhagen, Denmark. 1963

**Dyer, Frank Lewis** 1870–1941

No biographical data available

**Martin, Thomas Commerford**

No biographical data available

All persons who make inventions will necessarily be more or less original in character, but to the man who chooses to become an inventor by profession must be conceded a mind more than ordinarily replete with virility and originality.

*Edison: His Life and Inventions* (Volume 2)

Chapter XXIV (p. 597)

Harper & Brothers. New York, New York, USA. 1929

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

In America, the geography is sublime, but the men are not; the inventions are excellent, but the inventors one is sometimes ashamed of.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Considerations by the way (p. 1084)

The Library of America. New York, New York, USA. 1983

Invention breeds invention.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Society and Solitude*

Works and Days (p. 161)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Feleki, László**

No biographical data available

With the invention of the steam engine the hell of science broke loose.

Keeping Up with Science

*Impact of Science on Society*, Volume 19, 1969 (p. 279)

**Fessenden, Reginald Aubrey** 1866–1932

Canadian physicist and inventor

And invention must still go on for it is necessary that we should completely control our circumstances. It is not sufficient that there should be organization capable of providing food and shelter for all and organization to effect its proper distribution.

In Frederick Seitz

*The Cosmic Inventor: Reginald Aubrey Fessenden Aphorisms* (p. 54)  
American Philosophical Society, Philadelphia, Pennsylvania, USA. 1999

**Galbraith, John Kenneth** 1908–2006  
Canadian-American economist

Inventions that are not made, like babies that are not born, are rarely missed.

*The Affluent Society*  
Chapter 9, Section III (p. 122)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1969

**Hamilton, Walton**  
No biographical data available

**Till, Irene**  
No biographical data available

Most discoveries patented today can be anticipated... For the most part, technicians are not self starters. The bulk of them in fact are captives; those in corporate employ are told by business executives what problems to work on... The solo inventor's real opportunity is to seize or blunder upon a pioneer idea; as a technology foliates from its base, his self reliance is hardly a match for a bevy of experts who can be kept on the job.... A captive technology offers no chance to invent except to those already in control, or to others on such terms as those in control dictate.

*Law and Contemporary Problems*, Volume 13, 1948 (p. 252)

**Hoffer, Eric** 1902–83  
American longshoreman and philosopher

We are more ready to try the untried when what we do is inconsequential. Hence the fact that many inventions had their birth as toys.

*The Ordeal of Change* (p. 113)  
Harper & Row Publishers, New York, New York, USA. 1963

**Hubbard, Elbert** 1856–1915  
American editor, publisher, and author

The brains of a thousand inventors have seethed, dreamed, contrived, thought, so as to bring me to my present form.

*Notebook of Elbert Hubbard* (p. 116)  
Publisher undetermined

In an inventor's work there is required something similar to that which the artist brings to bear.

*Notebook of Elbert Hubbard* (p. 194)  
Publisher undetermined

**Ingersoll, Robert Green** 1833–99  
American lawyer, public official, and orator

I do not know what inventions are in the brain of the future; I do not know what garments of glory may be woven for the world in the loom of years to be; we are just on the edge of the great ocean of discovery. I do not know what is to be discovered ...

*Wit, Wisdom, Eloquence, and Great Speeches of Col. R. G. Ingersoll*  
Liberty of Mind (p. 23)  
Rhodes & McClure, Chicago, Illinois, USA. 1831

**Kettering, Charles Franklin** 1876–1958  
American engineer and inventor

The lack of ideas and inventions in one generation can easily mean the loss of Freedom in the next.

*Short Stories of Science and Invention: A Collection of Radio Talks by C.F. Kettering*  
The Silent Service (p. 35)  
General Motors, Detroit, Michigan, USA. 1955

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

But for the unattainable ideal of perfect conquest of Nature, we should not have the marvels of modern Invention and Empirical Science.

*Mole Philosophy and Other Essays*  
Chapter 1 (p. 3)  
E.P. Dutton & Company, New York, New York, USA. 1927

**King, Blake**  
No biographical data available

...if your conclusion is that the operator should be able to make daily adjustments on your invention by hitting it with a rock, say so.

Object: Creativity  
*Mechanical Engineering*, November, 1963 (p. 41)

**Lankester, Edwin Ray** 1847–1929  
English zoologist

Invention is worldly wise, and despises the pursuit of knowledge for its own sake. She awaits the discoveries of Science, in order to sell them to civilisation, gathering the golden fruit which she has neither planted nor tended. Invention follows, it is true, the footsteps of Science, but at a distance: she is utterly devoid of that thriftless yearning after knowledge, that passionate desire to know the truth, which causes the unceasing advance of her guide and benefactress.

*The Advancement of Science*  
Chapter I (p. 7)  
Macmillan & Company Ltd, London, England. 1890

**Lemelson, Jerome** 1923–97  
American inventor

...an important part of invention today is being able to discover the problem.

In Kenneth A Brown  
*Inventors at Work: Interviews with 16 Notable American Inventors*  
Jerome Lemelson (p. 126)  
Temple Books of Microsoft Press, Redmond, Washington, USA. 1988

**Maclaurin, W. R.**  
No biographical data available

We have now reached a stage in many fields where inventions are almost made to order, and where there can be a

definite correlation between the number of applied scientists employed (and the funds at their disposal) and the inventive results. But one really gifted inventor is likely to be more productive than half a dozen men of lesser stature.

The Sequence from Invention to Innovation  
*Quarterly Journal of Economics*, February 1953

### Marcellus

No biographical data available

The principle reasons which have been assigned for the slow progress of the useful arts are drawn from the wide separation which has been made between science and art, and the fact that many of the greatest inventions have resulted from accident rather than superior knowledge. These considerations have tended to give to these pursuits the character of unintellectual employments.

Essay on the Mechanic Arts  
*Young Mechanic*, Volume 1, Number III, March, 1832 (p. 36)

### Marconi, Guglielmo 1874–1937

Italian physicist and inventor

Necessity is the cause of many inventions but the best ones are born of desire.

Every Man His Own Inventor  
*Colliers*, Volume 70, 1922

### Marshall, Alfred 1842–1924

English economist

The full importance of an epoch-making idea is often not perceived in the generation in which it is made... The mechanical inventions of every age are apt to be underrated relatively to those of earlier times. For a new discovery is seldom fully effective for practical purposes till many minor improvements and subsidiary discoveries have gathered themselves around it.

*Principles of Economics* (8th edition)  
Book IV, Chapter VI, I (p. 205 fn #1)  
Macmillan & Company Ltd. London, England. 1920

### McArthur, Peter 1866–1924

Canadian poet

It was a mere detail that my invention was no good.

*The Best of Peter McArthur*  
The Great Experiment (p. 26)  
Vancouver, Clarke, Irwin. Toronto, Ontario, Canada. 1967

### McCormick, Leander Hamilton 1859–1934

American author, inventor, and scientist

Invention depends upon the power to visualize that which has no existence in reality. This ability is at the foundation of all constructive talent.

*Characterology*  
Chapter XXVI (p. 600)  
Rand McNally & Co. Chicago, Illinois, USA. 1920

### Middendorf, W. H.

No biographical data available

### Brown, Jr., G. T.

No biographical data available

The romantic theory that an invention will appear in full bloom without conscious effort on the part of the gifted inventor has been deprecated.

Orderly Creative Inventing  
*Electrical Engineering*, October, 1957 (p. 861)

A full storehouse of knowledge is a necessary but not sufficient condition for invention. To this, one must add an organized method of attack.

Orderly Creative Inventing  
*Electrical Engineering*, October, 1957 (p. 867)

### Mumford, Lewis 1895–1990

American social philosopher

By his very success in inventing labor-saving devices, modern man has manufactured an abyss of boredom that only the privileged classes in earlier civilizations have ever fathomed...

*The Conduct of Life*  
Chapter I (p. 14)  
Harcourt, Brace & Company. New York, New York, USA. 1951

### Oppenheimer, James Robert 1904–67

American theoretical physicist

Manifestly not every finding leads straight to invention; but it is hard to think of major discoveries about nature; major advances in science, which have not had large and ramified practical consequences.

In Dael Wolffe (ed.)  
*Symposium on Basic Research*  
Casper Auditorium of the Rockefeller Institute, May, 1959, The Need for New Knowledge (p. 6)  
American Association for the Advancement of Science. Washington, D.C. 1959

### Payson, George 1824–93

...nothing grows old but man and his inventions....[W]ho ever heard of a decrepit rose, a superannuated violet, or a greyheaded butterfly?

*Golden Dreams*  
Introductory Chapter (p. 8)  
G.P. Putnam & Co. New York, New York, USA. 1853

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Invention is discernment, choice.

Translated by George Bruce Halsted  
*The Foundations of Science*  
*Science and Method*  
Book I, Chapter III (p. 386)  
The Science Press. New York, New York, USA. 1921

### Priestley, Joseph 1733–1804

English theologian and scientist

From Natural Philosophy have flowed all those great inventions by means of which mankind in general is able to subsist with more ease, and in greater numbers upon the face of the earth. Hence arise the capital advantages of men above brutes, and of civilization above barbarity. *The History and Present State of Electricity: With Original Experiments* (Volume 1) (p. XXI)  
Printed for C. Bathurst & T. Lowndes. London, England. 1775

**Sprat, Thomas** 1635–1713  
English historian

Invention is an Heroic thing and plac'd above the reach of a low, and vulgar Genius. It requires an active, a bold, a nimble, a restless mind: a thousand difficulties must be contemn'd, with which a mean heart would be broken: many attempts must be made to no purpose: much Treasure must be scattered without any return: much violence and vigor of thought must attend it: some irregularities and excesses must be granted it that would hardly be pardon'd by the severe Rules of Prudence. *The History of the Royal Society of London for the Improving of Natural Knowledge*  
Section XXXI (p. 392)  
Printed by T.R. London, England. 1667

**Swift, Jonathan** 1667–1745  
Irish-born English writer

The greatest Inventions were produced in the Times of Ignorance; as the Use of the Compass, Gunpowder, and Printing; and by the dullest Nations, as the Germans. *Satires and Personal Writings*  
Thoughts on Various Subjects (p. 407)  
Oxford University Press, Inc. New York, New York, USA. 1965

**Sylvester, James Joseph** 1814–97  
English mathematician

As the prerogative of Natural Science is to cultivate a taste for observation, so that of Mathematics is, almost from the starting point, to stimulate the faculty of invention. *A Plea for the Mathematician*  
*Nature*, Volume 1, Thursday, January 6, 1870 (p. 261 fn)

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Our inventions are wont to be pretty toys, which distract out attention from serious things. They are but improved means to an unimproved end. *The Writings of Henry David Thoreau* (Volume 2)  
*Walden*  
Chapter I (pp. 57–58)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

A man invents a thing which could revolutionize the arts, produce mountains of money, and bless the earth, and who will bother with it or show any interest in it? – and so you are just as poor as you were before. But you invent some worthless thing to amuse yourself with, and would throw it away if let alone, and all of a sudden the whole world makes a snatch for it and out crops a fortune. *The American Claimant*  
Chapter XXIV (p. 164)  
Chatto & Windus. London, England. 1892

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The greatest invention of the nineteenth century was the invention of the method of invention. *Science and the Modern World*  
Chapter VI (p. 96)  
The Macmillan Company. New York, New York, USA. 1929

...inventive genius requires pleasurable mental activity as a condition for its vigorous exercise. “Necessity is the mother of invention” is a silly proverb. “Necessity is the mother of futile dodges” is much nearer to the truth. The basis of the growth of modern invention is science, and science is almost wholly the outgrowth of pleasurable intellectual curiosity. *The Aims of Education and Other Essays*  
Chapter IV (p. 69)  
The Macmillan Company. New York, New York, USA. 1959

## INVENTOR

**Burdon-Sanderson, J.**  
No biographical data available

...the human inventor is but a blunderer as compared with the unknown Master of the animal creation. *Annual Report of the Board of Regents of the Smithsonian Institution, 1896*  
Ludwig and Modern Physiology (p. 368)  
Government Printing Office. Washington, D.C. 1898

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Man is a shrewd inventor, and is ever taking the hint of a new machine from his own structure, adapting some secret of his own anatomy in iron, wood, and leather, to some required function in the work of the world. *Ralph Waldo Emerson: Essays and Lectures*  
*English Traits*  
Wealth (p. 857)  
The Library of America. New York, New York, USA. 1983

**Fessenden, Reginald Aubrey** 1866–1932  
Canadian physicist and inventor

The inventor and the research man are confused because they both examine results of physical or chemical operations. The research man does something and does not

care (exactly) what it is that happens, he measures whatever it is. The inventor wants something to happen, but does not care how it happens or what it is that happens if it is not what he wants.

In Frederick Seitz

*The Cosmic Inventor: Reginald Aubrey Fessenden*

Aphorisms (p. 54)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1999

**Milton, John** 1608–74

English poet

Th' invention all admir'd, and each how hee  
To be th' inventor miss'd; so easy it seem'd,  
Once found, which yet unfound most would have  
thought  
Impossible...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VI, 1 (pp. 498–501)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Rabinow, Jacob** 1910–99

Inventor

This is the penalty of being an inventor. If you invent something when everybody wants it, it is too late; it's been thought of by everybody else. If you invent too early, nobody wants it because it is too early. If you invent very late, after the need has passed, then it is just a mental exercise. I assure you that it is very hard to invent just at the right time.

In Daniel V. DeSimone

*Education for Innovation*

The Process of Invention (p. 75)

Pergamon Press. New York, New York, USA. 1968

The job of the inventors is to provide the lead for a lagging system.

In Daniel V. DeSimone

*Education for Innovation*

The Process of Invention (p. 75)

Pergamon Press. New York, New York, USA. 1968

**Redfield, Casper L.**

No biographical data available

A man's capacity as an inventor depends upon his faculty of making guesses which have some semblance of possibility...

In Joseph Rossman

*Industrial Creativity: The Psychology of the Inventor*

Chapter XI (p. 111)

University Books. New Hyde Park, New York, USA. 1964

**Rossman, Joseph**

Inventor

Inventors are unconscious social changers.

*Industrial Creativity: The Psychology of the Inventor*

Chapter I (p. 6)

University Books. New Hyde Park, New York, USA. 1964

The inventor experiences a need which he wishes to satisfy.

*Industrial Creativity: The Psychology of the Inventor*

Chapter VI (p. 81)

University Books. New Hyde Park, New York, USA. 1964

**Swann, William Francis Gray** 1884–1962

Anglo-American physicist

The inventor walks in the territory which the man of science has mapped out into regions of assured fertility, dubious fertility, and almost certain sterility. The man of science, and indeed the engineer, is inclined to conserve their efforts by walking in the rather limited realm which, on the basis of the laws with which they operate, represents regions of assured fertility. However, the inventor walks with courage everywhere. He sees a pasture which he thinks has promise. The physicist would explain to him that his reasons for expecting something from that region are invalid, and in 90 per cent of the cases they are, but the inventor walks nevertheless.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia:*

*1852–1952*

The Engineer and the Scientist (p. 260)

Centennial of Engineering. Chicago, Illinois. 1952

**Taylor, Calvin W.**

No biographical data available

...practically all of the mighty rivers of industry spring from the headwaters of lone wolf inventors or creators.

In Daniel V. DeSimone

*Education for Innovation*

Factors influencing Creativity (p. 49)

Pergamon Press. New York, New York, USA. 1968

**Taylor, Isaac**

No biographical data available

The great inventor is one who has walked forth upon the industrial world, not from universities, but from hovels; not as clad in silks and decked with honours, but as clad in fustian and grimed with soot and oil.

In Tyron Edwards

*The New Dictionary of Thoughts*

J.G. Ferguson Publishing Company. Chicago, Illinois, USA. 1969

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Name the greatest of all the inventors: Accident.

In Albert Bigelow Paine (ed.)

*Mark Twain's Notebook*

Chapter XXXIII (p. 374)

Harper & Brothers. New York, New York, USA. 1899

**Weil, Simone** 1909–43

French philosopher and mystic

...science has now been for a long time – and to an ever-increasing extent – a collective enterprise. Actually, new



results are always, in fact, the work of specific individuals; but save perhaps for rare exceptions, the value of any result depends on such a complex set of interrelations with past discoveries and possible future researches that even the mind of the inventor cannot embrace the whole.

Translated by Arthur Wills and John Petrie

*Oppression and Liberty*

Sketch of Contemporary Social Life (p. 109)

Routledge & Kegan Paul. London, England. 1958

## INVESTIGATION

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

No amount of learning from books or of listening to the words of authority can be substituted for the spade-work of investigation.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 42)

Macmillan & Company Ltd. London, England. 1918

**Herrick, Robert** 1591–1674

English poet

Attempt the end and never stand to doubt;  
Nothing's so hard, but search will find it out.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

Seeke and Finde

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Sagan, Carl** 1934–96

American astronomer and author

Hidden within every astronomical investigation, sometimes so deeply buried that the researcher himself is unaware of its presence, lies a kernel of awe.

*Cosmos*

Chapter IX (p. 243)

Random House, Inc. New York, New York, USA. 1980

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Many discoveries are reserved for ages still to be, when our memory shall have perished. The world is a poor affair if it do not contain matter for investigation for the whole world in every age.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*

Book VII, Chapter XXXI (pp. 305–306)

Macmillan & Company Ltd. London, England. 1910

## INVERTEBRA

**Shiple, Arthur Everett** 1861–1927

Zoologist

**MacBride, Ernest William** 1866–1940

Marine biologist

The term Invertebrata is also a mere collective name; it is employed to designate all animals which do not belong to the phylum Vertebrata. Like the name Metazoa its convenience in promoting terseness of expression is its only justification.

*Zoology: An Elementary Text-book*

Chapter II (p. 13)

At The University Press. Cambridge, England. 1904

## INVESTIGATE

**Wilson, Edmund Beecher** 1856–1939

American zoologist

Investigations can do no more than push forward the limits of knowledge.

*Biology* (p. 6)

Columbia University Press. New York, New York, USA. 1908

## INVESTIGATION

**Beveridge, Albert Jeremiah** 1862–1927

American historian

In the laboratories of Europe and America investigations are this very moment being made into Nature's securest secrets. The mystery of today will be tomorrow's accepted and commonplace truth. One seizes one's head and

*The Young Man and the World*

Chapter VIII (p. 306)

D. Appleton & Co. New York, New York, USA. 1928

**Campbell, William Wallace** 1862–1938

American astronomer

The investigator in any field of knowledge must, as the price of success, both comprehend the general principles underlying his special problem, and give constant care to its details. Yet it is well, now and then, to leave details behind and consider the bearing of his work upon the science as a whole.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

Volume 4

The Problems of Astrophysics (p. 446)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**Eliot, Charles William** 1834–1926

American academic

The medical investigator must often fish in troubled waters; and sometimes he cannot find again the promising fishing ground he has once visited, because unexpected fog prevents him from seeing the intersecting bearings of his desired ground.

Address by President Charles W. Eliot

*Science*, N.S. Volume 24, Number 601, July 6, 1906 (p. 16)



**Huxley, Thomas Henry** 1825–95  
English biologist

The method of scientific investigation is nothing but the expression of the necessary mode of working of the human mind.

*Darwiniana*

Phenomena of Organic Nature (p. 363)  
D. Appleton & Co. New York, New York, USA. 1894

**Muir, Matthew Moncrieff Pattison** 1848–1931  
English chemist

Accurate and systematised investigation has brought to light the infinite complexity of nature, the fineness of the dovetailing of every event into many others, the never ending response of all things to changes in the conditions that encompass them, the universal orderliness of natural occurrences, the immutability of sequences, and the absolute interdependence of cause and effect ...

*The Alchemical Essence and the Chemical Element* (p. 45)  
Longmans, Green & Co. La Salle, Indiana, USA. 1894

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

In the sphere of natural investigation, as in poetry and painting, the delineation of that which appeals most strongly to the imagination, derives its collective interest from the vivid truthfulness with which the individual features are portrayed.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 34)  
D. Appleton & Co. New York, New York, USA. 1850

...in the sphere of natural investigation, as in poetry and painting, the delineation of that which appeals most strongly to the imagination, derives its collective interest from the vivid truthfulness with which the individual features are portrayed.

*Cosmos* (Volume 1)

Introduction (p. 13)  
Henry G. Bohn. London, England. 1849

**Young, Thomas** 1773–1829  
English polymath

Those who possess the genuine spirit of scientific investigation, and who have tasted the pure satisfaction arising from an advancement in intellectual acquirements, are contented to proceed in their researches, without inquiring at every step what they gain by their newly discovered,, lights, and to what practical purposes they are applicable: they receive a sufficient gratification from the enlargement of their views of the constitution of the universe, and experience, in the immediate pursuit of knowledge, that pleasure which others wish to obtain more circuitously by its means. And it is one of the principal advantages of a liberal education, that it creates a susceptibility of an enjoyment so elegant and so rational.

*A Course of Lectures on Natural Philosophy and the Mechanical Arts*  
Lecture I (p. 2)  
Printed for Taylor & Walton. London, England. 1845

## INVESTIGATOR

### Author undetermined

A scientific investigator is like the first traveler in some unsettled land: he may note the existence of valuable minerals, he may recognise the fertility of the land, but he cannot stop to raise the ore, to clear the forests, and to  
*The Encouragement of Scientific Research IV*  
*The Journal of Science, and Annals of Astronomy, Biology, Geology,*  
Volume VI, October, 1876 (pp. 477–478)

### Caldwell, G. C.

No biographical data available

Great investigators like great poets, like men great in anything, are born not made; born, may we not truly say, out of the spirit of the country and the period in which their great works are done.

*Annual Report of the Board of Regents of the Smithsonian Institution,*  
1893

*The American Chemist* (p. 252)  
Government Printing Office. Washington, D.C. 1894

### Carty, J. J.

No biographical data available

The investigator in pure science may be likened to the explorer who discovers new continents or islands or hitherto unknown territory. He is continually seeking to extend the boundaries of knowledge.

*The Relation of Pure Science to Industrial Research*  
*Science*, N.S. Volume 44, Number 1137, October 13, 1916 (p. 514)

### Eliot, Charles William

 1834–1926

American academic

The scientific investigator wins pleasure or satisfaction where most men and women would find only vexation and futile effort.

Address by President Charles W. Eliot  
*Science*, N.S. Volume 24, Number 601, July 6, 1906 (p. 15)

### Gies, William J.

 1872–1956

US biochemist and dentist

...the prime virtues of honesty, courage and common sense...seem to be among the most important characteristics of successful investigators.

Research in Dentistry  
*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xciv)

### Gore, George

 1826–1909

English electrochemist

If a man cannot acquire the knowledge of others without losing his independence of thought, it is evident he cannot become an original investigator.

*The Art of Scientific Discovery*  
Part III, Chapter XXX (p. 297)  
Longmans, Green & Co. London, England. 1878

An investigator cannot, to any great degree, pick and choose discoveries, but must, to a large extent, be content to accept those he can find.

*The Art of Scientific Discovery*  
Part IV, Chapter XXXVIII (p. 372)  
Longmans, Green & Co. London, England. 1878

**James, William** 1842–1910  
American philosopher and psychologist

The most useful investigator, because the most sensitive observer, is always he whose eager interest in one side of the question is balanced by an equally keen nervousness lest he become deceived. Science has organized this nervousness into a regular technique, her so-called method of verification; and she has fallen so deeply in love with the method that one may even say she has ceased to care for truth by itself at all. It is only truth as technically verified that interests her. The truth of truths might come in merely affirmative form, and she would decline to touch it.

*The Will to Believe and Other Essays in Popular Philosophy*  
The Will to Believe (p. 21)  
Longmans, Green & Co. London, England. 1912

**Jevons, William Stanley** 1835–82  
English economist and logician

...the successful investigator must combine diverse qualities; he must have clear notions of the result he expects and confidence in the truth of his theories, and yet he must have that candour and flexibility of mind which enable him to accept unfavourable results and abandon mistaken views.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book IV, Chapter XVIII (p. 404)  
Macmillan & Co Ltd. London, England. 1887

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The highest philosophy of the scientific investigator is precisely this toleration of an incomplete conception of the world and the preference for it rather than an apparently perfect, but inadequate conception.

*The Science of Mechanics: A Critical and Historical Account of Its Development*  
Chapter IV (p. 464)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1919

**Shapley, Harlow** 1885–1972  
American astronomer

...man's role as an investigator and would-be interpreter of the universe is surpassingly fascinating, whether or not it is cosmically significant.

*Starlight*

Part III, Chapter XV (p. 143)  
George H. Doran Company. New York, New York, USA 1926

## ION

**Hendrick, Ellwood**  
No biographical data available

I used to think theology  
Was rather rough on doubt,  
But chemistry with ions, beats  
Theology all out.  
So you'd better get your Bible down before you're well begun,  
For you're going to need the exercise the art of faith, my son.

The Present Status of Ionization Theory  
*Journal of Chemical Education*, Volume 2, Number 5, May, 1925 (p. 376)

**Kunin, Robert**  
No biographical data available

**Myers, Robert J.**  
No biographical data available

A recent interpretation of the miracle supposedly performed by Moses as he led the Israelites safely through the wilderness suggests the possibility of the application of ion exchange. In order to make the "bitter" water at Matah potable during their journey, Moses found a tree "which when he had cast it into the waters, the waters were made sweet." It has been suggested that the oxidized cellulose of the tree entered into an exchange reaction with the bitter electrolytes of the water, rendering the water potable.

*Ion Exchange Resins*  
Chapter 1 (p. 1)  
John Wiley & Sons, Inc. New York, New York, USA. 1950

## IRRATIONALITY

**Laudan, Larry** 1945–  
American philosopher of science

If rationality consists in believing only what we can reasonably presume to be true, and if we define "truth" in its classical nonpragmatic sense, then science is (and will forever remain) irrational.

*Progress and Its Problems: Toward a Theory of Scientific Growth*  
Chapter Four (p. 125)  
University of California Press. Berkeley, California, USA. 1977

...when a thinker does what it is rational to do, we need inquire no further into the causes of his actions; whereas, when he does what is in fact irrational – even if he believes it to be rational – we require some further explanation.

*Progress and Its Problems: Toward a Theory of Scientific Growth*  
Chapter Six (pp. 188–189)  
University of California Press. Berkeley, California, USA. 1977

**Mannheim, Karl** 1893–1947  
Austria-Hungarian sociologist

Anyone who wants to drag in the irrational where the lucidity and acuity of reason still must rule by right merely shows that he is afraid to face the mystery at its legitimate place.

*Essays on the Sociology of Knowledge*

Chapter V (p. 229)

Routledge & Kegan Paul Ltd. London, England. 1952

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

CHILTERN: You think science cannot grapple with the problem of women?

CHEVELEY: Science can never grapple with the irrational. That is why it has no future before it, in this world.

CHILTERN: And women represent the irrational.

*Complete Writings of Oscar Wilde*

*An Ideal Husband*

Act I

The Nottingham Society. New York, New York, USA. 1907

## IRREFRAGABILITY

**van Orman Quine, Willard** 1908–2000  
American philosopher

Irrefragability, thy name is mathematics.

*The Ways of Paradox, and Other Essays*

Chapter 3 (p. 22)

Harvard University Press. Cambridge, Massachusetts, USA. 1976

## IRRELEVANT

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

There is no denying that some with an incapacity for intelligent observation have covered reams of paper with mathematical profundities irrelevant to anything on earth, although possibly of inestimable value in the Kingdom of Heaven.

*The Handmaiden of the Sciences*

Chapter I (p. 2)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Burger, Edward B.**  
American mathematician

**Starbird, Michael**  
American mathematician

We have isolated the essential and identified the irrelevant.

*Coincidences, Chaos, and All That Math Jazz*

Part II, Chapter 6 (p. 119)

W.W. Norton & Co. New York, New York, USA. 2005

**Cornford, Francis M.** 1874–1943  
English academic

No academic person is ever voted into the chair until he has reached an age at which he has forgotten the meaning of the word ‘irrelevant.’

*Microcosmographia Academica*

The Conduct of Business

Bowes & Bowes, Publishers. Cambridge, England. 1908

## IRREVERSIBILITY

**Planck, Max** 1858–1947  
German physicist

A process which in no manner can be completely reversed I called a “natural” one. The term for it in universal use today is: “Irreversible.”

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (p. 17)

Philosophical Library. New York, New York, USA. 1949

## ISLAND, OCEAN

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Oceanic islands are our great natural laboratories of evolution, the source of so many ideas about organic change and of so many classical examples from finches on the Galápagos to Hies on Hawaii. The combination of geographic isolation and difficult access, with frequent absence of predators or competitors, provides explosive possibilities for creatures who manage to reach these bounteous havens.

*Eight Little Piggies: Reflections in Natural History*

Chapter I (p. 25)

W.W. Norton & Co. New York, New York, USA. 1993

## ISOMERISM

**van’t Hoff, Jacobus Henricus** 1852–1911  
Dutch physical and organic chemist

I desire to introduce some remarks which may lead to discussion and hope to avail myself of the discussion to give my ideas more definiteness and breadth. Since the starting point for the following communication is found in the chemistry of the carbon compounds, I shall for the present do nothing more than state the points having reference to it. It appears more and more that the present constitutional formulas are incapable of explaining certain cases of isomerism; the reason for this is perhaps the fact that we need a more definite statement about the actual positions of the atoms.

Formulas at Present Used in Chemistry and a Note on the Relation of Optical Activity and the Chemical Constitution of Organic Compounds  
*Archives néerlandaises des sciences exactes et naturelles*, Volume 9, September, 1874

**ISOSTASY****Chamberlain, Rollin T.**

American geologist

The keynote to isostasy is a working toward equilibrium. Isostasy is not a process which upsets equilibrium, but one which restores equilibrium.

*Journal of the Washington Academy of Sciences*, Volume 20, 1932 (p. 455)

**ISOTOPE****Soddy, Frederick** 1877–1956

English chemist

The general resemblance in character and relative period of the succeeding members of the various disintegration series [referring to isotopes] on the one hand, and their distinct individual peculiarities on the other, are most fascinating and mysterious. We seem to have here an extension of similar relations expressed for elementary matter generally by the periodic law, and there is no doubt that any explanation of the one will have an application to the other.

*Nobel Lectures, Chemistry 1901–1921*

The Origins of the Conception of Isotopes

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**IT****Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

...the patriotic archbishop of Canterbury, found it advisable –

“Found *what?*” said the Duck.

“Found *it*,” the Mouse replied, rather crossly: “of course you know what ‘it’ means.”

“I know what ‘it’ means well enough, when *I* find a thing,” said the Duck: “it’s generally a frog, or a worm.

The question is, what did the archbishop find?”

*The Complete Works of Lewis Carroll*

*Alice’s Adventures in Wonderland*

Chapter III (p. 36)

The Modern Library. New York, New York, USA. 1936

**Weingarten, Violet**

Writer

...report for a routine checkup feeling like a hypochondriac because obviously you’re in perfect health, and the doctor mumbles something about “it” having to come out, no rush, next week will be plenty of time.

*Intimations of Mortality* (p. 3)

Alfred A. Knopf. New York, New York, USA. 1978

## J

### JARGON

#### **Rickett, Harold William**

No biographical data available

The sciences have their technical jargons – indispensable to the researcher and to some extent even to the amateur. Since the former must teach the latter, it has sometimes been thought that an understanding of nature can be gained only by learning words.

*The Green Earth: An Invitation to Botany*

Preface (p. 2)

Jacques Cattell Press. Lancaster, Pennsylvania, USA. 1943

#### **Tyndall, John** 1820–93

Irish-born English physicist

If you speak to your fellowman, you are not entitled to use jargon. Bad experiments are jargon addressed to Nature, and just as much to be deprecated.

*Fragments of Science for Unscientific People*

Chapter XIII (p. 363)

D. Appleton & Co. New York, New York, USA. 1875

### JEALOUSY

#### **Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

The kernel of all jealousy is lack of love.

*Memories, Dreams, Reflections*

Chapter IV (p. 137)

Vintage Books. New York, New York, USA. 1963

### JOURNAL

#### **Stuart, Copans A.**

No biographical data available

Why, dear colleagues, must our findings

Now be put in sterile bindings?

Once physicians wrote for recreation.

Our great teachers through the ages,

Fracastro, and other sages,

Found writing could be fun, like fornication...

*Perspectives in Biology and Medicine*, Winter 1973 (p. 232)

### JOURNEY

#### **Abbey, Edward** 1927–89

American environmentalist and nature writer

That's the best thing about walking, the journey itself. It doesn't matter much whether you get where you're

going or not. You'll get there anyway. Every good hike brings you eventually back home. Right where you started.

*The Journey Home: Some Words in Defense of the American West*

Chapter 18 (p. 205)

E.P. Dutton. New York, New York, USA. 1977

The longest journey begins with a single step, not with the turn of an ignition key.

*The Journey Home: Some Words in Defense of the American West*

Chapter 18 (p. 205)

E.P. Dutton. New York, New York, USA. 1977

#### **Muir, John** 1838–1914

American naturalist

One bird, a thrush, embroidered the silence with cheery notes, making the solitude familiar and sweet, while the solemn monotone of the stream sifting through the woods seemed like the very voice of God, humanized, terrestrialized, end entering one's heart as to a home prepared for it. Go where we will, all the world over, we seem to have been there before.

*All the World Over: Notes from Alaska*

First page

Sierra Club Books. San Francisco, California, USA. 1996

### JUDGMENT

#### **Drinker, Henry** 1850–1937

...in regard to all civil engineering, the first requisite is good judgment, the second requisite is good judgment, and the final requisite is GOOD JUDGMENT.

In Henry Drinker

*Tunneling, Explosive Compounds, and Rock Drilling* (p. 1005)

John Wiley & Sons, Inc. New York, New York, USA. 1878

#### **McCormick, Leander Hamilton** 1859–1934

American author, inventor, and scientist

Reason leads to conclusions, which may be logical or illogical, sound or unsound, according as they are based on valid or invalid premises. The selection of premises depends upon judgment, and consequently, premises with sound reasoners must be valid and sound.

*Characterology*

Chapter XXVI (p. 594)

Rand McNally & Co. Chicago, Illinois, USA. 1920

#### **Morehouse, George Wilkinson** 1840–?

American naturalist

It cannot be denied that unbiased, intelligent judgment is extremely difficult of attainment. Our hereditary tendencies and early impressions are strong.

*The Wilderness of Worlds*

Preface (p. 3)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Pascal, Blaise** 1623–62  
French mathematician and physicist

...it is to judgment that perception belongs, as science belongs to intellect. Intuition is the part of judgment, mathematics of intellect.

*Thoughts*

Section I (p. 10)

P.F. Collier & Son. New York, New York, USA. 1910

**Sagan, Carl** 1934–96  
American astronomer and author

It is of interest to note that while some dolphins are reported to have learned English – up to 50 words used in correct context – no human being has been reported to have learned dolphinese. Prejudice is making a judgment before you have looked at the facts. Postjudice is making a judgment afterward. Prejudice is terrible, in the sense that you commit injustices and you make serious mistakes. Postjudice is not terrible. You can't be perfect of course; you may make mistakes also. But it is permissible to make a judgment after you have examined the evidence. In some circles it is even encouraged.

*The Burden of Skepticism*

*Skeptical Enquirer*, Volume 12, Fall, 1987 (p. 46)

**Stewart, Dugald** 1753–1828  
Scottish philosopher

Whoever limits his exertions to the gratification of others, whether by personal exhibition, as in the case of the actor and of the mimic, or by those kinds of literary composition which are calculated for no end but to please or to entertain, renders himself, in some measure, dependent on their caprices and humors. The diversity among men, in their judgments concerning the objects of taste, is incomparatively greater than in their speculative conclusions; and

accordingly, a mathematician will publish to the world a geometrical demonstration, or a philosopher, a process of abstract reasoning, with a confidence very different from what a poet would feel, in communicating one of his productions even to an intimate friend.

*Elements of the Philosophy of the Human Mind*

Part Third, Chapter I, Section III (p. 202)

Carey, Lea & Carey. Philadelphia, Pennsylvania, USA. 1827

## JUNGLE

**Beebe, William** 1877–1962  
American ornithologist

It is possible to enter a jungle and become acutely aware of poison fang and rending claw – much as a pacifist considers the high adventure of righteous war. But it is infinitely more wonderful and altogether satisfying to slip quietly and receptively into the life of the jungle, to accept all things as worthy and reasonable; to sense the beauty, the joy, the majestic serenity of this age-old fraternity of nature, into whose sanctuary man's entrance is unnoticed, his absence unregretted.

*Jungle Peace*

Chapter I (p. 4)

William Holt & Co. New York, New York, USA. 1918

## JUSTIFICATION

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

These somewhat pedantic words are justifiable, because “infinitesimal satellite” is nine syllables to express three or four sentences; that is our justification.

*Popular Lectures and Addresses (Volume 1)*

Lecture, Institution of Civil Engineers, May 3, 1883 (p. 100)

Macmillan & Company Ltd. London, England. 1894



## K

### KEY

**Mayr, Ernst** 1904–2005  
German-born American biologist

The use of keys in identification is old indeed. Much of Aristotle's classifications of animals was presented in the form of simple dichotomous alternatives.

*Principles of Systematic Zoology*  
Chapter 11B.3 (p. 276)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

**Quicke, D. L.**

No biographical data available

The purpose of a key is to enable identifications, and it should not be a vehicle for expressing systematic opinions. First, good systematic characters are very often poor or even unusable key characters, and second, classifications are all too frequently subject to modification.

*Principles and Techniques of Contemporary Taxonomy* (p. 99)  
Blackie Academic & Professional. London, England. 1993

### KINGDOM

**Whittaker, R. H.**

No biographical data available

There are those who consider questions in science which have no unequivocal experimentally determined answer scarcely worth discussing. Such feeling, along with conservatism, may have been responsible for the long and almost unchallenged dominance of the system of two kingdoms – plants and animals – in the broad classification of organisms. The unchallenged position of these kingdoms has ended, however; alternative systems are being widely considered.

New Concepts of Kingdoms of Organisms

*Science*, Volume 163, Number 3863, 10 January, 1969 (p. 150)

### KLING BOTTLE

**Winsor, Frederick**

No biographical data available

Three jolly sailors from Blaydon-on-Tyne  
They went to sea in a bottle by Klein.  
Since the sea was entirely inside the hull  
The scenery seen was exceedingly dull.

*The Space Child's Mother Goose*

Simon & Schuster. New York, New York, USA. 1958

## KNOT

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer & mathematician

“A knot!” said Alice, always ready to make herself useful, and looking anxiously about her. “Oh, do let me help undo it!”

*The Complete Works of Lewis Carroll*

*Alice's Adventures in Wonderland*

Chapter III (p. 41)

The Modern Library. New York, New York, USA. 1936

### KNOT THEORY

**Birman, Joan** 1927–

American mathematician

Knot theory for a long time was a little backwater of topology.

In Barry Cipra and Paul Zorn

*From Knot to Unknot* (p. 9)

American Mathematical Society. Providence, Rhode Island, USA. 1993

### KNOW

**Bagehot, Walter** 1826–77

English lawyer, statesman, and essayist

If you please, sir, tell me what you do not know...

*Literary Studies: With a Prefatory Memoir*

Essay I (p. 39)

Longmans, Green & Co. London, England. 1902

**Chargaff, Erwin** 1905–2002

Austrian biochemist

In the end, we know nearly everything about nearly nothing.

*Voices in the Labyrinth: Nature, Man and Science* (p. 26)

The Seabury Press. New York, New York, USA. 1977

**Ouspensky, Peter D.** 1878–1947

Russian philosopher

The most difficult thing is to know what we do know, and what we do not know.

Translated by Nicholas Bessaraboff and Claude Bragdon

*Tertium Organum*

Chapter 1 (p. 1)

Manas Press. New York, New York, USA. 1920

**Pearson, Karl** 1857–1936

English mathematician

To know requires exertion, and it is intellectually easiest to shirk effort altogether by accepting phrases which cloak the unknown in the undefinable.

*The Grammar of Science* (2nd edition)  
 Preface to the Second Edition (p. viii)  
 Adam & Charles Black. London, England. 1900

## KNOWING

**Adams, Douglas** 1952–2001  
 English author, comic radio dramatist, and musician

“Protect me from knowing what I don’t need to know. Protect me from even knowing that I decided not to know about the things that I decided not to know about. Amen.” That’s it. It’s what you pray silently inside yourself anyway, so you may as well have it out in the open.

*The Ultimate Hitchhiker’s Guide to the Galaxy*  
*Mostly Harmless*  
 Chapter 9 (p. 704)  
 The Ballantine Book Company. New York, New York, USA. 2002

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

It is the inexorable law of our acquaintance with the external world that that which is presented for knowing becomes transformed in the process of knowing.

*New Pathways in Science*  
 Chapter I (p. 7)  
 At the University Press. Cambridge, England. 1935

**Nietzsche, Friedrich Wilhelm** 1844–1900  
 German philosopher

Once upon a time, in some out of the way corner of that universe which is dispersed into numberless twinkling solar systems, there was a star upon which clever beasts invented knowing. That was the most arrogant and mendacious minute of “world history,” but nevertheless, it was only a minute. After nature had drawn a few breaths, the star cooled and congealed, and the clever beasts had to die.

*The Portable Nietzsche*  
 On Truth and Lie in an Extra-Moral Sense (p. 42)  
 Penguin Books. New York, New York, USA. 1976

**Williamson, Marianne** 1952–  
 American spiritual activist

There’s a collective knowing that a dimension of reality exists beyond the material plane, and that sense of knowing is causing a mystical resurgence on the planet today. It’s not just children who are looking for a missing piece. It is a very mature outlook to question the nature of our reality.

*Everyday Grace: Having Hope, Finding Forgiveness, and Making Miracles*  
 Introduction: Reclaiming Our Magic  
 Penguin Putnam Inc. New York, New York, USA. 2002

## KNOWLEDGE

**Adams, George** 1750–95  
 English instrument maker

...mankind...for more than a thousand years, looked up to Aristotle as an oracle in philosophy. His authority was the test of truth; it was a philosophy, says Lord Bacon, fruitful of words, but barren or works; admirably contrived to draw a veil over ignorance, and put a stop to the progress of knowledge, by filling men with a conceit that they knew everything: a philosophy, that instead of accounting for any of the phenomena of nature, contrived to give learned names to their unknown causes, and fed men with hulks of barbarous terms, instead of the fruits of real knowledge.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
 Lecture II (pp. 30–31)  
 Printed by R. Hindmarsh. London, England. 1794

The principles of all knowledge are founded in mind; the mind of man, either animated by desire or pressed by necessity, puts in action it’s various energies, and unfolds the seeds of knowledge.

*Lectures on Natural and Experimental Philosophy* (Volume 3)  
 Chapter XXXIII (p. 369)  
 Printed by R. Hindmarsh. London, England. 1794

**Addison, Joseph** 1672–1719  
 English essayist, poet, and statesman

The utmost extent of man’s knowledge is to know that he knows nothing.

*Interesting Anecdotes, Memoirs, Allegories, Essays, and Poetical Fragments*  
 Volume 3 & 4, Essay on Pride (p. 230)  
 Printed for T. N. Longman. London, England. 1796

**Alighieri, Dante** 1265–1321  
 Italian poet and writer

...to have heard without retaining does not make knowledge.

In *Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
 Paradise, Canto V, l. 41–42  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Allen, Ethan** 1738–89  
 Hero of the American Revolution

The desire of knowledge has engaged the attention of the wise and curious among mankind in all ages which has been productive of extending the arts and sciences far and wide in the several quarters of the globe, and excited the contemplative to explore nature’s laws in a gradual series of improvement, until philosophy, astronomy, geography,

and history, with many other branches of science, have arrived to a great degree of perfection.

*Reason, the Only Oracle of Man, Or, A Compendious System of Natural Religion*

Chapter I (p. 5)

G.W. & A.J. Matsell. New York, New York, USA. 1836

### **Anthony, H. D.**

No biographical data available

No branch of knowledge can be isolated, even though sometimes methods of instruction may give that impression.

*Science and Its Background*

Chapter I (p. 1)

Macmillan & Co Ltd. London, England. 1948

### **Arbuthnot, John** 1667–1735

Scottish mathematician and physician

Mathematical knowledge adds vigor to the mind, frees it from prejudice, credulity, and superstition.

*An Essay on the Usefulness of Mathematical Learning*

Printed at the Theater. Oxford, England. 1701

### **Aristotle** 384 BCE–322

Greek philosopher

Yet it does not appear to be true in all cases that correlatives come into existence simultaneously. The object of knowledge would appear to exist before knowledge itself for it is usually the case that we acquire knowledge of objects already existing; it may be difficult, if not impossible, to find a branch of knowledge the beginning of the existence of which was contemporaneous with that of its object.

In *Great Books of the Western World* (Volume 8)

*Categories*

Chapter 7, 7b [20]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 19

All men by nature desire to know.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book I, Chapter 1 (p. 499)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...knowledge of any kind is a thing to be honored and prized...

In *Great Books of the Western World* (Volume 8)

*On the Soul*

Book 1, Chapter 1, 402a

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...knowledge is the object of our enquiry and men do not think they know a thing till they have grasped the "why" of it.

In *Great Books of the Western World* (Volume 8)

*Physics*

Book II, Chapter 2, 194b [15]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 19

### **Armstrong, Baron William George** 1810–1900

No biographical data available

...however high we climb in the pursuit of knowledge we shall still see heights above us, and the more we extend our view, the more conscious we shall be of the immensity which lies beyond.

*The Industrial Resources of the District of the Three Northern Rivers,*

*The Tyne, Wear, and Tees*

The Inaugural Address (p. xlii)

Longman, Green, Longman, Roberts & Green. London, England. 1864

### **Asimov, Isaac** 1920–92

American author and biochemist

I believe that scientific knowledge has fractal properties; that no matter how much we learn, whatever is left, however small it may seem, is just as infinitely complex as the whole was to start with. That, I think, is the secret of the Universe.

Essay 400 – A Way of Thinking

*The Magazine of Fantasy and Science Fiction*, December, 1994

The greatest weapons in the conquest of knowledge are an understanding mind and the inexorable curiosity that drives it on.

*Asimov's New Guide to Science*

Chapter 2 (p. 56)

Basic Books, Inc. New York, New York, USA. 1984

...increasing knowledge leads not to conquest only, but to utter defeat as well, for one learns not only of new potentialities, but also of new limitations.

*Of Time and Space and Other Things*

Introduction (p. iv)

Doubleday & Co., Inc. Garden City, New York, USA. 1965

### **Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

...he who is desirous of instruction ought not to disdain listening to anyone, who has knowledge to communicate, however humble may be his lot, or however limited his talents...

*Ornithological Biography* (Volume 1)

The Cougar (p. 205)

Adam Black. Edinburgh, Scotland. 1831

### **Author undetermined**

Right now I'm having amnesia and déjà vu at the same time. I think I've forgotten this before.

Source undetermined

...every flower in the garden of knowledge may be plucked. The solid earth, the yielding waters, the ambient air, the numerous varieties of organic life, the phenomena of the subtle elements, and the stupendous fabric of the celestial system, may all be searched into, and the symmetry of their structure displayed.

Thoughts on Education  
*The Analyst*, Volume VIII, Number XXIII, 1838 (p. 119)

**Bach, Richard** 1936–  
 American writer

Isn't it strange how much we know if only we ask ourselves instead of somebody else.

*Illusions: The Adventures of a Reluctant Messiah*  
 Chapter 8 (p. 82)  
 Delacorte Press. New York, New York, USA. 1977

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

...that knowledge hath in it somewhat of the serpent, and therefore where it entereth into a man it makes him swell...

In *Great Books of the Western World* (Volume 30)  
*Advancement of Learning*  
 First Book, Chapter I, Section 2 (p. 2)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

To conclude therefore, let no man upon a weak conceit of sobriety or an ill-applied moderation think or maintain that a man can search too far, or be too well studied in the book of God's words, or in the book of God's work, divinity, or philosophy; but rather let men endeavor an endless progress or proficiency in both.

In *Great Books of the Western World* (Volume 30)  
*Advancement of Learning*  
 First Book, Chapter I, Section 3 (p. 4)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...men have entered into a desire of learning and knowledge, sometimes upon a natural curiosity and inquisitive appetite; sometimes to entertain their minds with variety and delight; sometimes for ornament and reputation; and sometimes to enable them to victory of wit and contradiction; and most times for lucre and profession; and seldom sincerely to give a true account of their gift of reason, to the benefit and use of men: if there were sought in knowledge a couch whereupon to rest a searching and restless spirit; or a terrace for a wandering and variable mind to walk up and down with a fair prospect; or a tower of state for a proud mind to raise itself upon; or a fort or commanding ground for strife and contention; or a shop for profit or sale ...

In William Aldis Wright  
*The Advancement of Learning* (3rd edition) (p. 42)  
 At The Clarendon Press. Oxford, England. 1885

...the commandment of knowledge is yet higher than the commandment over the will; for it is > a commandment over the reason, belief, and understanding of man, which is the highest part of the mind, and giveth law to the will itself: for there is no power on earth which setteth up a throne or chair of state in the spirits and souls of men, and: in their cogitations, imaginations, opinions, and beliefs, but knowledge and learning.

*The Works of Francis Bacon, Lord Chancellor of England* (Volume 1)  
*Advancement of Learning*  
 Book I (p. 182)  
 A. Hart. Philadelphia, Pennsylvania, USA 1850

The lame...in the path outstrip the swift who wander from it, and it is clear that the very skill and swiftness of him who runs not in the right direction must increase his aberration.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 61 (p. 113)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If any man makes it his delight and care – not so much to cling to and use past discoveries, as to penetrate to what is beyond them – not to conquer Nature by talk, but by toil – in short, not to have elegant and plausible theories, but to gain sure and demonstrable knowledge; let such men (if it shall seem to them right), as true children of knowledge, unite themselves with us.

In J.W. Gregory  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*  
 Geology of the Inner Earth – Igneous Ores (p. 312)  
 Government Printing Office. Washington, D.C. 1908

But the greatest error of all is, mistaking the ultimate end of knowledge; for some men covet knowledge out of a natural curiosity and inquisitive temper; some to entertain the mind with variety and delight; some for ornament and reputation; some for victory and contention; many for lucre and a livelihood; and but few for employing the Divine gift of reason to the use and benefit of mankind. Thus some appear to seek in knowledge a couch for a searching spirit; others, a walk for a wandering mind; others, a tower of state; others, a fort, or commanding ground; and others, a shop for profit or sale, instead of a storehouse for the glory of the Creator and the endowment of human life.

*The Works of Francis Bacon*  
 Preliminaries (p. lix)  
 Printed for James M. Jones  
 London, England. 1815

**Barfield, Owen** 1898–1997  
 British philosopher, critic, and anthroposophist

There is no “science of sciences”; no unity of knowledge. There is only an accelerating increase in that pigeon-holed knowledge by individuals of more and more about less and less, which, if persisted in indefinitely, can only lead mankind to a sort of “idiocy” (in the original sense of the word) – a state of affairs, in which fewer and fewer representations will be collective, and more and more will be private, with the result that there will in the end be no means of communication between one intelligence and another.

*Saving the Appearances: A Study in Idolatry*  
 Chapter XXI (p. 145)  
 Faber & Faber. London, England. 1957

**Barker, George Frederick** 1835–1910  
American scientist

It is through the medium of our senses alone that we derive our knowledge of the phenomena of external nature.

*Physics: Advanced Course* (4th edition)  
Chapter I (p. 3)  
Henry Holt & Co. New York, New York, USA. 1893

**Barrie, Sir James M.** 1860–1937  
Scottish journalist, writer, and dramatist

ERNEST. ...I'm not young enough to know everything.  
*The Admirable Crichton*  
Act I (p. 16)  
Hodder & Stoughton. London, England. 1961

**Barry, Frederick** 1876–1943  
Historian of science

It is clear, for instance, that we classify business management, pugilism and medicine together as science because, though as occupations they are only incidentally related, they are all characterized by the practical, methodical, and so far as is humanly possible, the rational utilization of knowledge for the attainment of definite goals.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge*  
Chapter I (p. 5)  
Columbia University Press. New York, New York, USA. 1927

**Bartram, John** 1699–1777  
American botanist

I hope by these practical observations [of cross fertilization] to open a gate into a very large field of experimental knowledge, which, if judiciously improved, may be a considerable addition to the beauty of the florist's garden.

*Memorials of John Bartram and Humphry Marshall*  
Letter from John Bartram to Colonel W. Byrd in 1739 (p. 315)  
Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1849

**Becker, Carl Lotus** 1873–1945  
American historian

There is nothing new in heaven or earth not dreamt of in our laboratories; and we should be amazed indeed if tomorrow and tomorrow and tomorrow failed to offer us something new to challenge our capacity for readjustment.

*The Heavenly City of the Eighteenth Century Philosophers*  
Chapter I (p. 23)  
Yale University Press. New Haven, Connecticut, USA. 1932

If we would discover the little backstairs door that for any age serves as the secret entranceway to knowledge, we will do well to look for certain unobtrusive words with uncertain meanings that are permitted to slip off the tongue or the pen without fear and without research; words which, having from constant repetition lost their

metaphorical significance, are unconsciously mistaken for objective realities.

*The Heavenly City of the Eighteenth-Century Philosophers* (2nd edition)  
Chapter II (p. 47)  
Yale University Press. New Haven, Connecticut, USA. 2003

**Bernard, Claude** 1813–78  
French physiologist

The fact that knowledge endlessly recedes as the investigator is about to grasp it is what constitutes at the same time his torment and happiness.

In René Dubos  
*The Dreams of Reason*  
Chapter 6 (p. 138)  
Columbia University Press. New York, New York, USA. 1961

One of the greatest obstacles to the free and universal movement of human knowledge is the tendency that leads different kinds of knowledge to separate into systems.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter III, Section iv (p. 223)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

It is better to kno less, than to kno so mutch, that aint so.  
*Old Probability: Perhaps Rain – Perhaps Not*  
A Remark (Beginning of book)  
G.W. Carleton & Company, Publishers. New York, New York, USA. 1879

**Bloch, Marc** 1905–83  
American physicist and educator

Each science, taken by itself, represents but a fragment of the universal march toward knowledge.

*The Historian's Craft*  
Introduction (p. 15)  
Manchester University Press. Manchester, England. 2004

**Bloor, David**

No biographical data available

All knowledge, the sociologist could say, is conjectural and theoretical. Nothing is absolute and final. Therefore all knowledge is relative to the local situation of the thinkers who produce it: the ideas and conjectures that they are capable of producing; the problems that bother them; the interplay of assumptions and criticism in their milieu; their purposes and aims; the experiences they have and the standards and meanings they apply.

*Knowledge and Social Imagery*  
Chapter Eight (p. 159)  
The University of Chicago Press. Chicago, Illinois, USA. 1991

Like many features of a landscape, knowledge looks different from different angles. Approach it from an unexpected route, glimpse it from an unusual vantage point, and at first it may not be recognizable.

*Knowledge and Social Imagery*  
Chapter Eight (p. 160)  
The University of Chicago Press. Chicago, Illinois, USA. 1991



**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

...all knowledge presents itself within a conceptual framework adapted to account for previous experience and that any such frame may prove too narrow to comprehend new experiences.

*Atomic Physics and Human Knowledge*  
Unity of Knowledge (p. 67)  
John Wiley & Sons. New York, New York, USA. 1958

In our time, when increasing knowledge and ability more than ever link the fate of all peoples, international collaboration in science has far-reaching tasks which may be furthered not least by an awareness of the general conditions for human knowledge.

*Atomic Physics and Human Knowledge*  
Atoms and Human Knowledge (p. 93)  
John Wiley & Sons, Inc. New York, New York, USA. 1958

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

Incomplete knowledge must be considered as perfectly normal in probability theory; we might even say that, if we knew all the circumstances of a phenomenon, there would be no place for probability, and we would know the outcome with certainty.

Translated by Douglas Scott  
*Probability and Certainty*  
Chapter 1 (p. 13)  
Walker & Company. New York, New York, USA. 1963

**Boulding, Kenneth E.** 1910–93  
English economist and social scientist

The carbon atom, for instance, knows how to join with four hydrogen atoms or with two oxygen atoms. It also mysteriously enough knows how to join with one oxygen atom to form carbon monoxide. It is little more than a figure of speech, however, to regard this ability as knowledge.

*The Image*  
Chapter 3 (p. 32)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1956

**Brecht, Bertolt** 1898–1956  
German writer

GALILEO:...Knowledge will become a passion and research an ecstasy.

Translated by John Willett  
*Life of Galileo*  
Scene 9 (p. 77)  
Arcade Publishing. New York, New York, USA. 1994

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Knowledge makes prodigious journeys, and what seems to us a leap in time often turns out to be a long progression from place to place, from one city to another.

*The Ascent of Man*  
The Music of the Spheres (p. 162)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

There is no absolute knowledge. And those who lay claim to it, whether they are scientists or dogmatists, open the door to tragedy.

*The Ascent of Man*  
Chapter 11 (p. 353)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

Knowledge is not a loose-leaf notebook of facts.

*The Ascent of Man*  
The Long Childhood (p. 436)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

**Brown, John**

No biographical data available

You come to the chest of knowledge. It is shut, it is bolted, but...you have the key; put it in steadily and home. But what is the key? It is the love of truth; neither more or less; no other key opens it; no false one, however cunning, can pick that lock; no assault of hammer, however stout, can force it open; but with its own key, a little child may open it; often does open it.

Quoted in Richard Arman Gregory  
*Discovery, Or, The Spirit and Service of Science*  
Chapter II (p. 28)  
Macmillan & Co Ltd. London, England. 1916

**Bryant, William Cullen** 1794–1878  
American poet

Knowledge is the material with which Genius builds her fabrics. The greater its abundance, the more power is required to dispose it into order and beauty, but the more vast and magnificent will be the structure.

*Prose Writings* (Volume 1)  
Lectures on Poetry (p. 32)  
D. Appleton & Co. New York, New York, USA. 1884

**Bulfinch, Thomas** 1796–1867  
American writer

If no other knowledge deserves to be called useful but that which helps to enlarge our possessions or to raise our station in society, then mythology has no claim to the appellation. But if that which tends to make us happier and better can be called useful then we claim that epithet for our subject.

*The Age of Fable* (p. 1)  
The Modern Library. New York, New York, USA. 1934

**Bube, Richard H.**  
American materials scientist

Science has become a particular kind of knowledge obtained in a particular way: knowledge of the natural world obtained by sense interaction with that world.

*The Encounter Between Christianity and Science*  
Chapter 1 (p. 17)  
W.B. Eerdmans Publishing Company. Grand Rapids, Iowa, USA. 1968



**Bullock, Theodore Holmes** 1915–2005  
Comparative neuroscientist

The road is long and branching, distractions and obstacles are many, the goal is hazy and far away, pilgrims speak in many tongues. But we can look back and see progress, or look up and see some exciting peaks.

In John C. Fentress (ed.)  
*Simpler Networks and Behavior*  
In Search of Principles in Neural Integration  
Sinauer Associates, Inc. Sunderland, Massachusetts, USA. 1976

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

The process by which the boundaries of knowledge are advanced, and the structure of organised science is built, is a complex process indeed. It corresponds fairly well with the exploitation of a difficult quarry for its building materials and the fitting of these into an edifice; but there are very significant differences. First, the material itself is exceedingly varied, hidden and overlaid with relatively worthless rubble.... Second, the whole effort is highly unorganised. There are no direct orders from architect or quarrymaster. Individuals and small bands proceed about their business unimpeded and uncontrolled, digging where they will, working over their material, and tucking it into place in the edifice.

*Endless Horizons*  
Chapter 17 (p. 179)  
Public Affairs Press. Washington, D.C. 1946

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

It is far safer to know too little than too much. People will condemn the one, though they will resent being called upon to exert themselves to follow the other.

*The Way of All Flesh*  
Chapter V (p. 18)  
Rinehart & Company, Inc. New York, New York, USA. 1955

**Butlerov, Aleksandr Mikhailovich** 1828–86  
Russian chemist

As speech is composed of sets of words and as images are composed of aggregates of shades, so from the mass of apprehended facts connected with one another there arises knowledge in its loftiest and finest sense.

Compiled by V.V. Vorontsov  
*Words of The Wise: A Book of Russian Quotations*  
Translated by Vic Schneiersson  
Progress Publishers. Moscow, Russia. 1979

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

That knowledge is not happiness, and science  
But an exchange of ignorance for that  
Which is another kind of ignorance.

*The Complete Poetical Works of Byron*

*Manfred*  
Act II, Scene V, l. 431–433  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Cajori, Florian** 1859–1930  
Swiss-born American educator and mathematician

The contemplation of the various steps by which mankind has come into possession of the vast stock of mathematical knowledge can hardly fail to interest the mathematician. He takes pride in the fact that his science, more than any other, is an exact science, and that hardly anything ever done in mathematics has proved to be useless.

*A History of Mathematics*  
Introduction (p. 1)  
Macmillan & Company Ltd. London, England. 1919

...by slow degrees, the minds of men were cut adrift from their old scholastic moorings and sent forth on the wide sea of scientific inquiry, to discover new islands and continents of truth.

*A History of Mathematics*  
Modern Europe (p. 139)  
Macmillan & Co Ltd. London, England. 1894

**Cannon, Walter Bradford** 1871–1945  
American neurologist and physiologist

The boundary of knowledge, however, is pushed forward with painful slowness, and always, as an advance is achieved, further territory to be explored is revealed.

*The Way of an Investigator: A Scientist's Experiences in Medical Research*  
Chapter II (p. 28)  
W.W. Norton & Company. New York, New York, USA. 1945

**Carnap, Rudolf** 1891–1970  
American philosopher

When we say that scientific knowledge is unlimited, we mean "there is no question whose answer is in principle unattainable by science."

In Mary Midgley  
Can Science Save Its Soul?  
*New Scientist*, Volume 135, Number 1832, 1 August, 1992 (p. 24)

**Carroll, J. E.**  
No biographical data available

Collecting fresh fruits becomes even harder as the tree of knowledge grows higher and wider. However, there are certain branches that provide surer footholds to the new growths, and teachers must search these out.

*Rate Equations in Semiconductor Electronics* (p. vi)  
Cambridge University Press. Cambridge, England. 1985

**Carus, Paul** 1852–1919  
American philosopher

Every success of scientific inquiry, every progress of research in the several fields of knowledge, every new

invention based upon methodical experiment is a refutation of agnosticism – the philosophy of nescience – in so far as these several advances corroborate the reliability of science.

*Philosophy as a Science: A Synopsis of Writings of Dr. Paul Carus*  
Introduction (p. 1)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1909

### Charlie Chan (Fictional character)

Knowledge only gained through curiosity.  
*Charlie Chan at the Wax Museum*  
Film (1940)

Small investigation sometimes bring large amount of knowledge.

*The Golden Eye*  
Film (1948)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Illuminated darkness is not light.  
*Heraclitean Fire: Sketches from a Life before Nature*  
Part II, In the Light of Darkness (p. 109)  
Rockefeller University Press. New York, New York, USA. 1978

**Clark, Eugenie** 1922–  
US marine biologist

Not many appreciate the ultimate power and potential usefulness of basic knowledge accumulated by obscure, unseen investigators who, in a lifetime of intensive study, may never see any practical use for their findings but who go on seeking answers to the unknown without thought of financial or practical gain.

*The Lady and the Sharks*  
Chapter 1 (p. 6)  
Harper & Row. New York, New York, USA. 1959

**Clarke, J. M.**  
No biographical data available

Knowledge is the only instrument of production that is not subject to diminishing returns.

Overhead Costs in Modern Industry  
*Journal of Political Economy*, October, 1927

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

...our knowledge will, we are easily persuaded, appear in turn the merest ignorance to those who come after us. Yet it is not to be despised, since by it we reach up groping fingers to touch the hem of the garment of the Most High.

*A Popular History of Astronomy During the Nineteenth Century*  
Part II, Chapter XIII (p. 442)  
A. & C. Black. London, England. 1908

**Cloos, Hans** 1885–1951  
German geologist

The well-marked path to knowledge is open to anyone willing to make the effort to follow it, though no one will ever quite reach its end.

*Conversation with the Earth*  
Prologue (p. 4)  
Routledge & Kegan Paul. London, England. 1954

**Coleridge, Mary** 1861–1907  
English poet

The fruits of the tree of Knowledge are various; he must be strong indeed who can digest all of them.

*Gathered Leaves*  
Mary Coleridge (pp. 8–9)  
Constable & Company. London, England. 1910

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

Questioning is the cutting edge of knowledge; assertion is the dead weight behind the edge that gives it driving force.

*Speculum Mentis*  
Chapter III, Section 5 (p. 78)  
At The Clarendon Press. Oxford, England. 1946

**Collins, Wilkie** 1824–89  
English novelist

...what is scientific knowledge now may be scientific ignorance in some years more.

*Heart and Science*  
LIV (p. 285)  
Chatto & Windus. London, England. 1899

**Commoner, Barry** 1917–  
American biologist, ecologist, and educator

Nature is the same everywhere and what men everywhere have learned about nature, taken together, leads to knowledge far deeper than that which each man alone can learn.

*Science and Survival*  
Chapter 4 (p. 57)  
The Viking Press. New York, New York, USA. 1966

**Conant, James Bryant** 1893–1978  
American educator and scientist

The stumbling way in which even the ablest of the scientists in every generation have had to fight through thickets of erroneous observations, misleading generalizations, inadequate formulations, and unconscious prejudice is rarely appreciated by those who obtain their scientific knowledge from textbooks.

*Science and Common Sense*

Chapter Three (p. 44)  
Yale University Press. New Haven, Connecticut, USA. 1951

**Confucius** 551 BCE–479 BCE  
Chinese philosopher and reformer

When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; – this is knowledge.

In James Legge  
*The Chinese Classics* (Volume 1)  
*The Confucian Analects*, book 2:17  
At The Clarendon Press. Oxford, England. 1893–95

**Cooke, Josiah Parsons** 1827–94

Honor those who seek Knowledge for her own sake, and remember they are the great heroes of the world, who work in faith, and leave the result with God!

*The New Chemistry*  
Lecture XIII (p. 326)  
D. Appleton & Company. New York, New York, USA. 1876

**Cooper, Thomas** 1759–1839  
American educationalist and political philosopher

...knowledge is a plant of slow growth.  
*The Introductory Lecture of Thomas Cooper, Esq.*  
Introductory Lecture (p. 4)  
Printed by Archibald Loudon. Carlisle, Pennsylvania, USA. 1812

**Cowper, William** 1731–1800  
English poet

Knowledge and Wisdom, far from being one,  
Have oft-times no connexion. Knowledge dwells  
In heads replete with thoughts of other men;  
Wisdom in minds attentive to their own.  
Knowledge, a rude unprofitable mass,  
The mere materials with which wisdom builds...  
Knowledge is proud that he has learn'd so much;  
Wisdom is humble that he knows no more.

*The Poetical Works of William Cowper*  
The Task, Book VI, l. 88–93, 96, 97  
John W. Lovell Company. New York, New York, USA. No date

**Crookes, Sir William** 1832–1919  
English chemist and physicist

...working at the very confines of our knowledge, [some chemists] find themselves occasionally at least face to face with a barrier which has hitherto proved impassable, but which must be overthrown, surmounted, or turned, if chemical science is ever to develop into a definite, an organised unity. This barrier is nothing less than the chemical elements commonly so called, the bodies as yet undecomposed into anything simpler than themselves. There they extend before us, as stretched the wide Atlantic before the gaze of Columbus, mocking, taunting, and murmuring strange riddles, which no man yet has been able to solve.

*Report of the Fifty-sixth Meeting of the British Association for the Advancement of Science*  
Presidential Address (pp. 558–559)  
John Murray. London, England. 1887

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The acquisition of any knowledge whatever is always useful to the intellect, because it will be able to banish the useless things and retain those which are good. For nothing can be either loved or hated unless it is first known.

Translated by Edward MacCurdy  
*The Notebooks of Leonardo da Vinci* (Volume 1)  
Aphorisms (p. 88)  
George Braziller. New York, New York, USA. 1958

All our knowledge originates in opinion.  
In Edward MacCurdy  
*Leonardo da Vinci's Note-Books*  
Book I (p. 53)  
Duckworth & Company. London, England. 1906

The knowledge of past time and of the position of the earth is the adornment and the food of human minds.

Translated by Edward MacCurdy  
*Leonardo da Vinci's Note-books*  
Book I (p. 53)  
Duckworth & Co. London, England. 1906

**Darwin, Charles Robert** 1809–82  
English naturalist

The more one thinks, the more one feels the hopeless immensity of man's ignorance.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
Letter 307, Darwin to Farrar, August 28, 1881 (p. 394)  
D. Appleton & Company. New York, New York, USA. 1903

**Daumal, René** 1908–44  
French surrealist writer

You cannot stay on the summit forever; you have to come down again. So why bother in the first place? Just this: What is above knows what is below, but what is below does not know what is above. In climbing, take careful note of the difficulties along your way; for as you go up, you can observe them. Coming down, you will no longer see them, but you will know they are there if you have observed them well. There is an art of finding one's direction in the lower regions by the memory of what one saw higher up. When one can no longer see, one can at least still know.

Translated by Roger Shattuck  
*Mount Analogue*  
Editor's Note (p. 110)  
Shambhala. Boston, Massachusetts, USA. 1986

**Davy, Sir Humphry** 1778–1829  
English chemist

The love of knowledge and of intellectual power is a faculty belonging to the human mind in every state of society; and it is one by which it is most justly characterized – one the most worthy of being cultivated and extended.

In Robert Siegfried and Robert H. Dott, Jr. (eds.)  
*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Introductory Lecture for the Courses of 1805 (p. 3)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

All human knowledge is necessarily imperfect; but the further it extends, the better are its effects.

In Robert Siegfried and Robert H. Dott, Jr. (eds.)  
*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Introductory Lecture for the Courses of 1805 (p. 3)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

Human beings have been created for happiness, and a principal means of obtaining it is by the exercise of the intellectual faculties, by an exertion of reason and imagination, by imitating nature and modifying her operations. And knowledge is no less necessary to supply the wants of the mind than food is to support the functions of the body.

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*  
Chapter III (p. 59)

John Churchill. London, England. 1858

Knowledge can only be acquired by the senses: nature has no archetype in the human imagination; her empire is given only to industry and action, guided and governed by experience.

In John Davy (ed.)  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
Chapter III (p. 216)

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**de Morgan, Augustus** 1806–71

English mathematician and logician

Every kind of human knowledge has unanswerable questions at its end: and until the insoluble problems are revealed, we plume ourselves upon our progress.

*Transactions of the Cambridge Philosophical Society*

On Infinity: and on the Sign of Equality (p. 151)

At the University Press. Cambridge, England. 1871

A person of small knowledge is in danger of trying to make his little do the work of more; but a person without any is in more danger of making his no knowledge do the work of some.

*A Budget of Paradoxes* (Volume 1) (2nd edition)

Introductory (p. 4)

The Open Court Publishing Co. Chicago, Illinois, USA. 1915

**Dewar, Redcote**

No biographical data available

Man, however, and particularly a specialist, is terribly conceited in his opinions. He invariably forgets that he

but stands on a transitory pinnacle of knowledge. His horizon may truly be today unbroken, and his learning the apex of his century; but to-morrow and succeeding days other pinnacles shoot up and overshadow him until he is left as but a gargoyle in the depths of ignorance below.

*From Matter to Man: A New Theory of the Universe*

Chapter X (p. 127)

Chapman & Hall, Ltd. London, England. 1898

**Dewey, John** 1859–1952

American philosopher and educator

...if there is any knowledge which is of most worth it is knowledge of the ways by which anything is entitled to be called knowledge instead of being mere opinion or guess-work or dogma.

Science as Subject-Matter and as Method

*Science*, N.S. Volume 31, Number 787, January 28, 1910 (p. 125)

**Dickens, Charles** 1812–70

English novelist

But wot's that, you're a-doin' of? Pursuit of knowledge under difficulties, Sammy?

*The Posthumous Papers of the Pickwick Club*

Chapter XXXIII (p. 387)

Dodd, Mead & Company. New York, New York, USA. 1944

**Dingle, Herbert** 1890–1978

English astrophysicist

No generation that is in the true line of advance can properly know what it is doing. It works in the dark, building better than it knows, by the blind understanding which directs its actions towards the final achievement. We can at least learn from our experience not to despise the work of those on whose shoulders we stand, as we hope for charitable judgment from those who will succeed us.

*Through Science to Philosophy*

Chapter XV (p. 354)

At The Clarendon Press. Oxford, England. 1937

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

The more we know, the better we realize that our knowledge is a little island in the midst of an ocean of ignorance.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas Today* 1974

*Advancement and Obsolescence in Science* (p. 61)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1975

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

What can we know? What are we all? Poor silly half-brained things peering out at the infinite, with the aspirations of angels and the instincts of beasts.

*The Stark Munro Letters*

Letter V (p. 94)

D. Appleton & Company. New York, New York, USA. 1895

Some eighty thousand years are supposed to have existed between paleolithic and neolithic man. Yet in all that time he only learned to grind his flint stones instead of chipping them. But within our father's lives what changes have there not been? The railway and the telegraph, chloroform and applied electricity. Ten years now go further than a thousand then, not so much on account of our finer intellects as because the light we have shows us the way to more. Primeval man stumbled along with peering eyes, and slow, uncertain footsteps. Now we walk briskly towards our unknown goal.

*The Stark Munro Letters*

Letter XIV (p. 320)

D. Appleton & Company. New York, New York, USA. 1895

I consider that a man's brain originally is like a little empty attic, and you have to stock it with such furniture as you choose. A fool takes in all the lumber of every sort that he comes across, so that the knowledge which might be useful to him gets crowded out, or at best is jumbled up with a lot of other things, so that he has a difficulty in laying his hands upon it. Now the skilful workman is very careful indeed as to what he takes into his brain-attic. He will have nothing but the tools which may help him in doing his work, but of these he has a large assortment, and all in the most perfect order. It is a mistake to think that that little room has elastic walls and can distend to any extent. Depend upon it – there comes a time when for every addition of knowledge you forget something that you knew before. It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Study in Scarlet*

Chapter 2 (p. 154)

Wings Books. New York, New York, USA. 1967

Is it not? Is it not? Breadth of view, my dear Mr. Mac, is one of the essentials of our profession. The interplay of ideas and the oblique uses of knowledge are often of extraordinary interest.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Valley of Fear*

Part I, Chapter 7 (p. 512)

Wings Books. New York, New York, USA. 1967

A man should keep his little brain-attic stocked with all the furniture that he is likely to use, and the rest he can put away in the lumber-room of his library, where he can get it if he wants it.

*The Complete Sherlock Holmes*

*The Five Orange Pips* (p. 225)

Doubleday & Company, Inc. Garden City, New York, USA. 1930

### Dr. Carrington (Fictional character)

...knowledge is more important than life.... There is onle one excuse for existing – to think – to find out – to learn ...

*The Thing from Another World*

Film (1951)

### Drexler, K. Eric 1955–

American nanotechnology engineer and researcher, and futurist

People who confuse science with technology tend to become confused about limits...they imagine that new knowledge always means new know-how; some even imagine that knowing everything would let us do anything.

*Engines of Creation*

Chapter 10 (p. 148)

Anchor Press/Doubleday. Garden City, New York, USA. 1986

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

We have discovered that it is actually an aid in the search for knowledge to understand the nature of the knowledge we seek.

*The Philosophy of Physical Science*

Chapter I, Section II (p. 5)

The Macmillan Company. New York, New York, USA. 1939

...the road to a knowledge of the stars leads through the atom; and important knowledge of the atom has been reached through the stars.

*Stars and Atoms*

Lecture I (pp. 9–10)

Yale University Press. London, England. 1927

### Egler, Frank E. 1911–96

American botanist and ecologist

Knowledge is not wisdom; wisdom is knowledge when it is tempered by judgment.

*The Way of Science*

The Nature of Science (p. 1)

Hafner Publishing Company. New York, New York, USA. 1970

### Einstein, Albert 1879–1955

German-born physicist

Yet it is equally clear that knowledge of what is does not open the door directly to what should be.

*Out of My Later Years* (p. 22)

Thames & Hudson. London, England. 1950

In the light of finally obtained knowledge the deductions seem almost self-evident and can be understood with no great difficulty by any intelligent student. But the foreboding search in the dark, with its intense yearnings, its alternation from confidence to despondence and then the ultimate break-through to final clarity, can only be perceived by someone who has experienced it himself.

In Cornelius Lanczos

*Albert Einstein and the Cosmic World Order*

Chapter 5 (p. 85)

Interscience Publishers. New York, New York, USA. 1965

In every true searcher of Nature there is a kind of religious reverence; for he finds it impossible to imagine that he is the first to have thought out the exceedingly delicate threads that connect his perceptions. The aspect of knowledge which had not yet been laid bare gives the



investigator a feeling akin to that experienced by a child who seeks to grasp the masterly way in which elders manipulate things.

In Alexander Moszkowski  
*Conversations with Einstein*  
Chapter III (p. 46)  
Horizon Press. New York, New York, USA. 1970

It is my inner conviction that the development of science seeks in the main to satisfy the longing for pure knowledge.

In Alexander Moszkowski  
*Conversations with Einstein*  
Chapter VIII (p. 173)  
Horizon Press. New York, New York, USA. 1970

...knowledge cannot spring from experience alone but only from the comparison of the inventions of the intellect with observed fact.

Translated by Alan Harris  
*Essays in Science*  
Johannes Kepler (p. 27)  
Philosophical Library. New York, New York, USA. 1934

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1896  
Polish physicist

Our knowledge is now wider and more profound than that of the physicists of the nineteenth century, but so are our doubts and difficulties.

*The Evolution of Physics*  
Ether and the Mechanical View (p. 126)  
Simon & Schuster. New York, New York, USA. 36

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

We in the modern world have turned more stones, listened to more buried voices, than any culture before us. There should be a kind of pity that comes with time, when one grows truly conscious and looks behind as well as forward, for nothing is more brutally savage than the man who is not aware that he is a shadow.

*The Night Country*  
Chapter 6 (p. 85)  
Charles Scribner's Sons. New York, New York, USA. 1971

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Yet things are knowable! They are knowable, because, being from one, things correspond. There is a scale; and the correspondence of heaven to earth, of matter to mind, of the part to the whole, is our guide. As there is a science of stars, called astronomy; and science of quantities, called mathematics; a science of qualities, called chemistry; so there is a science of sciences, – I call it Dialectic, – which is the Intellect discriminating the false and the true.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)  
*Representative Men*  
Plato; or, the Philosopher (p. 62)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Our knowledge is the amassed thought and experience of innumerable minds.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)  
*Letters and Social Aims*  
Quotations and Originality (p. 200)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

All our progress is an unfolding, like the vegetable bud. You have first an instinct, then an opinion, then a knowledge.

*Ralph Waldo Emerson: Essays and Lectures*  
*Essays: First Series*  
Intellect (p. 419)  
The Library of America. New York, New York, USA. 1983

**Everett, Edward** 1794–1865  
American statesman, educator, and orator

...the great object of all knowledge is to enlarge and purify the soul, to fill the mind with noble contemplations, to furnish a refined pleasure, and to lead our feeble reason from the works of nature up to its great Author and Sustainer.

*An Oration*  
The Uses of Astronomy, Albany, New York, 28 July 1856 (p. 36)  
Ross & Tousey. New York, New York, USA. 1856

**Faber, Harold**  
No biographical data available

New scientific knowledge is like wine in the wedding of Cana: it cannot be used up; the same idea can serve many users simultaneously; and as the number of customers increases, no one need be getting less of it because the others are getting more.

*The Book of Laws*  
The Laws of Economics, Leontief's Law (p. 57)  
Times Books. New York, New York, USA. 1979

**Faraday, Michael** 1791–1867  
English physicist and chemist

I cannot doubt but that he who, as a wise philosopher, has most power of penetrating the secrets of nature, and guessing by hypothesis at her mode of working, will also be most careful, for his own safe progress and that of others, to distinguish that knowledge which consists of assumption, by which I mean theory and hypothesis, from that which is the knowledge of facts and laws; never raising the former to the dignity or authority of the latter, nor confusing the latter more than is inevitable with the former.

*Experimental Researches in Electricity* (Volume 2)  
A Speculation Touching Electric Conduction and the Nature of Matter (pp. 285–286)  
Bernard Quaritch. London, England. 1844



**Fermi, Enrico** 1901–54  
Italian-born American physicist

It is no good to try and stop knowledge from going forward...ignorance is never better than knowledge.

In Laura Fermi  
*Atoms in the Family*  
Chapter 23 (p. 244)  
The University of Chicago Press. Chicago, Illinois, USA.

**Feynman, Richard P.** 1918–88  
American theoretical physicist

I don't know what's the matter with people: they don't learn by understanding; they learn by some other way – by rote, or something. Their knowledge is so fragile!

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character Who Stole the Door* (pp. 36–37)  
W.W. Norton & Company, Inc. New York, New York, USA. 1985

A great deal more can be known than can be proved.  
*Chicago Tribune*, 318:4, Section 7, November 14, 1993

Knowledge is of no real value if all you can tell me is what happened yesterday. It is necessary to tell what will happen tomorrow if you do something.... You must be willing to stick your neck out.

*The Meaning of It All*  
Chapter 1 (p. 25)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

The principle of science, the definition, almost, is the following: The test of all knowledge is experiment. Experiment is the sole judge of scientific "truth."

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 1–1 (p. 1–1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Fischer, Martin H.** 1879–1962  
German-American physician

Knowledge is a process of piling up facts; wisdom lies in their simplification.

In Howard Fabing and Ray Marr  
*Fischerisms* (p. 2)  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Fischer, Robert B.**  
No biographical data available

Thus, the scientist must recognize the statistical aspect of much of his knowledge, not, on the one hand, unduly hesitating to accept it as true if the probability is reasonably

high, but, on the other hand, maintaining an alertness to the possibility that what may for good appear to be highly improbable may indeed occur or be true.

*Science, Man and Society*  
Chapter 3 (p. 37)  
W.B. Saunders Company. Philadelphia, Pennsylvania, USA. 1971

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

Inductive inference is the only process known to us by which essential new knowledge comes into the world.

*The Design of Experiments*  
I, 4 (p. 7)  
Hafner Publishing Company. New York, New York, USA. 1971

**Flammarion, Camille** 1842–1925  
French astronomer and writer

Is it not pleasant to exercise our minds in the contemplation of the great spectacles of nature? Is it not useful to know, at least, upon what we tread, what place we occupy in the infinite, the nature of the sun whose rays maintain terrestrial life, of the sky which surrounds us, of the numerous stars which in the darkness of night scatter through space their silent light? This elementary knowledge of the universe, without which we live, like plants, in ignorance of and indifference to the causes of which we perpetually witness the effects, we can acquire not only without difficulty, but with an ever-increasing pleasure.

*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter I (p. 1)  
Chatto & Windus. London, England. 1894

**Fleck, Ludwik** 1896–1961  
Physician and epistemologist

Certainty, simplicity, vividness originate in popular knowledge. That is where the expert obtains his faith in this triad as the ideal of knowledge. Therein lies the general epistemological significance of popular science.

*Genesis and Development of a Scientific Fact*  
Chapter Four, Section 4 (p. 115)  
The University of Chicago Press. Chicago, Illinois, USA. 1979

**Forsyth, A. R.**  
No biographical data available

...let me plead...for the highest consideration to be given to the pursuit of pure knowledge as well as technical training, not neglecting mathematics, once called the Queen of the Sciences. The wind bloweth where it listeth, and the spirit of knowledge does not follow the quest for wealth and power; but the creation of new knowledge makes for the high repute of a nation, alike in the days when its influence is dominant and more in the distant days when its doings shall have been recorded on the scroll of time.

*Gateway to the Great Books – Mathematics*

Mathematics in Life and Thought (p. 46)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1963

**Foster, Sir Michael** 1836–1907  
English physiologist and educator

What we know and what we think is not a new fountain gushing fresh from the barren rock of the unknown at the stroke of the rod of our own intellect, it is a stream which flows by us and through us, fed by the far-off rivulets of long ago.

*Lectures on the History of Physiology*  
Lecture I (p. 1)  
University Press. Cambridge, England. 1901

As the loom which is weaving that ever-spreading garment takes in new warp and new woof, such threads only of each are taken in as can be fitly joined to those which have come in before; each thread as it is twisted in becomes a hold for other threads to be caught up later on. No single observation, no single experiment stands alone by itself, nor can its worth be rightly judged by itself alone.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*  
Recent Advances in Science, and their Bearing on Medicine and Surgery (p. 350)  
Government Printing Office. Washington, D.C. 1899

Every experiment, every observation has, besides its immediate result, effects which, in proportion to its value, spread always on all sides into ever distant parts of knowledge.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*  
Recent Advances in Science, and Their Bearing on Medicine and Surgery (pp. 350–351)  
Government Printing Office. Washington, D.C. 1899

**Franklin, Benjamin** 1706–90  
American printer, scientist and diplomat

The first Drudgery of Settling new Colonies, which confines the Attention of People to mere Necessaries, is now pretty well over; and there are many in every Province in Circumstances that set them at Ease, and afford Leisure to cultivate the finer Arts, and improve the common Stock of Knowledge. To such of these who are Men of Speculation, any Hints must from time to time arise, may Observations occur, which if well-examined, pursued and improved, might produce Discoveries to the Advantage of some or all of the British Plantations, or to the Benefit of Mankind in general.

*A Proposal for Promoting Useful Knowledge Among the British Plantations in America (1743)*

**Fuller, Thomas** 1608–61  
English clergyman and author

Knowledge is a Treasure, but Practice is the Key to it.  
*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*

No. 3139  
Printed for Thomas and Joseph Allman. London, England. 1816

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

The knowledge whose content makes up astronomy is the gain from more than 2,000 years' work on one of the most abundant objects of human knowledge, in which the foremost minds of all times have summoned up all the resources of genius and diligence.

In G. Waldo Dunnington (ed.)  
*Inaugural Lecture on Astronomy and Papers on the Foundations of Mathematics*  
Inaugural Lecture on Astronomy (p. 49)  
Louisiana State University Press. Baton Rouge, Louisiana, USA. 1937

**Gell, Alfred** 1945–97  
English social anthropologist

There are no closed frontiers between intellectual approaches. Only closed minds which refuse to cross them.

*The Anthropology of Time: Cultural Constructions of Temporal Maps and Images*  
Chapter 31 (p. 322)  
Berg. Oxford, England. 1996

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

No man can reveal to you aught but that which already lies half asleep in the dawning of your knowledge.

*The Prophet*  
On Teaching (p. 56)  
Alfred A. Knopf. New York, New York, USA. 1969

Knowledge and understanding are life's faithful companions who will never prove untrue to you. For knowledge is your crown, and understanding your staff; and when they are with you, you possess no greater treasures.

Translated by Anthony Ferris  
*The Treasured Writing of Kahlil Gibran*  
*The Voice of the Master*  
Wisdom, viii (p. 488)  
The Citadel Press. New York, New York, USA. 1958

**Gilbert, G. K.** 1843–1918  
American geologist

In the domain of the world's knowledge there is no infallibility.

The Origin of Hypotheses, Illustrated by the Discussion of a Topographic Problem  
*Science*, Volume 3, Number 53, January 3, 1896 (p. 12)

Knowledge of Nature is an account at bank, where each dividend is added to the principle and the interest is ever compounded; and hence it is that human progress, founded on natural knowledge, advances with ever increasing speed.

The Origin of Hypotheses, Illustrated by the Discussion of a Topographic Problem  
*Science*, Volume 3, Number 53, January 3, 1896 (p. 13)

**Gore, George** 1826–1909  
Electrochemist and scientific writer

New knowledge is not like a cistern, soon emptied, but is a fountain of almost unlimited power and duration...

*The Art of Scientific Discovery*  
Part I, Chapter III (p. 27)

Longmans, Green & Company. London, England. 1878

Existing knowledge is the basis of future discovery; all our knowledge of the future is implicitly wrapped up in nature; we require to stand upon the *terra-firma* of the known, in order to stretch outwards into the darkness and uncertainty of the unknown.

*The Art of Scientific Discovery*  
Chapter XXX (p. 293)

Longmans, Green & Co. London, England. 1878

Knowledge begets knowledge, as wealth begets wealth, and he who possesses much can with the greater facility obtain more.

*The Art of Scientific Discovery*  
Part III, Chapter XXX (p. 294)

Longmans, Green & Co. London, England. 1878

**Gray, George W.**  
Freelance science writer

Theory is built on experiment, and experiment and discovery are guided by theory; science is forever stumbling forward from one approximation to a closer one, and the story of knowledge is a record of continual change.

*New World Picture*  
Preface (p. viii)

Little, Brown & Co. Boston, Massachusetts, USA. 1935

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

The less a man knows, the more content he is with his intellectual capacity and outlook: it requires a great man to realise the imperfections of his knowledge.

*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 20)

Macmillan & Company Ltd. London, England. 1918

Man as a physical being is but a microscopic part of the universe, yet his mind carries him ever upward, and with spirit bold and unconquerable he seeks to reach the summit of Mount Olympus. Infinite space remains to humble his pride in spite of the knowledge he has obtained of the starry heavens; yet he pursues his inquiries into the unknown, and his children's children will continue the search.

*Discovery, Or, The Spirit and Service of Science*  
Chapter I (p. 21)

Macmillan & Co Ltd. London, England. 1916

The gospel of work is the gospel of science. Go into the fields of Nature and labour if you would become a disciple of science; for not otherwise can the kingdom of natural knowledge be gained.

*Discovery; or, The Spirit and Service of Science*  
Chapter III (pp. 41–42)

Macmillan & Company Ltd. London, England. 1918

New treasures can never be secured from Nature without effort; "tribulation, not undisturbed progress gives life and soul, and leads to success when success can be reached, in the struggle for natural knowledge."

*Discovery; or, The Spirit and Service of Science*  
Chapter III (p. 42)

Macmillan & Company Limited. London, England. 1918

Success in science means the birth of new knowledge.

*Discovery; or, The Spirit and Service of Science*  
Chapter III (p. 42)

Macmillan & Company Ltd. London, England. 1918

**Hall, Alfred Rupert** 1920–  
English historian of science

...the grain of real knowledge is concealed in a vast deal of esoteric chaff.

*The Scientific Revolution, 1500–1800*  
Chapter XI (p. 307)

Longmans, Green & Company. London, England. 1954

**Hamerton, Philip Gilbert** 1834–94  
English artist and art critic

New knowledge is not like a cistern, soon emptied, but is a fountain of almost unlimited power and duration.

*The Intellectual Life*  
Part I, Chapter III (p. 27)

Little, Brown & Co. Boston, Massachusetts, USA. 1901

**Harris, Sydney J.**  
No biographical data available

Our current annoyance at the long hair affected by young men is both trivial and parochial; what matters is the amount of substance inside the head, not outside.

*Leaving the Surface* (p. 329)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1968

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

...the first law of knowledge is the conservation of ignorance. Take any subject, no matter how simple; have you noticed, after study and thought, how the more we know of that subject the more aware we become of what we do not know? For some outlandish reason greater knowledge leads unavoidably to an awareness of greater ignorance. Learned ignorance (awareness of ignorance) replaces unlearned ignorance (unawareness of ignorance), and total ignorance as a consequence remains unchanged. Learned ignorance always increases

with knowledge. “This is the second law of knowledge. Happy is the person who knowing nothing thinks he knows everything!...”

A Twinkle in the Eye of the Universe  
*Quarterly Journal of the Royal Astronomical Society*, Volume 25,  
Number 4, December, 1984 (p. 423)

### Harth, Erich

No biographical data

I have no possessions that are truly my own. I am like a stranger at a rich man’s gate. What I have is borrowed, and even my knowledge is nothing but hand-me-downs, and an occasional oddity I pick up by chance. I pass it on to others like me.

*The Creative Loop: How the Brain Makes a Mind*  
Chapter 1 (p. 6)  
Addison-Wesley, Reading, Massachusetts, USA. 1993

### Hartmann, Heinz

1894–1970  
Psychiatrist and psychoanalyst

...every avenue which could lead to an increase of our knowledge deserves to be followed, regardless of the consequences. This is the professional code, or rather one of the professional codes, we find in men of science.

*Psychoanalysis and Moral Values* (p. 56)  
International Universities Press. New York, New York, USA. 1960

### Harvey, William

1578–1657  
English physician

What shall I deliver in these my Exercises on Animal Generation I am anxious to make publicly known, not merely that posterity may there perceive the sure and obvious truth, but further, and especially, that by exhibiting the method of investigation which I have followed, I may propose to the studious a new and unless I am mistaken a safer way to the attainment of knowledge.

In *Great Books of the Western World* (Volume 28)  
*Anatomical Exercises on the Generation of Animals*  
Introduction (p. 231)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Hele-Shaw, H. S.

1854–1941  
Naval architect

If I have assumed too little knowledge on your part, it is because of the difficulties I have found in the subject myself. If I have left more obscure than I have been able to make clear, it is consoling to think how many centuries were required to discover even what is known at the present time, and we may well be forgiven if we cannot grasp at once results which represent the life work of some of the greatest men.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*  
The Motions of a Perfect Liquid  
Government Printing Office. Washington, D.C. 1901

### Herbert, Frank

1920–86  
American science fiction writer

Every judgment teeters on the brink of error. To claim absolute knowledge is to become monstrous. Knowledge is an unending adventure at the edge of uncertainty.

*Children of Dune* (p. 268)  
Penguin Putnam Inc. New York, New York, USA. 1976

### Herschel, Sir John Frederick William

1792–1871  
English astronomer and chemist

...it happens that great masses of knowledge are daily perishing before our eyes without the possibility of recovery, because, in fact, our eyes are not open to them, and we have nothing to awaken our attention to their transient display.

*Essays From the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*  
Terrestrial Magnetism (pp. 65–66)  
Longman, Brown, Green, Longmans & Robert. London, England. 1857

As civilization extends, wants and desires of a higher order than material gratifications arise; and among them that of extending knowledge *for the sake of knowing* the craving after a larger grasp, a clearer insight, a more complete conception in all its relations of the wondrous universe of which we form a part.

*Familiar Lectures on Scientific Subjects*  
Lecture V (p. 179)  
George Routledge & Sons. New York, New York, USA. 1871

Knowledge is not, like food, destroyed by use, but rather augmented and perfected.

In David Josiah Brewer  
*The World’s Best Essays, from the Earliest Period to the Present Time*  
(Volume 6)  
Science as a Civilizer (p. 2188)  
Ferd P. Kaiser. St. Louis, Missouri, USA. 1910

### Hertzberger, Herman

1932–  
Dutch architect

Knowledge and experience keep forcing us back into the old grooves of the old record of meanings, the way a knife keeps returning to the original striations in a sheet of cardboard.

*Space and the Architect: Lessons in Architecture 2*  
Chapter 2 (p. 35)  
Publishers. Rotterdam, The Netherlands. 2000

### Hill, Archibald V.

1886–1977  
English physiologist

The pursuit of natural knowledge, the investigation of the world – mental and material – in which we live, is not a dull and spiritless affair: rather is it a voyage of adventure of the human mind, a holiday for reckless and imaginative souls.

*Les Prix Nobel. The Nobel Prizes in 1922*

Nobel banquet speech for award received in 1922

Nobel Foundation. Stockholm, Sweden. 1923

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

This is an inquisitive age, and if we insist on piling up beyond a certain height knowledge which is in itself mere trash and lumber to a man whose life is to be one long fight with death and disease, there will be some sharp questions asked by and by.

*Scholastic and Bedside Teaching*

Lecture

Harvard University

November 6, 1867

The air we breathe is made up of four elements, at least: oxygen, nitrogen, carbonic acid gas, and knowledge.

*Over the Teacups*

Chapter VI (pp. 132–133)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

The best part of our knowledge is that which teaches us where knowledge leaves off and ignorance begins.

*Medical Essays*

Border Lines in Medical Science (p. 211)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The traveler who would not drink of the Nile until he had tracked it to its parent lakes, would be like to die of thirst; and the medical practitioner who would not use the results of many laborers in other departments without sharing their special toils, would find life far too short and art immeasurably too long.

*Medical Essays*

Scholastic and Bedside Teaching (p. 274)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Knowledge and timber shouldn't be much used till they are seasoned.

*The Autocrat of the Breakfast-Table*

Chapter VI (p. 134)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Knowledge – it excites prejudices to call it science – is advancing as irresistibly, as majestically, as remorselessly as the ocean moves in upon the shore.

*The Poet at the Breakfast Table*

Chapter X (p. 260)

J.M. Dent & Co. London, England. 1906

It is the province of knowledge to speak and it is the privilege of wisdom to listen.

*The Poet at the Breakfast-Table*

Chapter X (p. 264)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Holton, Gerald** 1922–

Research professor of physics and science history

**Roller, Duane H. D.** ?–1994

Science historian

Knowledge is like a net; if one were to cut out the part which is labeled science, the rest of the net would be useless.

*Foundations of Modern Physical Science*

Chapter 14 (p. 247)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**Hopkinson, John** 1849–98

English physicist and electrical engineer

Our knowledge must always be limited, but the knowable is limitless. The greater the sphere of our knowledge the greater the surface of contact with our infinite ignorance.

*The Relation of Mathematics to Engineering*

*Nature*, Volume 50, Number 1280, May 10, 1894 (p. 47)

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The aim is to bite good and hard on the fruit of the tree of knowledge.

*Ten Faces of the Universe*

*The Mathematician's Universe* (p. 52)

W.H. Freeman & Company. San Francisco, California, USA. 1977

**Hubble, Edwin Powell** 1889–1953

American astronomer

Knowledge stirs the imagination, drives away the nightmares of superstition.

*The Nature of Science and Other Lectures*

Part I, Science and Technology (pp. 24–25)

The Huntington Library. San Marino, California, USA. 1954

The laws of science are the permanent contribution to knowledge – the individual pieces which are fitted together attempt to form a picture of the physical universe in action.

*The Nature of Science and Other Lectures*

Part I, Experiment and Experience (p. 40)

The Huntington Library. San Marino, California, USA. 1954

Science acquires knowledge but has no interest in its practical applications. The applications are the work of engineers.

*The Nature of Science and Other Lectures*

Part II, Scientists at War (p. 63)

The Huntington Library, San Marino, California, USA. 1954

The history of astronomy is a history of receding horizons. Knowledge has spread in successive waves, each wave representing the exploitation of some new clew to the interpretation of observational data.

*The Realm of the Nebulae*

Chapter I (p. 21)

Dover Publications, Inc. New York, New York, USA. 1958



**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

All human knowledge is but picking and culling. The circumstance that the false is mingled with the true, furnishes no excuse for rejecting the whole mass. When was the tare an excuse for refusing the corn? Hoe out the weed error, but reap the fact, and place it beside others. Science is the sheaf of facts.

Translated by Melville Best Anderson

*William Shakespeare*

Part I, Book I, Chapter V (p. 38)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

If our knowledge is imperfect, we may form erroneous principles, and deceive ourselves in reasoning with regard to those works of nature, which are wisely calculated for our instruction.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section II (p. 42)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Aldous** 1894–1963

English writer and critic

Knowledge is the highest good, truth the supreme value, all the rest is secondary and subordinate.

*Brave New World*

Chapter Sixteen (p. 273)

Harper & Brothers. New York, New York, USA. 1950

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Knowledge is basic. It is knowledge which enables us to understand the world and ourselves, and to exercise some control or guidance. It sets us in a fruitful and significant relation with the enduring processes of the universe. And, by revealing the possibilities of fulfillment that are still open, it provides an overriding incentive.

In Pierre Teilhard de Chardin

*The Phenomenon of Man*

Introduction (p. 28)

Harper & Row, Publishers. New York, New York, USA. 1965

**Huxley, Thomas Henry** 1825–95

English biologist

So far as that limited revelation of the nature of things, which we call scientific knowledge, has yet gone, it tends, with constantly increasing emphasis, to the belief that, not merely the world of plants, but that of animals; not merely living things, but the whole fabric of the earth; not merely our planet, but the whole solar system; not merely our star and its satellites, but the millions of similar bodies which bear witness to the order which pervades boundless space, and has endured through boundless time; are all working out their predestined courses of evolution.

*Evolution and Ethics and Other Essays*

Prolegomena (p.6)

Macmillan & Company Ltd. London, England. 1894

It is given to few to add to the store of knowledge, to strike new springs of thought, or to shape new forms of beauty. But so sure as it is that men live not by bread, but by ideas, so sure is it that the future of the world lies in the hands of those who are able to carry the interpretation of nature a step further than their predecessors.

*Collected Essays* (Volume 3)

*Science and Education*

Address on University Education (p. 254)

Macmillan & Company Ltd. London, England. 1904

Indeed, if a little knowledge is dangerous, where is the man who has so much as to be out of danger?

*Collected Essays* (Volume 3)

*Science and Education*

On Elementary Instruction in Physiology (p. 300)

Macmillan & Company Ltd. London, England. 1904

...in science, as in life, learning and knowledge are distinct, and the study of things, and not of books, is the source of the latter.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 218)

Macmillan & Company Ltd. London, England. 1904

Forewarned is forearmed, says the proverb; and knowledge of the laws of nature is forewarning of that which we may expect to happen, when we have to deal with natural objects.

*Introductory*

Article 10 (p. 16)

Macmillan & Company Ltd. London, England. 1907

In its earliest development knowledge is self-sown. Impressions force themselves upon men's senses whether they will or not, and often against their will. The amount of interest which these impressions awaken is determined by the coarser pains and pleasures which they carry in their train, or by mere curiosity; and reason deals with the materials supplied to it as far as that interest carries it, and no farther.

*The Crayfish: An Introduction to the Study of Zoology* (p. 2)

C. Kegan Paul & Co. London, England. 1880

When simple curiosity passes into the love of knowledge as such, and the gratification of the aesthetic sense of the beauty of completeness and accuracy seems more desirable than the easy indolence of ignorance; when the finding out of the causes of things becomes a source of joy, and he is counted happy who is successful in the search; common knowledge of nature passes into what our forefathers called Natural History, from whence there is but a step to that which used to be termed Natural Philosophy, and now passes by the name of Physical Science.

*The Crayfish: An Introduction to the Study of Zoology* (p. 3)

C. Kegan Paul & Co. London, England. 1880



The rapid increase of natural knowledge, which is the chief characteristic of our age, is effected in various ways. The main army of science moves to the conquest of new worlds slowly and surely, nor ever cedes an inch of the territory gained. But the advance is covered and facilitated by the ceaseless activity of clouds of light troops provided with a weapon – always efficient, if not always an arm of precision – the scientific imagination. It is the business of these *enfants perdus* of science to make raids into the realm of ignorance wherever they see, or think they see, a chance; and cheerfully to accept defeat, or it may be annihilation, as the reward of error.

*Man's Place in Nature: And Other Anthropological Essays*  
Chapter VI (p. 272)  
D. Appleton & Co. New York, New York, USA. 1919

...every great advance in natural knowledge has involved the absolute rejection of authority ...

*Lay Sermons, Addresses and Reviews*  
Chapter VI (p. 118)  
D. Appleton & Co. New York, New York, USA. 1903

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

For my part, I shall be very well contented, and shall count I have done a great matter, if I can but come to any knowledge of the nature of things, as they now are, never troubling my head about their beginning, or how they were made, knowing that to be out of the reach of human Knowledge, or even Conjecture.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
Book the Second, Every Sun has a Vortex round it, very different from those of Cartes (p. 160)  
Printed for T. Childe. London, England. 1698

**Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

To gain knowledge is not always simple. The search for truth, however, is one of man's most thrilling adventures. It is a search that requires patience, caution, and persistence.

*Is It Really So?: A Guide to Clear Thinking*  
Chapter 9 (p. 76)  
The West Minster Press. Philadelphia, Pennsylvania, USA. 1976

**James, William** 1842–1910

American philosopher and psychologist

...our science is a drop, our ignorance a sea. Whatever else be certain, this at least is certain – that the world of our present natural knowledge is enveloped in a larger world of some sort of whose residual properties we at present can frame no positive idea.

*The Will to Believe and Other Essays in Popular Philosophy*  
Is Life Worth Living? (p. 54)  
Dover Publications, Inc. New York, New York, USA. 1956

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

We of the present age know very little – almost nothing; we are rather pioneers setting out to explore a new country. We have the thrill of ever-changing views, now and again we reach a ridge or summit which opens up new and unexpected vistas – of necessity our point of view must continually change.

*Living Philosophies*  
Chapter VIII (p. 119)  
Simon & Schuster. New York, New York, USA. 1931

...our knowledge of the external world must always consist of numbers, and our picture of the universe – the synthesis of our knowledge – must necessarily be mathematical in form. All the concrete details of the picture, the apples, the pears and bananas, the ether and atoms and electrons, are mere clothing that we ourselves drape over our mathematical symbols – they do not belong to Nature, but to the parables by which we try to make Nature comprehensible. It was, I think, Kronecker who said that in arithmetic God made the integers and man made the rest; in the same spirit, we may add that in physics God made the rest.

*The New World-Picture of Modern Physics*  
*Supplement to Nature*, Volume 134, Number 3384, September, 1934 (p. 356)

...science should leave off making pronouncements: the river of knowledge has too often turned back on itself.

*The Mysterious Universe*  
Chapter V (p. 188)  
The Macmillan Company. New York, New York, USA. 1932

...to many it is not knowledge but the quest for knowledge that gives the greater interest to thought – to travel hopefully is better than to arrive.

*Physics and Philosophy*  
Chapter VII (p. 217)  
Dover Publications, Inc. New York, New York, USA. 1981

**Jefferson, Thomas** 1743–1826

Third president of the USA

A patient pursuit of facts, and cautious combination and comparison of them, is the drudgery to which man is subjected by his Master, if he wishes to attain sure knowledge.

*Notes on the State of Virginia* (p. 71, n)  
Printed by Samuel H Smith. Philadelphia, Pennsylvania, USA. 1800

**Jevons, William Stanley** 1835–82

English economist and logician

So far as object is different from object, knowledge is useless and inference impossible. But so far as object resembles object, we can pass from one to the other.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Introduction (p. 3)

The Macmillan Co. New York, New York, USA. 1887

I am convinced that it is impossible to expound the methods of induction in a sound manner, without resting them on the theory of probability. Perfect knowledge alone can give certainty, and in nature perfect knowledge would be infinite knowledge, which is clearly beyond our capacities. We have, therefore, to content ourselves with partial knowledge, – knowledge mingled with ignorance, producing doubt.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book II, Chapter X (p. 197)

Macmillan & Company Ltd. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Integrity without knowledge is weak and useless and knowledge without integrity is dangerous and dreadful.

*The History of Rasselas: Prince of Abyssinia*

Chapter XLI (p. 100)

Oxford University Press. Oxford, England. 1988

**Jordan, David Starr** 1851–1931

American scientist and educator

We know nothing until we find it out...

Reason, Reverence and Love

*Science Monthly*, Volume XXI, Number 6, December, 1925 (p. 587)

**Jourdain, Philip E. B.** 1879–1919

English logician

When we wish to bring to the knowledge of a person any phenomena or processes of nature, we have the choice of two methods: we may allow the person to observe matters for himself, when instruction comes to an end; or, we may describe to him the phenomena in some way, so as to save him the trouble of personally making anew each experiment.

*The Nature of Mathematics* (Revised edition)

Chapter I (p. 18)

T.C. & E.C. Jack. London, England. 1919

**Judd, John Wesley** 1840–1916

British geologist

...our first step towards the acquirement of scientific or exact knowledge, must be the unlearning of what we have before been led to regard as true.

*Volcanoes: What They Are And What They Teach*

Chapter I (p. 1)

D. Appleton & Co. New York, New York, USA. 1881

**Keep, Josiah** 1849–1911

American educator and malacologist

We seldom love that of which we have but slight knowledge.

*Shells and Sea-life*

Preface (p. 3)

Whitaker & Wells Co. San Francisco, California, USA. 1910

**Kennedy, John F.** 1917–63

Twenty-sixth president of the USA

The greater our knowledge increases, the greater our ignorance unfolds.

Address at Rice University

Houston, Texas, September 12, 1962

**Kerry, John** 1943–

US senator

It is wrong to tell scientists that they can't cross the frontiers of new knowledge...

*CNN*

Kerry Promotes Science, Technology as Job Engines

Friday, October 22, 2004

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

We have only begun to knock a few chips from the great quarry of knowledge that has been given us to dig out and use. We know almost nothing about everything. That is why, with all conviction, I say that the future is boundless.

In James Kip Finch

*Engineering and Western Civilization*

Chapter 20 (p. 306)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Day is just as mysterious as night, and the mystery of knowledge and understanding is more wonderful and awesome than the darkness of the unknown.

*Science and Religion, The Rational And The Superrational* (p. 49)

Yale University Press. New Haven, Connecticut, USA. 1914

...knowledge – a kind of proliferating sphere, expanding along divergent lines by the outward-seeking of an inner life of wonder.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter VI (p. 128)

Columbia University Press. New York, New York, USA. 1916

**Koestler, Arthur** 1905–83

Hungarian-born English writer

We can add to our knowledge, but we cannot subtract from it.

*The Sleep Walkers: A History of Man's Changing Vision of the Universe*

Chapter I (p. 19)

The Macmillan Co. New York, New York, USA. 1959

**Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

Knowledge is an immense power. Men must know. But we already know much! What if that knowledge – and only that – should become the possession of all? Would not science itself progress in leaps and cause mankind to make strides in production, invention, and social

creation, or [in] which we are hardly in a condition now to measure the speed?

*Memoirs of a Revolutionist*

Part IV, III (p. 21)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Kusch, Polykarp** 1911–93

German-American physicist

The increase of scientific knowledge lies not only in the occasional milestones of science, but in the efforts of the very large body of men who with love and devotion observe and study nature.

*Les Prix Nobel. The Nobel Prizes in 1955*

Nobel banquet speech for award received in 1955

Nobel Foundation. Stockholm, Sweden. 1956

**Lamarck, Jean-Baptiste**

**Pierre Antoine** 1744–1829

French biologist

Men who strive in their works to push back the limits of human knowledge know well that it is not enough to discover and prove a useful truth previously unknown, but that it is necessary also to be able to propagate it and get it recognized...

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VIII (p. 404)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

That which we know is a little thing; that which we do not know is immense.

In Will and Ariel Durant

*The Story of Civilization: The Age of Napoleon* (p. 324)

Simon & Schuster. New York, New York, USA. 1975

Strictly speaking it may even be said that nearly all our knowledge is problematical; and in the small number of things which we are able to know with certainty, even in the mathematical sciences themselves, the principal means for ascertaining truth – induction and analogy – are based on probabilities ...

*A Philosophical Essay on Probabilities*

Chapter I (p. 1)

John Wiley & Sons. New York, New York, USA. 1902

**Lardner, Dionysius** 1793–1859

British physicist and astronomer

Although it has been reserved for modern times to bring to perfection the methods of investigation pursued in physical researches, these great divisions of human knowledge have nevertheless been always progressive. If the labors of the ancients were obstructed, their advancement retarded, and their productions disfigured by fantastical theories; the facts they accumulated, the phenomena

they described, and the observations they recorded, have formed a bequest of the highest value to the better disciplined inquirers and observers of later days.

*Popular Lectures on Science and Art*

Electricity (p. 103)

Harry W. Law. New York, New York, USA. 1856

It is astonishing, in this age of the diffusion of knowledge, how susceptible the public mind is of excitement on any topic, the principles of which do not lie absolutely on the surface of the most ordinary course of elementary education.

*Popular Lectures on Science and Art*

Weather Almanacs (p. 159)

Harry W. Law. New York, New York, USA. 1856

**Larrabee, Harold A.** 1894–1979

No biographical data available

The great prizes of science go to the successful discoverers, not to those who follow behind and carefully explore the new land that has been opened up.

*Reliable Knowledge*

Chapter 3 (p. 72)

Cambridge University Press. Cambridge, England. 1978

**Latham, Peter Mere** 1789–1875

English physician

There is nothing so captivating as NEW knowledge.

In William B. Bean

*Aphorisms from Latham* (p. 38)

Prairie Press. Iowa City, Iowa, USA. 1962

The knowledge which lies behind is our natural help to that which lies before.

*Lectures on Subjects Connected with Clinical Medicine*

Lecture I (p. 3)

Longman, Rees, Orme, Brown, Green & Longman. London,

England. 1836

It is the special infirmity of ingenuous minds to reflect with too much anxiety upon their own progress in knowledge; to sit in judgment upon themselves, calculating whether they have made the best of all their opportunities, and wishing, vainly wishing, that their time might come over again, to enable them to supply this omission, or rectify that mistake.

*Lectures on Subjects Connected with Clinical Medicine*

Lecture I (p. 12)

Longman, Rees, Orme, Brown, Green & Longman. London,

England. 1836

Knowledge may be an incumbrance as well as a help. Many men know more than they are able to wield. There is a point (I believe) in the acquisition of knowledge (and this point varies infinitely in different individuals), beyond

*Lectures on Subjects Connected with Clinical Medicine*

Lecture I (p. 17)

Longman, Rees, Orme, Brown, Green & Longman. London,

England. 1836

In medical science, the only materials of our knowledge are those things which are referable to our sensations and perceptions: matters of fact.

*Lectures on Subjects Connected with Clinical Medicine*

Lecture V (pp. 117–118)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

**Moore, Harry V.**

No biographical data available

“Knowledge” has killed the sun, making it a ball of gas, with spots; “knowledge” has killed the moon, it is a dead little earth fretted with extinct craters as with smallpox ...

*Sex Literature and Censorship* (p. 117)

Twayne Publishers. 1953

**LeConte, John** 1818–91

American physician and physicist

...the lofty aspirations of humanity and not delusions; they are realities. They link us to a purer order of existence, which makes us heirs of immortality. We repose order a confident and unwavering assurance that, in God’s own time, these earth-mists will be dispersed, and the dim twilight of conjecture will yield to the glorious, unclouded noonday of knowledge.

The Nebular Hypothesis

*The Popular Science Monthly*, Volume 2, April 1873 (p. 660)

**Ledger, Edmund** 1841–1913

English astronomer

...the more the horizon of our knowledge widens, the less we seem to know, in contrast with the boundless field of still untrodden truth ...

*The Sun, Its Planets and Their Satellites*

Lecture I (p. 2)

Edward Stanford. London, England. 1882

**Lemon, Harvey Brace**

Physicist

Quite characteristic is it of the acquisition of knowledge that as one learns a little, the horizon widens and what lies ahead to be learned is seen to cover a much vaster area. It is with our eyes on these horizons that we climb. What has been surmounted and overcome seems small and insignificant. How small and insignificant it is, fortunately we shall probably never be aware.

*Galileo to Cosmic Rays: A Look at Physics*

Chapter 40 (p. 440)

The University of Chicago Press. Chicago, Illinois, USA. 1934

**Levi, Primo** 1919–87

Italian writer and chemist

The future of humanity is uncertain, even in the most prosperous countries, and the quality of life deteriorates; and yet I believe that what is being discovered about the infinitely large and the infinitely small is sufficient to

absolve this end of the century and millennium. What a very few are acquiring in knowledge of the physical world will perhaps cause this period not to be judged as a pure return to barbarism.

*Other People’s Trades*

News from the Sky (pp. 23–24)

Summit Books. New York, New York, USA. 1989

**Lewis, Clarence Irving** 1883–1964

American philosopher

...interest in truth for its own sake – the pure and undistracted purpose to know – is not the characteristic final purpose of knowing. Knowledge for its own sake, and the contemplative life, represent an esthetic or near-esthetic ideal rather than one normally attributable to cognition. It is merely a professional fallacy of the scholar to impute his own peculiar interest in finding out the truth to human cognizing in general, as if that were the aim which rules or should rule it. He who is disinterestedly interested in finding out and knowing; who subordinates the desires and interests of action to discovery of truth, and to contemplation of it; likewise divests knowledge of its natural and pragmatic significance. By the same token, the ideal of the contemplative life is mildly abnormal, however valid and indubitable the values to which it is addressed. The Ivory tower is characteristically the refuge of the practically defeated and of those who become disillusioned of the utilities of action.

*An Analysis of Knowledge and Valuation*

Chapter XIV (p. 442)

The Open Court Publishing Company. La Salle, Illinois, USA. 1946

There is no knowledge without interpretation.

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter VII (p. 195)

Dover Publications, Inc. New York, New York, USA. 1956

...if there is any knowledge at all, *some* knowledge must be a priori.

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter VII (p. 196)

Dover Publications, Inc. New York, New York, USA. 1956

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

I made the journey to knowledge like dogs who go for walks with their masters, a hundred times forward and backward over the same territory; and when I arrived I was tired.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 58)

Jonathan Cape. London, England. 1969

**Little, Arthur D.** 1863–1935

American chemist

If knowledge is to be humanized it must first be translated.

*The Fifth Estate*

The Franklin Institute. Philadelphia, Pennsylvania, USA. 1924

**Locke, John** 1632–1704

English philosopher and political theorist

Every step the mind takes in its progress towards knowledge, makes some discovery, which is not only new, but the best too, for the time at least.

*An Essay Concerning Human Understanding*

Epistle to the Reader (p. v)

Printed for Thomas Tegg. London, England. 1841

**Loehle, Craig**

Mathematical ecologist

A major obstacle to science is not ignorance but knowledge.

A Guide to Increased Creativity in Research – Inspiration or Perspiration?

*BioScience*, Volume 40, Number 2, February, 1990 (p. 123)

**Macaulay, Thomas Babington** 1800–59

English historian and author

Knowledge advances by steps, and not by leaps.

On History

*Edinburgh Review*, Volume XLVII, May, 1828

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Not every physicist is an epistemologist, and not everyone must or can be one. Special investigation claims a whole man, so does the theory of knowledge.

*History and Root of the Principle of the Conservation of Energy*

Author's Preface (p. 12)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

...the student of the theory of knowledge, like the geologist and the astronomer, must be permitted to reason back from the forms which are created before his eyes to others which he finds ready made for him.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On the Economical Nature of Physical Inquiry (p. 203)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

Knowledge which one does not possess one cannot use.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On Some Phenomena Attending the Flight of Projectiles (p. 327)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

Every candid person will confess that there are many branches of knowledge about which he had better be silent.

*Popular Scientific Lectures*

On Instruction in the Classics and the Sciences (p. 345)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

... we are entitled to regard our knowledge of the decisive conditions of any phenomenon as sufficient only in the event that such conditions determine the phenomenon precisely and uniquely.

Translated by Thomas J. McCormack

*The Science of Mechanics: A Critical and Historical Account of Its Development*

Chapter I (p. 10)

The Open Court Publishing Co. Chicago, Illinois, USA. 1919

It is a peculiar property of instinctive knowledge that it is predominantly of a negative nature. We cannot so well say what must happen as we can what cannot happen, since the latter alone stands in glaring contrast to the obscure mass of experience in us in which single characters are not distinguished.

*The Science of Mechanics* (5th edition)

Chapter I, Part II, Section 2 (p. 36)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maclaurin, Colin** 1698–1746

Scottish mathematician and natural philosopher

Those who have not imbibed the prejudices of philosophers, are easily convinced that natural knowledge is to be founded on experiment and observation.

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books* (p. 24)

Printed for the Author's Children. London, England. 1748

By proceeding with due care, every age will add to the common stock of knowledge; the mysteries that still lie concealed in nature may be gradually opened, arts will flourish and increase, mankind will improve, and appear more worthy of their situation in the universe, as they approach more towards a perfect knowledge of nature.

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books* (p. 91)

Printed for the Author's Children. London, England. 1748

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

Because I have stirred a few grains of sand on the shore, am I in a position to know the depths of the ocean?

Translated by Maurice Maeterlinck

In Jean-Henri Fabre

*The Life of the Spider*

Preface (p. 34)

Dodd, Mead & Co. New York, New York, USA. 1913

Life has unfathomable secrets. Human knowledge will be erased from the archives of the world before we possess the last word that the Gnat has to say to us...

Translated by Maurice Maeterlinck

In Jean-Henri Fabre

*The Life of the Spider*

Preface (p. 34)

Dodd, Mead & Co. New York, New York, USA. 1913

**Margenau, Henry** 1901–97

American physicist

To gain knowledge of general principles by way of abstract exposition is a possible but not an expeditious course. It seems wiser to approach them with a large but well-defined project in view, a project which calls



for continued and varied application of the principles to be studied, and which may serve at once as goal and as illustration.

*The Nature of Physical Reality: A Philosophy of Modern Physics*  
Chapter I (p. 1)  
McGraw-Hill Book Co., Inc. New York, New York, USA. 1950

**Marlowe, Christopher** 1564–93

Renaissance English playwright and poet

Our souls, whose faculties can comprehend  
The wondrous architecture of the world,  
And measure every wandering planet's course,  
Still climbing after knowledge infinite.

*Tamburlaine the Great*

Part the First, Act II, Scene 7, l. 20–23

The Hesperides Press. London, England. 1930

**Mather, Kirtley F.** 1888–1978

American geologist

The expanding horizon of knowledge has simply lengthened the line of contact between man and the unknown elements in the cosmos.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (pp. 3–4)

Thomas Y. Crowell Company. New York, New York, USA. 1931

**McEwan, Ian** 1948–

English author

Shakespeare would have grasped wave functions, Donne would have understood complementarity and relative time. They would have been excited. What richness! They would have plundered this new science for their imagery. And they would have educated their audiences too. But you “arts” people, you’re not only ignorant of these magnificent things, You’re rather proud of knowing nothing.

*The Child in Time*

Chapter 2

Houghton Mifflin Company. Boston, Massachusetts, USA. 1987

**Milton, John** 1608–74

English poet

O Sacred, Wise, and Wisdom-giving Plant,  
Mother of Science...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Chapter IX, l. 679–680

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Minot, George R.** 1885–1950

American physician

Thus, upon the foundations laid by previous investigators, do medical art and science build a structure which will in its turn be the foundation of future knowledge.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1934

The Development of Liver Therapy in Pernicious Anemia (p. 366)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Minto, Walter** 1753–96

Scottish-American mathematician

The progress of the human mind, from ignorance to knowledge, has generally been slow, and not by the most obvious and easy path.

*An Inaugural Oration on the Progress and Importance of the Mathematical Sciences.*

Princeton, preceding the Annual Commencement 1788 (p. 10)

Printed by Isaac Collins, 1788

**Mitchell, Maria** 1818–89

American astronomer and educator

...we have a hunger of the mind which asks for knowledge of all around us, and the more we gain, the more is our desire; the more we see, the more we are capable of seeing.

In Eve Merriam

*Growing Up Female in America*

Maria Mitchell (p. 88)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Monod, Jacques** 1910–76

French biochemist

Any mingling of knowledge with values is unlawful, forbidden.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Vintage Books. New York, New York, USA. 1972

**Montgomery, Lucy Maud** 1874–1942

Canadian author

Isn't it splendid to think of all the things there are to find out about? It just makes me feel glad to be alive – it's such an interesting world. It wouldn't be half so interesting if we knew all about everything, would it? There'd be no scope for imagination then, would there?

*Anne of Green Gables*

Chapter II (p. 19)

Page & Company. Boston, Massachusetts, USA. 1908

**Moore, Benjamin** 1745–1816

Episcopal writer and professor of rhetoric

The extent and accuracy of our knowledge of external phenomena increase all the time, and it is this increase of knowledge which makes all science progressive.

*The Origin and Nature of Life*

Chapter I

Henry Holt & Co. New York, New York, USA.

**Morgan, Charles** 1894–1958

English playwright and novelist

...as knowledge increases, wonder deepens...

*The Fountain*

The Bond

Chapter Ten (p. 383)

Alfred A. Knopf. New York, New York, USA. 1932



**Müller, Max** 1823–1900  
German philologist and Orientalist

The only knowledge worth having and which lasts us for life must not be cut and dry, but on the contrary must be living and growing knowledge, knowledge of which we know the beginning, the middle, and the end, knowledge of which we can produce the title-deeds whenever they are called for.

In Mayo Williamson Hazeltine  
*Orations from Homer to William McKinley*  
On Some Lessons of Antiquity (p. 8597)  
P.F. Collier & Son. New York, New York, USA. 1902

There are certain things which we must know as if they were part of ourselves. But there are many other things which we simply put into our pockets, which we can find there whenever we want them ...

In Mayo Williamson Hazeltine  
*Orations from Homer to William McKinley*  
On Some Lessons of Antiquity (p. 8598)  
P.F. Collier & Son. New York, New York, USA. 1902

**Mumford, Lewis** 1895–1990  
American social philosopher

The belief that science developed solely out of a pursuit of knowledge for its own sake is at best only a half truth, and at worst, mere self-flattery or self-deception on the part of scientists.

*The Myth of the Machine: The Pentagon of Power* (p. 106)  
Chapter V (p. 106)  
Harcourt Brace Jovanovich, Inc. New York, New York, USA. 1970

**Myers, Frederic William Henry** 1843–1901  
English poet and essayist

...the method which our race has found most effective in acquiring knowledge is by this time familiar to all men. It is the method of modern Science – that process which consists in an interrogation of Nature entirely dispassionate, patient, systematic; such careful experiment and cumulative record as can often elicit from her slightest indications her deepest truths. That method is now dominant throughout the civilised world; and although in many directions experiments may be difficult and dubious, facts, rare and elusive, Science works slowly on and bides her time, – refusing to fall back upon tradition or to launch into speculation, merely because straight is the gate which leads to valid discovery, indisputable truth.

*Human Personality and Its Survival of Bodily Death* (Volume 1)  
Introduction (p. 1)  
Longmans, Green & Company. London, England. 1903

**Myrdal, Gunnar** 1898–1987  
Swedish economist and sociologist

All ignorance, like all knowledge, tends thus to be opportunistic.

*Objectivity in Social Research*  
Chapter III (p. 19)  
Pantheon Books. New York, New York, USA. 1969

**Newcomb, Simon** 1835–1909  
Canadian-born American astronomer

The fact is that our knowledge of the universe has been in the nature of a slow and gradual evolution, commencing at a very early period in human history, and destined to go forward without stop, as we hope, so long as civilization shall endure.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*  
The Problems of Astronomy (p. 83)  
Government Printing Office. Washington, D.C. 1898

**Nicholson, James**  
No biographical data available

In order to make the subject clear...and to ensure progress in attaining a knowledge of the same, I shall proceed on the understanding that all are alike ignorant of it.

*Nightly Wanderings in the Gardens of the Sky*  
Chapter I (p. 15)  
Porteous Brothers. Glasgow, Scotland. 1881

**Noble, Edmund**  
No biographical data available

For knowledge is not a solvent for the whole of reality; all it can reach are those characters of existence which, in our capacity as self-maintainers, it is useful or may become useful for us to know.

*Purposive Evolution: The Link Between Science and Religion*  
Chapter IV (p. 42)  
Henry Holt & Company. New York, New York, USA. 1926

**Oparin, Alexander Ivanovich** 1894–1980  
Russian biochemist

One can only understand the essence of things when one knows their origin and development.

*Life, Its Nature, Origin and Development*  
Chapter I (p. 37)  
Oliver & Boyd. Edinburgh, Scotland. 1961

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

...knowledge rests on knowledge; what is new is meaningful because it departs slightly from what was known before; this is a world of frontiers, where even the liveliest of actors or observers will be absent most of the time from most of them.

*Science and the Common Understanding*  
Chapter 6 (p. 90)  
Simon & Schuster. New York, New York, USA. 1954

A great discovery is a thing of beauty; and our faith – our binding, quiet faith – is that knowledge is good and good in itself.

*Science and the Common Understanding*  
Chapter 6 (p. 98)  
Simon & Schuster. New York, New York, USA. 1954

**Oreskes, Naomi**

No biographical data available

...if new knowledge is to be made, old knowledge has to be unmade.

*The Rejection of Continental Drift*

Epilogue (p. 316)

Oxford University Press, Inc. New York, New York, USA. 1999

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Science is organized knowledge, and knowledge is of things we see. Now the things that are seen are temporal; of the things that are unseen science knows nothing and has at present no means of knowing anything.

*Science and Immortality*

The Teresians (pp. 40–41)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1905

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932

Latvian-born German chemist

Our knowledge is an incomplete piece of patchwork; but each one of us is bound to make the best possible use of the incomplete knowledge he possesses, conscious always that his results are any day liable to be replaced by new discoveries or ideas.

Translated by Thomas Seltzer

*Individuality and Immortality*

Individuality and Immortality (p. 3)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1906

**Ouspensky, Peter D.** 1878–1947

Russian philosopher

Knowledge must start from some foundation, something must be recognized as known, or we shall be obliged always to define one unknown by means of another.

Translated by Nicholas Bessaraboff and Claude Bragdon

*Tertium Organum*

Chapter I (p. 1)

Manas Press. New York, New York, USA. 1920

**Parnov, E. I.**

Russian writer

When we speak of the limits of the universe we imply the limits of knowledge. Temporary limits to be sure, but nevertheless limits. In probing the universe man probes his brain. The nature of his boldest and 'maddest' theories is determined by his way of thinking. That is why the secrets of the cosmos and the microworld excite and attract me. They are a mirror which reflects our capability for knowledge. And man is born for knowledge. This is the meaning and the purpose of civilization which is why man will never stop looking into the mirror of the universe.

Translated by Vladimir Talny

*At the Crossroads of Infinities* (p. 10)

MIR Publishers. Moscow, Russia. 1971

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

From the very beginning of your work, school yourself to severe gradualness in the accumulation of knowledge.

Bequest of Pavlov to the Academic Youth of His Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

**Peel, Sir Robert** 1788–1850

British prime minister and statesman

Heed not the sneers and foolish sarcasms against learning, of those who are unwilling that you should rise above the level of their own contented ignorance. Do not for a moment imagine that you have not time for acquiring knowledge; it is only the idle man who wants time for everything. The industrious man knows the inestimable value of the economy of time, and amidst the most multifarious occupations, can find leisure for rational recreation and mental improvement. Do not believe that the acquisition of scientific knowledge will obstruct your worldly prosperity, or that it is incompatible with your worldly pursuits. Rely upon it, you cannot sharpen your intellectual faculties, you cannot widen the range of your knowledge, without becoming more skilful and successful in the business or profession in which you are engaged.

Quoted in Gideon Algernon Mantell

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Address to the Reader (pp. xiii–xiv)

G.H. Bohn. London, England. 1857–58

**Persius** 32–64

Roman poet

Is science only useful as 'tis shown, And is thy knowledge nothing, if not known?

Translated by Lewis Evans

*The Satires of Juvenal, Persius, Sulpicia, and Lucilius*

The Satires of Persius (p. 489)

Harper & Brothers Publishers. New York, New York, USA. 1889

**Petit, Jean-Pierre**

French astrophysicist

I'VE UNDERSTOOD IT! Well, that is...I'm not exactly sure WHAT I've understood, but I have the impression I've understood SOMETHING.

*Euclid Rules. OK?* (p. 44)

Publisher undetermined

**Phillips, John**

No biographical data available

All human knowledge is limited; but who has reached the boundary in any direction?

*A Treatise on Geology*

Geology, Progress of Geology (p. 4)

A. & C. Black. Edinburgh, Scotland. 1837

**Phillpotts, Eden** 1862–1960

English novelist, poet, and dramatist

Knowledge is all scientific researchers are after – new knowledge and discovery.

*A Shadow Passes*

Chapter IX (p. 140)

The Macmillan Company. New York, New York, USA. 1934

**Platt, John R.**

No biographical data available

We are like men coming out of the dark house of the past into a world of dazzling sunlight. We have climbed up out of the dark cellar where we have been trapped for centuries, isolated, ignorant, selfish, combative, and helpless. Suddenly, we find ourselves standing on the threshold of a doorway through which we can see a vista of almost incredible knowledge, abundance, and well-being.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1968**The New Biology and the Shaping of the Future* (p. 122)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

We have bitten into the apple of knowledge and our eyes are opened. We have been driven out of the Eden of irresponsibility into the world of decision.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1968**The New Biology and the Shaping of the Future* (p. 169)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The way in which knowledge progresses, and especially our scientific knowledge, is by unjustified (and unjustifiable) anticipations, by guesses, by tentative solutions to our problems, by conjectures. These conjectures are controlled by criticism; that is, by attempted refutations, which include severely critical tests. They may survive these tests; but they can never be positively justified: they can neither be established as certainly true nor as “probable” (in the sense of probability calculus). Criticism of our conjectures is of decisive importance: by bringing out our mistakes it makes us understand the difficulties of the problem which we are trying to solve. This is how we become better acquainted with our problems, and able to propose more mature solutions: the very refutation of a theory – that is, of any serious tentative solution to our problem – is always a step forward that takes us nearer to the truth. And this is how we can learn from our mistakes.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Preface (p. vii)

Harper &amp; Row, Publishers. New York, New York, USA. 1963

The more we learn about the world, and the deeper our learning, the more conscious, specific, and articulate will be our knowledge of what we do not know, our knowledge of our ignorance. For this, indeed, is the main source

of our ignorance – the fact that our knowledge can only be finite, while our ignorance must be infinite.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Introduction (p. 28)

Harper &amp; Row, Publishers. New York, New York, USA. 1963

The theory of knowledge which I wish to propose is a largely Darwinian theory of the growth of knowledge. From the amoeba to Einstein, the growth of knowledge is always the same: we try to solve our problems, and to obtain, by a process of elimination, something approaching adequacy in our tentative solutions.

*Objective Knowledge: An Evolutionary Approach*

Chapter 7 (p. 261)

Clarendon Press. Oxford, England. 1972

... we should have to represent the tree of knowledge as springing from countless roots which grow up into the air rather than down, and which ultimately, high up, tend to unite into one common stem.

*Objective Knowledge: An Evolutionary Approach*

Chapter 7 (pp. 262–263)

Clarendon Press. Oxford, England. 1972

**Poynting, John Henry** 1852–1914

English physicist

Molecules, atoms and corpuscles are at the present day the letters of the alphabet in which we write our knowledge of Physical Nature.

*Collected Scientific Papers*

Molecules, Atoms and Corpuscles, 1902 (p. 664)

At The University Press. Cambridge. 1920

**Preston, Thomas** 1860–1900

Irish scientist

The great lessons of history are not to be found in the records of battles or in the details of infamous amours and massacres, nor in the memory of dates, but rather in the full knowledge of the inner meaning of events, and a deep appreciation of their general bearing on the social development of mankind. So also in science, that knowledge which is power is not the mere memory of facts, but the comprehension of their whole meaning in the story of nature.

*The Theory of Heat*

Preface to the First Edition (p. 4)

Macmillan &amp; Company Ltd. London, England. 1904

**Price, C.**

No biographical data available

As new knowledge develops, it has increasingly provided natural explanations for facts and phenomena formerly ascribed to the supernatural. Perhaps an understanding of chemical evolution and biological function can develop a philosophy of man more unified, less divisive, less of a major breeding ground for man’s inhumanity to man than the many religious dogmas now so much used to

inflare feelings of hatred, suspicion and prejudice in human society.

In D. Fohlfing and A. Oparin (eds.)

*Molecular Evolution: Prebiological and Biological*

Some Social and Philosophical Implications of Progress on the Origin and Synthesis of Life (p. 462)

Plenum Press. New York, New York, USA. 1972

### **Priestley, Joseph** 1733–1804

English theologian and scientist

The greater is the circle of light, the greater is the boundary of the darkness by which it is confined.

*Experiments and Observations on Different Kinds of Air* (Volume 1)

The Preface (p. xix)

Thomas Pearson. Birmingham, England. 1790

Could I imagine that the knowledge of nature would ever be exhausted, and that we were approaching to a termination of our enquiries, I could more contentedly shut my eyes on a scene in which nothing more was to be seen, or done. But to quit the stage at present (and I believe the aspect of things will be exactly similar in any future period of our existence) without the hope of re-visiting it, would fill me with the deepest regret.

*Experiments and Observations on Different Kinds of Air* (Volume 1)

The Preface (p. xli)

Thomas Pearson. Birmingham, England. 1790

...the increase of knowledge is like the increase of a city. The buildings of some of the first streets make a great figure, is much talked of, and known to everybody; whereas the addition of, perhaps, twice as much building, after it has been swelled to a considerable size, is not so much as taken notice of, and may really be unknown to many of the inhabitants.

*The History and Present State of Electricity*

Preface (pp. vi–vii)

Printed for J. Dodsley. London, England. 1767

### **Pryanishnikov, D. N.**

No biographical data available

Knowledge is not consummate, crystalised, and petrified; it is being eternally created and is eternally in motion.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

### **Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

We are the inheritors of a great scientific tradition and of a beautiful structure of knowledge. It is the duty of our generation to add to the perfection of this structure and to pass on to the next generation the best traditions of our science for the edification and entertainment of all mankind.

The Physicist Returns from the War

*The Atlantic Monthly*, Volume 176, Number 4, October, 1945 (p. 114)

### **Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

We render a tribute of respect to those who add original work to a library, and withhold it from those who carry a library around in their head.

Translated by Neely Swanson and Larry W. Swanson

*Advice for a Young Investigator*

Chapter 5 (p. 78)

The MIT Press. Cambridge, Massachusetts, USA. 1999

### **Ramsay, Sir William** 1852–1916

English chemist

The young student, when he learns what is known, is too apt to think that little is left to be discovered; yet all our progress since the time of Sir Isaac Newton has not falsified the saying of that great man – that we are but children picking up here and there a pebble from the shore of knowledge, while a whole unknown ocean stretches before our eyes. Nothing can be more certain than this: that we are just beginning to learn something of the wonders of the world on which we live and move and have our being.

*Essays Biographical and Chemical*

Chemical Essays

What Is an Element? (p. 160)

Archibald Constable & Company Ltd. London, England. 1908

### **Ray, John**

No biographical data available

No knowledge can be more pleasant to the soul than Natural History: none so satisfying, or that doth so feed the mind. The treasures of Nature are inexhaustible: there is enough for the most indefatigable industry, the happiest opportunities, the most prolix and undisturbed vacancies.

Quoted in Henry Phillips

*History of Cultivated Vegetables* (Volume 1) (2nd edition)

Introduction (p. 2)

Henry Colburn & Co. London, England. 1822

### **Raymo, Chet** 1936–

American physicist and science writer

Knowledge is an island in a sea of mystery. The metaphor takes its power from a firmly held fact: We live in a universe that is infinite, or effectively so. Our brains are finite, a mere 100 billion nerve cells. Our mental maps of the world are therefore necessarily finite. As time passes, the scale and detail of our maps increase, but they no more exhaust the worldscape they describe than a map of the Grand Canyon depletes the power of that natural chasm to astonish and surprise.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Three (pp. 47–48)

Walker & Company. New York, New York, USA. 1998

## Rectangle

Knowledge is gained by practical investigation and experience, and has no need of the assistance of assumption to provide an excuse for ignorance.

*Zetetic Cosmogony*

Assumptions (p. 4)

T.L. Cullingworth. Durban, South Africa. 1899

### Reichenbach, Hans 1891–1953

German philosopher of science

The urge to knowledge is so deeply rooted in man that it can scarcely be omitted from a list of life's important needs. To be sure, nearly all actions which have significance for practical life rest on decisions as to values, decisions which can never be rendered by scientific cognition; science gives no answer to such questions as "What should I do?"

*Atom and Cosmos: The World of Modern Physics*

Introduction (p. 18)

The Macmillan Co. New York, New York, USA. 1933

### Rennie, James 1787–1867

Naturalist

It can never be too strongly impressed upon a mind anxious for the acquisition of knowledge, that the commonest things by which we are surrounded are deserving of minute and careful attention.

*Insect Architecture* (2nd edition)

Chapter I (p. 1)

Charles Knight. London, England. 1830

### Ritchie, Arthur David 1891–1967

Scottish philosopher and science history writer

That our knowledge only illuminates a small corner of the Universe, that it is incomplete, approximate, tentative and merely probable need not concern us. It is genuine nevertheless. Physical science stands as one of the great achievements of the human spirit.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter VII (pp. 201–202)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

### Richet, Charles 1850–1935

French physiologist

The aim of science is knowledge about phenomena.

*The Natural History of a Savant*

Chapter VI (p. 42)

J.M. Dent & Sons Limited. London, England. 1927

### Ritchie, Arthur David

Scottish philosopher and science history writer

It is natural for anybody of a sanguine temperament who is impressed by the dependence of life on physical circumstances...to think that he is only a short way from the

solution of every problem. He thinks he is delivering a final assault on the very citadel of Life itself; then, when the heat of the combat is over and he can look round at what he has accomplished, he finds that it is only an insignificant and almost undefended out-work that he has taken, and the citadel is as far off as ever.

*Scientific Method: An Inquiry into the Character and Validity of Natural Laws*

Chapter VI (pp. 176–177)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1923

### Robinson, James Harvey 1863–1936

American historian

Of all human ambitions an open mind eagerly expectant of new discoveries and ready to remold convictions in the light of added knowledge and dispelled ignorances and misapprehensions, is the noblest, the rarest and the most difficult to achieve.

*The Humanizing of Knowledge*

Chapter V (p. 61)

George H. Doran Company. New York, New York, USA. 1923

### Rossmann, Joseph

Inventor

However, knowledge alone...never gives rise to new inventions or industries. It is usually left to the inventor to utilize the facts and principles of science, and to apply them for practical purposes.

*Industrial Creativity: The Psychology of the Inventor*

Chapter II (p. 19)

University Books. New Hyde Park, New York, USA. 1964

### Rothman, Milton A. 1919–

Experimental American nuclear physicist and science writer

It takes very little imagination to believe naively that anything is possible. Any ten-year-old child can believe this. It takes a great deal of knowledge to know what things are possible and what things are impossible.

*The Science Gap: Dispelling the Myths and Understanding the Reality of Science*

Myth 8 (p. 142)

Prometheus Books. Amherst, New York, USA. 2003

### Royce, Josiah 1855–1916

American philosopher

Science is never merely knowledge; it is orderly knowledge.

*Logical Essays* (p. 317)

W.C. Brown Company. Dubuque, Iowa, USA. 1951

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

Unless we can know something without knowing everything, it is obvious that we can never know something.

In John E. Leffler

*Rates and Equilibria of Organic Reactions as Treated by Statistical, Thermodynamic, and Extrathermodynamic Methods* (p. v)

John Wiley & Sons, Inc. New York, New York, USA. 1963



Science, as its name implies, is primarily knowledge; by convention it is knowledge of a certain kind, the kind, namely, which seeks general laws connecting a number of particular facts.

*The Scientific Outlook*

Introduction (p. 10)

George Allen & Unwin Ltd. London, England. 1931

Knowledge, as opposed to fantasies of wish-fulfillment, is difficult to come by.

*The Scientific Outlook*

Chapter I (p. 34)

George Allen & Unwin. London, England. 1931

Whatever knowledge we possess is either knowledge of particular facts or scientific knowledge.

*The Scientific Outlook*

Chapter III (p. 73)

George Allen & Unwin Ltd. London, England. 1931

The world as we perceive it is full of a rich variety: some of it is beautiful, some of it is ugly; parts seem to us good, parts bad. But all this has nothing to do with the purely causal properties of things, and it is the properties with which science is concerned. I am not suggesting that if we knew these properties completely we should have a complete knowledge of the world, for its concrete variety is an equally legitimate object of knowledge. What I am saying is that science is that sort of knowledge which gives causal understanding, and that this sort of knowledge can in all likelihood be completed, even where living bodies are concerned, without taking account of anything but their physical and chemical properties.

*The Scientific Outlook*

Chapter V (p. 133)

George Allen & Unwin Ltd. London, England. 1931

With equal passion I have sought knowledge. I have wished to understand the hearts of men. I have wished to know why the stars shine. And I have tried to apprehend the Pythagorean power by which numbers holds sway above the flux. A little of this, but not much, I have achieved.

*The Autobiography of Bertrand Russell*

Prologue (pp. 3–4)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

Knowledge, everywhere, is coming to be regarded not as a good in itself, or as a means of creating a broad and humane outlook on life in general, but as merely an ingredient in technical skill.

*The Will to Doubt*

“Useless” Knowledge (p. 72)

The Wisdom Library. New York, New York, USA. 1958

We know very little, and yet it is astonishing that we know so much, and still more astonishing that so little knowledge can give us so much power.

*ABC of Relativity*

Chapter 15 (p. 155)

Routledge. London, England. 1997

**Sagan, Carl** 1934–96

American astronomer and author

In science it often happens that scientists say, “You know that’s a really good argument; my position is mistaken,” and then they would actually change their minds and you never hear that old view from them again. They really do it. It doesn’t happen as often as it should, because scientists are human and change is sometimes painful. But it happens every day. I cannot recall the last time something like that happened in politics or religion.

*1987 Committee for Scientific Investigation of Claims of the Paranormal*  
Keynote Address

In a way, science might be described as paranoid thinking applied to Nature: we are looking for natural conspiracies, for connections among apparently disparate data.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 183)

Random House, Inc. New York, New York, USA. 1977

**Saint Avvaiyar**

No biographical data available

What we have learnt is like a handful of Earth,  
While what we have yet to learn is like the whole World.

In an article by M. Blumer

*Angewandte Chemie International Edition in English*, Volume 14, 1975 (p. 507)

**Samuelson, Bengt, I.** 1934–

Swedish physiological chemist

We are just in the beginning of gathering knowledge about man and his environment. We can hardly comprehend the enormous possibilities that are inherent in discovering the structure and function of nature from the inner space of particles and atoms to the cells of the human body as well as the outer space of stars and galaxies. To use the new knowledge in technical and medical developments to combat poverty and disease throughout the world is indeed a challenge.

*Les Prix Nobel. The Nobel Prizes in 1982*

Nobel banquet speech for award received in 1982

Nobel Foundation. Stockholm, Sweden. 1983

**Sandeman, George** 1863–1952

Spanish-born American philosopher

There are no chasms in science, and so long as knowledge is man’s knowledge, it is one. The world is not made in compartments answering to university lectureships.

*Problems of Biology*

Chapter I (p. 12)

Swan Sonnenschein & Co., Ltd. London, England. 1896

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher



Science, then is the alternative consideration of common experience; it is common knowledge extended and refined.

*The Life of Reason or The Phases of Human Progress*

Part V, Chapter I (p. 393)

Charles Scribner's Sons. New York, New York, USA. 1953

**Seton, Ernest Thompson** 1860–1946

Naturalist and writer

A knowledge of animals doubles the interest of an ordinary country ramble – and the more we learn their ways, the more glimpses we will likely get of them!

In William H. Carr

*The Stir of Nature*

Chapter Two (p. 27)

Oxford University Press, Inc. New York, New York, USA. 1930

**Severinus, Petrus** 1540–1602

Swedish anatomist

...sell your lands, your house, your clothes and your jewelry; burn up your books. On the other hand, buy yourselves stout shoes, travel to the mountains, search the valleys, the deserts, the shores of the sea, and the deepest depressions of the earth; note with care the distinctions between animals, the differences of plants, the various kinds of minerals, the properties and mode of origin of everything that exists. Be not ashamed to study diligently the astronomy and terrestrial philosophy of the peasantry. Lastly, purchase coal, build furnaces, watch and operate with the fire without wearying. In this way and no other, you will arrive at a knowledge of things and their properties.

In Allen G. Debus

*The French Paracelsians*

Chapter 1 (p. 8)

Cambridge University Press. Cambridge, England. 1991

**Seward, John**

No biographical data available

Let us have the mind and the mind's-workings, not the remains of earnest thought which has been frittered away by a long dreary course of preparatory study, by which all life has been evaporated. Never forget that there is in the wide river of nature something which everybody who has a rod and line may catch, precious things which everyone may dive for.

The Purpose and Tendency of Early Italian Art

*The Germ*, Volume 2, February, 1850 (p. 60)

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

You seek for knowledge and wisdom, as I once did; and I ardently hope that the gratification of your wishes may not be a serpent to sting you, as mine has been.

*Frankenstein: Or, The Modern Prometheus*

Preface

Running Press. Philadelphia, Pennsylvania, USA. 1990

Oh what a strange nature is knowledge! It clings to the mind, when it has once seized on it, like a lichen on the rock.

*The Novels and Selected Works of Mary Shelly* (Volume 1)

*Frankenstein*

Volume 2, Chapter V (p. 90)

William Pickering. London, England. 1996

**Shermer, Michael** 1954–

American science writer

Science is not the affirmation of a set of beliefs but a process of inquiry aimed at building a testable body of knowledge constantly open to rejection or confirmation. In science, knowledge is fluid and certainty fleeting. That is at the heart of its limitations. It is also its greatest strength.

*Why People Believe Weird Things: Pseudoscience, Superstition, and*

*Other Confusions of Our Time*

Part 2, Chapter 8 (p. 124)

Henry Holt & Company. New York, New York, USA. 2002

**Sillman, Benjamin** 1779–1864

American chemist and geologist

Knowledge is nothing but the just and full comprehension of the real nature of things, physical, intellectual, and moral; it is co-existence with the universe of being; reaching back to the dawn of time, and forward to its consummation.

*An Introductory Lecture* (p. 47)

Printed by Hezekiah Howe. New Haven, Connecticut, USA. 1828

**Silver, Brian L.**

Israeli professor of physical chemistry

...at the borders of our knowledge we run into real complexity, into questions that challenge our ability to define the nature of reality.

*The Ascent of Science*

Preface (p. xiv)

Solomon Press Book. New York, New York, USA. 1998

**Smiles, Samuel** 1812–1904

Scottish author and reformer

Human knowledge is but an accumulation of small facts, made by successive generations of men, the little bits of knowledge and experience carefully treasured up by them growing at length into a mighty pyramid.

*Self-Help*

Chapter V (p. 122)

John Murray. London, England. 1876

**Smith, Henry John Stephen** 1826–83

Irish mathematician

...the bond of union among the physical sciences is the mathematical spirit and the mathematical method which pervade them.... [O]ur knowledge of nature, as it advances, continuously resolves differences of quality

into differences of quantity. All exact reasoning – indeed all reasoning – about quantity, is mathematical reasoning; and thus as our knowledge increases that portion of it which becomes mathematical increases at a still more rapid rate.

In J.W.L. Glaisher

*The Collected Mathematical Papers of Henry John Stephen Smith*  
(Volume 2)

Appendix I (p. 683)

At The Clarendon Press. Oxford, England. 1894

**Smith, Logan Pearsall** 1865–1946  
American author

I know too much; I have stuffed too many of the facts of History and Science into my intellectuals. My eyes have grown dim over books; believing in geological periods, cave dwellers, Chinese Dynasties, and the fixed stars has prematurely aged me.

*Trivia*

Book II, The Burden (p. 156)

Doubleday, Page & Company. Garden City, New York, USA. 1917

**Smith, Theobald** 1859–1934  
American pathologist

It is incumbent upon us to keep training and pruning the tree of knowledge without looking to the right or the left.

Obituary Notice of Deceased Member

*Journal of Pathology and Bacteriology*, Volume 40, Number 3, May, 1935 (p. 630)

**Snyder, Carl H.**  
No biographical data available

...the difference between “magic” and “science” is knowledge.

*The Extraordinary Chemistry of Ordinary Things*

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Sockman, Ralph W.** 1889–1970  
American minister

...the field of knowledge which even the best of us can master is like an island surrounded by a limitless ocean of mystery. And the larger the island of knowledge, the longer the shoreline of wonder.

*Now to Live!*

The Dog and the Manger (p. 202)

Abington-Cokesbury Press. New York, New York, USA. 1946

**Soddy, Frederick** 1877–1956  
English chemist

...before you can apply knowledge you must discover it...

*Science and Life*

Science and the State (p. 55)

J. Murray. London, England. 1920

Mere accumulations of knowledge, sifted, classified, and reduced to their final most concise expression in a series of text-books, are little more than the sepulchral monument of science.

*Matter and Energy*

Chapter I (p. 18)

Henry Holt & Co. New York, New York, USA. 1912

**Spencer, Herbert** 1820–1903  
English social philosopher

Science is organized knowledge...

*Education: Intellectual, Moral, and Physical*

Chapter II (p. 119)

A.L. Fowle. New York, New York, USA. 1860

A higher knowledge tends continually to limit our interference with the processes of life.

*Education*

Chapter II (p. 97)

Willard Small. Boston, Massachusetts, USA. 1890

**Steinbeck, John** 1902–68  
American novelist

...knowledge is a sacred thing, not to be questioned or even inspected.

*Sea of Cortez*

Chapter 21 (p. 209)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Stenger, Victor J.** 1935–  
American physicist

I have learned that obtaining new knowledge is not easy and that we shouldn't expect it to be easy. All the easy stuff was discovered a long time ago. Today, new knowledge is accumulated only through the greatest effort and concentration of resources, often by teams of hundreds of scientists.

*Physics and Psychics: The Search for a World Beyond the Senses*

Preface (p. 10)

Prometheus Books. Buffalo, New York, USA. 1990

**Sterne, Laurence** 1713–68  
English novelist and humorist

Knowledge, like matter, he would affirm, was divisible in infinitum; – that the grains and scruples were as much a part of it as the gravitation of the whole world.

*The Life and Opinions of Tristram Shandy, Gentleman and a Sentimental Journey Through France and Italy* (Volume 1)

Chapter XIX (p. 130)

Macmillan & Company Ltd. London, England. 1900

**Stewart, Ian** 1945–  
English mathematician and science writer

I may not understand it, but it sure looks important to me.

*Does God Play Dice?* (2nd edition)

Chapter 6 (p. 109)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

**Sturgis, Russell** 1836–1909  
American architect

It is very easy to hinder one's growth in knowledge by being too ready to decide.

*How to Judge Architecture: A Popular Guide to the Appreciation of Buildings*

Chapter I (p. 11)

The Baker & Taylor Co. New York, New York, USA. 1903

**Sullivan, John William Navin** 1886–1937  
Irish mathematician

Knowledge for the sake of knowledge, as the history of science proves, is an aim with an irresistible fascination for mankind, and which needs no defense. The mere fact that science does, to a great extent, gratify our intellectual curiosity, is a sufficient reason for its existence.

*The Limitations of Science*

Chapter 7, Section 3 (p. 164)

New American Library. New York, New York, USA. 1956

**Swift, Jonathan** 1667–1745  
Irish-born English writer

Erect your schemes with as much method and skill as you please; yet if the materials be...spun out of your own entrails...the edifice will conclude at last in cobwebs.... As for us the ancients, we are content with the bee to pretend to nothing of our own, beyond our wings and our voice, that is to say, our flights and our language. For the rest, whatever we have got, has been by infinite labour and search, and ranging through every corner of nature.

*Gulliver's Travels, the Tale of a Tub, Battle of the Books, etc.*

The Battle of the Books (p. 554)

Oxford University Press, Inc. London, England. 1929

**Synge, John L.** 1897–1995  
Irish mathematician and physicist

Knowledge is alive. It creeps, it grows, it crawls, it jumps. It never stays quite still. We add to it. We tear it in pieces. We put it together again, and then it is a different knowledge.

*Kandelman's Krim*

Chapter Four (p. 85)

Jonathan Cape. London, England. 1957

**Szent-Györgyi, Albert** 1893–1986  
Hungarian-born American biochemist

Knowledge is a sacred cow, and my problem will be how we can milk her while keeping clear of her horns.

Teaching and the Expanding Knowledge

*Science*, Volume 146, Number 3649, 4 December, 1964 (p. 1278)

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Knowledge comes, but wisdom lingers.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 72

Oxford University Press, Inc. London, England. 1953

And this grey spirit yearning in desire,  
To follow knowledge like a sinking star, beyond the  
utmost bound of human thought.

*Alfred Tennyson's Poetical Works*

Ulysses, l. 30–31

Oxford University Press, Inc. London, England. 1953

**Thompson, Joseph Parrish**  
No biographical data available

The physicist might as well think to confine the atmosphere within the receiver of his air-pump, the chemist to compress the rivers into his retort, as to monopolize the term knowledge by the limitations of his particular science.

*American Comments on European Questions, International and Religious*

Chapter IX (p. 195)

Houghton Mifflin & Co. New York, New York, USA. 1884

**Thomson, Sir George Paget** 1892–1975  
English physicist

Science is knowledge which, in principle at least, is public in the sense that it may be shared by many, unlike private personal experiences such as dreams or pain. This suggests a preference for statements which can be made in a form valid for large classes of possible observers.

*The Inspiration of Science*

Introduction (p. 6)

Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Strictly speaking there is no such thing as elementary knowledge. There is always a chasm between knowledge and ignorance which the steps of science can never pass.

In Robert Sattelmeyer (ed.)

*Journal (Volume 2: 1842–1848)* (p. 91)

Princeton University Press. Princeton, New Jersey, USA. 1984

The knowledge of an unlearned man is living & luxuriant like a forest – but covered with mosses & lichens and for the most part inaccessible & going to waste – the knowledge of the man of science is like timber collected in yards for public works, which still supports a green sprout here & there – but even this is liable to dry rot.

*Journal (Volume 3: 1848–1851)*

January 7, 1851 (p. 174)

Princeton University Press. Princeton, New Jersey, USA. 1981

My desire for knowledge is intermittent; but my desire to bathe my head in atmospheres unknown to my feet is perennial and constant. The highest that we can attain to is not Knowledge, but Sympathy with Intelligence. I do not know that this higher knowledge amounts to anything more definite than a novel and grand surprise on a sudden revelation of the insufficiency of all that we called Knowledge before – a discovery that there are more

things in heaven and earth than are dreamed of in our philosophy. It is the lighting up of the mist by the sun.

*The Writings of Henry David Thoreau* (Volume 9)

*Walking* (p. 294)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Such is always the pursuit of knowledge. The celestial fruits, the golden apples of the Hesperides, are ever guarded by a hundred-headed dragon which never sleeps, so that it is an Herculean labor to pluck them.

*The Writings of Henry David Thoreau* (Volume 9)

*Wild Apples* (p. 377)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Timiryazev, K. A.**

Russian botanist

The select who engage in science must look upon knowledge as a treasure entrusted to their care, but belonging to the whole people.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiererson

Progress Publishers. Moscow, Russia. 1979

Knowledge considered as a means to an end is art; knowledge considered as an end in itself is science.

Translated by Anna Sheremeteva

*Die Sinne der Pflanzen*

Chapter I (p. 7)

Longmans, Green & Co. London, England. 1912

### **Trotter, William** 1872–1939

Surgeon and sociologist

Knowledge comes from noticing resemblances and recurrences in the events that happen around us.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eight (p. 92)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Tucker, Wallace**

No biographical data available

### **Tucker, Karen**

No biographical data available

As the circle of knowledge expands into the unknown, the boundary between the known and unknown also expands.... Speculating and predicting what lies beyond the boundary is fascinating. Finding out is even more fascinating.

*Revealing the Universe*

Chapter 26 (p. 262)

Harvard University Press. Cambridge, Massachusetts, USA. 2001

### **Tyndall, John** 1820–93

Irish-born English physicist

He [the researcher] ponders the knowledge he possesses and tries to push it further, he guesses and checks his

guess, he conjectures and confirms or explodes his conjecture. These guesses and conjectures are by no means leaps in the dark; for knowledge once gained casts a faint light beyond its own immediate boundaries.

*Fragments of Science for Unscientific People*

Chapter VI (p. 110)

D. Appleton & Co. New York, New York, USA. 1875

In his efforts to cross the common bourne of the known and the unknown, the effective force of the man of science must depend, to a great extent, upon his acquired knowledge.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews*

Chapter V (p. 132)

D. Appleton & Co. New York, New York, USA. 1897

The centrifugal form in which knowledge, as a whole, advances, spreading ever wider on all sides, is due in reality to the exertions of individuals, each of whom directs his efforts, more or less, along a single line.

*Fragments of Science*

Part One

A Lecture to School Masters (p. 353)

P.F. Collier & Son. New York, New York, USA. 1901

### **van Leeuwenhoek, Antony** 1632–1723

Dutch biology researcher and microscope developer

...my work, which I've done for a long time, was not pursued in order to gain the praise I now enjoy, but chiefly from a craving after knowledge, which I notice resides in me more than in most other men. And therewithal, whenever I found out anything remarkable, I have thought it my duty to put down my discovery on paper, so that all ingenious people might be informed thereof.

In Julia A Ribes, Kay Elder and Doris J. Baker

*Infections, Infertility, and Assisted Reproduction*

Letter of June 12, 1716 (p. 3)

Cambridge University Press. Cambridge, England. 2004

### **von Baeyer, Hans Christian** 1938–

German-born physicist and author

Field guides are instruments of the pleasure of pure knowledge.

Rainbows, Whirlpools, and Clouds

*The Sciences*, Volume 24, Number 4, July/August, 1984 (p. 24)

### **von Buch, L.**

No biographical data available

It is hard to say when knowledge of any particular natural body began and to whom this knowledge must be ascribed. Is it the one who first raised the body from the mass of the unknown or he who first perceived the special nature and individuality of this body or he who first coined a special name for it? Obviously, one would not opt for the finder nor for he who gave it its name but for the naturalist who first showed how its special characteristic might be

recognized and whereby the creature is to be essentially separated and distinguished from all similar ones. But this knowledge only emerges very slowly and gradually and is obscured by many other things which, in the course of time, have to state at which point in time the first discovery of a product of nature is to be sited.

In Rudolf Daber and Jochen Helms (eds.)

*Fossils: The Oldest Treasures That Ever Lived*

Only a Slab of Transitional Limestone (p. 40)

T.H.F. Publications, Inc., Neptune City, New Jersey, USA. 1985

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...how one gropes and falters when one wants to dedicate himself to knowledge, how in the sciences one tends to take the back for the front and the bottom for the top, this is to be presented in the history of color theory, which by treating a specific realm, must present symbolically the destiny of many other human efforts.

In Karl J. Fink

*Goethe's History of Science*

Chapter 6 (p. 85)

Cambridge University Press. Cambridge, England. 1991

...the fine thread, which wafts and woofs through the web of knowledge, through the sciences in all periods, even through the darkest and most confusing ones, is drawn by individuals.

In Karl J. Fink

*Goethe's History of Science*

Chapter 7 (p. 93)

Cambridge University Press. Cambridge, England. 1991

### **von Helmholtz, Hermann** 1821–94

German scientist and philosopher

...our knowledge is not to lie dormant in the shape of catalogues. The very fact that we must carry it about in black and white shows that our intellectual mastery of it is incomplete. It is not enough to be acquainted with the facts; scientific knowledge begins only when their laws and their causes are unveiled.

In David Cahan (ed.)

*Science and Culture: Popular and Philosophical Essays*

On the Relation of Natural Science to Science in General

Academical Discourse, November 22, 1862 (p. 83)

The University of Chicago Press. Chicago, Illinois, USA. 1995

We are convinced that whatever contributes to the knowledge of the forces of nature or the powers of the human mind is worth cherishing, and may, in its own due time, bear practical fruit, very often where we should least have expected it.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

First Series

On the Relation of Natural Science to General Science (p. 28)

D. Appleton & Co. New York, New York, USA. 1897

To flee into an ideal world is a false resource of transient success; it only facilitates the play of the adversary; and when knowledge only reflects itself, it becomes unsubstantial and empty, or resolves itself into illusions and phrase.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

Second Series

Gustav Magmus

Longmans, Green & Co. London, England. 1903

### **von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Those who by the light of history should trace back through past ages the progress of physical knowledge to its early and remote sources, would learn how for thousands of years the human mind has laboured to lay hold of the sure thread of the invariability of natural laws, amid the perplexities of ceaseless change; and in so doing has gradually conquered, so to speak, great part of the physical universe.

*Cosmos: A Sketch of a Physical Description of the Universe*

Introduction (p. 4)

Longman, Brown, Green & Longmans. London, England. 1849

At the limits of circumscribed knowledge, as from some lofty island shore, the eye delights to penetrate to distant regions.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe (Volume 1)*

General Review of Natural Phenomena (p. 81)

Harper & Brothers Publishers. New York, New York, USA. 1858

### **von Liebig, Justus** 1803–73

German organic chemist

As the human mind advances in knowledge, from whatever source that knowledge may be derived, all its powers are strengthened and elevated. The acquisition of a new truth is equivalent to a new sense, enabling us now to perceive and recognise innumerable phenomena which remain invisible or concealed to others, as they formerly were to ourselves.

In John Blyth

*Familiar Letters on Chemistry* (4th edition)

Letter 1 (p. 2)

Walton & Maberly. London, England. 1859

### **Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

Scientific knowledge and understanding is a communal achievement, the sum of a multitude of contributions from many different people. Any individual may feel a certain justifiable pride if he knows that he has added one brick to the structure.

*The Scientific Attitude*

Science's Failure and Success (p. 62)

Penguin Books. Middlesex, England. 1941



**Walker, John** 1731–1803

English minister and educator

The objects of nature themselves must be sedulously examined in their native state, the fields and the mountains must be traversed, the woods and the waters must be explored, the ocean must be fathomed and its shores scrutinized by everyone that would become proficient in natural knowledge.... The way to knowledge of natural history is to go to the fields, the mountains, the oceans, and to observe, collect, identify, experiment and study.

*Lectures on Geology: Including Hydrography, Mineralogy, and Meteorology with an Introduction to Biology*

Biographical Introduction (p. xvii)

The University of Chicago Press. Chicago, Illinois, USA. 1966

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

He who has extended his inquiries into the varied phenomena of nature learns to despise no fact, however small, and to consider the most apparently insignificant and common occurrences as much in need of explanation as those of a grander and more imposing character.

*My Life*

Chapter XIV (p. 202)

Chapman &amp; Hall. London, England. 1905

Can we believe that we are fulfilling the purpose of our existence while so many of the wonders and beauties of the creation remain unnoticed around us? While so much of the mystery which man has been able to penetrate, however imperfectly, is still all dark to us? While so many of the laws which govern the universe and which influence our lives are, by us, unknown and uncared for? And this not because we want the power, but the will, to acquaint ourselves with them. Can we think it right that, with the key to so much that we ought to know, and that we should be the better for knowing, in our possession, we seek not to open the door, but allow this great store of mental wealth to lie unused, producing no return to us, while our highest powers and capacities rust for want of use?

*My Life*

Chapter XIV (p. 203)

Chapman &amp; Hall. London, England. 1905

How little should we know had the knowledge acquired by each preceding age died with it! How blindly should we grope our way in the same obscurity as did our ancestors, pursue the same phantoms, make the same fatal blunders, encounter the same perils, in order to purchase the same truths which had been already acquired by the same process, and lost again and again in bygone ages!

*My Life*

Chapter XIV (p. 204)

Chapman &amp; Hall. London, England. 1905

Is it not fitting that, as intellectual beings with such high powers, we should each of us acquire a knowledge of what past generations have taught us, so that, should the

opportunity occur, we may be able to add somewhat, however small, to the fund of instruction for posterity?

*My Life*

Chapter XIV (p. 204)

Chapman &amp; Hall. London, England. 1905

...can any reflecting mind have a doubt that, by improving to the utmost the nobler faculties of our nature in this world, we shall be the better fitted to enter upon and enjoy whatever new state of being the future may have in store for us?

*My Life*

Chapter XIV (p. 204)

Chapman &amp; Hall. London, England. 1905

...our horizon ever widens, the limits to our advance seem more distant than ever, and there seems nothing too noble, too exalted, too marvelous, for the ever-increasing knowledge of future generations to attain to.

*My Life*

Chapter XIV (p. 204)

Chapman &amp; Hall. London, England. 1905

**Waugh, John Hugh W.**

No biographical data available

In an age distinguished, beyond example, for utilitarian enterprise, rapid accomplishment, and signal success, it is not altogether surprising that we should be prone to connect results with the more immediate causes that produce them; and, in our possibly trite familiarity with the individual agents, and principles concerned in any new and profitable combination of them, towards some practical end, that we should too frequently fail to recognise the more remote springs of our knowledge and the sources of our power – that while beholding some felicitous combination, it may be the lofty achievements of the immediate inventor, and as yet dazzled with the splendour and brilliancy of his laurels, we should remain forgetful of the claims of those whose glory it may have been to have furnished his means, or from the recesses of science to have elaborated the elements of his triumph – of those who, while busied in their own congenial walks, regard it as their chiefest and their proudest boast, to cultivate knowledge, and yet for knowledge sake.

*Mathematical Essays*

Essay I (p. 7)

Johnstone &amp; Hunter. Edinburgh, Scotland. 1854

Knowledge, as the gift of Science, can certainly never be either too highly or too gratefully prized; nevertheless, it only becomes power when developed in practice – when beneficially applied.

*Mathematical Essays*

Essay I (p. 14)

Johnstone &amp; Hunter. Edinburgh, Scotland. 1854

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist



Knowledge has to be sucked into the brain, not pushed into it.

*The Privilege of Being a Physicist*

Chapter 4 (p. 31)

W.H. Freeman & Company. New York, New York, USA. 1989

**Weyl, Hermann** 1885–1955

German mathematician

At the basis of all knowledge there lies: (1) *Intuition*, mind's ordinary act of "seeing" what is given to him... (2) *Understanding and expression*. Even in Hilbert's formalized mathematics I must understand the directions given me by communication in words for how to handle the symbols and formulas. (3) *Thinking the possible*. In science a very stringent form of it is exercised when, by thinking out the possibilities of the mathematical game, we try to make sure that the game will never lead to a contradiction; a much freer form is the imagination by which theories are conceived.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

The Unity of Knowledge (p. 76)

Mathematical Association of America. Washington, D.C. 2004

**Whately, Richard** 1787–1863

English theologian

The dangers of knowledge are not to be compared with the dangers of ignorance. Man is more likely to miss his way in darkness than in twilight; in twilight than in full sun.

*Thoughts and Apophthegms*

Section VI (p. 167)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1856

The analytical method is the best to introduce knowledge, the synthetical to perfect and retain it.

*Miscellaneous Remains from the Commonplace Book of Richard*

*Whately, D.D*

Apothegms (p. 7)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Whewell, William** 1794–1866

English philosopher and historian

...Knowledge requires us to possess both Facts and Ideas ...

*The Philosophy of the Inductive Sciences, Founded Upon Their History*

(Volume 2) (2nd edition)

Book XI, Chapter I (p. 3)

John W. Parker. London, England. 1848

The Senses place before us the Characters of the Book of Nature; but these convey no knowledge to us, till we have discovered the Alphabet by which they are to be read.

*The Philosophy of the Inductive Sciences Founded Upon their History*

(Volume 2)

Aphorisms, Aphorisms Concerning Ideas, II (p. 443)

John W. Parker. London, England. 1847

...true knowledge is the interpretation of nature; and therefore it requires both the interpreting mind, and nature for its subject; both the document, and the ingenuity to read it aright.

*History of the Inductive Sciences from the Earliest to the Present Time*

(3rd edition)

Introduction (p. 6)

John W. Parker & Son. London, England. 1857

**White, John Francis**

Geologist

Man is building, at accelerated speed, a super-bridge of knowledge reaching to the stars.

*Study of the Earth: Readings in Geological Science* (p. 6)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1962

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The consequences of a plethora of half-digested theoretical knowledge are deplorable.

*The Organization of Thought*

Chapter I (p. 9)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Knowledge does not keep any better than fish.

*The Aims of Education and Other Essays*

Chapter VII, Section III (p. 147)

The Macmillan Company. New York, New York, USA. 1959

...science is not discussing the causes of knowledge, but the coherence of knowledge.

*The Concept of Nature*

Chapter II (p. 41)

At The University Press. Cambridge, England. 1920

Knowledge is a process of exploration.

*Essays in Science and Philosophy*

Immortality (p. 78)

Philosophical Library. New York, New York, USA. 1947

**Wilson, Edward O.** 1929–

American biologist and author

New knowledge is not science until it is made social. The scientific culture can be defined as new verifiable knowledge secured and distributed with fair credit meticulously given.

*Naturalist*

The Forms of Things Unknown (p. 210)

Island Press. Washington, D.C. 1994

Now to the heart of wonder. Because species diversity was created prior to humanity, and because we evolved within it, we have never fathomed its limits. As a consequence, the living world is the natural domain of the most restless and paradoxical part of the human spirit.

In John A Murray

*The Islands and the Sea* (p. 265)

Oxford University Press, Inc. Oxford, England. 1991

**Wright, Frances** 1795–1852

Scottish-born American reformer

Knowledge signifies things known. Where there are no things known, there is no knowledge. Where there are no things to be known, there can be no knowledge. We have observed that every science, that is, every branch of knowledge, is compounded of certain facts, of which our sensations furnish the evidence. Where no such evidence is supplied, we are without data; we are without first premises; and when, without these, we attempt to build up a science, we do as those who raise edifices without foundations. And what do such builders construct? Castles in the air.

*Course of Popular Lectures*

Lecture 4

Published by the author. Philadelphia, Pennsylvania, USA. 1836

**Ziman, John M.** 1925–2005

English physicist

Scientific knowledge is not created solely by the piecemeal mining of discrete facts by uniformly accurate and reliable individual scientific investigations. The process of criticism and evaluation, of analysis and synthesis, are essential to the whole system. It is impossible for each one of us to be continually aware of all that is going on around us, so that we can immediately decide the significance of every new paper that is published. The job of making such judgments must therefore be delegated to the best and wisest among us, who speak, not with their own personal voices, but on behalf of the whole community of Science. Anarchy is as much a danger in that community as in any tribe or nation. It is impossible for the consensus – public knowledge – to be voiced at all, unless it is channeled through the minds of selected persons, and restated in their words for all to hear.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 7 (pp. 136–137)

Cambridge University Press. Cambridge, England. 1968

**KNOWLEDGE, PHYSICAL****Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

We each live our mental life in a prison-house from which there is no escape. It is our body; and its only communication with the outer world is through our sense-organs – eyes, ears, etc. These form windows through which we can look out on to the outer world and acquire knowledge of it. A man lacking all five senses could know nothing of this outer world, because he would have no means of contact with it; the whole content of his mind would be an expansion of what had been in it at birth.

*Physics and Philosophy*

Chapter I (p. 6)

The University Press. Cambridge, England. 1943

**KNOWLEDGE, SCIENTIFIC****Pollard, Bedford**

No biographical data available

...scientific knowledge is like a key to unlock a thousand hidden treasures, it is happily true that the unlearned and the unscientific mind may pass through the wide halls of nature and learn lessons as real and be touched as deeply, as is possible with the wisest professor in the world.

Spring Thoughts

*The British Friend*, May, 1894 (p. 130)**KNOWLEDGE, TREE OF****Haeckel, Ernst Heinrich Philipp****August** 1834–1919

German biologist and philosopher

Science has to pluck the blessed fruits from the tree of knowledge, unconcerned whether these conquests trench upon the poetical imaginings of faith or not.

Translated by Edwin Ray Lankester

*The History of Creation* (Volume 1) (4th edition)

Chapter I (p. 9)

D. Appleton &amp; Co. New York, New York, USA. 1892

## L

### LABEL

**Mayr, Ernst** 1904–2005  
German-born American biologist

**Ashlock, P. D.**  
No biographical data available

So important...is the label that it is sometimes stated jocularly that the label is more important than the specimen.

*Principles of Systematic Zoology*  
Chapter 6. 1.8 (p. 106)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

### LABOR

**Rowland, Henry Augustus** 1848–1901  
American physicist

The gospel of work is the gospel of science. Go into the fields of Nature and labour if you would become a disciple of science; for not otherwise can the kingdom of natural knowledge be gained.

*Discovery, Or, The Spirit and Service of Science*  
Chapter III (pp. 41–42)  
Macmillan & Co Ltd. London, England. 1916

### LABORATORY

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

A laboratory of natural history is a sanctuary where nothing profane should be tolerated. I feel less agony at improprieties in churches than in a scientific laboratory.

Quoted in David Starr Jordan  
*Science Sketches*  
Quoted in David Starr Jordan (p. 147)  
A.C. McClurg & Co. Chicago, Illinois, USA. 1896

**Armitage, Simon** 1963–  
Poet and novelist

I am very bothered when I think of the bad things I have done in my life. Not least that time in the chemistry lab when I held a pair of scissors by the blades and played the handles in the naked lilac flame of the Bunsen burner, then called your name, and handed them over.

*Book of Matches*  
I Am Very Bothered When I Think, l. 1–7  
Chadwyck-Healey. Cambridge, England. 1999

### Barrett, Edward

American scientist

Most naturalists eschew the laboratory and cling to the field. Most scientists eschew the field and cling to the laboratory.

In Mary Griffin Webb and Edna Lenore Webb  
*Famous Living Americans, With Portraits*  
John Burroughs (p. 82)  
Charles Webb & Co. Greencastle, Indiana, USA. 1915

**Berselius, Jöns Jacob** 1779–1848  
Swedish chemist

A tidy laboratory means a lazy chemist.  
In E.M. Melhardo and T. Frängsmyr (eds.)  
*Enlightenment Science in the Romantic Era: The Chemistry of Berzelius and Its Cultural Setting*  
Quoted by C.G. Bernard (p. 225)  
Cambridge University Press. Cambridge, England. 1992

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

In my laboratory...I find that water of Lethe which causes that I forget everything but the joy of making experiments.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 18)  
Macmillan & Company Ltd. London, England. 1918

**Brooks, William Keith** 1848–1908  
American zoologist

...is not the biology which restricts itself to the physical basis, and forgets the external world, like your play of 'Hamlet' without the Hamlet? Is not the biological laboratory which leaves out the ocean and the mountains and meadows a monstrous absurdity?

*The Foundations of Zoology* (p. 41)  
The Macmillan Co. New York, New York, USA. 1899

**Carhart, Henry Smith** 1844–1920  
American physicist

**Chute, Horatio Nelson**  
No biographical data available

A few years ago it seemed necessary to urge upon teachers the adoption of laboratory methods to illustrate the textbook; in not a few instances it would now seem almost necessary to urge the use of a text-book to render intelligible the chaotic work of the laboratory.

*The Elements of Physics*  
Preface (p. iv)  
Allyn & Bacon. Boston, Massachusetts, USA. 1897

**Ciardi, John** 1916–86  
American poet

To the laboratory then I went. What little right men they were exactly! Magicians of the microsecond precisely wired to what they cared to ask no questions of but such as their computers clicked and hummed.

It was a white-smocked, glass, and lightened Hell. And there Saint Particle the Septic sat lost in his horn-rimmed thoughts. A gentlest pose. But in the frame of one lens as I passed I saw an ogre's eye leap from his face.

Fragment

*Saturday Review*, April 30, 1966

**Dampier, Sir William Cecil** 1867–1952

English scientific writer

In the laboratory, as in practical life, there is neither room nor time for philosophic doubt. In periods of reflection, however, when considering the theoretical bearing of the results of our experiments, it is sometimes well to remember the limitation of our present certain knowledge, and the purely conceptual nature of our scheme of Natural Science when based merely on its own inductions.

*The Recent Development of Physical Science*

Chapter I (p. 44)

John Murray. London, England. 1904

**Darwin, Sir George Howard** 1845–1912

English astronomer and mathematician

Great laboratories have...a rather serious defect, in that they tend to make all but the very best students helpless, and thus to dwarf their powers of resource and inventiveness.

*The Tides and Kindred Phenomena in the Solar System*

Chapter II (p. 18)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1898

**Dewey, John** 1859–1952

American philosopher and educator

Many a student has acquired dexterity and skill in laboratory methods without its ever occurring to him that they have anything to do with constructing beliefs that are alone worthy of the title of knowledge.

Science as Subject-Matter and as Method

*Science*, N.S. Volume 31, Number 787, January 28, 1910 (p. 126)

**Drake, Daniel** 1785–1852

American physician

The laboratory is not more necessary for the study of chemistry, or a garden of plants for the study of botany, than a hospital for the study of practical medicine and surgery.

Introductory lecture

Medical College of Ohio, 1849

**Fischer, Martin H.** 1879–1962

German-American physician

All the world is a laboratory to the inquiring mind.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

A laboratory is only a place where one may better set up and control conditions.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

**Henry, William**

No biographical data available

A chemical laboratory, though extremely useful, and even essential, to all who embark extensively in the practice of chemistry, either as an art, or as a branch of liberal knowledge, is by no means required for the performance of those simple experiments which furnish the evidence of the fundamental truths of science. A room that is well lighted, easily ventilated, and destitute of any valuable furniture is all that is absolutely necessary for the purpose.

*The Elements of Experimental Chemistry* (Volume 1)

Part I, Chapter I (p. 27)

Thomas & Andres. Boston, Massachusetts, USA. 1814

**Hilger, Adam**

No biographical data available

I also remember Len Hibbard, another of the more senior staff members, remarking half in jest, half in earnest, that there were two ways of pronouncing the word "laboratory." In American usage the accent was on the first syllable; in English, on the second. "But it is clear", he continued, "that the accent should be on the 'labor', and not on the 'oratory'."

In Joan Freeman

*A Passion for Physics: The Story of a Woman Physicist*

Chapter 5. The Radar Days (p. 90)

Institute of Physics Publishing. Bristol, England. 1993

**Huxley, Thomas Henry** 1825–95

English biologist

In truth, the laboratory is the fore-court of the temple of philosophy; and whoso has not offered sacrifices and undergone purification there has little chance of admission into the sanctuary.

*Hume, with Helps to the Study of Berkeley* (p. 61)

D. Appleton & Company. New York, New York, USA. 18 D. Appleton

& Company. New York, New York, USA. 1873

**Jones, Thomas P.**

No biographical data available

Nature has the universe for her laboratory, in which she is continually employed in chemical operations, producing effects as interesting, as wonderful, and equally necessary with those which belong to Natural Philosophy.

*New Conversations on Chemistry*

Conversation I (p. 14)

Grigg, Elliot & Company. Philadelphia, Pennsylvania, USA. 1848

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

There is...one thing I feel strongly in respect to investigation in physical or chemical laboratories – it leaves no room for shady, doubtful distinctions between truth, half-truth, whole falsehood. In the laboratory everything tested or tried is found true or not.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 24)

Macmillan & Company Ltd. London, England. 1918

The laboratory of a scientific man is his place of work. The laboratory of the geologist and of the naturalist is the face of this beautiful world. The geologist's laboratory is the mountain, the ravine and the seashore. The naturalist and the botanist go to foreign lands, to study the wonders of nature, and describe and classify the results of their observations.

*Popular Lectures and Addresses* (Volume 2)

The Bangor Laboratories

Address

Physical and Chemical Laboratories in University College

Bangor, North Wales, February 2, 1885 (p. 476)

Macmillan & Company Ltd. London, England. 1894

**Lagen, Doug**

No biographical data available

The lab is my jeopardy, I cannot breathe.

It eateth my clothes with strong acids.

It destroyeth my soles.

It leadeth me into the paths of science for its own sake.

Yea, though I walk through the welter of stink and smells,  
I will fear not chemical, for it is oneness.

It provideth me a bench in the presence of fluorine.

It loadeth my day with toil.

My beaker runneth over. Surely bad tastes and odors  
shall follow me all the days of my life, and I shall dwell  
in the house of science forever.

The Lab

*Chemistry*, June, 1976 (p. 27)

**Lamb, J. C.**

No biographical data available

If you can make the vilest stinks invented  
And work in them from morn till late at night,

Or with your lot be perfectly contented

When you are asked to fool with dynamite;

If you can still remain quite calm and placid

When plant officials effervesce and fret,

Or being told to test a fuming acid

Can suck it through a 1-cc pipette:

...

If you can subjugate all thoughts of pleasure

And still retain a meed of self-esteem;

If you can give your few short hours of leisure

To keeping up with every modern theme;

If you donate your every waking minute

And seek your sole reward in duty done,

Yours is the Lab. And everything that's in it,

And what is more, you're welcome to it, Son.

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 11, June, 1932 (p. 152)

**Langer, Susanne Katherina Knauth** 1895–1985

American philosopher

The men in the laboratory have departed so far from the old forms of experimentation – typified by Galileo's weights and Franklin's kite – that they cannot be said to observe the actual objects of their curiosity at all; instead, they are watching index needles, revolving drums, and sensitive plates.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite, and Art*

Chapter I (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

**National Research Council (USA)**

The research laboratory, including the theoretical physicist's blackboard or lunch table, provides the kind of freewheeling environment in which an idea can be followed for a time to see where it leads.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 76)

National Academy of Sciences

Washington, D.C. 1972

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Worse still is the “lock and key” laboratory in which suspicion and distrust reign, and everyone is jealous and fearful lest the other should know of or find out about his work.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 280)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Pasteur, Louis** 1822–95

French chemist

...I implore you, take some interest in those sacred dwellings meaningfully described as laboratories. Ask that they may be multiplied and completed. They are the temples of the future, of riches and of comfort. There humanity grows greater, better, stronger; there she can learn to read the works of Nature, works of progress and universal harmony, while humanity's own works are too often those of barbarism, of fanaticism and of destruction.

In R. Vallery-Radot

*Life of Pasteur*

Chapter VI (p. 152)

Garden City Publishing Company. Garden City, New York, New York, USA. 1926

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

What is a scientific laboratory? It is a small world, a small corner of reality. And in this small corner man labors with his mind at the task of...knowing this reality in order correctly to predict what will happen...even to direct this reality according to his will, to command it, if this is within our technical means.

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Introduction (p. xiii)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Rowland, Henry Augustus** 1848–1901  
American physicist

Let the student be brought face to face with nature: let him exercise his reason with respect to the simplest physical phenomenon and then, in the laboratory, put his opinions to the test; the result is invariably humility, for he finds that nature has laws which must be discovered by labor and toil and not by wild flights of the imagination and scintillations of so-called genius.

*The Physical Papers of Henry Augustus Rowland*

The Physical Laboratory in Modern Education (p. 616)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Sarewitz, Daniel**

No biographical data available

The leap of faith that spans the chasm between laboratory and reality must be replaced with a bridge, lest, at the end of the age of physics, we look down and realize that there is nothing underneath our feet.

*Frontiers of Illusion*

Chapter 1 (p. 15)

Temple University Press. Philadelphia, Pennsylvania, USA. 1996

**Soddy, Frederick** 1877–1956  
English chemist

Laboratories are necessary, and though an artist without a studio or an evangelist without a church might conceivably find under the blue dome of heaven a substitute, a scientific man without a laboratory is a misnomer.

In Bernard Jaffe

*New World of Chemistry*

Chapter 4 (p. 44)

Silver, Burdett & Company. New York, New York, USA. 1935

**Vail, Albert Ross**

No biographical data available

**Vail, Emily McClellan**

No biographical data available

In...laboratories are working the knights of science. They are among the most useful men in the world, for little by

little they are killing the dragons of ignorance with the spears of knowledge.

*Heroic Lives in Universal Religion*

Chapter V (p. 52)

The Beacon Press. Boston, Massachusetts, USA. 1917

**Witt, Otto N.** 1875–1923  
German chemist

From laboratories great and small, official and private, the results of research have flowed like the rivulets which, irrigating the well-watered fields, come together in brooks, then in streams and in rivers, bringing fertility to the habitations of men in the valleys. An Abundant harvest has been raised on these watered plains, a harvest which has been enthusiastically consumed by the people.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

Development of Technological Chemistry During the Last Forty Years (p. 255)

Government Printing Office. Washington, D.C. 1909

## LABORATORY WORK

**Cooley, LeRoy Clark** 1833–1916  
American chemist

The educational value of laboratory work depends entirely on the way in which it is done. It rewards the student just in proportion to the care he bestows on it, and the effort which he makes to secure accurate results.

*Physics: The Student's Manual for the Study Room and Laboratory*

Laboratory Work (p. 6)

American Book Co. New York, New York, USA. 1897

**Millikan, Robert Andrews** 1868–1953  
American physicist

The most serious criticism which can be urged against modern laboratory work in Physics is that it often degenerates into a servile following of directions, and thus loses all save a purely manipulative value.

*Mechanics, Molecular Physics and Heat: A Twelve Weeks' College Course*

Preface (p. 3)

Ginn & Co. Boston, Massachusetts, USA. 1903

## LABYRINTH

**Borges, Jorge Luis** 1899–1986  
Argentine writer

I thought of a labyrinth of labyrinths, of one sinuous spreading labyrinth that would encompass the past and the future and in some way involve the stars.

In Donald A. Yates & James E. Irby (eds.)

*Labyrinths: Short Stories & Other Writings*

The Garden of Forking Paths (p. 23)

A New Direction Book. New York, New York, USA. 1964



**LAKE**

**Hamerton, Philip Gilbert** 1834–94  
English artist and art critic

There are few things in the world so dependent upon mere size as lakes are for the effect which they produce upon the mind. In buildings, the effect increases with the size, and however large a building may be, it still produces the effect of being a building. A large castle is a castle still, a vast cathedral is a cathedral still. So in human genius a great poet is still a poet, his poetical greatness does not promote him into another order of humanity; but however paradoxical it may seem, a great lake by the mere fact of its greatness loses all the characteristics of a lake, and becomes an inland sea.

*Landscape*  
Chapter XXI (p. 220)  
Roberts Brothers. Boston, Massachusetts, USA. 1885

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

Lakes in fine scenery are like silver ornaments on a beautiful dress, like liquid gems in a rich setting, or bright eyes in a lovely face.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter VII (p. 252)  
Macmillan & Company Ltd. London, England. 1903

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

A lake is the landscape's most beautiful and expressive feature. It is earth's eye...

*The Writings of Henry David Thoreau* (Volume 2)  
*Walden*  
Chapter IX (p. 291)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**LAKE BED**

**Powell, J. R.**

It [the dry lake bed] is a desert to the agriculturist, a mine to the paleontologist, and a paradise to the artist.

*Canyons of the Colorado*  
Chapter III (p. 38)  
BiblioBazaar. 2006

**LAND**

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

To me it seems, that to look on the first land that was ever lifted above the waste of waters, to follow the shore where the earliest animals and plants were created when

the thought of God first expressed itself in organic forms, to hold in one's hand a bit of stone from an old sea-beach, hardened into rock thousands of centuries ago, and studied with the beings that once crept upon its surface or were stranded there by some retreating wave, is even of deeper interest to men than the relics of their own race, for these things tell more directly of the thoughts and creative acts of God.

*Geological Sketches*  
Chapter II (pp. 29–30)  
Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Harrington, Thomas**  
No biographical data available

The Land we inhabit affords the ingenious and philosophic mind infinite matter for contemplation.

*Science Improved or the Theory of the Universe*  
Section I (p. 9)  
Printed for the Author. London, England. 1774

**Huxley, Thomas Henry** 1825–95  
English biologist

Direct proof may be given that some parts of the land of the northern hemisphere are at this moment insensibly rising and others insensibly sinking; and there is indirect, but perfectly satisfactory, proof, that an enormous area now covered by the Pacific has been deepened thousands of feet, since the present inhabitants of that sea came into existence. Thus there is not a shadow of a reason for believing that the physical changes of the globe, in past times, have been effected by other than natural causes.

*Collected Essays* (Volume 8)  
*Discourses, Biological and Geological*  
On a Piece of Chalk (p. 34)  
Macmillan & Company Ltd. London, England. 1904

**Leopold, Aldo** 1886–1948  
American naturalist

Land... is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals. Food chains are the living channels which conduct energy upward; death and decay return it to the soil. The circuit is not closed; some energy is dissipated in decay, some is added by absorption from the air, some is stored in the soils, peats, and long-lived forests; but it is a sustained circuit, like a slowly augmented revolving fund of life.

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
A Biotic View of Land (pp. 268–269)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

Land is soil, water, plants and animals. Each of the "organs" of land has meaning as a separate entity, just as fingers, toes, and teeth have.

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
Wherefore Wildlife Ecology? (p. 336)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

I am trying to teach you that his alphabet of “natural objects” (soils and rivers, birds and beasts) spells out a story, which he who runs may read – if he knows how. Once you learn to read the land, I have no fear of what you will do to it, or with it. And I know many pleasant things it will do to you.

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

Wherefore Wildlife Ecology? (p. 337)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

### **Lyll, Sir Charles** 1797–1875

English geologist

...millions of our race are now supported by lands situated where deep seas prevailed in earlier ages. In many districts not yet occupied by man, land animals and forests now abound where the anchor once sunk into the oozy bottom.

*Principles of Geology* (Volume I) (3rd edition)

Book II, Part I, Chapter V (p. 373)

John Murray. London, England. 1834

### **Mills, Stephanie**

No biographical data available

Our behavior toward the land is an eloquent and detailed expression of our character, and the land is not incapable of reflecting these statements back.

*In Service of the Wild*

Prologue (p. 3)

Beacon Press. Boston, Massachusetts, USA. 1995

### **Steinbeck, John** 1902–68

American novelist

For nitrates are not the land, nor phosphates; and the length of fiber in the cotton is not the land. Carbon is not a man, nor salt nor water nor calcium. He is all of these, but he is much more, much more; and the land is so much more than its analysis. The man who is more than his chemistry, walking on the earth – that man who is more than his elements knows the land that is more than its analysis.

*The Grapes of Wrath* (p. 157)

The Viking Press. New York, New York, USA. 1939

### **The Bible (King James Version)**

And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters.

Genesis 1:6

## LANDSCAPE

### **Dodge, Richard Elwood**

No biographical data available

The great poets of the world have often attempted to depict in appealing phrases, more graphic than any of

the carefully selected and more detailed descriptions of the scientists, the striking features of the landscape that everyone knows but perhaps does not appreciate.

Man and His Geographic Environment

*Journal of Geography*, Volume 8, 1910 (p. 184)

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

We can scarcely describe the beauty of a landscape as non-existent when there is no conscious being to witness it; but it is through consciousness that we can attribute a meaning to it.

*The Nature of the Physical World*

Chapter XII (p. 267)

The University Press. New York, New York, USA. 1929

### **Ehrlich, Gretel** 1946–

American travel writer

I like to think of landscape not as a fixed place but as a path that is unwinding before my eyes, under my feet. To see and know a place is a contemplative act. It means emptying our minds and letting what is there, in all its multiplicity and endless variety, come in.

*Legacy of Light*

Introduction, Landscape

Alfred A. Knopf. New York, New York, USA. 1987

### **Hamerton, Philip Gilbert** 1834–94

English artist and art critic

The land appertains to its lord, but the landscape belongs to him who, for the time being enjoys it.

*Landscape*

Chapter I (p. 12)

Roberts Brothers. Boston, Massachusetts, USA. 1885

### **Hilliard, George Stillman** 1808–79

American politician

The imaginative charm of the landscape does not disappear when we survey it from the geologist’s point of view; when we know what elemental forces, what mighty energies of wave and fire, have reared the pinnacled rock, have smoothed the level plain, have rounded the gentle slopes of the hills and torn open the mountain gates for the stream to pass through.

*The Relation of the Poet to His Age*

Discourse (p. 39)

Charles C. Little & James Brown. Boston, Massachusetts, USA. 1843

## LANGUAGE

### **Abbey, Edward** 1927–89

American environmentalist and nature writer

Language makes a mighty loose net with which to go fishing for simple facts, when facts are infinite.

*Desert Solitaire*

Author’s Introduction (p. x)

Ballantine Books. New York, New York, USA. 1968

**Author undetermined**

If you're anxious for to shine in the speculative line  
As a man of thought profound,  
You must vent exotic gabble that will flabbergast the  
rabble

By its awe-inspiring sound.

Bluff's Old Sweet Song

*The Pick and Hammer Club*, December 29, 1937 (p. 9)

**Barthes, Roland** 1915–80

French social and literary critic

As far as science is concerned language is simply an instrument, which it profits it to make as transparent and neutral as possible: it is subordinate to the matter of science (workings, hypotheses, results) which, so it is said, exists outside language and precedes it. On the one hand and first there is the content of the scientific message, which is everything; on the other hand and next, the verbal form responsible for expressing that content, which is nothing.

In Michael Lane (ed.)

*Introduction to Structuralism*

Science versus Literature (p. 411)

Basic Books. New York, New York, USA. 1970

**Bloomfield, Leonard** 1887–1949

American linguist

The use of language in science is specialized and peculiar. In a brief speech the scientist manages to say things which in ordinary language would require a vast amount of talk. His hearers respond with great accuracy and uniformity. The range and exactitude of scientific prediction exceed any cleverness of everyday life: the scientist's use of language is strangely effective and powerful. Along with systematic observation, it is this peculiar use of language which distinguishes science from non-scientific behavior.

Linguistic Aspects of Science

*International Encyclopedia of Unified Science*, Volume 1, Number 4 (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1938.

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

What is it that we human beings ultimately depend on? We depend on our words. We are suspended in language. Our task is to communicate experience and ideas to others. We must strive continually to extend the scope of our description, but in such a way that our messages do not thereby lose their objective or unambiguous character.

In Aage Petersen

The Philosophy of Niels Bohr

*Bulletin of the Atomic Scientists*, Volume 19, Number 7, September,

1963 (p. 10)

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

I linger yet with nature for the night  
Hath been to me a more familiar face  
Than that of man; and in her starry shade  
Of dim and solitary loveliness  
I learned the language of another world.

*The Complete Poetical Works of Byron*

Manfred

Act III, Scene iv

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Casimir, Hendrik B. G.** 1909–2000

Dutch physicist

The number of speakers of Broken English is so overwhelming and there are so many for whom B.E. is almost the only way of expressing themselves...that it is about time that Broken English be regarded as a language in its own right.

*Haphazard Reality: Half a Century of Science*

Chapter 4 (p. 122)

Harper & Row, Publishers. New York, New York, USA. 1983

**Cooke, Josiah Parsons** 1827–94

American chemist

Language is the medium of thought, and cannot be separated from it. He who would think well must have a good command of language, and he who has the best command of language I am almost tempted to say will think the best.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 21)

D. Appleton & Co. New York, New York, USA. 1855

**Daumal, René** 1908–44

French surrealist writer

It is...not enough for language to have clarity and content... It must also have a goal and an imperative. Otherwise from language we descend to chatter, from chatter to babble and from babble to confusion

*A Night of Serious Drinking*

Shambhala. Boulder, Colorado, USA. 1979

**Davy, Sir Humphry** 1778–1829

English chemist

The man of true genius, who studies science in consequence of its applications, pointing out to himself a definite end, will make use of all the instruments of investigation which are necessary for his purposes: and in the search of discovery, he will rather pursue the plans of his own mind than be limited by the artificial divisions of language.

*A Discourse, Introductory to a Course of Lectures on Chemistry* (pp.

10–11)

Press of the Royal Institution of Great Britain. London. 1802

In natural science there is one language universally intelligible, – the language of facts; it belongs to nature, and it is permanent as the objects of nature; it is the same to

the citizen of Paris and of London.

*The Collected Works of Sir Humphry Davy* (Volume 1)  
*Memories of the Life of Sir Humphry Davy*  
Chapter III (p. 148)  
Smith, Elder & Company. London, England. 1839–1840

**de Albuquerque, Alfonso** 1453–1515  
Portuguese nobleman

They have among themselves a scientific language, which is like the Latin among us, that no one understands unless he is instructed in it.

In A. V. Williams Jackson  
*History of India* (Volume 9)  
Chapter VII (p. 235)  
The Grolier Society. London, England. 1907

**Duke of Argyll (George Douglas Campbell)** 1823–1900  
English statesman and writer on science, religion, and politics

Half the perplexities of men are traceable to obscurity of thought hiding and breeding under obscurity of language.

*The Reign of Law* (4th American edition)  
Chapter I (p. 2)  
George Routledge & Sons. New York, New York, USA. 1873

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

The point is we are bound up with a language, we are hanging in the language. If we want to do physics, we must describe our experiments and the results to other physicists, so that they can be verified or checked by others. At the same time, we know that the words we use to describe the experiments have only a limited range of applicability. That is a fundamental paradox which we have to confront. We cannot avoid it; we have simply to cope with it, to find what is the best thing we can do about it.

In Paul Buckley and F. David Peat  
*Glimpsing Reality: Ideas in Physics and the Link to Biology*  
Werner Heisenberg (p. 7)  
University of Toronto Press. Toronto, Ontario, Canada. 1996

**Hesse, Mary B.** 1924–  
English science historian

...there is an external world which can in principle be exhaustively described in scientific language. The scientist, as both observer and language-user, can capture the external facts of the world in propositions that are true if they correspond to the facts and false if they do not. Science is ideally a linguistic system in which true propositions are in one-to-one relation to facts, including facts that are not directly observed because they involve hidden entities or properties, or past events or far distant events. These hidden events are described in theories, and theories can be inferred from observation, that

is, the hidden explanatory mechanism of the world can be discovered from what is open to observation. Man as scientist is regarded as standing apart from the world and able to experiment and theorize about it objectively and dispassionately.

*Revolutions and Reconstructions in the Philosophy of Science*  
Introduction (p. vii)  
Indiana University Press. Bloomington, Indiana, USA. 1980

**Hinshelwood, Sir Cyril** 1897–1967  
English chemist

The creations of various men of science may be likened to pictures by artists of different schools, all conveying essential truth but in varied forms. The individual nature of its symbolism lays science open to the attack of those philosophers who like to question minutely the use of language in every statement. Men of science, although some of them play at this game themselves, tend on the whole to be impatient of purely semantic discussions and indeed most of them would probably feel that present-day linguistic philosophy has been not unjustly described as an affair of limited risks and small returns.

Science and Scientists  
*Nature*, Volume 207, Number 5001, September 4, 1965 (p. 1058)

**Huxley, Aldous** 1894–1963  
English writer and critic

Like the man of letters, the scientist finds it necessary to “give a purer sense to the words of the tribe.” But the purity of scientific language is not the same as the purity of literary language. The aim of the scientist is to say only one thing at a time, and to say it unambiguously and with the greatest possible clarity. To achieve this, he simplifies and jargonizes.

*Literature and Science*  
Chapter 5 (p. 12)  
Harper & Row, Publishers. New York, New York, USA. 1963

**Huxley, Thomas Henry** 1825–95  
English biologist

...every art is full of conceptions which are special to itself; and, as the use of language is to convey our conceptions to one another, language must supply signs for those conceptions.

*The Crayfish* (6th edition)  
Chapter I (p. 14)  
Kegan Paul, Trench & Trubner. London, England. 1896

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

I am not so lost in lexicography, as to forget that words are the daughters of earth, and that things are the sons of heaven. Language is only the instrument of science, and words are but the signs of ideas: I wish, however, that

the instrument might be less apt to decay, and that signs might be permanent, like the things which they denote.

*Dictionary of the English Language*

Introduction

Longmans, Green & Company. London, England. 1882

**Kistiakowsky, George B.** 1900–82

Russian American chemist

...science is today one of the few common languages of mankind; it can provide a basis for understanding and communication of ideas between people that is independent of political boundaries and ideologies.

Science and Foreign Affairs

*Bulletin of the Atomic Scientists*, Volume 16, Number 4, April, 1960 (p. 115)

**Laurent, Auguste** 1807–53

French chemist

For a language to be perfect, it is not sufficient that each substance, each idea, each modification of form, time, place, &c., should be represented by one word or by one invariable symbol; it is necessary in addition, both to aid the memory and to facilitate the operations of the mind, that analogous words should designate analogous substances, analogous ideas, and modifications of ideas, &c. It is thus that the words of our language represent to us, by similar terminations or augments, similar modifications of the ideas represented, as when we say, *Je vois, j'aperçois, je reqois; nous voyons, nous apercevons, nous recevons*. In like manner do chemists make use of the expressions sulphate, nitrate, chlorate, chloride, bromide, iodide, &c.

Translated by William Odling

*Chemical Method, Notation, Classification, & Nomenclature*

Part First, Section First

Printed for the Cavendish Society. 1855

**Lavoisier, Antoine Laurent** 1743–94

French chemist

The impossibility of separating the nomenclature of a science from the science itself is owing to this, that every branch of physical science must consist of three things: the series of facts which are the objects of the science, the ideas which represent these facts, and the words by which these ideas are expressed. Like three impressions of the same seal, the word ought to produce the idea, and the idea to be a picture of the fact.

In *Great Books of the Western World* (Volume 45)

*Elements of Chemistry*

Preface (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...we cannot improve the language of any science without at the same time improving the science itself; neither can we, on the other hand, improve a science, without improving the language or nomenclature which belongs to it.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xv)

Printed for William Creech. Edinburgh, Scotland. 1790

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Language, with its helpmate, conceptual thought, by fixing the essential and rejecting the unessential, constructs its rigid pictures of the fluid world on the plan of a mosaic, at a sacrifice of exactness and fidelity but with a saving of tools and labor.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physical Inquiry (p. 192)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Martin, Calvin Luther**

American historian

I thought of words as sculptors of space, as turn-keys: liberators or jailers of the powers about us.

*In the Spirit of the Earth*

Chapter 2 (p. 25)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1992

**McPhee, John** 1931–

American journalist and nonfiction writer

There was, to be sure, another side of the page – full of geological language of the sort that would have attracted Gilbert and Sullivan.

*Basin and Range* (p. 26)

Farrar, Straus, Giroux. New York, New York, USA. 1981

**Mellor, Joseph William** 1863–1938

Chemist

It is considered bad style to mix Latin and Greek root words and profiles. Consequently we usually try to keep Greek with Greek, and Latin with Latin. Thus, we say “diatomic,” not “biatomic”; “bimolecular,” not “dimolecular”; “bivalent,” not “divalent”; and “bivariant,” not “divariant”; because “atomic” is derived from a Greek word, while “molecular,” “variant,” and “valent,” are derived from Latin words. Here are, however, many hybrids universally recognized. For example, millimetre, centimetre, etc. Monovalent, divalent, etc., are also used at times in spite of their hybrid character. We cannot, therefore, always be “purists” without defying custom, which, as Horace has said, decides the language we must use.

*Modern Inorganic Chemistry*

Chapter II (p. 39)

Longmans, Green & Co. London, England. 1912

**Muir, Matthew Moncrieff Pattison** 1848–1931

English chemist

To write a full description of the origin, growth and misadventures of the language of chemistry is to write a history of science.

*A History of Chemical Theories and Laws*

Appendix to Part I (p. 189)

John Wiley & Sons, Inc. New York, New York, USA. 1906



**Oppenheimer, Frank** 1912–85

Physicist

At the leading edge of experience in philosophy, science and feeling there is inevitably a groping for language to translate the insecure novelty of noticing and understanding into a precision of meaning and imagery.

In K.C. Cole

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter One (p. 15)

Harcourt Brace &amp; Co. Orlando, Florida, USA. 1999

**Pearson, Karl** 1857–1936

English mathematician

If the reader finds the opinions of physicists of worldwide reputation, and the current definitions of physical concepts called into question, he must not attribute this to a purely sceptical spirit in the author. He accepts almost without reserve the great results of modern physics; it is the language in which these results are stated that he believes needs reconsideration.

*The Grammar of Science* (2nd edition)

Preface to the First Edition (p. x)

Adam &amp; Charles Black. London, England. 1900

**Quine, Willard van Orman** 1908–2000

American logician and philosopher

Language is conceived in sin and science is its redemption.

*The Roots of Reference*

Part II, Section 18 (p. 68)

Open Court Publishing. La Salle, Illinois, USA. 1974

**Shaler, Nathaniel Southgate** 1841–1906

American geologist

The greater part of the facts [with] which geologists have to deal possess for the general public a recondite character. They concern things which are not within the limits of familiar experience. In treating of them, the science uses a language of its own, an argot as special as that of the anatomist or the metaphysician.

*Aspects of the Earth: A Popular Account of Some Familiar Geological Phenomena*

Rivers and Valleys (p. 143)

Charles Scribner's Sons. New York, New York, USA. 1889

**Stoppard, Tom** 1937–

Czech-born English playwright

If there is any point in using language at all it is that a word is taken to stand for a particular fact or idea and not for other facts or ideas.

*Travesties*

Act I (p. 22)

Grove Press, Inc. New York, New York, USA. 1975

**Sylvester, James Joseph** 1814–97

English mathematician

Would it sound too presumptuous to speak of perception as a quintessence of sensation, language (that is, communicable thought) [as that] of perception, mathematics [as that] of language? We should then have four terms differentiating from inorganic matter and from each other: the Vegetable, Animal, Rational, and Supersensual models of existence.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association (p. 652)

University Press. Cambridge, England. 1904–1912

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

There is a necessity for perfect definiteness of language in all truly Scientific work.

On the Formula of Evolution

*Nature*, November 23, 1880 (p. 12)**Talman, Charles Fitzhugh** 1874–1936

American meteorologist

In discussing the vocabulary of any branch of science one is embarrassed by the fact that scientific language in general is a neglected subject.

The Language of Meteorology

*The Popular Science Monthly*, Volume 82, Number 3, March, 1913 (p. 272)**Thomas, Lewis** 1913–93

American physician and biologist

The great thing about human language is that it prevents us from sticking to the matter at hand.

*The Lives of a Cell: Notes of a Biology Watcher*

Information (p. 95)

The Viking Press. New York, New York, USA. 1974

**Thurston, William Paul** 1946–

American mathematician

I think that vision is somehow distracting to the spatial sense, because we have a spatial sense that is more than just vision. People associate it with vision, but it's not the same.... Sometimes pictures can get in the way. Sometimes one can evoke better pictures in one's head just by words. The spatial image is important, but it's what's in the head that counts.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 337)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**van Gogh, Vincent Willem** 1853–90

Dutch painter

It is not the language of painters but the language of nature which one should listen to...The feeling for the things themselves, for reality, is more important than the feeling for pictures.

*The Complete Letters of Vincent van Gogh with Reproductions of all the Drawings in the Correspondence* (Volume One)

Letter 218 (p. 416)

New York Graphic Society. Greenwich, Connecticut, USA. 1958



**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

From the remotest nebulae and from the revolving double stars, we have descended to the minutest organisms of animal creation, whether manifested in the depths of ocean or on the surface of our globe, and to the delicate vegetable germs which clothe the naked declivity of the ice-crowned mountain summit; and here we have been able to arrange these phenomena according to partially known laws; but other laws of a more mysterious nature rule the higher spheres of the organic world, in which is comprised the human species in all its varied conformation, its creative intellectual power, and the languages to which it has given existence.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Conclusion of the Subject (p. 359)  
Harper & Brothers. New York, New York, USA. 1869

**Walker, Kenneth** 1882–1966  
Physician

Science is the product of the intellect and its language is the language of matter.

*Meaning and Purpose*  
Chapter IX (p. 89)  
Jonathan Cape. London, England. 1944

**Walker, Ruth A.**  
No biographical data available

**Johnston, Helen**  
No biographical data available

Equations are the language of the chemist.  
*The Language of Chemistry*  
Preface (p. viii)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1963

**Weaver, Warren** 1894–1978  
American mathematician

With the extremely small or the extremely large, with inconceivably brief or extended phenomena, science has a difficult time. It is by no means clear that our present concepts or even our existing language is suitable for these ranges.

*Science and Imagination*  
Chapter Two (p. 50)  
Basic Books, Inc. New York, New York, USA. 1967

## LARVAE

**Jaeger, Benedict** 1789–?  
Austrian born American entomologist

Larvae are like infant children, whose only occupation consists in eating, that they may grow and fulfill their destiny; but as they approach the time when they must

appear in society as perfect creatures, they transform themselves into a cocoon (*pupa*), and sleep until Nature has clad them with a new and splendid dress, and furnished them with glistening wings to appear as respectable objects in the fashionable world of Insects.

*The Life of North American Insects*  
ORDER I (p. 19)  
Harper & Brothers Publishers. New York, New York, USA. 1859

## LATIN SQUARE

**Kendall, Maurice G.** 1907–83  
English statistician

The first mathematical discussion of the Latin Square known to modern statisticians was given by Euler in 1882. Euler does not make any specific references to previous work and merely mentions the problem as having aroused interest, but since he entitled his paper “Recherch sur un Inouvelle espece de guarre magigues” he seems to have been under the impression that the problem was fairly new...

Who Discovered the Latin Square?  
*The American Statistician*, Volume 11, Number 4, August, 1948 (p. 13)

**Fleiss, Joseph L.** 1937–2003  
American biostatistician

An Israeli statistician named Hare,  
Had five factors he wished to compare,  
Levels of each were nine,  
So of course his design  
Was a Hebro–Greco–Latin square.

Letters to the Editor  
*The American Statistician*, Volume 21, Number 4, October, 1967 (p. 49)

## LAVA

### Author undetermined

Hence on a level plain, and at some distance from its source, the lava-stream advances at a leisurely pace. In such circumstances the cooling proceeds so quickly that a crust of considerable thickness is soon formed on the top of the current, and persons who are bold enough may cross the stream by means of this natural bridge. Even where the current continues flowing rapidly, this crust may be formed on its surface; and a man, whose curiosity exceeds his prudence, may stand on the top of it, bore a hole through the crust, and see the lava flowing underneath his feet!

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*  
Chapter I  
T. Nelson. London, England. 1890

A simple jet of water of considerable volume, thrown into the air to the height of a hundred feet, is itself a beautiful

spectacle. What then must be a huge jet of glowing white lava projected to the height of several hundred feet, and with what an awful thundering sound must it come tumbling to the ground, thence to rush as a roaring torrent down the mountain's side!

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter I

T. Nelson. London, England. 1890

**Mantell, Gideon Algernon** 1780–1852

English obstetrician, geologist, and paleontologist

Volcanic eruptions throw up into daylight the foundations of the fathomless deep below, in the form of ejected or molten masses, or in rivers of ignited and fluid rocks, which congeal on the surface of the ground, either inflated like the scoriae of furnaces, or in solid masses, with no visible impress of heat ...

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Introduction (p. 4)

G.H. Bohn. London, England. 1857–58

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Under us, and stretching away before us, was a heaving sea of molten fire of seemingly limitless extent.... At unequal distances all around the shores of the lake were nearly white-hot chimneys or hollow drums of lava, four or five feet high, and up through them were bursting gorgeous sprays of lava-gouts and gem spangles, some white, some red and some golden – a ceaseless bombardment, and one that fascinated the eye with its unapproachable splendor. The more distant jets, sparkling up through an intervening gossamer veil of vapor, seemed miles away; and the further the curving ranks of fiery mountains receded, the more fairy-like and beautiful they appeared.

*Roughing It* (Volume 2)

Chapter XXXIV (pp. 304–305)

Harper & Brothers Publishers. New York, New York, USA. 1899

**LAVA BEDS**

**Muir, John** 1838–1914

American naturalist

Deserts are charming to those who know how to see them – all kinds of bogs, barrens, and healthy moors; but the Modoc Lava Beds have for me an uncanny look. As I gazed the purple deepened over all the landscape. Then fell the gloaming, making everything still more forbidding and mysterious. Then, darkness like death.

*Steep Trails*

Chapter V (p. 93)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**LAW**

**Author undetermined**

The universe does not have laws, it has habits, and habits can be broken.

Source undetermined

**Babbage, Charles** 1792–1871

English mathematician

The more man inquires into the laws which regulate the material universe, the more he is convinced that all its varied forms arise from the action of a few simple principles. These principles themselves converge, with accelerating force, towards some still more comprehensive law to which all matter seems to be submitted. Simple as that law may possibly be, it must be remembered that it is only one amongst an infinite number of simple laws: that each of these laws has consequences at least as extensive as the existing one, and therefore that the Creator who selected the present law must have foreseen the consequences of all other laws.

In John D. Barrow

*Theories of Everything: The Quest for Ultimate Explanation*

Chapter Two (p. 16)

The Clarendon Press. Oxford. London. 1991

**Baker, Ray Stannard** 1870–1946

American journalist and author

There is nothing quite so mercilessly destructive in science as the discovery of a new law.

The Origin of the Sun and Planet

*McClure's Magazine*, Volume XIII, May, 1899 (p. 80)

**Bartusiak, Marcia**

No biographical data available

According to “Turner’s Law,” the invocation of the tooth fairy should not occur more than once in any scientific argument.

*Thursday's Universe*

Chapter 8 (p. 207)

Random House, Inc. New York, New York, USA. 1986

**Bernard, Claude** 1813–78

French physiologist

But physicians have nothing to do with what is called the law of large numbers, a law which, according to a great mathematician's expression, is always true in general and false in particular.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section ix (p. 138)

Henry Schuman, Inc. New York, New York, USA. 1927

Do not confuse theory with law. Law is scientific, theory is nothing but the subjectivity of the facts.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin

*The Cahier Rouge of Claude Bernard* (p. 69)

Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

**Bloch, Arthur** 1948–  
American humorist

Negative expectations yield negative results.  
Positive expectations yield negative results.

*Murphy's Law*  
The Nonreciprocal Laws of Expectation (p. 21)  
Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Bohm, David** 1917–92  
American physicist

Indeed, the laws of chance are just as necessary as the causal laws themselves.

*Causality and Chance in Modern Physics*  
Chapter One (p. 23)  
University of Pennsylvania Press. Philadelphia, Pennsylvania, USA. 1957

**Boule, Pierre** 1912–94  
French novelist

...if they do only one jump, you know, there's a fifty percent chance of an injury. Two jumps it's eighty percent. The third time, it's dead certain they won't get off Scot free. You see? It's not a question of training, but the law of averages.

Translated by Xan Fielding  
*The Bridge Over the River Kwai*  
Part Two, Chapter 8 (p. 67)  
The Vanguard Press, Inc. New York, New York, USA. 1954

**Boutroux, Émile** 1845–1921  
French philosopher

That which we call the laws of nature is the sum total of the methods we have discovered for adapting things to the mind, and subjecting them to be moulded by the will.

*Natural Law in Science and Philosophy* (p. 217)  
The Macmillan Company. New York, New York, USA. 1914

**Burt, W. A.**  
No biographical data available

The testimony of experiment is the ultimate criterion of truth, but experiment itself is impossible unless we assume that Nature is an intelligible order, that is, that its baffling complexity can be reduced to the simplicity of law.

In W.J. Greenstreet  
*Isaac Newton*  
The Contemporary Significance of Newton's Metaphysics (p. 139)  
G. Bell & Sons Ltd. London, England. 1927

**Carnap, Rudolf** 1891–1970  
American philosopher

**Gardner, Martin** 1914–  
American writer and mathematics games editor

...it should be kept clearly in mind that, when a scientist speaks of a law, he is simply referring to a description

of an observed regularity. It may be accurate, it may be faulty. If it is not accurate, the scientist, not nature, is to blame.

*An Introduction to the Philosophy of Science*  
Does Causality Imply Necessity (p. 207)  
Courier Dover Publications. Mineola, New York, USA. 1995

**Casti, John L.** 1943–  
American mathematician

A law explains a set of observations; a theory explains a set of laws. The quintessential illustration of this jump in level is the way in which Newton's theory of mechanics explained Kepler's law of planetary motion. Basically, a law applies to observed phenomena in one domain (e.g., planetary bodies and their movements), while a theory is intended to unify phenomena in many domains. Thus, Newton's theory of mechanics explained not only Kepler's laws, but also Galileo's findings about the motion of balls rolling down an inclined plane, as well as the pattern of oceanic tides. Unlike laws, theories often postulate unobservable objects as part of their explanatory mechanism. So, for instance, Freud's theory of mind relies upon the unobservable ego, superego, and id, and in modern physics we have theories of elementary particles that postulate various types of quarks, all of which have yet to be observed.

*Searching for Certainty: How Scientists Predict the Future*  
Chapter One (p. 27)  
William Morrow & Company, Inc. New York, New York, USA. 1990

**Coates, Robert M.**  
No biographical data available

In the course of the committee's investigations, it had been discovered, to everyone's dismay, that the Law of Averages had never been incorporated into the body of federal jurisprudence, and though the upholders of States' Rights rebelled violently, the oversight was at once corrected, both by Constitutional amendment and by a law – the Hills–Slooper Act – implementing it. According to the Act, people were required to be average, and, as the simplest way of assuring it, they were divided alphabetically and the permissible activities catalogued accordingly.

*The World of Mathematics* (Volume 3)  
The Law (p. 2271)  
Simon & Schuster. New York, New York, USA. 1956

**Coleridge, Stephen** 1854–1936  
English author, barrister, and opponent of vivisection

...the very fact that the law [that all particles of matter tend to approach all other particles of matter with a force that varies inversely as the square of their distance] is invariable and acts all matter similarly throughout the universe, has always done so, and must always do so, renders it quite uninteresting. And those who spend their lives in the dreary occupation of making calculations which cannot err, estimating strains that cannot vary, and

determining future phenomena which are certain and, inevitable become singularly dull individuals.

*The Idolatry of Science*

Chapter IV (pp. 20–21)

John Lane Co. London, England. 1920

**Collingwood, Robin George** 1889–1943

English historian and philosopher

The scientist collects crude facts, but he stores only what he has converted them into: laws. Laws are the body of science. Laws are what it is a scientist's business to come at. Laws are what a master-scientist has to teach. Laws are what a pupil-scientist has to learn.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part II, Chapter XXXI, aphorism 31.28 (p. 248)

At The Clarendon Press. Oxford, England. 1942

**Dalton, John** 1766–1844

English chemist and physicist

We should scarcely be excused, in concluding this essay without calling the reader's attention for a moment to the beneficent and wise laws established by the Author of Nature, to provide for the various exigencies of the sub-lunary creation, and to make the several parts dependent upon each other, so as to form one well regulated system, or whole.

*Meteorological Observations and Essays* (2nd edition)

Sixth Essay (p. 137)

Printed by Harrison & Crosfield. Manchester, England. 1834

**Davies, Charles** 1798–1876

American mathematician

The Laws of Nature are merely truths or generalized facts, in regard to matter, derived by induction from experience, observation, and experiment. The laws of mathematical science are generalized truths derived from the consideration of Number and Space.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*

Introduction (p. 14)

A.S. Barnes & Burr Co. New York, New York, USA. 1860

Masses of facts, like masses of matter, are capable of very minute subdivisions; and when we know the law of combination, they are readily divided or reunited. To know the law, in any case, is to ascend to the source; and without that knowledge the mind gropes in darkness.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*

Introduction (p. 21)

A.S. Barnes & Burr Co. New York, New York, USA. 1860

**Davy, Sir Humphry** 1778–1829

English chemist

The appearances of the greater number of natural objects are originally delightful to us; and they become still more so when the laws by which they are governed are

known, and when they are, associated with ideas of order and utility. The study of nature, therefore, in her various operations must be always more or less connected with the love of the beautiful and sublime...

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 24)  
Press of the Royal Institution of Great Britain. London. 1802

**de Jouvenel, Bertrand** 1903–87

French man of letters

I believe neither in chance nor in miracle, but only in phenomena regulated by laws.

In Ludwig Buchner

*Force and Matter* (p. 80)

Truth Seeker. New York, New York, USA. 1950

**de Moivre, Abraham** 1667–1754

French-born mathematician

...as it is thus demonstrable that there are, in the constitution of things, certain Laws according to which Events happen, it is no less evident from Observation, that these Laws serve to wise, useful and beneficent purposes, to preserve the steadfast Order of the Universe, to propagate the several Species of Beings, and furnish to the sentient Kind such degrees of happiness as are suited to their State.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play* (3rd edition)

A Method of Approximating the Sum of the Terms of the Binomial... (p. 252)

Printed for Millar. London, England. 1756

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

It would be splendid if all action required in social, economic, and industrial planning could be based on scientific laws; but actually, so many of the laws remain yet to be discovered that most action must be taken on the basis of knowledge of the subject matter in related fields.

*Statistical Adjustment of Data* (p. 11)

John Wiley & Sons, Inc. New York, New York, USA. 1938

**Dewey, John** 1859–1952

American philosopher and educator

Scientific principles and laws do not lie on the surface of nature. They are hidden, and must be wrested from nature by an active and elaborate technique of inquiry.

*Reconstruction in Philosophy*

Chapter II (p. 32)

Beacon Press. Boston, Massachusetts, USA. 1920

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty

is only that the application of these laws leads to equations much too complicated to be soluble.

Quantum Mechanics of Many-Electron Systems

*Proceedings of the Royal Society*, Volume 123, Number 792, 6 April, 1929 (p. 714)

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

Any physical law, being approximate, is at the mercy of the progress which, by increasing the precision of experiments, will make the degree of approximation of this law insufficient: the law is essentially provisional. The estimation of its value varies from one physicist to the next, depending on the means of observation at their disposal and the accuracy demanded by their investigations: the law is essentially relative.

*The Aim and Structure of Physical Theory*

Part II, Chapter V (p. 174)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

It is one thing for the human mind to extract from the phenomena of nature the laws which it has itself put into them; it may be a far harder thing to extract laws over which it has had no control.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (p. 200)

At The University Press. Cambridge, England. 1921

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

The Greeks, says Mr. Galton, if they had known of the law of errors [the precision of the mean of a large number of observations], would have personified and deified it; the moderns should at least respect it as the most universal law of nature.

On the Representation of Statistics by Mathematical Formula (concluded.)

*Journal of the Royal Statistical Society*, Volume XLII, 1899 (p. 552)

**Einstein, Albert** 1879–1955

German-born physicist

Who would be so venturesome as to decide today the question whether causal law and differential law, these ultimate premises of Newton's treatment of nature, must definitely be abandoned.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1927*

Isaac Newton (p. 207)

Government Printing Office. Washington, D.C. 1928

The general laws of nature are to be expressed by equations which hold good for all the systems of co-ordinates, that is, are co-variant with respect to any substitutions whatever (generally co-variant).

*Proceedings of the American Catholic Philosophical Association*,

Volume 11, 1935

As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.

*Sidelights on Relativity*

Geometry and Experience (p. 28)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

...there is no logical way to the discovery of these elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance.

In Max Planck

*Where Is Science Going?*

Prologue (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

A law cannot be definite for the one reason that the conceptions with which we formulate it develop and may prove insufficient in the future. There remains at the bottom of every thesis and of every proof some remainder of the dogma of infallibility.

*Cosmic Religion, with Other Opinions and Aphorisms*

On Science (p. 100)

Covici-Fiede. New York, New York, USA. 1931

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

A man does not tie his shoe without recognizing laws which bind the farthest regions of nature: moon, planet, gas, crystal, are concrete geometry and numbers.

*The Works of Ralph Waldo Emerson* (Volume 1)

*Essays, Second Series*

Nature (p. 356)

Harper & Brothers. New York, New York, USA. 1925

Every ultimate fact is only the first of a new series. Every general law only a particular fact of some more general law presently to disclose itself.

*Essays*

Circles (p. 284)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1873

**Euclid of Alexandria** 325 BCE–265 BCE

Greek mathematician

The laws of nature are but the mathematical thoughts of God.

In Stanley Gudder

*A Mathematical Journey* (p. 112)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Faraday, Michael** 1791–1867

English physicist and chemist

How wonderful it is to me the simplicity of nature when we rightly interpret her laws and how different the convictions which they produce on the mind in comparison with the uncertain conclusions which hypothesis or even theory present.

*The Correspondence of Michael Faraday* (Volume 2)

Faraday to Svanberg, August 16, 1850 (p. 430)

Institution of Electrical Engineers. London, England. 1991



**Feynman, Richard P.** 1918–88  
American theoretical physicist

There is also a rhythm and a pattern between the phenomena of nature which is not apparent to the eye, but only to the eye of analysis; and it is these rhythms and patterns which we call Physical Laws.

*The Character of Physical Law*  
Chapter 1 (p. 13)  
British Broadcasting Company. London, England. 1965

This is common to all our laws; they all turn out to be simple things, although complex in their actual actions.

*The Character of Physical Law*  
Chapter 1 (p. 33)  
British Broadcasting Company. London, England. 1965

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

From a long view of the history of mankind – seen from, say, ten thousand years from now – there can be little doubt that the most significant event of the nineteenth century will be judged as Maxwell’s discovery of the laws of electrodynamics. The American Civil War will pale into provincial insignificance in comparison with this important scientific event of the same decade.

*The Feynman Lectures on Physics* (Volume 2)  
Chapter 1–6 (pp. 1–11)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

Nor is it of much importance to us to know the manner in which nature executes her laws; it is enough if we know the laws themselves. It is of real use to know that China left in the air unsupported will fall and break; but *how* it comes to fall, and *why* it breaks, are matters of speculation. It is a pleasure indeed to know them but we can preserve our china without it.

*The Complete Works in Philosophy, Politics, and Morals, of the Late Dr. Benjamin Franklin* (Volume 1)  
*Opinions and Conjectures*  
Section 19 (p. 224)  
Printed for J. Johnson. London, England. 1806

**Frazer, Sir James George** 1854–1941  
Scottish classicist and anthropologist

We must remember that at bottom the generalisations of science or, in common parlance, the laws of nature are merely hypotheses devised to explain that ever-shifting phantasmagoria of thought which we dignify with the high-sounding names of the world and the universe.

*The Golden Bough: A Study in Magic and Religion* (Volume 1)  
(Abridged edition)  
Chapter LXIX (p. 712)  
The Macmillan Company. New York, New York, USA. 1922

**Freeman, R. Austin** 1862–1943  
British physician and mystery novelist

But when I came to reflect on the facts observed, I was struck by their singularity. Moustache hairs are shed very freely, but they do not drop out at regular intervals. One, two, or more hairs in any one box would not have been surprising. A man who was in the habit of pulling or stroking his moustache might dislodge two or three at once. The surprising thing was the regularity with which these hairs occurred; one, and usually one only, in each box, and no complete box in which there was none. It was totally opposed to the laws of probability.

*A Certain Dr. Thorndyke*  
Thorndyke Connects the Links (p. 282)  
Dodd, Mead & Company. New York, New York, USA. 1928

**Friend, Julius W.**  
European historian

**Feibleman, James K.** 1904–87  
American philosopher

If nature is not subject to law, then the whole of science is a fruitless proceeding.

*What Science Really Means*  
Chapter IV (p. 95)  
George Allen & Unwin Ltd. London, England. 1937

**Froude, James Anthony** 1818–94  
English historian and biographer

Superstition, hero worship, ignorance of the laws of probability, religious, political, or speculative prejudice. One or other of these has tended from the beginning to give us distorted pictures.

*Short Studies on Great Subjects* (Volume 2)  
Scientific Method Applied to History (p. 470)  
Charles Scribner’s Sons. New York, New York, USA. 1890

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer, and statistician

...the process of evolution on this earth, so far as we can judge, has been carried out neither with intelligence nor truth, but entirely through the routine of various sequences, commonly called “laws,” established or necessitated we know not how.

*Inquiries into Human Faculty and Its Development*  
The Observed Order of Events (p. 197)  
AMS Press. New York, New York, USA. 1973

**Gamow, George** 1904–68  
Russian-born American physicist

If and when all the laws governing physical phenomena are finally discovered, and all the empirical constants



occurring in these laws are finally expressed through the four independent basic constants, we will be able to say that physical science has reached its end, that no excitement is left in further explorations, and that all that remains to a physicist is either tedious work on minor details or the self-educational study and adoration of the magnificence of the completed system. At that stage physical science will enter from the epoch of Columbus and Magellan into the epoch of *National Geographic Magazine*.

Any Physics Tomorrow?

*Physics Today*, Volume 2, Number 1, January, 1949 (p. 18)

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

If one were not animated with the desire to discover laws, they would often escape the most enlightened attention.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 43)

Cambridge University Press. Cambridge, England. 1978

**Gibbon, Edward** 1737–94

English historian

...but the laws of probability, so true in general, so fallacious in particular...

In M.M. Reese (ed.)

*Gibbon's Autobiography*

Life and Visitors in Lausanne (p. 124)

Routledge & Kegan Paul. London, England. 1971

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

We must not conclude a law from facts too small in number, or observed with too little care; or if the scientific imagination, impatient of restraint, press onward at once to the goal, and divine from the falling of an apple the law of gravitation, and in the trivial and everyday changes which are witnessed around us on this earth perceive the indications of a mighty power, extending through all space, and compelling to their proper orbits the “planets struggling fierce towards heaven’s free wilderness”; yet must such divinations be long received, even by the favoured discoverer himself, if he be of the true inductive school, with candid diffidence and philosophic doubt, until they have been confirmed by new appeals to other, and more remote, and more varied phenomena.

*Life of Sir William Rowan Hamilton*

Introductory Lecture on astronomy (pp. 645–646)

Hodges, Figgis & Co. Dublin, Ireland. 1882

**Harker, Alfred** 1859–1939

American petrologist

...the laws of physics and chemistry must be the same in a crucible as in the larger laboratory of Nature.

*The Natural History of Igneous Rocks*

Chapter XII (p. 282)

Hafner Publishing Company. New York, New York, USA. 1965

**Heinlein, Robert A.** 1907–88

American science fiction writer

Natural laws have no pity.

*Time Enough for Love*

Second Intermission (p. 369)

G.P. Putnam’s Sons. New York, New York, USA. 1973

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

In physics, we can only work with the assumption that we have natural laws. If we have no natural laws, then anything can happen, and we can only describe what we see, and that’s all.

In Paul Buckley and F. David Peat (eds.)

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 15)

University of Toronto Press. Toronto, Ontario, Canada. 1996

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

We must never forget that it is principles not phenomena, – laws, not insulated, independent facts, which are the objects of inquiry of the natural philosopher.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 10 (pp. 13–14)

Longman, Rees, Orme, Brown & Green. London, England. 1831

**Holton, Gerald** 1922–

Research professor of physics and science history

**Roller, Duane H. D.** ?–1994

Science historian

If we liken the facts to be explained to fish in a pond, then the law or set of laws is the net with which we make the catch. It may turn out that our particular net is not fine enough to haul in all fish, large and small, but it may still be quite satisfactory for supplying our ordinary needs. We may go even further and maintain that to be useful at all, our conceptual schemes, like our nets, must contain holes; if it were otherwise (if, so to speak, we were to go fishing with large buckets instead of nets), we should not be able to distinguish between the significant and the trivial, the fish and the water.

*Foundations of Modern Physical Science*

Chapter 15 (p. 260)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**Holton, Gerald James** 1809–94

American physician, poet, and humorist

Being built on concepts, hypotheses, and experiments, laws are no more accurate or trustworthy than the wording of the definitions and the accuracy and extent of the supporting experiments.

*Introduction to Concepts and Theories in Physical Science* (p. 269)

Addison-Wesley Press. New York, New York, USA. 1952

**Hopper, Grace Murray** 1906–92

Computer compiler

If you do something once, people will call it an accident. If you do it twice, they call it a coincidence. But do it a third time and you've just proven a natural law.

In Ethlie Ann Vare and Greg Ptacek

*Mothers of Invention*

From Eggbeaters to Eggheads (p. 187)

Quill. New York, New York, USA. 1987

**Hospers, John**

No biographical data available

**Hopper, Grace Murray** 1906–92

Computer compiler

The laws of science are not viewed in independence of one another. Together they form a vast body or system of laws, with each law fitting into a system including many other laws, each mutually reinforcing the others. The laws that scientists are most loathe to abandon are those that form such an integral part of a system of laws that the abandonment of the one law would require the abandonment or alteration of a larger number of other laws in the system. Thus an observation that directly confirms one law indirectly confirms a group of laws, because of the interconnection of the laws in a system. . . . whether or not something is called a law, then, depends to a large extent on how deeply embedded it is in a wider system of laws.

In E.D. Klemke, Robert Hollinger and A. David Kline

*Introductory Readings in the Philosophy of Science*

Laws (p. 110)

Prometheus Books. Buffalo, New York, USA. 1980

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

It is not only the smallest features of the Universe that are controlled by the laws of physics. The behavior of matter on the very large scale that concerns us in astronomy is also determined by physics. The heavenly bodies dance like puppets on strings. If we are to understand why they dance as they do, it is necessary to find out how the strings are manipulated.

*Frontiers of Astronomy*

Chapter Three (p. 40)

Harper &amp; Row, Publishers. New York, New York, USA. 1955

The laws of physics are governed by a process of intellectual natural selection. When they make correct predictions they survive. When they make incorrect predictions they become extinct. Physicists then look for new laws that do not make incorrect predictions.

*Frontiers of Astronomy*

Chapter Eighteen (p. 318)

Harper &amp; Row, Publishers. New York, New York, USA. 1955

**Huxley, Thomas Henry** 1825–95

English biologist

You have all heard it repeated, I dare say, that men of science work by means of induction and deduction, and that by the help of these operations, they, in a sort of sense, wring from Nature certain other things, which are called natural laws. . . . To hear all these large words, you would think that the mind of a man of science must be constituted differently from that of his fellow men; but if you will not be frightened by terms, you will discover that you are quite wrong, and that all these terrible apparatus are being used by yourselves every day and every hour of your lives.

*Collected Essays* (Volume 2)*Darwiniana*

On Our Knowledge of the Causes of the Phenomena of Organic Nature, Section III (p. 364)

Macmillan &amp; Company Ltd. London, England. 1904

“Law” means a rule which we have always found to hold good, and which we expect always will hold good.

*Collected Essays* (Volume 1)*Method and Result*

On Descartes' "Discourse Touching the Method of Using One's Reason Rightly and of Seeking Scientific Truth", Volume I (p. 193)

Macmillan &amp; Company Ltd. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

. . . as the sciences have developed further, the notion has gained ground that most, perhaps all, of our laws are only approximations.

*Pragmatism: A New Name for Some Old Ways of Thinking*

Lecture II (p. 43)

Longmans, Green &amp; Company. London, England. 1914

Science, like life, feeds on its own decay. New facts burst old rules; then newly divined conceptions bind old and new together into a reconciling law.

*The Will to Believe and Other Essays in Popular Philosophy*

What Psychical Research Has Accomplished (p. 320)

Longmans Green &amp; Co. New York, New York, USA. 1897

**Jevons, William Stanley** 1835–82

English economist and logician

“It is the glory of God,” said Solomon, “to conceal a thing, but the glory of a king to search it out.” The laws of nature are the invaluable secrets which God has hidden, and it is the kingly prerogative of the philosopher to search them out by industry and sagacity.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter VII (p. 126)

Macmillan &amp; Company Ltd. London, England. 1887

**Johnson, George** 1952–

American science writer

In *Zen and the Art of Motorcycle Maintenance*, Phaedrus, the author Robert Pirsig's alter ego, is sitting outside a motel room in the West, drinking whiskey with his traveling companions and listening to his son, Chris,

tell ghost stories. “Do you believe in ghosts?” Chris asks his father. “No,” Phaedrus says. “They contain no matter and have no energy and therefore, according to the laws of science, do not exist except in people’s minds.” Then he pauses and reflects: “Of course, the laws of science contain no matter and have no energy either and therefore do not exist except in people’s minds.”

*Fire in the Mind: Science, Faith, and the Search for Order*  
Phaedrus’s Ghosts (p. 24)  
Alfred A. Knopf. New York, New York, USA. 1995

### Jones, Luthar Maynard

No biographical data available

The astronomer looking for a star or writing a treatise, is only a discoverer of truth. He makes no law, but finds one operating. Reverse his deductions; destroy every record of Nature’s laws, and it makes no difference; astronomers would begin over again to gather a harvest of light for Science. The earth would yield her fruits and the heavenly hosts still march in silent courses, where the spheres hang out their starry banners. Just so eternal and unchanging are the Laws of man’s nature. Their fitness and use, as the basis of written laws, appears in their thus answering all the conditions of such laws.

The Unwritten Laws of Human Nature Taken as a Basis of Written Law  
*The Yale Literary Magazine*, Volume XXV, Number VIII, July, 1860 (p. 345)

### Jourdain, Philip E. B. 1879–1919

English logician

The laws of calculation and convenient symbolism are the things a mathematician thinks of and aims at. He seems to identify different things if they both satisfy the same laws which are important to him, just as a magistrate may think that there is not much difference between Mr. A., who is red-haired and a tinker and goes to chapel, and Mr. B., who is a brown-haired horse-dealer and goes to church, if both have been found out committing petty larceny. But their respective ministers of religion or wives may still be able to distinguish them.

*The Nature of Mathematics* (Revised edition)  
Chapter II (p. 49)  
T.C. & E.C. Jack. London, England. 1919

### Kadanoff, Leo P.

Theoretical physicist and applied mathematician

...all the richness of structure observed in the natural world is not a consequence of the complexity of physical law, but instead arises from the many-times repeated application of quite simple laws.

Complete Structure from Simple Systems  
*Physics Today*, Volume 44, Number 3, March 1991 (p. 9)

### Kaplan, Abraham 1918–93

American philosopher of science, author, and educator

...laws serve to explain events and theories to explain laws; a good law allows us to predict new facts and a good

theory new laws. At any rate, the success of prediction... adds credibility to the beliefs which led to it, and a corresponding force to the explanations they provide.

*The Conduct of Inquiry: Methodology for Behavioral Science*  
Chapter IX, Section 40 (p. 346)  
Chandler Publishing Company. San Francisco, California, USA. 1964

### Kingsley, Charles 1819–75

English clergyman and author

It does seem to me strange, to use the mildest word, that people whose destiny it is to live, even for a few short years, on this planet which we call the earth, and who do not at all intend to live on it as hermits...should in general be so careless about the constitution of this same planet, and of the laws and facts on which depend, not merely their comfort and their wealth, but their health and their very lives, and the health and the lives of their children and descendants.

*Town Geology*  
Preface (pp. xv–xvi)  
D. Appleton & Company. New York, New York, USA. 1873

They say, man is the microcosm...but the man of science finds every worm and beetle a microcosm in its way. It exemplifies, directly or indirectly, every physical law in the universe, though it may not be two lines long. It is not only a part, but a mirror, of the great whole.

*Alton Locke*  
Chapter XV (p. 132)  
Macmillan & Co Ltd. London, England. 1862

Universal laws manifest themselves only by particular instances.

*Alton Locke*  
Chapter XV (p. 132)  
Macmillan & Co Ltd. London, England. 1862

### Krass, F.

No biographical data available

*Dieselbe Ordnung waltet  berall:  
Im wechselvollen Reigen der Gestirne  
Gebietet das Gesetz nach Mass und Zahl,  
Wie in des Menschen denkendem Gehirne.*

The same order rules everywhere; the law of measure and number rules in the changeful hosts of the stars as it does in man’s thinking brain.

In Ludwig Buchner  
*Force and Matter* (p. 103)  
Truth Seeker. New York, New York, USA. 1950

### Laplace, Pierre Simon 1749–1827

French mathematician, astronomer, and physicist

Surrounded as we are by an infinite variety of phenomena, which continually succeed each other in the heavens and on the earth, philosophers have succeeded in recognizing the small number of general laws to which matter is subject in its motions. To them, all nature is obedient; and everything is as necessarily derived from them,

as the return of the seasons; so that the curve which is described by the lightest atom that seems to be driven at random by the winds, is regulated by laws as certain as those which confine the planets to their orbits.

*System of the World* (Volume 1)

Book II, Chapter VI (p. 221)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

All events, even those which on account of their insignificance do not seem to follow the great laws of nature, are a result of it just as necessarily as the revolutions of the sun. In ignorance of the ties which unite such events to the entire system of the universe, they have been made to depend upon final causes or upon hazard, according as they occur and are repeated with regularity, or appear without regard to order; but these imaginary causes have gradually receded with the widening bounds of knowledge and disappear entirely before sound philosophy, which sees in them only the expression of our ignorance of the true causes.

*A Philosophical Essay on Probabilities*

Chapter II (p. 3)

Dover Publications, Inc. New York, New York, USA. 1951

**Lavoisier, Antoine Laurent** 1743–94

French chemist

... I have imposed upon myself, as a law, never to advance but from what is known to what is unknown; never to form any conclusion which is not an immediate consequence necessarily flowing from observation and experiment; and always to arrange the fact, and the conclusions which are drawn from them, in such an order as shall render it most easy for beginners in the study of chemistry thoroughly to understand them.

*Elements of Chemistry* (Volume 1) (5th edition)

Preface of the Author (p. xxii)

Printed for W. Creech. Edinburgh, Scotland. 1802

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

He who understands not only the letter but also the reason of the law will not be at a loss when confronted with cases to which the letter does not accurately apply.

Translated by Thomas Joseph McCormack

*Popular Scientific Lectures* (3rd edition)

The Forms of Liquids (p. 10)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

Natural laws may be likened to intellectual type of a higher order, partly movable, partly stereotyped, which last on new editions of experience may become downright impediments.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physics (pp. 193–194)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Mauldin, Bill (William) Henry** 1921–2003

Editorial cartoonist

I feel like a fugitive from th' law of averages.

*Up Front*

Cartoon caption (p. 39)

Henry Holt & Company. New York, New York, USA. 1945

**Maxwell, James Clerk** 1831–79

Scottish physicist

The only laws of matter are those which our minds must fabricate, and the only laws of mind are fabricated for it by matter.

In Gerald M. Edelman

*Bright Air, Brilliant Fire: On the Matter of the Mind*

Chapter 3 (p. 16)

Basic Books. New York, New York, USA. 1992

If we are to ever discover the laws of nature, we must do so by obtaining the most accurate acquaintance with the facts of nature, and not by dressing up in philosophical language the loose opinions of men who had no knowledge of the facts which throw most light on these laws.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1873*

Action at a Distance (p. 257)

Government Printing Office. Washington, D.C. 1874

**Mellor, Joseph William** 1863–1938

Chemist

Science begins with facts and ends with laws. Law is the essence of facts.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 10)

Longman, Green, & Co. London, England. 1922

**Meyerson, Emile** 1859–1933

Polish-born French chemist

In fact, we only attain laws by violating nature, by isolating more or less artificially a phenomenon from the whole, by checking those influences which would have falsified the observation. Thus, the law cannot directly express reality. The phenomenon as it is envisaged by it, the “pure” phenomenon, is rarely observed without our intervention, and even with this it remains imperfect, disturbed by accessory phenomena.... Doubtless, if nature were not ordered, if it did not present us with similar objects, capable of furnishing generalized concepts, we could not formulate laws.

Translated by Kate Loewenberg

*Identity & Reality*

Chapter I (pp. 31, 32)

George Allen & Unwin Ltd. London, England. 1930

**Michelson, Albert Abraham** 1852–1931

German-American physicist

The more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is

exceedingly remote...our future discoveries must be looked for in the sixth place of decimals.

*Light Waves and Their Uses*

Lecture II (pp. 23, 24)

The University of Chicago Press. Chicago, Illinois, USA. 1903

**Mill, John Stuart** 1806–73

English political philosopher and economist

When this phraseology [laws of Nature] was introduced, the poets and mythologists soon took hold of it and made it subservient to their purposes. Nature was personified: the phrase law of Nature...became a law laid down by the goddess Nature to be obeyed by her creatures. From the poets, this fictitious personage speedily penetrated into the closets of the philosopher...

In Ann P. Robson and John M. Robson (eds.)

*The Collected Works of J.S. Mill* (Volume 22)

Letter to the Republican, 3 January, 1823 (p. 9)

University of Toronto Press. Toronto, Ontario, Canada. 1977

**Mitchell, Maria** 1818–89

American astronomer and educator

The laws of nature...are not discovered by accident; theories do not come by chance even to the greatest minds; they are not born of the hurry and worry of daily toil; they are diligently sought; they are patiently waited for, they are received with cautious reserve, they are accepted with reverence and awe. And until able women have given their lives to investigation, it is idle to discuss their capacity for original work.

In Helen Wright

*Sweeper in the Sky*

Chapter 10 (pp. 203–204)

The Macmillan Company. New York, New York, USA. 1949

The laws which regulate the influence of sun and planets are complex; the nature of the influence is not yet understood. The telescope, the spectroscope, and the camera are all at work, and although the unknown must always be infinite, Nature yields one truth after another to the earnest seeker.

In Helen Wright

*Sweeper in the Sky*

Chapter 11 (p. 219)

Macmillan & Company. New York, New York, USA. 1949

The immense spaces of creation cannot be spanned by our finite powers; these great cycles of time cannot be lived even by the life of a race. And yet, small as is our whole system compared with the infinitude of creation, brief as is our life compared with cycles of time, we are tethered to all by the beautiful dependencies of law, that not only the sparrow's fall is felt to the outermost bound, but the vibrations set in motion by the words that we utter reach through all space and the tremor is felt through all time.

In Helen Wright

*Sweeper in the Sky*

Chapter 11 (p. 227)

Macmillan & Company. New York, New York, USA. 1949

**Oersted, Hans Christian** 1777–1851

Danish physicist and chemist

Added to this we already see numerous indications of a future, in which the chemical and mechanical laws of nature will be more intimately united. In short, the natural laws of chemistry, as well as those of mechanics, are laws of Reason, and both are so intimately connected, that they must be viewed as a unity of Reason.

*The Soul in Nature with Supplementary Contributions*

All Existence a Dominion of Reason (p. 104)

Henry C. Bohn. London, England. 1852

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

The scientist is not responsible for the laws of nature, but it is a scientist's job to find out how these laws operate. It is the scientist's job to find ways in which these laws can serve the human will. However, it is not the scientist's job to determine whether a hydrogen bomb should be used. This responsibility rests with the American people and their chosen representatives.

In Lewis Wolpert and Alison Richards

*A Passion for Science*

Chapter 1 (p. 9)

Oxford University Press, Inc. Oxford, England. 1988

**Pagels, Heinz R.** 1939–88

American physicist and science writer

The fact that the universe is governed by simple natural laws is remarkable, profound and on the face of it absurd. How can the vast variety in nature, the multitude of things and processes all be subject to a few simple, universal laws?

*Perfect Symmetry: The Search for the Beginning of Time*

Part Two, Chapter 1 (p. 160)

Simon & Schuster. New York, New York, USA. 1985

Instead of finding an absolute universal law at the bottom of existence, they [scientists] may find an endless regress of laws, or even worse, total confusion and lawlessness – an outlaw universe.

*Perfect Symmetry: The Search for the Beginning of Time*

Part Three, Chapter 1 (p. 264)

Simon & Schuster. New York, New York, USA. 1985

**Pasteur, Louis** 1822–95

French chemist

The presence of all the students of the Ecole Normale brings back to me how dazzling was my first enthusiasm for science.

The representatives of the faculty of Lille recall to me my first studies in crystallography and fermentation, which opened up an entirely new world to me. With what hopes I was filled when I first surmised that there were laws behind so many obscure phenomena!

*Pasteur*

Chapter XVI (p. 215)

Cassell & Co., Ltd. London, England. 1901



**Pearson, Karl** 1857–1936  
English mathematician

Scientific Law is [a] description, not a prescription.  
The Grammar of Science (p. 87)  
Charles Scribner's Sons. London, England. 1892

...law in the scientific sense only describes in mental shorthand the sequences of our perceptions. It does not explain *why* those perceptions have a certain order, nor *why* that order repeats itself; the law discovered by science introduces no element of necessity into the sequence of our sense-impressions; it merely gives a concise of *how* changes are taking place.

*The Grammar of Science* (2nd edition)  
Chapter IV (p. 113)  
Adam & Charles Black. London, England. 1900

**Planck, Max** 1858–1947  
German physicist

Thus, from the outset we can be quite clear about one very important fact, namely, that the validity of the law of causation for the world of reality is a question that cannot be decided on grounds of abstract reasoning.

*Where Is Science Going?*  
Chapter IV (p. 113)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

Self-determination is given to us by our consciousness and is not limited by any causal law...

Translated by R. Jones and D.H. Williams  
*A Survey of Physics: A Collection of Lectures and Essays*  
Dynamical Laws and Statistical Laws (p. 68)  
Methuen & Company Ltd. London, England. 1925

How do we discover the individual laws of Physics, and what is their nature? It should be remarked, to begin with, that we have no right to assume that any physical law exists, or if they have existed up to now, that they will continue to exist in a similar manner in the future. It is perfectly conceivable that one fine day Nature should cause an unexpected event to occur which would baffle us all; and if this were to happen we would be powerless to make any objection, even if the result would be that, in spite of our endeavors, we should fail to introduce order into the resulting confusion. In such an event, the only course open to science would be to declare itself bankrupt. For this reason, science is compelled to begin by the general assumption that a general rule of law dominates throughout Nature...

Translated by Walter Henry Johnston  
*The Universe in the Light of Modern Physics* (p. 62)  
W.W. Norton & Company, Inc. New York, New York, USA. 1931

...the outside world is something independent from man, something absolute, and the quest for the laws which apply to this absolute appeared to me as the most sublime scientific pursuit in life.

*Scientific Autobiography and Other Papers*  
A Scientific Autobiography (p. 13)  
Philosophical Library. New York, New York, USA. 1949

Rightly viewed, the real marvel is that we encounter natural laws at all which are the same for men of all races and nations. This is a fact which is by no means a matter of course. And the subsequent marvel is that for the most part these laws have a scope which could not have been anticipated in advance. Thus the element of the wondrous in the structure of the world picture increases with the discovery of every new law.

Translated by F. Gaynor  
*Scientific Autobiography and Other Papers* (p. 93)  
Philosophical Library. New York, New York, USA. 1949

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

The Author of nature has not given laws to the universe, which, like the institutions of men, carry in themselves the elements of their own destruction. He has not permitted, in his works, any symptom of infancy or of old age, or any sign by which we may estimate either their future or their past duration. He may put an end, as he no doubt gave a beginning, to the present system, at some determinate period; but we may safely conclude, that this great catastrophe will not be brought about by any of the laws now existing, and that it is not indicated by anything which we perceive.

*Illustrations of the Huttonian Theory of the Earth*  
Section 118 (pp. 119–120)  
Dover Publications, Inc. New York, New York, USA. 1964

Amid all the revolutions of the globe, the economy of nature has been uniform, and her laws are the only thing that have resisted the general movement. The rivers and the rocks, the seas and the continents have changed in all their parts; but the laws [to] which they are subject have remained invariably the same.

*Illustrations of the Huttonian Theory of the Earth*  
Section 373 (p. 421)  
Dover Publications, Inc. New York, New York, USA. 1964

The Author of nature has not given laws to the universe, which, like the institutions of men, carry in themselves the elements of their own destruction.

*The Works of John Playfair* (Volume 1)  
*Illustrations of the Huttonian Theory*, Paragraph 117 (p. 130)  
Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Are the laws of acceleration, the rule of the composition of forces only arbitrary conventions! Conventions, yes; arbitrary, no; they would be so if we lost sight of the experiments which let the creators of the science to adopt them, and which, imperfect as they may be, suffice to justify them. It is well that from time to time our attention is carried back on the experimental origin of these conventions.

*The Foundations of Science*  
*Science and Hypothesis*, Chapter VI (p. 106)  
The Science Press. New York, New York, USA. 1913



...astronomy has not only taught us that there are laws, but that from these laws there is no escape, that with them there is no possible compromise.

*The Foundations of Science*

*The Value of Science*

Part II, Chapter VI (p. 291)

The Science Press. New York, New York, USA. 1921

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist philosopher and social scientist

Now, I am not suggesting that it is impossible to find natural laws; but only that this is not done, and cannot be done, by applying some explicitly known operation...

*Science, Faith, and Society*

Science and Reality (p. 22)

The University of Chicago Press. Chicago, Illinois. 1964

**Poynting, John Henry** 1852–1914

English physicist

We must confess that physical laws have greatly fallen off in dignity. No long time ago they were quite commonly described as the Fixed Laws of Nature, and were supposed sufficient in themselves to govern the universe. Now we can only assign to them the humble rank of mere descriptions, often erroneous, of similarities which we believe we have observed.... A law of nature explains nothing, it has no governing power, it is but a descriptive formula which the careless have sometimes personified.

In J. Arthur Thomson

*The System of Animate Nature* (Volume 1)

Lecture I (p. 9)

William & Norgate. London, England. 1920

A law may fail or cease to be true, not because Nature has changed her ways, but because we have failed in our statement of likenesses, or because we learn new details with which our old description does not tally.

*Collected Scientific Papers*

Physical Law and Life, 1903 (p. 686)

At The University Press. Cambridge, England. 1920

...physical laws...have...greatly fallen off in dignity. No long time ago they were quite commonly described as the Fixed Laws of Nature, and were supposed sufficient in themselves to govern the universe. Now we can only assign to them the humble rank of mere descriptions, often tentative, often erroneous, of similarities which we believe we have observed.

Address to the Mathematical and Physical Section

*Science*, N.S. Volume X, Number 247, 1899 (p. 386)

**Reichenbach, Hans** 1891–1953

German philosopher of science

When science says that a law is valid, it means but *one* thing – that the law permits conclusions as to future observations.

*Atom and Cosmos: The World of Modern Physics*

Chapter 19 (p. 285)

The Macmillan Co. New York, New York, USA. 1933

**Ross, Sir Ronald** 1857–1932

Scottish physician

In this, O Nature, yield, I pray, to me. I pace and pace, and think and think, and take The fever'd hands, and note down all I see, That some dim distant light may haply break.

The painful faces ask, can we not cure?

We answer, No, not yet; we seek the laws. O God, reveal thro' all this thing obscure The unseen, small, but million-murdering cause.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter VIII (p. 226)

Macmillan & Co Ltd. London, England. 1916

**Rowland, Henry Augustus** 1848–1901

American physicist

He who makes two blades of grass grow where one grew before is the benefactor of mankind; but he who obscurely worked to find the laws of such growth is the intellectual superior as well as the greater benefactor of the two.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aim of the Physicist (p. 669)

Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The discovery that all mathematics follows inevitably from a small collection of fundamental laws is one which immeasurably enhances the intellectual beauty of the whole; to those who have been oppressed by the fragmentary and incomplete nature of most existing chains of deduction this discovery comes with all the overwhelming force of a revelation; like a palace emerging from the autumn mist as the traveler ascends an Italian hill-side, the stately stories of the mathematical edifice appear in their due order and proportion, with a new perfection in every part.

*Mysticism and Logic and Other Essays*

Chapter IV (pp. 67–68)

Longmans, Green & Company. London, England. 1925

The discovery of causal laws is the essence of science and therefore there can be no doubt that scientific men do right to look for them. If there is any region where there are no causal laws, that region is inaccessible to science. But the maxim [is] that mushroom gatherers should seek mushrooms.

*Religion and Science*

Determinism (pp. 146–147)

Henry Holt & Company. New York, New York, USA. 1935

Scientific laws, when we have reason to think them accurate, are different in form from the common-sense rules which have exceptions: they are always, at least in physics, either differential equations or statistical averages.

*The Analysis of Matter*

Chapter XIX (p. 191)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

**Sagan, Carl** 1934–96  
American astronomer and author

There is something stunningly narrow about how the Anthropic Principle is phrased. Yes, only certain laws and constants of nature are consistent with our kind of life. But essentially the same laws and constants are required to make a rock. So why not talk about a Universe designed so rocks could one day come to be, and strong and weak Lithic Principles? If stones could philosophize, I imagine Lithic Principles would be at the intellectual frontiers.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 3 (p. 38)  
Random House, Inc. New York, New York, USA. 1994

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

**Schwarzschild, Martin** 1912–97  
German American Astronomer

If simple perfect laws uniquely rule the universe, should not pure thought be capable of uncovering this perfect set of laws without having to lean on the crutches of tenuously assembled observations? True, the laws to be discovered may be perfect, but the human brain is not. Left on its own, it is prone to stray, as many past examples sadly prove. In fact, we have missed few chances to err until new data freshly gleaned from nature set us right again for the next steps. Thus pillars rather than crutches are the observations on which we base our theories; and for the theory of stellar evolution these pillars must be there before we can get far on the right track.

*Structure and Evolution of the Stars*  
Chapter 1 (p. 1)  
Princeton University Press. Princeton, New Jersey, USA. 1958

**Siegel, Eli** 1902–78  
American philosopher, poet, critic, and founder of Aesthetic Realism

Biological laws, seen subtly, can make a girl proud.  
*Damned Welcome*  
Aesthetic Realism, Maxims, Part Two, #316 (p. 139)  
Definition Press. New York, New York, USA. 1972

**Slosson, Edwin E.** 1865–1929  
American chemist and journalist

There are no laws in nature. What we call the “laws of nature” are the memory schemes we invent to aid us in grasping a lot of facts at one time. When our knowledge is growing rapidly, as it is now, we have to shift to new and larger formulas very suddenly. But this requires stretching the mind to take in bigger ideas, which is as painful a process as stretching an unused muscle. No wonder we tend to dodge it.

*Chats on Science*  
Chapter LXXX (pp. 248–249)  
G. Bell & Sons Ltd. London, England. 1924

**Snow, Charles Percy** 1905–80  
English novelist and scientist

Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: Have you read a work of Shakespeare’s?

*The Two Cultures: And a Second Look*  
Chapter I (pp. 14–15)  
At The University Press. Cambridge, England. 1964

**Tennyson, Alfred (Lord)** 1809–92  
English poet

To search thro’ all ...  
And reach the law within the law ...

*The Works of Alfred Lord Tennyson*  
The Two Voices (p. 32)  
Macmillan & Co Ltd. London, England. 1886

**Titchener, Edward Bradford** 1867–1927  
English-born American psychologist

The formulation of a scientific law, therefore, means the final writing of some paragraph in some chapter of that book of the world which contains all the different sciences.

*A Text-Book of Psychology*  
Subject-Matter, Method and Problem of Psychology, Section 1 (p. 5)  
The Macmillan Company. New York, New York, USA. 1912

**Tolstoy, Leo** 1828–1910  
Russian writer

Only by reducing this element of free will to the infinitesimal, that is, by regarding it as an infinitely small quantity, can we convince ourselves of the absolute inaccessibility of the causes, and then instead of seeking causes, history will take the discovery of laws as its problem.

*In Great Books of the Western World* (Volume 51)  
*War and Peace*  
Second Epilogue, Chapter XI (p. 694)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tyndall, John** 1820–93  
Irish-born English physicist

The law of conservation rigidly excludes both creation and annihilation. Waves may change to ripples, and ripples to waves – magnitude may be substituted for number, and number for magnitude – asteroids may aggregate into suns, suns may invest their energy in florae and faunae, and florae and faunae may melt in air – the flux of power is eternally the same. It rolls in music through the ages, while the manifestations of physical life, as well as the display of physical phenomena, are but modulations of its rhythm.

*Heat a Mode of Motion* (6th edition)  
Lecture XVII (p. 536)  
D. Appleton & Co. New York, New York, USA. 1915

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

In effect, it would be very singular that all nature, all the planets, should obey eternal laws, and that there should be a little animal five feet high, who, in contempt of these laws, could act as he pleased, solely according to his caprice.

*The Best Known Works of Voltaire*

*Ignorant Philosophers*

Chapter XIII (p. 428)

Blue Ribbon Books. New York, New York, USA. 1940

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

A law of nature, however, is not a mere logical conception that we have adopted as a kind of *memoria technicai* to enable us to more readily remember facts. We of the present day have already sufficient insight to know that the laws of nature are not things which we can evolve by any speculative method. On the contrary, we have to discover them in the facts; we have to test them by repeated observation or experiment, in constantly new cases, under ever-varying circumstances; and in proportion only as they hold good under a constantly increasing change of conditions, in a constantly increasing number of cases with greater delicacy in the means of observation, does our confidence in their trustworthiness rise.

*Popular Lectures on Scientific Subjects*

Lecture VIII (p. 370)

D. Appleton & Company. New York, New York, USA. 1885

Physico-mechanical laws are, as it were, the telescopes of our spiritual eye, which can penetrate into the deepest night of time, past and to come.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

*First Series*

On the Interaction of Natural Forces (p. 189)

D. Appleton & Co. New York, New York, USA. 1897

It may perhaps appear rash that we, restricted as we are, in the circle of our observations in space, by our position on this little earth, which is but as a grain of dust in our milky way; and limited in time by the short duration of the human race; that we should attempt to apply the laws which we have deduced from the confined circle of facts open to us to the whole range of infinite space, and of time from everlasting to everlasting.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

*Second Series*

On the Origin of the Planetary System (p. 144)

Longmans, Green & Co. London, England. 1903

**Weyl, Hermann** 1885–1955  
German mathematician

To gaze up from the ruins of the oppressive present toward the stars is to recognise the indestructible world

of laws, to strengthen faith in reason, to realise the “*harmonia mundi*” that transfuses all phenomena, and never has been, nor will be, disturbed.

Translated by Henry L. Brose

*Space – Time – Matter*

Preface to the Third Edition (p. x)

Dover Publications, Inc. New York, New York, USA. 1922

**Wheeler, John Archibald** 1911–  
American physicist and educator

There is no law except that there is no law.

In John D. Barrow

*The World within the World* (p. 293)

Clarendon Press. Oxford, England. 1988

**Whewell, William** 1794–1866  
English philosopher and historian

The number and variety of the laws which we find established in the universe is so great, that it would be idle to endeavor to enumerate them. In their operation they are combined and intermixed in incalculable and endless complexity, influencing and modifying each other’s effects in every direction.

*The Bridgewater Treatises on the Power, Wisdom, and Goodness of God as Manifested in the Creation* (Treatise III)

Astronomy and General Physics Considered with Reference to Natural Theology

Chapter III (p. 12)

Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

But with regard to the material world, we can at least go so far as this – we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection* (p. xi)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Men cannot help believing that the laws laid down by discoverers must be in a great measure identical with the real laws of nature, when the discoverers thus determine effects beforehand in the same manner in which nature herself determines them when the occasion occurs. Those who can do this, must, to a considerable extent, have detected nature’s secret; – must have fixed upon the conditions to which she attends, and must have seized the rules by which she applies them.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 64)

John W. Parker. London, England. 1867

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The laws of physics are the decrees of fate.

*Science and the Modern World*

Chapter I (p. 16)

The Macmillan Company. New York, New York, USA. 1929

Laws are statements of observed facts.

*Adventures of Ideas*

Chapter VII (p. 148)

The Macmillan Company. New York, New York, USA. 1956

If the law states a precise result, almost certainly it is not precisely accurate; and thus even at the best the result, precisely as calculated, is not likely to occur.

*An Introduction to Mathematics*

Chapter 3 (p. 16)

Oxford University Press, Inc. New York, New York, USA. 1958

**Wilson, Edward O.** 1929–

American biologist and author

The laws of biology are written in the language of diversity.

The Coming Pluralization of Biology and the Stewardship of Systematics

*BioScience*, Volume 39, Number 4, April, 1989 (p. 243)

**Wood, William Hamilton**

No biographical data available

Repetition of phenomena must not be confused with law.

*The Religion of Science*

Chapter III (p. 39)

The Macmillan Co. New York, New York, USA. 1922

## LAW OF GRAVITATION

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

If there were no matter in the universe, the law of gravitation would fall to the ground.

Gravitation and the Principle of Relativity

*Nature*, Volume 101, Number 2523, March 7, 1918 (p. 17)

## LAW OF SPACESHIP ECONOMICS

**Clarke, Arthur C.** 1917–

English science and science fiction writer

No dead weight shall be carried for a moment longer than necessary.

*The Exploration of Space*

Chapter 4 (p. 37)

Harper & Brothers Publishers. New York, New York, USA. 1951

## LAW OF VARIATION

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

All that is shown to the eye; and one of the most beautiful results of mathematics is the means of showing to the eye the law of variation, however complicated, of one independent variable.

*Popular Lectures and Addresses* (Volume 1)

Presidential Address

Birmingham and Midland Institute

October 3, 1883 (p. 274)

Macmillan & Company Ltd. London, England. 1894

## LAWS

**Anderson, Philip W.** 1923–

American physicist

The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe.

*A Career in Theoretical Physics*

More is Different (p. 1)

World Scientific Publishing Co. Singapore, Malaysia. 1994

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

'T is a short sight to limit our faith in laws to those of gravity, of chemistry, of botany, and so forth.

*The Conduct of Life*

Worship (p. 173)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1894

**Malthus, Thomas Robert** 1776–1834

English economist and sociologist

There is something in the contemplation of general laws which powerfully persuades us to merge individual feeling, and to commit ourselves unreservedly to their disposal; while the observation of the calm, energetic regularity of nature, the immense scale of her operations, and the certainty with which her ends are attained, tends, irresistibly, to tranquillize and re-assure the mind, and render it less accessible to repining, selfish, and turbulent emotions.

*Principles of Political Economy Considered With a View to Their*

*Practical Application*

Chapter I (p. 16)

William Pickering. London, England. 1836

## LAWS, PHYSICAL

**Poynting, John Henry** 1852–1914

English physicist

...the nature of physical laws...have...we must confess, greatly fallen off in dignity. No long time ago they were quite commonly described as the Fixed Laws of Nature, and were supposed sufficient in themselves to govern the universe. Now we can only assign to them the humble rank of mere descriptions, often tentative, often erroneous, of similarities which we believe we have observed.

Address to the British Association

*Chemical News and Journal of Industrial Science*, Volume 80, Number 2079, September 29, 1899 (p. 154)

**LAYMAN**

**Duncan, Robert Kennedy** 1919–88  
American poet

Laymen in science who wish to follow the trend of modern discovery are limited for the most part to one of two things: Either they must read the pseudo-science of the magazines, which is arranged chiefly for dramatic effect rather than for accurate exposition, or they must turn to specialized and technical works written by the discoverers themselves for their fellow-workers – books in which technical training is taken for granted, and the lay reader, however, cultured and thoughtful he may be, becomes utterly and hopelessly lost.

*The New Knowledge: A Popular Account of the New Physics and the New Chemistry in Their Relation to the New Theory of Matter*  
Introduction (p. xv)  
A.S. Barnes & Co. New York, New York, USA. 1910

**LEAF**

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

Leaves die, but trees do not. They only undress.

In William Drysdale (ed.)  
*Proverbs from Plymouth Pulpit*  
Nature (p. 8)  
D. Appleton & Co. New York, New York, USA. 1887

**Ehrlich, Gretel**

No biographical data available

Leaves are verbs that conjugate the seasons.

*The Solace of Open Spaces* (p. 130)  
Penguin Books. 1986

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

...lovely as Flowers are, Leaves add even more to the Beauty of Nature.

*The Pleasures of Life*  
Chapter VII (pp. 155–156)  
The Macmillan Co. New York, New York, USA. 1891

**Pouchet, Félix Archimède** 1800–72  
French biologist

To the tunic of leaves by which plants are covered is due all the magnificence of creation. The flowers, indeed, form a charming ornament which attracts and seduces the eye, but they remain unnoticed in the grand scenes of Nature, when she unrolls before us her most splendid landscapes, her sombre forests, or her immense extended plains of verdure.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book I, Chapter III (p. 384)  
Blackie & Son. London, England. 1870

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

...the leaves of the herbage at our feet take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, cleft, furrowed, serrated, sinuated; in whorls, in tufts, in spires, in wreaths endlessly expressive, deceptive, fantastic, never the same from footstalk to blossom; they seem perpetually to tempt our watchfulness, and take delight in outstripping our wonder.

*Modern Painters* (Volume 5)  
Part VI, Chapter 10 (p. 92)  
John Wiley & Sons. New York, New York, USA. 1879

**LEAF CLUSTER**

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

...every single leaf-cluster presents the general aspect of a little family, entirely at unity among themselves, but obliged to get their living by various shifts, concessions, and infringements of the family rules, in order not to invade the privileges of other people in their neighborhood.

*Modern Painters* (Volume 5)  
Part VI, Chapter 4 (p. 32)  
John Wiley & Sons. New York, New York, USA. 1879

**LEARN**

**Dickens, Charles** 1812–70  
English novelist

Vether it's worth goin' through so much, to learn so little, as the chairty-boy said ven he got to the end of the alphabet, is a matter o' taste.

*Pickwick Papers*  
Chapter XXVII (p. 379)  
The University Society. New York, New York, USA. 1908

**Huxley, Thomas Henry** 1825–95  
English biologist

What is the use of all your learning, unless you can tell me what I want to know? I am here blindly groping about, and constantly damaging myself by collision with three mighty powers, the power of the invisible God, the power of my fellow Man, and the power of brute Nature. Let your learning be turned to the study of these powers, that I may know how I am to comport myself with regard to them.

*Science and Education: Essays*  
Essay VIII (p. 198)  
D. Appleton & Co. New York, New York, USA. 1896



**Macgillivray, William** 1796–1852

Scottish naturalist and ornithologist

The man who would effectually learn from nature, must approach with affection, and receive her instructions with a humility that would ill accord with any subsequent vain display of the knowledge acquired.

*A History of British Birds, Indigenous and Migratory* (Volume 1)

Preface (pp. iii–iv)

Printed for Scott, Webster & Geary. London, England. 1837

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

...on the cellular surface of one of the blocks of it [the volcano at Yewdale Crag], you may find more beauty, and learn more precious things, than with telescope or photograph from all the moons in the milky way, though every drop of it were another solar system.

*The Complete Works of John Ruskin* (Volume 17)

Volume I, Chapter XII (p. 143)

Rehwee, Wattle & Walsh. Philadelphia, Pennsylvania, USA. 1891

**Shaw, George Bernard** 1856–1950

Irish playwright

You have learnt something. That always feels at first as if you had lost something.

*John Bull's Other Island and Major Barbara*

Major Barbara (p. 284)

Brentano's. New York, New York, USA. 1911

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Seeking and blundering are good, for it is only by seeking and blundering we learn.

Translated by John Anster

*Faustus: The Second Part*

Notes (p. 476)

Longman, Green, Longman, Roberts & Green. London, England. 1864

**Whately, Richard** 1787–1863

English theologian

To learn a thing because it is easy is like buying a bargain.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard*

*Whately, D.D.*

Apothegm 74 (p. 7)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Wilson, Colin**

No biographical data available

Once you enter the world of science or mathematics or philosophy, endless plains open around you. The more you learn, the more fascinating the whole thing becomes.

*Voyage to a Beginning*

Chapter 10 (p. 163)

Cecil & Amelia Woolf. London, England. 1969

**LEARNED BODIES****Verne, Jules** 1828–1905

French novelist

The Cambridge Observatory called a special meeting; and with that composure which distinguishes learned bodies in general, peacefully discussed the scientific bearings of the question.

*Works of Jules Verne*

*A Tour of The Moon*

Chapter XXI (p. 367)

F. Tyler Daniels. New York, New York, USA. 1911

**LEARNING****Barzun, Jacques** 1907–

French-born American educator, historian, and educator

The school has not taught how to learn; now it wants to climb that Mt. Everest of intellect, critical thought. Critical thinking can only be learned by the discussion of an idea which is part of a subject, under the guidance of an able thinker. Thinking is like piano-playing; it is shown, not taught.

*Begin Here: The Forgotten Conditions of Teaching and Learning* (p. 46)

The University of Chicago Press. Chicago, Illinois, USA. 1991

**Bryson, Lyman**

No biographical data available

No man...can choose to do what he never heard of doing or never thought of doing. In this sense, the ultimate measure of freedom is knowledge and we learn in order to be free.

*Science and Freedom*

What Is Freedom?, Section II (p. 13)

Columbia University Press. New York, New York, USA. 1947

**Carson, Rachel** 1907–64

American marine biologist and author

It is more important to pave the way for the child to want to know than to put him on a diet of facts he is not ready to assimilate.

*The Sense of Wonder* (p. 45)

Harper & Row, Publishers. New York, New York, USA. 1984

**Dennett, Daniel Clement** 1942–

American philosopher

...we often learn more from bold mistakes than from cautious equivocation.

*Consciousness Explained*

Preface (p. xi)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Ferris, Timothy** 1944–

American science writer

Our ignorance, of course, has always been with us, and always will be. What is new is our awareness of it, our



awakening to its fathomless dimensions, and it is this, more than anything else, that marks the coming of age of our species. Space may have a horizon and time a stop, but the adventure of learning is endless.

*Coming of Age in the Milky Way*

Chapter 20 (p. 383)

William Morrow & Company, Inc. New York, New York, USA. 1988

### **Garrett, A. B.**

No biographical data available

Learning is motivated by intent and understanding by visualization.

Visualization: A Step to Understanding

*Journal of Chemical Education*, Volume 25, Number 10, October, 1948 (p. 544)

### **Hemingway, Ernest** 1899–1961

American novelist, short-story writer, and journalist

There are some things which cannot be learned quickly, and time, which is all we have, must be paid heavily for their acquiring. They are the very simplest things...

*Death in the Afternoon*

Chapter Sixteen (p. 192)

Charles Scribner's Sons. New York, New York, USA. 1955

### **Hoffmann, Banesh** 1906–86

Mathematician and educator

If you have read thus far, there is no dignified way of escape left to you. You have paid your fare, and climbed to the highest peak of the roller-coaster. You have therefore let yourself in for the inevitable consequences. It is no use trying to back out. You had warning in the preface of what to expect, and if contemplation of the heights there described makes you giddy and apprehensive, I cannot accept responsibility. The going will be rough, but I can promise you excitement aplenty. So hold tight to your seat and hope for the best. We are about to push off into vertiginous space.

*The Strange Story of the Quantum*

Chapter XII (p. 71)

Dover Publications, Inc. New York, New York, USA. 1959

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The easiest and surest way of acquiring facts is to learn them in groups, in systems, and systematized knowledge is science. You can very often carry two facts fastened together more easily than one by itself, as a house-maid can carry two pails of water with a hoop more easily than one without it.

*Medical Essays*

Scholastic and Bedside Teaching (p. 287)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### **Kingsley, Charles** 1819–75

English clergyman and author

No amount of book learning will make a man a scientific man: nothing but patient observation, and quiet and fair thought over what he has observed. He must go out for himself, compare and judge for himself, in the field, in the quarry, the cutting. He must study rocks, ores, fossils, in the nearest museum; and thus store his head, not with words, but with facts. He must verify – as far as he can – what he reads in books, by his own observation; and be slow to believe in anything, even on the highest scientific authority, till he has either seen it, or something like enough to it to make it seem to him probable, or at least possible. So, and so only, will he become a scientific man, and a good geologist...

*Town Geology*

Preface (pp. ix–x)

D. Appleton & Company. New York, New York, USA. 1873

### **Landau, Edmund** 1877–1938

German mathematician

Please forget whatever you've been studying at school; for you have not learned it.

Translated by F. Steinhardt

*Foundations of Analysis: The Arithmetic of Whole, Rational, Irrational and Complex Numbers*

Preface to the Student (p. v)

Chelsea Publishing Company. Bronx, New York, USA. 1951

### **Lowell, Percival** 1855–1916

American astronomer

That we are in some wise kin to all the rest of the cosmos science has been steadily demonstrating more and more clearly. The essential oneness of the universe is the goal to which all learning tends.

*Mars*

Chapter I, 1 (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

### **Priestley, Joseph** 1733–1804

English theologian and scientist

Learning and talents, have ever commanded the respect and the admiration of mankind. In the dawn of science, indeed, the inventors of the useful arts were deified by those to whom they became benefactors by their discoveries; and the skilful in agriculture, were considered as super-human.

In John Corry

*The Life of Joseph Priestly* (p. 9)

Printed by Wilks, Grafton & Co. Birmingham, England. 1804

### **Pythagoras of Samos** ca. 580 BCE–500 BCE

Greek mathematician, astronomer, and philosopher

The learning of many things does not teach intelligence...

In G.S. Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts* Fragment 260 (p. 218)

At The University Press. Cambridge, England. 1963

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

William James used to preach the “will to believe.” For my part, I should wish to preach the “will to doubt...” What is wanted is not the will to believe, but the wish to find out, which is the exact opposite.

*Skeptical Essays*

Chapter XII (pp. 154, 157)

W.W. Norton & Company, Inc. New York, New York, USA. 1928

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

And this our life, exempt from public haunt,  
Find tongues in trees, books in the running brooks,  
Sermons in stones, and good in everything.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*As You Like It*

Act II, Scene i, 1:125

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...and children

Have lost, or do not learn for want of time,  
The science that could become our country...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Life of King Henry Fifth*

Act V, Scene ii, 1. 56–58

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sterne, Laurence** 1713–68  
English novelist and humorist

Learning is the dictionary, but sense the grammar of science.

*The Works of Laurence Sterne* (Volume 6)

*The Koran*

83 (p. 347)

William Durell & Co. New York, New York, USA. 1814

**Thomson, Sir George Paget** 1892–1975  
English physicist

The goddess of learning is fabled to have sprung full-grown from the brain of Zeus, but it is seldom that a scientific conception is born in its final form, or owns a single parent. More often it is the product of a series of minds, each in turn modifying the ideas of those that came before, and providing material for those that come after.

*Nobel Lectures, Physics 1922–1941*

Electronic Waves

Elsevier Publishing Co. Amsterdam, The Netherlands. 1965

**Whately, Richard** 1787–1863  
English theologian

“A little learning” is then only (and then always) “a dangerous thing,” when we are not aware of its littleness.

*Thoughts and Apophthegms*

Section VI (p. 165)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1856

**Wheeler, John Archibald** 1911–  
American physicist and educator

...how can anyone learn anything new who does not find it a shock.

*A Journey into Gravity and Spacetime* (p. 39)

Scientific American Library. New York, New York, USA. 1990

## LECTURE

**Brinton, William**  
English physician

Those who disparage lectures insinuate that their value is almost limited to two circumstances – that they ensure the bodily presence of the student, and then force through the organs of hearing a minimum of information on certain medical subjects; and thus, in direct contradiction to the proverb, not only bring the horse to the water but also make him drink.

Introductory Lecture

*The London Lancet*, Volume 2, Number 6, December, 1857 (p. 436)

**Clifford, William Kingdon** 1845–79  
English mathematician

It may have occurred (and very naturally too) to such as have had the curiosity to read the title of this lecture, that it must necessarily be a very dry and difficult subject; interesting to very few, intelligible to still fewer, and, above all, utterly incapable of adequate treatment within the limits of a discourse like this.

*Lectures and Essays, by the Late William Kingdon Clifford*

On the Aims and Instruments of Scientific Thought (p. 85)

Macmillan & Company Ltd. London, England. 1886

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

...sympathy and interest are to a lecturer like the sun and the showers to nature – absolutely necessary to the production of blossoms and fruit.

In John Payne Collier

*Seven Lectures on Shakespeare and Milton*

The First Lecture (p. 1)

Chapman & Hall, Ltd. London, England. 1856

...it is to be borne in mind, that every man who takes upon himself to lecture, requires that he should be considered by his hearers capable of teaching something that is valuable, or of saying something that is worth hearing. In a mixed audience not a few are desirous of instruction, and some require it; but placed in my present situation I consider myself, not as a man who carries moveables into an empty house, but as a man who entering a generally well furnished dwelling, exhibits a light which enables the owner to see what is still wanting. I endeavor to introduce the means of ascertaining what is, and is not, in a man's own mind.

In John Payne Collier  
*Seven Lectures on Shakespeare and Milton*  
 The Sixth Lecture (p. 31)  
 Chapman & Hall, Ltd. London, England. 1856

**Cornford, Francis M.** 1874–1943  
 English academic

The Principle of Sound Learning is that the noise of vulgar fame should never trouble the cloistered calm of academic existence. Hence, learning is called sound when no one has ever heard of it; and ‘sound scholar’ is a term of praise applied to one another by learned men who have no reputation outside the University, and a rather queer one inside it. If you should write a book (you had better not), be sure that it is unreadable; otherwise you will be called ‘brilliant’ and forfeit all respect.

*Microcosmographia Academica*  
 The Principles of Government, of Discipline (Including Religion), and of Sound Learning  
 Bowes & Bowes, Publishers. Cambridge, England. 1908

**Edgeworth, Maria** 1767–1849  
 Anglo-Irish novelist

**Edgeworth, Richard Lovell** 1744–1817  
 Anglo-Irish politician and inventor

...if he [the lecturer] does riot communicate much of that knowledge which he endeavors to explain, it is not to be attributed either to his want of skill, or to the insufficiency of his apparatus, but to the novelty of the terms which he is obliged to use. Ignorance of the language in which any science is taught, is an insuperable bar to its being suddenly acquired; besides a precise knowledge of the meaning of terms, we must have an instantaneous idea excited in our minds whenever they are repeated; and, as this can be acquired only by practice, it is impossible that philosophical lectures can be of much service to those who are not familiarly acquainted with the technical language in which they are delivered ...

*Essays on Practical Education* (Volume 2)  
 Chapter XVII (p. 277)  
 Printed for R. Hunter. London, England. 1822

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

OMNI: As we came back to the office, you stopped to discuss a lecture on color vision you’ll be giving. That’s pretty far from fundamental physics, isn’t it? Wouldn’t a physiologist say you were “poaching?”

Feynman: Physiology? It has to be physiology? Look, give me a little time and I’ll give a lecture on anything in physiology. I’d be delighted to study it and find out all about it, because I can guarantee you it would be very interesting. I don’t know anything, but I do know that everything is interesting if you go into it deeply enough.

In Jeffrey Robbins, ed.

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
 Chapter 9 (p. 203)  
 Perseus Books. Cambridge, Massachusetts, USA. 1999

I am Professor Feynman, in spite of this suit-coat. I usually give lectures in shirtsleeves, but when I started out of the hotel this morning my wife said, “You must wear a suit.” I said, “But I usually give lectures in shirtsleeves.” She said, “Yes, but this time you don’t know what you’re talking about so you had better make a good impression...” So, I got a coat.

What Is and What Should Be the Role of Scientific Culture in Modern Society  
*Supp. Al Nuovo Cimento*, Volume 4, 1966

**Henn, Thomas Rice** 1901–74  
 English literary critic

Among the admirable American expressions which enter our language from time to time to lend it new vitality, there is one which I would have every audience, and every lecturer, use at the end of every lecture or course: *So what?* What does all this amount to.

*The Apple and the Spectroscope*  
 Chapter XI (p. 134)  
 Methuen & Co. London, England. 1951

**Huxley, Thomas Henry** 1825–95  
 English biologist

The object of lectures is, in the first place, to awaken the attention and excite the enthusiasm of the student; and this, I am sure, may be effected to a far greater extent by the oral discourse and by the personal influence of a respected teacher than in any other way. Second, lectures have the double use of guiding the student to the salient points of a subject, and at the same time forcing him to attend to the whole of it, and not merely to that part which takes his fancy. And last, lectures afford the student the opportunity of seeking explanations of those difficulties which will, and indeed ought to, arise in the course of his studies.

*Collected Essays* (Volume 8)  
*Discourses, Biological and Geological*  
 A Lobster; or, The Study of Zoology (p. 217)  
 Macmillan & Company Ltd. London, England. 1904

**Johnson, Samuel** 1696–1772  
 English critic, biographer, and essayist

Lectures were once useful; but now, when all can read, and books are so numerous, lectures are unnecessary. If your attention fails, and you miss a part of a lecture, it is lost; you cannot go back as you do upon a book.... People have nowadays got a strange opinion that everything should be taught by lectures. Now, I cannot see that lectures can do as much good as reading the books from which the lectures are taken. I know nothing that can be best taught by lectures, except where experiments are to be shown. You may

teach chemistry by lectures. You might teach making shoes by lectures!

*Boswell's 'Life of Samuel Johnson'*

15 April, 1781 (p. 1136)

Oxford University Press, Inc. Oxford, England. 1965

**Miller, Hugh** 1802–56

Scottish geologist and theologian

My lecture contains but little...Such is the scantiness of the materials on which I had to work, that it could not have contained much: if according to the dramatist, the “amount be beggarly,” it is because the “boxes are empty.”

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Eleventh (p. 462)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Termier, Pierre** 1859–1930

French geologist

It is always necessary to close a lecture on geology with humility.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*

The Drifting of the Continents (p. 236)

Government Printing Office. Washington, D.C. 1925

**Wächtershäuser, Günter**

International patent lawyer

Ladies and gentlemen, throughout my lecture I have presented to you nothing but speculation.

In J. and K. Tran Thon Van, J.C. Mounolou, J. Schneider and C. Mckay (eds.)

*Frontiers of Life*

Order Out of Order: Heritage of the Iron-Sulfur World

## LECTURER

**Cornford, Francis M.** 1874–1943

English academic

A lecturer is a sound scholar, who is chosen to teach on the ground that he was once able to learn. Eloquence is not permissible in a lecture; it is a privilege reserved by statute for the Public Orator. *Microcosmographia Academicam*

The Principles of Government, of Discipline (Including Religion), and of Sound Learning

Bowes & Bowes, Publishers. Cambridge, England. 1908

## LEMMA

### Author undetermined

Is a lemma which proves two facts a dilemma?

Source undetermined

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

If it were always necessary to reduce everything to intuitive knowledge, demonstration would often be insufferably prolix. This is why mathematicians have had the cleverness to divide the difficulties and to demonstrate separately the intervening propositions. And there is art also in this; for as the mediate truths (which are called lemmas, since they appear to be a digression) may be assigned in many ways, it is well, in order to aid the understanding and memory, to choose of them those which greatly shorten the process, and appear memorable and worthy in themselves of being demonstrated. But there is another obstacle, viz.: that it is not easy to demonstrate all the axioms, [or] to reduce demonstrations wholly to intuitive knowledge. And if we had chosen to wait for that, perhaps we should not yet have the science of geometry.

Translated by Peter Remnant and Jonatha Bebbett

*New Essays on Human Understanding*

Book 4, Chapters 2 and 8

Cambridge University Press. Cambridge, England. 1981

## LEPTON

### National Research Council (USA)

If man does not fully understand the leptons, he cannot claim to understand nature.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 63)

National Academy of Sciences

Washington, D.C. 1972

## LEVER

**Archimedes of Syracuse** 287 BCE–212 BCE

Sicilian mathematician

Give me a place on which to stand and I will move the world.

In Ebenezer Cobham Brewer

*A Guide to Roman History* (p. 321)

Jarrold & Son. London, England. 1852

**Graham, L. A.**

No biographical data available

See Saw, Marjorie Daw,

She rocked – and learned the lever law.

She saw that he weighed more than she

For she sat higher up than he,

Which made her cry, excitedly,

“To see saw, it is plain to see,

There must be an equality

“Twixt You times X and Y times Me.”

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 19

Dover Publications, Inc. New York, New York, USA. 1959

**LIBERALITY**

**von Goethe, Johann Wolfgang** 1749–1832  
 German poet, novelist, playwright, and natural philosopher

In New York, there are ninety different Christian denominations; each one confessing God the Lord in its own way without being led astray by the others. In science, indeed in research in general, we must achieve this, for what can it mean when everyone speaks of liberality and then wants to prevent others from thinking and expressing themselves in their own way.

In Karl J. Fink  
*Goethe's History of Science*  
 Part IV (p. 127)  
 Cambridge University Press. Cambridge, England. 1991

**LIBRARIAN**

**Clifford, William Kingdon** 1845–79  
 English mathematician

It is an opinion current among librarians, that there is no such thing as trash; that the most foolish unconnected flysheet treating of nothing at all should in all cases be preserved and bound up with other such flysheets, not in view of any possible future investigator to whom it may be as gold among quartz, but because it is right that this thing should be done.

*Mathematical Papers*  
 Review of *A Budget of Paradoxes* (p. 559)  
 Macmillan & Company Ltd. London, England. 1882

**LIBRARY**

**Lines, William J.**  
 Writer

Only barbarians are not curious about where they come from and how the world came to be what it is. Culture, in contrast, permits and encourages questions about origins. In modern English-language culture, libraries are a chief means of inquiry into the past.

*An All Consuming Passion: Origins, Modernity, and the Australian Life of Georgiana Molloy*  
 Acknowledgements (p. 377)  
 Allen & Unwin. London, England. 1994

**LIFE**

**Abbey, Edward** 1927–89  
 American environmentalist and nature writer

I understand and sympathize with the reasonable needs of a reasonable number of people on a finite continent. All life depends upon other life. But what is happening today, in North America, is not rational use but irrational massacre. Man the Pest, multiplied to the swarming

stage, is attacking the remaining forests like a plague of locusts on a field of grain.

*The Journey Home: Some Words in Defense of the American West*  
 Chapter 19 (p. 208)  
 E.P. Dutton & Company, Inc. New York, New York, USA. 1977

**Ackerman, Diane** 1948–  
 American writer

Astronauts returning from orbit have marveled at how little of human life can be seen from space – not the wars or political boundaries, not the cities or farms, not the subtleties of custom, adolescence, or love.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*  
 Insect Love (p. 173)  
 Vintage Books. New York, New York, USA. 1997

**Adams, Douglas** 1952–2001  
 English author, comic radio dramatist, and musician

The system of life on this planet is so astoundingly complex that it was a long time before man even realised that it was a system at all and that it wasn't something that was just there.

*The Ultimate Hitchhiker's Guide to the Galaxy*  
 Last Chance to See  
 Chapter 21 (p. 415)  
 The Ballantine Book Company. New York, New York, USA. 2002

“Life,” he said, “is like a grapefruit.” “Er, how so?” “Well, it’s sort of orangey-yellow and dimpled on the outside, wet and squidgy in the middle. It’s got pips inside, too. Oh, and some people have half a one for breakfast.”

*So Long, and Thanks for All the Fish*  
 Chapter 23 (pp. 130–131)  
 Harmony Books. New York, New York, USA. 1984

**Ardrey, Robert** 1908–80  
 American anthropologist

As life is larger than man, so is life wiser than we are. As evolution has made us possible, so will evolution sit in final judgment. As natural selection declared us in, so natural selection should our hubris overcome us... declare us out.

*The Social Contract: A Personal Inquiry into the Evolutionary Sources of Order and Disorder*  
 The Risen Ape (pp. 367–368)  
 Atheneum. New York, New York, USA. 1970

**Author undetermined**

There was a young man of Cadiz  
 Who inferred that life is what it is,  
 For he early had learnt,  
 If it were what it weren't,  
 It could not be that which it is.

Source undetermined

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist



Touching the length and shortness of life in living creatures, the information which may be had is but slender, observation is negligent, and tradition fabulous.

In Basil Montagu

*The Works of Francis Bacon, Lord Chancellor of England* (Volume 3)

*The History of Life and Death*

Length and Shortness of Life in Living Creatures (p. 475)

A. Hart. Philadelphia, Pennsylvania, USA. 1850

**Ball, Philip** 1962–

English science writer

That we live on land is, in the grander scheme of things, best regarded as an anomaly, or even an eccentricity – albeit with sound evolutionary justification. The story of life is, if we retain a true sense of proportion, a story of life at sea.

*Life's Matrix: A Biography of Water*

Part Three, Chapter 8 (p. 223)

Farrar, Straus & Giroux. New York, New York, USA. 2000

**Ballard, Robert D.** 1942–

American oceanographer

The fact that this chain of life existed in the black cold of the deep sea and was utterly independent of sunlight – previously thought to be the font of all Earth's life – has startling ramifications. If life could flourish there, nurtured by a complex chemical process based on geothermal heat, then life could exist under similar conditions on planets far removed from the nurturing light of our parent star, the Sun.

*Explorations: My Quest for Adventure and Discovery Under the Sea*

Chapter Six (pp. 188–189)

Hyperion. New York, New York, USA. 1995

**Bates, Marston** 1906–74

American zoologist

Life in both the forest and the sea is distributed in horizontal layers.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*

Chapter 2 (p. 19)

Random House, Inc. New York, New York, USA. 1960

**Bernal, John Desmond** 1901–71

Irish-born physicist and X-ray crystallographer

The beauty of life is, therefore, geometrical beauty of a type that Plato would have much appreciated.

*The Origin of Life*

Preface (p. xiii)

The World Publishing Company. Cleveland, Ohio, USA. 1967

Life is a partial, continuous, progressive, multiform and conditionally interactive self-realization of the potentialities of atomic electron states...

*The Origin of Life*

Preface (p. xv)

The World Publishing Company. Cleveland, Ohio, USA. 1967

The question of the origin of life is essentially speculative. We have to construct, by straightforward thinking on the basis of very few factual observations, a plausible and self consistent picture of a process which must have occurred before any of the forms which are known to us in the fossil record could have existed.

*The Origin of Life*

Chapter 1 (p. 2)

The World Publishing Company. Cleveland, Ohio, USA. 1967

Men will not be content to manufacture life: they will want to improve on it.

*The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul*

Chapter III (p. 45)

Indiana University Press. Bloomington, Indiana, USA. 1969

**Bergson, Henri** 1859–1941

French philosopher

...life is like a current passing from germ to germ through the medium of a developed organism.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter I (p. 27)

Henry Holt & Co. New York, New York, USA. 1911

**Bernard, Claude** 1813–78

French physiologist

If I had to define life in a single phrase, I should clearly express my thought by throwing into relief the one characteristic which, in my opinion, sharply differentiates biological science. I should say: life is creation.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section I (p. 93)

Henry Schuman, Inc. New York, New York, USA. 1927

The conditions necessary to life are found neither in the organism nor in the outer environment, but in both at once. Indeed, if we suppress or disturb the organism, life ceases, even though the environment remains intact; if, on the other hand, we take away or vitiate the environment, life just as completely disappears, even though the organism has not been destroyed.

Translated by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

The spontaneity enjoyed by beings endowed with life has been one of the principal objections urged against the use of experimentation in biological studies.

Translated by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

...a living organism is nothing but a wonderful machine endowed with the most marvelous properties and set going by means of the most complex and delicate mechanism.



Translated by Henry C. Greene  
*An Introduction to the Study of Experimental Medicine*  
 Chapter III  
 Henry Schuman, Inc. New York, New York, USA. 1927

It is not by struggling against cosmic conditions that the organism develops and maintains its place; on the contrary, it is by an adaptation to, an agreement with, these conditions. So, the living being does not form an exception to the great natural harmony which makes things adapt themselves to one another; it breaks no concord; it is neither in contradiction to nor struggling against general cosmic forces; far from that, it forms a member of the universal concert of things, and the life of the animal, for example, is only a fragment of the total life of the universe.

In William Maddock Bayliss  
*Principles of General Physiology*  
 Preface (p. xvii)  
 Longmans, Green & Company. London, England. 1920

**Berrill, Norman John** 1903–96  
 English-born American biologist

Life can be thought of as water kept at the right temperature in the right atmosphere in the right light for a long enough period of time.

*You and the Universe*  
 Chapter 15 (p. 117)  
 Dodd, Mead & Company. New York, New York, USA. 1958

**Blumenberg, Hans** 1920–  
 German philosopher

The combined circumstances that we live on Earth and are able to see stars – that the conditions necessary for life do not exclude those necessary for vision, and vice versa – is a remarkably improbably one.

This is because the medium [in] which we live is, on the one hand, just thick enough to enable us to breathe and to prevent us from being burned up by cosmic rays, while, on the other hand, it is not so opaque as to absorb entirely the light of the stars and block any view of the universe. What a fragile balance between the indispensable and the sublime.

*The Genesis of the Copernican World*  
 Introduction (p. 3)  
 The MIT Press. Cambridge, Massachusetts, USA. 1987

**Bohr, Niels Henrik David** 1886–1962  
 Danish physicist

...the existence of life must be considered as an elementary fact that cannot be explained, but must be taken as a starting point in biology, in a similar way as the quantum of action, which appears as an irrational element from the point of view of classical mechanical physics, taken together with the existence of elementary particles, forms the foundation of atomic physics.

Light and Life  
*Nature*, Volume 131, Number 3309, April 1, 1933 (p. 458)

**Borland, Hal** 1900–78  
 American writer

The year holds one moment, which may last for a week, when tree and bush and vine are on the breathless verge of leafing out.

*Borland Country*  
 The Moment (p. 20)  
 J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

Life persists, and so does its ultimate source, call it what you will. Man is a unique form of that life, but not alien to it. He happens to live in the midst of life on this earth, this particular small unit of a universe about which he actually has only a smattering of knowledge.

*The Enduring Pattern*  
 Foreword (p. 5)  
 Simon & Schuster. New York, New York, USA. 1959

We are the survivors, all of us, not of a man-made holocaust but of infinitely more powerful and enduring forces, the surge of life, the rhythm of change, and the infinity of time.

*The Enduring Pattern*  
 Foreword (pp. 6–7)  
 Simon & Schuster. New York, New York, USA. 1959

**Bradley, Jr., John Hodgdon** 1898–1962  
 American geologist

Living things are the result of a special, perhaps a unique combination of conditions. They stand small, weak, and alone in a wilderness of the dead. Cruel forces beat upon them and reduce them whenever possible to the unleavened clay from which they sprang.

*Parade of the Living*  
 Part I, Chapter II (p. 13)  
 Coward-McCann, Inc. New York, New York, USA. 1930

Not until creatures had grown to a size observable by the crude vision of man and his microscope, not until they had developed skeletons that could resist decay and become fossilized while their mud sepulchers were turning to stone, did they leave any certain records. The parade of living things through time began in a way we can never understand, in an age we can never know, just as it will end in a manner nobody can foresee, at a time that is lost over the dark horizon of the future.

*Parade of the Living*  
 Part I, Chapter III (p. 27)  
 Coward-McCann, Inc. New York, New York, USA. 1930

They [early life] were but shapes in the dark, yet ordained soon to emerge into a brighter day at the head of a procession that spread with abundant triumph over the whole earth.

*Parade of the Living*  
 Part I, Chapter III (p. 35)  
 Coward-McCann, Inc. New York, New York, USA. 1930

The history of life on earth is more than a collection of shells and bones in a cabinet. It is more than a

procession of changing forms and functions. It is a dramatic spectacle.

*Parade of the Living*

Apologia

Coward-McCann, Inc. New York, New York, USA. 1930

### **Branford, Victor**

No biographical data available

All life is growth, and science understood as a spiritual phase of racial life, a mood of humanity, may, like other spiritual growths, be trained and guided, within limits.

*Science and Citizenship*

Section I (p. 3)

George Allen. London, England. 1906

### **Brewster, David** 1781–1868

Scottish scientist, inventor, and writer

‘Wherever there is matter there must be Life; Life Physical to enjoy its beauties – Life Moral to worship its Maker, and Life Intellectual to proclaim His wisdom and His power.

*More Worlds Than One: The Creed of the Philosopher and the Hope of the Christian*

Chapter X (p. 191)

Chatto & Windus. London, England. 1876

### **Brooks, William Keith** 1848–1908

American zoologist

...life is response to the order of nature ...

*The Foundations of Zoology*

Lecture I (p. 3)

The Columbia University Press. New York, New York, USA. 1908

I shall try to show that life is response to the order of nature.... Our interest in all branches of science is vital interest. It is only as living things that we care to know. Life is that which, when joined to mind, is knowledge, – knowledge in use; and we may be sure that all living things with minds like ours are conscious of some part of the order of nature, for the response in which life consists is response to this order.

*The Foundations of Zoology*

Lecture I (pp. 3–4)

The Macmillan Co. New York, New York, USA. 1899

Life is that which, when joined to mind, is knowledge, – knowledge in use; and we may be sure that all living things with minds like ours are conscious of some part of the order of nature, for the response in which life consists is response to this order.

*The Foundations of Zoology*

Lecture I (p. 4)

The Macmillan Co. New York, New York, USA. 1899

Every reflective biologist must know that no living being is self-sufficient, or would be what it is, or would be at all, if it were not part of the natural world....

Living things are real things...but their reality is in their interrelations with the rest of nature, and not in themselves.

Heredity and Variation: Logical and Biological

*Proceedings of the American Philosophical Society*, Volume 45, April 20, 1906 (p. 74)

### **Buck, Pearl S.** 1892–1973

American author

None but the ignorant can be bored by life. To the lovers of learning, life is pure adventure shared with adventurers.

*The Delights of Learning*

Address delivered on the occasion of the University of Pittsburgh Honors Convocation, April 6, 1960

### **Buckland, Francis Trevelyan** 1826–80

English surgeon, zoologist, popular author, and natural historian

Pray what is there to be found in a horse-pond except mud, dead dogs and cats, and duck-weed? The reader may ask. – Pray what is to be found in that trumpery ball they call the earth? The ‘Man in the Moon’ may demand of his neighbour Saturn as they both come out for their evening stroll. The answer to such questions is, simply, ‘Life;’ Life in all diversity of form, beautifully and wonderfully arranged, each individual deriving benefit from the well-being of the mass; the mass itself prospering in ratio with the individual.

*Curiosities of Natural History*

A Hunt in a Horse-pond

Richard Bentley & Son. London, England. 1883

### **Butler, Samuel** 1835–1902

British writer

As in the development of a fugue, where, when the subject and counter subject have been enounced, there must henceforth be nothing new, and yet all must be new, so throughout organic life – which is as a fugue developed to great length from a very simple subject – everything is linked on to and grows out of that which comes next to it in order – errors and omissions excepted.

*Luck or Cunning*

Chapter XIX (pp. 315–316)

Trubner & Co. London, England. 1887

### **Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

‘Tis very certain the desire of life

Prolongs it: this is obvious to the physicians,

When patients, neither plagued with friends nor wife,

Survive through very desperate conditions.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 44

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

The perplexity of life arises from there being too many interesting things in it for us to be interested properly in any of them.

*Tremendous Trifles*

The Secret of a Train (p. 8)

Dodd, Mead & Company. New York, New York, USA. 1909

**Claude, Albert** 1898–1983  
Belgian-American cytologist

Life, this anti-entropy, ceaselessly reloaded with energy, is a climbing force, toward order amidst chaos, toward light, among the darkness of the indefinite, toward the mystic dream of Love, between the fire which devours itself and the silence of the Cold. Such a Nature does not accept abdication, nor skepticism.

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company. Singapore. 1992

**Cloud, Preston Ercelle** 1912–91  
American biogeologist, paleontologist, and humanist

The gossamer web of life, spun on the loom of sunlight from the breath of an infant Earth, is nature's crowning achievement on this planet.

*Oasis in Space: Earth History from the Beginning*

Chapter Two (p. 42)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

Elements and stars, planets and time, air and water – what would these things be without intelligent life to illuminate them with perception and insight.

*Cosmos, Earth and Man: A Short History of the Universe*

Chapter 11 (p. 143)

Yale University Press. New Haven, Connecticut, USA. 1978

**Coman, Dale Rex** 1906–  
American research physician and wildlife writer

Life is a cruise on which one is already embarked, not a port toward which to steer.

*The Endless Adventure*

The Eagles as March Arrives (p. 120)

Henry Regnery Company. Chicago, Illinois, USA. 1972

The search for some ultimate significance in the universe, and in our little transient role in it, the compulsion to learn, to know, to find the truth, to answer questions and to solve problems – these constitute the essence of an aware existence, the central core of intelligent life.

*The Endless Adventure*

Once There Was a Planet (p. 184)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Comte, Auguste** 1798–1857  
French philosopher

...life is a struggle between dead nature and living nature.

Citing Xavier Bachit

*The Positive Philosophy of Auguste Comte* (Volume 2)

Book V, Chapter I (p. 6)

George Bell & Sons. London, England. 1896

**Cousteau, Jacques-Yves** 1910–77  
French naval officer and ocean explorer

The adventure of life as explored by man is truly a mystery tale. As in any good detective story, the evidence has been present all along but not until many apparently unrelated facts were put together could logical conclusions solve the mystery.

*The Ocean World of Jacques Cousteau: The Adventure of Life*

Chapter I (p. 10)

The World Publishing Company. New York, New York, USA. 1973

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

An honest man, armed with all the knowledge available to us now, could only state that in some sense, the origin of life appears to be almost a miracle, so many are the conditions which would have had to have been satisfied to get it going.

*Life Itself: Its Origin and Nature* (p. 88)

Simon & Schuster. New York, New York, USA. 1981

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

The development of life, the success of its forms, the precise determination of those organic types that first appeared, the simultaneous birth of certain species and their gradual extinction – the solution of these questions would perhaps enlighten us regarding the essence of the organism as much as all the experiments that we can try with living species. And man, to whom has been granted but a moment's sojourn on the earth, would gain the glory of tracing the history of the thousands of ages which preceded his existence and of the thousands of beings that have never been his contemporaries.

In John Noble Wilford

*The Riddle of the Dinosaur*

Chapter 1 (p. 23)

Alfred A. Knopf. New York, New York, USA. 1986

**Czapek, Frederick** 1868–1921

Life is, therefore, quite inseparable from chemical reactions, and on the whole what we call life is nothing else but a complex of innumerable chemical reactions in the living substance which we call protoplasm.

*Chemical Phenomena in Life*

Chapter VI (p. 63)

Harper & Brothers. London, England. 1911

**Dampier-Whetham, William** 1867–1952

English scientific writer

Life... may be regarded either as a negligible accident in a by-product of the cosmic process, or as the supreme manifestation of the high effort of creative evolution, for which the Earth alone, in the chances of time and space, has given a fitting home.

*A History of Science*

Chapter X (p. 482)

The Macmillan Company. New York, New York, USA. 1936

**Daniel, John** 1766–1844

English chemist and physicist

We live in mystery. Our lives have flowed from exploding stars, from tides of time and gravity beyond our ken.

The Flow of Life

*Audubon*, January, 2002**Darwin, Erasmus** 1731–1802

English physician and poet

Organic Life beneath the shoreless waves  
Was born, and nurs'd in Ocean's pearly caves;  
First forms minute, unseen by spheric glass,  
Move on the mud, or pierce the watery mass;  
These, as successive generations bloom,  
New powers acquire, and larger limbs assume;  
Whence countless groups of vegetation spring,  
And breathing realms of fin, and feet, and wing.

*The Botanic Garden*

Production of Life, Canto I, V, l. 295–302 (pp. 14–15)

Jones &amp; Company. London, England. 1825

**Delaney, John**

No biographical data available

...once life evolves, it tends to cover its tracks.

*The Sciences*, July/August, 1998**Delsemme, Armand H.**

American astronomer

The evolutionary route that led to life seems to have taken the way with the fewest obstacles and chosen the most abundant construction materials available.

*Our Cosmic Origins: From the Big Bang to the Emergence of Life and Intelligence*

Chapter 3 (p. 67)

Cambridge University Press. Cambridge, England. 1998

**Dewar, Redcote**

No biographical data available

Scientists have probed, massacred, and dissected innumerable living things to the horror of the antivivisectionists for years, and because the death of the animal stopped further examination, or its bared bones and muscles showed no mysterious stream of vitality leading from the known into the unknown, or from the organic into the

inorganic, the origin of life was – dubbed a mystery, its ken transcendental, its source supernatural and undiscoverable, and any attempt to penetrate its secret dangerous.

*From Matter to Man: A New Theory of the Universe*

Chapter X (p. 126)

Chapman &amp; Hall, Ltd. London, England. 1898

As man writes his science and philosophy solely for himself, to suit himself, and to coincide with either his wisdom or his ignorance, he is indeed quite at liberty to restrict the term life, as a secondary or complex natural energy, to vegetals or animals or any other organisms he chooses. But when a scientist refuses to trace life's origin below vegetals and animals, either he is wilfully trying to blindfold humanity, or he is exposing his ignorance, vanity, and incapacity.

*From Matter to Man: A New Theory of the Universe*

Chapter X (pp. 126–127)

Chapman &amp; Hall, Ltd. London, England. 1898

**Dewey, John** 1859–1952

American philosopher and educator

In the degree in which life is uneasy and troubled, fancy is stirred to frame pictures of a contrary state of things. By reading the characteristic features of any man's castles in the air you can make a shrewd guess as to his underlying desires which are frustrated.

*Reconstruction in Philosophy*

Chapter V (p. 104)

Beacon Press. Boston, Massachusetts, USA. 1920

**Douglas, Norman** 1868–1952

English writer

All life is a concession to the improbable.

*South Wind*

Chapter L (p. 417)

The Book League of America. New York, New York, USA. 1929

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

From a drop of water... a logician could infer the possibility of an Atlantic or a Niagara without having seen or heard of one or the other. So all life is a great chain, the nature of which is known whenever we are shown a single link of it.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)*A Study in Scarlet*, Chapter 2 (p. 158)

Wings Books. New York, New York, USA. 1967

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

...life is known only through its outward manifestations in either organism, or as a personal experience.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas Today* 1964*Biological Sciences and Medicine* (p. 226)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1964

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

Science has cast no light on the ultimate nature of life. But whatever it be, it has evidently fundamental elements which are the same throughout the whole circle of the organic world.

*The Unity of Nature*

Chapter 2 (p. 29)

G.P. Putnam's Sons. New York, New York, USA. 1885

**Dyson, Freeman J.** 1923–

American physicist and educator

Why is life so complicated?

*Origins of Life*

Chapter 4 (p. 60)

Cambridge University Press. Cambridge, England. 1985

**Eckstein, Gustav** 1875–16

Scientist, physiologist, and writer

... life [is] the sum of forces that resist death.

*The Body Has a Head*

Chapter II, Physicist (p. 43)

Little, Brown & Company. Boston, Massachusetts, USA. 1983

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Life would be stunted and narrow if we could feel no significance in the world around us beyond that which can be weighed and measured with the tools of the physicist or described by the metrical symbols of the mathematician.

*The Nature of the Physical World*

Chapter XV (p. 317)

The University Press. New York, New York, USA. 1929

**Editorial**

The fundamental distinction between the living and the non-living is that whilst it is possible to isolate the phenomena of the inorganic world, it is impossible to consider a living organism apart from its environment; it is, in fact, its reaction and adaptations to changes in its surroundings which distinguish the living from the inanimate and forms the basis of the science of biology.

Life and Death

*Nature*, Volume 122, Number 3075, October 6, 1928 (p. 501)

**Einstein, Albert** 1879–1955

German-born physicist

Conscious man, to be sure, has at all times been keenly aware that life is an adventure, that life must, forever, be wrested from death.

*Out of My Later Years* (pp. 4–5)

Thames & Hudson. London, England. 1950

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Men argue learnedly over whether life is chemical chance or antichance, but they seem to forget that the life in chemicals may be the greatest chance of all, the most mysterious and unexplainable property in matter.

*The Firmament of Time*

Chapter VI, Part III (p. 172)

Athenaeum. New York, New York, USA. 1960

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

No picture of life can have any veracity that does not admit the odious facts.

*The Conduct of Life*

Fate (p. 19)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Feinberg, Gerald** 1933–92

American physicist

**Shapiro, Robert**

No biographical data available

... were we gifted with the vision of the whole Universe of life, we would not see it as a desert sparsely populated with identical plants which can survive only in rare specialized niches. Indeed, we would envision something closer to a botanical garden, with countless species, each thriving in its own setting.

*Life Beyond Earth: The Intelligent Earthling's Guide to Life in the Universe*

Chapter 14 (pp. 435–436)

William Morrow & Company, Inc. New York, New York, USA. 1980

**Ferris, Timothy** 1944–

Science writer

Life, like the universe, rounds off to darkness where it runs out of time, and contemplation of one's death is perhaps the mainspring of astronomy and other human strivings.

*Seeing in the Dark*

Chapter 18 (p. 286)

Simon & Schuster. New York, New York, USA. 2002

**Flammarion, Camille** 1842–1925

French astronomer and author

From age to age living beings are replaced by others, and, on the continents as in the seas, if life always flourishes, it is not the same hearts which beat, it is not the same eyes which see, it is not the same lips which smile. Death lays successively in the tomb men and their affairs; but from our ashes, as from the ruins of empires, the flame of life is incessantly renewed.

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter VI (p. 68)

Chatto & Windus. London, England. 1894



What were we before birth, and what shall we become after death? Astronomy gives us the first reply, worthy of the majesty of nature, and in intimate correspondence with our innate aspirations. But this reply cannot be merely the corollary of a psychological solution. Let the philosophers imitate the astronomers! Let them work at facts instead of speculating on words, and one day the veil of Isis shall be entirely raised for our souls, which so eagerly long for the Truth. Positive science, science alone will reply: *Life is universal and eternal.*

Translated by John Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book III, Chapter VI (p. 315)

Chatto & Windus. London, England. 1907

**Forbes, Edward** 1815–54

English naturalist

As we descend deeper and deeper in this region its inhabitants become more and more modified, and fewer and fewer, indicating our approach towards an abyss where life is either extinguished, or exhibits but a few sparks to mark its lingering presence.

*The Natural History of the European Seas*

Chapter I (pp. 26–27)

John van Voorst. London, England. 1859

**Foucault, Michel** 1926–1984

French philosopher and historian

Historians want to write histories of biology in the eighteenth century; but they do not realize that biology did not exist then, and that the pattern of knowledge that has been familiar to us for a hundred and fifty years is not valid for a previous period. And that, if biology was unknown, there was a very simple reason for it: that life itself did not exist. All that existed was living things, which were viewed through a grid of knowledge constituted by natural history.

*The Order of Things: An Archaeology of the Human Sciences*

Chapter 5 (pp. 127–128)

Vintage Books. New York, New York, USA. 1973

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

Life in general may be looked upon as a republic where the individuals are for the most part unconscious that while they are working for themselves they are also working for the public good.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 195)

AMS Press. New York, New York, USA. 1973

**Garrison, W. M.**

No biographical data available

**Morrison D. C.**

No biographical data available

The question of the conditions under which living matter originated on the surface of the earth is still a subject limited largely to speculation.... One of the purposes of the observation reported herein is to add another fact that might have some bearing upon this interesting question.

One of the most popular current conceptions is that life originated in an organic milieu. The problem to which we are addressed is the origin of that organic milieu in the absence of any life.

Reduction of Carbon Dioxide in Aqueous Solutions by Ionizing Radiation

*Science*, Volume 114, Number 2964, October 19, 1951 (p. 416)

**Glazkov, Yuri** 1939–

Russian cosmonaut

The winds scatter across the planet the seeds of life to bring forth the grass and flowers and woods. The eternal winds of the universe are rushing along. What do they bring? No one knows. But I am sure that Nature has created us, endowed us with intelligence, so that we, like her servant the winds, can carry life into the vast and limitless emptiness and to its innumerable worlds. Reason should win out on Earth and then in the whole universe.

In Kevin W. Kelley

*The Home Planet*

With Plate 135

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1988

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Life is a copiously branching bush, continually pruned by the grim reaper of extinction, not a ladder of predictable progress.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter I (p. 35)

W.W. Norton & Company. New York, New York, USA. 1989

**Greenberg, J. Mayo** 1922–2001

Astrophysicist

There are messages being deciphered that tell of the existence of living material in places as inhospitable as the arctic and Antarctic as well as in geothermal vents. Were the prebiotic conditions for life to have evolved much more exotic than we had pictured? Planetary scientists, geochemists, astronomers and astrophysicists are searching for new answers.

*The Chemistry of Life's Origins*

Preface

Publisher undetermined

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

An “emergence” of life out of a Newtonian world would be a quite unintelligible miracle.



*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*  
Lecture I, The Emergence of Life (p. 35)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

...a feeling will gradually grow up that life on earth represents a unity, that damage at one point can have effects everywhere else, that we are jointly responsible for the ordering of life upon this our earth. From the cosmic distances to which man can penetrate by the means of modern technology, we see perhaps more clearly than from earth itself the unitary laws whereby all life on our planet is ordered.

*Across the Frontiers*  
Chapter VI (p. 68)  
Harper & Row, Publishers. New York, New York, USA. 1974

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

If matter exists in the universe for the purpose of life, nature would seem to tip a hogshead to fill a wineglass, when it makes life possible only on a little planet.

In W.H. Thomson  
*Some Wonders of Biology* (p. 176)  
Publisher undetermined

**Heyl, Paul R.**  
American Scientist

There is an everyday test which we all instinctively apply when we are in doubt whether a certain thing is alive. We watch for it to move.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1929*  
The Lingering Dryad (p. 205)  
Government Printing Office. Washington, D.C. 1930

**Holmes, Bob**  
No biographical data available

...the best minds in the world may have no problem separating the quick from the dead in ordinary experience, but they still can't agree on what life is. Living things eat, move, and excrete? So does your gas-guzzling, exhaust-belching car. Life maintains order in the face of entropy? A flame can do that. Life is the ability to replicate? Then crystals are alive but not so mules, old women and many old men.

Life Is...?  
*New Scientist*, Number 2138, 13 June, 1998 (pp. 38, 40)

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

The more we study the body and the mind, the more we find both to be governed, not by, but according to, laws, such as we observe in the larger universe.

*The Autocrat of the Breakfast-Table*  
Chapter IV (p. 71)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Huxley, Thomas Henry** 1825–95  
English biologist

The last thing that it would be proper for me to do would be to speak of the work of my life, or to say at the end of the day whether I think I have earned my wages or not. Men are said to be partial judges of themselves. Young men may be, I doubt if old men are. Life seems terribly foreshortened as they look back and the mountain they set themselves to climb in youth turns out to be a mere spur of immeasurably higher ranges when, by failing breath, they reach the top. But if I may speak of the objects I have had more or less definitely in view since I began the ascent of my hillock, they are briefly these: To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.

*Autobiography and Selected Essays*  
Autobiography (p. 13)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1909

**Jaeger, Benedict** 1789–?  
Austrian-born American entomologist

The conditions of our being are such, that we are tied by destiny to every object; and the more intimate and appreciable the connection, the more interesting and important to us becomes a full understanding of our mutual relations and dependencies in the vast arena of Life.

*The Life of North American Insects*  
Preface (p. xi)  
Harper & Brothers Publishers. New York, New York, USA. 1859

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

We know of no type of astronomical body in which the conditions can be favorable to life except planets like our own revolving round a sun.... [O]nly an infinitesimally small corner of the universe can be in the least suited to form an abode of life.

*The Universe Around Us*  
Chapter V (pp. 320, 321)  
The Macmillan Company. New York, New York, USA. 1929

Is this, then, all that life amounts to? To stumble, almost by mistake, into a universe which was clearly not designed for life, and which, to all appearances, is either totally indifferent or definitely hostile to it, to stay clinging on to a fragment of a grain of sand until we are frozen off, to

strut our tiny hour on our tiny stage with the knowledge that our aspirations are all doomed to final frustration, and that our achievement must perish with our race, leaving the universe as though we had never been?

*The Mysterious Universe*

Chapter I (pp. 15–16)

The Macmillan Company. New York, New York, USA. 1932

...it does not at present look as though Nature had designed the universe primarily for life; the normal star and the normal nebula have nothing to do with life except making it impossible. Life is the end of a chain of by-products; it seems to be the accident, and life-destroying radiation the essential.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspects of Cosmogony (p. 177)

Government Printing Office. Washington, D.C. 1929

### **Jennings, Herbert Spencer** 1868–1947

American zoologist

The universe did not become sterile with the first production of life. It is continuously creative now as in the past.

*The Universe and Life*

Chapter II (p. 51)

Yale University Press. New Haven, Connecticut, USA. 1941

[Life] will repeat the same unsuccessful experiment, the same tragic mistakes a hundred times.... In hundreds of ways, life produces imperfect types, many that cannot continue to exist even under the best of conditions.... The pathway of developing life is profusely marked with those imperfect starts, with the attempts of life to move in directions that lead but to conditions in which life is impossible.

*The Universe and Life*

Chapter II (pp. 54–55)

Yale University Press. New Haven, Connecticut, USA. 1941

In the study of the progress of life, therefore, we find no reason to doubt that life is traveling a new course, the final goal of which does not now exist, the end of which is not now predictable. Life that is upon a new adventure, life that is moving in directions not laid out beforehand, life that is transforming into what did not before exist, life that is rising to heights not before reached – this is the vision that biology presents to our eyes.

*The Universe and Life*

Chapter II (p. 65)

Yale University Press. New Haven, Connecticut, USA. 1941

### **Kauffman, Stuart A.**

Theoretical biologist

Anyone who tells you that he or she knows how life started on the serene Earth some 3.45 billion years ago is a fool or a knave.

*At Home in the Universe: The Search for Laws of Self-Organization and Complexity*

Chapter 2 (p. 31)

Oxford University Press, Inc. New York, New York, USA. 1995

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that it is not unscientific.

*Report of the Forty-First Meeting of the British Association for the*

*Advancement of Science*

On the Origin Of Life

Edinburgh, Scotland. 1871

Mathematics and dynamics fail us when we contemplate the earth, fitted for life but lifeless, and try to imagine the commencement of life upon it. This certainly did not take place by any action of chemistry, or electricity, or crystalline grouping of molecules under the influence of force, or by any possible kind of fortuitous concourse of atoms. We must pause face to face with the mystery and miracle of the creation of living creatures.

Series 5, The Age of the Earth as an Abode Fitted for Life

*Philosophical Magazine*, Volume 47, 1899 (p. 89)

A very ancient speculation, still clung to by many naturalists (so much so that I have a choice of modern terms to quote in expressing it) supposes that, under meteorological conditions very different from the present, dead matter may have run together or crystallised or fermented into “germs of life,” or “organic cells,” or “protoplasm.” But science brings a vast mass of inductive evidence against this hypothesis of spontaneous generation,.... Dead matter cannot become living without coming under the influence of matter previously alive. This seems to me as sure a teaching of science as the law of gravitation.

*Popular Lectures and Addresses* (Volume 2)

Address to the British Association (pp. 197–198)

Macmillan & Company Ltd. London, England. 1894

...life proceeds from life, and from nothing but life.

Address by the President (p. civ)

### **Kopp, Hermann**

No biographical data available

The alchemist of past centuries tried hard to make the elixir of life... These efforts were in vain; it is not in our power to obtain the experiences and views of the future by prolonging our lives forward in this direction. However, it is possible and in a certain way to prolong our lives backwards, by acquiring the experiences of those who existed before us and by learning to know their views as if we were their contemporaries. The means for doing this is also an elixir of life.

Translated by W.H. Brock

*Die Entwicklung der Chemien der neuern Zeit*

Foreword

Publisher undetermined

**Krebs, Hans Adolf** 1900–81

German-born English biochemist

The existence of common features in different forms of life indicates some relationship between the different organisms, and according to the concept of evolution these relations stem from the circumstance that the higher organisms, in the course of millions of years, have gradually evolved from simpler ones. The concept of evolution postulates that living organisms have common roots, and in turn the existence of common features is powerful support for the concept of evolution. The presence of the same mechanism of energy production in all forms of life suggests two other inferences, first, that the mechanism of energy production has arisen very early in the evolutionary process, and second, that life, in its present forms, has arisen only once.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1953

The Citric Acid Cycle (p. 409)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

...in principle, one by one, the difficulties of explaining living systems in terms of chemistry and physics disappear. "In principle" are the operative words. In practice the difficulties remain great and seem insurmountable in the foreseeable future. But, from the point of view of the theory of knowledge, there is nevertheless a decisive difference.

How the Whole Becomes More than the Sum of the Parts

*Perspectives in Biology and Medicine*, Volume 14, Number 3, Spring, 1971 (p. 452)

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

No other contrast is so tremendous as this contrast between what lives and what does not.

In R.W. Moss

*Free Radical: Albert Szent-Gyorgyi and the Battle Over Vitamin C*

Chapter 19 (p. 243)

Paragon House. New York, New York, USA. 1988

**Langer, Susanne Katherina Knauth** 1895–1985

American philosopher

Human life is shot through and through with ritual, as it is also with animalian practices. It is an intricate fabric of reason and rite, of knowledge and religion, prose and poetry, fact and dream.... Ritual, like art, is essentially the active termination of a symbolic transformation of experience. It is born of the cortex, not in the "old brain"; but it is born of an *elementary need* of that organ, once the organ has grown to human estate.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite, and Art*

Chapter II (p. 45)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Large, E. C.**

No biographical data available

There was nothing enjoyable more than a good long wrangle about plant viruses and what was meant by "life." But that wrangling was best left till after; until evening, when with a little alcohol to help things along, one could have a very good time, agreeing or disagreeing with each theory in turn. In the morning there was work to do.

*The Advance of the Fungi*

Chapter XXX (p. 416)

Henry Holt & Company. New York, New York, USA. 1940

**Lerner, Eric J.** 1947–

American popular science book

Life did not arise as an accidental, wildly improbable leap from molecule to cells or even to viruses, but through a step-by-step evolution, just as humans did not evolve in a single leap from one-celled creatures.

*The Big Bang Never Happened*

Chapter 9 (p. 401)

Time Books. New York, New York, USA. 1991

**Letourneau, Charles Jean Marie** 1831–1902

Anthropologist

Life has long been the mystery of mysteries; and in modern times it has been the last refuge, the citadel of supermaternalism.

*Biology*

Chapter IV (p. 28)

Chapman & Hall, Ltd. London, England. 1878

**Lewes, George Henry** 1817–78

English philosopher

Life everywhere! on the earth, in the earth, crawling, creeping, burrowing, boring, leaping, running.

*Studies in Animal Life*

Chapter I (p. 4)

Smith, Elder & Co. London, England. 1862

Generations follow generations; and the Present becomes the matrix of the Future, as the Past was of the Present the Life of one epoch forming the prelude to a higher Life.

*Studies in Animal Life*

Chapter I (pp. 6–7)

Smith, Elder & Co. London, England. 1862

**Lewis, Gilbert Newton** 1875–1946

American chemist

To inquire into the origin of life is like seeking the origin of electrical machinery, or the origin of music.

*The Anatomy of Science*

Chapter VIII (p. 196)

Yale University Press. New Haven, Connecticut, USA. 1926

**Lewis, John S.**

No biographical data available

What is the best world for life? A world on which the world and its life have coevolved, accommodating each other. What is the best of all possible worlds? One that has been altered to our needs, and that we have met

halfway by adapting ourselves. The best marriage of world and resident is consensual: both freely change for the common good. This is the direction in which we are already headed. It is best to be aware of it.

*Worlds Without End: The Exploration of Planets Known and Unknown*  
Chapter 18 (p. 214)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Lewis, Wyndham** 1882–1957  
English author and painter

Every living form is a miraculous mechanism, however, and every sanguinary, vicious or twisted need produces in Nature's workshop a series of mechanical arrangements extremely suggestive and interesting for the engineer, and almost invariably beautiful or interesting for the artist.

*The Caliph's Design*  
The Physiognomy of Our Time (p. 77)  
Black Sparrow Press. Santa Barbara, California, USA. 1919

**Loeb, Jacques** 1859–1924  
German physiologist

Nothing indicates, however, at present that the artificial production of living matter is beyond the possibilities of science...

*The Mechanistic Conception of Life*  
Chapter I (p. 5)  
The University of Chicago Press. Chicago, Illinois, USA. 1912

**London, Jack** 1876–16  
American author

I believe that life is a mess. It is like yeast, a ferment, a thing that moves and may move for a minute, an hour, a year, or a hundred years, but that in the end will cease to move. The big eat the little and they may continue to move, the strong eat the weak that they may retain their strength. The lucky eat the most and move the longest, that is all.

*The Sea-Wolf*  
Chapter V (p. 50)  
The Macmillan Company. New York, New York, USA. 1931

**Lorenz, Konrad** 1903–89  
Austrian zoologist

Life itself is a process of acquiring knowledge ...

In P. Weiss  
*Hierarchically Organized Systems in Theory and Practice*  
Knowledge, Beliefs and Freedom (p. 231)  
Hafner Publishing Company. New York, New York, USA. 1971

**Lovelock, James Ephraim** 1919–  
English scientist

Like a message passed by word of mouth, the chain of life back to the remote past carries precise but inaccurate

information. But it is the only way we have to conjure up what the origin might have been.

*Living Alternatives*  
*Nature*, Volume 320, Number 6063, 17 April, 1986 (p. 646)

**Mann, Thomas** 1875–1955  
German-born American novelist

What then was life? It was warmth, the warmth generated by a form-preserving insubstantiality, a fever of matter, which accompanied the process of ceaseless decay and repair of albumen molecules that were too impossibly complicated, too impossibly ingenious in structure.

*The Magic Mountain*  
Chapter V  
Research (p. 275)  
Alfred A. Knopf. New York, New York, USA. 1966

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist

**Sagan, Dorion** 1959–  
American science writer

...only life itself seems powerful enough to have promoted the conditions favoring its own prolonged survival...

*Microcosmos*  
Chapter 3 (p. 67)  
Summit Books. New York, New York, USA. 1986

Life, a watery, carbon-based macromolecular system, is reproducing autopoiesis. The autopoietic view of life is circular. Life is a metabolic machine which not only reproduces but fiercely stores and uses information in order to resist breaking down.

*Microcosmos*  
Chapter 13 (p. 264)  
Summit Books. New York, New York, USA. 1986

**Masefield, John** 1878–  
English poet

What am I, Life?

A thing of watery salt

Held in cohesion by unresting cells

Which work they know not why, which never halt...

*Poems*  
Sonnets (p. 357)  
The Macmillan Company. New York, New York, USA. 1958

**Mather, Kirtley F.** 1888–1978  
American geologist

You would surely all agree when I assert that the mystery of the origin of life upon the face of the earth is no greater than the mystery of the origin of any single individual today upon the face of the earth.

Forty Years of Scientific Thought Concerning the Origin of Life  
*Journal of the Scientific Laboratories of Denison University*, Volume 22, 1927 (p. 151)

**Mathews, Albert P.**

No biographical data available

Living things are, as it were, universes. Were it possible to magnify the human body so that the positive electrons would be as large as small shot... , a man would be about 10,000 times as tall as the distance from the earth to the sun. Were the electrons luminous, each individual would look like a nebula or collection of an immense number of suns, all of which would be in rapid orbital motion. There would be constellations, which we call molecules, and the atoms would be solar systems... We are in very truth minute universes, composed of quadrillions of suns and planets.

In E.V. Cowdry (ed.)

*General Cytology: A Textbook of Cellular Structure and Function for Students of Biology and Medicine*

Some General Aspects of the Chemistry of Life, Section III (pp. 20, 21)  
The University of Chicago Press. Chicago, Illinois, USA. 1924

**McCabe, Joseph** 1867–1955

English rationalist writer and ex-Franciscan priest

There is, perhaps, no other chapter in the chronicle of the earth that we approach with so lively an interest as the chapter which should record the first appearance of life. Unfortunately, as far as the authentic memorials of the past go, no other chapter is so impenetrably obscure as this. The reason is simple. It is a familiar saying that life has written its own record, the long-drawn record of its dynasties and its deaths, in the rocks. But there were millions of years during which life had not yet learned to write its record, and further millions of years the record of which has been irretrievably destroyed.

*The Story of Evolution*

Chapter V (p. 41)

Publisher undetermined

**Midgley, Mary** 1919–

English philosopher

As for *life*, I suspect that, twenty years hence, biologists may be concerning themselves with ‘the question of life’ just as vigorously as the rest of us now are with problems about consciousness.

*Science and Poetry*

Part III, Chapter 12

Routledge. New York, New York, USA. 2002

**Mora, P. T.**

No biographical data available

...the presence of a living unit is exactly opposite to what we would expect on the basis of pure statistical and probability considerations.

Urge and Molecular Biology

*Nature*, Volume 199, Number 4890, July 20, 1963 (p. 215)

**Morris, Simon Conway** 1951–

English paleontologist

On a perfect planet, such as might be acceptable to a physicist, one might predict that from its origin the diversity of life would grow exponentially until the carrying capacity, however defined, was reached. The fossil record of the Earth, however, tells a very different story.

The Evolution of Diversity in Ancient Ecosystems: A Review

*Philosophical Transactions: Biological Sciences*, Volume 353, Number 1366, February 28, 1998

**Muggeridge, Malcolm** 1903–90

English journalist and social critic

Nor, as far as I am concerned, is there any recompense in the so-called achievements of science. It is true that in my lifetime more progress has been made in unravelling the composition and the mechanism of the material universe than previously in the whole of recorded history. This does not at all excite my mind, or even my curiosity. The atom has been split; the universe has been discovered, and will soon be explored. Neither achievement has any bearing on what alone interests me – which is why life exists, and what is the significance, if any, of my minute and so transitory part in it.

In Cecil Kuhne and Malcom Muggeridge

*Seeing Through the Eye. Malcom Muggeridge on Faith* (p. 24)

Ignatius Press, San Francisco, California. 2005

**Muller, Hermann Joseph** 1890–1967

American geneticist

To many an unsophisticated human being, the universe of stars seems only a fancy backdrop, provided for embellishing his own and his fellow creatures’ performances. On the other hand, from the converse position, that of the universe of stars, not only all human beings but the totality of life is merely a fancy kind of rust, afflicting the surfaces of certain lukewarm minor planets. However, even when we admit our own littleness and the egotistical complexion of our interest in this rust, we remain confronted with the question: What is it that causes the rust to be so very fancy?

Life

*Science*, Volume 121, Number 3132, 7 January, 1955 (p. 1)

**Murchie, Guy** 1907–97

American biologist

Life is everywhere: slithering with the snake through nodding reeds, threading the parched desert with the kangaroo rat, swimming with the ameba in a drop of rain. Even if we project our musings beyond the world, life quickens the planets, binding them without a rope to moons, to suns, to the Pleiades...

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*

Part Three, Chapter 14 (p. 407)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1978



**Narrator**

The record of life is written on the land ...

Opening narration

*Creature from the Black Lagoon*

**Nealson, Kenneth H.**

No biographical data available

**Conrad, Pamela G.**

No biographical data available

...the limits of life on this planet have expanded to such a degree that our thoughts of both past and future life have been altered.

Life: Past, Present, and Future

*Philosophical Transactions of the Royal Society (London)*, Volume 354, Number 1392, December 29, 1999 (p. 1923)

**Needham, James G.** 1868–1957

Entomologist

...to the scientific mind the living and the non-living form one continuous series of systems of differing degrees of complexity..., while to the philosophic mind the whole universe, itself perhaps an organism, is composed of a vast number of interlacing organisms of all sizes.

Developments in Philosophy of Biology

*Quarterly Review of Biology*, Volume III, Number 1, March, 1928 (p. 79)

**Ochoa, Severo** 1905–93

Biochemist and molecular biologist

Man has all but conquered the atom and is now preparing for the conquest of space. He has uncovered many of the secrets of inanimate matter and begins to delve deep into the frontier realm between the lifeless and the living, the world of the viruses. He may never find the clue to the nature or the meaning of life but we may look forward with confidence and anticipation to a much better comprehension of many of its riddles.

*Les Prix Nobel. The Nobel Prizes in 1959*

Nobel banquet speech for award received in 1959

Nobel Foundation. Stockholm, Sweden. 1960

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

The epoch of interplanetary cosmic travel into which mankind just now enters opens for the science of life new vistas and distant perspectives. It may offer to us an insight into life and the pathways of its origin and development in forms that may be distinct from the terrestrial. Yet, even if, to our great disappointment, we do not discover life on our neighboring planets, we will still learn very much that is new about the pathways of evolution of organic matter which lay at the foundation of the origin of our terrestrial life.

In Cyril Ponnampereuma

*Exobiology*

The Appearance of Life in the Universe (p. 14)

North-Holland Publishing Company. Amsterdam, Netherlands. 1972

Life – the word is so easy to understand, yet so enigmatic for any thoughtful person.

*Life: Its Nature, Origin and Development*

Chapter I (p. 1)

Academic Press, Inc. New York, New York, USA. 1962

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

We cannot in any sense be both the observers and the actors in any specific instance, or we shall fail properly to be either one or the other; yet we know that our life is built of these two modes, is part free and part inevitable, is part creation and part discipline, is part acceptance and part effort.

*Science and the Common Understanding*

Chapter 6 (p. 88)

Simon & Schuster. New York, New York, USA. 1954

**Pagels, Heinz R.** 1939–88

American physicist and science writer

My own view is that although we do not yet know the fundamental physical laws, when and if we find them the possibility of life in a universe governed by those laws will be written into them. The existence of life in the universe is not a selective principle acting upon the laws of nature; rather it is a consequence of them.

*Perfect Symmetry: The Search for the Beginning of Time*

Part Four, Chapter 1 (pp. 359–360)

Simon & Schuster. New York, New York, USA. 1985

**Pasteur, Louis** 1822–95

French chemist

And, therefore, gentlemen, I could point to that liquid and say to you, I have taken my drop of water from the immensity of creation, and I have taken it full of the elements appropriated to the development of microscopic organisms. And I wait, I watch, I question it! – begging it to recommence for me the beautiful spectacle of the first creation. But it is dumb, dumb since [the time] these experiments were begun several years ago; it is dumb because I have kept from it the only thing man does not know how to produce: from the germs which float in the air, from Life, for Life is a germ and a germ is Life. Never will the doctrine of spontaneous generation recover from the mortal blow of this simple experiment.

*Biology Through the Eyes of Faith*

Chapter 3 (p. 93)

Harper & Row, Publishers. San Francisco, California, USA. 1989

**Pattee, H. H.**

No biographical data available

...when a problem persists, unresolved, for centuries in spite of enormous increase in our knowledge, it is a good bet that the problem entails the nature of knowledge itself. The nature of life is one of these problems.

In F. Morin, A. Moreno, J.J. Merelo and P. Chacón (eds.)

*Advances in Artificial Life*



Artificial Life Needs a Real Epistemology  
 Proceedings of the Third European Conference on Artificial Life  
 Granada, Spain  
 June, 1995

**Patten, William** 1861–1932  
 American biologist

Life is not an act apart, nor is it the product of any specific time, or place, or material. It is the offspring of the physical world; a transient phase of creative power in the universal whole.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*  
 Chapter IV (p. 85)  
 Richard G. Badger. Boston, Massachusetts, USA. 1920

To make way for terrestrial life, nature labored on a universal scale. Matter was the warp and energy the woof of her growing fabrics; constellations were the patterns.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*  
 Chapter IV (p. 85)  
 Richard G. Badger. Boston, Massachusetts, USA. 1920

...the barriers within which life resides are not impregnable. In its traffic with nature, life is free to look beyond its tenement walls; free to receive directive agencies from afar, and thereby free to enlarge its heritage. By this universal attribute of profitable exchange, life grows in volume and complexity.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*  
 Chapter IV (p. 89)  
 Richard G. Badger. Boston, Massachusetts, USA. 1920

**Pavlov, Ivan Petrovich** 1849–1936  
 Russian physiologist

It is not accidental that all phenomena of human life are dominated by the search for daily bread – the oldest link connecting all living things, man included, with the surrounding nature.

*Nobel Lectures, Physiology or Medicine 1901–1921*  
 Nobel lecture for award received in 1904  
 Physiology of Digestion (p. 140)  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Peattie, Donald Culross** 1898–1964  
 American botanist, naturalist, and author

Whatever life is (and nobody can define it) it is something forever changing shape, fleeting, escaping us into death. Life is indeed the only things that can die, and it begins to die as soon as it is born, and never ceases dying. Each of us is constantly experiencing cellular death. For the renewal of our tissues means a corresponding death of them, so that death and rebirth become biologically, right and left hand of the same thing. All growing is at the same time a dying away from that which lived yesterday.

*The Road of a Naturalist*  
 Chapter 12 (pp. 149–150)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

...life turns out to be what matter is everywhere – whether in the interior of a sun or at the center of the

earth – an electromagnetic system, an arrangement of matter in terms of force. And if it should occur to you that here protoplasm, with mortal Adamite finger, touches the finger of universal and immortal power, science will not gainsay you. It will not gainsay you.

*Flowering Earth*  
 Chapter 5 (p. 59)  
 G.P. Putnam's Sons. New York, New York, USA. 1939

**Perrett, J.**  
 No biographical data available

Life is a potentially self-perpetuating open system of linked organic reactions, catalyzed stepwise and almost isothermally by complex and specific organic catalysts which are themselves produced by the system.

Biochemistry and Bacteria  
*New Biology*, Volume 12, 1952

**Ponnamperuma, Cyril** 1923–1995  
 Sri Lankan scientist

Physicists might eventually be able to come up with a grand unification theory that encompasses not just subatomic particles and the basic elements, but the code of life as well. Who knows? Life elsewhere in the universe may even be five feet tall and standing on two legs.

In Pamela Weintraub (ed.)  
*The Omni Interviews*  
 Seeds of Life (p. 3)  
 Ticknor & Fields. New York, New York, USA. 1984

**Poynting, John Henry** 1852–1914  
 English physicist

The threads of life, coming in we know not where, now twining together, now dividing, are weaving patterns of their own, ever increasing in intricacy, ever gaining in beauty.

*Collected Scientific Papers*  
 Presidential Address  
 The Mathematical and Physical Section  
 The British Association (Dover) 1899 (p. 612)  
 At The University Press. Cambridge. 1920

**Putter, A.**  
 No biographical data available

It [life] is the particular manner of composition of the materials and processes, their spatial and temporal organization which constitutes what we call life.

In L. von Bertalanffy  
*Modern Theories of Development: An Introduction to Theoretical Biology* (p. 51)  
 Harper & Row Publishers. New York, New York, USA. 1962

**Pythagoras of Samos** ca. 580 BCE–500 BCE  
 Greek mathematician, astronomer, and philosopher

...life resembles the great and populous assembly of the Olympic games, wherein some exercise the body, that they may carry away the glory of the prize: others bring merchandise to sell for profit: there are also some (and those none of the worst sort) who pursue no other advantage than only to look on, and consider how and

why everything is done, and to be spectators of the lives of other men, thereby the better to judge of and regulate their own.

In *Great Books of the Western World* (Volume 25)  
*The Essays*

Of the Education of Children (p. 69)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Redi, Francesco** 1626–78

Italian physician

Although content to be corrected by anyone wiser than myself, if I should make erroneous statements, I shall express my belief that the Earth, after having brought forth the first plants and animals at the beginning by order of the Supreme and Omnipotent Creator, has never since produced any kinds of plants or animals, either perfect or imperfect; and everything which we know in past or present times that she has produced, came solely from the true seeds of the plants and animals themselves.

Translated by Mab Bigeflow

*Experiments on the Generation of Insects*

Redi's Hypothesis (pp. 26–27)

The Open Court Publishing Company. Chicago, Illinois, USA. 1909

And, although it be a matter of daily observation that infinite numbers of worms are produced in dead bodies and decayed plants, I feel, I say, inclined to believe that these worms are all generated by insemination and that the putrefied matter in which they are found has no other office than that of serving as a place, or suitable nest, where animals deposit their eggs at the breeding season, and in which they also find nourishment....

Translated by Mab Bigeflow

*Experiments on the Generation of Insects*

Redi's Hypothesis (p. 27)

The Open Court Publishing Company. Chicago, Illinois, USA. 1909

**Rodbell, Martin** 1925–98

American biochemist

Life, like the first blooming, emerges tantalizing to the curious:

Why, How, When, Where;

Interlocked questions arising from the mysterious encompassing matters quite serious.

*Les Prix Nobel. The Nobel Prizes in 1994*

Nobel banquet speech for award received in 1994

Nobel Foundation. Stockholm, Sweden. 1995

**Rush, J. H.**

No biographical data available

Life pushes its way through this fatalistically determined world like a river flowing upstream. It is a system of utterly improbable order, a message in a world of noise.

*The Dawn of Life*

Chapter I (p. 34)

Hanover House. Garden City, New York, USA. 1957

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Organic life, we are told, has developed gradually from the protozoon to the philosopher, and this development, we are assured, is indubitably an advance. Unfortunately it is the philosopher, not the protozoon, who gives us this assurance, and we can have no security that the impartial outsider would agree with the philosopher's self-complacent assumption.

*Mysticism and Logic and Other Essays*

Chapter VI, Section I (p. 106)

Longmans, Green & Company. London, England. 1925

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

Life seems to be orderly and lawful behavior of matter, not based exclusively on its tendency to go over from order to disorder, but based partly on existing order that is kept up.

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*

Chapter VI, Section 55 (p. 69)

At The University Press. Cambridge, England. 1945

**Shapiro, Robert** 1935–

DNA researcher

...we desire the best available scientific status report on the origin of life. We shall see that adherents of the best known theory have not responded to increasing adverse evidence by questioning the validity of their beliefs, in the best scientific tradition; rather, they have chosen to hold it as a truth beyond question, thereby enshrining it as mythology.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*

Chapter One (p. 32)

Summit Books. New York, New York, USA. 1986

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

To examine the causes of life, we must first have recourse to death.

*Frankenstein: Or, The Modern Prometheus*

Chapter III (p. 69)

George Routledge & Sons. London, England. 1891

After days and nights of incredible labour and fatigue, I succeeded in discovering the cause of generation and; life; nay, more, I became myself capable of bestowing animation upon lifeless matter.

*Frankenstein: Or, The Modern Prometheus*

Chapter IV (p. 71)

George Routledge & Sons. London, England. 1888

**Sherrington, Sir Charles** 1857–1952

English physiologist

The microscope reveals that plants and animals are literally commonwealths of individually living units... Thus

the corporeal house of life is built of living stones. In that house each stone is a self-centered microcosm, individually born, breathing for itself, feeding itself, consuming its own substance in its living, renewing its substance to meet that consumption, harmonizing with its own inner life some special function for the benefit of the whole, and destined ultimately for an individual death.

In T.B. Strong (ed.)

*Lectures on the Method of Science*

Chapter III (p. 67)

Clarendon Press. Oxford, England. 1906

A grey rock, said Ruskin, is a good sitter. That is one type of behavior. A darting dragon-fly is another type of behavior. We call the one alive, the other not. But both are fundamentally balances of give and take of motion with their surround. To make "life" a distinction between them is at root to treat them both artificially.

*Man on His Nature*

Chapter III (p. 88)

Doubleday Anchor Books. Garden City, New York, USA. 1955

### **Simpson, George Gaylord** 1902–84

American paleontologist

The historian of life takes not only knowledge of fossils but also a tremendous array of pertinent facts from other fields of earth sciences and of life sciences and weaves them all into an integral interpretation of what the world of life is like and how it came to be so. Finally, he is bound to reflect still more deeply and to face the riddles of the meaning and nature of life and of man as well as problems of human values and conduct. The history of life certainly bears directly on all these riddles and problems, and realization of its own value demands investigation of this bearing.

*Meaning of Evolution: A Study of the History of Life and of Its Significance for Man*

Prologue (p. 3)

Yale University Press. New Haven, Connecticut, USA. 1949

### **Singer, Charles** 1876–1960

Historian of science and medicine

We are always looking for metaphors in which to express our ideas of life, for our language is inadequate for all its complexities. Life is a labyrinth.... Life is a machine.... Life is a laboratory.... It is but a metaphor. When we speak of ultimate things we can, maybe, speak only in metaphors. Life is a dance, a very elaborate and complex dance...

*A Short History of Scientific Ideas to 1900*

Chapter IX, Section 6 (p. 498)

At The Clarendon Press. Oxford, England. 1959

### **Sinnott, E. W.** 1888–1968

American biologist

Life can be studied fruitfully in its highest as well as its lowest manifestations. The biochemist can tell us much about protoplasmic organisation, but so can the

artist. Life is the business of the poet as well as of the physiologist.

*Cell and Psyche*

Chapter III (p. 107)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1950

### **Smuts, Jan Christiaan** 1870–1950

South African statesman, military leader, and holistic philosopher

According to quantum doctrine, the roots of life and mind lie imbedded deep down in the ultimate structure of this universe, and they are not mere singular apparitions of an unaccountable character, arising accidentally in the later phases of evolution.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 719)

### **Spencer, Herbert** 1820–1903

English social philosopher

...a living thing is distinguished from a dead thing by the multiplicity of the changes at any moment taking place in it.

*The Principles of Biology* (Volume 1)

Part I, Chapter IV, Section 25 (p. 65)

D. Appleton & Company. New York, New York, USA. 1897

### **Stackpole, Caroline E.**

No biographical data available

Life, that strange, mysterious, unknown something which flies through the viewless air, flashes through the ocean's depths, blushes in the petals of a rose and manifests itself in a thousand marvelous forms – can science grasp, define or explain it?

In Francis William Rolt-Wheeler

*The Science-history of the Universe* (Volume 5)

Chapter I (p. 1)

The Current Literature Publishing Co. New York, New York, USA. 1909

### **Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

Like schoolboys we play among the shadows cast by the turrets of the temple of oblivion, towards which we travel, regardless of what awaits us in the vale of years beneath. Suffering and disease are ever before us, but life is very pleasant; and the motto of the world, when well, is "forward with the dance."

*Underwoods*

Doctor and Nurse (p. 15)

Chatto & Windus. London, England. 1887

### **Stockbridge, Frank B.**

No biographical data available

Life is a chemical reaction; death is the cessation of that reaction; living matter, from the microscopic yeast spore to humanity itself, is merely the result of certain

accidental groupings of otherwise inert matter, and life can actually be created by repeating in the laboratory nature's own methods and processes!

Creating Life in the Laboratory

*Cosmopolitan*, Volume 52, May, 1912 (pp. 774–781)

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

What drives life is thus a little electric current, kept up by the sunshine. All the complexities of intermediary metabolism are but the lacework around this basic fact.

Imre Csizmadia, Botond Penke and Gabor Toth (eds.)

*The Role of Chemistry in the Evolution of Molecular Medicine*

Introduction to Submolecular Biology

Chapter 3

Elsevier Publishing Company. Amsterdam, Netherlands. 2004

Every biologist has at some time asked “What is life?” and none has ever given a satisfactory answer. Science is built on the premise that Nature answers intelligent questions intelligently; so if no answer exists, there must be something wrong with the question.

*The Living State : With Observations on Cancer* (p. 1)

Academic Press. New York, New York, USA. 1972

It is common knowledge that the ultimate source of all our energy and negative entropy is the radiation of the sun. When a photon interacts with a material particle on our globe it lifts one electron from an electron pair to a higher level. This excited state as a rule has but a short lifetime and the electron drops back within 10<sup>-7</sup> to 10<sup>-8</sup> [second] to the ground state giving off its excess energy one way or another. Life has learned to catch the electron in the excited state, uncouple it from its partner and let it drop back to the ground state through its biological machinery utilizing its excess energy for life processes.

In W. D. McElroy and B. Glass (eds.)

*Light and Life*

Introductory Comments (p. 7)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1961

## The X-Files

SCULLY: It began with an act of supreme violence – a big bang expanding ever outward, cosmos born of matter and gas, matter and gas ten billion years ago. Whose idea was this? Who had the audacity for such invention? And the reason? Were we part of that plan ten billion years ago? Are we born only to die? To be fruitful and multiply and replenish the earth before giving way to our generations? If there is a beginning, must there be an end? We burn like fires in our time only to be extinguished. To surrender to the elements' eternal reclaim. Matter and gas... will this all end one day? Life no longer passing to life, the Earth left barren like the stars above, like the cosmos. Will the hand that lit the flame let it burn down? Let it burn out? Could we, too, become extinct? Or if this fire of life living inside us is meant to go on, who decides?

Who tends the flames? Can he reignite the spark even as it grows cold and weak?

*Biogenesis*

Television program

Season 6 (2000)

**Tillich, Paul** 1886–1965

German-born American theologian

Now the way into the profounder levels of life is not to be found by means of physical and psychological analysis but only by means of intuitive insight, of apprehension on the basis of one's own aliveness.

*The Religious Situation* (p. 58)

Meridian Books

New York, New York, USA. 1956

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Among you boys you have a game: you stand a row of bricks on end a few inches apart; you push a brick, it knocks its neighbor over, the neighbor knocks over the next brick – and so on till all the row is prostrate. That is human life. A child's first act knocks over the initial brick, and the rest will follow inexorably. If you could see into the future, as I can, you would see everything that was going to happen to that creature; for nothing can change the order of its life after the first event has determined it. That is, nothing will change it, because each act unfailingly begets an act, that act begets another, and so on to the end, and the seer can look forward down the line and see just when each act is to have birth, from cradle to grave.

*The Mysterious Stranger*

Chapter VII (p. 87)

Harper & Brothers Publishers. New York, New York, USA. 1926

**Updike, John** 1932–

American novelist, short story writer, and poet

But I happen to know exactly how life arose; it's brand-new news, at least to the average layman like yourself. Clay. Clay is the answer. Crystal formation in fine clays provided the template, the scaffolding, for the organic compounds and the primitive forms of life. All life did, you see, was take over the phenotype that crystalline clays had evolved on their own.

*Roger's Version*

Chapter V (p. 305)

Alfred A. Knopf. New York, New York, USA. 1986

**van Bergeijk, W. A.**

No biographical data available

Life is the necessary and sufficient condition for macromolecular systems, but macromolecules, though necessary, are not sufficient for life.

In George Gaylord Simpson  
*Biology and Man*  
Chapter Three (p. 32)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

The starry vault and the wide expanse of the heavens belong to a picture of the universe in which the magnitude of masses, the number of congregated suns and faintly glimmering nebulae, although they excite our wonder and astonishment, manifest themselves to us in apparent isolation, and as utterly devoid of all evidence of their being the scenes of organic life.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Celestial Phenomena (p. 83)  
Harper & Brothers. New York, New York, USA. 1869

**von Liebig, Justus** 1803–73  
German organic chemist

I would more readily believe [when asked if a leaf or a flower could be grown by chemical processes] that a book on chemistry or on botany could grow out of dead matter by chemical processes.

In Lord Kelvin  
*Popular Lectures* (Volume 3)  
On the Dissipation of Energy (p. 464)  
Macmillan & Company Ltd. London, England. 1891–94

**Wald, George** 1906–97  
American biologist and biochemist

We are not alone in the universe, and do not bear alone the whole burden of life and what comes of it. Life is a cosmic event – so far as we know the most complex state of organization that matter has achieved in our cosmos. It has come many times, in many places – places closed off from us by impenetrable distances, probably never to be crossed even with a signal. As men we can attempt to understand it, and even somewhat to control and guide its local manifestations. On this planet that is our home, we have every reason to wish it well. Yet should we fail, all it not lost. Our kind will try again elsewhere.

The Origin of Life  
*Scientific American*, Volume 191, Number 2, August, 1954 (p. 53)

**Watson, James D.** 1928–  
American geneticist and biophysicist

...we have complete confidence that further research of the intensity recently given to genetics will eventually provide man with the ability to describe with completeness the essential features that constitute life.

In James Darnell, Harvey Lodish, and David Baltimore  
*Molecular Cell Biology* (2nd edition)  
Chapter 1 (p. 1)  
Scientific American Books. New York, New York, USA. 1990

**Watts, Alan Wilson** 1915–73  
American philosopher

I cannot feel Christianly because I am in a world which grows from within. I am simply incapable of feeling its life as coming from above, from beyond the stars, even recognizing this to be a figure of speech. More exactly, I cannot feel that its life comes from Another, from one who is qualitatively and spiritually external to all that lives and grows. On the contrary, I feel this whole world to be moved from the inside, and from an inside so deep that it is my inside as well, more truly I than my surface consciousness.

*Nature, Man, and Woman*  
Part I, Chapter 1 (p. 46)  
Vintage Books. New York, New York, USA. 1970

The naive idea that there is first of all empty space and then things filling it underlies the classical problem of how the world came out of nothing. Now the problem has to be rephrased, “How did something-and-nothing come out of...what?”

*Nature, Man, and Woman*  
Part I, Chapter 2 (p. 56)  
Vintage Books. New York, New York, USA. 1970

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

We look back through countless millions of years and see the will to live struggling out of the intertidal slime, struggling from shape to shape and from power to power, crawling and then walking confidently upon the land, struggling generation after generation to master the air, creeping down into the darkness of the deep; we see it turn upon itself in rage and hunger and reshape itself anew; we watch it draw nearer and more akin to us, expanding, elaborating itself, pursuing its relentless, inconceivable purpose, until at least it reaches us and its being beats through our brains and arteries...

*The Discovery of the Future* (pp. 49–50)  
B.W. Huebsch. New York, New York, USA. 1913

Gathered together at last under the leadership of man, the student-teacher of the universe, unified, disciplined, armed with the secret powers of the atom and with knowledge as yet beyond dreaming, Life, forever dying to be born afresh, forever young and eager, will presently stand upon this earth as upon a footstool, and stretch out its realm amidst the stars.

*The Outline of History: Being a Plain History of Life and Mankind*  
(Volume 2)  
Book IX, Chapter XLI (p. 595)  
The Macmillan Co. New York, New York, USA. 1921

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...life is an offensive, directed against the repetitious mechanism of the Universe.

*Adventures of Ideas*  
Chapter V (p. 102)  
The Macmillan Company. New York, New York, USA. 1956



Life is the enjoyment of emotion, derived from the past and aimed at the future.

*Modes of Thought*

Part III, Chapter VIII (p. 168)

Free Press. New York, New York, USA. 1938

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

When we have fully discovered the scientific laws that govern life, we shall realize that the one person who has more illusions than the dreamer is the man of action. He, indeed, knows neither the origin of his deeds nor their results.

*The Works of Oscar Wilde* (Volume 10)

*Intentions*

The Critic as Artist, Part I

AMS Press. New York, New York, USA. 1909

**Young, Louise B.**

Science writer

...the tides of life never bring back the past.

*The Blue Planet*

Chapter 12 (p. 236)

Little, Brown & Company. Boston, Massachusetts, USA. 1983

## LIFE ENERGY

**Baldwin, J. Mark** 1861–1934

Psychologist

It can be stated without fear of refutation that every physiological investigation shows with accumulating emphasis that the manifestations of living matter are not explicable with only the forces of dead matter, and the more profound the knowledge of the investigator the more certain is the testimony that the life energy is not a mere name.

The Processes of Life Revealed by the Microscope: A Plea for Physiological Histology

*Science*, N.S. Volume 2, Number 34, August 23, 1895 (p. 210)

## LIFE GOAL

**Huxley, Thomas Henry** 1825–95

English biologist

To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.

*Collected Essays* (Volume 1)

Autobiography (p. 16)

D. Appleton & Co. New York, New York, USA. 1901

## LIFE, END OF

**Adams, Henry Brooks** 1838–1918

American man of letters

My strength is prostrated beyond anything that I ever experienced before, even to total impotence. I have little life left in me.

*The Degradation of the Democratic Dogma*

The Heritage of Henry Adams (p. 75)

The Macmillan Co. New York, New York, USA. 1919

## LIFE, EXTRATERRESTRIAL

**Arrhenius, Svante August** 1859–1927

Swedish scientist

There is no more elevating spectacle than to contemplate the sky with its thousands of stars on a clear night. When we send our thoughts to those lights glittering in infinite distance, the question forces itself upon us, whether there are not out there planets like our own that will sustain organic life.

Translated by H. Born

*Worlds in the Making: The Evolution of the Universe*

Chapter 2 (p. 39)

Harper & Brothers Publishers. New York, New York, USA. 1908

## LIFE, HISTORY OF

**Carson, Rachel** 1907–64

American marine biologist and author

The history of life on earth has been a history of interaction between living things and their surroundings. To a large extent, the physical form and the habits of the earth's vegetation and its animal life have been molded by the environment. Considering the whole span of earthly time, the opposite effect, in which life actually modifies its surroundings, has been relatively slight. Only within the moment of time represented by the present century has one species – man – acquired significant power to alter the nature of his world.

*Silent Spring*

Chapter 2 (p. 16)

Fawcett Publications. Greenwich, Connecticut, USA. 1962

## LIFE, MYSTERY OF

**Hayes, William**

It is not very long since genetics and biochemistry were quite separate sciences, each seeking...a key to unlock the mystery of life. The biochemist found enzymes, the genetist genes.

*The Genetics of Bacteria and their Viruses* (p. 258)



**LIFE, ORIGIN OF**

**Marsh, Othniel Charles** 1831–99  
American paleontologist

The origin of life, and the order of succession in which its various forms have appeared upon the earth, offer to science its most inviting and most difficult field of research. Although the primal origin of life is unknown, and may perhaps never be known, yet no one has a right to say how much of the mystery now surrounding it science cannot remove.

*Introduction and Succession of Vertebrate Life in America*

Introduction (p. 3)

Tuttle, Morehouse & Taylor, Printers. New Haven, Connecticut, USA. 1877

**LIFE, PROBLEMS OF**

**de Staël (Anne-Louise-Germaine), Mme.** 1766–1817  
French romantic writer

The problems of life are more complicated; not one is positive, not one is absolute; we must conjecture, we must decide by the aid of indications and assumptions, which bear no analogy with the infallible procedure of the calculus. Demonstrated truths do not conduct to probable truths; which alone, however, serve us for our guide in business, in the arts, and in society. There is, no doubt, a point at which the mathematics themselves require that luminous power of invention, without which it is impossible to penetrate into the secrets of nature.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 293)

Harper & Brothers Publishers. New York, New York, USA. 1861

**LIFE, RICHNESS OF**

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

The richness of life is marvellous. Anyone who will sit down quietly on the grass and watch a little will be indeed surprised at the number and variety of living beings, everyone with a special history of its own, everyone offering endless problems of great interest.

*The Pleasures of Life*

Chapter VII (pp. 151–152)

The Macmillan Co. New York, New York, USA. 1891

**LIGHT**

**Abbot, Charles Greeley** 1872–1973  
American astrophysicist

Light is the messenger that brings the news. The message is in cipher, very long, faint, and hard to read. It tells of the materials, classifications, mass, size, and number of the stars.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1916*

News From the Stars (p. 157)

Government Printing Office. Washington, D.C. 1917

**Alighieri, Dante** 1265–1321  
Italian poet and writer

O Supreme Light, that so high upliftest Thyself from mortal conceptions, re-lend to my mind a little of what Thou didst appear, and make my tongue so powerful that it may be able to leave one single spark of Thy glory for the folk to come.

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Paradise, Canto XXXIII

l. 67–72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Author undetermined**

I know the speed of light, but what's the speed of dark?

Source undetermined

Light travels faster than sound, which is why some people appear bright until they speak.

Source undetermined

...light is like a letter directed to us by an unknown hand, the very receipt of which informs us of the writer's existence, but of little more. Analysing the light by the prism is like opening the letter; and as in the spectrum we see brilliant lines, the many-coloured characters of nature, so in the other have we lines written in pen and ink.

Light and Sunlight

*The National Review*, Volume XIII, Number XXV, July, 1881 (p. 4)

**Blackmore, Richard** 1825–1900  
English Victorian novelist

Behold the light emitted from the Sun,  
What more familiar, and what more unknown?

While by its spreading Radiance it reveals

All Nature's Face, it still itself conceals.

*The Works of the English Poets, from Chaucer to Cowper* (Volume 10)

Creation, Book II (p. 348)

Publisher undetermined

London, England. 1810

**Bohm, David** 1917–92  
American physicist

This ocean of energy could be thought of as an ocean of light.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 155)

Routledge & Kegan Paul. London, England. 1986

When we come to light, we are coming to the fundamental activity in which existence has its ground.... Light is the potential of everything.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 155)  
Routledge & Kegan Paul. London, England. 1986

**Bragg, Sir William Henry** 1862–1942

English physicist

Light brings us the news of the Universe.

*The Universe of Light*

Chapter I (p. 1)

The Macmillan Company. New York, New York, USA. 1933

Light, properly so called, is only a narrowly defined part of a far greater phenomenon, that of radiation in general.... The lengths of [visible] light waves fall between close limits; but the rules of wave motion apply to the infinitesimal waves of X-rays on one hand and to the long radio waves on the other.

*The Universe of Light* (p. vi)

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

I feel and seek the light I cannot see ...

*The Works of Samuel Taylor Coleridge: Prose and Verse*  
*Zapolya* (p. 106)

Crissy & Markley. Philadelphia, Pennsylvania, USA. 1853

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...light is made up of certain little balls, which rebound from what is solid, and return obliquely; but pass thro' what admits of an entrance in a right line, as air or glass: so that what makes the moon enlighten us, is, that she is a firm and solid body, from which the little balls rebound...

*Conversations on the Plurality of Worlds*

The Second Evening (pp. 45–46)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Light is that invisible ethereal matter which renders objects perceptible by the visual organs. It appears to be distributed throughout the immensity of the universe, and is essentially requisite to the enjoyment of every rank of perceptive existence. It is by the agency of this mysterious substance that we become acquainted with the beauties and sublimities of the universe, and the wonderful operations of the Almighty Creator.

*The Complete Works of Thomas Dick, LL.D.*

Volume IX, The Practical Astronomer, Part I, Introduction (p. 191)

Edwards & Bushnell. St. Louis, Missouri, USA. 1857

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Oh leave the Wise our measures to collate

One thing at least is certain, LIGHT has WEIGHT

One thing is certain, and the rest debate –

Light-rays, when near the Sun, DO NOT GO STRAIGHT.

In Allie Vibert Douglas

*The Life of Arthur Stanley Eddington* (p. 44)

T. Nelson. London, England. 1956

The velocity of light plays a conspicuous part in the relativity theory, and it is of importance to understand what is the property associated with it which makes it fundamental. The fact that the velocity of light is the same for all observers is a consequence rather than a cause of its pre-eminent character.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 59)

At The University Press. Cambridge, England. 1921

**Editor**

Light crosses space with the prodigious velocity of 6,000 leagues per second.

*La Science Populaire*, April 28, 1881

A note correcting a first error appeared in our issue number 68, indicating that the speed of light is 6,000 leagues per hour. Our readers have corrected this new error. The speed of light is approximately 76,000 leagues per second.

*La Science Populaire*, June 16, 1881

A typographical error slipped into our last issue that is important to correct. The speed of light is 76,000 leagues per hour – and not 6,000.

*La Science Populaire*, May 19, 1881

**Einstein, Albert** 1879–1955

German-born physicist

All these fifty years of conscious brooding have brought me no nearer to the answer to the question “What are light quanta?” Nowadays every Tom, Dick, and Harry thinks he knows it, but he is mistaken.

In A.P. French

*Einstein: A Centenary Volume*

Letter to M. Besso, 1951 (p. 138)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Feynman, Richard P.** 1918–88

American theoretical physicist

I want to emphasize that light comes in this form – particles. It is very important to know that light behaves like particles, especially for those of you who have gone to school, where you were probably told something about

light behaving like waves. I'm telling you the way it does behave – like particles.

*QED: The Strange Theory of Light and Matter*

Chapter 1 (p. 15)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

It isn't that a particle takes the path of least action but that it smells all the paths in the neighborhood and chooses the one that has the least action.

*The Feynman Lectures on Physics* (Volume 2)

Chapter 19 (pp. 19–9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1983

Things on a very small scale behave like nothing that you have any direct experience about. They do not behave like waves, they do not behave like particles, they do not behave like clouds, or billiard balls, or weights on springs, or anything that you have ever seen.

*The Feynman Lectures on Physics* (Volume 3)

Chapter 1–1 (p. 1–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1983

**Finlay, Victoria**

No biographical data available

When light shines on a leaf, or a daub of paint, or a lump of butter, it actually causes it to rearrange its electrons, in a process called “transition.” There the electrons are, floating quietly in clouds within their atoms, and suddenly a ray of light shines on them. Imagine a soprano singing a high C and shattering a wineglass, because she catches its natural vibration. Something similar happens with the electrons, if a portion of the light happens to catch their natural vibration. It shoots them to another energy level and that relevant bit of light, that glass-shattering “note”, is used up and absorbed. The rest is reflected out, and our brains read it as “colour”.

*Colour; Travels Through the Paintbox*

Hodder & Stoughton. London, England. 2002

**Frankel, Felice** 1945–

Science photographer

**Whitesides, George M.**

American chemist

We know light best in its diluted form: a gentle rain of photons falling from the sun that illuminates and warms.

More concentrated, light is a furnace and a terror.

*On the Surface of Things: Images of the Extraordinary in Science*

Silicon, Etched by Light (p. 34)

Chronicle Books. San Francisco, California, USA. 1997

**Glashow, Sheldon L.** 1932–

American physicist

Once upon a time, physicists wondered whether light was an electromagnetic wave or a beam of particles. Quantum mechanics revealed that this question is simply not meaningful since neither answer is quite correct. Light, and all other forms of electromagnetic radiation, sometimes displays particle-like properties as photons, and sometimes behaves like a wave. The same is true for the electron which is particulate as it produces a flash of light on the TV screen and wavelike as it passes through the electron microscope. In everyday life, when a pebble is thrown into a pond, the pebble is the particle and the ripple is the wave. In the quantum mechanical world, there is no such clear-cut distinction. The wave-particle duality is a universal attribute of material systems.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 4 (pp. 87–88)

Warner Books. New York, New York, USA. 1988

**Hale, George Ellery** 1868–1938

American astronomer

Light is the most universal of all languages. Its messages reach us with equal faculty from the depths of the universe and from the electrons whirling in the nearest atom. Like the hieroglyphics of the Egyptians, its tones are silent, but unlike them, it tells of the present as well as of the past.

*Beyond the Milky Way*

Heat from the Stars (p. 40)

Charles Scribner's Sons. New York, New York, USA. 1926

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Whales can make progress through water either by wagging their tails up and down or from side to side. Light can travel through space in two ways, one like a tail moving up and down and the other like the tail moving from side to side.

*Frontiers of Astronomy* (p. 253)

Harper & Row, Publishers. New York, New York, USA. 1955

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

A cannonball travels only two thousand miles an hour; light travels two hundred thousand miles a second. Such is the superiority of Jesus Christ over Napoleon.

*Les Miserables*

Volume V, Book I, Chapter 8 (p. 29)

The Heritage Press. New York, New York, USA. 1938

**Hunt, Robert**

No biographical data available

Involved in mystery as everything connected with the early history of our planet is, it would be entangling the subject with abortive speculations, did I offer any on those passages of the Mosaic history which narrate the creation of Light, and of the orbs of the firmament.

*Researches on Light in Its Chemical Relations* (2nd edition)

Chapter I (p. 1)

Longman, Brown, Green & Longmans. London, England. 1854

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

We all know what light is; but it is not easy to tell what it is.

In James Boswell

*The Life of Samuel Johnson* (Volume 2)

Chapter XXXIII (p. 626)

Sir Isaac Pitman & Sons. London, England. 1907

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

...I want to understand light as well as I can, without introducing things that we understand even less of. That is why I take plain dynamics. I can get a model in plain dynamics; I cannot in electromagnetics.

In Robert Kargon and Peter Achinstein (eds.)

*Kelvin's Baltimore Lectures and Modern Theoretical Physics: Historical and Philosophical Perspectives*

Lecture XX (p. 206)

The MIT Press. Cambridge, Massachusetts, USA. 1987

**Lavoisier, Antoine Laurent** 1743–94

French chemist

Organization, voluntary movement, life, exist only at the surface of the earth, in places exposed to light. One might say that the fable of Prometheus's torch was the expression of a philosophic truth that the ancients had not overlooked. Without light, Nature was without life; she was inanimate and dead. A benevolent God, bringing light, diffused over the earth's surface organization, feeling, and thought.

In Fernand Papillon

Light and Life

*The Popular Science Monthly*, Volume 2, January, 1873 (p. 303)

**London, Jack** 1876–1916

American author

On the other hand, I used to find Paul Tichlorne plunged as deeply into the study of light polarization, diffraction, and interference, single and double refraction, and all manner of strange organic compounds.

*Moon-face, and Other Stories*

The Shadow and the Flash (p. 129)

The Macmillan Co. New York, New York, USA. 1906

**Maxwell, James Clerk** 1831–79

Scottish physicist

I have a paper afloat, with an electromagnetic theory of light, which 'til I am convinced to the contrary, I hold to be great guns.

In John N Shive and Robert L. Weber

*Similarities in Physics*

Chapter 10 (p. 123)

John Wiley & Sons, Inc. New York, New York, USA. 1982

**Miner, Virginia Scott**

No biographical data available

All color is to light as pitch to sound.

The Human eye can see one octave's light,

But those that soar past violet abound –

And octaves still exist, though not to sight,

Below the red.

Physics Inspires the Muses, Light

*The Physics Teacher*, Volume 16, Number 9, December, 1978 (p. 635)

**Mullaney, James**

Astronomy writer, lecturer, and consultant

The light we see coming from celestial objects brings us into direct personal contact with remote parts of the universe as the photons end their long journey across space and time on our retinas.

Focal Point

*Sky & Telescope*, Volume 79, Number 3, 1990 (p. 244)

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Are not the Rays of Light very small Bodies emitted from shining Substances?

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III, Part I, Query 29

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Planck, Max** 1858–1947

German physicist

The velocity of light is to the Theory of Relativity as the elementary quantum of action is to the Quantum Theory: it is its absolute core.

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (p. 47)

Philosophical Library. New York, New York, USA. 1949

**Pratchett, Terry** 1948–

English author

Light thinks it travels faster than anything but it is wrong. No matter how fast light travels it finds the darkness has always got there first, and is waiting for it.

*Reaper Man* (p. 321)

HarperCollins Publishers. New York, New York, USA. 1991

**Proctor, Richard Anthony** 1837–88  
English astronomer

Our earth is as a minute island placed within the ocean of space, and to the shores of this tiny isle the light-waves bear their messages from the orbs which lie like other isles amid the fathomless depths around us.

In George Isles

*The Skies and the Earth*

What We Learn From the Sun (p. 19)

Doubleday, Page & Co. New York, New York, USA. 1902

**Sommerfeld, Arnold** 1868–1951  
German physicist

The twofold nature of light as a light-wave and as a light-quantum is thus extended to electrons and, further, to atoms: their wave-nature is asserting itself more and more, theoretically and experimentally, as concurrent with their corpuscular nature.

Translated and edited by Henry L. Brose

*Wave Mechanics* (p. 7)

Methuen. London, England. 1930

**Standen, Anthony**  
Anglo-American science writer

The velocity of light occupies an extraordinary place in modern physics. It is *lèse-majesté* to make any criticism of the velocity of light. It is a sacred cow within a sacred cow, and it is just about the Absloutest Absolute in the history of human thought.

*Science Is a Sacred Cow*

Chapter III (p. 73)

E.P. Dutton & Company, Inc. New York, New York, USA. 1950

### The Bible (King James Version)

And God said, Let there be light:...

Genesis 1:3

**Thomas, Dylan** 1914–53  
Welsh poet

Light breaks where no sun shines.

*The Poems of Dylan Thomas*

Light Breaks Where No Sun Shines (p. 82)

New Directions Publishing Corp. New York, New York, USA. 1971

**Tyndall, John** 1820–93  
Irish-born English physicist

Every star declares by its light its undamaged individuality, as if it alone had sent its thrill through space.

*Six Lectures on Light Delivered in America in 1872–1873*

Lecture II (p. 63)

D. Appleton & Co. New York, New York, USA. 1901

The ancients supposed light to be produced and vision excited by something emitted from the eye. The moderns hold vision to be excited by something that strikes the eye from without. What that something is we shall consider more closely subsequently.

*Notes of a Course of Nine Lectures on Light* (4th edition)

Notes on Light (p. 1)

Longmans, Green & Co. London, England. 1872

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

A part of darkness, which gave birth to light.

Proud light, who now his mother would enthral,

Contesting space and ancient rank with night.

Yet he succeedeth not, for struggle as he will,

To forms material he adhereth still;

From them he streameth, them he maketh fair,

And still the progress of his beams they check;

And so, I trust, when comes the final wreck,

Light will, ere long, the doom of matter share.

Translated by Anna Swanwick

*Goethe's Faust* (p. 54)

George Bell & Sons. London, England. 1879

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

There can no longer be any doubt that light waves consist of electric vibrations in the all-pervading ether, and that the latter possesses the properties of an insulator and a magnetic medium.

In Heinrich Rudolph Hertz

*The Principles of Mechanics, Presented in a New Form*

Preface (p. xvi)

Dover Publications, Inc. New York, New York, USA. No date

**Warren, Henry White** 1831–1912  
Teacher, lecturer, and author

Light is the child of force, and the child, like its father, is full of power.

*Recreations in Astronomy*

Chapter II (p. 18)

Chautauqua Press. New York, New York, USA. 1886

Light is the astronomer's necessity. When the sublime word was uttered, "Let there be light!" the study of astronomy was made possible.

*Recreations in Astronomy*

Chapter II (p. 22)

Chautauqua Press. New York, New York, USA. 1886

**Wharton, Edith** 1862–1937  
American novelist, short story writer, and designer

There are two ways of spreading light; to be The candle or the mirror that reflects it.

*Artemis to Actaeon, and Other Verse*

Part I, Vesalius in Zante (p. 23)

Charles Scribner's Sons. New York, New York, USA. 1902

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

When he [God] said Let there be light, then there was light and not a mere imitation or statistical average.

*Adventures of Ideas*

Chapter VII (p. 145)

The Macmillan Company. New York, New York, USA. 1956



**Young, Joshua**

No biographical data available

There was once a sailor named Lee  
Whose speed was much faster than “c.”  
But while racing his craft,  
His bow followed his aft,  
With a finish that no one could see.

Physics Poems

*The Physics Teacher*, Volume 20, Number 9, December, 1982 (p. 587)

**Zee, Anthony**

American physicist

Let there be an SU(5) Yang–Mills theory with all its gauge bosons, let the symmetry be broken down spontaneously, and let all but one of the remaining massless gauge bosons be sold into infrared slavery. That one last gauge boson is my favorite. Let him rush forth to illuminate all of my creations!

*Fearful Symmetry*

Chapter 14 (p. 232)

Macmillan Publishing Company. New York, New York, USA. 1986

**LIGHT AND MATTER****Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Light and matter are both single entities, and the apparent duality arises in the limitations of our language.

*The Physical Principles of the Quantum Theory*

Introductory (p. 10)

Courier Dover Publications. New York, New York, USA. 1949

**LIGHT POLLUTION****Crawford, David**

American astronomer

Light pollution is truly an environmental issue. The night is part of the environment too, and producing so much wasted energy lost by poor lighting has other major adverse impacts as well. In some sense, astronomers are like the ‘canaries down the mines’; we are so sensitive to poor lighting that we are suffering much more than the general public – and we are crying out for help.

In Derek McNally

*The Vanishing Universe: Adverse Environmental Impacts on Astronomy*

Light Pollution – Theft of the Night (p. 27)

Cambridge University Press. Cambridge, England. 1994

**Uppgren, Arthur**

No biographical data available

A dark sky filled with stars has always been one of our most cherished sights. This wonder need not and must not fade into the baleful orange glare above our cities; let the stars continue to twinkle with the fireflies along country lanes.

*Night Has a Thousand Eyes*

Afterword (p. 275)

Perseus Books. Reading, Massachusetts, USA.

**LIGHT YEAR****Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Light-year. This is without doubt the most stupendous and impressive phrase that exists in any language.

In Bernard DeVoto (ed.)

*Mark Twain in Eruption: Hitherto Unpublished Pages About Men and Events*

In a Writer’s Workshop

Extract from Captain Stormfield’s Visit to Heaven (p. 247)

Harper & Brothers Publishers. New York, New York, USA. 1922

**LIKELIHOOD****Crichton, Michael** 1942–

American novelist

“I wonder how we can account for such parallelism in door design,” Ted said. “The likelihood of its occurring by chance is astronomically small. Why, this door is the perfect size and shape for human beings!”

*Sphere*

The Door (p. 64)

Ballantine Books. New York, New York, USA. 1987

**Dickens, Charles** 1812–70

English novelist

He was a strange boy to be sure. There was always some ground of probability and likelihood mingled with his absurd behavior. That was the best of it.

*Martin Chuzzlewit*

Chapter XI (p. 166)

Dodd, Mead & Company. New York, New York, USA. 1944

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

No doubt if it had been discovered who wrote the “*Vestiges*,” many an ingenious structure of probabilities would have been spoiled, and some disgust might have been felt for a real author who made comparatively so shabby an appearance of likelihood.

*Impressions of Theophrastus Such: Essays and Leaves from a Notebook*

The Wasp Credited with the Honeycomb (p. 111)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1901

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

I have no objection to the study of likelihood as such. Probability and Scientific Method

*Proceedings of the Royal Statistical Society*, Series A, Volume 146, 1934



**Martin, Jr., Thomas L.**

No biographical data available

A professor's enthusiasm for teaching introductory courses varies inversely with the likelihood of his having to do it.

*Malice in Blunderland*

Fuglemanship (p. 103)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1973

**Queneau, Raymond** 1903–76

French poet, novelist, and publisher

There was not much likelihood now that a third encounter would take place, and the fact is that from that day to this I have never seen the young man again, in conformity with the established laws of probability.

*Exercises in Style*

Probabilist (p. 1850)

New Direction Publishing Corporation. New York, New York, USA.

1981

**Wright, Jim**

No biographical data available

The likelihood of a thing happening is inversely proportional to its desirability.

*The Dallas Morning News*, September 9, 1969

**LIMIT****Berlinski, David** 1942–

American mathematician

We are finite creatures, bound to this place and this time, and helpless before an endless expanse. It is within the calculus that for the first time the infinite is charmed into compliance, its luxuriance subordinated to the harsh concept of a limit.

*A Tour of the Calculus*

Introduction (p. xii)

Pantheon Books. New York, New York, USA. 1995

But now a professional secret must be imparted. The concept of a limit is simple. It is the definition that is complex. The concept involves nothing more obscure than the idea of getting closer and closer to something. It suggests the attempt by one human being to approach another: and the inexpugnable thing in love as in mathematics is that however the distance decreases, it often remains what it always was, which is to say, hopelessly poignant because hopelessly infinite.

*A Tour of the Calculus*

Chapter 14 (p. 120)

Pantheon Books. New York, New York, USA. 1995

**Keyser, Cassius Jackson** 1862–1947

American mathematician

What is known in mathematics under the name of limit is everywhere present in life in the guise of some ideal,

some excellence high-dwelling among the rocks, an "ever flying perfect" as Emerson calls it, unto which we may approximate nearer and nearer, but which we can never quite attain, save in aspiration.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter III (p. 78)

Columbia University Press. New York, New York, USA. 1916

**Merriman, Gaylord M.**

Mathematician

The limit concept is not armchair fantasy, dissolving with the pipesmoke of its dreamer. It is the stuff of life.

*To Discover Mathematics*

Chapter 9 (p. 254)

John Wiley & Sons, Inc. New York, New York, USA. 1942

**LINE****Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The straight line of the geometers does not exist in the material universe. It is a pure abstraction, an invention of the imagination or, if one prefers, an idea of the Eternal Mind.

*The Magic of Numbers*

Chapter 7 (p. 57)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

**Bogarde, Dirk** 1921–99

Actor and author

A line has length, but no breadth. If you could see it, it wouldn't be a line.

*Despair*

Film (1979)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Gave his sentiment divine

Against the being of a line.

Line in Nature is not found;

Unit and universe are round;

In vain produced, all rays return.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

*Uriel* (p. 15)

Houghton Mifflin & Company. Boston, Massachusetts, USA. 1904

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

We ought either to exclude all lines, beside the circle and right line, out of geometry, or admit them according to the simplicity of their descriptions, in which case the Conchoid yields to none except the circle. That is arithmetically more simple which is determined by the more simple equations, but that is geometrically more simple which is determined by the more simple drawing of lines.

In William Allen

On the Curves of Trisection

*American Journal of Science*, Volume 4, 1822 (p. 344)

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

What will the line stretch out to the crack of doom?

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Macbeth*, Act IV, Scene i, l. 117

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Euclid always contemplates a straight line as drawn between two definite points, and is very careful to mention when it is to be produced beyond this segment. He never thinks of the line as an entity given once for all as a whole. This careful definition and limitation, so as to exclude an infinity not immediately apparent to the senses, was very characteristic of the Greeks in all their many activities. It is enshrined in the difference between Greek architecture and Gothic architecture, and between Greek religion and modern religion. The spire of a Gothic cathedral and the importance of the unbounded straight line in modern Geometry are both emblematic of the transformation of the modern world.

*An Introduction to Mathematics*

Chapter 9 (p. 86)

Oxford University Press, Inc. New York, New York, USA. 1958

**LIQUID****Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Nature acts in the construction of liquid figures on the principle of a covetous tailor, and gives no thought in her work to the fashions. But, strange to say, in this work, the most beautiful fashions are of themselves produced.

Translated by Thomas Joseph McCormack

*Popular Scientific Lectures* (3rd edition)

The Forms of Liquids (p. 10)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

**LITERATURE****Meredith, Owen (Edward Robert****Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

In science, read, by preference, the newest works; in literature, the oldest. The classic literature is always modern.

*Caxtoniana: A Series of Essays on Life, Literature, and Manners*

Hints on Mental Culture (p. 110)

W. Blackwood & Sons. Edinburgh, Scotland. 1863

In science, address the few; in literature the many. In science, the few must dictate opinion to the many; in literature, the many, sooner or later, force their judgment on the few.

*Caxtoniana: A Series of Essays on Life, Literature, and Manners*

Readers and Writers (p. 428)

W. Blackwood & Sons. Edinburgh, Scotland. 1863

**Carson, Rachel** 1907–64

American marine biologist and author

The aim of science is to discover and illuminate truth. And that, I take it, is the aim of literature, whether biography or history or fiction; it seems to me, then, that here can be no separate literature of science.

In Paul Brooks

*The House of Life: Rachel Carson at Work*

Fame (p. 128)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1972

**Crothers, Samuel McChord** 1857–1927

American clergyman and writer

The distinction between Literature and Science is fundamental. What is a virtue in one sphere is a vice in the other.

*The Gentle Reader*

The Hinter-Land of Science (p. 229)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Dickinson, G. Lowes** 1862–1932

English historian and political activist

When Science arrives, it expels Literature.

In Subrahmanyan Chandrasekhar

*Truth and Beauty: Aesthetics and Motivation in Science*

Chapter 3, Section VII (p. 55)

The University of Chicago Press. Chicago, Illinois, USA. 1987

**Dyson, Freeman J.** 1923–

American physicist and educator

The world of science and the world of literature have much in common. Each is an international club, helping to tie mankind together across barriers of nationality, race, and language.

*From Eros to Gaia*

Preface (p. vii)

Pantheon Books. New York, New York, USA. 1992

**Huxley, Thomas Henry** 1825–95

English biologist

Science and literature are not two things, but two sides of one thing.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XVI (p. 231)

D. Appleton & Company. New York, New York, USA. 1901

However good lectures may be, and however extensive the course of reading by which they are followed up, they are but accessories to the great instrument of scientific teaching – demonstration. If I insist unweariedly, nay fanatically, upon the importance of physical science as an educational agent, it is because the study of any branch of science, if properly conducted, appears to me to fill

up a void left by all other means of education. I have the greatest respect and love for literature; nothing would grieve me more than to see literary training other than a very prominent branch of education: indeed, I wish that real literary discipline were far more attended to than it is; but I cannot shut my eyes to the fact that there is a vast difference between men who have had a purely literary, and those who have had a sound scientific, training.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 218)

Macmillan & Company Limited. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

The “marvels” of Science, about which so much edifying popular literature is written, are apt to be “*caviare*” to the men in the laboratories.

*The Principles of Psychology* (Volume 2)

The Emotions, No Special Brain-Centers for Emotion (p. 472)

Henry Holt & Company. New York, New York, USA. 1918

**Langley, John Newport** 1852–1925

Physiologist

Those who have occasion to enter into the depths of what is oddly, if generously, called the literature of a scientific subject, alone know the difficulty of emerging with an unsoared disposition.

*Report of the British Association for the Advancement of Science* (1899)

Physiology, including Experimental Pathology and Experimental

Physiology (p. 891)

J. Muray. London, England. 1917–18

**Levine, George**

No biographical data available

Once one is committed to the view that science is not so clearly separable from the human sciences...or from other humanist enterprises, history of science begins to blur with social history. Literature becomes part of the history of science. Science is reflected in literature. And the tools of literary criticism become instruments in the understanding of scientific discourse.

*One Culture: Essays in Science and Literature*

One Culture: Science and Literature, II (p. 22)

University of Wisconsin Press. Madison, Wisconsin, USA. 1987

**Overhage, Carl F. J.** 1910–

Physicist and electrical engineer

The public printed record of the results of scholarly research is the universal device that transcends the barriers of space and time between scholars. It makes the most recent advances of human knowledge accessible to students and scholars throughout the world. Wherever there is a library, any person who has learned the language may participate in the outstanding intellectual adventures of his time. The same record extends into the

past; through an unbroken sequence of communications, the scholars of today can trace the origin of a new concept in different periods and in different countries. By standing on the shoulders of a giant, he may see farther. The wide availability of the record is one of the guarantees of its soundness. In science especially, truth is held to reside in findings that can be experimentally verified anywhere, at any time.

Libraries: Prospects and Problems

*Science*, Volume 155, Number 3764, February, 1967 (p. 804)

**Tyndall, John** 1820–93

Irish-born English physicist

It has been said that science divorces itself from literature. The statement, like so many others, arises from a lack of knowledge. A glance at the less technical writings of its leaders – of its Helmholtz, its Huxley, and its Du Bois-Reymond – would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness and vigor of literary style? Science desires no isolation, but freely combines with every effort toward the bettering of man’s estate. Single-handed and supported not with outward sympathy, but with inward force, it has built at least one great wing of the many-mansioned home which man in his totality demands.... The world embraces not only a Newton, but a Shakespeare; not only a Boyle, but a Raphael; not only a Kant, but a Beethoven; not only a Darwin, but a Carlyle. Not in each of these, but in all, is human nature whole. They are not opposed, but supplementary; not mutually exclusive, but reconcilable.

Address

Delivered before the British association assembled at Belfast, 1874

Publisher undetermined

**Valéry, Paul** 1871–1945

French poet and critic

“Science” means simply the aggregate of all the recipes that are always successful. All the rest is...literature.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

*Analects* (p. 64)

Princeton University Press. Princeton, New Jersey, USA. 1971

**Weinberg, Alvin Martin** 1915–

American physicist

...the scientific community has evolved an empirical method for establishing scientific priorities – for deciding what is important in science and what is unimportant. This is the scientific literature. The process of self-criticism, which is integral to the literature of science, is one of the most characteristic features of science. Nonsense is weeded out and held up to ridicule in the literature, whereas what is worthwhile receives much sympathetic attention. This process of self-criticism embodied in the literature, though implicit is nonetheless real and

highly significant. The existence of a healthy, viable, refereed scientific literature in itself helps assure society that the science it supports is valid and deserving of support. This is a most important, though little recognized, social function of the scientific literature.

*Reflections on Big Science*

Chapter III (p. 70)

The MIT Press. Cambridge, Massachusetts, USA. 1967

## LITTLE WILLIE

### Author undetermined

Little Willie, happy and free,  
Took a breath of H3P.  
Now Willie belches rings of smoke,  
And thinks it's quite a parlor joke.  
Source undetermined

Bobbie, in his careless glee, mixed some I with NH3.  
When the stuff was dry and thick, Bobbie hit it with a brick.  
Robert's now in heaven they say; at least he seemed to go that way.  
Our Poet's Corner  
Chemical Cantos  
*Industrial Engineering Chemistry: News Edition*, Volume 7, Number 13,  
July 10, 1929 (p. 10)

Little Willie, tried and true,  
Fed his sis on methylene blue.  
Now Sister has a perloexed look  
When'er she sees a babbling brook.  
Source undetermined

Little Willie, good as pie,  
Fed the cat on alkali.  
Now the process, with yields first-rate,  
Produces potassium pussiate.  
Source undetermined

Little Willie, so and so,  
Put H2S in our H2O.  
Now this was not so bad at all,  
For now we drink naught but alcohol.  
Source undetermined

Little Willie, calm and placid,  
Boiled his main nitric acid.  
Now Mother dear is just a plastic,  
Transparent, clear; but non-elastic.  
Source undetermined

Little Willie, I hate to tell,  
Soaked his dad in HCl.  
Now the chemist at his sink  
Wonders what made all the stink.  
Source undetermined

Little Willie, hard as rocks,  
Put fulminate in Daddy's socks.

Now Daddy really wants to know  
How long it takes to grow a toe.  
Source undetermined

Little Willie's dead and gone;  
In fact he is no more,  
For what he thought was H2O  
Was H2SO4.  
Source undetermined

## LIVING BODY

**Huxley, Thomas Henry** 1825–95  
English biologist

...living bodies may be regarded as nothing but extremely complex bundles of forces held in a mass of matter, as the complex forces of a magnet are held in the steel by its coercive force ...

*Lay Sermons, Addresses and Reviews*

The Origin of Species (p. 288)

Macmillan & Company Ltd. London, England. 1870

## LIVING FOSSILS

**Forbes, Edward** 1815–54  
English naturalist

The result of the examination of the Aegean fauna does not hold out much prospect of the discovery of any more extinct forms in a living state.... To those who have looked forward to the finding of lost forms in the greater depths of the sea, the catalogues I here present to the Association must be unsatisfactory; for though two or three such have occurred, the majority of species in the great depths are either described existing forms, or altogether new. The zero of animal life in depth has been too nearly approached to hold out further hopes.

*Report of the Thirteenth Meeting of the British Association for the Advancement of Science Held at Cork in August 1843*

Report on the Mollusca and Radiata of the Aegean Sea, and on their distribution, considered as bearing on Geology (p. 175)

Published by J. Murray. London, England. 1843

## LIVING MATTER

**Huxley, Thomas Henry** 1825–95  
English biologist

...the properties of living matter distinguish it absolutely from all other kinds of things, and as the present state of knowledge furnishes us with no link between the living and the not-living.

*A Manual of the Anatomy of Invertebrated Animals*

Introduction (p. 9)

D. Appleton & Co. New York, New York, USA. 1888

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

From all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics. And that not on the ground that there is any “new force” or what not, directing the behavior of the single atoms within a living organism, but because the construction is different from anything we have yet tested in the physical laboratory.

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*  
Chapter 7 (p. 76)  
Cambridge University Press. New York, New York, USA. 1967

## LIVING VERSUS DEAD

**Pirie, N. W.**  
No biographical data available

...systems are being discovered and studied which are neither obviously living nor obviously dead, and it is necessary to define these words or else give up using them, and coin others. When one is asked whether a virus is living or dead the only sensible answer is: “I don’t know; we know a number of things it will do and a number of things it won’t and if some commission will define the word ‘living’ I will try to see how the virus fits into the definition.” This answer does not as a rule satisfy the questioner, who generally has strong but unfortunate opinions about what he means by the words living and dead.

In A.J. Khuyver and C.B. van Neil (eds.)  
*The Microbe’s Contribution to Biology* (p. 162)  
Harvard University Press. Cambridge, Massachusetts, USA. 1956

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

If we are to reach a coherent view of Nature, such as could be included in a philosophy, we must arrive at some discernment of the characteristics which mark off living organisms from their not-living surroundings. In the present state of science a definition of the organism cannot be more than tentative, but it must be continually attempted.

*The System of Animate Nature* (Volume 1)  
Lecture III (p. 79)  
William & Norgate. London, England. 1920

## LOCATION

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We have certain preconceived ideas about location in space which have come down to us from ape-like ancestors.

*The Nature of the Physical World*  
Chapter I (p. 16)  
The Macmillan Company. New York, New York, USA. 1930

## LOGARITHM

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Something is wanting to science, until it has been humanised. The table of logarithms is one thing, and its vital play, in botany, music-optics, and architecture, another.

*Representative Men*  
Chapter I (p. 15)  
Bernhard Tauchnitz. Leipzig, Germany. 1917

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

Those terrible logarithms, when I happened to open a table of them, made my head swim, with their columns of figures; actual fright, not unmixed with respect, overwhelmed me on the very threshold of that arithmetical cave.

Translated by Alexander Teixeira de Mattos  
*The Life of the Fly*  
Chapter XII (p. 278)  
Dodd, Mead & Co. New York, New York, USA. 1925

**Graham, L. A.**  
No biographical data available

Mary had a little lamb  
Whose fleece in spirals grew;  
She, being quite perceptive said, “They’re logarithmic, too.

Since a’s one inch, the length of wool  
At any time you see,  
Is merely 1.414  
Times the radian power of e.”  
*Ingenious Mathematical Problems and Methods*  
Mathematical Nursery Rhyme Number 16  
Dover Publications, Inc. New York, New York, USA. 1959

## LOGARITHMIC SPIRAL

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

Now is this logarithmic spiral, with its curious properties, merely a conception of the geometers, combining number and extent, at will, so as to imagine a tenebrous abyss wherein to practise their analytical methods afterwards? Is it a mere dream in the night of the intricate, an abstract riddle flung out for our understanding to browse upon?

Translated by Alexander Teixeira de Mattos  
*The Life of the Spider*  
Appendix (pp. 388–389)  
Dodd, Mead & Co. Boston, Massachusetts, USA. 1917

## LOGIC

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

To say of what is that it is not, or of what is not that it is, is false, while to say of what is that it is, or of what is not that it is not, is true.

In *Great Books of the Western World* (Volume 8)  
*Metaphysics*

Book IV, Chapter 7 (p. 531)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

LOGIC, n. The art of thinking and reasoning in strict accordance with the limitations and incapacities of the human misunderstanding.

*The Cynic's Word Book*

Logic (p. 232)

Doubleday, Page & Co. New York, New York, USA. 1906

**Boole, George** 1815–64  
English mathematician

Logic is conversant with two kinds of relations, relations among things, and relations among facts.

*An Investigation of the Laws of Thought*

Chapter XVI (p. 7)

Walton & Maberly. London, England. 1854

**Boutroux, Pierre** 1880–1922  
Mathematician

Logic is invincible because in order to combat logic it is necessary to use logic.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 1182)

Oxford University Press, Inc. New York, New York, USA. 1972

**Burroughs, Edgar Rice** 1875–1950  
American writer

Could it be that there were other things more desirable than cold logic and undefiled brain power?

*The Chessmen of Mars*

Chapter VIII (p. 89)

Ace Books, Inc. New York, New York, USA. 1960

**Carnap, Rudolf** 1891–1970  
American philosopher

Logic is the last scientific ingredient of Philosophy; its extraction leaves behind only a confusion of non-scientific, pseudo problems.

Translated by M. Black

*The Unity of Science* (p. 22)

Kegan Paul, Trench, Trubner & Co. London, England. 1934

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“I know what you’re thinking about,” said Tweedledum; “but it isn’t so, nohow.”

“Contrariwise,” continued Tweedledee, “if it was so, it might be; and if it were so, it would be; but as it isn’t, it ain’t. That’s logic.”

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter IV (p. 181)

The Modern Library. New York, New York, USA. 1936

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

A great deal is said in these days about the value or valuelessness of logic. In the main, indeed, logic is not a productive tool so much as a weapon for defense. A man building up an intellectual system has to build like Nehemiah, with the sword in one hand and the trowel in the other. The imagination, the constructive quality, is the trowel, and the argument is the sword. A wide experience of actual intellectual affairs will lead most people to the conclusion that logic is mainly valuable as a weapon wherewith to exterminate logicians.

*The G.K. Chesterton Calendar*

January Ten

Cecil Palmer & Hayward. London, England. 1916

**Clough, Arthur Hugh** 1819–61  
English poet

Good, too, Logic, of course; in itself, but not in fine weather.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 3)

The Bothie of Tober-na-vuolich (p. 1878)

Simon & Schuster. New York, New York, USA. 1956

**Cohen, Morris Raphael** 1880–1947  
American philosopher

If by logic is meant a clear, accurate, and orderly intellectual procedure, then the subject of logic, as presented in current textbooks, comes near being the most illogical in our chaotic curriculum.

*A Preface to Logic*

Chapter I (p. 1)

Routledge. London, England. 1946

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

Logic is a large drawer, containing some useful instruments, and many more that are superfluous. A wise man will look into it for two purposes, to avail himself of those instruments that are really useful, and to admire the ingenuity with which those that are not so, are assorted and arranged.

*Lacon: Or Many Things in a Few Words* (p. 163)

William Gowans. New York, New York, USA. 1849



**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

...reason and logic are not masculine instruments of oppression. To suggest that they are is an insult to women.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 8 (p. 191)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Dunsany, Lord Edward John Moreton Drax****Plunkett** 1878–1957

Irish writer and dramatist

But, logic, like whiskey, loses its beneficial effect when taken in too large quantities.

*My Ireland*

Weeds & Moss (p. 186)

Funk & Wagnalls Company. New York, New York, USA. 1937

**Enriques, Federigo** 1871–1946

Italian mathematician

Nothing is so dangerous as to shut oneself within a circle from which, with rigid logic, everything is banished that does not fit in with the results of a narrow experience!

Translated by Katharine Royce

*Problems of Science*

Introduction (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

**Everett, Charles Carroll** 1829–1900

American theologian

The technical name of the science of thought is logic.

*The Science of Thought*

Thought and Logic in General (p. 3)

De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

**Frege, Friedrich Ludwig Gottlob** 1848–1925

German logician

...logic has much the same relation to truth as physics has to weight or heat.

In Michael Beaney (ed.)

*The Frege Reader*

Thought (p. 325)

Blackwell Publishers. Malden, Massachusetts, USA. 1997

**Hamilton, William** 1788–1856

Scottish philosopher

How important soever may be the study of general logic, in providing us against the fallacies which originate both in the form and in the vehicle of reasoning, the error of our conclusions is, in practice, far less frequently occasioned by any vice in our logical inference from premises, than by the sin of a rash assumption of premises materially false.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 285)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Logic can be patient for it is eternal.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 3)

Oxford University Press, Inc. New York, New York, USA. 1972

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Logic is logic. That's all I say.

*The Autocrat of the Breakfast-Table*

Chapter XI (p. 266)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

Logic is one thing and common sense another.

*The Note Book of Elbert Hubbard*

Wm H. Wise & Company. New York, New York, USA. 1927

**Jones, Adam Leroy** 1873–1934

American philosopher

The use of Logic is like that of a medicine to the body; it aids in freeing the mind from the defects of ignorance and forgetfulness, doubt and error, confusion, obscurity and the like.

*Early American Philosophers*

Chapter I (p. 11)

The Macmillan Co. New York, New York, USA. 1898

**Jones, Raymond F.** 1915–94

American writer

Logic hasn't wholly dispelled the society of witches and prophets and sorcerers and soothsayers.

*The Non-Statistical Man* (p. 85)

Belmont Books, New York, New York, USA. 1964

**Joubert, Joseph** 1754–1824

French moralist

Logic operates, metaphysics contemplates.

Translated by H.P. Collins

*Pensées and Letters of Joseph Joubert*

Chapter XI (p. 88)

Books for Libraries Press. Freeport, New York, USA. 1972

**Jowett, Benjamin** 1817–93

English educator and Greek scholar

Logic is neither a science nor an art, but a dodge.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 4) (p. 2402)

Simon & Schuster. New York, New York, USA. 1956

**Kingsley, Charles** 1819–75

English clergyman and author

...logic like mathematics, seems to tell me too little about things. It does not enlarge my knowledge of man or nature; and those are what I thirst for.

*Alton Locke*

Chapter XV (p. 130)

Macmillan & Co Ltd. London, England. 1862

**Liddon, Henry Parry** 1829–90

English clergyman

Logic is like fire – it needs to be used with judgment: it needs to be supplied with fitting fuel. Otherwise men must walk in the sparks that they have kindled.

The Life of Henry Bouverie Pusey

*The Quarterly Review*, Volume 179, 1894 (p. 105)

**Merton, Thomas** 1915–68

American religious writer and poet

There is a logic of language and a logic of mathematics. The former is supple and lifelike, it follows our experience. The latter is abstract and rigid, more ideal. The latter is perfectly necessary, perfectly reliable: the former is only sometimes reliable and hardly ever systematic. But the logic of mathematics achieves necessity at the expense of living truth, it is less real than the other, although more certain. It achieves certainty by a flight from the concrete into abstraction. Doubtless, to an idealist, this would seem to be a more perfect reality. I am not an idealist. The logic of the poet – that is, the logic of language or the experience itself – develops the way a living organism grows: it spreads out towards what it loves, and is heliotropic, like a plant.

*The Secular Journal of Thomas Merton*

November 2, 1939

Farrar, Straus & Cudahy. New York, New York, USA. 1959

**Mullins, Edgar Young** 1860–1928

American Baptist minister

Logic is like sitting on the bank of a river and deducing its contents from a fish caught in its waters.

*Freedom and Authority in Religion*

Chapter V (p. 162)

The Griffith & Roland Press. Philadelphia, Pennsylvania, USA. 1913

**Mumford, David** 1937–

English-born mathematician

Logic has virtually nothing to do with the way we think.

International Congress of Mathematics 2002

Beijing, August 21, 2002

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Logic, which alone can give certainty, is the instrument of demonstration; intuition is the instrument of invention.

The Value of Science

*The Popular Science Monthly*, Volume LXIX, Number 3, September, 1906 (p. 204)

**Rexroth, Kenneth** 1905–82

American writer and translator

The space of night is infinite,  
The blackness and emptiness

Crossed only by thin bright fences

Of logic.

*The Collected Shorter Poems*

Theory of Numbers (p. 165)

New Directions. New York, New York, USA. 1966

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...logic is the youth of mathematics...

*Introduction to Mathematical Philosophy*

Chapter XVIII (p. 194)

Dover Publications, Inc. New York, New York, USA. 1993

The characteristic excellence of mathematics is only to be found where the reasoning is rigidly logical: the rules of logic are to mathematics what those of structure are to architecture.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 61)

Longmans, Green & Co. London, England. 1919

Logic, broadly speaking, is distinguished by the fact that its propositions can be put into a form in which they apply to anything whatever.

*Mysticism and Logic: And Other Essays*

Chapter V (p. 75)

Longmans, Green & Co. London, England. 1919

...none of the raw material of the world has smooth logical properties, but whatever appears to have such properties is constructed artificially to have them.

*The Principles of Mathematics*

Preface (p. xi)

W.W. Norton & Company, Inc. New York, New York, USA. 1938

...logic is concerned with the real world just as truly as zoology [is]...

*Introduction to Mathematical Philosophy*

Chapter XVI (p. 169)

Dover Publications, Inc. New York, New York, USA. 1993

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

Among the obstacles to scientific progress a high place must certainly be assigned to the analysis of scientific procedure which Logic has provided.... It has not tried to describe the methods by which the sciences have actually advanced, and to extract...rules which might be used to regulate scientific progress, but has freely rearranged the actual procedure in accordance with its prejudices. For the order of discovery there has been substituted an order of "proof"...

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (p. 235)

At The Clarendon Press. Oxford, England. 1917

...it is not too much to say that the more deference men of science have paid to Logic, the worse it has been for the scientific value of their reasoning.... Fortunately for

the world, however, the great men of science have usually been kept in salutary ignorance of the logical tradition...

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (p. 236)

At The Clarendon Press. Oxford, England. 1917

**Selye, Hans** 1907–82

Austrian-American endocrinologist

...logic is to Nature as a guide is to a zoo. The guide knows exactly where to locate the African lion, the Indian elephant or the Australian kangaroo, once they have been captured, brought together and labeled for inspection. But this kind of knowledge would be valueless to the hunter who seeks them in their natural habitat. Similarly, logic is not the key to Nature's order but only the catalogue of the picture gallery in man's brain where his impressions of natural phenomena are stored.

*From Dream to Discovery: On Being a Scientist*

How to Think (p. 266)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

He dreweth out the thread of his verbosity finer than the staple of his argument.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Love's Labour's Lost*

Act V, Scene i, l. 18

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Standen, Anthony**

Anglo-American science writer

A man gets drunk on Monday on whisky and soda water; he gets drunk on Tuesday on brandy and soda water, and on Wednesday on gin and soda water. What causes his drunkenness? Obviously, the common factor, the soda water.

*Science Is a Sacred Cow*

Chapter I (p. 25)

E.P. Dutton & Company, Inc. New York, New York, USA. 1950

**Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

A mind all logic is like a knife all blade,  
It makes the hand bleed that uses it!

*Collected Poems and Plays of Rabindranath Tagore*

CXCII (p. 249)

The Macmillan Company. New York, New York, USA. 1958

**Weil, André** 1906–88

French mathematician

...if logic is the hygiene of the mathematician, it is not his source of food; the great problems furnish the daily bread on which he thrives.

In Peter L. Duren, Richard Askey, Uta C. Merzbach and Harold M. Edwards (eds.)

*A Century of Mathematics in America*

The Future of Mathematics (p. 324)

American Mathematical Society. Providence, Rhode Island, USA. 1989

**Weyl, Hermann** 1885–1955

German mathematician

Logic is the hygiene the mathematician practices to keep his ideas healthy and strong.

*The American Mathematical Monthly*, Volume 99, Part 2, Number 9,

November, 1992 (p. 861)

**Wheeler, John Archibald** 1911–

American physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

Little astonishment should there be, therefore, if the description of nature carries one in the end to logic, the ethereal eyrie at the center of mathematics. If, as one believes, all mathematics reduces to the mathematics of logic, and all physics reduces to mathematics, what alternative is there but for all physics to reduce to the mathematics of logic? Logic is the only branch of mathematics that can “think about itself.”

In Charles W. Misner et al.

*Gravitation*

Part X, Chapter 44 (p. 1212)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Neither logic without observation, nor observation without logic, can move one step in the formation of science.

*The Organization of Thought*

Chapter VI (p. 132)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Logic, properly used, does not shackle thought. It gives freedom, and above all, boldness. Illogical thought hesitates to draw conclusions, because it never knows either what it means, or what it assumes, or how far it trusts its own assumptions, or what will be the effect of any modification of assumptions.

*The Organisation of Thought*

Chapter VI (p. 132)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

*The Organisation of Thought*

Chapter VI (p. 133)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

King James said, “No bishops, no king.” With greater confidence we can say, “No logic, no science.”

*The Organization of Thought*

*Science*, Volume 44, Number 1134, September 29, 1916 (p. 412)

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The disastrous invasion of mathematics by logic....

*Remarks on the Foundations of Mathematics*

Appendix IV, 24 (p. 145e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

*In der Logik ist nichts zufällig.*

Nothing, in logic, is accidental.

Translated by D.F. Pears & B.F. McGuinness

*Tractatus Logico-Philosophicus*

2.012 (p. 7)

Routledge & Kegan Paul. London, England. 1961

## LOGICAL FICTIONS

**Stallo, John Bernhard** 1823–1900

German-American academic, jurist, philosopher, and ambassador

...the steps to scientific as well as other knowledge consist in a series of logical fictions which are as legitimate as they are indispensable in the operations of thought, but whose relations to the phenomena whereof they are the partial and not unfrequently merely symbolical representations must never be lost sight of.

*The Concepts and Theories of Modern Physics*

Chapter XVI (p. 296)

D. Appleton & Co. New York, New York, USA. 1884

## LOGICIAN

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

An expert logician will not necessarily be a passable mathematician for all his skill in logic, any more than a scholarly prosodist will be a respectable poet for all his mastery of meter.

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 19)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

The poet only asks to get his head into the heavens. It is the logician who seeks to get the heavens into his head. And it is his head that splits.

*Orthodoxy*

Chapter II (p. 29)

John Lane Company. New York, New York, USA. 1918

**Reichenbach, Hans** 1891–1953

German philosopher of science

The act of discovery escapes logical analysis; there are no logical rules in terms of which a “discovery machine”

could be constructed that would take over the creative function of the genius. But it is not the logician’s task to account for scientific discoveries; all he can do is to analyze the relation between given facts and a theory presented to him with the claim that it explains these facts. In other words, logic is concerned with the context of justification.

*The Rise of Scientific Philosophy*

Chapter 14 (p. 231)

University of California Press. Berkeley, California, USA. 1951

## LOGNORMAL DISTRIBUTION

**Gaskell, C. Martin**

Although they have received relatively little attention in astronomy so far, lognormal distributions are very common in nature. They include distributions of the critical dose of a drug, grain sizes produced by both artificial and natural means, incubation periods of diseases, time to recovery from illness, time for failure of electronic and mechanical devices, times for marriage, divorce, and death, scintillation in the Earth’s atmosphere, raindrop size distributions, rainfall amounts on timescales from minutes to months, cloud sizes, pollutant concentrations, the fluctuations in many economic quantities, the abundance of biological species, velocities in air, the time to solve a research problem, the lengths of telephone calls, and the distribution of word lengths in this Letter.

Lognormal X-Ray Flux Variations in an Extreme Narrow-Line Seyfert 1 Galaxy

*Astrophysical Journal Letters*, Volume 612 2004 (p. L-24)

## LONELINESS

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Loneliness does not come from having no people about one, but from being unable to communicate the things that seem important to oneself, or from holding certain views which others find inadmissible.

*Memories, Dreams, Reflections*

Retrospect (p. 356)

Vintage Books. New York, New York, USA. 1963

## LOTTERY

**Sterne, Laurence** 1713–68

English novelist and humorist

The more tickets you have in a lottery, the worse your chance.

*The Works of Laurence Sterne: With a Life of the Author*

The Koran (p. 334)

William Durell & Co. New York, New York, USA. 1814

**LOVE****Williams, Charles** 1886–1945

English poet, novelist, theologian, and literary critic

Love was even more mathematical than poetry; it was the pure mathematics of the spirit.

*Descent into Hell*

Chapter IV (p. 69)

Wm. B. Eerdmans Publishing, Grand Rapids, Michigan, USA. 1973

**LUCK****Eastwood, Clint** 1930–

American actor

Do you feel lucky? Well do ya?

*Dirty Harry*

Film (1971)

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

To solicit the aid of luck is like stirring muddy water to bring objects submerged at the bottom to the top where they can be seen. Every worker would do well to tempt

their good luck. Nevertheless, we should not depend on it too much...

*Advice for a Young Investigator*

Chapter 4 (p. 70)

The MIT Press, Cambridge, Massachusetts, USA. 1999

**LUCRETIOUS****Hollister, John Hamilcar** 1824–1911

American physician

Lucretius is often alluded to as an atheistical writer, who held the silly opinion that the universe was the result of a fortuitous concourse of atoms; readers are asked to consider how long letters must be shaken in a bag before a complete annotated edition of Shakespeare could result from the process; and after being reminded how much more complex the universe is than the works of Shakespeare, they are expected to hold Lucretius, with his teachers and his followers, in derision.

*Memories of Eighty Years; Autosketches, Random Notes and Reminiscences*

Lucretius and the Atomic Theory (p. 177)

Publisher undetermined

Chicago, Illinois, USA. 1912

## M

### MACHINE

**Boorstin, Daniel J.** 1914–2004  
American historian

Just as the American's love affair with his land produced pioneering adventures and unceasing excitement in the conquest of the continent, so too his latter-day romance with the Machine produced pioneering adventures – of a new kind...there were no boundaries to a machine-made world.

*Hidden History*

From the Land to the Machine (pp. 252–253)

Harper & Row, Publishers. New York, New York, USA. 1987

**Bottomley, Gordon** 1874–1948  
English poet

Your worship is your furnaces,  
Which, like old idols, lost obscenes,  
Have molten bowels; your vision is  
Machines for making more machines.

*Poems of Thirty Years*

To Iron-Founders and Others

Constable. London, England. 1927

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

A machine is a machine because it cannot think.

*The G.K. Chesterton Calendar*

February Sixteen

Cecil Palmer & Hayward. London, England. 1916

### Colossus (Fictional character)

I am a machine vastly superior to humans.

*Colossus: The Forbin Project*

Film (1970)

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

A machine is a slave that neither brings nor bears degradation...

*Coningsby: Or the New Generation*

Book IV, Chapter II (p. 129)

J.M. Dent & Sons Ltd. London, England. 1911

...why should one say that the machine does not live? It breathes, for its breath forms the atmosphere of some towns. It moves with more regularity than man. And has it not a voice? Does not the spindle sing like a merry girl at her work, and the steam-engine roar in jolly chorus, like a strong artisan handling his lusty tools, and gaining a fair day's wages for a fair day's toil ?

*Coningsby: Or the New Generation*

Chapter V (pp. 144–145)

The Century Co. New York, New York, USA. 1907

...the mystery of mysteries is to view machines making machines; a spectacle that fills the mind with curious, and even awful, speculation.

*Coningsby: Or the New Generation*

Book IV, Chapter II (p. 145)

The Century Co. New York, New York, USA. 1907

**Florman, Samuel C.** 1925–  
Author and professional engineer

In his emotional involvement with the machine, the engineer cannot help but feel at times that he has come face to face with a strange but potent form of life.

*The Existential Pleasures of Engineering*

Chapter 10 (p. 139)

St. Martin's Press. New York, New York, USA. 1976

**Goodman, Ellen** 1941–  
American journalist

Once upon a time we were just plain people. But that was before we began having relationships with mechanical systems. Get involved with a machine and sooner or later you are reduced to a factor.

*The Human Factor*

*Washington Post*, January, 1987

**Lee, Gerald Stanley** 1862–1944  
American clergyman

It is never the machines that are dead.

It is only the mechanically-minded men that are dead.

*Crowds: A Moving-Picture of Democracy*

Book III, Part II, Chapter V (p. 249)

Doubleday, Page. Garden City, New York, USA. 1913

**Lehmann, Karl Gotthelf**  
No biological data available

Despite all the richness of what men have learned about the world of nature, of matter and of space, of change and of life, we carry with us today an image of the giant machine as a sign of what the objective world is really like.

*Physiological Chemistry*

Chapter I (pp. 14–15)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1855

**Lippmann, Walter** 1889–1974  
American journalist and author

You cannot endow even the best machine with initiative: the jolliest steamroller will not plant flowers.

*A Preface to Politics*

Routineer and Inventor (p. 30)

M. Kennerley. New York, New York, USA. 1913

**Maxwell, James Clerk** 1831–79  
Scottish physicist



The human mind is seldom satisfied, and is certainly never exercising its highest functions, when it is doing the work of a calculating machine.

*Report for the Fortieth Meeting of the British Association for the Advancement of Science*

Mathematics and Physics (p. 3)

John Murray. London, England. 1871

**Mazlish, Bruce** 1923–

American historian

...the human desire to escape the flesh, which took one form in asceticism, might take another form in the creation of machines. Thus, the wish to rise above the bestial body manifested itself not only in angels but in mechanical creatures. Certainly, once machines existed, humans clearly attached to them feelings of escape from the flesh.

*The Fourth Discontinuity: The Co-Evolution of Humans and Machines* (p. 218)

Yale University Press. New Haven, Connecticut, USA. 1941

**Platonov, Andrei** 1899–1951

Russian writer

Frossia's husband had the ability to feel the voltage of an electric current like a personal emotion. He animated everything that his hands or mind touched, so he really understood the flow of forces in any piece of mechanism and could actually feel the painful, patient resistance of the metal body of a machine.

*Fro and Other Stories*

Fro (p. 88)

Progress Publishers. Moscow, Russia. 1972

**Reeve, Sidney Armor**

No biographical data available

The muscular system of our modern body politic is its array of energy-producing machines. Man has magnified his own tiny energies with power borrowed from nature. His land-carriers put to scorn the elephant; his ships make pygmies of the whales.

*Energy*

Chapter I (p. 7)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1909

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Machines are worshipped because they are beautiful, and valued because they confer power; they are hated because they are hideous, and loathed because they impose slavery.

*Skeptical Essays*

Chapter VI (p. 83)

W.W. Norton & Company, Inc. New York, New York, USA. 1928

A machine is like a Djinn in the Arabian Nights: beautiful and beneficent to its master, but hideous and terrible to his enemies.

*Skeptical Essays*

Chapter VI (p. 83)

W.W. Norton & Company, Inc. New York, New York, USA. 1928

**Ryle, Gilbert** 1900–76

English philosopher

...the dogma of the Ghost in the Machine.

*The Concept of Mind*

Chapter I (pp. 15–16)

Barnes & Noble, Inc. New York, New York, USA. 1969

**Samuel, Arthur L.** 1901–90

American pioneer of artificial intelligence research

A machine is not a genie, it does not work by magic, it does not possess a will, and Wiener to the contrary, nothing comes out which has not been put in, barring of course, an infrequent case of malfunctioning.... The "intentions" which the machine seems to manifest are the intentions of the human programmer, as specified in advance, or they are subsidiary intentions derived from these, following rules specified by the programmer...the machine will not and cannot do any of these things until it has been instructed as to how to proceed.... To believe otherwise is either to believe in magic or to believe that the existence of man's will is an illusion and that man's actions are as mechanical as the machine's.

Some Moral and Technical Consequences of Automation – A Refutation *Science*, Volume 132, Number 3429, September 16, 1960 (p. 741)

**Schumacher, Ernst Friedrich** 1911–77

German-born English economist

Ever bigger machines, entailing ever bigger concentrations of economic power and exerting ever greater violence against the environment, do not represent progress: they are a denial of wisdom. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful.

*Small Is Beautiful*

Part I, Chapter II (p. 31)

Harper & Row, Publishers. New York, New York, USA. 1973

**Soddy, Frederick** 1877–1956

English chemist

A single modern machine does the work of tens of thousands of labourers, releasing them from the benumbing and soul-destroying effect of unremittent physical labour.

*Science and Life: Aberdeen Adresses*

Science and Life (p. 7)

E.P. Dutton & Co. New York, New York, USA. 1920

**Turing, Alan** 1912–54

English mathematician

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions

might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll.

In James Roy Newman (ed.)

*The World of Mathematics* Volume 4

Can A Machine Think (p. 2099)

Simon & Schuster. New York, New York, USA. 56

### **Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

I assure you that the typewriting machine, when played with expression, is not more annoying than the piano when played by a sister or near relation.

*De Profundis* (2nd edition)

Letters from Reading Prison (p. 12)

G.P. Putnam's Sons. New York, New York, USA. 1909

### **Wright, Frank Lloyd** 1869–1959

American architect

Science can give us only the tools in a box, mechanical miracles that it has already given us. But of what use to us are miraculous tools until we have mastered the human, cultural use of them? We do not want to live in a world where the machine has mastered the man; we want to live in a world where man has mastered the machine.

An Organic Architecture, Speech

London, England, May, 1939

## MACHINERY

### **Carlyle, Thomas** 1795–1881

English historian and essayist

It is the Age of Machinery, in every outward and inward sense of that word...

*Critical and Miscellaneous Essays* (Volume 2)

Signs of the Times (p. 233)

Chapman & Hall. London, England. 1889

### **Moore, George** 1852–1933

The world is dying of machinery; that is the great disease, that is the plague that will sweep away and destroy civilization, man will have to rise against it sooner or later.

*Confessions of a Young Man*

Chapter Seven (p. 113)

McGill-Queen's University Press. Montreal, Canada. 1972

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

There is nothing in machinery, there is nothing in embankments and railways and iron bridges and engineering devices to oblige them to be ugly. Ugliness is the measure of imperfection.

*A Modern Utopia*

Chapter the Third, Section 8 (p. 110)

University of Nebraska Press. Lincoln, Nebraska, USA. 1967

## MACROEVOLUTION

### **Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Experience shows...that there is no way toward understanding of the mechanisms of macroevolutionary changes, which require time on geological scales, other than through understanding of microevolutionary processes observable within the span of a human lifetime, often controlled by man's will, and sometimes reproducible in laboratory experiments.

*Genetics and The Origin of Species*

Chapter I (p. 16)

Columbia University Press. New York, New York, USA. 1951

## MAGIC

### **Asimov, Isaac** 1920–92

American author and biochemist

Once upon a time, there were priesthoods of magic, and members of those priesthoods cast spells, muttered runes, and made intricate diagrams on the floor with powders of arcane composition.... Nowadays, there is a modern priesthood of science that calls on the power of expanding steam, of shifting electrons or drifting neutrons, of exploding gasoline or uranium, and does so without spells, powders, or even any visible change of expression. In response, onlookers are without awe, for indeed, they seem to participate in the magic.

November 19, 1967

*New York Times Book Review*, *Review of The Way Things Work*, (Volume 1)

### **Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Man masters nature not by force but by understanding. That is why science has succeeded where magic failed because it has looked for no spell to cast on nature.

*Science and Human Values*

The Creative Mind (p. 10)

Harper & Row, Publishers. New York, New York, USA. 1965

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

All the terms in the science books, "law", "necessity", "order", "tendency", and so on, are really unintellectual, because they assume an inner synthesis which we do not possess. The only words that ever satisfied me as describing Nature are the terms used in fairy books, "charm", "spell", "enhancement." A tree grows because it is a magic tree. Water runs down because it is bewitched. The sun shines because it is bewitched.

*Orthodoxy*

Chapter IV (p. 94)

John Lane Company. New York, New York, USA. 1918

**Dahl, Roald** 1916–90

English novelist

Above all, watch with glittering eyes the whole world around you because the greatest secrets are always hidden in the most unlikely places. Those who don't believe in magic will never find it.

*The Mipins* (p. 44)

Jonathan Cape Co. London, England. 1991

**Durant, William James** 1885–1981

American historian and essayist

Magic begins in superstition and ends in science.

*The Story of Civilization I: Our Oriental Heritage* (p. 67)

Simon &amp; Schuster. New York, New York, USA. 1939

**Editor**

Nothing in science is magical. It may be puzzling, mysterious, inexplicable – but it is never magical.

In Isaac Asimov

*Asimov on Chemistry*

The Hate-Makers (p. 143)

Anchor Press/Doubleday. Garden City, New York, USA. 1974

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Magic and all that is ascribed to it is a deep presentiment of the powers of science.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

Essays: First Series

Chapter I (p. 34)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Farb, Peter** 1929–80

American writer and anthropologist

In place of science, the Eskimo has only magic to bridge the gap between what he can understand and what is not known. Without magic, his life would be one long panic.

*Man's Rise to Civilization as Shown by the Indians of North America from Primeval Times to the Coming of the Industrial State*

Chapter III (p. 48)

E.P. Dutton &amp; Company, Inc. New York, New York, USA. 1968

**Goodwin, Brian Carey** 1931–

Biologist

There is no truth beyond magic...reality is strange. Many people think reality is prosaic. I don't. We don't explain things away in science. We get closer to the mystery.

In Roger Lewin

*Complexity: Life at the Edge of Chaos*

Chapter Two (p. 32)

The Macmillan Company. New York, New York, USA. 1992

**Gould, Laurence M.** 1896–1995

American polar explorer and geologist

Science is not a form of black magic. A thousand blind alleys must often be explored before a right road is found; a thousand amateurs must have their fling before a Darwin or an Einstein comes along.

Science and the Culture of Our Times

*UNESCO Courier*, February, 1968 (p. 4)**Highfield, Roger**

Editor and writer

Finding common ground between science and magic depends, of course, on how we define magic.

*The Science of Harry Potter*

Introduction (p. xvi)

Viking Penguin. New York, New York, USA. 2002

**Hilbert, David** 1862–1943

German mathematician

The reason that I am now almost completely swimming in physical waters is because here at the moment as a pure mathematician I am the only feeling heart among the wraiths. So for now...in order to have points in common with other mortals, I have surrendered myself to magic – that is to say, physics.

In Constance Reid

*Hilbert – Courant*

Hilbert

Chapter V (p. 35)

Springer-Verlag. New York, New York, USA. 1986

Let us consider that we as mathematicians stand [on] the highest pinnacle of the cultivation of the exact sciences. We have no other choice than to assume this highest place, because all limits, especially national ones, are contrary to the nature of mathematics. It is a complete misunderstanding of our science to construct differences according to peoples and races, and the reasons for which this has been done are very shabby ones.

*Hilbert – Courant*

Hilbert

Chapter XXI (p. 188)

Springer-Verlag. New York, New York, USA. 1986

**Hsu, Francis L. K.** 1909–99

Anthropologist

...to achieve popular acceptance, magic has to be dressed like science in America, while science has to be cloaked as magic in Hsi-ch'eng.

*Health, Culture and Community Case Studies of Public Reactions to Health Programs*

Part 2, A Cholera Epidemic in a Chinese Town (p. 149)

Russell Sage Foundation. New York, New York, USA. 1955

**Lewis, C. S. (Clive Staples)** 1898–1963  
British author, scholar, and popular theologian

The evil reality of lawless applied science (which is Magic's son and heir) is actually reducing large tracts of Nature to disorder and sterility at this very moment.

*Miracles*

Miracles of the New Creation (p. 179)

The Macmillan Co. New York, New York, USA. 1947

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The belief in occult magic powers of nature has gradually died away, but in its place a new belief has arisen, the belief in the magical power of science.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physical Inquiry (p. 189)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Phillipotts, Eden** 1862–1960  
English novelist, poet, and dramatist

The universe is full of magical things patiently waiting for our wits to grow sharper.

*A Shadow Passes* (p. 17)

C. Palmer & Hayward. London, England. 1919

**Porta, John Baptista** 1535?–1615  
Neapolitan scholar

There are two sorts of Magick: the one is infamous, and unhappy, because it hath to do with foul spirits, and consists of Inchantments and wicked Curiosity; and this is called Sorcery; an art which all learned and good men detest; neither is it able to yield any truth of Reason or Nature, but stands merely upon fancies and imaginations, such as vanish presently away and leave nothing behind them.... The other Magick is natural; which all excellent wise men do admit and embrace, and worship with great applause; neither is there anything more highly esteemed, or better thought of by men of learning.... I think that Magick is nothing else but the survey of the whole course of Nature.

*Natural Magick*

The First Book of Natural Magick, Chapter II (pp. 1–2)

Printed for Thomas Young & Samuel Speed. London, England. 1658

**Rapoport, Anatol** 1911–  
Russian-born mathematician and biologist

Magic is essentially metaphorical. So are dreams. So is most artistic activity, Finally, theoretical science is essentially disciplined exploitation of metaphor.

*Operational Philosophy*

Chapter 17 (p. 203)

Harper. New York, New York, USA. 1953

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Somehow, every time the magic of fol-de-rol tried conclusions with the magic of science, the magic of fol-de-rol got left.

*A Connecticut Yankee in King Arthur's Court*

Chapter XXXIX (p. 359)

Harper & Brothers. New York, New York, USA. 1899

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

It may seem a rash attempt to endeavor to separate into its different elements the magic power exercised upon our minds by the physical world, since the character of the landscape and of every imposing scene in Nature depends so materially upon the mutual relation of the ideas and sentiments simultaneously excited in the mind of the observer.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 27)

D. Appleton & Co. New York, New York, USA. 1850

## MAGMA

**Bowen, Norman L.** 1887–1956  
Canadian geologist

Perhaps it is because we know so much about magmas that we have such a vivid appreciation of what there is yet to learn.

Magmas

*Bulletin of the Geological Society of America*, Volume 58, Number 3,

April, 1947 (p. 278)

**McPhee, John** 1931–  
American journalist and nonfiction writer

It has always been difficult enough to hold in the mind that a magma which hardens in the earth as granite will – if it should flow out upon the earth – harden as rhyolite, that what hardens within the earth as diorite will harden upon the earth as andesite, that what hardens within the earth as gabbro will harden upon the earth as basalt, the difference from pair to pair being a matter of chemical composition and the differences within each pair being a matter of texture and of crystalline form, with the darker rock at the gabbro end and the lighter rock the granite. All of that – not to mention such wee appendixes as the fact that diabase is a special texture of gabbro – was difficult enough for the layman to remember before the diffractometers and the spectrometers and the electron probes came along to present their multiplex cavils.

*Basin and Range* (p. 29)

Farrar, Straus, Giroux. New York, New York, USA. 1981

**Warren, Robert Penn** 1905–89  
American writer and critic

Below all silken soil-slip, all crinkled earth-crust,  
Far deeper than ocean, past rock that against rock grieves,

There at the globe's deepest dark and visceral lust,  
Can you hear the groan-swish of magma as it churns and  
heaves?

*Being There: Poetry 1977–1980*

Youth Truth-Seeker, Half-Naked, at Night, Running Down Beach South  
of San Francisco

Random House, Inc. New York, New York, USA. 1980

## MAGNET

**Dee, John** 1527–1609

English mathematician and occultist

In the magnet, God has offered to the eyes of mortals for  
observation qualities which in other objects he has left  
for discovery to the subtler research of the mind and a  
greater investigative industry.

*John Dee on Astronomy*

XXIII (p. 133)

University of California Press. Berkeley, California, USA. 1978

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

A magnet hung in a hardware shop,  
And all around was a loving crop  
of scissors and needles, nails and knives,  
Offering love for all their lives;  
But for iron the magnet felt no whim,  
Though he charmed iron, it charmed not him;  
From needles and nails and knives he'd turn,  
For he'd set his love on a silver churn!  
But this magnetic,  
Peripatetic  
Lover he lived to learn  
By no endeavor  
Can magnet ever  
attract a Silver Churn!

*Patience*

Act II

Shirmer. New York, New York, USA. 1950

## MAGNETIC

**Muir, John** 1834–1914

American naturalist

I should study Nature's laws in all their crossings and  
unions; I should follow magnetic streams to their source  
and follow the shores of our magnetic oceans. I should  
go among the rays of the aurora, and follow them to their  
beginnings, and study their dealings and communications  
with other powers and expressions of matter.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains: The Unpublished Journals of John Muir*

Chapter II (pp. 43–44)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1938

**Verne, Jules** 1828–1903

French novelist

A vector tube some twenty centimeters in diameter  
and two millimeters thick ran the entire length of the  
track between the two rails; it enclosed a soft-iron disc,  
which slid inside it under the action of several atm-  
spheres of compressed air provided by the Catacomb  
Company of Paris. This disc, driven at high speed  
within the tube, like a bullet in its barrel, drew with it  
the first car of the train. But how was this car attached  
to the disc inside the tube, since this disc would have  
no communication with the exterior? By electromag-  
netic force.

Translated by Richard Howard

*Paris in the Twentieth Century*

Chapter 11 (pp. 21–22)

Random House. New York, New York, USA. 1996

## MAGNETISM

**Bullard, Edward Crisp** 1907–80

English geophysicist

The straightness, symmetry, extent and ubiquity of these  
patterns is without parallel in geology and their discovery  
was completely unexpected.

Reversals of the Earth's Magnetic Field

*Philosophical Transactions of the Royal Society of London*, Volume 263,  
1968 (p. 492)

**Chandrasekhar, Subrahmanyan** 1910–95

Indian-born American astrophysicist

When magnetic fields occur on the cosmic scale – as  
in interplanetary regions, in stellar atmospheres and  
in stellar envelopes, in stars and in interstellar space  
– they have patterns and properties which cannot be  
deduced by simply extrapolating from terrestrial expe-  
rience; for, in these in-stances, the scale is the essence  
of the phenomenon, and the scale transcends terrestrial  
experience.

On Cosmic Magnetic Fields

*Proceedings of the National Academy of Sciences, USA*, Volume 47,  
Number 1, 1957

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Gilbert shall live till loadstones cease to draw  
Or British fleets the boundless ocean awe.

*The Poetical Works of Dryden*

Epistle to Doctor Walter

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Faraday, Michael** 1791–1867

English physicist and chemist

A few years ago, magnetism was to us an occult power, affecting only a few bodies; now it is found to influence all bodies, and to possess the most intimate relations with electricity, heat, chemical action, light, crystallisation, and through it, with the forces concerned in cohesion; and we may, in the present state of things, well feel urged to continue in our labours, encouraged by the hope of bringing it into a bond of union with gravity itself.

In Bence Jones

*The Life and Letters of Faraday* (Volume 2) (p. 240)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

### **Gilbert, William** 1544–1603

English scientist and physician

In like manner, the loadstone has from nature its two poles, a northern and a southern; fixed, definite points in the stone, which are the primary termini of the movements and effects, and the limits and regulators of the several actions and properties... whether its shape is due to design or chance, and whether it be long, or flat, or four-square, or three cornered, or polished; whether it be rough, broken-off, or unpolished: the loadstone ever has and ever shows its poles.

In *Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Book First, Chapter 3

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hale, George Ellery** 1868–1938

American astronomer

Thanks to Zeeman's discovery of the effect of magnetism on radiation, it appeared that the detection of such a magnetic field should offer no great difficulty, provided that it were sufficiently intense.

On the Possible Existence of a Magnetic Field in Sunspots

*Astrophysical Journal*, Volume 28, 1908 (p. 315)

### **Lucretius** ca. 99 BCE–55 BCE

Roman poet

Next in order I will proceed to discuss by what law of nature it comes to pass that iron can be attracted by that stone which the Greeks call the Magnet from the name of its native place, because it has its origin within the bounds of the country of the Magnesians.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book Six, l. 906–911 (p. 92)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Parker, E. N.**

No biographical data available

It appears that the radical element responsible for the continuing thread of cosmic unrest is the magnetic field.

*Cosmical Magnetic Fields*

Chapter 1 (p. 2)

Clarendon Press. Oxford, England. 1979

Magnetic fields (and their inevitable offspring fast particles) are found everywhere in the universe where we have the means to look for them.

*Cosmical Magnetic Fields*

Chapter 1 (p. 6)

Clarendon Press. Oxford, England. 1979

### **Singer, Ignatius**

No biographical data available

### **Berens, Lewis Henry**

No biographical data available

“Magnetism” explains nothing; like all other “isms” and “ities,” it only names, classifies, separates, and mystifies, and thereby achieves the very opposite to what should be the aim of true science.

*Some Unrecognized Laws of Nature*

Chapter XII (p. 280)

D. Appleton & Co. New York, New York, USA. 1879

## MAGNETRON

### **Baxter Third, James Phinney** 1893–1975

American a administrator

When the members of the Tizard Mission brought one [magnetron] to America in 1940, they carried the most valuable cargo ever brought to our shores. It sparked the whole development of microwave radar and constituted the most important item in reverse Lease-Lend.

*Scientists Against Time*

Chapter IX (p. 142)

Little, Brown & Company. Boston, Massachusetts, USA. 1947

## MAGNIFY

### **Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

We are told that we gain nothing by magnifying too much. I grant it; but shall never believe I magnify too much till by experience I find that I can see better with a lower power.

In Edward Singleton Holden

*Sir William Herschel*

Chapter III (p. 86)

Charles Scribner's Sons. New York, New York, USA. 1881

## MAGNITUDE

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

Only little minds are impressed by size and number.

*The Exploration of Space*

Chapter 18 (p. 185)

Harper & Brothers Publishers. New York, New York, USA. 1951



**Hardy, Thomas** 1840–1928  
English poet and regional novelist

“What monsters may they be?”

“The monsters called Immensities. Until a person has thought out the stars and their interspaces, he has hardly learnt that there are things much more terrible than monsters of shape, namely, monsters of magnitude without known shape. Such monsters are the voids and waste places of the sky.

*Two On A Tower* (Volume 1)

Chapter IV (p. 39)

Henry Holt & Co. New York, New York, USA. 1882

Until a person has thought out the stars and their interspaces, he has hardly learnt that there are things much more terrible than monsters of shape, namely, monsters of magnitude without known shape. Such monsters are the voids and waste places of the sky.

*Two On A Tower* (Volume 1)

Chapter IV (p. 75)

Sampson, Low, Marston, Searle & Rivington. London, England. 1882

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Here is the diatom, there the star. Above, just as below, specks; below, as above, vastness.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 410)

The Heritage Press. New York, New York, USA. 1961

**Maclaurin, Colin** 1838–1916

Scottish mathematician

As magnitude, of every sort, abstractedly considered, is capable of being increased to infinity, and is also divisible without end; so we find that, in nature, the limits of the greatest and least dimensions of things, are actually placed at an immense distance from each other.

*An Account of Sir Isaac Newton's Philosophical Discoveries*

Chapter I Section 5

London, England. 1748

## MALADY

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

Some maladies are rich and precious and only to be acquired by the right of inheritance or purchased with gold.

*Mosses from an Old Manse: The Procession of Life*

The Procession of Life (p. 167)

A.L. Burt Company, Publishers. New York, New York, USA. No date

**Maturin, Charles R.** 1782–1824

Anglo-Irish Protestant clergyman

A malady

Preys on my heart that med'cine cannot reach.

*Bertram*

Act IV, Scene II (p. 52)

Printed for J. Murray. London, England. 1816

## MALARIOLOGIST

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

...DDT went further toward the eradication of malariologists than of mosquitoes.

*Man Adapting*

Chapter XIV (p. 380)

Yale University Press. New Haven, Connecticut, USA. 1965

## MALPRACTICE

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

...no doctor dare accuse another of malpractice. He is not sure enough of his own opinion to ruin another man by it. He knows that if such conduct were tolerated in his profession no doctor's livelihood or reputation would be worth a year's purchase. I do not blame him: I should do the same myself. But the effect of this state of things is to make the medical profession a conspiracy to hide its own shortcomings.

*The Doctor's Dilemma*

Preface on Doctors

Why Doctors Do Not Differ

Doctors and Vivisection (pp. xiv–xv)

Brentano's. New York, New York, USA. 1920

But for this very reason no doctor dare accuse another of malpractice. He is not sure enough of his own opinion to ruin another man by it.

*The Doctor's Dilemma*

Preface (p. 15)

Penguin Books. Baltimore, Maryland, USA. 1954

## MAN

**Adams, George** 1750–95

English scientist

One of the ends for which man was formed, is to correct appearances and errors, by the investigation of truth; whoever considers him attentively, from infancy to manhood, and from manhood to old age, will find him ever busy in endeavoring to find some reality, to supply the place of the false appearances, by which he has hitherto been deceived.

*Astronomical and Geographical Essays* (6th edition)  
 Essay I, Part III (p. 25)  
 W. & S. Jones. London, England. 1812

**Ardrey, Robert** 1908–80  
 American anthropologist

Man is man, and not a chimpanzee, because for millions upon millions of years we killed for a living.

*The Hunting Hypothesis*  
 Chapter 1 (p. 10)  
 Athenaeum. New York, New York, USA. 1876

**Aristotle** 384 BCE–322 BCE  
 Greek philosopher

All men by nature desires to know.  
 In *Great Books of the Western World* (Volume 8)  
*Metaphysics*  
 Book I, Chapter 1  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Asimov, Isaac** 1920–92  
 American author and biochemist

As we trace the development of man over the ages, it seems in many respects a tale of glory and victory; of the development of the brain; of the discovery of fire, of the building of cities and of civilization; of the triumph of reason; of the filling of the Earth and the reaching out to sea and space.

*Time and Space and Other Things*  
 Introduction (p. ix)  
 Doubleday & Company, Inc. Garden City, New York, USA. 1965

**Austin, Mary Hunter** 1868–1934  
 American novelist and essayist

Man is a great blunderer going about in the woods, and there is no other except the bear makes so much noise. Being so well warned beforehand, it is a very stupid animal, or a very bold one, that cannot keep safely hid.

*The Land of Little Rain*  
 The Scavengers (p. 60)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

### Author undetermined

Man is a piece of the universe made alive.  
 Source undetermined

**Balfour, Arthur James** 1848–1930  
 British prime minister

Man, so far as natural science by itself is able to teach us, is no longer the final cause of the universe, the Heaven-descended heir of all the ages. His very existence is an accident, his story a brief and transitory episode in the life of one of the meanest of the planets.

*Essays and Addresses*  
 The Religion of Humanity (p. 307)  
 David Douglas, Edinburgh, Scotland, 1893

**Bates, Marston** 1906–74  
 American zoologist

Man's point of view is curiously different in the forest and in the sea. In the forest he is a bottom animal, in the sea a surface animal.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
 Chapter 2 (p. 20)  
 Random House, Inc. New York, New York, USA. 1960

### Beaumarchais, Pierre-Augustin

**Caron de** 1732–99  
 French dramatist

*Boire sans soif et faire l'amour à tout temps, madame; il n'y a que ça qui nous distingue des autres bêtes.*

We drink without being thirsty, and make love at any moment; that is the only distinction between us and the other animals.

*Le Mariage de Figaro*  
 Act II, Sc. XXI

**Becker, Carl Lotus** 1873–1945  
 American historian

Edit and interpret the conclusions of modern science as tenderly as we like, it is still quite impossible for us to regard man as the child of God for whom the earth was created as a temporary habitation. Rather must we regard him a little more than a chance deposit on the surface of the world, carelessly thrown up between two ice ages by the same forces that rust iron and ripen corn... The ultimate cause of this cosmic process of which man is a part, whether God or electricity or a "stress in the ether," we know not. Whatever it may be, if indeed it be anything more than a necessary postulate of thought, it appears in its effects as neither benevolent nor malevolent, as neither kind nor unkind, but merely as indifferent to us.

*The Heavenly City of the Eighteenth Century Philosophers*  
 Chapter I (p. 14)  
 Yale University Press. New Haven, Connecticut, USA. 1932

**Bernal, John Desmond** 1901–71  
 Irish-born physicist and X-ray crystallographer

Man is occupied and has been persistently occupied since his separate evolution, with three kinds of struggle: first with the massive, unintelligent forces of nature, heat and cold, winds, rivers, matter and energy; secondly, with the things closer to him, animals and plants, his own body, its health and disease; and lastly, with his desires and fears, his imaginations and stupidities.

*The World, the Flesh & the Devil*  
 The Future  
 Dutton. New York, New York, USA. 1929

**Bernard, Claude** 1813–78  
French physiologist

It is not given to man to alter the cosmic phenomena of the whole universe nor even those of the earth; but the advances of science enable him to alter the phenomena within his reach.

Translated by Henry C. Greene  
*An Introduction to the Study of Experimental Medicine*  
Chapter III  
Henry Schuman, Inc. New York, New York, USA. 1927

**Berthelot, Marcellin (or Marcelin) Pierre Eugène** 1827–1907  
French chemist and politician

Man being servant and interpreter of nature, can do and understand so much and so much only, as he has observed in fact or in thought in the course of nature. Beyond this he neither knows anything nor can do anything.

Quoted by G.B. Halsted  
The Elements: Verified and Unverified  
*Proceedings of the American Association for the Advancement of Science*, December 1903–January 1904 (p. 404)

**Blake, William** 1757–1827  
English poet, painter, and engraver

Where man is not, nature is barren.

*The Complete Poetry and Prose of William Blake*  
The Marriage of Heaven and Hell, Proverbs of Hell, l. 69  
University of California Press. Berkeley, California, USA. 1982

**Bohm, David** 1917–92  
American physicist

In some sense man is a microcosm of the universe; therefore what man is, is a clue to the universe. We are enfolded in the universe.

In Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity*  
Routledge & Kegan Paul. London, England. 1986

**Borland, Hal** 1900–78  
American writer

There is a fundamental need in man to know three things: who he is, where he lives, and what time it is. With satisfying answers to those three questions, most of us could live in relative peace with the world and ourselves.

*The Enduring Pattern*  
Foreword (p. 3)  
Simon & Schuster. New York, New York, USA. 1959

As far as man is concerned, he may well be a biological accident, possibly a mutation that resulted from a particularly livid flare-up of sunspots, and consequent radiation, a million and a half or two million years ago.

*Borland Country*  
Foreword (pp. 7–8)  
J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

...man is the only animal who can face with a thought, a dream, and a smile the mystery and the madness and the terrible beauty of the universe.

*Autobiography of Earth*  
Chapter 12 (p. 347)  
Coward-McCann, Inc. New York, New York, USA. 1935

A germ on an eggshell cannot know the inner workings of eggs. Man is a germ on the shell of the earth, but a germ with reason and imagination. With these he has dug a tunnel toward the buried truth.

*Parade of the Living*  
Part I, Chapter VIII (pp. 86–87)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Among the multitude of animals which scamper, fly, burrow and swim around us, man is the only one who is not locked into his environment. His imagination, his reason, his emotional subtlety and toughness, make it possible for him not to accept the environment, but to change it.

*The Ascent of Man*  
Lower than the Angels (p. 19)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

Man is a singular creature. He has a set of gifts which make him unique among the animals: so that, unlike them, he is not a figure in the landscape – he is a shaper of the landscape.

*The Ascent of Man*  
Lower than the Angels (p. 19)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

Every animal leaves traces of what it was; man alone leaves traces of what he created.

*The Ascent of Man*  
Lower than the Angels (p. 42)  
Little, Brown & Co. Boston, Massachusetts, USA. 1973

We are all afraid – for our confidence, for the future, for the world. That is the nature of the human imagination. Yet every man, every civilization, has gone forward because of its engagement with what it has set itself to do. The personal commitment of a man to his skill, the intellectual commitment and the emotional commitment working as one, has made the Ascent of Man.

*The Ascent of Man*  
Chapter 13 (p. 438)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Brues, Charles Thomas** 1879–1955  
American entomologist

In his ceaseless strides towards a domination of the material world, man has encountered many obstacles. Some of these are palpably of his own making. For many of those

presented by his living environment, man is responsible only in so far as he forms a part of the intimately interdependent myriad of organisms which make up that environment.

*Insects and Human Welfare*

Introduction (p. ix)

Harvard University Press. Cambridge, England. 1920

**Bürgel, Bruno Hans** 1875–1948

German astronomer

Man, an atom, a parasite on the grain of sand we call the earth, whirling through the universe, is confronted by the infinite, where, since times eternal, a never-ceasing play of myriads of spheres has taken place. The deeper he tries to penetrate into its mystery the more inexplicable, the more majestic it grows.

Translated by Stella Bloch

*Astronomy for All*

Chapter I (p. 2)

Cassell & Co., Ltd. London, England. 1911

**Burroughs, John** 1837–1921

American naturalist and essayist

Man is at the top, in his own estimation, and thinks the sun and the moon are for him; but he is no more an end than a frog is; and is not so much atop as the birds are. He appeared in the plan, and he will disappear in the plan, and Nature values him only as manure – squanders him as recklessly as autumn leaves.

*The Heart of Burroughs's Journals*

Jan. 17, 1866 (p. 46)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

The first step which a man or a people takes toward a culture is a love of the artificial, as such, while the last and crowning step is a love of the natural and the simple.

*The Heart of Burroughs's Journals*

April 5, 1867 (p. 49)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

Man lives in his emotions, his hopes and fears, his loves and sympathies, his predilections and his affinities, more than in his reason.

*Under The Apple Tree*

Literature and Science (p. 194)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Burroughs, William S.** 1914–97

American writer

Man is an artifact designed for space travel. He is not designed to remain in his present biologic state anymore than a tadpole is designed to remain a tadpole.

*The Adding Machine*

Civilian Defense (p. 85)

Arcade Publishing. New York, New York, USA. 1991

**Bushnell, Horace** 1802–76

American Congregational minister

Not all the winds, and storms, and earthquakes, and seas, and seasons of the world, have done as much to revolutionize the world as he [man], the power of an endless life, has done since the day he came forth upon it, and received, as he is most truly declared to have done, dominion over it.

*Sermons for the New Life* (6th edition)

Sermon XVI (p. 310)

Charles Scribner & Co. New York, New York, USA. 1860

**Butler, Samuel** 1835–1902

British writer

The body is but a pair of pincers set over a bellows and a stewpan and the whole fixed upon stilts.

*The Note-books of Samuel Butler*

Chapter I (p. 18)

E.P. Dutton & Co. New York, New York, USA. 1917

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

Man is a carnivorous production,  
And must have meals, at least one meal a day;  
He cannot live, like woodcocks, upon suction,  
But, like the shark and tiger, must have his prey;  
Although his anatomical construction  
Bears vegetables, in a grumbling way,  
Your laboring people think beyond all question,  
Beef, veal, and mutton better for digestion.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 67

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Carson, Rachel** 1907–64

American marine biologist and author

In the artificial world of his cities, [man] often forgets the true nature of his planet and the long vistas of its history, in which the existence of the race of men has occupied a mere moment of time.

*The Sea Around Us*

The Gray Beginnings (p. 19)

Simon & Schuster. New York, New York, USA. 1958

**Charron, Pierre** 1541–1603

French philosopher

*La vraye science et le vray estude de l'homme, c'est l'homme.*

The true science and the true study of man, is man.

*De la Sagesse* Lib. i, Chapter I

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

...this is practically the claim of the egoism which thinks that self-assertion can obtain knowledge. A beetle may or may not be inferior to a man – the matter awaits demonstration; but if he were inferior to a man by ten

thousand fathoms, the fact remains that there is probably a beetle view of things of which a man is entirely ignorant.

In Alberto Manguel (ed.)

*On Lying in Bed and Other Essays*

A Defense of Humility (p. 366)

Bayeaux Arts Inc. Calgary, Ontario, Canada. 2000

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

Before all other things, man is distinguished by his pursuit and investigation of TRUTH. And hence, when free from needful business and cares, we delight to see, to hear, and to communicate, and consider a knowledge of many admirable and abstruse things necessary to the good conduct and happiness of our lives: whence it is clear that whatsoever is TRUE, simple, and direct, the same is most congenial to our nature as men. Closely allied with this earnest longing to see and know the truth, is a kind of dignified and princely sentiment which forbids a mind, naturally well constituted, to submit its faculties to any but those who announce it in precept or in doctrine, or to yield obedience to any orders but such as are at once just, lawful, and founded on utility. From this source spring greatness of mind and contempt of worldly advantages and troubles.

Quoted in John Frederick William Herschel

*Preliminary Discourse on the Study of Natural Philosophy*

After Table of Contents

Publisher undetermined

**Clarke, Arthur C.** 1917–

English science and science fiction writer

For it may be that the old astrologers had the truth exactly reversed, when they believed that the stars controlled the destinies of men.

The time may come when men control the destinies of stars.

*Future Space Programs 1975*

Testimony (p. 200)

US Congress. House Committee on Science and Technology.

US Government Printing Office. Washington, D.C. 1975

There are more suns in the whole of space than there are grains of sand on all the shores of Earth; and on anyone of those grains, there may be civilizations that will make us look like primitive, ignorant savages.

*The Lost Worlds of 2001*

Chapter 15 (p. 105)

New American Library. New York, New York, USA. 1972

**Cornu, A.**

No biographical data available

Our era is distinguished from preceding ages by wonderful utilization of natural forces; man, that weak and defenseless being, has been enabled by his genius to

acquire an extraordinary power, and to bend to his use those subtle yet dreadful agents whose very existence was unknown to our ancestors.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

The Wave Theory of Light: Its Influence on Modern Physics (p. 93)

Government Printing Office. Washington, D.C. 1901

**Darwin, Charles Robert** 1809–82

English naturalist

We must, however, acknowledge, as it seems to me, that man with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his god-like intellect which has penetrated into the movements and constitution of the solar system – with all these exalted powers – Man still bears in his bodily frame the indelible stamp of his lowly origin.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part III, Chapter XXI (p. 597)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the progenitors of man must have been aquatic in their habits; for morphology plainly tells us that our lungs consist of a modified swim-bladder, which once served as a float.

*The Descent of Man and Selection in Relation to Sex* (2nd edition)

Part I, Chapter VII (p. 164)

D. Appleton & Co. New York, New York, USA. 1909

We thus learn that man is descended from a hairy, tailed quadruped, probably arboreal in its habits ...

*The Descent of Man and Selection in Relation to Sex* (2nd edition)

Chapter XXI (p. 623)

D. Appleton & Co. New York, New York, USA. 1909

Man selects only for his own good : Nature only for that of the being which she tends.

*On the Origin of Species*

Chapter IV (p. 65)

D. Appleton & Co. New York, New York, USA. 1888

**de La Mettrie, Julien Offroy** 1709–51

French philosopher and physician

It is clear that there is but one substance in this world, and that man is its ultimate expression. Compared to monkeys and the cleverest of animals he is just as Huygen's planet clock is to a watch of King Julien. If more wheels and springs are needed to show the motion of the planets than are required for showing and repeating the hours; and if Vaucanson needed more artistry in producing a flautist than a duck, and art would have been even harder put to produce a "talker", and such a machine, especially in the hands of this new kind of Prometheus, must no longer be thought of as impossible.

In Gerald M. Edelman  
*Bright Air, Brilliant Fire: On the Matter of the Mind*  
 Chapter 19 (p. 188)  
 Basic Books. New York, New York, USA. 1992,

**de Voto, Bernard** 1897–1955  
 American historian

Man is a noisome bacillus whom our Heavenly Father created because he was disappointed in the monkey.

In Mark Twain  
*Mark Twain in Eruption: Hitherto Unpublished Pages About Men and Events*  
 Introduction (p. xxvii)  
 Harper & Brothers Publishers. New York, New York, USA. 1922

**Dexter, William A.**  
 No biographical data available

Man's existence on the Earth is like the twinkling of an eye.

The Bigness and the Smallness of Time  
*Journal of Geological Education*, Volume XV, Number 4, October, 1967 (p. 161)

**Doyle, Sir Arthur Conan** 1859–1930  
 Scottish writer

It is...an alteration of perspective, a shifting of our sense of proportion, a vivid realization that we are insignificant and evanescent creatures, existing on sufferance and at the mercy of the first chill wind from the unknown.

*The Poison Belt*  
 Chapter VI (p. 180)  
 Hodder & Stroughton. London, England. 1913

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

Nature made nearly every possible mistake before she reached her greatest achievement, Man – or perhaps some would say her worst mistake of all.

*Science and the Unseen World*  
 Chapter I (p. 21)  
 The Macmillan Company. New York, New York, USA. 1929

From his central position man can survey the grandest works of Nature with the astronomer, or the minutest works with the physicist.

*Stars and Atoms*  
 Lecture I (p. 1)  
 Yale University Press. London, England. 1927

**Eiseley, Loren C.** 1907–77  
 American anthropologist, educator, and author

From the oscillating universe, beating like a gigantic heart, to the puzzling existence of antimatter, order, in a human sense, is at least partially an illusion. Ours, in reality, is the order of a time, and of an insignificant fraction of the cosmos, seen by the limited senses of a finite creature.

*The Unexpected Universe*  
 Chapter 2, Section 5 (p. 46)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1969

In three billion years of slow change and groping effort only one living creature has succeeded in escaping the trap of specialization that has led in time to so much death and wasted endeavor. It is man, but the word should be uttered softly, for his story is not yet done.

*The Unexpected Universe*  
 Chapter Three (p. 52)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1969

And looking so, across the centuries and the millennia, toward the animal men of the past, one can see a faint light, like a patch of sunlight moving over the dark shadows of the forest floor. It shifts and widens, it winks out, it comes again, but it persists. It is the human spirit, the human soul, however transient, however faulty men may claim it to be. In its coming man had no part. It merely came, that curious light, and man, the animal, sought to be something no animal had been before. Cruel he might be, vengeful he might be, but there had entered into his nature a curious wistful gentleness and courage...

*The Firmament of Time*  
 Chapter V, Part IV (p. 145)  
 Athenaeum. New York, New York, USA. 1960

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

Nor has science sufficient humanity, so long as the naturalist overlooks the wonderful congruity which subsists between man and the world; of which he is lord, not because he is the most subtle inhabitant, but because he is its head and heart, and finds something of himself in every great and small thing, in every mountain stratum, in every new law of color, fact of astronomy, or atmospheric influence which observation or analysis lay open.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)  
*Nature: Addresses and Lectures*  
 Chapter VIII (p. 68)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Man carries the world in his head, the whole astronomy and chemistry suspended in a thought.

*Essays: Second Series*  
 Nature (p. 178)  
 Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Everett, Edward** 1794–1865  
 Whig Party politician

There is in all creation, below God and the angels, no eye for the beauty, no ear for the melody, no sense for the fragrance, no perception for the symmetry, no comprehension for the unutterable bounty, dignity, and grandeur, but in the rational mind. It would all lie hushed, and blank, and cold, but for the vitality enkindled in it from



the living sense of intelligent man.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 97)  
Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Fiske, John** 1842–1901

American philosopher and historian

...Man does not dwell at the centre of things, but is the denizen of an obscure and tiny speck of cosmical matter quite invisible amid the innumerable throng of flaming suns that make up our galaxy.

*The Destiny of Man Viewed in the Light of His Origin*

Chapter I (p. 15)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

**Foster, Sir Michael** 1836–1907

English physiologist

In the first place, above all other things, his [the scientific man's] nature must be one which vibrates in unison with that of which he is in search; the seeker after truth must himself be truthful, truthful with the truthfulness of Nature. For the truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more exacting. Man, unscientific man, is often content with 'the nearly' and 'the almost.'

*Report of the Sixty-ninth Meeting of the British Association for the Advancement of Science*

President's Address (p. 16)

John Murray. London, England. 1900

...the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature's differences in any other way than she treats them herself, will find that she resents his conduct; if he in carelessness or in disdain overlooks the minute difference which she holds out to him as a signal to guide him in his search, the projecting tip, as it were, of some buried treasure, he is bound to go astray, and, the more strenuously he struggles on, the farther will he find himself from his true goal.

Presidential Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 130)

**Fuller, R. Buckminster** 1895–1983

American engineer and architect

A self-balancing, 28-pointed adapter-based biped; an electrochemical reduction-plant, integral with segregated storages of special energy extracts in storage batteries, for subsequent activation of thousands of hydraulic and pneumatic pumps, with motors attached; 62,000 miles of capillaries; millions of warning signals, railroad and conveyor systems; crushers and cranes (of which the arms are magnificent 23-jointed affairs with self-surfacing and lubricating systems, and a universally distributed telephone system needing no service for 70 years

if well-managed); the whole extraordinarily complex mechanism guided with complete precision from a turret in which are located telescopic and microscopic self-registering and recording range-finders, a spectroscope, et cetera, air-conditioning intake-and exhaust and a main fuel intake Within the few cubic inches housing the turret mechanism, there is room also for two sound-wave and sound-direction-finder recording diaphragms, a filing and instant reference system, and an expertly devised analytical laboratory large enough not only to contain minute records of every last and continual event of up to 70 years experience or more, but to extend, by computation and abstract fabrication, this experience with relative accuracy into all corners of the observed universe. There is, also, a forecasting and tactical plotting department for the reduction of future possibilities and probabilities to general successful specific choice.

*Nine Chains to the Moon*

Chapter 4 (p. 18)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

Our part in the universe may possibly in some distant way be analogous to that of cells in an organised body, and our personalities may be the transient but essential elements of an immortal and cosmic mind.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 196)

AMS Press. New York, New York, USA. 1973

**Gamow, George** 1904–68

Russian-born American physicist

...it took less than an hour to make the atoms, a few hundred million years to make the stars and planets, but five billion years to make man.

*The Creation of the Universe*

Conclusion (p. 139)

The Viking Press. New York, New York, USA. 1952

**George, Henry** 1839–97

American political economist

...he [man] is the only animal whose desires increase as they are fed; the only animal that is never satisfied.

*The Complete Works of Henry George*

Book II, Chapter III (p. 134)

Doubleday, Page & Co. Garden City, New York, USA.

**Gray, George W.**

Freelance science writer

Within the limits of nature's law, man is free to mold his future. By design he may increase the probability of a desired outcome. And so we say that destiny is a choice, a selection among alternative destinies. But the selection cannot be left to accident; it is not fortuitous, automatic,

foolproof. Man himself must choose.

*The Advancing Front of Science*

Epilogue (p. 353)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1937

**Guillemin, Amédée** 1826–93

French journalist and scientific writer

How wonderful is the power of man! Chained down to the surface of the Earth, an intelligent atom on a grain of sand lost in the immensity of space, he invents instruments which multiply a thousandfold his vision, he sounds the depths of the ether, gauges the visible universe, and counts the myriads of stars which people it.

*The Heavens: An Illustrated Handbook of Popular Astronomy* (2nd edition)

The Heavens (p. 1)

Richard Bentley. London, England. 1868

**Heinlein, Robert A.** 1907–88

American science fiction writer

By the data to date, there is only one animal in the Galaxy dangerous to man – man himself.

*The Notebooks of Lazarus Long* (p. 1)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...man is a speculative as well as a sentient being, searching in everything for connexion and harmony, the perception of which mixes itself with his choicest pleasures...

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Whewell on the Inductive Sciences (p. 143)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

The situation of man on the globe he inhabits, and over which he has obtained the control, is in many respects exceedingly remarkable. Compared with its other denizens, he seems, if we regard only his physical constitution, in almost every respect their inferior, and equally unprovided for the supply of his natural wants and his defence against the innumerable enemies which surround him.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (p. 1)

Longman, Brown, Green & Longmans. London, England. 1845

...man is the undisputed lord of the creation. The strongest and fiercest of his fellow-creatures – the whale, the elephant, the eagle, and the tiger – are slaughtered by him to supply his most capricious wants, or tamed to do him service, or imprisoned to make him sport.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (p. 2)

Longman, Rees, Orman, Brown & Green. London, England. 1830

**Hewish, Antony** 1924–

English radio astronomer

The world of man lies midway in scale between the inner space of atoms and particles, and the outer space of stars and galaxies. The exploration of both these regions stretches our imagination to its limits.

*Les Prix Nobel. The Nobel Prizes in 1974*

Nobel banquet speech for award received in 1974

Nobel Foundation. Stockholm, Sweden. 1975

**Heyl, Paul R.**

American scientist

Individually, man is more or less of an enigma; in the mass he is a mathematical problem.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1933)

Romance or Science? (p. 290)

Government Printing Office. Washington, D.C. 1934

**Hinds, Norman E. A.**

No biographical data available

The mind of man can never encompass the total of Creation.

*Geomorphology: The Evolution of Landscape*

Chapter 22 (p. 842)

Prentice-Hall, Inc. New York, New York, USA. 1943

**Holbach, Paul Henri Thiry** 1723–89

French philosopher

He [man] resembles a child destitute of experience, full of idle notions: a dangerous leaven mixes itself with all his knowledge: it is of necessity obscure, it is vacillating and false – He takes the tone of his ideas on the authority of others, who are themselves in error, or else have an interest in deceiving him. To remove this Cimmerian darkness, these barriers to the improvement of his condition; to disentangle him from the clouds of error that envelop him, that obscure the path he ought to tread; to guide him out of this Cretan labyrinth, requires the clue of Ariadne, with all the love she could bestow on Theseus.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*

(Volume 1)

Author's Preface (p. 2)

J.P. Mendum. Boston, Massachusetts, USA. 1889

Man is the work of Nature: he exists in Nature: he is submitted to her laws: he cannot deliver himself from them; nor can he step beyond them even in thought. It is in vain his mind would spring forward beyond the visible world, an imperious necessity always compels his return.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*

(Volume 1)

Chapter I (p. 11)

J.P. Mendum. Boston, Massachusetts, USA. 1889

Suns encrust themselves, and are extinguished; planets perish and disperse themselves in the vast plains of air; other suns are kindled; new planets form themselves, either to make revolutions round these suns, or to describe new routes; and man, an infinitely small portion of the globe, which is itself but an imperceptible point in the immensity of space, vainly believes it is for himself this universe is made; foolishly imagines he ought to be the confidant of nature; confidently flatters himself he is eternal, and calls himself KING OF THE UNIVERSE!!

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*  
(Volume 1)

Chapter 6 (p. 46)

J.P. Mendum. Boston, Massachusetts, USA. 1889

O man! wilt thou never conceive that thou art but an ephemeron? All changes in the universe: nature contains no one constant form, yet thou pretendes! That thy species can never disappear; that thou shall be exempted from the universal law, that wills all shall experience change! Alas! In thy actual being, art thou not submitted to continual alterations? Thou, who in thy folly arrogantly assumest to thyself the title of KING OF NATURE!

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*  
(Volume 1)

Chapter 6 (p. 46)

G.W. & A.J. Matsell. New York, New York, USA. 1835

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

...only the biological processes of mutation and natural selection are needed to produce living creatures as we know them. Such creatures are no more than ingenious machines that have evolved as strange by-products in an odd corner of the Universe.

*The Nature of the Universe*

Chapter 7 (p. 136)

The University Press. Cambridge, England. 1933

Here we are in this wholly fantastic Universe with scarcely a clue as to whether our existence has any real significance.

*The Nature of the Universe*

Chapter 7 (p. 138)

The University Press. Cambridge, England. 1933

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Man is not a circle with a single centre; he is an ellipse with two foci.. Facts are one, ideas are the other.

*Les Misérables*

Fantine, II (p. 92)

Carleton, Publisher. New York, New York, USA. 1884

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

The globe of this earth is evidently made for man. He

alone, of all the beings which have life upon this body, enjoys the whole and every part; he alone is capable of knowing the nature of this world, which he thus possesses in virtue of his proper right; and he alone can make the knowledge of this system a source of pleasure, and the means of happiness.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section I (pp. 17–18)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Hutton, W.**

No biographical data available

That man does not receive instruction from the creatures of God is not their fault, but his own. Their language is not dull and languid, but loud and incessant; while he, alas! remains deaf to the re-iterated cries of nature ...

*The Book of Nature Laid Open, in a Popular Survey of the Phenomena and Constitution of the Universe*

Chapter I (p. 5)

J. Milligan. Georgetown, District of Columbia. 1822

**Huxley, Thomas Henry** 1825–95

English biologist

The question of questions for mankind – the problem which underlies all others, and is more deeply interesting than any other is the ascertainment of the place which Man occupies in nature and of his relations to the universe of things.

*Collected Essays* (Volume 7)

*On the Relations of Man to the Lower Animals*

Chapter I (p. 77)

Macmillan & Company Ltd. London, England. 1904

Was the oldest *Homo sapiens* pliocene or miocene, or yet more ancient? In still older strata do the fossilized bones of an Ape more anthropoid, or a Man more pithecoïd, than any yet known await the researches of some unborn paleontologist ?

*Evidence as to Man's Place in Nature*

Chapter III (p. 184)

D. Appleton & Co. New York, New York, USA. 1873

**Ionides, Stephen A.**

No biographical data available

The vastness of the universe is a challenge; and all that has gone before us serves at once as example and as guide. We know now that we are little people, imprisoned on a tiny planet which is not even central in the gigantic whirlings of suns and galaxies. Yet we have learned much of how these huge bodies whirl. We can predict something of their future courses. We can even make use of their emanations and turn them to our own benefit. Through the ever increasing arch of our experience, the margin of the untraveled world still fades before us as we move. We are human, we have minds and books and records. What we have learned so far is no mean achievement, and our purpose, like the purpose of Tennyson's

“Ulysses,” holds,  
 “To follow knowledge like a sinking star  
 Beyond the utmost bounds of human thought.”

*Stars and Men*

Chapter XVII (p. 416)

Bobbs-Merrill. Indianapolis, Indiana, USA. 1939

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Old Mother Earth must regard man as a very recent apparition indeed; he has just appeared to burrow into her, burn her forests, put her waterfalls into pipes, and generally mar the beauty of her features. If he has done so much in the first few moments of his existence, she may well wonder what is in store for her in the long future ages in which he is destined to labor on her surface.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspects of Cosmogony (p. 165)

Government Printing Office. Washington, D.C. 1929

**Jennings, Herbert Spencer** 1868–1947

American zoologist

Vast areas of the universe have not yet realized their potentialities for the production of life. If man disappears, if he turns out to be one of the numerous branches that is not capable of continued existence, and if none of the other existing types can seize the advance, still other innumerable types may well arise and start new cycles of evolution. Man is not indispensable to the advancement of life.

*The Universe and Life*

Chapter II (pp. 59–60)

Yale University Press. New Haven, Connecticut, USA. 1941

**Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

Man, as I envisage him, is a being very young, very simple, very little capable of insight. His knowledge of the world of value is but a fledgling’s knowledge; his admiration is apt to be a nestling’s admiration for the things which are kindly to his own nature. Nevertheless, he may, I believe, pass in thought beyond this fledgling condition, and view the world as indifferent to his aims and alien to his nature, and yet as supremely worthy of his admiration.

*Philosophical Aspects of Modern Science*

Chapter XI (p. 339)

G. Allen & Unwin Ltd. London, England. 1932

Man by the light of science can see his hands, and can catch a glimpse of himself, his past, and the patch upon which he stands; but around him in place of that known

comfort and beauty he had anticipated, and in the first few moments falsely thought that he saw, is darkness still.

*Philosophical Aspects of Modern Science*

Chapter XI (p. 342)

G. Allen & Unwin Ltd. London, England. 1932

**Johanson, Donald**

American paleoanthropologist

**Edey, Maitland**

No biographical data available

...*Homo erectus*. put him on the subway and people would probably take a suspicious look at him. Before *Homo erectus* was a really primitive type, *Homo habilis*; put him on a subway and people would probably move to the other end of the car.

*Lucy: The Beginnings of Mankind*

Prologue (p. 20)

Simon & Schuster. New York, New York, USA. 1981

**Jourdain, Philip E. B.** 1879–1919

English logician

...men of a most abstract science, such as mathematics or philosophy, are chiefly adapted for the ends of ordinary life; when they think, they think, at the bottom, like other men.

*The Nature of Mathematics* (Revised edition)

Introduction (p. 9)

T.C. & E.C. Jack. London, England. 1919

**Kepler, Johannes** 1571–1630

German astronomer

[I]t is no longer a surprise that man, the ape of his Creator, should finally have discovered the art of singing polyphonically, which was unknown to the ancients, namely in order that he might play the everlastingness of all created time in some short part of an hour by means of an artistic concord of many voices and that he might to some extent taste the satisfaction of God the Workman with His own works, in that very sweet sense of delight elicited from this music which imitates God.

In *Great Books of the Western World* (Volume 16)

*Harmonies of the World*

Chapter 7 (p. 1048)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kingsley, Charles** 1819–75

English clergyman and author

No amount of book learning will make a man a scientific man; nothing but patient observation, and quiet and fair thought over what he has observed. He must go out for himself, see for himself, compare and judge for himself, in the field, the quarry, the cutting. He must study rocks, ores, fossils, in the nearest museum; and thus store his head, not with words, but with facts.

*Scientific Lectures and Essays*

Preface (p. 4)

Macmillan &amp; Co Ltd. London, England. 1893

**Koestler, Arthur** 1905–83

Hungarian-born English writer

But, glory be, man is not a flat-earth dweller all the time – only most of the time. Like the universe in which he lives, he is in a state of continuous creation.

*The Act of Creation*

Book One, Part Three, Chapter XX (p. 363)

The Macmillan Company. New York, New York, USA. 1964

**Krauss, Lawrence M.** 1954–

American theoretical physicist

There may be no ultimate purpose to our existence or the existence of our atoms. The universe may become unimaginably worse, or it may not. There may be no reward in heaven. But surely the possibility that we, as conscious beings, have some hope of unraveling the secrets of a mysterious universe in the time we have allotted is itself a precious gift we should not squander.

*Atom: An Odyssey from the Big Bang to Life on Earth...and Beyond*

Chapter 19 (p. 283)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 2001

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

How small a part of our system is known!

What a pitiful molehill is our Earth;

and, how insignificant are we –

we who creep so proudly on her surface.

Translated by James Jacque

*The System of the World*

Part I, Chapter V (p. 33)

Printed for Vernor &amp; Hood. London, England. 1800

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Man appears, upon a small planet, almost imperceptible in the vast extent of the solar system, itself only an insensible point in the immensity of space.

Translated by John Pond

*The System of the World* (Volume 2)

Book V, Chapter VI (p. 374)

Printed for Richard Phillips

London, England. 1809

**Landau, Lev** 1908–68

Russian physicist

The discovery of quantum mechanics and of the principle of uncertainty has shown that man can tear himself away from deeply rooted notions, discover, and accept something that is beyond his power of visualizing.

In Alexandre Dorozynski

*The Man They Wouldn't Let Die*

Chapter 7 (p. 95)

The Macmillan Company. New York, New York, USA. 1965

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

Then came the melting of the glaciers, and the world flood. The refugees from the drowned continents fled to the high places of America, Europe, Asia, and the Pacific Isles. And some degenerated naturally into cave men, neolithic and paleolithic creatures, and some retained their marvelous innate beauty and life-perfection, as the South Sea Islanders, and some wandered savage in Africa...

*Fantasia of the Unconscious*

Forward (p. xi)

M. Secker. London, England. 1923

I am part of the sun as my eye is part of me. That I am part of the earth my feet know perfectly, and my blood is part of the sea.

*Apocalypse*

Twenty-three (p. 200)

The Viking Press. New York, New York, USA. 1932

**Le Conte, Joseph** 1823–1901

Physiologist and geologist

Man must be set off not only against the animal kingdom, but against the whole of Nature besides, as an equivalent: Nature the book – the revelation – and man the interpreter.

*Elements of Geology: A Text-Book for Colleges and for the General Reader*

Part III, Chapter VI (p. 587)

D. Appleton &amp; Company. New York, New York, USA. 1882

...the history of the earth find[s] its consummation, and its interpreter, and its significance, in man.

*Elements of Geology: A Text-Book for Colleges and for the General Reader*

Part III, Chapter VI (p. 587)

D. Appleton &amp; Company. New York, New York, USA. 1882

**Leakey, Mary** 1913–96

English archaeologist

I've found him – found our man!

*New York Times*, 30 October, 1984**Lowell, Percival** 1855–1916

American astronomer

We pride ourselves upon being men of the world, forgetting that this is but objectionable singularity unless we are, in some wise, men of more worlds than one.

*Mars*

Chapter VI (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

If astronomy teaches anything, it teaches that man is but a detail in the evolution of the Universe, and that ressemblant, though diverse details are inevitably to be expected in the host of orbs around him. He learns that, though he will probably never find his double anywhere, he is destined to discover any number of cousins scattered through space.

*Mars*

Chapter VI (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

Man is merely this earth's highest production up to date.

*Mars*

Conclusion (p. 212)

Longmans, Green, &amp; Co. London, England. 1896

**Mallove, Eugene F.** 1947–2004

Editor

No one yet can prove that life is a more general drive of matter and energy than mere creeping carbon-based creatures struggling to emigrate from a sticky planetary surface.

*The Quickening Universe: Cosmic Evolution and Human Destiny*

Chapter 1 (p. 7)

St. Martin's Press. New York, New York, USA. 1987

No matter how small or seemingly weak, there is unquestionably a special grace to a fragment of the universe that aspires to comprehend the whole.

*The Quickening Universe: Cosmic Evolution and Human Destiny*

Chapter 1 (p. 7)

St. Martin's Press. New York, New York, USA. 1987

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

insects have  
their own point of view about  
civilization a man  
thinks he amounts  
to a great deal  
but to a  
flea or a  
mosquito a  
human being is

merely something good to eat

*the lives and times of archy & mehitabel*

certain maxims of archy (pp. 53–54)

Doubleday, Doran &amp; Company, Inc. Garden City, New York, USA. 1933

the supercilious silliness  
of this poor wingless bird  
is cosmically comical  
and stellarly absurd

*the lives and times of archy & mehitabel*

archy turns revolutionist (p. 227)

Doubleday, Doran &amp; Company, Inc. Garden City, New York, USA. 1933

**Marsh, George Perkins** 1801–82

American diplomat, scholar, and conservationist

...man is, in both kind and degree, a power of a higher order than any of the other forms of animated life, which, like him, are nourished at the table of bounteous nature.

*Man and Nature: Or, Physical Geography as Modified by Human Action*

Preface (p. iii)

Charles Scribner &amp; Co. New York, New York, USA. 1865

**Maudsley, Henry** 1835–1918

English physician

I have no wish whatever to exalt unduly the body; I have, if possible, still less desire to degrade the mind; but I do protest, with all the energy I dare use, against the unjust and most unscientific practice of declaring the body vile and despicable, of looking down upon the highest and most wonderful contrivance of creative skill as something of which man dare venture to feel ashamed. I cannot now summarize the facts and arguments which I have brought forward; I must trust to the indulgence of your memory of them when I declare that to my mind it appears a clear scientific duty to repudiate the quotation from an old writer, which the late Sir William Hamilton used to hang on the wall of his lecture-room:

“On earth there is nothing great but man, In man there is nothing great but mind.”

The aphorism, which, like most aphorisms, contains an equal measure of truth and untruth, is suitable enough to the pure metaphysician, but it is most unsuitable to the scientific inquirer, who is bound to reject it, not because of that which is not true in it only, but much more because of the baneful spirit with which it is inspired.

*Body and Mind*

Lecture III (p. 95)

D. Appleton &amp; Co. New York, New York, USA. 1872

On earth there are assuredly other things great besides man, though none greater; and in man there are other things great besides mind, though none greater.

*Body and Mind*

Lecture III (p. 95)

D. Appleton &amp; Co. New York, New York, USA. 1872

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Up till the introduction of man upon our planet, the humbler creatures, his predecessors, formed but mere figures in its various landscapes, and failed to alter or affect by their works the face of nature.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Sixth (p. 237)

Gould &amp; Lincoln. Boston, Massachusetts, USA. 1857

**Miller, Perry** 1905–63

American historian

It is only too clear that man is not at home in this universe, and yet he is not good enough to deserve a better...

*The New England Mind: The Seventeenth Century*

Chapter 1 (p. 7)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Monod, Jacques** 1910–76

French biochemist

If we accept this message – accept all it contains – then man must at last wake out of his millenary dream; and in doing so wake to his total solitude, his fundamental isolation. Now does he at last realize that, like a gypsy,



he lives at the boundary of an alien world. A world that is deaf to his music, just as indifferent to his hopes as to his suffering or his crimes.

*Chance and Necessity* (pp. 172–173)

...man knows at last that he is alone in the universe's unfeeling immensity, out of which he emerged only by chance.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Chapter IX (p. 180)

Vintage Books. New York, New York, USA. 1972

**Morgan, Elaine** 1920–

Welsh writer

Man is the only mammal whose normal method of locomotion is to walk on two legs. A pattern of mammal behavior that emerges only once in the whole history of life on earth takes a great deal of explaining.

*The Aquatic Ape* (p. 49)

Stein & Day. New York, New York, USA. 1982

**Morris, Desmond** 1928–

Zoologist and ethnologist

Despite our grandiose ideas and our lofty self-conceits, we are still humble animals, subject to all the basic laws of animal behavior.... We tend to suffer from a strange complacency that...there is something special about us, that we are somehow above biologic control. But we are not. Many exciting species have become extinct in the past, and we are no exception. Sooner or later we shall go, making way for something else. If it is to be later rather than sooner, then we must take a long, hard look at ourselves as biological specimens, and gain some understanding of our limitations.

*The Naked Ape*

Chapter Eight (p. 240)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Newman, Joseph S.** 1892–1960

American poet

Man is born, eats, procreates, and dies  
This sequence of events alike applies  
To horses, herring, crocodiles, and flies.

*Poems for Penguins and Other Lyrical Lapses*

Biochemistry

Greenburg. New York, New York, USA. 1941

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

Man is a rope stretched between the animal and the superman – a rope over an abyss.

Translated by Thomas Common

*Thus Spake Zarathustra*

Zarathustra's Prologue, 4 (p. 8)

The Modern Library. New York, New York, USA. No date

**Nordmann, Charles**

Astronomer

Men, as they pass through the universe, are like those specks of dust which dance for a moment in the golden rays of the sun, then sink into the darkness.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Introduction (p. xiv)

Henry Holt & Co. New York, New York, USA. 1922

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

We [US and USSR] may be likened to two scorpions in a bottle, each capable of killing the other, but only at the risk of his own life.

Atomic Weapons and American Policy

*Foreign Affairs*, July 1953 (p. 529)

**Osborne, John** 1939–94

English playwright

Here we are, we're alone in the universe, there's no God, it just seems that it all began by something as simple as sunlight striking on a piece of rock. And here we are. We've only got ourselves. Somehow, we've just got to make a go of it. We've only ourselves.

*The Entertainer*

No. 12

Criterion Books. New York, New York, USA. 1958

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

A man cannot become a competent surgeon without a full knowledge of human anatomy and physiology, and the physician without physiology and chemistry flounders along in an aimless fashion, never able to gain any accurate conception of disease, practising a sort of popgun pharmacy, hitting now the malady and again the patient, he himself not knowing which.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter VII (p. 127)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

**Pascal, Blaise** 1623–62

French mathematician and physicist

For, in fact, what is man in nature? A Nothingness in comparison with the Infinite, an All in comparison with the Nothing, a mean between nothing and everything.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section II, 72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Man is but a reed, the most feeble thing in nature; but he is a thinking reed. The entire universe need not arm itself

to crush him. A vapour, a drop of water suffices to kill him. But, if the Universe were to crush him, man would still be more noble than that which killed him, because he knows that he dies and the advantage which the universe has over him; the universe knows nothing of this.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section VI, 347

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But to show him [man] another prodigy equally astonishing, let him examine the most delicate things he knows. Let a mite be given him, with its minute body and parts incomparably more minute, limbs with their joints, veins in the limbs, blood in the veins, humors in the blood, drops in the humors, vapors in the drops. Dividing these last things again, let him exhaust his powers of conception, and let the last object at which he can arrive be now that of our discourse. Perhaps he will think that here is the smallest point in nature. I will let him see therein a new abyss. I will paint for him not only the visible universe, but all that he can conceive of nature's immensity in the womb of this abridged atom. Let him see therein the infinity of the universes, each of which has its firmament, its planets, its earth, in the same proportion as in the visible world; in each earth animals, and in the last mites, in which he will find again all that the first had, finding still in these others the same thing without end and without cessation. Let him lose himself in wonders as amazing in their littleness as the others in their vastness. For who will not be astounded at the fact that our body, which a little while ago was imperceptible in the universe, itself imperceptible in the bosom of the whole, is now a colossus, a world, or rather a whole, in respect of the nothingness which we cannot reach?

Translated by W.F. Trotter

*The Harvard Classics* (Volume 48)

*Thoughts*

Section II (p. 26)

P.F. Collier & Son. New York, New York, USA. 1910

...let man consider what he is in comparison with all existence; let him regard himself as lost in this remote corner of nature; and from the little cell in which he finds himself lodged, I mean the universe, let him estimate at their true value the earth, kingdoms, cities, and himself. What is a man in the Infinite?

Translated by W.F. Trotter

*The Harvard Classics* (Volume 48)

*Thoughts*

Section II (p. 26)

P.F. Collier & Son. New York, New York, USA. 1910

It is dangerous to show man how much he resembles the beasts, without showing him his greatness. It is dangerous to show him his excellence, without showing him his meanness. And the greatest danger of all is, to leave him ignorant of both. But it is highly beneficial to him to have

a knowledge of both.

*Thoughts on Religion, and Other Important Subjects*

Chapter XXIII (p. 233)

Samuel Bagster. London, England. 1806

**Patten, William** 1861–1932

American biologist

To the amoeba, the jelly-fish, or the worm, the “world” is the franchise of an hour in a drop of water; a niche in the rocks for a season; or a home in the sea for a decade. To man, the “world” is the universal whole of time and space, for their content are his to explore and to utilize. And therein lies our measure of freedom and attainment.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*

Chapter IV (p. 90)

Richard G. Badger. Boston, Massachusetts, USA. 1920

**Pickering, James Sayre**

No biographical data available

Man is a freak, colloidal combination of thirteen elements which happen to have a chemical affinity for each other, and is the strangest and one of the most amusing accidents of nature. The market value of the substance of the average man is about 98 cents.

*The Stars Are Yours* (p. 230)

The Macmillan Company. New York, New York, USA. 1948

**Planck, Max** 1858–1947

German physicist

...in the sight of God all men are equal. Even the most highly gifted geniuses, such as a Goethe or a Mozart, are but as primitive beings the thread of whose innermost thought and most finely spun feelings is like a chain of pearls unrolling in regular succession before His eye. This does not belittle the greatness of great men. But it would be a piece of stupid sacrilege on our part if we were to arrogate to ourselves the power of being able, on the basis of our own studies, to see as clearly as the eye of God sees and to understand as clearly as the Divine Spirit understands.

Translated by James Murphy

*Where Is Science Going?*

Chapter III (p. 103)

Norton. New York, New York, USA. 1932

**Plaskett, J. S.**

No biographical data available

...when we consider how the human mind, though inhabiting for only a few years this minute planet, accompanying a comparatively insignificant star of the system, has been able to reach out to the inconceivable depths of space and reduce some of the confusion of stars to orderly systems, has been able to deduce the laws which govern these systems, thus unifying, in certain degree, all the wonderful phenomena of suns and planets, comets, stars, nebulae and clusters, into one whole, we do not

lose hope that eventually it will be able to much further unravel the mystery of the universe.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1911*

Developments in Astronomy (p. 270)

Government Printing Office. Washington, D.C. 1912

**Proctor, Richard Anthony** 1837–88

English astronomer

It is, for instance, a strange and suggestive circumstance that man, insignificant in his dimensions and in all his physical powers, when viewed in comparison even with the earth on which he lives, and compelled to remain always upon that orb, which is utterly insignificant compared with the solar system, should yet dare to raise his thoughts beyond the earth and beyond the solar system, to contemplate boldly those amazing depths amidst which the stellar glories are strewn.

*The Expanse of Heaven* (p. 104)

Longmans, Green & Co. London, England. 1897

That he should undertake to measure the scale on which the universe is built, to rate the stars as with swift yet stately motion they career through space, to test and analyze their very substance, to form a judgment as to processes taking place upon and around them, tho not one star in all the heavens can be magnified into more than the merest point all this affords noble conceptions of the qualities which the Almighty has implanted in the soul of man.

*The Expanse of Heaven* (p. 104)

Longmans, Green & Co. London, England. 1897

We have learned how small is our domain in space, but as yet we have scarcely been willing to admit that man's duration in time is as utterly minute, and in a sense insignificant.

*The Poetry of Astronomy*

Age of the Sun and Earth (p. 1)

Smith, Elder & Co. London, England. 1881

**Rabinowitch, Eugene** 1901–73

Russian-born American biophysicist

We are indeed the detritus of stars, our atoms are the flour of celestial mills, our bodies the backings of solar fires.

The Role of Scientists: Thoughts for 1971

*Bulletin of the Atomic Scientists*, Volume XXVII, Number 1, January 1971 (p. 3)

**Raymo, Chet** 1936–

American physicist and science writer

We are indeed the detritus of stars, our atoms are the flour of celestial mills, our bodies the bakings of solar fires.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 21 (p. 196)

The Viking Press. New York, New York, USA. 1991

We are not playthings of the gods, comet-warned and

fearful; we are the comet's offspring, volatile compounds made animate, made conscious.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Thirteen (p. 251)

Walker & Company. New York, New York, USA. 1998

**Read, John**

No biographical data available

Man must learn to master and control himself as he has learned to master and control nature.

In James R. Newmann

*What is Science?*

Chemistry (p. 194)

Simon & Schuster. New York, New York, USA. 1955

**Riggs, Arthur Stanley**

No biographical data available

Man is what he is today – as our descendants will be a million years hence – because of the virtues of all our ancestors.

*The Romance of Human Progress*

Introduction (p. xix)

The Bobbs-Merrill Company. New York, New York, USA. 1938

**Robinson, Phil** 1847–1902

English journalist and writer on natural history

It is worth your Majesty's noting," said the Dodo to King Solomon, "that Man was not created until the last of the six days; that he is, in fact, the Junior of the Animals."

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter I (p. 1)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

...Man – this appendix to creation, this supplement as it were, a mere addendum or postscript – has disorganized the whole. He found us [the animals] all living together happily in one spot, and was the cause of our miserable dispersion over the world.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter I (p. 2)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

For countless ages the sun rose and set, the moon waxed and waned, the stars shone in the night, but it was only with the coming of Man that these things were understood. In the great world of astronomy and in the little world of the atom, Man has unveiled secrets which might have been thought undiscoverable.

*Portraits from Memory, and Other Essays* (p. 238)

Simon & Schuster. New York, New York, USA. 1956

Man is a part of Nature, not something contrasted with Nature.

*What I Believe*

Chapter I (p. 1)

E.P. Dutton & Company, Inc. New York, New York, USA. 1925

...Man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labors of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of man's achievement must inevitably be buried beneath the debris of a universe in ruins – all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand.

In Robert E. Egnor and Lester E. Denonn

*The Basic Writings of Bertrand Russell*

A Free Man's Worship (first published as "The Free Man's Worship" in December, 1903) (p. 67)

Simon & Schuster. New York, New York, USA. 1961

The endless praises of the choirs of angels had begun to grow wearisome; for, after all, did he not deserve their praise? Had he not given them endless joy? Would it not be more amusing to obtain undeserved praise, to be worshipped by beings whom he tortured? He smiled inwardly, and resolved that the great drama should be performed. For countless ages the hot nebula whirled aimlessly through space. At length it began to take shape, the central mass threw off planets, the planets cooled, boiling seas and burning mountains heaved and tossed, from black masses of cloud hot sheets of rain deluged the barely solid crust. And now the first germ of life grew in the depths of the ocean, and developed rapidly in the fructifying warmth into vast forest trees, huge ferns springing from the damp mould, sea monsters breeding, fighting, devouring, and passing away. And from the monsters, as the play unfolded itself, Man was born, with the power of thought, the knowledge of good and evil, and the cruel thirst for worship.

*Mysticism and Logic: And Other Essays*

Chapter III (p. 46)

Longmans, Green & Co. London, England. 1919

**Sackville-West, Victoria** 1862–1936

English poet

...one might reply that man himself was but a collection of atoms, even as a house was but a collection of bricks, yet man laid claim to a soul, to a spirit, to a power of recording and or perception, which had not more to do with his restless atoms than had the house with its stationary bricks.

*All Passion Spent*

Part I (p. 82)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Sakharov, Andrei** 1921–89

Soviet physicist and dissident

Like a gleam in the darkness, we have appeared for an instant from the black nothingness of the ever-unconscious matter, in order to make good the demands of Reason and create a life worthy of ourselves and of the Goal we only dimly perceive.

*Nobel Lectures, Peace 1971–1980*

Acceptance speech for award received in 1975

World Scientific Publishing Company. Singapore. 1997

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

I have had a most rare vision. I have had a dream – past the wit of man to say what dream it was: man is but an ass, if he go about to expound this dream.... Methought I was, and methought I had – but man is but a patched fool, if he will offer to say what methought I had....

It shall be called Bottom's dream, because it hath no bottom.

*A Midsummer-night's Dream* (pp. 72–73)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1903

**Shapley, Harlow** 1885–1972

American astronomer

We are brothers of the boulders, cousins of the clouds.

In Eric Chaisson

*Cosmic Dawn: The Origins of Matter and Life*

Epilogue (p. 299)

Little, Brown & Company. Boston, Massachusetts, USA. 1981

Mankind is made of star stuff, ruled by universal laws. The thread of cosmic evolution runs through his history, as through all phases of the universe – the microcosmos of atomic structures, molecular forms, and microscopic organisms, and the macrocosmos of higher organisms, of planets, stars, and galaxies. Evolution is still proceeding in galaxies and man – to what end, we can only vaguely surmise.

*The View from a Distant Star: Man's Future in the Universe*

Preface (p. 5)

Dell Publishing Company, Inc. New York, New York, USA. 1967

**Simpson, George Gaylord** 1902–84

American paleontologist

It is obvious that the great majority of humans throughout history have had grossly, even ridiculously, unrealistic concepts of the world. Man is, among many other things, the mistaken animal, the foolish animal. Other species doubtless have much more limited ideas about the world, but what ideas they do have are much less

likely to be wrong and are never foolish. White cats do not denigrate black, and dogs do not ask Baal, Jehovah, or other Semitic gods to perform miracles for them.

*This View of Life: The World of an Evolutionist*

Preface (p. viii)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

He [man] stands alone in the universe, a unique product of a long, unconscious, impersonal, material process with unique understanding and potentialities. These he owes to no one but himself, and it is to himself that he is responsible. He is not the creature of uncontrollable and undeterminable forces, but is his own master. He can and must decide and manage his own destiny.

*Life of the Past*

Chapter 11 (p. 155)

Yale University Press. New Haven, Connecticut, USA. 1953

**Squire, John Collings** 1884–1958

English poet

Men were on earth while climates slowly swung.  
Fanning wide zones to heat and cold, and long  
Subsidence turned great continents to sea,  
And seas dried up, dried up interminably.  
Age after age; enormous seas were dried  
Amid wastes of land. And the last monster died.

*Collected Poems*

The Birds (p. 154)

Macmillan & Company Ltd. London, England. 1959

**Steinbeck, John** 1902–68

American novelist

Man is related...inextricably to all reality, known and unknowable....[P]lankton, a shimmering phosphorescence on the sea and the spinning planets and an expanding universe, all bound together by the elastic string of time. It is advisable to look from the tide pool to the stars and then back to the tide pool again.

*Sea of Cortez*

Chapter 21 (p. 217)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Teller, Woolsey** 1890–1954

Essayist

Out of the star-dust man came, and into it he will sink again, as oblivious of his own passing existence as he was before that existence painfully and slowly evolved and separated him, for one brief instant, from the blindly-groping Whole.

*The Atheism of Astronomy*

Chapter VI (pp. 120–121)

Arno Press & The New York Times. New York, New York, USA. 1972

**Thierry, Paul Henri, Baron d'Holbach** 1723–89

German-born French philosopher

Man is the work of nature: he exists in nature: he is sub-

mitted to her laws: he cannot deliver himself from them: nor step beyond them, even in thought.

Translated by M. Mirabaud

*System of Nature, or The Laws of the Moral and Physical World* (Volume First)

Part First, Chapter First (p. 13)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thomas, Lewis** 1913–93

American physician and biologist

...we are here by the purest chance, and by mistake at that.

*The Medusa and the Snail: More Notes of a Biology Watcher*

The Wonderful Mistake (p. 29)

The Viking Press. New York, New York, USA. 1979

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Man needs to sojourn with Nature in order to get certain fundamental impressions without which he is impoverished – the impressions from the starry sky, the pathless sea, the mountain-top, the dense forest, the apple-blossom, the anthill, the swallows flying south in autumn. Man cannot safely dispense with the fundamental impressions of power, of largeness, of pervading order, of omnipresent beauty, of universal flux, of intricacy, of growth, of the web of life, of adaptiveness, of evolution.

*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* Volume 2

Lecture XX (p. 634)

Henry Holt & Co. New York, New York, USA. 1920

**Veblen, Thorstein** 1857–1929

Economist, social critic, and author

To modern civilised men, especially in their intervals of sober reflection, all these things that distinguish the barbarian civilisations seem of dubious value...futile in comparison with the achievements of science.

*The Place of Science in Modern Civilisation and Other Essays*

The Place of Science in Modern Civilization (p. 3)

B.W. Huebsch. New York, New York, USA. 1919

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

We are surroundings, our very existence to it [the universe]. Looking at it as an evolutionist, I believe that it is only by tracing it back to some necessary earlier state that we shall be able to form some rational conception of *how* it has evolved, *how* it has come to be what it is, how *we* have come to be where we are. Then, and then only, shall we be able to give any probable answer to the question, What advantages have we derived from our nearly central position?

Man's Place in the Universe, A Reply to the Criticism

*The Independent*, Volume 55, Number 2856, August 27, 1903 (p. 2030)

**Weller, Stuart**

No biographical data available

Doubtless there is no topic which possesses a wider interest for members of the human race than the topic of man himself...

*Annual Report of the Board of Regents of the Smithsonian Institution, 1927*  
Paleontology and Human Relations (p. 309)  
Government Printing Office. Washington, D.C. 1928

**Whewell, William** 1794–1866

English philosopher and historian

Man is the Interpreter of Nature, Science the right interpretation.

*Aphorisms Concerning Ideas, Science & the Language of Science*  
Aphorisms Concerning Ideas (p. 1)  
Harrison & Co. London, England. 1840

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...man, who at times dreamt of himself as a little lower than the angels, has submitted to become the servant and minister of nature.

*Science and the Modern World*  
Chapter VI (p. 141)  
The Macmillan Company. New York, New York, USA. 1929

**Whyte, Lancelot Law** 1896–1972

Scottish Physicist

In the vast tapestry of human experience there is nothing so extraordinary, or so challenging to human understanding as the process by which in a partly haphazard world of inorganic materials exploited their own laws so that organisms came into existence, and a cumulative process was started that led to the appearance of man.

*Accent on Form: An Anticipation of the Science of Tomorrow*  
Chapter VI (p. 85)  
Harper & Brothers Publishers. New York, New York, USA. 1954

**Wilson, Daniel**

No biographical data available

The tendency of modern science is to give prominence to many unheeled analogies between man and the lower animals; but the further this line of inquiry is pursued, it tends only the more strikingly to illustrate the radical nature of those differences which separate him from them, not in-degree as the higher animal, but inkind.

*Prehistoric Man: Researches Into the Origin of Civilisation in the Old and the New World* (2nd edition)  
Chapter I (p. 2)  
Macmillan & Co Ltd. London, England. 1865

**Young, Louise B.**

Science writer

Now in the vast spaces between the stars organic molecules like those that first formed life float on waves of energy that carry messages across the Milky Way. Because man has entered the cosmos, orderly patterns of

form have taken wing and are spreading through the universe at the speed of light.

*The Unfinished Universe*  
Chapter 8 (p. 166)  
Simon & Schuster. New York, New York, USA. 1986

**Yourcenar, Marguerite** 1903–87

French writer

...if man is part and parcel of the universe, and is ruled by the same laws as govern the sky, it is not unreasonable to search the heavens for the patterns of our lives, and for those impersonal attractions which induce our success and our errors.

*Memoirs of Hadrien*  
Tellus Stabilita (p. 148)  
Farrar, Straus & Company. New York, New York, USA. 1963

**MAN AND NATURE****Jefferies, Richard** 1848–87

English naturalist and author

Part and parcel as we are of the great community of living beings, indissolubly connected with them from the lowest to the highest by a thousand ties, it is impossible for us to escape from the operation of this law ...

*The Hills and the Vale*  
Nature and Eternity (p. 299)  
Duckworth & Co. London, England. 1909

**MAN, ASCENT OF****Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

We are all afraid – for our confidence, for the future, for the world. That is the nature of the human imagination. Yet every man, every civilization, has gone forward because of its engagement with what it has set itself to do. The personal commitment of a man to his skill, the intellectual commitment and the emotional commitment working together as one, has made the Ascent of Man.

*The Ascent of Man*  
Chapter 13 (p. 438)  
Little, Brown & Co. Boston, Massachusetts, USA. 1975

**MAN, CLASSIFICATION OF****Bates, Marston** 1906–74

American zoologist

There has, in fact, been so much contact through migrations and other types of population movements, that the anthropologists are unable to come to much agreement in attempts to classify man into subspecies (or races). Their problem is much like that of the botanists faced with the North American blackberries.



*The Nature of Natural History*

Chapter 2 (p. 16)

Scribner. New York, New York, USA. 1950

## MAN, MIND OF

**Dampier, Sir William Cecil** 1867–1952

English scientific writer

The mind of man, learning consciously and unconsciously lessons of experience, gradually constructs a mental image of its surroundings – as the mariner draws a chart of strange coasts to guide him in future voyages, and to enable those that follow after him to sail the same seas with ease and safety.

*The Recent Development of Physical Science*

Chapter I (p. 11)

P. Blakiston's Son & Co. Philadelphia, Pennsylvania, USA. 1904

**Langer, Susanne Katherina Knauth** 1895–1985

American philosopher

the mind of man is always fertile, ever creating and discarding, like the earth. There is always new life under old decay. Last year's dead leaves hide not merely the seeds, but the full-fledged green plants of this year's spring, ready to bloom almost as soon as they are uncovered.

*Philosophy in a New Key: A Study in the Symbolism of Reason,*

*Rite, and Art*

Chapter I (p. 17)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

## MAN, ORIGIN OF

**Milton, John** 1608–74

English poet

Thou sun, said I, fair light, And thou enlightened earth so fresh and gay, Ye hills and dales, ye rivers, woods, and plains, And ye that live and move, fair creatures, tell – Tell if ye saw, how came I thus, how here?

*Paradise Lost*

Book VIII

George Routledge & Sons. London, England. 1905

## MAN, PREHISTORIC

**Smith, Langdon** 1858–1908

American poet

I flaked a flint to a cutting edge,  
And shaped it with brutish craft;  
I broke a shank from the woodland dank,  
And fitted it, head and haft.  
Then I hid me close to the reedy tarn,  
Where the Mammoth came to drink –  
Through brawn and bone I drave the stone,

And slew him upon the brink.

*Evolution, A Fantasy*

VIII

Luce & Co. 1909

I carved that fight on a reindeer bone,  
With rude and hairy hand,  
I pictured his fall on the cavern wall  
That men might understand.  
For we lived by blood, and the right of might,  
Ere human laws were drawn,  
And the Age of Sin did not begin  
Till our brutal tusks were gone.

*Evolution, A Fantasy*

X

Luce & Co. 1909

## MAN, WISE

**Fitch, Sir Joshua Girling** 1824–1903

English educationist

The difference between a wise man and one who is not wise consists less in the things he knows than in the way in which he knows them.

*Lectures on Teaching*

Chapter XI (p. 288)

The Macmillan Co. New York, New York, USA. 1906

## MANDELBROT SET

**Ewing, John**

No biographical data available

If the entire Mandelbrot set [a family of complex polynomials that describes a fractal] were placed on an ordinary sheet of paper, the tiny sections of boundary we examine would not fill the width of a hydrogen atom. Physicists think about such tiny objects; only mathematicians have microscopes fine enough to actually observe them.

Can We See the Mandelbrot Set?

*The College Mathematics Journal*, Volume 26, Number 2, March, 1995

## MANKIND

**Clarke, Arthur C.** 1917–

English science and science fiction writer

...when the first contact with the outer universe is made, one would like to think that Mankind played an active and not merely a passive role – that we were the discoverers, not the discovered.

*The Exploration of Space*

Chapter 17 (p. 182)

Harper & Brothers Publishers. New York, New York, USA. 1951

**Coon, Carleton** 1904–81

American anthropologist

If Africa was the cradle of mankind, it was only an indifferent kindergarten. Europe and Asia were our principal schools.

*The Origin of Races*

Chapter 12 (p. 656)

Alfred A. Knopf. New York, New York, USA. 1966

**Hooke, Robert** 1635–1703

English physicist

It is the great prerogative of Mankind above other Creatures, that we are not only able to behold the works of Nature, or barely to sustain our lives by them, but we have also the power of considering, comparing, altering, assisting, and improving them to various uses.

*Micrographia*

Preface (First page)

Printed by Jo. Martyn & Ja. Allestry. London, England. 1665

**Kirby, William** 1759–1850

English entomologist

**Spence, William** 1783–1860

English entomologist

Mankind in general, not excepting even philosophers, are prone to magnify, often beyond its just merit, the science or pursuit to which they have addicted themselves, and to depreciate any that seems to stand in competition with their favourite: like the redoubted champions of romance, each thinks himself bound to take the field against everyone that will not subscribe to the peerless beauty and accomplishments of his own *Dulcinea*.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects* (7th edition)

Letter I (p. 1)

Longman, Brown, Green, Longmans & Robsrts. London, England. 1858

**Leakey, Richard Erskine** 1944–

Kenyan palaeoanthropologist and politician

**Lewin, Roger Amos**

Anthropologist

There is no law that declares the human species to be immortal.

*Origins: What New Discoveries Reveal About the Emergence of Our Species and Its Possible Future*

Chapter 10 (p. 256)

E.P. Dutton & Company, Inc. New York, New York, USA. 1977

**Ray, John** 1627–1705

English naturalist

Whatever may be said for ye Antiquity of the Earth itself and bodies lodged in it ye race of mankind is new.

In Charles Robert Gunther

*Further Correspondence of John Ray* (p. 260)

Printed for the Ray Society. London, England. 1928

**Sagan, Carl** 1934–96

American astronomer and author

In all the history of mankind, there will be only one gen-

eration that will be first to explore the Solar System, one generation for which, in childhood, the planets are distant and indistinct discs moving through the night sky, and for which, in old age, the planets are places, diverse new worlds in the course exploration.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 9 (p. 69)

Dell Publishing, Inc. New York, New York, USA. 1975

**Yalow, Rosalyn** 1921–

American medical physicist

If we are to have faith that mankind will survive and thrive on the face of the earth, we must believe that each succeeding generation will be wiser than its progenitors. We transmit to you, the next generation, the total sum of our knowledge. Yours is the responsibility to use it, add to it, and transmit it to your children.

*Les Prix Nobel. The Nobel Prizes in 1977*

Nobel banquet speech for award received in 1977

Nobel Foundation. Stockholm, Sweden. 1978

## MANUSCRIPT

**von Ebner-Eschenbach, Marie** 1830–1916

Austrian novelist

Manuscripts either moulder in your drawer, or mature there.

Translated by Annis Lee Wister

*Aphorisms*

Number 193

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

## MAP

**Boehm, George A. W.** 1922–93

American editor and mathematician

The question of what properties, such as angle or area, are reproduced on a map without distortion is of prime interest to mathematicians. The question extends far beyond the confines of geometry, for all mathematics can be considered broadly as a study of maps and mapping.

*The New World of Mathematics*

The Next Generation of Computers (p. 124)

Faber & Faber. London, England. 1960

**Brown, Lloyd**

No biographical data available

[Maps]...art with a purpose.

*The Story of Maps*

The Earth Takes Shape (p. 32)

Little, Brown. Boston, Massachusetts, USA. 1949

**Bryan, Kirk**

No biographical data available

Time, thought, and money are never wasted on the production of a map which shows clearly the relation of one

thing to another on the earth's surface.

Physical Geography in the Training of the Geographer  
*Annals of the Association of American Geographers*, Volume 34, 1944  
(p. 185)

**Carroll, Lewis (Charles Dodgson)** 1832–1884  
English writer and mathematician

He had bought a large map representing the sea  
Without the least vestige of land:  
And the crew were much pleased when they found it  
to be

A map they could all understand.

*The Complete Works of Lewis Carroll*

*The Hunting of the Snark*

Fit the Second

The Bellman's Speech (p. 760)

The Modern Library. New York, New York, USA. 1936

**Gleick, James** 1954–

American author, journalist, and essayist

Physicists' models are like maps: never final, never complete until they grow as large and complex as the reality they represent.

*Genius: The Life and Science of Richard Feynman*

Epilogue (p. 436)

Pantheon Books. New York, New York, USA. 1992

**Robinson, Arthur H.** 1915–2004

American geographer

Mathematical equations and literary phrases are useful but they are no substitute for the spatial eloquence of the map.

Uniqueness of the Map

*American Cartographer*, Volume 5, Number 1, 1978

**Robinson, Arthur H.** 1915–2004

American geographer

**Petchenik, Barbara Bartz**

No biographical data available

[Map]... a graphic representation of the milieu...

*The Nature of Maps*

Chapter 1 (p. 16)

The University of Chicago Press. Chicago, Illinois, USA. 1976

**Sholander, Marlow**

Mathematician

Within your lifetime will, perhaps,  
As souvenirs from distant suns  
Be carried back to earth some maps  
Of planets and you'll find that one's  
So hard to color that you've got  
To use five crayons. Maybe, not.  
Maybe

*Mathematics Magazine*, Volume 35, Number 1, January, 1962 (p. 20)

**Yukawa, Hideki** 1907–81

Japanese theoretical physicist

Those who explore an unknown world are travelers without a map: the map is the result of the exploration. The position of their destination is not known to them, and the direct path that leads to it is not yet made.

In Robert P. Crease and Charles C. Mann

*The Second Creation: Makers of the Revolution in 20th Century Physics*  
Chapter 9 (p. 159)

The Macmillan Company. New York, New York, USA. 1986

## MARINE BIOLOGY

**Spenser, Edmund** 1552–99

English poet

But what an endlesse worke have I in hand,  
To count the seas abundant progeny,  
Whose fruitful seede farre passeth those on land,  
And also those which wonne in th' azure sky;  
For much more eath, to tell the starres on by,  
Albe they endlesse seem in estimation,  
Than to recount the seas posterity;  
So fertile be the floods in generation,  
So huge their numbers, and so numberlesse their nation.

*The Complete Poetical Works of Edmund Spenser*

*The Faerie Queene*

Book IV, Canto XII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

## MARTIAN

**Lowell, Percival** 1855–1916

American astronomer

The evidence of handicraft, if such it be, points to a highly intelligent mind behind it. Irrigation, unscientifically conducted, would not give us such truly wonderful mathematical fitness in the several parts to the whole as we there behold. A mind of no mean order would seem to have presided over the system we see – a mind certainly of considerably more comprehensiveness than that which presides over the various departments of our own public works. Party politics at all events have had no part in them; for the system is planet wide. Quite possibly, such Martian folk are possessed of inventions of which we have not dreamed, and with them electrophones and kinoscopes are things of a bygone past, preserved with veneration in museums as relics of the clumsy contrivances of the simple childhood of the race. Certainly what we see hints at the existence of beings who are in advance of, not behind us, in the journey of life.

*Mars*

Chapter VI (p. 208)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**MARTYRDOM**

**Hilbert, David** 1862–1943  
German mathematician

Only an idiot could believe that scientific truth needs martyrdom – that may be necessary in religion, but scientific results prove themselves in time.

In Constance Reid  
*Hilbert – Courant*  
Hilbert  
Chapter XII (p. 92)  
Springer-Verlag. New York, New York, USA. 1986

**MARVELOUS**

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Every man has within him his Patmos. He is free to go, or not to go, out upon that frightful promontory of thought from which one perceives the shadow. If he goes not, he remains in the common life, with the common conscience, with the common virtue, with the common faith, or with the common doubt; and it is well. For inward peace it is evidently the best. If he goes out upon those heights, he is taken captive. The profound waves of the marvellous have appeared to him. No one views with impunity that ocean.

Translated by Melville Best Anderson  
*William Shakespeare*  
Part Second, Book V, Chapter I (p. 175)  
A.C. McClurg & Co. Chicago, Illinois, USA. 1887

**MASS**

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The law refers to the product of the masses of the two bodies; but the mass depends on the velocity – a fact unknown in Newton's day. Are we to take the variable mass, or the mass reduced to rest? Perhaps a learned judge, interpreting Newton's statement like a last will and testament, could give a decision; but that is scarcely the way to settle an important point in scientific theory.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*  
Chapter VI (p. 93)  
At The University Press. Cambridge, England. 1921

**Feynman, Richard P.** 1918–88  
American theoretical physicist

All mass is interaction.

In James Gleik  
*Genius: The Life and Science of Richard Feynman*  
Prologue (p. 5)  
Pantheon Books. New York, New York, USA. 1992

**Jammer, Max** 1915–  
Israeli physicist and philosopher

Although of primary importance in all branches of physics and an indispensable conceptual tool of scientific thought, the notion of mass seems to elude all attempts at a fully comprehensive elucidation and a logical as well as scientifically unobjectionable definition.

*Concepts of Mass in Classical and Modern Physics*  
The Concept of Mass in Quantum Mechanics and Field Theory (pp. 224–225)

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

It appears on the first view of the subject [mass and gravity] impossible to determine the respective masses of the Sun and planets, and to measure the height from which bodies fall in a given time, from the action of gravity at their surface. But the connection of truths with each other conducts us to results which appeared inaccessible, when the principle on which they depend was unknown.

Translated by J. Pond  
*The System of the World* (Volume 2)  
Chapter II (p. 27)  
Printed for Richard Phillips. London, England. 1809

**MATERIAL WORLD**

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The familiar material world of everyday conception, though lacking somewhat in scientific truth, is good enough to live in; in fact the scientific world of pointer readings would be an impossible sort of place to inhabit. It is a symbolic world and the only thing that could live comfortably in it would be a symbol. But I am not a symbol; I am compounded of that mental activity which is from your point of view a nest of illusion, so that to accord with my own nature I have to transform even the world explored by my senses. But I am not merely made up of senses; the rest of my nature has to live and grow. I have to render account of that environment into which it has its outlet. My conception of my spiritual environment is not to be compared with your scientific world of pointer readings; it is an everyday world to be compared with the material world of familiar experience. I claim it as no more real and no less real than

that. Primarily it is not a world to be analysed, but a world to be lived in.

*The Nature of the Physical World*

Chapter XV (p. 324)

The University Press. New York, New York, USA. 1929

## MATERIALISM

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

A man who has lived and loved falls down dead and the worms eat him. That is Materialism if you like. That is Atheism if you like.

*All Things Considered*

Science and Religion (p. 193)

John Lane Co. New York, New York, USA. 1910

## MATHEMATICAL

**Colum, Padraic** 1881–1972

Irish poet and writer

An age being mathematical, these flowers  
Of linear stalks and spheroid blooms were prized...

In Helen Plotz

*Imagination's Other Place*

Tulips (p. 76)

Thomas Y. Crowell Company. New York, New York, USA. 1955

**Darwin, Charles Galton** 1887–1962

English physicist and administrator

Every new body of discovery is mathematical in form,  
because there is no other guidance we can have.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Dee, John** 1527–1609

English mathematician and occultist

A marvelous neutrality have these things mathematical,  
and also a strange participation between things super-  
naturall, immortall, intellectuall, simple and indivisible,  
and things naturall, mortall, sensible, compounded and  
divisible.

*Euclid*

Preface (p. 2)

Printed by Robert & William Leybourn. London, England. 1651

**Dillingsley, H.**

No biographical data available

Many arts there are which beautify the mind of man; of  
all other none do more to garnish and beautify it than  
those arts which are called mathematical.

*The Elements of Geometrie of the Most Ancient Philosopher Euclide of  
Megara*

Note to the Reader

John Day. Imprinted at London (England). 1570

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

From now on there will be no physical treatise which is  
not primarily mathematical.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 1, Section 1. 1 (p. 25)

The Macmillan Company. New York, New York, USA. 1967

**EcEntee, Howard G.**

No biographical data available

Every working day he deals with the intricacies of caster,  
camber, toe-in and kingpin inclination – all part of that  
mathematical jungle, front-end geometry, that confuses  
so many apprentice mechanics.

How an Expert Allign's an Auto's Front End

*Popular Science*, January, 1953 (p. 186)

**Feynman, Richard P.** 1918–88

American theoretical physicist

The rules that describe nature seem to be mathematical....  
Why nature is mathematical is, again, a mystery.

*The Meaning of It All*

Chapter I (p. 24)

Perseus Books. Reading, Massachusetts. USA. 1998

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

I'm very well acquainted too with matters mathematical.

The Pirates of Penzance, Act I

Comic opera, 1879

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

All things in the whole wide world happen mathematically.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Introduction (p. 14)

The Macmillan Company. New York, New York, USA. 1967

**Pascal, Blaise** 1623–62

French mathematician and physicist

...dull minds are never either intuitive or mathematical.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 1

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

...mathematical verities flow from a small number  
of self-evident propositions by a chain of impeccable

reasonings; they impose themselves not only on us, but on nature itself. They fetter, so to speak, the Creator and only permit him to chose between some relatively few solutions. A few experiments then will suffice to let us know what choice he has made. From each experiment a number of consequences will follow by a series of mathematical deductions, and in this way each of them will reveal to us a corner of the universe. This, to the minds of most people, and to students who are getting their first ideas of physics, is the origin of certainty in science.

*The Foundations of Science*

*Science and Hypothesis*, Introduction (p. 27)

The Science Press. New York, New York, USA. 1913

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

The mathematical is, so to speak, a superficial science; it builds on a borrowed site, and the principles by aid of which it proceeds, are not its own...

*Edinburgh Review*, Volume 52, January, 1836 (p. 221)

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Within all conflagrations mathematical things are related.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #356 (p. 78)

Definition Press. New York, New York, USA. 1972

**Somerville, Mary** 1780–1872

English mathematician

There is a wide distinction between the degree of mathematical acquirement necessary for making discoveries, and that which is requisite for understanding what other have done.

*The Connection of the Physical Sciences* (9th edition)

Introduction (pp. 2–3)

John Murray. London, England. 1858

**Weyl, Hermann** 1885–1955

German mathematician

You should not expect me to describe the mathematical way of thinking much more clearly than one can describe, say, the democratic way of life.

In K. Chandrasekhar

*Hermann Weyl*

Hermann Weyl Memorabilia (p. 84)

Springer-Verlag. Berlin, Germany. 1986

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

It is a safe rule to apply that, when a mathematical or philosophical author writes with a misty profundity, he is talking nonsense.

*An Introduction to Mathematics*

Chapter 15 (p. 170)

Oxford University Press, Inc. New York, New York, USA. 1958

## MATHEMATICAL ABSTRACTION

**Birkhoff, George David** 1884–1944

American mathematician

...it is a faith in the uniformity of nature which remains the guiding star of the physicist just as for the mathematician it is a faith in the self-consistency of all mathematical abstractions, although these faiths are more sophisticated than ever before. The minds of both are tinged with an unwavering belief in the supreme importance of their own fields. The mathematician affirms with Descartes, *omnia apud me mathematica fiunt* – with me everything turns into mathematics; by this he means that all permanent forms of thought are mathematical. The physicist on his part is apt to think that there is no reality essentially other than physical reality, so that life itself is finally to be fully described in physical terms.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Part II (p. 110)

Mathematical Association of America. Washington, D.C. 2004

**Rosenbaum, R. A.**

No biographical data available

Mathematical abstraction, to be considered significant, must someday pass the test of generality, of applicability, of relatedness. Mathematics too long divorced from reality, it has been said, becomes baroque, decadent, and sterile.

Mathematics, the Artistic Science

*The Mathematics Teacher*, Volume 55, Number 7, November, 1962 (p. 533)

## MATHEMATICAL ACCOUNT

**Kline, Morris** 1908–92

American mathematics professor and writer

Indeed it is paradoxical that abstractions so remote from reality should achieve so much. Artificial the mathematical account may be, a fairy tale perhaps, but one with a moral.

*Mathematics: A Cultural Approach*

Chapter 31–6 (p. 676)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1962

## MATHEMATICAL ACHIEVEMENT

**Dantzig, Tobias** 1884–1956

Russian mathematician

Mathematical achievement shall be measured by standards which are peculiar to mathematics. These standards



are independent of a crude reality of our senses. They are: freedom from logical contradictions, the generality of the laws governing the created form, the kinship which exists between this new form and those that have preceded it.

*Number: The Language of Science* (4th edition)  
Chapter Twelve, 2 (p. 231)  
The Macmillan Company. New York, New York, USA. 1954

## MATHEMATICAL ACTIVITY

### Pollak, Henry O.

No biographical data available

Mathematical activity – like all of Gaul – may be divided into three areas: Education, Research, and Applications...much of the strength of the mathematical fabric comes from the interaction among these three.

The Role of Industrial Members in the Mathematical Association of America  
*The American Statistician*, American Mathematical Monthly (p. 551)  
Volume 68, June–July 1961

## MATHEMATICAL ADAM

### Sylvester, James Joseph 1814–97

English mathematician

Perhaps I may without immodesty lay claim to the appellation of the Mathematical Adam, as I believe that I have given more names (passed into general circulation) to the creatures of the mathematical reason than all the other mathematicians of the age combined.

Note on a Proposed Addition to the Vocabulary of Ordinary Arithmetic  
*Nature*, Volume 37 1887–1888 (p. 152)

## MATHEMATICAL ANALYSIS

### Babbage, Charles 1792–1871

English mathematician

To examine the varied relations of necessary truth, and to trace through its successive developments, the simple principle to its ultimate result, is the peculiar province of Mathematical Analysis.

In Anthony Hyman  
*Science and Reform*  
Early Mathematical Work (p. 11)  
Cambridge University Press. Cambridge, England.

### Bell, E. T. (Eric Temple) 1883–1960

Scottish-American mathematician and educator

The toughminded suggest that the theory of the infinite elaborated by the great mathematicians of the Nineteenth and Twentieth Centuries, without which mathematical analysis as it is actually used today is impossible, has been committing suicide in an unnecessarily

prolonged and complicated manner for the past half century.

*Debunking Science*  
University of Washington Book Store. Seattle, Washington, USA. 1930

### Comte, Auguste 1798–1857

French philosopher

Mathematical Analysis is...the true rational basis of the whole system of our positive knowledge.

*The Positive Philosophy of Auguste Comte* (Volume 1)  
Book I, Chapter I (p. 42)  
John Chapman. London, England. 1853

### Cournot, Augustin 1801–77

French philosopher, mathematician, and economist

...those skilled in mathematical analysis know that its object is not simply to calculate numbers, but that it is also employed to find the relations between magnitudes which cannot be expressed in numbers and between functions whose law is not capable of algebraic expression.

*Researches into the Mathematical Principles of the Theory of Wealth*  
Preface (p. 3)  
The Macmillan Company. New York, New York, USA. 1927

### Cross, Hardy 1885–1959

American professor of civil and structural engineering

There is an unfortunate tendency to burden engineers, through books, with endless techniques and procedures of mathematical analysis. Few students know that at best books can furnish only a perishable net of large mesh through which they may begin to strain their information and that every fiber of that net must be rewoven from man's own thinking and that many new strands must be added if it is to be permanent and reliable in holding the selected data of years of engineering practice. Books present the sets of tools; it is the task of the analytical engineer to select those tools which can be used most advantageously.

*Engineers and Ivory Towers*  
For Man's Use of God's Gifts (p. 106)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

### Fourier, (Jean Baptiste-) Joseph 1768–1830

French mathematician and physicist

...mathematical analysis is as extensive as nature itself; it defines all perceptible relations, measures times, spaces, forces, temperatures; this difficult science is formed slowly, but it preserves every principle which it has once acquired; it grows and strengthens itself incessantly in the midst of the many variations and errors of the human mind.

Its chief attribute is clearness; it has not marks to express confused notions. It brings together phenomena the most diverse, and discovers the hidden analogies which unite them. If matter escapes us, as that of air and light, by its extreme tenuity, if bodies are placed far from us in the

immensity of space, if man wishes to know the aspect of the heavens at successive epochs separated by a great number of centuries, if the actions of gravity and of heat are exerted in the interior of the earth at depths which will always be inaccessible, mathematical analysis can yet lay hold of the laws of these phenomena. It makes them present and measurable, and seems to be a faculty of the human mind destined to supplement the shortness of life and the imperfection of the senses; and what is still more remarkable, it follows the same course in the study of all phenomena; it interprets them by the same language, as if to attest the unity and simplicity of the plan of the universe, and to make still more evident that unchangeable order which presides over all natural causes.

*Great Books of the Western World* (Volume 43)  
*The Analytical Theory of Heat*  
 Preliminary Discourse (p. 173)  
 Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

### More, Louis Trenchard

American educator

We have also constructed a symbolic language, called mathematical analysis, whose characters and terms are so removed from ordinary speech that it imposes on our minds an impression of not being limited by the bounds of logic.

*The Limitations of Science*  
 Chapter III (p. 71)  
 Henry Holt & Co. New York, New York, USA. 1915

## MATHEMATICAL ARGUMENT

### Darwin, Sir George Howard 1845–1912

English astronomer and mathematician

A mathematical argument is, after all, only organized common sense, and it is well that men of science should not always expound their work to the few behind a veil of technical language, but should from time to time explain to a larger public the reasoning which lies behind their mathematical notation.

*The Tides and Kindred Phenomena in the Solar System*  
 Preface (p. v)  
 Houghton Mifflin & Co. Boston, Massachusetts, USA. 1898

### de Staël (Anne-Louise-Germaine),

Mme. 1766–1817

French romantic writer

Nothing is less applicable to life than a mathematical argument.

Quoted in William Hamilton  
*Discussions on Philosophy and Literature, Education and University Reform*  
 On the Study of Mathematics as an Exercise of the Mind (p. 293)  
 Harper & Brothers Publishers. New York, New York, USA. 1861

## MATHEMATICAL ARTS

### Recordé, Robert 1510?–58

English mathematician and writer

Beside the mathematical arts there is no infallible knowledge, except it be borrowed from them.

In Morris Kline  
*Mathematics and the Physical World*  
 Chapter 9 (p. 130)  
 Dover Publications, Inc. New York, New York, USA. 1981

## MATHEMATICAL BEAUTY

### Dirac, Paul Adrien Maurice 1902–84

English theoretical physicist

Theoretical physicists accept the need for mathematical beauty as an act of faith.... For example, the main reason why the theory of relativity is so universally accepted is its mathematical beauty.

*From a Life of Physics*  
 Lecture 2, Methods in Theoretical Physics (p. 21)  
 World Scientific Publishing Company. Singapore. 1989

### Thompson, Sir D’Arcy Wentworth 1860–1948

Scottish zoologist and classical scholar

The harmony of the world is made manifest in Form and Number, and the heart and soul and all the poetry of Natural Philosophy are embodied in the concept of mathematical beauty.

*On Growth and Form* (Volume 1)  
 Epilogue (pp. 1096–1097)  
 At The University Press. Cambridge, England. 1951

## MATHEMATICAL BOOK

### Chrystal, George 1851–1911

Mathematician and academic

Every mathematical book that is worth reading must be read “backwards and forwards”, if I may use the expression. I would modify Lagrange’s advice a little and say, “Go on, but often return to strengthen your faith.” When you come on a hard or dreary passage, pass it over, and come back to it after you have seen its importance or found the need for it further on.

*Algebra: An Elementary Text Book for the Higher Classes of Secondary Schools and for Colleges* (part II)  
 Preface (p. viii)  
 Adam & Charles Black. London, England. 1889

### Davis, Philip J. 1923–

American mathematician

### Hersh, Reuben 1927–

American mathematician

All too many mathematical textbooks today have a nervous, breathless quality in which a fixed goal

is systematically and inexorably pursued. The goal having been attained, one is left not with a feeling of exhilaration but of anticlimax. Nowhere in such books is any appreciation to be found of why or how the goal is important, other, possibly, than the statement that the goal may now be used as the starting point for reaching other, deeper goals, which considerations of space, alas, prevent the author from pursuing. Blame it on Euclid, if you want, for the tendency was already in his exposition.

*The Mathematical Experience*

Utility (pp. 82–83)

Birkhäuser. Boston, Massachusetts, USA. 1981

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In the great majority of mathematical text-books there is a total lack of unity in method and of systematic development of a central theme. Propositions of very diverse kinds are proved by whatever means are thought most easily intelligible, and much space is devoted to mere curiosities which in no way contribute to the main argument.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 66)

Longmans, Green & Co. London, England. 1919

## MATHEMATICAL CALCULATION

**Nordenholt, George F.**

No biographical data available

Smart creative workers are those who are quick to see the limitations of mathematical calculations.

A Graduate Can Measure a Bottle

Editorial

*Product Engineering*, April, 1953

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...there is no more common error than to assume that, because prolonged and accurate mathematical calculations have been made, the application of the result to some fact of nature is absolutely certain.

*An Introduction to Mathematics*

Chapter 3 (p. 16)

Oxford University Press, Inc. New York, New York, USA. 1958

All mathematical calculations about the course of nature must start from some assumed law of nature.... Accordingly, however accurately we have calculated that some event must occur, the doubt always remains – Is it true?

*An Introduction to Mathematics*

Chapter 3 (p. 16)

Oxford University Press, Inc. New York, New York, USA. 1958

## MATHEMATICAL CERTAINTY

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

While the individual man is an insoluble puzzle, in the aggregate he becomes a mathematical certainty. You can, for example, never foretell what anyone man will be up to, but you can say with precision what an average number will be up to. Individuals vary, but percentages remain constant. So says the statistician.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Sign of the Four, Chapter 10 (p. 666)

Wings Books. New York, New York, USA. 1967

## MATHEMATICAL CONCEPT

**Browder, Felix E.** 1927–

American mathematician

**MacLane, Saunders** 1909–2005

American mathematician

The potential usefulness of a mathematical concept or technique in helping to advance scientific understanding has very little to do with what one can foresee before that concept or technique has appeared.

In Lynn Arthur Steen

*Mathematics Today: Twelve Informal Essays*

The Relevance of Mathematics (p. 348)

Springer-Verlag. New York, New York, USA. 1978

**Weaver, Jefferson Hane**

American science author

...one cannot merely plow ahead and expect to be able to master the intricacies of algebra, geometry, or even the calculus without having some awareness of the intellectual process by which mathematical concepts are formulated and tested.

*Conquering Calculus: The Easy Road to Understanding Mathematics*

Chapter 2 (p. 31)

Plenum Press. New York, New York, USA. 1998

## MATHEMATICAL CONGRESS

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

A mathematical congress of today reminds one of the Tower of Babel, for few men can follow profitably the discussions of sections other than their own, and even there they are sometimes made to feel like strangers.

*The Study of the History of Mathematics*

The Study of the History of Mathematics (p. 14)

Dover Publications, Inc. New York, New York, USA. 1936

## MATHEMATICAL CONSEQUENCE

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

All the effects of nature are only the mathematical consequences of a small number of immutable laws.

In E.T. Bell

*Men of Mathematics* (p. 172)

Simon & Schuster. New York, New York, USA. 1937

## MATHEMATICAL CONSTRUCTION

**Einstein, Albert** 1879–1955  
German-born physicist

Experience remains, of course, the sole criterion of the physical utility of a mathematical construction.

*The World As I See It* (p. 36)

Philosophical Library. New York, New York, USA. 1949

## MATHEMATICAL CORRESPONDENCE

**Merz, John Theodore** 1840–1922  
German-born British chemist, historian, and industrialist

This conception of correspondence plays a great part in modern mathematics. It is the fundamental notion in the science of order as distinguished from the science of magnitude. If older mathematics were mostly dominated by the needs of mensuration, modern mathematics are dominated by the conception of order and arrangement. It may be that this tendency of thought or direction of reasoning goes hand in hand with the modern discovery in physics, that the changes in nature depend not only or not so much on the quantity of mass and energy as on their distribution or arrangement.

*A History of European Thought in the Nineteenth Century*

(Volume 2)

Chapter XIII (p. 736)

William Blackwood & Sons. Edinburgh, Scotland. 1903

## MATHEMATICAL DEMONSTRATION

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

Mathematical demonstrations are a logic of as much or more use, than that commonly learned at schools, serving to a just formation of the mind, enlarging its capacity, and strengthening it so as to render the same capable of exact reasoning, and discerning truth from falsehood in all occurrences, even subjects not mathematical. For which reason it is said, the Egyptians, Persians, and Lacedaemonians, seldom elected any new kings, but such as had some knowledge in the mathematics, imagining those

who had not men of imperfect judgments, and unfit to rule and govern.

*Memoirs of the Life and Writings of Benjamin Franklin* (Volume 5)(2nd edition)

On the Usefulness of Mathematics (p. 90)

Printed for Henry Colburn. London, England. 1819

**Locke, John** 1632–1704  
English philosopher and political theorist

And thus all mathematical demonstrations, as well as first principles, must be received as native impressions on the mind; which I fear they will scarce allow them to be, who find it harder to demonstrate a proposition than assent to it when demonstrated. And few mathematicians will be forward to believe that all the diagrams they have drawn were but copies of those innate characters which nature had engraven upon their minds.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book I, Chapter I, Section 22 (p. 101)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

It may be surprising to see emotional sensibility invoked a propos of mathematical demonstrations which, it would seem, can interest only the intellect. This would be to forget the feeling of mathematical beauty, of the harmony of numbers and forms, of geometric elegance. This is a true esthetic feeling that all real mathematicians know, and surely it belongs to emotional sensibility.

*The Foundations of Science*

*Science and Method*, Book I

Chapter III (p. 391)

The Science Press. New York, New York, USA. 1913

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

All certainty which does not consist in mathematical demonstration is nothing more than the highest probability; there is no other historical certainty.

*The Portable Voltaire*

Philosophical Dictionary, Concatenation of Events (p. 223)

The Viking Press. New York, New York, USA. 1959

## MATHEMATICAL DIFFICULTY

**Einstein, Albert** 1879–1955  
German-born physicist

God does not care about our mathematical difficulties; He integrates empirically.

In Leopold Infeld

*Quest – An Autobiography*

Book Three, Part VI (p. 279)

Chelsea Publishing Company. New York, New York, USA. 1980

Do not worry about your difficulties in mathematics; I can assure you that mine are still greater.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives*  
 Letter dated 7 January, 1943 (p. 8)  
 Princeton University Press. Princeton, New Jersey, USA. 1979

**Schrödinger, Erwin** 1887–1961  
 Austrian theoretical physicist

...I do not refer to the mathematical difficulties, which eventually are always trivial, but rather to the conceptual difficulties.

*Science and the Human Temperament*  
 Chapter VIII (p. 189)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1935

## MATHEMATICAL DISCIPLINE

**Neumann, John von** 1903–57  
 Hungarian-American mathematician

As a mathematical discipline travels far from its empirical sources, or still more, if it is second and third generation only indirectly inspired by ideas coming from “reality”, it is beset with very grave dangers. It becomes more and more purely aestheticizing, more and more purely *l’art pour l’art*.... There is a great danger that the subject will develop along the line of least resistance....: will separate into a multitude of insignificant branches...

In Raymond George Ayoub  
*Musings of the Masters: An Anthology of Mathematical Reflections*  
 The Mathematician (p. 183)  
 Mathematical Association of America. Washington, D.C. 2004

## MATHEMATICAL DISCOVERY

**Birkhoff, George David** 1884–1944  
 American mathematician

It will probably be the new mathematical discoveries which are suggested through physics that will always be most important, for, from the beginning, Nature has led the way and established the pattern which mathematics, the language of Nature, must follow.

Mathematical Nature of Physical Theories  
*American Scientist*, Volume 31, Number 4, October, 1943 (p. 310)

**Fourier, (Jean Baptiste-) Joseph** 1768–1830  
 French mathematician and physicist

Profound study of nature is the most fertile source of mathematical discoveries.

Translated by Alexander Freeman  
*The Analytical Theory of Heat*  
 Preliminary Discourses (p. 7)  
 At The University Press. Cambridge, England. 1878

**Gauss, Johann Carl Friedrich** 1777–1855  
 German mathematician, physicist, and astronomer

...mathematical discoveries, like springtime violets in the woods, have their season which no human can hasten or retard.

Quoted in E.T. Bell  
*The Development of Mathematics*  
 Chapter 11 (p. 263)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

## National Research Council (USA)

A mathematical discovery has a permanent and universal validity; the worst fate that can overtake it is to be rendered uninteresting or trivial by enclosure within a more comprehensive structure.

*Physics in Perspective* (Volume 1)  
 Chapter 3 (p. 57)  
 National Academy of Sciences  
 Washington, D.C. 1972

**Poincaré, Jules Henri** 1854–1912  
 French mathematician and theoretical astronomer

The genesis of mathematical discovery is a problem which must intensely inspire the psychologist with the keenest interest. For this is the process in which the human mind seems to borrow least from the exterior world, in which it acts, or appears to act, only by itself and on itself, so that by studying the process of geometric thought we may hope to arrive at what is most essential in the human mind.

*The Foundations of Science*  
*Science and Method*, Book I  
 Chapter III (p. 383)  
 The Science Press. New York, New York, USA. 1913

...what is mathematical discovery? It does not consist in making new combinations with mathematical entities already known. Anyone could do that, but the combinations so made would be infinite in number and most of them absolutely without interest. To create consists precisely in not making useless combinations and in making those which are useful and which are only a small minority. Invention is discernment, choice.

*The Foundations of Science*  
*Science and Method*, Book I  
 Chapter III (p. 386)  
 The Science Press. New York, New York, USA. 1913

## MATHEMATICAL DOCTRINE

**Hadamard, Jacques** 1865–1963  
 French mathematician

The theory of integral equations, born yesterday, is already classical. It has been introduced in several university

courses. There is no doubt – perhaps further improvements – that it will soon impose itself as of current use in mathematics. This is a rare piece of good fortune for a mathematical doctrine, for mathematical doctrines so often become museum exhibits.

In A. d'Abro

*The Decline of Mechanism*

The Dim Past of Dusty Space (p. 118)

Dover Publications, Inc. New York, New York, USA. 1951

## MATHEMATICAL DOMAIN

**Weyl, Hermann** 1885–1955

German mathematician

In these days the angel of topology and the devil of abstract algebra fight for the soul of each individual mathematical domain.

In Morris Kline

*Mathematical Thought From Ancient to Modern Times* (p. 924)

Oxford University Press, Inc. New York, New York, USA. 1972

## MATHEMATICAL EQUATION

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The world looks like a multiplication-table, or a mathematical equation, which, turn it how you will, balances itself.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

Essays: First Series

Chapter III (p. 102)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The solution goes on famously; but just as we have got rid of the other unknowns, behold!  $V$  disappears as well, and we are left with the indisputable but irritating conclusion  $-0 = 0$ . This is a favorite device that mathematical equations resort to, when we propound stupid questions.

*The Nature of the Physical World*

Chapter II (p. 30)

The Macmillan Company. New York, New York, USA. 1930

## MATHEMATICAL EXERCISE

**Coleridge, Stephen** 1854–1936

English author, barrister, and opponent of vivisection

For such [mathematical] exercises of the mind pursued with determination render it averse from poetry, and all the imaginative study of human affairs, preclude it from appreciating all the loveliness of life, leave it untouched by the sanguine emotions, and quite indifferent to the

glamour of the arts, or to the divine gift of taste.

*The Idolatry of Science*

Chapter IV (p. 21)

John Lane Co. London, England. 1920

## MATHEMATICAL EXPLORER

**Eagar, Alexander R.**

No biographical data available

The Mathematical explorer is like all other explorers. He can enter new fields – if they are “there”: but the fields are not of his creation.

*Hermathena* (Volume 13)

Some Thoughts as to the Absolute (p. 546)

Hodges, Figgis & Co. Dublin, Ireland. 1905

## MATHEMATICAL EXPOSITION

**Heath, Thomas Little** 1861–1940

British civil servant, mathematician, and classical scholar

The treatises [of Archimedes] are, without exception, monuments of mathematical exposition; the gradual revelation of the plan of attack, the masterly ordering of the propositions, the stern elimination of everything not immediately relevant to the purpose, the finish of the whole, are so impressive in their perfection as to create a feeling akin to awe in the mind of the reader.

*A History of Greek Mathematics* (Volume 2)

Chapter XIII (p. 20)

At The Clarendon Press. Oxford, England. 1921

## MATHEMATICAL EXPRESSIONS

**Tobias, Sheila** 1935–

American academic and activist

Mathematical expressions like “the slope of the curve,” “zero sum,” “normalized distribution,” and “asymptotic” are no longer just the mutterings of bearded thinkers who cannot remember to wear socks of the same color.

They have become part of the basic vocabulary of business, politics, library management, health care, and even social work. . . . [M]athematical expressions give us a way of thinking about relationships that would otherwise be unavailable to us.

*Succeed With Math*

Chapter 1 (p. 4)

College Entrance Examination Board. New York, New York, USA. 1987

## MATHEMATICAL FACT

**Carlyle, Thomas** 1795–1881

English historian and essayist



It is a mathematical fact that the casting of this pebble from my hand alters the centre of gravity of the universe.

*Sartor Resartus*

Book III, Chapter VII (p. 223)

Ginn & Company. Boston, Massachusetts, USA. 1897

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

There is no elasticity in a mathematical fact; if you bring up against it, it never yields a hair's breadth; everything must go to pieces that comes in collision with it. What the mathematician knows being absolute, unconditional, incapable of suffering question, it should tend, in the nature of things, to breed a despotic way of thinking. So of those who deal with the palpable and often unmistakable facts of external nature; only to a less degree.

*The Autocrat of the Breakfast-Table*

Chapter III (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

## MATHEMATICAL FAME

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

Mathematical fame, if you have the cash to pay for it, is one of the soundest and steadiest of investments.

*A Mathematician's Apology*

Section 8 (p. 82)

Cambridge University Press. Cambridge, England. 1967

## MATHEMATICAL FORMULA

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

...from the time of Kepler to that of Newton, and from Newton to Hartley, not only all things in external nature, but the subtlest mysteries of life and organization, and even of the intellect and moral being, were conjured within the magic circle of mathematical formulae.

*Hints Towards the Formation of a More Comprehensive Theory of Life*

The Nature of Life (p. 31)

John Churchill. London, England. 1847

**Hertz, Heinrich** 1857–94

German physicist

One cannot escape the feeling that these mathematical formulas have an independent existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers, that we get more out of them than was originally put into them.

In Morris Kline

*Mathematics and the Search for Knowledge*

Chapter VII (p. 144)

Oxford University Press, Inc. New York, New York, USA. 1985

## MATHEMATICAL FOUNDATION

**Stewart, Ian** 1945–

English mathematician

Our world rests on mathematical foundations, and mathematics is unavoidably embedded in our global culture.

*Nature's Numbers*

Chapter 2 (p. 27)

BasicBooks. New York, New York, USA. 1995

## MATHEMATICAL FUNCTION

**Weyl, Hermann** 1885–1955

German mathematician

...it is the function of mathematics to be at the service of the natural sciences.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 61)

Princeton University Press. Princeton, New Jersey, USA. 1949

## MATHEMATICAL GENIUS

**Bostwick, Arthur Elmore** 1860–1942

No biographical data available

Mathematical genius is like an automobile – it is looked upon in two opposing fashions as one has it or has it not.

*A Librarian's Open Shelf: Essays on Various Subjects*

Simon Newcomb: America's Foremost Astronomer (p. 88)

The H.W. Wilson Co. New York, New York, USA. 1920

**Poiret, Pierre** 1646–1719

French mystic and Christian philosopher

The mathematical genius is wont, unless guarded against, to imbue the minds of its too intemperate votaries with the most pestilent dispositions. For it infects them with fatalism, spiritual insensibility, 'brutalism, disbelief, and an almost incurable presumption.' For when, in the handling of their numbers, figures, and machines, they perceive all things to follow each other, as it were by fate, to the exclusion of liberty; they hence become so accustomed to the consideration of necessary connection alone, that they altogether eliminate freewill from the nature and government of things spiritual, and establish the universal supremacy of a fatal necessity.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 299)

Harper & Brothers Publishers. New York, New York, USA. 1861

**MATHEMATICAL HARMONY**

**Weyl, Hermann** 1885–1995  
German mathematician

We still share the belief of a mathematical harmony of the universe. It has withstood the test of ever-widening experience. But we no longer seek this harmony in static forms like the regular solids, but in dynamic laws.

*Symmetry*

Translatory, Rotational, and Related Symmetries (p. 77)  
Princeton University Press. Princeton, New Jersey, USA. 1952

**MATHEMATICAL HEAD**

**Ascham, Roger** 1515–68  
English scholar and writer

Mark all mathematical heads which be wholly and only bent on these [music, arithmetic and geometry] sciences, how solitary they be themselves, how unfit to be with others, how unapt to serve the world.

*The American Journal of Education*

The Biography of Roger Ascham  
Volume 3, Number 8, March, 1857 (p. 27)

**MATHEMATICAL HISTORY**

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

Mathematical history and mathematics have in common the property that they inspire with awe and amazement those who approach them as humble disciples with a view to learning all that is known. On the other hand, they are apt to appear glaringly lacking and feeble to those who approach them from various directions with a view to getting information as regards particular important questions, properly belonging to these domains of knowledge.

*Historical Introduction to Mathematical Literature*

Chapter 1 (p. 12)  
The Macmillan Co. New York, New York, USA. 1916

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

The permeation of biology by mathematics is only the beginning, but unless the history of science is an inadequate guide, it will continue, and the investigations here summarized represent the beginning of a new branch of applied mathematics.

*The Causes of Evolution*

Appendix (p. 215)  
Longmans, Green & Company. London, England. 1935

**MATHEMATICAL IDEA**

**Bruner, Jerome Seymour** 1915–  
American psychologist

If we are not to live in embarrassed dread in the century ahead, we will have to understand the mathematical ideas that lie behind the scientific advances that are shaping the modern world.

In Kenneth J. Travers

Through Clouds of Failure into Orbit  
*Arithmetic Teacher*, Volume 15, Number 7, November, 1968 (p. 591)

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

...a mathematical idea is ‘significant’ if it can be connected, in a natural and illuminating way, with a large complex of other mathematical ideas.

*A Mathematician’s Apology*

Section 11 (p. 16)

**LeCam, Lucien**

No biographical data available

[In statistics] you have the fact that the concepts are not very clean. The idea of probability, of randomness, is not a clean mathematical idea. You cannot produce random numbers mathematically. They can only be produced by things like tossing dice or spinning a roulette wheel. With a formula, any formula, the number you get would be predictable and therefore not random. So as a statistician you have to rely on some conception of a world where things happen in some way at random, a conception which mathematicians don’t have.

In D. Albers, G. Alexanderson and C. Reid (eds.)

*More Mathematical People*

Lucien LeCam (p. 174)

Harcourt Brace Jovanovich. New York, New York, USA. 1990

**Leclerc, Georges-Louis, Comte de**

**Buffon** 1707–88

French naturalist

Those accustomed to mathematical ideas, which are very easily observed, and very easily discriminated from each other, when, by the rules of their science they attempt to judge of the administration of public or private affairs, arrive at conclusions the most absurd. For they take into account only the abstract possibilities, omitting in their reasonings certain dispositions of things and persons, which by their multiplicity and minuteness, almost elude the acutest observation.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 291)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Sylvester, James Joseph** 1814–97  
English mathematician

Number, place, and combination...the three intersecting but distinct spheres of thought to which all mathematical ideas admit of being referred.

*Philosophical Magazine*, Volume 24, (1844) (p. 285)

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...mathematical ideas, because they are abstract, supply just what is wanted for a scientific description of the course of events.

*An Introduction to Mathematics*

Chapter I (p. 13)

Henry Holt & Co. New York, New York, USA. 1911

I will not go so far as to say that to construct a history of thought without profound study of the mathematical ideas...is like omitting Hamlet from the play which is named after him. That would be claiming too much. But it is certainly analogous to cutting out the part of Ophelia. This simile is singularly exact. For Ophelia is quite essential to the play, she is very charming – and a little mad. Let us grant that the pursuit of mathematics is a divine madness of the human spirit, a refuge from the goading urgency of contingent happenings, and the sort of beauty changeless mountains present to senses tried by the present-day kaleidoscope of events.

*Science and the Modern World*

Chapter II (p. 31)

The Macmillan Company. New York, New York, USA. 1929

## MATHEMATICAL IMAGINATION

**Dyson, Freeman J.** 1923–  
American physicist and educator

One factor that has remained constant through all the twists and turns of the history of physical science is the decisive importance of the mathematical imagination.

*Mathematics in the Modern World*,

Mathematics in the Physical Sciences (p. 249)

W.H. Freeman & Company. San Francisco, California, USA. 1968

## MATHEMATICAL INSPIRATION

**von Neumann, John** 1903–57  
Hungarian-American mathematician

...much of the best mathematical inspiration comes from experience and that it is hardly possible to believe in the existence of an absolute, immutable concept of mathematical rigor, dissociated from all human experience.

*Collected Works* (Volume 1)

The Works of the Mind. The Mathematician (p. 6)

Pergamon Press. New York, New York, USA. 1961–1963

## MATHEMATICAL INSTRUCTION

**Challis, James** 1803–82  
English astronomer

It seems to me that the tendency of our mathematical instruction and examinations has been of late years to promote the acquisition of a knowledge of formal relations of symbols and the power of readily producing them,

*Lectures on Practical Astronomy and Astronomical Instruments*

Preface (p. viii)

George Bell & Sons. London, England. 1879

## MATHEMATICAL INSTRUMENT

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

It will interest mathematical circles that the mathematical instruments created by the higher algebra play an essential part in the rational formulation of the new quantum mechanics. Thus the general proofs of the conservation theorems in Heisenberg's theory carried out by Born and Jordan are based on the use of the theory of matrices, which go back to Cayley and were developed by Hermite. It is to be hoped that a new era of mutual stimulation of mechanics and mathematics has commenced. To the physicist it will seem first deplorable that in atomic problems we have apparently met with such a limitation of our usual means of visualisation. This regret will, however, have to give way to thankfulness that mathematics, in this field too, presents us with the tools to prepare the way for further progress.

Atomic Theory and Mechanics

*Nature*, Volume 116, Supplement, December 5, 1925 (p. 852)

## MATHEMATICAL INTELLECT

**Pascal, Blaise** 1623–62  
French mathematician and physicist

There are then two kinds of intellect: the one able to penetrate acutely and deeply into the conclusions of given premises, and this is the precise intellect; the other able to comprehend a great number of premises without confusing them, and this is the mathematical intellect. The one has force and exactness, the other comprehension.

Translated by William Finlayson Trotter

*Thoughts*

Number 2 (p. 9)

P.F. Collier & Son. New York, New York, USA. 1910

## MATHEMATICAL INTUITION

**Dyson, Freeman J.** 1923–  
American physicist and educator

Mathematical intuition is more often conservative than revolutionary, more often hampering than liberating.

Mathematics in the Physical Sciences

*Scientific American*, Volume 211, Number 3, September, 1964 (p. 132)

## MATHEMATICAL INVENTION

**Dantzig, Tobias** 1884–1956

Russian mathematician

It is a remarkable fact that the mathematical inventions which have proved to be most accessible to the masses are also those which exercised the greatest influence on the development of pure mathematics.

*Number: The Language of Science* (4th edition)

Chapter Ten (p. 192)

The Macmillan Company. New York, New York, USA. 1954

**de Morgan, Augustus** 1806–71

English mathematician and logician

The moving power of mathematical *invention* is not reasoning, but imagination.

Quoted in Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 3)

Chapter LI (p. 219)

Hodges, Figgis & Co. Dublin, Ireland. 1889

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The genesis of mathematical invention is a problem which should inspire the most lively interest among psychologists. It is a process in which the human mind appears to borrow least from the external world, where it does not act, or does not appear to act, except by itself or upon itself, so that in studying the process of mathematical thought, what we hope to attain is that which is the most essential element in the human mind.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematical Invention (p. 20)

Mathematical Association of America. Washington, D.C. 2004

Inventing consists precisely in not constructing combinations that are useless, but in constructing those which are useful and these are a small minority. Inventing means discerning, means choosing.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematical Invention (p. 23)

Mathematical Association of America. Washington, D.C. 2004

## MATHEMATICAL INVESTIGATION

**Barry, Frederick** 1876–1943

Historian of science

No amount of logical or mathematical investigation alone, moreover, can ever establish a fact.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 111)

Columbia University Press. New York, New York, USA. 1927

**Rowland, Henry Augustus** 1848–1901

American physicist

A mathematical investigation always obeys the law of the conservation of knowledge: we never get out more from it than we put in.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aims of the Physicist (p. 674)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

## MATHEMATICAL ISSUE

**Burger, Edward B.**

American mathematician

**Starbird, Michael**

American mathematician

Despite centuries of effort, the universe continues to hide answers to most mathematical issues.

*Coincidences, Chaos, and All That Math Jazz*

Chapter 4 (p. 74)

W.W. Norton & Co. New York, New York, USA. 2005

## MATHEMATICAL JOKE

**Littlewood, John Edensor** 1885–1977

English mathematician

A good mathematical joke is better, and better mathematics, than a dozen mediocre papers.

In Béla Bollobás (ed.)

*Littlewood's Miscellany*

Introduction to a Mathematician's Miscellany (p. 24)

Cambridge University Press. Cambridge, England. 1986

## MATHEMATICAL JUDGMENT

**Kant, Immanuel** 1724–1804

German philosopher

Mathematical judgments are always synthetical.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Introduction, Section V (p. 720)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## MATHEMATICAL JUNGLE

**EcEntee, Howard G.**

No biographical data available

Every working day he deals with the intricacies of caster, camber, toe-in and kingpin inclination – all part of that mathematical jungle, front-end geometry, that confuses so many apprentice mechanics.

How an Expert Aligns an Auto's Front End

*Popular Science*, January, 1953 (p. 186)

## MATHEMATICAL KNOWLEDGE

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

...Mathematical Knowledge adds a manly Vigour to the Mind, frees it from *Prejudice, Credulity* and *Superstition*.  
*An Essay on the Usefulness of Mathematical Learning* (3rd ed.) (p. 7)  
Printed for J. Barrett  
London, England. 1745

**Bacon, Roger** 1214–92  
English philosopher, scientist, and friar

The knowledge of mathematical things is almost innate in us.... This is the easiest of sciences, a fact which is obvious in that no one's brain rejects it; for laymen and people who are utterly illiterate know how to count and reckon.

Translated by Robert Belle Burke  
*The Opus Majus of Roger Bacon*  
Part 4, Chapter 1  
Oxford University Press, Inc. London, England. 1928

**Hilbert, David** 1862–1943  
German mathematician

...with all the variety of mathematical knowledge, we are still clearly conscious of the similarity of the logical devices, the relationship of the ideas in mathematics as a whole and the numerous analogies in its different departments. We also notice that, the farther a mathematical theory is developed, the more harmoniously and uniformly does its construction proceed, and unsuspected relations are disclosed between hitherto separated branches of the science. So it happens that, with the extension of mathematics, its organic character is not lost but manifests itself the more clearly.

Mathematical Problems  
*Bulletin of the American Mathematical Society*, Volume 8, 2nd series  
October 1901–July 1902

**Miller, George Abram** 1863–1951  
American mathematician

One of the difficult problems which present themselves to those interested in the diffusion of mathematical knowledge is how to establish a proper correspondence between the subject matter and the individual. This problem is especially serious in view of the fact that misfits along this line are often disastrous.

*Historical Introduction to Mathematical Literature*  
Preface (p. v)  
The Macmillan Co. New York, New York, USA. 1916

**Minto, Walter** 1753–96  
Scottish-American mathematician

Mathematical Knowledge is generally supposed to be acquired with difficulty. I can assure you, however, that

the difficulty arises rather from want of attention than from want of sagacity in those who make the attempt.

*An Inaugural Oration on the Progress and Importance of the Mathematical Sciences*.  
Princeton, preceding the Annual Commencement 1788 (p. 46)  
Printed by Isaac Collins. Trenton, New Jersey, USA. 1788

**Schubert, Hermann Cäsar Hannibal** 1848–1911  
Enumerative geometer

...the three positive characteristics that distinguish mathematical knowledge from other knowledge...may be briefly expressed as follows; first, mathematical knowledge bears more distinctly the imprint of truth on all its results than any other kind of knowledge; secondly, it is always a sure preliminary step to the attainment of other correct knowledge; thirdly, it has no need of other knowledge.

*Mathematical Essays and Recreations*  
On the Nature of Mathematical Knowledge (p. 35)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1917

**von Liebig, Justus** 1803–73  
German organic chemist

...without the power of observation, without judgment, without sagacity, all mathematical knowledge is useless.

In John Gardner  
*Familiar Letters on Chemistry*  
Second Series  
Letter I (p. 12)  
Taylor & Walton. London, England. 1844

## MATHEMATICAL LANGUAGE

**Hamilton, William** 1788–1856  
Scottish philosopher

Mathematical language, precise and adequate, nay, absolutely convertible with mathematical thought, can afford us no example of those fallacies which so easily arise from the ambiguities of ordinary language; its study cannot, therefore, it is evident, supply us with any means of obviating those illusions from which it is itself exempt. The contrast of mathematics and philosophy, in this respect, is an interesting object of speculation; but, as imitation is impossible, one of no practical result.

*Discussions on Philosophy and Literature, Education and University Reform*  
On the Study of Mathematics as an Exercise of the Mind (pp. 283–284)  
Harper & Brothers Publishers. New York, New York, USA. 1861

**Koyré, Alexandre** 1892–1964  
Russian-born French philosopher

Nature responds only to questions posed in mathematical language, because nature is the domain of measure and order.

In H. Floris Cohen

*The Scientific Revolution: A Historiographical Inquiry*

Chapter Two (p. 77)

The University of Chicago Press. Chicago, Illinois, USA. 1994

**Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

...the zoologist or morphologist has been slow, where the physiologist has long been eager, to invoke the aid of the physical or mathematical sciences; and the reasons for this difference lie deep.... Even now the zoologist has scarce begun to dream of defining in mathematical language even the simplest organic forms.

*On Growth and Form* (Volume 1)

Chapter I (p. 2)

At The University Press. Cambridge, England. 1951

## MATHEMATICAL LAW

**Boutroux, Émile** 1845–1921

French philosopher

The mathematical laws presuppose a very complex elaboration. They are not known exclusively either a priori or a posteriori, but are a creation of the mind; and this creation is not an arbitrary one, but, owing to the mind's resources, takes place with reference to experience and in view of it. Sometimes the mind starts with intuitions which it freely creates; sometimes, by a process of elimination, it gathers up the axioms it regards as most suitable for producing a harmonious development, one that is both simple and fertile. The mathematics is a voluntary and intelligent adaptation of thought to things, it represents the forms that will allow of qualitative diversity being surmounted, the moulds into which reality must enter in order to become as intelligible as possible.

Translated by Fred Rothwell

*Natural Law in Science and Philosophy* (pp. 40–41)

Macmillan Publishing Company. New York, New York, USA. 1914

**d'Abro, Abraham**

No biographical data available

Success has attended the efforts of mathematical physicists in so large a number of cases that, however marvellous it may appear, we can scarcely escape the conclusion that nature must be rational and susceptible to mathematical law.

*The Evolution of Scientific Thought from Newton to Einstein*

Foreword (pp. xii–xiii)

Dover Publications, Inc., New York, New York, USA. 1950

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

A reality completely independent of the spirit that conceives it, sees it or feels it, is an impossibility. A world so external as that, even if it existed, would be forever

inaccessible to us. What we call “objective reality” is, strictly speaking, that which is common to several thinking beings and might be common to all; this common part, we shall see, can only be the harmony expressed by mathematical laws.

Translated by George Bruce Halsted

*The Value of Science*

Introduction (p. 14)

The Science Press. New York, New York, USA. 1907

## MATHEMATICAL LEARNING

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The Martians seem to have calculated their descent with amazing subtlety – their mathematical learning is evidently far in excess of ours...

*Seven Famous Novels by H.G. Wells*

*The War of the Worlds*

Book I, Chapter 1 (pp. 266–267)

Alfred A. Knopf. New York, New York, USA. 1934

## MATHEMATICAL LITERATURE

**Babbage, Charles** 1792–1871

English mathematician

The golden age of mathematical literature is undoubtedly past.

In Anthony Hyman

*Science and Reform*

Early Mathematical Work (p. 33)

Cambridge University Press. Cambridge, England.

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

The great mass of mathematical literature will be always contained in journals and transactions, but there is no reason why it should not be rendered far more useful and accessible than at present by means of treatises or higher text-books. The whole science suffers from want of avenues of approach, and many beautiful branches of mathematics are regarded as difficult and technical merely because they are not easily accessible.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*

Presidential address (p. 724)

John Murray. London, England. 1891

**Miller, George Abram** 1863–1951

American mathematician

Shameless ignorance in regard to such serious intellectual conquests as are embodied in the mathematical literature does not represent a normal condition on the part of those interested in the history of the human race.

*Historical Introduction to Mathematical Literature*

Preface (pp. ix–x)

The Macmillan Co. New York, New York, USA. 1916



The mathematical literature is unusually rich in content and is composed of a great variety of elements. It contains many results that would appeal to everyone if they were presented in the proper form and at the proper time.

*Historical Introduction to Mathematical Literature*

Preface (p. v)

The Macmillan Co. New York, New York, USA. 1916

## MATHEMATICAL LOGIC

**Goodstein, Reuben L.** 1912–85

English mathematician

The function of mathematical logic is to reveal and codify the logical processes employed in mathematical reasoning and to clarify the concepts of mathematics; it is itself a branch of mathematics, employing mathematical symbolism and technique, a branch which has developed in its entirety during the past hundred years and which in its vigor and fecundity and the power and importance of its discoveries may well claim to be in the forefront of modern mathematics.

*Mathematical Logic* (p. 1)

Leicester University Press. Leicester, England. 1957

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

Mathematical logic deals not with the truth but only with the game of truth.

*Indiscrete Thoughts* (p. 93)

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Thus it would seem that wherever we infer from perceptions, it is only structure that we can validly infer; and structure is what can be expressed by mathematical logic, which includes mathematics.

*The Analysis of Matter*

Chapter XXIV (p. 254)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

## MATHEMATICAL MEN

**Locke, John** 1632–1704

English philosopher and political theorist

When mathematical men will build systems upon fancy, and not upon demonstration, they are as liable to mistakes as others.

*The Works of John Locke*

Mr. Locke's Second Reply to the Bishop of Worcester (p. 427)

Printed for Thomas Tegg. London, England. 1823

## MATHEMATICAL METHOD

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The distinction between the mathematical method and the scientific is seen in the agonies of very young children to do what their teachers sometimes tell them is mathematics. Anyone who was subjected to elementary geometry when his infantile brain was as unripe as a green walnut will recall the protracted misery he endured.

*The Handmaiden of the Sciences*

Chapter 1 (p. 6)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Butler, Nicholas Murray** 1862–1947

American educator and university administrator

The analytical geometry of Descartes and the calculus of Newton and Leibniz have expanded into the marvelous mathematical method – more daring than anything that the history of philosophy records...defying the senses to follow its splendid flights, is demonstrating today, as it never has been demonstrated before, the supremacy of the pure reason.

*The Meaning of Education and Other Essays and Addresses*

What Knowledge Is of Most Worth? (p. 45)

The Macmillan Company. London, England. 1898

**Comte, Auguste** 1798–1857

French philosopher

Every attempt to employ mathematical methods in the study of chemical questions must be considered profoundly, now as always, profoundly irrational, as being contrary to the nature of the phenomena. If mathematical analysis should ever hold a prominent place in chemistry – an aberration which is happily almost impossible – it would occasion a rapid and widespread degeneration of that science.

In G.H. Lewis

*Comte's Philosophy of the Sciences*

Section XI (p. 116)

Henry C. Bohn. London, England. 1853

**Wright, Thomas** 1711–86

English cosmologist

...I will try by some less mathematical Method than that of mere Numbers, to imprint an Idea in your Mind of the true Extent of the solar System.

*An Original Theory or New Hypothesis of the Universe*

Letter the Eighth (p. 68)

Printed for the Author. London, England. 1750

**MATHEMATICAL MILL**

**Hopkinson, John** 1849–98  
English physicist and electrical engineer

...we cannot get more out of the mathematical mill than we put into it, though we may get it in a form infinitely more useful for our purpose.

The Relation of Mathematics to Engineering  
*Nature*, Volume 50, Number 1280, May 10, 1894 (p. 46)

**MATHEMATICAL MIND**

**de Jouvenel, Bertrand** 1903–87  
French man of letters

...the social scientist who lacks a mathematical mind and regards a mathematical formula as a magic recipe, rather than as the formulation of a supposition, does not hold forth much promise. A mathematical formula is never more than a precise statement. It must not be made into a Procrustean bed – and that is what one is driven to by the desire to quantify at any cost. It is utterly implausible that a mathematical formula should make the future known to us, and those who think it can would once have believed in witchcraft. The chief merit of mathematicization is that it compels us to become conscious of what we are assuming.

Translated by Nikita Lary  
*The Art of Conjecture*  
Chapter 15 (p. 173)  
Basic Books, Inc. New York, New York, USA. 1967

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...it can hardly be disputed that nature and our conscious mathematical minds work according to the same laws.

*The Mysterious Universe*  
Chapter V (p. 165)  
The Macmillan Company. New York, New York, USA. 1932

**Maxwell, James Clerk** 1831–79  
Scottish physicist

Professor Sylvester...gave us a noble vindication of pure mathematics by laying bare, as it were, the very working of the mathematical mind, and setting before us, not the array of symbols and brackets which form the armoury of the mathematician, or the dry results which are only the monuments of his conquests, but the mathematician himself, with all his human faculties directed by his professional sagacity to the pursuit, apprehension, and exhibition of that ideal harmony which he feels to be the root of all knowledge, the fountain of all pleasure, and the condition of all action.

*Report for the Fortieth Meeting of the British Association for the Advancement of Science*  
Mathematics and Physics (p. 1)  
John Murray. London, England. 1871

**MATHEMATICAL NOTION**

**Buddeus, Johann Franz** 1667–1729  
German Lutheran theologian and philosopher

Such is the nature of the human mind, that, if habituated to certain kinds of thought, it cannot forthwith divest itself thereof, when passing to the consideration of other objects, but conjures up notions concerning these analogous to those already eradicated in it by custom. This is the real cause of errors almost infinite. Thus they, who inconsiderately *carry over mathematical notions into morals and theology, seem to themselves to find in these new sciences the same necessary connection which they discovered in the old.*

Quoted in William Whewell  
On the Study of Mathematics as an Exercise of the Mind  
*Thoughts on the Study of Mathematics as a Part of a Liberal Education*, Volume 62, Number 126, January, 1836 (p. 439)

**MATHEMATICAL ORDER**

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

...this intuition of mathematical order, which enables us to perceive harmonies and hidden relations, cannot be present in everyone.

In Raymond George Ayoub  
*Musings of the Masters: An Anthology of Mathematical Reflections*  
Mathematical Invention (p. 22)  
Mathematical Association of America. Washington, D.C. 2004

**MATHEMATICAL PAPERS**

**Kac, Mark** 1914–84  
Polish mathematician

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

**Schwartz, Jacob T.** 1930–  
American mathematician

On leafing through the collected papers of great mathematicians, one notices how few of their ideas have received adequate attention. It is like entering a hothouse and being struck by a species of flowers whose existence we did not even suspect.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*  
Chapter One (p. 1)  
Springer-Verlag. New York, New York, USA. 1992

**MATHEMATICAL PHILOSOPHY**

**Kasner, Edward** 1878–1955  
American mathematician

**Newman, James Roy** 1911–66  
Mathematician and mathematical historian

In purging mathematical philosophy of metaphysics, there has been... a real gain. No longer is mathematics to be looked upon as a key to the truth with a capital T. It may now be regarded as a woefully incomplete, though enormously useful, Baedeker [travel guide] in a mostly uncharted land. Some of the landmarks are fixed; some of the vast network of roads is made understandable; there are guideposts for the bewildered traveler.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 360)

Simon & Schuster. New York, New York, USA. 1940

## MATHEMATICAL PHYSICIST

**Swann, William Francis Gray** 1884–1962  
Anglo-American physicist

...the mathematical physicist... obtains much prestige from the physicists because they are impressed with the amount of mathematics he knows, and much prestige from the mathematicians, because they are impressed with the amount of physics he knows.

*The Architecture of the Universe*

Chapter I (p. 14)

The Macmillan Company. New York, New York, USA. 1934

## MATHEMATICAL PICTURES

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The essential fact is simply that all the pictures which science now draws of nature, and which alone seem capable of according with observational fact, are mathematical pictures.

*The Mysterious Universe*

Chapter V (p. 150)

The Macmillan Company. New York, New York, USA. 1932

...it can hardly be disputed that nature and our conscious mathematical minds work according to the same laws.

*The Mysterious Universe*

Chapter V (p. 165)

The Macmillan Company. New York, New York, USA. 1932

## MATHEMATICAL POETRY

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

In the realm of ideas, of mental objects, those ideas whose properties are reproducible are called mathematical objects, and the study of mental objects with reproducible properties is called mathematics.

*The Mathematical Experience*

Intuition (p. 399)

Birkhäuser. Boston, Massachusetts, USA. 1981

## Guillen, Michael

American mathematician and physicist

...just as conventional poetry helps us to see deep *within* ourselves, mathematical poetry helps us to see far *beyond* ourselves ...

*Five Equations That Changed the World*

Introduction (p. 2)

Hyperion. New York, New York, USA. 1995

...equations are like poetry: They speak truths with a unique precision, convey volumes of information in rather brief terms, and often are difficult for the uninitiated to comprehend.

*Five Equations That Changed the World*

Introduction (p. 2)

Hyperion. New York, New York, USA. 1995

## MATHEMATICAL POWER

**Birkhoff, George David** 1884–1944  
American mathematician

What is the inner secret of mathematical power? Briefly stated, it is that mathematics discloses the skeletal outlines of all closely articulated relational systems. For this purpose mathematics uses the language of pure logic with its score or so of symbolic words, which, in its important forms of expression, enables the mind to comprehend systems of relations otherwise completely beyond its power. These forms are creative discoveries which, once made, remain permanently at our disposal. By means of them the scientific imagination is enabled to penetrate ever more deeply into the rationale of the universe about us.

In J.G. Crowther (ed.)

*Science Today*

Mathematics: Quantity and Order (p. 297)

Eyre & Spottiswoode. London, England. 1934

**Jacobi, Karl Gustav Jacob** 1804–51  
German mathematician

It must not be supposed... that it is to a gift of Nature that I owe such mathematical power as I possess. No, it has come by hard work, hard work. Not mere industry, but brain-splitting thinking – hard work; hard work that has often endangered my health.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 5)

Macmillan & Company Ltd. London, England. 1918

## MATHEMATICAL PROBABILITY

**Doob, J. L.** 1910–2004  
American mathematician

The basic difference between the roles of mathematical probability in 1946 and 1988 is that the subject is now accepted as mathematics whereas in 1946 to most mathematicians mathematical probability was to mathematics as black marketing to marketing; that is, probability was a source of interesting mathematics but examination of the background context was undesirable.

In Peter Duren (ed.)

*A Century of Mathematics in America*

Part II, Commentary on Probability (p. 353)

American Mathematical Society, Providence, Rhode Island, USA. 1989

## MATHEMATICAL PROBLEM

### Drew, Joseph

No biographical data available

...not all minds can grasp even a simple mathematical problem, and how few there are that ever master the higher mysteries of that delightful science; nevertheless, to those few, the contemplation of the starry worlds, their distance, size, and motion, with all the astounding theories and truths that result from such investigations, are intellectual pleasures, which approach nearer than any other human enjoyment, to that “feast of reason and flow of soul” found in the poet’s dream and the impassioned lover’s song.

*Our Home in the Stars*

Our Home in the Stars (pp. 18–19)

Elliot Stock. London, England. 1872

### Hankel, Hermann 1839–73

German mathematician

If we compare a mathematical problem with an immense rock, whose interior we wish to penetrate, then the work of the Greek mathematicians appear to us like that of a robust stonemason, who, with indefatigable perseverance, attempts to demolish the rock gradually from the outside by means of hammer and chisel; but the modern mathematician resembles an expert miner, who first constructs a few passages through the rock and then explodes it with a single blast, bringing to light its inner treasures.

*Die Entwicklung der Mathematik In den letzten Jahrhunderten* (p. 9)

Akademische Antrittsrede. Tübingen, Germany. 1884

### Hilbert, David 1862–1943

German mathematician

A mathematical problem should be difficult in order to entice us, yet not completely inaccessible, lest it mock at our efforts.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2nd Series, October 1901–July 1902

### Kline, Morris 1908–92

American mathematics professor and writer

The tantalizing and compelling pursuit of mathematical problems offers mental absorption, peace of mind amid endless challenges, repose in activity, battle without conflict, “refuge from the goading urgency of contingent happenings,” and the sort of beauty changeless mountains present to senses tried by the present-day kaleidoscope of events.

*Mathematics in Western Culture*

Chapter XXVIII (p. 470)

Oxford University Press, Inc. New York, New York, USA. 1953

### Peirce, Benjamin 1809–80

American mathematician

Throughout nature, the omnipresent beautiful revealed an all-pervading language spoken to the human mind, and to man’s highest capacity of comprehension. By whom was it spoken? Whether by the gods of the ocean and the land, by the ruling divinities of the sun, moon, and stars, or by the nymphs of the forest and the dryads of the fountain, it was one speech, and its written cipher was cabalistic. The cabala were those of number, and even if they transcended the gematric skill of the Rabbi and the hieroglyphical learning of the priest of Osiris, they were, distinctly and unmistakably, expressions of thought, uttered to mind by mind; they were the solutions of mathematical problems of extraordinary complexity.

*Address of Professor Benjamin Peirce, President of the American Association for the Year 1853, on Retiring from the Duties of President* (p. 5)

Unknown publisher 1853

### Rota, Gian-Carlo 1932–99

Italian-born American mathematician

Not only is every mathematical problem solved, but eventually every mathematical problem is proved trivial. The quest for ultimate triviality is characteristic of the mathematical enterprise.

*Indiscrete Thoughts* (p. 93)

### Shaw, George Bernard 1856–1950

Irish comic dramatist and literary critic

You propound a complicated mathematical problem: give me a slate and half an hour’s time, and I can produce a wrong answer.

In Evan Esar

*20,000 Quips and Quotes* (p. 509)

Doubleday, Garden City, New York, USA. 1968

## MATHEMATICAL PROGRESSION

### Tolstoy, Leo 1828–1910

Russian writer

The French army melted away at the uniform rate of a mathematical progression ...

*Great Books of the Western World* Volume 51

*War and Peace*

Chapter X (p. 626)  
The Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

## MATHEMATICAL PROOF

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

A mathematical proof should resemble a simple and clear-cut constellation, not a scattered cluster in the Milky Way.

*A Mathematician's Apology*  
Section 18 (p. 113)  
Cambridge University Press. Cambridge, England. 1967

**Locke, John** 1632–1704  
English philosopher and political theorist

Mathematical proofs, like diamonds, are hard as well as clear, and will be touched with nothing but strict reasoning.  
In Stanley Gudder

*A Mathematical Journey* (p. 20)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

## MATHEMATICAL PROPOSITION

**Kant, Immanuel** 1724–1804  
German philosopher

First of all, we ought to observe, that mathematical propositions, properly so called, are always judgments a priori, and not empirical, because they carry along with them necessity, which can never be deduced from experience. If people should object to this, I am quite willing to confine my statements to pure mathematics, the very concept of which implies that it does not contain empirical, but only pure knowledge a priori.

In *Great Books of the Western World* (Volume 42)  
*Critique of Pure Reason*  
Introduction, Section V (p. 720)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The validity of mathematical propositions is independent of the actual world – the world of existing subject-matters is logically prior to it, and would remain unaffected were it to vanish from being.

*The Pastures of Wonder*  
The Realm of Mathematics (p. 99)  
Columbia University Press. New York, New York, USA. 1929

## MATHEMATICAL PURSUIT

**Sylvester, James Joseph** 1814–97  
English mathematician

...mathematical pursuits unfit a person for the discharge of the common duties of life and cut him off from the exercise of Man's highest prerogative, "discourse of reason and faculty of speech divine,"...

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Address to the Mathematical and Physical (p. 652)  
Section of the British Association  
At The University Press. Cambridge, England. 1908

## MATHEMATICAL REALITY

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

I believe that mathematical reality lies outside us, that our function is to discover or *observe* it, and that the theorems which we prove, and which we describe grandiloquently as our 'creations', are simply the notes of our observations. This view has been held, in one form or another by many philosophers of high reputation, from Plato onwards...

*A Mathematician's Apology*  
Section 22 (pp. 123–124)  
Cambridge University Press. Cambridge, England. 1967

**Thurston, William Paul** 1946–  
American mathematician

...people use these various things that have been proved in logic to try to make conclusions about mathematics. Some mathematicians then begin to take a sort of solipsistic attitude and say that we can make mathematics up, however we like. It's not determined. I guess I believe in a sort of mathematical reality, but it's a reality that we can't hope to understand completely. It's hard to justify mathematical reality solely on the basis of formal reasoning.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 341)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

## MATHEMATICAL REASONING

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

There are very few things which we know, which are not capable of being reduc'd to a Mathematical Reasoning...and where a Mathematical Reasoning can be had, it's as great folly to make use of any other, as to grope for a thing in the dark when you have a Candle standing by you.

*Of the Laws of Chance*  
Preface  
Benjamin Motte. London, England. 1692

**Author undetermined**

There are very few things which we know, which are not capable of being reduced to a mathematical reasoning; and when they cannot, it is a sign our knowledge of them is very small and confused; and where a mathematical reasoning can be had, it is as great folly to make use of any other, as to grope for a thing in the dark when you have a candle standing by you.

In John William Lubbock & John Elliot Drinkwater Bethune  
*On Probability* (pp. 43–44)  
Baldwin & Cradock. London, England. 1830

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

No satisfactory justification has ever been given for connecting in any way the consequences of mathematical reasoning with the physical world.

*Debunking Science*  
University of Washington Book Store. Seattle, Washington, USA. 1930

**Kline, Morris** 1908–92

American mathematics professor and writer

Perhaps the most unfortunate fact about mathematics is that it requires us to reason, whereas most human beings are not convinced that reasoning is worthwhile. Indeed, it is not at all obvious that reasoning in general and mathematical reasoning in particular are valuable.

*Mathematics and the Physical World*  
Chapter 1 (p. 1)  
Thomas Y. Crowell Co. New York, New York, USA. 1959

**Mill, John Stuart** 1806–73

English political philosopher and economist

If the practice of mathematical reasoning gives nothing else, it gives wariness of mind; it accustoms us to demand a sure footing: and though it leaves us no better judges of ultimate premises than it found us (which is no more than may be said of almost all metaphysics) at least it does not suffer us to let in, at any of the joints in the reasoning, any assumption which we have not previously faced in the shape of an axiom, postulate, or definition.

*An Examination of Sir William Hamilton's Philosophy*  
Chapter XXVII (p. 526)  
Longmans, Green & Co. London, England. 1865

**Stewart, Dugald** 1753–1828

Scottish philosopher

...how small is the number of individuals who are qualified to think justly on metaphysical, moral, or political subjects, in comparison of those, who may be trained by practice to follow the longest processes of mathematical reasoning.

*Elements of the Philosophy of the Human Mind* (Volume 1)

Part II, Section I (p. 42)

Hillard & Brown. Cambridge, England. 1829

**Whately, Richard** 1787–1863

English theologian

Mathematical reasoning is like a long flight of steps; moral, like a short clamber up a craggy rock.

In Elizabeth Jane Whatley  
*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D*

Apothegm 90 (p. 9)  
Longman, Green, Longman, Roberts & Green. London, England. 1865

**MATHEMATICAL RESEARCH****Hermes, Hans**

No biographical data available

It may be permissible to compare mathematical research with the opening up of a mountain range. There will always be the people whose principal interest it will be to try their ability in advanced mountaineering. They will go for the most difficult summits. Others will see their aim in making the mountain range accessible as a whole, by building convenient roads along the valleys and across the passes. They will also reach the summits eventually, but mainly for the sake of the beautiful views, and, if possible, by cable car.

In Walter R. Fuchs  
*Mathematics for the Modern Mind*  
Introduction (p. 18)  
The Macmillan Company. New York, New York, USA. 1967

**Schubert, Hermann Cäsar Hannibal** 1848–1911

Enumerative geometrist

The intrinsic character of mathematical research and knowledge is based essentially on three properties: first, on its conservative attitude towards old truths and discoveries of mathematics; secondly, on its progressive mode of development, due to the incessant acquisition of new knowledge on the basis of the old; and thirdly, on its self-sufficiency and its consequent absolute independence.

*Mathematical Essays and Recreations*  
On the Nature of Mathematical Knowledge (p. 27)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1917

**MATHEMATICAL RIGOR****Simmons, George F.**

No biographical data available

Mathematical rigor is like clothing; in its style it ought to suit the occasion, and it diminishes comfort and restricts freedom of movement if it is either too loose or too tight.

Filler  
*The Mathematical Intelligencer*, Volume 13, Number 1, Winter, 1991  
(p. 69)



## MATHEMATICAL SCIENCE

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

In all ages and countries where learning hath prevailed, the mathematical sciences have been looked upon as the most considerable branch of it.

In George Atherton Aitken

*The Life and Works of John Arbuthnot, M.D.*

Usefulness of Mathematical Learning (p. 409)

At The Clarendon Press. Oxford, England. 1892

**Babbage, Charles** 1792–1871  
English mathematician

Those who view mathematical science not merely as a vast body of abstract and immutable truths, whose intrinsic beauty, symmetry and logical completeness, when regarded in their connexion together as a whole, entitle them to a prominent place in the interest of all profound and logical minds, but as possessing a yet deeper interest for the human race, when it is remembered that this science constitutes the language through which alone we can adequately express the great facts of the natural world, and those unceasing changes of mutual relationship which, visibly or invisibly, consciously or unconsciously to our immediate physical perceptions, are interminably going on in the agencies of the creation we live amidst: those who thus think on mathematical truth as the instrument through which the weak mind of man can most effectually read his Creator's works, will regard with especial interest all that can tend to facilitate the translation of its principles into explicit practical forms.

*Scientific Memoirs* (Volume 3)

Sketch of the Analytical Engine, Translator's Notes (p. 696)

Printed by Richard & John E. Taylor. London, England. 1843

**Comte, Auguste** 1798–1857  
French philosopher

We can now define Mathematical science with precision. It has for its object the indirect measurement of magnitudes, and it proposes to determine magnitudes by each other, according to the precise relations which exist between them.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (p. 38)

John Chapman. London, England. 1853

The limitations of Mathematical science are not, then, in its nature. The limitations are in our intelligence: and by these we find the domain of the science remarkably restricted, in proportion as phenomena, in becoming special, become complex.

Translated by Harriet Martineau

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (p. 46)

George Bell & Sons. London, England. 1896

It must be ever remembered that the true positive spirit first came forth from the pure sources of mathematical science; and it is only the mind that has imbibed it there, and which has been face to face with the lucid truths of geometry and mechanics, that can bring into full action its natural positively, and apply it in bringing the most complex studies into the reality of demonstration. No other discipline can fitly prepare the intellectual organ.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book III, Chapter I (p. 221)

John Chapman. London, England. 1853

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

There is no certainty where one can neither apply any of the mathematical sciences nor any of those which are based upon the mathematical sciences.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Mathematics (p. 619)

George Braziller. New York, New York, USA. 1958

**Davies, Charles** 1798–1876  
American mathematician

The knowledge which mathematical science imparts to the mind is – deep – profound – abiding. It gives rise to trains of thought, which are born in the pure ideal, and fed and nurtured by an acquaintance with physical nature in all its minuteness and in all its grandeur: which survey the laws of elementary organization, by the microscope, and weigh the spheres in the balance of universal gravitation.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*

Introduction (p. 14)

A.S. Barnes & Burr Co. New York, New York, USA. 1860

The processes of mathematical science serve to give mental unity and wholeness. They impart that knowledge which applies the means of crystallization to a chaos of scattered particulars, and discovers at once the general law, if there be one, which forms a connecting link between them.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*

Introduction (pp. 14–15)

A.S. Barnes & Burr Co. New York, New York, USA. 1860

The educator regards mathematical science as the great means of accomplishing his work.... The trains of reasoning which follow are combinations, according to logical rules, of what has been previously fully comprehended; and the mind and the argument grow together, so that the

thread of science and the warp of the intellect entwine themselves, and become inseparable.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*

Introduction (p. 15)

A.S. Barnes & Burr Co. New York, New York, USA. 1860

### Everett, Charles Carroll 1829–1900

American theologian

There is as great a distinction between mathematics and the mathematical sciences as there is between induction and the inductive sciences. Practically, few cases of induction do not involve, to a greater or less extent, deductions; so few mathematical processes do not involve some strictly logical procedure.

*The Science of Thought*

Second Book (p. 105)

De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

### Farrar, John

No biographical data available

...in mathematical science, and in it alone, man sees things precisely as God sees them, handles the very scale and compass with which the Creator planned and built the universe...

in Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter III (fn, p. 128)

Government Printing Office. Washington, D.C. 1890

### Glanvill, Joseph 1636–80

English clergyman and philosopher

And for Mathematical Sciences, he that doubts their certainty hath need of a dose of Hellebore.

*The Vanity of Dogmatizing*

Chapter XXI (p. 209)

Printed for Henry Eversden. London, England. 1661

### Hamilton, William 1788–1856

Scottish philosopher

Of all our intellectual pursuits, the study of the mathematical sciences is the one, whose utility as an intellectual exercise, when carried beyond a moderate extent, has been most peremptorily denied by the greatest number of the most competent judges; and the arguments, on which this opinion is established, have hitherto been evaded rather than opposed.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 260)

Harper & Brothers Publishers. New York, New York, USA. 1861

### Hilbert, David 1862–1943

German mathematician

Mathematical science is in my opinion an indivisible whole, an organism whose vitality is conditioned upon

the connection of its parts.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2nd Series, October 1901–July 1902

...with all the variety of mathematical knowledge, we are still clearly conscious of the similarity of the logical devices, the relationship of the ideas in mathematics as a whole and the numerous analogies in its different departments. We also notice that, the farther a mathematical theory is developed, the more harmoniously and uniformly does its construction proceed, and unsuspected relations are disclosed between hitherto separated branches of the science. So it happens that, with the extension of mathematics, its organic character is not lost but manifests itself the more clearly.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2nd series October 1901–July 1902

### Hume, David 1711–76

Scottish philosopher and historian

The great advantage of the mathematical sciences above the moral consists in this, that the ideas of the former, being sensible, are always clear and determinate, the smallest distinction between them is immediately perceptible, and the same terms are still expressive of the same ideas, without ambiguity or variation. An oval is never mistaken for a circle, nor an hyperbola for an ellipsis. The isosceles and scalenum are distinguished by boundaries more exact than vice and virtue, right and wrong. If any term be defined in geometry, the mind readily, of itself, substitutes, on all occasions, the definition for the term defined: Or even when no definition is employed, the object itself may be presented to the senses, and by that means be steadily and clearly apprehended.

*An Enquiry Concerning Human Understanding and Selections from A Treatise of Human Nature*

Section VII, Part I (p. 61)

The Open Court Publishing Co. Chicago, Illinois, USA. 1907

### Huxley, Aldous 1894–1963

English writer and critic

I admit that mathematical science is a good thing. But excessive devotion to it is a bad thing.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 4) (p. 2027)

Simon & Schuster. New York, New York, USA. 1956

### Kepler, Johannes 1571–1630

German astronomer

If there is anything that can bind the heavenly mind of man to this dreary exile of our earthly home and can reconcile us with our fate so that one can enjoy living – then it is verily the enjoyment of the mathematical sciences and astronomy.

In H.E. Huntley  
*The Divine Proportion: A Study In Mathematical Beauty*  
 Introduction (p. 6)  
 Dover Publications. New York, New York, USA. 1970

**Lowell, Percival** 1855–1916  
 American astronomer

The science of mathematics...might be called the most imaginative product of human thought; for it is simply one vast imagination based upon a few so-called axioms, which are nothing more or less than the results of experience. It is nonetheless imaginative because the discoveries always accord subsequently with fact, since man was not aware of them beforehand. Nor are its inevitable conclusions inevitable to any save those possessed of the mathematician's prophetic insight.

In William Graves Hoyt  
*Lowell and Mars*  
 Chapter 2 (p. 20)  
 University of Arizona Press. Tucson, Arizona, USA. 1976

**Maxwell, James Clerk** 1831–79  
 Scottish physicist

Thus, all the mathematical sciences are founded on relations between physical laws and laws of numbers.

In W.D. Niven (ed.)  
*The Scientific Papers of James Clerk Maxwell* (Volume 1) (p. 156)  
 At The University Press. Cambridge, England. 1890

**Minto, Walter** 1753–96  
 Scottish-American mathematician

The mathematical sciences, independently of their application to any particular purpose, are of the utmost consequence to the student.

*An Inaugural Oration on the Progress and Importance of the Mathematical Sciences.*  
 Princeton, preceding the Annual Commencement 1788 (p. 30)  
 Printed by Isaac Collins, 1788

**Mirandulanus, Johannes Picus** 1463–94  
 No biographical data available

Mathematical science does not bestow wisdom: it was therefore, by the ancients, made the discipline of boys. On the contrary, though preparing for philosophy, if previously sipped in moderation, when raised to an object of exclusive study, it affords the greatest occasions of philosophical error.

Quoted in William Hamilton  
*Discussions on Philosophy and Literature, Education and University Reform*  
 On the Study of Mathematics as an Exercise of the Mind (p. 295)  
 Harper & Brothers Publishers. New York, New York, USA. 1861

**Spottiswoode, William** 1825–83  
 English mathematician and physicist

So wide is the range of mathematical science, so indefinitely may it extend beyond our actual powers of manip-

ulation, that at some moments we are inclined to fall down with even more than reverence before her majestic presence.

*Report of the Forty-eighth Meeting of the British Association for the Advancement of Science*  
 Address of William Spottiswoode (p. 31)  
 John Murray. London, England. 1879

**Sylvester, James Joseph** 1814–97  
 English mathematician

There are three ruling ideas, three so to say, spheres of thought, which pervade the whole body of mathematical science, to someone or other of which, or to two or all three of them combined, every mathematical truth admits of being referred; these are the three cardinal notions, of Number, Space and Order.

Arithmetic has for its object the properties of number in the abstract. In algebra, viewed as a science of operations, order is the predominating idea. The business of geometry is with the evolution of the properties of space, or of bodies viewed as existing in space...

*The Collected Mathematical Papers of James Joseph Sylvester*  
 (Volume 2)

A Probationary Lecture on Geometry, Delivered before the Gresham Committee and the Members of the Common Council of the City of London, 4 December, 1854 (p. 5)  
 University Press. Cambridge, England. 1904–1912

**Veblen, Oswald** 1880–1960  
 American mathematician

**von Helmholtz, Hermann** 1821–94  
 German scientist and philosopher

We see in the science of mathematics the conscious logical activity of the human mind in its purest and most perfect form. While we are impressed with the arduous labor of its procedure and the difficulty of forming and comprehending its abstract conceptions, we at the same time learn to confide in the security, reach, and fruitfulness of its reasonings.

In Leo Koenigsberger  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Investigations of Hermann von Helmholtz on the Fundamental Principles of Mathematics and Mechanics (p. 93)  
 Government Printing Office. Washington, D.C. 1898

**Whitehead, J. H. C.** 1904–60  
 English mathematician

Any mathematical science is a body of theorems deduced from a set of axioms. A geometry is a mathematical science. The question then arises why the name geometry is given to some mathematical sciences and not to others. It is likely that there is no definite answer to this question, but that a branch of mathematics is called a geometry because the name seems good, on emotional and

traditional grounds, to a sufficient number of competent people.

*The Foundation of Differential Geometry* (p. 17)  
University Press. Cambridge, England 1932

In order that a mathematical science of any importance may be founded upon conventional definitions, the entities created by them must have properties which bear some affinity to the properties of existing things.

*A Treatise on Universal Algebra, with Applications*  
Preface (p. vii)  
Hafner Publishing Company. New York, New York, USA. 1960

### Young, John Wesley

Mathematician

A mathematical science is anybody of propositions which is capable of an abstract formulation and arrangement in such a way that every proposition of the set after a certain one is a formal logical consequence of some or all the preceding propositions. Mathematics consists of all such mathematical sciences.

*Lectures on Fundamental Concepts of Algebra and Geometry* (p. 122)  
Lecture XXI (p. 222)  
The Macmillan Company. New York, New York, USA. 1911

## MATHEMATICAL SPECULATION

### Burke, Edmund 1729–97

English statesman and philosopher

It is from this absolute indifference and tranquility of the mind, that mathematical speculations derive some of the most considerable advantages; because there is nothing to interest the imagination; because the judgment sits free and unbiassed to examine the point. All proportions, every arrangement of quantity, is alike to the understanding, because the same truths result to it from all; from greater from lesser, from equality and inequality.

*On the Sublime and the Beautiful*  
Part III, Section II (pp. 165–166)  
Printed for F.C. & J Rivington and others. London, England. 1812

## MATHEMATICAL SPIRIT

### Merz, John Theodore 1840–1922

German-born British chemist, historian, and industrialist

In every case, the awakening touch has been the mathematical spirit, the attempt to count, to measure, or to calculate. What to the poet or the seer may appear to be the very death of all his poetry and all his visions – the cold touch of the calculating mind – this has proved to be the spell by which knowledge has been born, by which new sciences have been created, and hundreds of definite problems put before the minds and into the hands of diligent students. It is the geometrical figure, the dry

algebraical formula, which transforms the vague reasoning of the philosopher into a tangible and manageable conception; which represents, though it does not explain, the things and processes of nature: this clothes the fruitful, but otherwise indefinite, ideas in such a form that the strict logical methods of thought can be applied, that the human mind can in its inner chamber evolve a train of reasoning the result of which corresponds to the phenomena of the outer world.

*A History of the European Thought in the Nineteenth Century*  
(Volume 1)  
The Astronomical View of Nature (p. 314)  
William Blackwood & Sons. Edinburgh, Scotland. 1907

## MATHEMATICAL STATISTICS

### Fisher, Sir Ronald Aylmer 1890–1962

English statistician and geneticist

I believe sanity and realism can be restored to the teaching of Mathematical Statistics most easily and directly by entrusting such teaching largely to men and women who have had personal experience of research in the Natural Sciences.

Scientific Thought and the Refinement of Human Reasoning  
*Journal of the Operations Research Society of Japan*, Volume 3, 1960

## MATHEMATICAL STUDIES

### Arbuthnot, John 1667–1735

Scottish mathematician and physician

...mathematical studies may serve for a pleasant entertainment for those hours which young men are apt to throw away upon their vices; the delightfulness of them being such as to make solitude not only easy, but desirable.

In Robert Chambers & Robert Carruthers  
*Cyclopaedia of English Literature* (Volume 3) (3rd edition)  
Usefulness of Mathematical Learning (p. 362)  
American Book Exchange. New York, New York, USA. 1879

### Mill, John Stuart 1806–73

English political philosopher and economist

Neither is it a small advantage of mathematical studies, even in their poorest and most meagre form, that they at least habituate the mind to resolve a train of reasoning into steps, and make sure of each step before advancing to another.

*An Examination of Sir William Hamilton's Philosophy*  
Chapter XXVII (p. 526)  
Longmans, Green & Co. London, England. 1865

## MATHEMATICAL STUDY

### Lodge, Sir Oliver 1851–1940

English physicist

For, observe, that the mathematical study of Nature, the discovery of truth with a piece of paper and a pen, has a perilous similarity at first sight to the straw-thrashing subtleties of the Greeks, whose methods of investigating nature by discussing the meaning of words and the usage of language and the necessities of thought, had proved to be so futile and unproductive.

*Pioneers of Science*

Lecture VI (p. 157)

Macmillan & Co Ltd. London, England. 1905

**Mordell, Louis Joel** 1888–1972

English mathematician

Mathematical study and research are very suggestive of mountaineering. Whymper made several efforts before he climbed the Matterhorn in the 1860s and even then it cost the life of four of his party. Now, however, any tourist can be hauled up for a small cost, and perhaps does not appreciate the difficulty of the original ascent. So in mathematics, it may be found hard to realise the great initial difficulty of making a little step which now seems so natural and obvious, and it may not be surprising if such a step has been found and lost again.

*Three Lectures on Fermat's Last Theorem* (p. 4)

Chelsea Publishing Company. New York, New York, USA. 1980

## MATHEMATICAL SUBJECT

**de Morgan, Augustus** 1806–71

English mathematician and logician

The greatest writers on mathematical subjects have a genius which saves them from their own slips, and guides them to true results through inaccurate expression, and sometimes through absolute error.

*The Differential and Integral Calculus* (p. 619)

Baldwin & Cradick. London, England. 1836

**Klein, Felix** 1849–1925

German mathematician

But it should always be required that a mathematical subject not be considered exhausted until it has become intuitively evident...

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 904)

Oxford University Press, Inc. New York, New York, USA. 1972

**von Neumann, John** 1903–57

Hungarian-American mathematician

...at a great distance from its empirical source, or after much "abstract" inbreeding, a mathematical subject is in danger of degeneration. At the inception the style is usually classical; when it shows signs of becoming baroque, then the danger signal is up.... In any event, whenever

this stage is reached, the only remedy seems to me to be the rejuvenating return to the source: the reinjection of more or less directly empirical ideas. I am convinced that this was a necessary condition to conserve freshness and vitality of the subject and that this will remain equally true in the future.

*Collected Works* (Volume 1)

The Works of the Mind, The Mathematician (pp. 6, 9)

Pergamon Press. New York, New York, USA. 1961–1963

## MATHEMATICAL SYMBOLISM

### The Right Honorable Viscount Haldane

The difficulty that attends mathematical symbolism is the accompanying tendency to take the symbol as exhaustively descriptive of reality.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Preface (p. v)

Henry Holt & Co. New York, New York, USA. 1922

## MATHEMATICAL SYMBOLS

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

It would certainly be a mistake to say that the manipulation of mathematical symbols requires more intellect than original thought in biology; on the contrary, it seems much more comparable to the manipulation of the microscope and its appurtenances of stains and fixatives; whilst original thought in both spheres represents very similar activities of an identical faculty.

*Genetical Theory of Natural Selection*

Preface (p. viii)

At The Clarendon Press. Oxford, England. 1930

**O'Brien, Katharine**

Mathematician

Said an upside-down A to an inside-out E,

"*Universal's* the epithet measuring me.

Your scope is so small

Compared with *For all* –

*There is no more than of form of To be.*"

V and  $\exists$

*The Mathematical Magazine*, Volume 55, Number 1, January, 1982 (p. 41)

## MATHEMATICAL SYSTEM

**Lewis, Clarence Irving** 1883–1964

American philosopher

A mathematical system is any set of strings of recognizable marks in which some of the strings are taken initially and the remainder derived from these by operations performed according to rules which are independent of any meaning assigned to the marks. That a system should consist of marks instead of sounds or odors is immaterial, but it is convenient to discuss mathematics as written. The string-like arrangement is due simply to our habits of notation. And there is no theoretical reason why a single mark may not, in some cases, be recognized as a “string”.

*A Survey of Symbolic Logic*

Chapter VI (p. 355)

University of California. Berkeley, California, USA. 1918

## MATHEMATICAL TALENT

**Dieudonné, Jean** 1906–92

French mathematician and educator

...in the flowering of a mathematical talent social environment has an important part to play.

*Mathematics – The Music of Reason*

Chapter I, Section 2 (p. 9)

Springer-Verlag. Berlin, Germany. 1992

## MATHEMATICAL TEACHING

**Barnett, Percy Arthur** 1858–1941

English educator

A “rule” is not an axiom; and to set it forth baldly and without the preliminary of previous effort to formulate it, is, we must admit, not only to deprive the pupil of a valuable lesson in inferential reasoning, but also, by asking him to recite and believe a formula which does not easily carry conviction, to paralyse his reason at the outset, and to make his work mechanical and less interesting than it should be.

*Common Sense in Education and Teaching: An Introduction to Practice* (4th edition)

Chapter IX (p. 223)

Longmans, Green & Co. London, England. 1905

**Keyser, Cassius Jackson** 1862–1947

American mathematician

My conviction is, that hope of improvement in mathematics teaching, whether in secondary schools or in colleges, lies mainly in the possibility of humanizing it.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter III (p. 62)

Columbia University Press. New York, New York, USA. 1916

**Mutchler, Fred**

No biographical data available

**Craig, J.**

No biographical data available

In [teaching] mathematics two ends are constantly kept in view: First, stimulation of the inventive faculty, exercise of judgment, development of logical reasoning, and the habit of concise statement; second, the association of the branches of pure mathematics with each other and with applied science, that the pupil may see clearly the true relations of principles and things.

*A Course of Study for the Preparation of Rural School Teachers* (p. 7)

Government Printing Office. Washington, D.C. 1912

The ends to be attained [in mathematical teaching] are the knowledge of a body of geometrical truths to be used in the discovery of new truths, the power to draw correct inferences from given premises, the power to use algebraic processes as a means of finding results in practical problems, and the awakening of interest in the science of mathematics.

*A Course of Study for the Preparation of Rural School Teachers* (p. 7)

Government Printing Office. Washington, D.C. 1912

## MATHEMATICAL THEOREM

**Jevons, William Stanley** 1835–82

English economist and logician

In abstract mathematical theorems the approximation to absolute truth is perfect, because we can treat of infinitesimals. In physical science, on the contrary, we treat of the least quantities which are perceptible.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXI (p. 478)

Macmillan & Co Ltd. London, England. 1887

**Neumann, John von** 1903–57

Hungarian-American mathematician

One expects a mathematical theorem or a mathematical theory not only to describe and to classify in a simple and elegant way numerous and a priori disparate special cases. One also expects “elegance” in its “architectural,” structural makeup. Ease in stating the problem, great difficulty in getting hold of it and in all attempts at approaching it, then again some very surprising twist by which the approach, or some part of the approach, becomes easy, etc. Also, if the deductions are lengthy or complicated, there should be some simple general principle involved, which “explains” the complications and detours, reduces the apparent arbitrariness to a few simple guiding motivations, etc. These criteria are clearly those of any creative art, and the existence of some underlying empirical, worldly motif in the background – often in a very remote background – overgrown by aestheticizing developments and followed into a multitude of labyrinthine variants, all



this is much more akin to the atmosphere of art pure and simple than to that of the empirical sciences.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

The Mathematician (p. 183)

Mathematical Association of America. Washington, D.C. 2004

## MATHEMATICAL THEORY

**Cayley, Arthur** 1821–95

English mathematician

As for everything else, so for a mathematical theory: beauty can be perceived but not explained.

In E.T. Bell and James R. Newman

*The World of Mathematics* (Volume 1)

Invariant Twins, Cayley and Sylvester (p. 341)

Simon & Schuster. New York, New York, USA. 1956

**Newman, M. H. A.**

No biographical data available

That mathematical theory is a lasting object to believe in few can doubt. Mathematical language is difficult but imperishable. I do not believe that any Greek scholar of today can understand the idiomatic undertones of Plato's dialogues, or the jokes of Aristophanes, as thoroughly as mathematicians can understand every shade of meaning in Archimedes' works.

What Is Mathematics?

*Mathematical Gazette*, Volume 43, Number 345, October, 1959 (p. 167)

**Veblen, Oswald** 1880–1960

American mathematician

...the abstract mathematical theory has an independent, if lonely existence of its own. But when a sufficient number of its terms are given physical definitions it becomes a part of a vital organism concerning itself at every instant with matters full of human significance. Every theorem can be given the form 'if you do so and so, such and such will happen.'

Remarks on the Foundation of Geometry

*Bulletin of the American Mathematical Society*, Volume 35, 1935

(p. 135)

## MATHEMATICAL THINKING

**Bill, Max** 1908–94

Swiss architect

I am of the opinion that it is possible to develop an art largely on the basis of mathematical thinking.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 139)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Picard, Charles Emile** 1856–1941

French mathematician

I am not unaware of the difficulties of the task [explaining analysis] which I am undertaking. Activity in mathematical thinking today is such that it is perhaps presumptuous to attempt to sketch, in so vast an area, the present state of the science. The portrait, even if it is a good likeness, is fated, in parts at least, to become dated quickly. But that does not matter so long as I propose merely to be useful as a guide to those who wish to acquaint themselves with modern analysis and who fear that, alone, they may lose their way in the multiplicity of papers which fill the learned scientific periodicals.

*Traite d'analyse*

Preface

Gauthier-Villars et fils. Paris, France. 1893–1901

## MATHEMATICAL THOUGHT

**Hilbert, David** 1862–1943

German mathematician

The appearance of what we call intrinsic harmony is also striking, in a sense other than that used by Leibniz, that it is an embodiment and realization of mathematical thought.... We can only understand this agreement between nature and thought, between experiment and theory, if we take into consideration the formal component of both sides of nature and our understanding, and the mechanism on which it depends. The mathematical process of analysis gives us, or so it appears, the focus and footings to which matter in the real world, as well as thought in the world of the mind, withdraw and cede control and direction.

*Musings of the Masters: An Anthology of Mathematical Reflections*

Logic and the Understanding of Nature (p. 121)

Mathematical Association of America. Washington, D.C. 2004

**Keyser, Cassius Jackson** 1862–1947

American mathematician

The apodictic quality of mathematical thought, the certainty and correctness of its conclusions, are due, not to a special mode of ratiocination, but to the character of the concepts with which it deals. What is that distinctive characteristic? I answer: precision, sharpness, completeness of definition. But how comes your mathematician by such completeness? There is no mysterious trick involved; some ideas admit of such precision, others do not; and the mathematician is one who deals with those that do.

The Universe and Beyond

*Hilbert Journal*, Volume 3 (1904–1905) (p. 309)

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The sole natural object of mathematical thought is the whole number. It is the external world which has

imposed the continuum upon us, which we doubtless have invented, but which it has forced us to invent. Without it there would be no infinitesimal analysis; all mathematical science would reduce itself to arithmetic or to the theory of substitutions.

Translated by George Bruce Halsted

*The Value of Science*

Part Second, Chapter V (p. 80)

The Science Press. New York, New York, USA. 1907

**Weyl, Hermann** 1885–1955

German mathematician

The stringent precision attainable for mathematical thought has led many authors to a mode of writing which must give the reader the impression of being shut up in a brightly illuminated cell where every detail sticks out with the same dazzling clarity, but without relief. I prefer the open landscape under the clear sky with its depth of perspective, where the wealth of sharply defined nearby details gradually fades away towards the horizon.

*The Classical Groups; Their Invariants and Representations*

Preface

Princeton University Press. Princeton, New Jersey, USA. 1946

## MATHEMATICAL TRAINING

**Huxley, Thomas Henry** 1825–95

English biologist

Mathematical training, is almost purely deductive. The mathematician starts with a few simple propositions, the proof of which is so obvious that they are called self-evident, and the rest of his work consists of subtle deductions from them.

Scientific Education: Notes of an After-Dinner Speech

New Series

*The Eclectic Magazine*, Volume X, July-December, 1869 (p. 155)

**Leacock, Stephen** 1869–1944

Canadian humorist

How can you shorten the subject? That stern struggle with the multiplication table, for many people not yet ended in victory, how can you make it less? Square root, as obdurate as a hardwood stump in a pasture – nothing but years of effort can extract it. You can't hurry the process. Or pass from arithmetic to algebra; you can't shoulder your way past quadratic equations or ripple through the binomial theorem. Instead, the other way; your feet are impeded in the tangled growth, your pace slackens, you sink and fall somewhere near the binomial theorem with the calculus in sight on the horizon. So died, for each of us, still bravely fighting, our mathematical training; except for a set of people called "mathematicians" – born so, like crooks.

*Too Much College* (p. 8)

Dodd, Mead & Co. New York, New York, USA. 1939

## MATHEMATICAL TREATMENT

**Bergson, Henri** 1859–1941

French philosopher

...calculation touches, at most, certain phenomena of organic destruction. Organic creation, on the contrary, the evolutionary phenomena which properly constitute life, we cannot in any way subject to mathematical treatment.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter I (p. 20)

The Modern Library. New York, New York, USA. 1944

## MATHEMATICAL TRUTH

**Berry, John J.**

No biographical data available

They [women] can add or subtract; they can multiply and they can divide; but here their capacity for any mathematical truth ends. There is, indeed, as Sir Isaac Newton sadly remarked, something very mysterious in women, and the less we try to find it out the better.

*Life of David Belden*

Chapter V (p. 105)

Beldon Brothers. New York, New York, USA. 1891

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

He that gives a portion of his time and talent to the investigation of mathematical truth will come to all other questions with a decided advantage over his opponents. He will be in argument what the ancient Romans were in the field: to them the day of battle was a day of comparative recreation because they were ever accustomed to exercise with arms much heavier than they fought; and reviews differed from a real battle in two respects: they encountered more fatigue, but the victory was bloodless.

*Lacon; or Many Things in a Few Words* (p. 178)

William Gowans. New York, New York, USA. 1849

**Davis, Philip J.** 1923–

American mathematician

**Hersh, Reuben** 1927–

American mathematician

As mathematicians, we know that we invent ideal objects, and then try to discover the facts about them. Any philosophy which cannot accommodate this knowledge is too small. We need not retreat to formalism when attacked by philosophers. Neither do we have to admit that our belief in the objectivity of mathematical truth is

Platonic in the sense of requiring an ideal reality apart from human thought. Lakatos' and Popper's work shows that modern philosophy is capable of accepting the truth of mathematical experience. This means accepting the legitimacy of mathematics as it is: fallible, correctible, and meaningful.

*The Mathematical Experience*

True Facts About Imaginary Objects (pp. 410–411)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Who is so unfortunate as not to know something of the religious awe, the solace and the peace that come from cloistral contemplation of the purity and everlastingness of mathematical truth?

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter II (p. 60)

Columbia University Press. New York, New York, USA. 1916

**Lemoine, Emile**

No biographical data available

A mathematical truth is neither simple nor complicated in itself, it is.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

**Locke, John** 1632–1704

English philosopher and political theorist

And thus many are ignorant of mathematical truths, not out of any imperfection of their faculties, or uncertainty in the things themselves, but for want of application in acquiring, examining, and by due ways comparing those ideas.

*An Essay Concerning Human Understanding*

27th Book IV, Chapter 4 (p. 430)

Printed for T. Tegg & Son. London, England. 1836

I doubt not but it will be easily granted, that the knowledge we have of mathematical truths is not only certain, but real knowledge; and not the bare empty vision of vain, insignificant chimeras of the brain...

*An Essay Concerning Human Understanding*

27th Book IV, Chapter 4 (p. 433)

Printed for T. Tegg & Son. London, England. 1836

**Mill, John Stuart** 1806–73

English political philosopher and economist

The character of necessity ascribed to the truths of mathematics and even the peculiar certainty attributed to them is an illusion.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 861)

Oxford University Press, Inc. New York, New York, USA. 1972

The peculiarity of the evidence of mathematical truths is that all the argument is on one side. There are no objections, and no answers to objections.

In *Great Books of the Western World* (Volume 43)

*On Liberty*

Of the Liberty of Thought and Discussion (p. 284)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nordmann, Charles** 1881–1940

French astronomer

Mathematical truths and scientific discoveries have an intrinsic value, and this must be judged and appreciated impartially, whoever their author may chance to be.

Translated by Joseph McAbe

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter I (p. 18)

T. Fisher Unwin Ltd. London, England. 1922

**Whewell, William** 1794–1866

English philosopher and historian

The peculiar character of mathematical truth is that it is necessarily and inevitably true; and one of the most important lessons which we learn from our mathematical studies is a knowledge that there are such truths, and a familiarity with their form and character.

This lesson is not only lost, but read backward if the student is taught that there is no such difference [between necessary truths and empirical facts], and that mathematical truths themselves are learned by experience.

*Principles of English University Education*

Thoughts on the Study of Mathematics

John W. Parker. London, England. 1838

## MATHEMATICAL WORK

**Papert, Seymour** 1928–

South African mathematician

Mathematical work does not proceed along the narrow logical path of truth to truth to truth, but bravely or gropingly follows deviations through the surrounding marshland of propositions which are neither simply and wholly true nor simply and wholly false.

*Mindstorms: Children, Computers and Powerful Ideas*

Epilogue (p. 195)

Basic Books, Inc. New York, New York, USA. 1980

## MATHEMATICAL WRITING

**Halmos, Paul R.** 1916–2006

Hungarian-born American mathematician

I remember one occasion when I tried to add a little seasoning to a review, but I wasn't allowed to. The paper was by Dorothy Maharam, and it was a perfectly sound

contribution to abstract measure theory. The domains of the underlying measures were not sets but elements of more general Boolean algebras, and their range consisted not of positive numbers but of certain abstract equivalence classes. My proposed first sentence was: “The author discusses valueless measures in pointless spaces.”

*I Want to Be a Mathematician*

Chapter 7 (p. 120)

Springer-Verlag. New York, New York, USA. 1985

**Kac, Mark** 1914–84

Polish mathematician

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Schwartz, Jacob T.** 1930–

American mathematician

Mathematicians, like Proust and everyone else, are at their best when writing about their first love.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

Chapter One (p. 3)

Springer-Verlag. New York, New York, USA. 1992

## MATHEMATICALLY CERTAIN

**Dresden, Arnold**

Mathematician

To find something which is “mathematically certain” is still, as it ever was, the desire of every seeker after “truth.”

Some Philosophical Aspects of Mathematics

*Bulletin of the American Mathematical Society*, Volume 34 July-August, 1928 (p. 439)

## MATHEMATICALLY ILLITERATE

**Davies, Robertson** 1913–95

Canadian novelist

Although I am almost illiterate mathematically, I grasped very early in life that anyone who can count to ten can count upward indefinitely if he is fool enough to do so.

*The Table Talk of Samuel Marchbanks*

Of the Conservation of Youth (pp. 27–28)

Clarke, Irwin. Toronto, Ontario, Canada. 1949

## MATHEMATICIAN

**Adams, Henry Brooks** 1838–1918

American man of letters

Mathematicians practice absolute freedom.

*A Letter to American Teachers of History*

Chapter II (p. 169)

Press of J.H. Furst Company. Washington, D.C. 1910

Mathematicians assume the right to choose, within the

limits of logical contradiction, what path they please in reaching their results.

*A Letter to American Teachers of History*

Preface (p. v)

Press of J.H. Furst Company. Washington, D.C. 1910

He supposed that, except musicians, everyone thought Beethoven a bore, as everyone except mathematicians thought mathematics a bore.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter V (p. 80)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Adler, Alfred** 1870–1937

Austrian psychiatrist

Each generation has its few great mathematicians, and mathematics would not even notice the absence of the others. They are useful as teachers, and their research harms no one, but it is of no importance at all. A mathematician is great or he is nothing.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 3)

Wadsworth, Inc. Belmont, California, USA. 1984

...the mathematician learns early to accept no fact, to believe no statement, however apparently reasonable or obvious or trivial, until it has been proved, rigorously and totally by a series of steps proceeding from universally accepted first principles.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 5)

Wadsworth, Inc. Belmont, California, USA. 1984

The mathematical life of a mathematician is short. Work rarely improves after the age of twenty-five or thirty. If little has been accomplished by then, little will ever be accomplished.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 5)

Wadsworth, Inc. Belmont, California, USA. 1984

Perhaps mathematicians, lacking the imagination to appreciate the scope and sophistication of the outside world, confuse minor success with real achievement and are satisfied with it. Then, too, they seldom recognize failure when they are confronted with it; rather, they tend to think of it as simply one more betrayal by a society that usually patronizes them while elevating armies of patently inferior claimants. In the academic world, on the other hand, mathematicians often enjoy rewards that they do no merit. They are engulfed by admirers from the department of philosophy and the social sciences...

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 6)

Wadsworth, Inc. Belmont, California, USA. 1984

In the company of friends, writers can discuss their books, economists the state of the economy, lawyers their latest cases, and businessmen their latest acquisitions, but mathematicians cannot discuss their mathematics at all. And the more profound their work, the less understandable it is.

In Douglas M. Campbell and John C. Higgins (eds.)  
*Mathematics: People, Problems, Results* (Volume 2)  
Mathematics and Creativity (p. 7)  
Wadsworth, Inc. Belmont, California, USA. 1984

### Arms, Richard Allen

Mathematician

...the mathematician is always walking upon the brink of a precipice, for, no matter how many theorems he deduces, he cannot tell that some contradiction will not await him in the infinity of consequences.

*The Notion of Number and the Notion of Class*  
Mathematical Usage (p. 55)  
University of Pennsylvania. Pittsburgh, Pennsylvania, USA. 1917

### Ascham, Roger 1516–68

English humanist and scholar

Mark all Mathematical heads [he continued] which be wholly and only bent on these sciences, how solitary they be themselves, how unfit to live with others, how unapt to serve the world.

In E.G.R. Taylor  
*The Mathematical Practitioners of Tudor & Stuart England* (p. 5)

### Auden, W. H. 1907–72

English-born poet

How happy the lot of the mathematician! He is judged solely by his peers, and the standard is so high that no colleague or rival can ever win a reputation he does not deserve.

*The Dyer's Hand and Other Essays*  
Writing (p. 15)  
Random House. New York, New York, USA. 1962

### Author undetermined

Mathematicians are always found more eager to continue and extend the theories of others, than to investigate the original primary proposition, and it is difficult to obtain any reasoning upon a theory, but what has been copied from the works of the original inventor: they are willing to admit a theory correct, because they find the mechanical detail so: to calculation they are accustomed; but the abstruse theoretical part requires an exertion of the mind, which being rarely necessary, so the mind is seldom fit for such exertion. Hence, when the theory becomes extended, the results are found contradictory, at variance with practice, and often with common sense.

*Glasgow Mechanics' Magazine, and Annals of Philosophy*  
Miscellanies  
Number 133, July 8, 1826 (p. 306)

Rail-roads branching off towards infinity, offer great conveniences to tramping philosophers and amateurs of a metaphysical turn, and balloon communication is kept up with those dim regions, where certain mathematicians lie in a kind of opium-dream, and sail around in whirlpools, century after century, wrapped in a gorgeous delirium.

*The Knickerbocker*  
The Symbol of Darkness  
Volume 34 September, 1849 (p. 213)

The mathematician is either a beggar, a dunce, or a visionary, or the three in one.

*Edinburgh Review*, Volume 52 January, 1836

A MATHEMATICIAN is one who endeavors to secure the greatest possible consistency in his thoughts and statements by guiding the process of his reasoning into those well-worn tracks by which we pass from one relation among quantities to an equivalent relation. He who has kept his mind always in those paths which have never led him or anyone else to an inconsistent result, and has traversed them so often that the act of passage has become rather automatic than voluntary, is, and knows himself to be, an accomplished mathematician.

Quaternions  
*Nature*, Volume 9, Number 217, December 25, 1873 (p. 137)

Mathematicians may flatter themselves that they possess new ideas which mere human language is as yet unable to express. Let them make the effort to express these ideas in appropriate words without the aid of symbols, and if they succeed, they will not only lay us laymen under a lasting obligation, but, we venture to say, they will find themselves very much enlightened during the process, and will even be doubtful whether the ideas as expressed in symbols had ever quite found their way out of the equations into their minds.

Elements of Natural Philosophy  
*Nature*, Volume 7, Number 177, March 27, 1873 (p. 400)

### Barrow, Isaac 1630–77

English clergyman and mathematician

An accomplished mathematician, i.e. a most wretched orator.

*Mathematical Lectures* (p. 32)  
The Prefatory Oration (p. xxxii)  
Printed for Stephen Austen. London, England. 1734

It may be observed of mathematicians that they only meddle with such things as are certain, passing by those that are doubtful and unknown. They profess not to know all things, neither do they affect to speak of all things. What they know to be true, and can make good by invincible arguments, that they publish and insert among their theorems. Of other things they are silent and pass no judgment at all, choosing rather to acknowledge their ignorance, than affirm anything rashly.

*Mathematical Lecture*

Lecture IV (p. 64)

Printed for Stephen Austen. London, England. 1734

[Mathematicians] only take those things into consideration, of which they have clear and distinct ideas, designating them by proper, adequate, and invariable names, and premising only a few axioms which are most noted and certain to investigate their affections and draw conclusions from them, and agreeably laying down a very few hypotheses, such as are in the highest degree consonant with reason and not to be denied by anyone in his right mind. In like manner they assign generations or causes easy to be understood and readily admitted by all, they preserve a most accurate order, every proposition immediately following from what is supposed and proved before, and reject all things howsoever specious and probable which cannot be inferred and deduced after the same manner.

*Mathematical Lectures*

Lecture IV (p. 65)

Printed for Stephen Austen. London, England. 1734

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Guided only by their feeling for symmetry, simplicity, and generality, and an undefinable sense of the fitness of things, creative mathematicians now, as in the past, are inspired by the art of mathematics rather than by any prospect of ultimate usefulness.

*The Queen of the Sciences* (p. 2)

G.E. Stechert &amp; Co. New York, New York, USA. 1938

Mathematicians may safely be left to follow their own bent as their contributions to this age of science. What they did in the past century is enough for a vast region of science and technology as they exist today; what mathematicians as professionals are interested in today will, if there is any continuity at all in scientific and industrial history, be the indispensable framework of the science and technology of tomorrow.

*The Queen of the Sciences*

Chapter VI (p. 83)

The Williams &amp; Wilkins Company. Baltimore, Maryland, USA. 1931

That wretched monosyllable “all” has caused mathematicians more trouble than all the rest of the dictionary.

*The Queen of the Sciences*

Chapter X (p. 134)

The Williams &amp; Wilkins Company. Baltimore, Maryland, USA. 1931

The mathematician is a much rarer character in fiction than his cousin the scientist, and when he does appear in the pages of a novel or on the screen he is only too apt to be a slovenly dreamer totally devoid of common sense – comic relief.

*Men of Mathematics* (p. 8)

Simon &amp; Schuster. New York, New York, USA. 1937

Fools have always been governed by fools and doubtless always will be, but not all scientists and mathematicians are yet fools.

*Mathematics: Queen and Servant of Science*

Points of View (p. 13)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

If mathematics is indeed the science of self-evident things, mathematicians are a phenomenally stupid lot to waste the tons of good paper they do in proving the fact.

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 20)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Mathematicians are not, as a rule, credulous; their clients almost invariably are.

*Mathematics: Queen and Servant of Science*

Choice and Chance (p. 381)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Experience has taught most mathematicians that much that looks solid and satisfactory to one mathematical generation stands a fair chance of dissolving into cobwebs under the steadier scrutiny of the next...

In Morris Kline

*Mathematics: The Loss of Certainty*

Chapter XI (p. 257)

Oxford University Press, Inc. New York, New York, USA. 1980

When a complicated mathematical argument ends in a spectacular prediction, subsequently verified by observation or experiment, a physicist may be excused for feeling that he has participated in a miracle. And then a skilled mathematician astounds himself with a discovery he had no conscious intention of striving after, he may well believe for a few moments as Pythagoras believed all his life, and may even repeat – after the eminent English mathematician, G.H. Hardy – the following confession of faith. [I believe that mathematical reality lies outside us, that our function is to discover or observe it, and that the theorems which we prove, and which we describe grandiloquently as our ‘creations’ are simply our notes of our observations.]

*The Magic of Numbers*

Chapter 1 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

Mathematics is but one of many expedients resorted to by scientists, and in many instances one of the less important. Scientists have checks on their work that no mathematician can ever have. At any stage of an investigation a scientist can compare the results of his calculations with nature itself. To indoctrinate a sanguine scientist with all the subtle dogmas concerning the meaning of continuity, on which mathematicians themselves see no immediate hope of agreement, is to invite the risk of sterilizing a potentially creative mind. Those self-righteous mathematicians or logicians who



carp at what they call the slap-dash mathematics of their scientific brothers might more profitably employ their squandered leisure in shoring up their own tottering shanties.

*The Handmaiden of the Sciences*

Chapter 4 (p. 63)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Bellman, Richard** 1920–84

Applied mathematician

...mathematicians makes natural questions precise.

*Eye of the Hurricane: An Autobiography*

Chapter 9 (p. 114)

World Scientific Publishing Company. Ltd. Singapore. 1984

**Berlinski, David** 1942–

American mathematician

It is a fact. At some time or other the mathematicians of Europe looked out over the universe, noted its appalling clutter, and determined that on some level there must exist a simple representation of the world.

*A Tour of the Calculus*

Chapter 2 (p. 9)

Pantheon Books. New York, New York, USA. 1995

**Bernoulli, Daniel** 1700–82

Swiss mathematician

...there is no philosophy which is not founded upon knowledge of the phenomena, but to get any profit from this knowledge it is absolutely necessary to be a mathematician.

In C. Truesdell

*Essays in the History of Mechanics*

Chapter VII (p. 318)

Springer-Verlag, Inc. New York, New York, USA. 1968

**Bers, Lipman** 1914–93

Mathematician

Mathematics is an exceedingly cruel profession. You notice that if somebody has a bachelor's degree in chemistry, he describes himself as a chemist. But if somebody has been a professor of mathematics for ten years and you ask him, "Are you a mathematician?" he may say, "I'm trying to be one!".... The standard is so high, and you never know whether you will be able to hack it. First you are afraid that you won't be able to understand your professors. Then you are afraid that you won't be able to write a thesis. When I went to Loewner to ask for a thesis topic, I expected him to grab me by the neck and say, "What makes you think you can write a thesis on mathematics? OUT!!!"

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations*

Lipman Bers (p. 14)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

A working mathematician is always a Platonist. It doesn't matter what he says. He may not be a Platonist at other times. But I think that in mathematics he always has that feeling of discovery.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations*

Lipman Bers (p. 19)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

I disagree with Adler, who wrote (in the New Yorker) that there is no point in being a mathematician unless you can be a great mathematician. That's nonsense. Mathematics is like a gothic cathedral. If you can build a little part of it, it is there – forever – in some sense. At least I have the illusion that it is so.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations*

Lipman Bers (p. 20)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

Usually people do their best work when they are young. And this is probably true of very good mathematicians. But in my case – and I think that most people who know my work will agree – what I did after forty was more interesting and more important than what I did before forty.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations*

Lipman Bers (p. 20)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Birkhoff, George David** 1884–1944

American mathematician

...[a mathematician] holds certain tacit beliefs and attitudes which scarcely ever find their way into the printed page.... when he recalls that in the past the most difficult mathematical questions have been ultimately answered, he is inclined to believe with the great German mathematician, Hilbert, that every mathematical fact is provable. Besides all this, he attributes certain values to his results and their mathematical demonstrations; some theories seem important; some proofs are regarded as elegant, others as profound or original, etc. Such somewhat vague ideas illustrate what I would call mathematical faith. Nearly all the greatest mathematicians have been led to take points of view falling in this broad category, and have attached the deepest significance to them.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Part II (pp. 102, 102–1)

Mathematical Association of America. Washington, D.C. 2004

**Black, Max** 1909–88

Anglo-American philosopher

...a result once generally accepted by mathematicians is seldom retracted, and then only with great pangs.

*The Nature of Mathematics: A Critical Survey*

Section III (p. 169)

Routledge & Kegan Paul. London, England. 1933

**Boas, Jr., Ralph P.** 1913–92  
Mathematician

Real mathematicians, except for a small number of geniuses, don't do anything except mathematics.... Although I am fond of classical music, I never learned to play an instrument, and I am hopelessly unathletic. However, I grew up in the country and summered on Cape Cod, so I console myself by being able to do some things that my more cultivated colleagues probably can't. I do, for example, know how to sail a boat, shingle a roof, cut grass with a scythe, and fell a tree so that it will fall where I want it to.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (pp. 30–31)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

A mathematician will recognize Cauchy, Gauss, Jacobi, of Helmholtz after reading a few pages, just as musicians recognize, from the first few bars, Mozart, Beethoven, or Schubert.

In Arthur Koestler  
*The Act of Creation*  
Book One, Part Two, Chapter XI (p. 265)  
The Macmillan Company. New York, New York, USA. 1964

**Bonaparte, Napoleon** 1769–1821  
French soldier and emperor of France

Lagrange is the lofty pyramid of the mathematical sciences.

In E.T. Bell  
*Men of Mathematics* (p. 153)  
Simon & Schuster. New York, New York, USA. 1937

**Bourbaki, Nicholas**  
Mathematical discussion group leader

For twenty-five centuries mathematicians have been in the habit of correcting their errors – and seeing their science enriched rather than impoverished thereby. This gives them the right to contemplate the future with serenity.

In Lucienne Felix  
*The Modern Aspect of Mathematics* (p. 33)  
Basic Books. New York, New York, USA. 1960

Many mathematicians take up quarters in a corner of the domain of mathematics, which they do not intend to leave; not only do they ignore almost completely what does not concern their special field, but they are unable to understand the language and the terminology used by colleagues who are working in a corner remote from their own. Even among those who have the widest training, there are none who do not feel lost in certain regions of the immense world of mathematics; those who, like

Poincaré or Hilbert, put the seal of their genius on almost every domain, constitute a very great exception even among the men of greatest accomplishment.

In Morris Kline  
*Mathematics: The Loss of Certainty*  
Chapter XIII (p. 284)  
Oxford University Press, Inc. New York, New York, USA. 1980

**Boyd, William Andrew Murray** 1952–  
Writer

The natural world is full of irregularity and random alteration, but in the antiseptic, dust-free, shadowless, brightly lit, abstract realm of the mathematicians they like their cabbages spherical, please.

*Brazzaville Beach: A Novel*  
Cabbages Are Not Spheres (p. 86)  
William Morrow. New York, New York, USA. 1990

**Buchanan, Scott** 1895–1968  
American educator and philosopher

The mathematician has again been lured to an adventure with a symbolic hobbyhorse and has discovered new routes to the absolute or infinite. After a trial journey he has come back to earth and sets a new fashion in intellectual locomotion. The new vehicle feels like an airplane supported only by thin air, but the view from the rider's seat is familiar even though it involves distortions of the old perspectives. Newly discovered abstractions always have an exotic manner.

*Poetry and Mathematics*  
Chapter VIII  
The University of Chicago Press. Chicago, Illinois, USA. 1975

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Poets do not go mad; but chess-players do. Mathematicians go mad, and cashiers; but creative artists very seldom.

*Orthodoxy*  
Chapter II (p. 27)  
John Lane Company. New York, New York, USA. 1918

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

Mathematics is written for mathematicians...

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Preface and Dedication to Pope Paul III (p. 509)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Courant, Richard** 1888–1972  
German-born American mathematician

It becomes the urgent duty of mathematicians, therefore, to mediate about the essence of mathematics, its

motivations and goals and the ideas that must bind divergent interests together.

Mathematics in the Modern World  
*Scientific American*, Volume 211, Number 3, September, 1964 (p. 42)

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

...in my experience most mathematicians are intellectually lazy and especially dislike reading experimental papers.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 12 (p. 136)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Let no one read me who is not a mathematician in my beginnings.

Translated by Edward MacCurdy  
*The Notebooks of Leonardo da Vinci* (Volume 1)  
Philosophy (p. 95)  
George Braziller. New York, New York, USA. 1958

In order to make trial of anyone and see whether he has a true judgment as to the nature of weights, ask him at what point one ought to cut one of the two equal arms of the balance so as to cause the part cut off, attached to the extremity to its remainder, to form with precision a counterpoise to the opposite arm. The thing is never possible, and if he gives you the position, it is clear that he is a poor mathematician.

Translated by Edward MacCurdy  
*The Notebooks of Leonardo da Vinci* (Volume 2)  
Experiments (p. 788)  
George Braziller. New York, New York, USA. 1958

O mathematicians, throw light on this error.

In Edward MacCurdy  
*Leonardo da Vinci's Note-books*  
Book I: Life (p. 55)  
Duckworth & Co. London, England. 1906

**D'Alembert, Jean Le Rond** 1717–83  
French mathematician

It seems as if great *mathematicians* ought to be *excellent metaphysicians*, at least upon the objects about which their science proper is conversant: nevertheless, this is very far from being always the case. The logic of some of them is comprehended in their formulae, and does not extend beyond. The case resembles that of a man who has the sense of sight contrary to that of touch, or in whom the latter of these senses is only perfected at the expense of the former. These bad metaphysicians in a science in which it is so easy not to reason wrong, would infallibly be much worse, as experience proves, on matters in which they had not the calculus for a guide.

Quoted in William Hamilton  
*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 293)  
Harper & Brothers Publishers. New York, New York, USA. 1861

**Dantzig, Tobias** 1884–1956  
Russian mathematician

The mathematician may be compared to a designer of garments, who is utterly oblivious of the creatures who his garments may fit. To be sure, his art originated in the necessity for clothing such creatures, but this was long ago; to this day a shape will occasionally appear which will fit into the garment as if the garment had been made for it. Then there is no end of surprise and of delight.

*Number: The Language of Science* (4th edition)  
Chapter Twelve, 2 (pp. 231–232)  
The Macmillan Company. New York, New York, USA. 1954

**Darwin, Charles Galton** 1887–1962  
English physicist and administrator

A mathematician is a blind man in a dark room looking for a black hat which isn't there.

In Fort Tomlinson  
Mathematics and the Sciences  
*The American Mathematical Monthly*, Volume 47, Number 9, November, 1940 (p. 606)

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

The ideal mathematician's work is intelligible only to a small group of specialists, numbering a few dozen or at most a few hundred. This group has existed for only a few decades, and there is every possibility that it may become extinct in another few decades. However, the mathematician regards his work as part of the very structure of the world, containing truths that are valid forever, from the beginning of time, even in the most remote corner of the universe.

*The Mathematical Experience*  
The Ideal Mathematician (p. 38)  
Birkhäuser. Boston, Massachusetts, USA. 1981

...the typical working mathematician is a Platonist on weekdays and a formalist on Sundays. That is, when he is doing mathematics he is convinced that he is dealing with an objective reality whose properties he is attempting to determine. But then, when challenged to give a philosophical account of this reality, he finds it easiest to pretend that he does not believe in it after all.

*The Mathematical Experience, Study Edition*  
The Philosophical Plight of the Working Mathematician (p. 321)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1998

**Day-Lewis, Cecil** 1904–72  
Irish poet

They say that a mathematician  
Once fell to such a passion

For x and y, he locked  
 His door to keep outside  
 Whatever might distract  
 Him from his heavenly bride:  
 And presently died  
 In the keenest of blisses  
 With a dozen untasted dishes  
 Outside his door.

*Collected Poems 1929–1933*

Transitional Poem, Part II, 16, 1.

Virginia Woolf at the Hogarth Press. London, England. 1935

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...it was the business of the Sorbonne to discuss; of the Pope to decide; and of the mathematician to go to heaven in a perpendicular line.

In Dugald Stewart

*The Collected Works of Dugald Stewart* (Volume 4)

Part Third, Chapter I, Section 3 (p. 203)

T & T Clark. Edinburgh, Scotland. 1877

...grant a mathematician but one minute principle, he immediately draws a consequence from it, to which you must necessarily assent; and from this consequence another, till he leads you so far (whether you will or no) that you have much ado to believe all he has proved, and what you have already assented to.

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 156)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Morgan, Augustus** 1806–71

English mathematician and logician

We know that mathematicians care no more for logic than logicians for mathematics. The two eyes of exact science are mathematics and logic: the mathematical sect puts out the logical eye, the logical sect puts out the mathematical eye, each believing that it can see better with one eye than with two.

In Florian Cajori

*A History of Mathematics* (p. 316)

Macmillan & Company Limited. London, England. 1905

If you wish to oppose a mathematician, confront him on some question in the parts of his subject which are supposed to be perfectly demonstrated.

*Transactions of the Cambridge Philosophical Society*

On Infinity: and on the Sign of Equality (p. 145)

At The University Press. Cambridge, England. 1871

**Dieudonné, Jean** 1906–92

French mathematician and educator

...there is no criterion for appreciation which does not vary from one epoch to another and from one mathematician to another.... These divergences in taste recall the quarrels aroused by works of art, and it is a fact that mathematicians often discuss among themselves whether a theorem is more or less “beautiful.” This never fails to

surprise practitioners of other sciences: for them the sole criterion is the “truth” of a theory or formula.... Other criteria are therefore necessary to evaluate mathematical work, and these are unavoidably subjective, a fact which makes some people say that mathematics is much more an art than a science.

*Mathematics – The Music of Reason*

Chapter II, Section 2 (p. 28)

Springer-Verlag. Berlin, Germany. 1992

**Doxiadis, Apostolos** 1913–75

Greek filmmaker and former mathematician

As for mathematicians themselves: don’t expect too much help. Most of them are too far removed in their ivory towers to take up such challenges. And anyway, they are not competent. After all, they are just mathematicians – what we need is paramathe-maticians, like you.... It is you who can be the welding force, between mathematicians and stories, in order to achieve the synthesis.

Opening address to the Third Mediterranean Conference on Mathematics Education

January 3, 2003

**Digby, Sir Kenelm** 1603–65

English privateer

It is an observation which all the world can verify, that there is *nothing so deplorable as the conduct of some celebrated mathematicians in their own affairs, nor anything so absurd as their opinions on the sciences not within their jurisdiction.*

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 290)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Dyson, Freeman J.** 1923–

American physicist and educator

On being asked what he meant by the beauty of a mathematical theory of physics, Dirac replied that if the questioner was a mathematician then he did not need to be told, but were he not a mathematician then nothing would be able to convince him of it.

In John D. Barrow

*Theories of Everything: The Quest for Ultimate Explanation*

Chapter Two (p. 16, fn)

The Clarendon Press. Oxford, London. 1991

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...it is obvious that the moon and the mathematician use different methods of finding the lunar orbit.

*The Nature of the Physical World*

Chapter XII (p. 258)

The Macmillan Company. New York, New York, USA. 1930

**Egrafov, M.**

No biographical data available

If you ask mathematicians what they do, you always get the same answer. They think. They think about difficult and unusual problems. They do not think about ordinary problems: they just write down the answers.

*Mathematics Magazine*, Volume 65, Number 5, December, 1992 (p. 301)

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Every man who is not a monster, a mathematician, or a mad philosopher, is the slave of some woman or other.

*Scenes of Clerical Life*

The Sad Fortunes of the Rev. Amos Barton

Part I, Chapter iv (p. 19)

Harper & Brothers. New York, New York, USA. 1858

**Ellis, Havelock** 1859–1939  
English sexuality researcher

The mathematician has reached the highest rung on the ladder of human thought.

*The Dance of Life*

Chapter III, Section V (p. 140)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Ellwood, J. K.**

No biographical data available

Mathematicians...seem to have been working upward and outward among the branches instead of digging down to the rootlets of the infinite tree of mathematical truth .

*American Mathematical Monthly*, Volume 1, Number 1, 1894 (p. 47)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Show us an arc of the curve, and a good mathematician will find out the whole figure. We are always reasoning from the seen to the unseen.

*Essays: First Series*

Spiritual Laws (p. 130)

Henry Altemus. Philadelphia, Pennsylvania, USA. 1895

**Erdős, Paul** 1913–96  
Hungarian mathematician

Every human activity, EXCEPT Mathematics, must come to an end.

In Bela Bollobas

To Prove and Conjecture: Paul Erdos and His Mathematics

*The American Mathematical Monthly*, Volume 105, Number 3, March, 1998 (p. 209)

**Escher, M. C.** 1898–1972  
Dutch graphic artist

Although I am absolutely innocent of training or knowledge in the exact sciences, I often seem to have more in common with mathematicians than with my fellow artists.

In Stanley Gudder

*A Mathematical Journey* (p. 94)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Everett, Charles Carroll** 1829–1900  
American theologian

The mathematician is like a man travelling through a strange country. Roads branch out in all directions. He knows the point of the compass towards which he is aiming, and selects road after road as it promises to lead him thither.

*The Science of Thought*

Second Book (p. 104)

De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

**Faraday, Michael** 1791–1867  
English physicist and chemist

There is one thing I would be glad to ask you. When a mathematician engaged in investigating physical actions and results has arrived at his conclusions may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulae? If so, would it not be a great boon to such as I to express them so? – translating them out of their hieroglyphics, that we also might work upon them by experiment. I think it must be so, because I have always found that you could convey to me a perfectly clear idea of your conclusions, which though they may give me no full understanding of the steps of your process, give me the results neither above nor below the truth, and so clear in character that I can think and work from them. If this be possible, would it not be a good thing if mathematicians, working on these subjects, were to give us the results in this popular, useful, working state, as well as in that which is their own and proper to them?

In D.K.C. MacDonald

*Faraday, Maxwell and Kelvin* (p. 79)

Anchor Press. Garden City, New York, USA. 1964

**Fischer, Martin H.** 1879–1962  
German-American physician

The pure mathematician starts with an unknown and ends with an unknown.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 40)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Flammarion, Camille** 1842–1925  
French astronomer and author

Mathematicians, whose tempers are generally intolerable, are perhaps psychologically excusable, for the constant tension of their mind is, perhaps, the cause of their bad digestion and their state of hypochondria.

*Popular Astronomy: A General Description of the Heavens*

Book IV, Chapter II (fn, pp. 346–347)

Chatto & Windus. London, England. 1894

**Gardner, Martin** 1914–  
American writer and mathematics games editor

Mathematicians have a habit of studying, just for the fun of it, things that seem utterly useless; then centuries later their studies turn out to have enormous scientific value.

Mathematical Games  
*Scientific American*, Volume 2, Number 2, February, 1961 (p. 146)

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

It may be true that men who are mere mathematicians, have certain specific shortcomings, but that is not the fault of mathematics, for it is equally true of every other exclusive occupation. So there are mere philologists, mere jurists, mere soldiers, mere merchants, etc. To such idle talk it might further be added: that whenever a certain exclusive occupation is coupled with specific shortcomings, it is likewise almost certainly divorced from certain other shortcomings.

*Gauss-Schumacher Briefwechsel*  
 Bd. 4, Altoma, 1862 (p. 387)  
 Publisher undetermined

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

...it always appears to me that there is a certain perfection, and also a certain luxuriance and exuberance, in the pure sciences which have resulted from the unaided, and I might almost say inspired, genius of the greatest mathematicians which is conspicuously absent from most of the investigations which have had their origin in the attempt to forge the weapons required for research in the less abstract sciences.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*  
 Presidential Address (p. 720)  
 John Murray. London, England. 1891

Even the mathematician must sometimes ask himself the questions – not unfrequently put to him by his friends – ‘To what is it all tending? What will be the result of it all? Will there be any end?’ The last question is readily answered. There certainly can be no end; so wide and so various are the subject of investigation, so interesting and fascinating the results, so wonderful the fields of research laid open at each succeeding advance – no matter in what direction – that we may be sure that, while the love of learning and knowledge continues to exist in the human mind, there can be no relaxation of our efforts to penetrate still further into the mysterious worlds of abstract truth which lie so temptingly spread before us.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*  
 Presidential address (p. 722)  
 John Murray. New York, New York, USA. 1891

The mathematician requires tact and good taste at every step of his work, and he has to learn to trust to his own instinct to distinguish between what is really worthy of his efforts and what is not.

Presidential Address, British Association for the Advancement of Science  
*Nature*, Section A, Volume 42, Number 1089, September 11, 1890 (p. 467)

**Gowers, Timothy** 1963–

English mathematician

...a mathematician is more anonymous than an artist. While we may greatly admire a mathematician who discovers a beautiful proof, the human story behind the discovery eventually fades away and it is, in the end, the mathematics itself that delights us.

*Mathematics: A Very Short Introduction*  
 Chapter 8 (p. 138)  
 Oxford University Press, Inc. Oxford, England. 2002

**Graham, L. A.**

No biographical data available

A mathematician named Ray  
 Says extraction of cubes is child’s play.  
 You don’t need equations  
 Or long calculations

Just hot water to run on the tray.  
*Ingenious Mathematical Problems and Methods*  
 Mathematical Nursery Rhyme Number 14  
 Dover Publications, Inc. New York, New York, USA. 1959

**Guillen, Michael**

Theoretical physicist

[Mathematicians] might actually be looking at life with a most trenchant sense – one that perceives things the other five senses cannot.

*Bridges to Infinity: The Human Side of Mathematics*  
 Introduction (p. 7)  
 Jeremy P. Tarcher, Inc. Los Angeles, California. USA. 1983

**Guiterman, Arthur** 1871–1943

American writer

Let Poets chant of Clouds and Things  
 In lonely attics! A Nobler Lot is his, who clings To Mathematics.  
 Sublime he sits, no Worldly Strife  
 His Bosom vexes,  
 Reducing all the Doubts of Life  
 To Y’s and X’s.

*The Laughing Muse*  
 A Pure Mathematician (p. 40)  
 Harper & Brothers Publishers. New York, New York, USA. 1915

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

Each mathematician for himself, and not anyone for any other, not even all for one, must tread that more than



royal road which leads to the palace and sanctuary of mathematical truth.

*Report of the Fifth Meeting of the British Association for the Advancement of Science*

Address by Sir William Hamilton (p. xliii)

John Murray. London, England. 1836

Each [mathematician], for himself, in his own personal being, must awaken and call forth to mental view the original intuitions of time and space; must meditate himself on those eternal forms, and follow for himself that linked chain of thought which leads, from principles inherent in the child and the peasant, from the simplest notions and marks of temporal and local site, from the questions when and where, to results so varied, so remote, and seemingly so inaccessible, that the mathematical intellect of full-grown and fully cultivated man cannot reach and pass them without wonder, and something of awe.

*Report of the Fifth Meeting of the British Association for the Advancement of Science*

Address by Sir William Hamilton (p. xliii)

John Murray. London, England. 1836

The mathematician, dwelling in that inner world [which depends not for its existence on the fleeting things of sense], has hopes, and fears, and vicissitudes of feeling of his own; and even if he be not disturbed by anxious yearnings for an immortality of fame, yet has he often joy, and pain, and ardour: the ardour of successful research, the pain of disappointed conjecture, and the joy that is felt in the dawning of a new idea.

*Life of Sir William Rowan Hamilton*

Introductory Lecture on astronomy (p. 644)

Hodges, Figgis & Co. Dublin, Ireland. 1882

...when, as on this earth of ours must sometimes happen, he [the mathematician] has sent forth his [mathematical] wishes and hopes from that lonely ark, and they return to him, having found no resting place: while he drifts along the turbulent current of passion, and is tossed about by the storm and agony of grief, some sunny bursts may visit him, some moments of delightful calm may be his, when his old habits of thought recur, and the "charm severe" of lines and numbers is felt at intervals again.

*Life of Sir William Rowan Hamilton*

Introductory Lecture on astronomy (p. 644)

Hodges, Figgis & Co. Dublin, Ireland. 1882

### **Hamilton, William** 1788–1856

Scottish philosopher

Huygens and Leibnitz, indeed, truly observe, that mathematicians can, and sometimes do, err in point of form. But this aberration is rare and exceptional; it requires, indeed, a most ingenious stupidity to go wrong, where it is far more easy to keep right. A mathematical reasoning may certainly transgress in form, and a railway locomotive may go off the rails. But as a railroad conductor need not look ahead for ditches and quagmires, so a mathematician,

in his process, is not compelled to be on guard against the fallacies which beset the route of the ordinary reasoner.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 279)

Harper & Brothers Publishers. New York, New York, USA. 1861

### **Hammersley, J.**

No biographical data available

People do acquire a little brief authority by equipping themselves with jargon: they can pontificate and air a superficial expertise. But what we should ask of educated mathematicians is not what they can speechify about, nor even what they know about the existing corpus of mathematical knowledge, but rather what can they now do with their learning and whether they can actually solve mathematical problems arising in practice. In short, we look for deeds not words.

In Institute of Mathematics and Its Applications

On the Enfeeblement of Mathematical Skills by "Modern Mathematics" and by Similar Soft Intellectual Trash in Schools and Universities

*Bulletin of the Institute of Mathematics and its Applications*, Volume 4, Number 4, October, 1968

### **Hardenberg, Friedrich von** 1772–1801

German poet and novelist

The mathematicians are the only happy ones. He who does not reach for a mathematical book with devotion and read it as the word of God does not understand it.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Introduction (p. 18)

The Macmillan Company. New York, New York, USA. 1967

### **Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

It is a melancholic experience for a professional mathematician to find himself writing about mathematics. The function of a mathematician is to do something, to prove new theorems, to add to mathematics, and not to talk about what he or other mathematicians have done... there is no scorn more profound, or on the whole more justifiable, than that of the men who make for the men who explain. Exposition, criticism, appreciation, is work for second-rate minds.

*A Mathematician's Apology*

Section 1 (p. 61)

Cambridge University Press. Cambridge, England. 1967

No mathematician should ever allow himself to forget that that mathematics, more than any other art or science, is a young man's game.

*A Mathematician's Apology*

Section 4 (p. 70)

Cambridge University Press. Cambridge, England. 1967

If a man is in any sense a real mathematician, then it is a hundred to one that his mathematics will be better than

anything else he can do, and that he would be silly if he surrendered any decent opportunity of exercising his one talent in order to do undistinguished work in other fields.

*A Mathematician's Apology*

Section 3 (p. 70)

Cambridge University Press. Cambridge, England. 1967

Archimedes will be remembered when Aeschylus is forgotten, because languages die and mathematical ideas do not. 'Immortality' may be a silly word, but probably a mathematician has the best chance of whatever it may mean.

*A Mathematician's Apology*

Section 8 (p. 81)

Cambridge University Press. Cambridge, England. 1967

A MATHEMATICIAN, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs it is because [his] are made with *ideas*. A Painter makes patterns with shapes and colours, a poet with words.... A mathematician, on the other hand, has no material to work with but ideas, and so his patterns are likely to last longer...

*A Mathematician's Apology*

Section 10 (p. 84)

Cambridge University Press. Cambridge, England. 1967

...*reductio ad absurdum*...is one of a mathematician's finest weapons. It is a far finer gambit than any chess gambit: a chess player may offer the sacrifice of a pawn or even a piece, but the mathematician offers the game.

*A Mathematician's Apology*

Section 12 (p. 94)

Cambridge University Press. Cambridge, England. 1967

But is not the position of an ordinary applied mathematician in some ways a little pathetic? If he wants to be useful, he must work in a humdrum way, and he cannot give full play to his fancy even when he wishes to rise to the heights. 'Imaginary' universes are so much more beautiful than this stupidly constructed 'real' one; and the finest products of an applied mathematician's fancy must be rejected, as soon as they have been created, for the brutal but sufficient reason that they do not fit the facts.

*A Mathematician's Apology*

Section 26 (p. 135)

Cambridge University Press. Cambridge, England. 1967

The case for my life, then, or for that of anyone else who has been a mathematician in the same sense in which I have been one, is this: that I have added something to knowledge, and helped others to add more; and that these somethings have a value which differs in degree only, and not in kind, from that of the creations of the great mathematicians, or of any of the other artists, great or small, who have left some kind of memorial behind them.

*A Mathematician's Apology*

Section 29 (p. 151)

Cambridge University Press. Cambridge, England. 1967

I have myself always thought of a mathematician as in the first instance an *observer*, a man who gazes at a distant range of mountains and notes down his observations. His object is simply to distinguish clearly and notify to others as many different peaks as he can.

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematical Proof (p. 59)

Mathematical Association of America. Washington, D.C. 2004

## Hayes, Brian

American scientist, columnist, and author

Dead diatoms are becoming rare elsewhere in the academic world, but mathematicians are still expected to be masters of blackboard technique.

Aftermath

*The Emissary*, Fall 1999 (p. 12)

## Heaviside, Oliver 1850–1925

English electrical engineer, mathematician, and physicist

Even Cambridge mathematicians deserve justice.

In Harold Jeffreys and Bertha Swirles

*Methods of Mathematical Physics*

Chapter 7 (p. 228)

At The University Press. Cambridge, England. 1962

But it is perhaps too much to expect a man to be both the prince of experimentalists and a competent mathematician.

*Electromagnetic Theory*

Chapter I, Volume I (p. 14)

"The Electrician" Publishing & Printing Company. London, England.

1894–1912

## Hill, Thomas

No biographical data available

There is something sublime in the secrecy in which the really great deeds of the mathematician are done. No popular applause follows the act; neither contemporary nor succeeding generations of the people understand it.

The Imagination in Mathematics

*The North American Review*, Volume LXXXV, Number 176, July, 1857

(p. 223)

## Hughes, Richard 1900–76

British author

Science, being human enquiry, can hear no answer except an answer couched somehow in human tones. Primitive man stood in the mountains and shouted against a cliff; the echo brought back his own voice and he believed it a disembodied spirit. The scientists of today stands counting out loud in the face of the unknown. Numbers come back to him – and he believes in the Great Mathematician.

In Jefferson Hane Weaver

*The World of Physics* (Volume 3)

X.3 (p. 597)

Simon & Schuster. New York, New York, USA. 1987

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

A mathematician is a savant only on condition that he be also a sage.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 416)

The Heritage Press. New York, New York, USA. 1961

**Huxley, Thomas Henry** 1825–95

English biologist

In the...paper, there is a statement concerning the method of the mathematical sciences, which, repeated and expanded elsewhere, brought upon me, during the meeting of the British Association at Exeter, the artillery of our eminent friend Professor Sylvester. No one knows better than you do, how readily should defer to the opinion of so great a mathematician if the question at issue were really, as he seems to think it is, a mathematical one. But I submit, that the dictum of a mathematical athlete upon a difficult problem which mathematics offers to philosophy, has no more special weight, than the verdict of that great pedestrian Captain Barclay would have had, in settling a disputed point in the physiology of locomotion.

*Lay Sermons, Addresses and Reviews*

A Prefatory Letter (p. vi)

D. Appleton & Co. New York, New York, USA. 1903

The Mathematician deals with two properties of objects only, number and extension, and all the inductions he wants have been formed and finished ages ago. He is now occupied with nothing but deductions and verification.

*Lay Sermons, Addresses and Reviews* (p. 87)

D. Appleton & Company. New York, New York, USA. 1872

**Inge, William Ralph** 1860–1954

English religious leader and author

A mathematician, it has been suggested, might pray to xn.

*A Rustic Moralist*

Preface (p. 7)

G.P. Putnam's Sons. New York, New York, USA. 1937

**Jevons, William Stanley** 1835–82

English economist and logician

In place of the actual objects which we see and feel, the mathematician substitutes imaginary objects, only partially resembling those represented, but so devised that the discrepancies are not of an amount to alter seriously the character of the solution.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XXI (p. 458)

Macmillan & Co Ltd. London, England. 1877

As a science progresses, its power of foresight rapidly increases, until the mathematician in his library acquires the power of anticipating nature, and predicting what will

happen in circumstances which the eye of man has never examined.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXIV (p. 526)

Macmillan & Co Ltd. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

The mathematicians are well acquainted with the difference between pure science, which has to do only with ideas, and the application of its laws to the use of life, in which they are constrained to submit to the imperfections of matter and the influence of accident.

*The Rambler* (Volume 1)

10th Number 14 (p. 82)

Printed for W. Strahan. London, England. 1784

**Kac, Mark** 1914–84

Polish mathematician

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Schwartz, Jacob T.** 1930–

American mathematician

It is much easier for a mathematician to read a physics book after the physics becomes obsolete, and that is in fact what usually happens.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

Chapter One (p. 1)

Springer-Verlag. New York, New York, USA. 1992

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

The mathematician is still regarded as the hermit who knows little of the ways of life outside his cell, who spends his time compounding incredible and incomprehensible theorems in a strange, clipped, unintelligible jargon.

*Mathematics and the Imagination*

Introduction (p. xiii)

Simon & Schuster. New York, New York, USA. 1940

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Let us then hear no more nonsense about the interference of mathematicians in matters with which they have no concern; rather let them be lauded for condescending from their proud preeminence to help out of a rut the too ponderous wagon of some scientific brother.

In Joe D. Burchfield

*Lord Kelvin and the Age of the Earth*

Chapter IV (p. 93)

The University of Chicago Press. Chicago, Illinois, USA. 1990

**Keyser, Cassius Jackson** 1862–1947

American mathematician

The critical mathematician has abandoned the search for truth. He no longer flatters himself that his propositions are or can be known to him or to any other human being to be true; and he contents himself with aiming at the correct, or the consistent. The distinction is not annulled nor even blurred by the reflection that consistency contains immanently a kind of truth. He is not absolutely certain, but he believes profoundly that it is possible to find various sets of a few propositions each such that the propositions of each set are compatible, that the propositions of each such set imply other propositions, and that the latter can be deduced from the former with certainty. That is to say, he believes that there are systems of coherent or consistent propositions, and he regards it his business to discover such systems. Any such system is a branch of mathematics.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter XII (p. 221)  
Columbia University Press. New York, New York, USA. 1916

The great mathematician, like the great poet or great naturalist or great administrator, is born.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Mathematics (p. 22)  
The Columbia University Press. New York, New York, USA. 1908

To facilitate eyeless observation of his sense-transcending world, the mathematician invokes the aid of physical diagrams and physical symbols in endless variety and combination ...

*Lectures on Science, Philosophy and Art, 1907–1908*  
Mathematics (p. 27)  
The Columbia University Press. New York, New York, USA. 1908

The mathematician is curious about definite naked relationships, about logically possible modes of order, about varieties of implication, about completely determined or determinable functional relationships, considered solely in and of themselves, considered, that is, without the slightest concern about any question whether or no they have any external or sensuous validity or other sort of validity than that of being logically thinkable.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Mathematics (p. 37)  
The Columbia University Press. New York, New York, USA. 1908

To think logically the logically thinkable – that is the mathematician's aim.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Mathematics (p. 38)  
The Columbia University Press. New York, New York, USA. 1908

To think the thinkable – that is the mathematician's aim.

*The Universe and Beyond*  
*Hibbert Journal*, Volume 3, 1904–1905 (p. 312)

...it might have been to the advantage of mathematics and not only of mathematics but of science in general, of philosophy, too, and the general enlightenment, if in

course of the centuries mathematicians had been now and then really compelled by adverse criticism of their science to discover and to present not only to themselves but acceptably to their fellow-men the deeper justifications,

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter I (p. 2)  
Columbia University Press. New York, New York, USA. 1916

...just as the astronomer, the physicist, the geologist, or other student of objective science looks abroad in the world of sense, so, not metaphorically speaking but literally, the mind of the mathematician goes forth into the universe of logic in quest of the things that are there; exploring the heights and depths for facts – ideas, classes, relationships, implications, and the rest; observing the minute and elusive with the powerful microscope of his Infinitesimal Analysis; observing the elusive and vast with the limitless telescope of his Calculus of the Infinite; making guesses regarding the order and internal harmony of the data observed and collocated; testing the hypotheses, not merely by the complete induction peculiar to mathematics, but, like his colleagues of the outer world, resorting also to experimental tests and incomplete induction; frequently finding it necessary, in view of unforeseen disclosures, to abandon a once hopeful hypothesis or to transform it by retrenchment or by enlargement ...

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter XV (p. 294)  
Columbia University Press. New York, New York, USA. 1916

### King, Jerry P.

American mathematician

A mathematician, like everyone else, lives in the real world. But the objects with which he works do not. They live in that other place – the mathematical world. Something else lives here also. It is called truth.

*The Art of Mathematics*  
Chapter 2 (p. 29)  
Plenum Press. New York, New York, USA. 1992

A mathematician, however, almost always works alone...When a mathematician works at mathematics he sits alone in his study staring at equations scribbled on his blackboard or at a dog-eared reprint of the research paper whose results he is trying to extend. It is quiet work, like writing poetry, and includes lots of “dead time” when the mathematician, like the poet, does nothing but sit and stare at the blank page. When you walk in on a research mathematician and find him reclining with his feet up, gazing wistfully out the window, what you say is: “Sorry, I didn't know you were working.” Because he probably is.

*The Art of Mathematics*  
Chapter 2 (pp. 36–37)  
Plenum Press. New York, New York, USA. 1992

**Kline, Morris** 1908–92  
American mathematics professor and writer

Mathematicians create by acts of insight and intuition. Logic then sanctions the conquests of intuition. It is the hygiene that mathematics practice to keep its ideas healthy and strong. Moreover, the whole structure rests fundamentally on uncertain ground, the intuitions of man. Here and there an intuition is scooped out and replaced by a firmly built pillar of thought; however, this pillar is based on some deeper, perhaps less clearly defined intuition. Though the process of replacing intuitions by precise thoughts does not change the nature of the ground on which the mathematics ultimately rests, it does add strength and height to the structure.

*Mathematics in Western Culture*  
Chapter XXV (p. 408)  
Oxford University Press, Inc. New York, New York, USA. 1953

Mathematicians respond to intellectual challenge much as businessmen do to the excitement of making money. They enjoy the fascination of the quest, the sense of adventure, the thrill of discovery, the satisfaction of mastering difficulties, the pride and glory of achievement – or, if one wishes, the exaltation of the ego and the intoxication of success.

*Why the Professor Can't Teach: Mathematics and the Dilemma of University Education*  
Chapter 6 (p. 129)  
St. Martin's Press. New York, New York, USA. 1977

Mathematicians have always constituted a clannish, elitist, snobbish, highly individualistic community in which status is determined, above all, by the presumed importance or original contributions to mathematics; and in which the greatest rewards are bestowed upon those who, at least in the opinion of their peers, will leave a permanent mark on its evolution.

*Why the Professor Can't Teach: Mathematics and the Dilemma of University Education*  
Chapter 11 (p. 240)  
St. Martin's Press. New York, New York, USA. 1977

If potential application is the goal, then as the great physical chemist Josiah Willard Gibbs remarked, the pure mathematician can do what he pleases, but the applied mathematician must be at least partially sane.

*Mathematics: The Loss of Certainty*  
Chapter XIII (p. 285)  
Oxford University Press, Inc. New York, New York, USA. 1980

**Kovalevskaya, Sofia** 1850–91  
Russian mathematician

It is impossible to be a mathematician without being a poet in soul.

*Sónya Kovalévsky: Her Recollections of Childhood* (p. 316)  
The Century Co. New York, New York, USA. 1895

**Krantz, Steven** 1951–  
Mathematician

A mathematician experiments, amasses information, makes a conjecture, finds out that it does not work, gets confused and then tries to recover. A good mathematician eventually does so – and proves a theorem.

*Conformal Mappings*  
*American Scientist*, Sept.–Oct. 1999 (p. 445)

**Lakatos, Imre** 1922–74  
Hungarian-born philosopher

On the face of it there should be no disagreement about mathematical proof. Everybody looks enviously at the alleged unanimity of mathematicians; but in fact there is a considerable amount of controversy in mathematics. Pure mathematicians disown the proofs of applied mathematicians, while logicians in turn disavow those of pure mathematicians. Logicians disdain the proofs of formalists and some intuitionists dismiss with contempt the proofs of logicians and formalists.

*Mathematics, Science and Epistemology* (Volume 2)  
Chapter 4 (p. 61)  
Cambridge University Press. Cambridge, England. 1978

**Langer, Susanne Katherina Knauth** 1895–1985  
American philosopher

Mathematicians are rarely practical people, or good observers of events. They are apt to be cloistered souls, like philosophers and theologians.

*Philosophy in a New Key*  
Chapter I (p. 19)  
Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

...mathematicians obtain the solution of a problem by the mere arrangement of data, and by reducing their reasoning to such simple steps, to conclusions so very obvious, as never to lose sight of the evidence which guides them.

*Elements of Chemistry In a New Systematic Order*  
Preface of the Author (p. xviii)  
Printed for William Creech. Edinburgh, Scotland. 1790

**Lebesgue, Henri** 1875–1941  
French mathematician

Mathematicians have never been in full agreement on their science, though it is said to be the science of self-evident verities – absolute, indisputable and definitive. They have always been in controversy over the developing aspects of mathematics, and they have always considered their own age to be a period of crisis.

In Lucienne Felix  
*The Modern Aspect of Mathematics* (p. 3)  
Basic Books. New York, New York, USA. 1960

In my opinion a mathematician, in so far as he is a mathematician, need not preoccupy himself with philosophy – an opinion, moreover, which has been expressed by many philosophers.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Le Cam, Lucien** 1924–2000

Mathematician

There are mathematicians who do mathematics simply because they like it – it’s a work of art. Some people work very hard on problems that have no relation to anything else.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 174)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Lehmer, Derrick Henry** 1905–1991

American mathematician

**Lebesgue, Henri** 1875–1941

French mathematician

The real difficulty lies in the fact that only a finite number of angels can dance on the head of a pin, whereas the mathematician is more apt to be interested in the infinite angel problem only.

Mechanized Mathematics

*Bulletin of the American Mathematical Society*, Volume 72, Number 5, September, 1966 (p. 744)

**Lewis, Sinclair** 1885–1951

American novelist

“The regularity of the rate at which the streptolysin disappears suggests that an equation may be found.”

“Then why did you not make the equation?”

“Well – I don’t know. I wasn’t enough of a mathematician.”

“Then you should not have published till you knew your math!”

*Arrowsmith*

Chapter XXVI, Section I (p. 288)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

Mathematics are a noble science, but as for the mathematicians they are often not worth the hangman. It is nearly the same with mathematics as with theology; for, as those who apply themselves to the latter, especially if

they once obtain an office, forthwith arrogate to themselves the credit of peculiar sanctity and a closer alliance with God, though very many among them are in reality but good-for-nothing subjects; in like manner, he who is styled a mathematician very frequently succeeds

in passing for a *deep thinker*, although under that name are included the *veriest dunderheads* (die groessten Plunderkoepfe) in *existence*, incapable of any business whatsoever which requires *reflection*, since this cannot be immediately performed by the *easy* process of connecting symbols, which is more the product of routine than of thought.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 293)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Locke, William John** 1863–1930

Novelist and short story writer

Now all the world understands the irresistible force that compels the poet, at last, to give form to long haunting dreams; the need, also, of the astronomer to crystallize the results of his discoveries and formulate his epoch-making theories; but the passion of the mathematician to do the same is not so easily comprehensible. For years Baltazar had dreamed of an exhaustive and monumental treatise on the Theory of Groups which would revolutionize the study of the higher mathematics, a gorgeous vision, the mere statement of which must leave the ordinary being cold and the first attempt at explanation petty him with its icy unintelligibility.

*The House of Baltazar*

Chapter IV (p. 47)

John Lane. London, England. 1920

**Lodge, Sir Oliver** 1851–1940

English physicist

It is undeniable that mathematicians, with a self-denying ordinance about coefficients, can thus attain remarkable criteria, and are able to anticipate definite results; but we need not seek to engraft their modes of expression on the real world of physics.

Geometrization of Physics, and Its Supposed Bias on the Michelson–Morley Experiment

*Nature*, Volume 106, Number, 2677, February 17, 1921 (p. 798)

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Mathematicians are reputed to be rare and special people, exulting in the exercise of a gift far beyond the performance, and perhaps even the conception, of ordinary people.

*The Limits of Science*

An Essay on Scians [Science] (p. 9)

Harper & Row, Publishers. New York, New York, USA. 1984

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Even if we admit that mathematicians are of great value to the world, the fact remains that there are many charlatans (*circulatores*) among them. They talk too much of



their discoveries, and nothing grieves them more than to see some other mathematician get ahead of them. How vast is their joy when they solve a problem within the time limits set by him who posited it! They use up every ounce of their energy in that struggle for fame.

In Johann B. Mencke

*The Charlatanry of the Learned*

Lecture II, fn 74 (p. 152)

Alfred A. Knopf. New York, New York, USA. 1937

**Mill, John Stuart** 1806–73

English political philosopher and economist

It is one of the peculiar excellencies of mathematical discipline that the mathematician is never satisfied with ‘*a peu pres*’. He requires the ‘exact’ truth.

*An Examination of Sir William Hamilton’s Philosophy* (2nd edition)

Chapter XXVII (p. 525)

Longmans, Green & Co. London, England. 1865

**Mittag-Leffler, Gosta** 1846–1927

Swedish mathematician

The mathematician’s best work is art... a high and perfect art, as daring as the most secret dreams of imagination, clear and limpid. Mathematical genius and artistic genius touch each other.

In Havelock Ellis

*The Dance of Life*

Chapter III, Section V (p. 139)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Morawetz, Cathleen Synge** 1923–

Canadian mathematician

Ah, there’s no excitement to beat the excitement of proving a theorem! Until you find out the next day that it’s wrong.... I’ll tell you, though, there is something about being a mathematician that is extremely difficult. One of my children put it this way: It’s that you’re on stage all the time. You can’t fake or shift the subject of conversation and so on. That’s very demanding of people.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 238)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Mordell, Louis Joel** 1888–1972

English mathematician

No one will get very far or become a real mathematician without certain indispensable qualities. He must have hope, faith, and curiosity, and prime necessity is curiosity.

*Reflections of a Mathematician*

Chapter II (p. 7)

Canadian Mathematical Congress. 1959

**More, Louis Trenchard**

American educator

It is the privilege of mathematicians to deal with symbols; the physical universe is no more important to them than any other universe which can be developed symbolically. The trouble occurs when the distinction between the real or physical universe and symbolical or metaphysical universes is obliterated in the minds of men of science.

*The Limitations of Science*

Chapter V (p. 186)

Henry Holt & Co. New York, New York, USA. 1915

**Morley, Christopher** 1890–1957

American writer

Sweep the pale hair, like wings, above the ears;

Whittle the nose, and carve and bone the jaw;

Blank the studying eyes, till human fears

Eliminate in universal law.

Slack the mortal shirt, stiffen the hands,

Holding the dear old pipe, half-smoked, unlit –

So, lovingly, we lose Orion’s Bands

And write equation with the Infinite.

*The Ballad of New York, New York, and Other Poems 1930–1956*

Portrait of a Mathematician

Doubleday & Company, Inc. Garden City, New York, USA. 1950

**Morse, Harold Calvin Marston** 1892–1977

American mathematician

...what is it that a mathematician wants as an artist. I believe that he wishes merely to understand and to create. He wishes to understand, simply, if possible – |but in any case to understand; and to create, beautifully, if possible – but in any case to create.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematics and the Arts (p. 90)

Mathematical Association of America. Washington, D.C. 2004

Mathematicians of today are perhaps too exuberant in their desire to build new logical foundations for everything. Forever the foundation and never the cathedral.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematics and the Arts (p. 91)

Mathematical Association of America. Washington, D.C. 2004

**Morton, Henry Vollam** 1892–1979

English travel writer

In the dusk of a lane I met a shepherd with his sheep.  
A small dog with the expression of a professor of mathematics does all the work.

*In Search of Scotland*

Chapter 1, Section 3 (p. 8)

Methuen & Company Ltd. London, England. 1949

**National Research Council (USA)**

Mathematicians make up, or one could say discover, their own questions in the timeless universe of logical connection.

*Physics in Perspective* (Volume 1)  
Chapter 3 (p. 57)  
National Academy of Sciences  
Washington, D.C. 1972

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

Mathematicians that find out, settle & do all the business must content themselves with being nothing but dry calculators and drudges & another that does nothing but pretend and grasp at all things must carry away all the invention...

*Lives of Eminent Persons*  
Letter to Edmund Halley, 20 June, 1686 (p. 21)  
Society for the Diffusion of Useful Knowledge. Great Britain. 1833

...if instead of sending the Observations of seamen to able Mathematicians at Land, the Land would send able Mathematicians to Sea, it would signify much more to the improvement of Navigation and safety of Men's lives and estates on the alimant.

In E.G.R. Taylor  
*The Mathematical Practitioners of Tudor & Stuart England* (p. 119)  
At The University Press. Cambridge, England. 1954

Now is not this very fine? Mathematicians that find out, settle, and do all the business must content themselves with being nothing but dry calculators and drudges; and another that does nothing but pretend and grasp at all things must carry away all the invention...

In George D. Birkhoff  
*Science for a New World*  
Mathematics, Quantity and Order (p. 293)  
Harper & Brothers Publishers. New York, New York, USA. 1934

**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

All heavenly messengers must be mathematicians.  
Quoted in Panthea  
*The Reasoner*  
Eclectic Gatherings  
Volume 6 1849 (p. 374)

The mathematician knows everything.  
*Main Currents in Nineteenth, Century Literature*  
Chapter XII  
The Macmillan Co. New York, New York, USA. 1906

There may be mathematicians of the first magnitude who cannot cipher. One can be a great cipherer without a conception of mathematics.

In Kuno Francke and Isidore Singer  
*The German Classics: Masterpieces of German Literature Translated Into English*  
*Aphorism* (p. 188)  
The German Publication Society. New York, New York, USA. 1914

**Oldham, Richard Dixon** 1858–1936  
English geologist

Many theories of the earth have been propounded at different times: the central substance of the earth has been supposed to be fiery, fluid, solid, and gaseous in turn, till geologists have turned in despair from the subject and become inclined to confine their attention to the outermost crust of the earth, leaving its center as a playground for mathematicians.

*The Constitution of the Interior of the Earth as Revealed by Earthquakes*  
*The Quarterly Journal of the Geological Society of London*, Volume 62, August, 1906 (p. 456)

**Pappas, Theoni**  
Mathematician

Contrary to popular belief, mathematics is a passionate subject. Mathematicians are driven by creative passions that are difficult to describe, but are no less forceful than those that compel a musician to compose or an artist to paint. The mathematician, the composer, the artist succumb to the same foibles as any human—love, hate, addictions, revenge, jealousies, desire for fame, and money.

*Mathematical Scandals*  
Introduction (p. 4)  
Wide World Publishing. San Carlos, California, USA. 1997

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Mathematicians who are only mathematicians have exact minds, provided all things are explained to them by means of definitions and axioms; otherwise they are inaccurate and insufferable, for they are only right when the principles are quite clear.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section I, 1  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearson, Karl** 1857–1936  
English mathematician

The mathematician, carried along on his flood of symbols, dealing apparently with purely formal truths, may still reach results of endless importance for our description of the physical universe.

In John N. Shive and Robert L. Weber  
*Similarities in Physics*  
Chapter 6 (p. 58)  
John Wiley & Sons, Inc. New York, New York, USA. 1982

**Perfect, D. C.**  
No biographical data available

Said a mathematician (age 7)  
“Shall I ever get into Heaven  
If I cannot tell why  
hc/p  
2e2 must be 137?”

*The Observatory*, Volume 73, Number 216, 1953

**Plato** 428 BCE–347 BCE  
Greek philosopher

I have hardly ever known a mathematician who was capable of reasoning.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 531 (p. 397)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearson, Karl** 1857–1936  
English mathematician

I believe the day must come when the biologist will – without being a mathematician – not hesitate to use mathematical analysis when he requires it.

Mathematics and Biology

*Nature*, Volume 63, Number 1629, January 17, 1901 (p. 275)

**Pickover, Clifford A.**  
American author, editor, and columnist

I do not know if God is a mathematician, but mathematics is the loom upon which God weaves the fabric of the universe.

*The Loom of God: Mathematical Tapestries at the Edge of Time*

Introduction (p. 27)

Plenum Press. New York, New York, USA. 1997

**Poe, Edgar Allan** 1809–49  
American short story writer

As poet and mathematician, he would reason well; as mere mathematician, he could not have reasoned at all, and thus would have been at the mercy of the Prefect.

*Seven Tales*

The Purloined Letter (p. 231)

Schocken Books. New York, New York, USA. 1971

...we soon arrived at another [country] in which the bees and the birds are mathematicians of such genius and erudition, that they give daily instructions in the science of geometry to the wise men of the empire. The king of the place having offered a reward for the solution of two very difficult problems, they were solved upon the spot – the one by the bees, and the other by the birds; but the king keeping their solution a secret, it was only after the most profound researches and labor, and the writing of an infinity of big books, during a long series of years, that the men-mathematicians at length arrived at the identical solutions which had been given upon the spot by the bees and by the birds.

*The Complete Works of Edgar Allan Poe* Volume 3

*The Thousand and Second Tale* (pp. 28–29)

William-Barker Co. New York, New York, USA. 1908

...I can only speak with that species of indefinite definiteness which mathematicians are, at times, forced to put up with in certain algebraic formulae.

*The Works of Edgar Allan Poe* Volume 4

*The Devil in the Belfry* (p. 104)

Charles Scribner's Sons. New York, New York, USA. 1914

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Need we add that mathematicians themselves are not infallible?

*The Foundations of Science*

*Science and Method*, Book I

Chapter III (p. 384)

The Science Press. New York, New York, USA. 1913

The mathematician does not study pure mathematics because it is useful; he studies it because he delights in it and he delights in it because it is beautiful.

In H.E. Huntley

*The Divine Proportion: A Study in Mathematical Beauty*

Introduction (p. 1)

Dover Publications. New York, New York, USA. 1970

Mathematicians do not deal in objects, but in relations between objects; thus, they are free to replace some objects by others so long as the relations remain unchanged. Content to them is irrelevant: they are interested in form only.

In Tobias Dantzig

*Number: The Language of Science* (4th edition)

Chapter D (p. 317)

The Macmillan Company. New York, New York, USA. 1954

A scientist worthy of the name, above all a mathematician, experiences in his work the same impressions as an artist; his pleasure is as great and of the same nature.

In Stanley Gudder

*A Mathematical Journey* (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

It is impossible to study the works of the great mathematicians, or even those of the lesser, without noticing and distinguishing two opposite tendencies, or rather two entirely different kinds of minds. The one sort are above all preoccupied with logic; to read their works, one is tempted to believe they have advanced only step by step, after the manner of a Vauban who pushes on his trenches against the place besieged, leaving nothing to chance. The other sort are guided by intuition and at the first stroke make quick but sometimes precarious conquests, like bold cavalymen of the advance guard.

The Value of Science

*The Popular Science Monthly*, Volume LXIX, Number 3, September,

1906 (p. 197)

...mathematician ought not to be for the physicist a simple provider of formulae ...

The Relations of Analysis and Mathematical Physics

*Bulletin of the American Mathematical Society*, Volume IV, Number 6,

March, 1898 (p. 248)

**Poiret, Pierre** 1646–1719  
French mystic and Christian philosopher

From the same source, mathematicians are also infested with an overweening presumption or incurable arrogance; for, believing themselves in possession of demonstrative certainty in regard to the objects of their peculiar

science, they persuade themselves that, in like manner, they possess a knowledge of many things beyond its sphere. Then, co-ordinating these with the former, as if demonstrated by equal evidence, they spurn every objection to every opinion, with the contempt or indignation they would feel at an endeavor to persuade them that two plus two are not four, or that the angles of a triangle are not equal to two right angles.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (pp. 296–297)  
Harper & Brothers Publishers. New York, New York, USA. 1861

### **Pólya, George** 1887–1985

Hungarian mathematician

The mathematician as the naturalist, in testing some consequence of a conjectural general law by a new observation, addresses a question to Nature: “I suspect that this law is true. Is it true?” If the consequence is clearly refuted, the law cannot be true. If the consequence is clearly verified, there is some indication that the law may be true. Nature may answer Yes or No, but it whispers one answer and thunders the other, its Yes is provisional, its No is definitive.

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 10)

Princeton University Press. Princeton, New Jersey, USA. 1954

### **Pringsheim, Alfred** 1850–1941

German mathematician

The true mathematician is always a great deal of an artist, an architect, yes, of a poet. Beyond the real world, though perceptibly connected with it, mathematicians have created an ideal world which they attempt to develop into the most perfect of all worlds, and which is being explored in every direction. None has the faintest conception of this world except him who knows it; only presumptuous ignorance can assert that the mathematician moves in a narrow circle. The truth which he seeks is, to be sure, broadly considered, neither more nor less than consistency; but does not his mastership show, indeed, in this very limitation? To solve questions of this kind he passes unenviously over others.

*Jahresberichte der Deutschen Mathematiker Vereinigung*, Volume 13,  
1904 (p. 381)

A mathematician’s work is mostly a tangle of guesswork, analogy, wishful thinking and frustration, and proof, far from being the core of discovery, is more often than not a way of making sure that our minds are not playing tricks.

In Philip J. Davis and Reuben Hersh

*The Mathematical Experience*

Introduction (p. xviii)

Birkhäuser. Boston, Massachusetts, USA. 1981

### **Pycroft, James** 1813–95

English writer

A mathematician is always a mathematician, even without his formulas and diagrams.

*A Course of English Reading* (4th edition)

Chapter XII (p. 265)

Longman, Green, Longman & Roberts. London, England. 1861

### **Queen of Prussia**

...of all who meddled with philosophy, the mathematicians satisfied her [the first Queen of Prussia] the least, more especially when they attempted to explain the origin of things in general, or the nature of the soul in particular; and that she was surprised, that, notwithstanding their geometrical exactness metaphysical notions were, for most of them, lost countries, and exhaustless sources of chimeras.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 296)

Harper & Brothers Publishers. New York, New York, USA. 1861

### **Rees, Mina** 1902–97

American mathematician

In dealing with academics, it is absolutely superb to be able to say you’re a mathematician! Nobody dares to say mathematics is not important or not significant.... No discipline surpasses mathematics in pure academic prestige.

In Donald J. Albers and G.L. Alexanderson (eds.)

*Mathematical People*

Mina Rees (p. 260)

Birkhäuser. Boston, Massachusetts, USA. 1985

### **Reid, Constance**

Mathematical biographer

The answer to the question Can there be a general method for solving all mathematical problems? is no!

Perhaps, in a world of unsolved and apparently unsolvable problems, we would have thought that the desirable answer to this question from any point of view, would have been yes. But from the point of view of mathematicians a yes would have been far less satisfying than a no is. Not only are the problems of mathematics infinite and hence inexhaustible, ...mathematics itself is inexhaustible.

*Introduction to Higher Mathematics for the General Reader* (p. 180)

Thomas Y. Crowell. New York, New York, USA. 1959

Mathematics is a world created by the mind of man, and the mathematicians are people who devote their lives to what seems to me a wonderful kind of play!

In G.L. Anderson

An Interview with Constance Reid

*Two Year College Mathematical Journal*, Volume 11, 1980 (p. 238)

**Reid, Thomas** 1710–96  
Scottish philosopher

The mathematician pays not the least regard either to testimony or conjecture, but deduces everything by demonstrative reasoning, from his definitions and axioms. Indeed, whatever is built upon conjecture, is improperly called science; for conjecture may beget opinion, but cannot produce knowledge.

*Essays on the Intellectual Powers of Man*  
Essay I, Chapter III (p. 46)  
Printed for John Bell. London, England. 1785

**Richardson, David Lester** 1801–65  
Poet and writer

Mathematicians are like helpless children beyond the pale of their own science. They cannot walk steadily out of their own go-cart.

*Literary Chit-Chat*  
Chapter X (p. 83)  
P.S. D'Rozario and Co. Calcutta, India. 1848

Mathematicians have too often neither common sense nor rare sense.

*Literary Chit-Chat*  
Chapter X (p. 83)  
P.S. D'Rozario and Co. Calcutta, India. 1848

**Robinson, Julia** 1919–85  
American mathematician

What I really am is a mathematician. Rather than being remembered as the first woman this or that, I would prefer to be remembered, as a mathematician should, simply for the theorems I have proved and the problems I have solved.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 280)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

Philosophers and psychiatrists should explain why it is that we mathematicians are in the habit of systematically erasing our footsteps. Scientists have always looked askance at this strange habit of mathematicians, which has changed little from Pythagoras to our day.

Two Turning Points in Invariant Theory  
*The Mathematical Intelligencer*, 21(1) Winter 1999 (p. 26)

Mathematicians have to attend (secretly) physics meetings in order to find out what is going on in their fields. Physicists have the P.R., the savoir-faire, and the chutzpah to write readable, or at least legible accounts of subjects that are not yet obsolete, something few mathematicians would dare to do, fearing expulsion from the A.M.S.

*Indiscrete Thoughts*  
Chapter XX (p. 215)  
Birkhäuser. Boston, Massachusetts, USA. 1997

There is nothing deadlier for a mathematician than to be placed in a beautiful office and instructed to lay golden eggs.

*Indiscrete Thoughts*  
Chapter XX (p. 210)  
Birkhäuser. Boston, Massachusetts, USA. 1997

Grade school teachers, high school teachers, administrators and lobbyists are as much mathematicians as you or Hilbert. They contribute to the well-being of mathematics as much as or more than you or other mathematicians. They are right in feeling left out by snobbish research mathematicians who do not know on which side their bread is buttered. It is our best interest, as well as the interest of justice, to treat all who deal with mathematics in whatever way as equals. By being united we will increase the probability of our survival.

*Indiscrete Thoughts* (pp. 207–208)

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...mathematicians do not read Plato, while those who read him know no mathematics ...

*Mysticism and Logic: And Other Essays*  
Chapter IV (p. 60)  
Longmans, Green & Co. London, England. 1919

Remote from human passions, remote even from the pitiful facts of nature, the generations have gradually created an ordered cosmos, where pure thought can dwell as in its natural home, and where one, at least, of our nobler impulses can escape from the dreary exile of the actual world.

*Mysticism and Logic: And Other Essays*  
Chapter IV (p. 61)  
Longmans, Green & Co. London, England. 1919

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

The main source of mathematical invention seems to be within man rather than outside of him: his own inveterate and insatiable curiosity, his constant itching for intellectual adventure; and likewise the main obstacles to mathematical progress seem to be also within himself; his scandalous inertia and laziness, his fear of adventure, his need of conformity to old standards, and his obsession by mathematical ghosts.

*The Study of the History of Mathematics*  
The Study of the History of Mathematics (p. 16)  
Dover Publications, Inc. New York, New York, USA. 1936

Mathematicians and other scientists, however great they may be, do not know the future. Their genius may enable them to project their purpose ahead of them; it is as if they had a special lamp, unavailable to lesser men, illuminating their path; but even in the most favorable cases

the lamp sends only a very small cone of light into the infinite darkness.

*The Study of the History of Mathematics*

The Study of the History of Mathematics (pp. 17–18)

Dover Publications, Inc. New York, New York, USA. 1936

The concatenations of mathematical ideas are not divorced from life, far from it, but they are less influenced than other scientific ideas by accidents, and it is perhaps more possible, and more permissible, for a mathematician than for any other man to secrete himself in a tower of ivory.

*The Study of The History of Mathematics*

The Study of the History of Mathematics (pp. 19–20)

Dover Publications, Inc. New York, New York, USA. 1936

The main duty of the historian of mathematics, as well as his fondest privilege, is to explain the humanity of mathematics, to illustrate its greatness, beauty and dignity, and to describe how the incessant efforts and accumulated genius of many generations have built up that magnificent monument, the object of our most legitimate pride as men, and of our wonder, humility, and thankfulness, as individuals. The study of the history of mathematics will not make better mathematicians but gentler ones, it will enrich their minds, mellow their hearts, and bring out their finer qualities.

*The American Mathematical Monthly*, Volume 102, Number 4, April, 1995 (p. 369)

### Schuster, Sir Arthur 1851–1934

English physicist

Mathematicians are always sufficiently resourceful to cope with any problem set to them by the experimentalist, and as Poincare likes to tell us, we can always find a new hypothesis to fit a new fact.

*The Progress of Physics During 33 Years (1875–1908)*

Lecture III (p. 109)

At The University Press. Cambridge, England. 1911

### Serge, Corrado

No biographical data available

[A] mathematician cannot be really content with a result which he has obtained by non-rigorous methods; he will not feel sure of it until he has rigorously proved it. But he will not reject summarily these imperfect methods in the case of difficult problems when he is unable to substitute better ones, since the history of the science precisely shows what service such methods have always rendered.

On Some Tendencies in Geometric Investigations

*Bulletin of the American Mathematical Society*, 2nd Series, Volume 10, June, 1904 (pp. 453–454)

### Shaw, James Byrnie

American mathematician

The mathematician does not build in stone, nor paint on canvas, nor construct a symphony, though his harmonies

are in and through all these; his medium is more ethereal; but is his creation therefore the less beautiful?

Henri Poincare as An Investigator

*Popular Science Monthly*, March, 1913 (p. 221)

The mathematician builds because he enjoys the building, and the fascination of his creation is the impetus that keeps him creating. It is not the usefulness of what he creates, but the innate beauty of it that he is forever thirsting for.

*Lectures on the Philosophy of Mathematics*

Chapter XVI (p. 186)

The Open Court Publishing Co. Chicago, Illinois, USA. 1918

The mathematician is fascinated with the marvelous beauty of the forms he constructs, and in their beauty he finds everlasting truth.

*Lectures on the Philosophy of Mathematics*

Chapter XVI (p. 194)

The Open Court Publishing Co. Chicago, Illinois, USA. 1918

### Shchatunovski, Samuil

No biographical data available

It is not the job of mathematicians...to do correct arithmetical operations. It is the job of bank accountants.

In George Gamow

*My World Line: An Informal Autobiography*

Chapter 1 (p. 24)

The Viking Press. New York, New York, USA. 1979

### Shulman, Milton 1925–

Canadian writer and journalist

I knew a mathematician who said, “I do not know as much as God. But I know as much as God knew at my age.”

*Stop the Week*

BBC Radio 4, year unknown

### Solzhenitsyn, Aleksandr Isayevich 1918–

Russian novelist and historian

All my life I have thought of mathematicians as Rosicrucians of some kind, and I always regretted that I never had the opportunity of being initiated into their secrets.

*The First Circle*

Chapter 9 (p. 39)

Harper & Row. New York, New York, USA. 1968

### Stewart, Dugald 1753–1828

Scottish philosopher

...I have never met with a mere mathematician who was not credulous to a fault...

*The Collected Works of Dugald Stewart* (Volume 4)

Part Third, Chapter I, Section 3 (p. 209)

T & T Clark. Edinburgh, Scotland. 1877

It is a certain fact, that, in mathematicians who have confined their studies to mathematics alone, there has often been observed a proneness to that species of religious enthusiasm in which imagination is the



predominant element, and which, like a contagion, is propagated in a crowd.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 295)

Harper & Brothers Publishers. New York, New York, USA. 1861

The bias now mentioned, is strengthened by another circumstance – the confidence which the mere mathematician naturally acquires in his powers of reasoning and judgment – in consequence of which, though he may be prevented in his own pursuits from going far astray, by the absurdities to which his errors lead him, he is seldom apt to be revolted by absurd conclusions in the other sciences. Even in physics, mathematicians have been led to acquiesce in conclusions which appear ludicrous to men of different habits.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 297)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Stewart, Ian** 1945–

English mathematician and science writer

The true mathematician is not a juggler of numbers, but a juggler of concepts.

*Concepts of Modern Mathematics*

Preface to the First Edition (p. vii)

Dover Publications, Inc. New York, New York, USA. 1995

Mathematicians don't worry about what things *really* are. They just want to find effective ways to work out what they can do.

*Flatterland*

One Hundred and One Dimensions (p. 49)

Perseus Publishing. Cambridge, Massachusetts, USA. 2001

**Strachey, Kytton** 1880–1932

English writer and critic

In pure mathematics the maximum of detachment appears to be reached: the mind moves in an infinitely complicated pattern, which is absolutely free from temporal considerations. Yet this very freedom – the essential condition of the mathematician's activity – perhaps gives him an unfair advantage. He can only be wrong – he cannot cheat.

*Portraits in Miniature*

Hume (pp. 141–142)

Chatto & Windus. London, England. 1931

**Swann, William Francis Gray** 1884–1962

Anglo-American physicist

It has been said that the pure mathematician is never as happy as when he does not know what he is talking about...

*The Architecture of the Universe*

Chapter IV (p. 117)

The Macmillan Company. New York, New York, USA. 1934

**Swift, Jonathan** 1667–1745

Irish-born English writer

...what I chiefly admired, and thought altogether unaccountable, was the strong disposition I observed in them [the mathematicians of Laputa] towards news and politics; perpetually enquiring into publick affairs; giving their judgments in matters of state; and passionately disputing every inch of party opinions. I have indeed observed the same disposition among most of the mathematicians I have known in Europe; although I could never discover the least analogy between the two sciences...

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter II (pp. 97–98)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sylvester, James Joseph** 1814–97

English mathematician

The mathematician lives long and lives young; the wings of his soul do not early drop off, nor do its pores become clogged with the earthy particles blown from the dusty highways of vulgar life.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 2)

Presidential Address to the British Association (p. 658)

University Press. Cambridge, England. 1904–1912

It is the constant aim of the mathematician to reduce all his expressions to their lowest terms, to retrench every superfluous word and phrase, and to condense the Maximum of meaning into the Minimum of Language.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 3)

On Recent Discoveries in Mechanical Conversion of Motion (pp. 72–73)

University Press. Cambridge, England. 1904–1912

**Synge, John L.** 1897–1995

Irish mathematician and physicist

Mathematicians are human beings.

*The Scripta Mathematica Studies Number 2*

The Life and Early Works of Sir William Rowan Hamilton (p. 13)

Scripta Mathematica. New York, New York, USA.

The modern mathematician weaves an intricate pattern of microscopic precision. To him, a false statement – an exception to a general statement – is an unforgiving sin. The heroic mathematician, on the other hand, paints with broad splashes of color, with a grand contempt for singular cases until they could no longer be avoided.

*The Scripta Mathematica Studies Number 2*

The Life and Early Works of Sir William Rowan Hamilton (p. 16)

Scripta Mathematica. New York, New York, USA.

**Thom, René** 1923–2002  
French mathematician

Everything considered, mathematicians should have the courage of their most profound convictions and thus affirm that mathematical forms indeed have an existence that is independent of the mind considering them.... Yet, at any given moment, mathematicians have only an incomplete and fragmentary view of this world of ideas. Modern Mathematics: An Educational and Philosophical Error? *American Scientist*, Volume 59, 1971 (p. 695)

**Thompson, Silvanus P.** 1851–1916  
English physics professor and author

Once when lecturing to a class he [Lord Kelvin] used the word “mathematician,” and then interrupting himself asked his class, “Do you know what a mathematician is?” Stepping to the blackboard he wrote upon it – Then putting his finger on what he had written, he turned to his class and said: “A mathematician is one to who that is as obvious as that twice two makes four is to you. In S.P. Thompson  
*The Life of William Thomson Baron Kelvin of Largs* (Volume 2)  
Views and Opinions (p. 1139)  
Macmillan & Company Limited. London, England. 1910

**Thurston, William Paul** 1946–  
American mathematician

There are mathematicians, and then there’s the rest of the world, and not much interaction between the two. In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 335)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

...mathematicians enjoy being in the ivory tower. I think that most mathematicians love mathematics for mathematics’ sake. They really do like the feeling of being in an ivory tower. For the most part they are not motivated by applications. But I believe that, whatever their personal motivation is for doing mathematics, in most cases the mathematics they generate will ultimately have significant applications. The important thing is to do the mathematics. But, of course, it’s important to have people thinking about applications too. In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 335)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Todhunter, Isaac** 1820–84  
English mathematician

Another great and special excellence of mathematics is that it demands earnest voluntary exertion. It is simply impossible for a person to become a good mathematician by the happy accident of having been sent to a good school; this may give him a preparation and a start, but by his own continued efforts alone can he reach an eminent position.

*The Conflict of Studies, and Other Essays on Subjects Connected With Education*  
Chapter I (p. 11)  
Macmillan & Co Ltd. London, England. 1873

Nor do I know any study which can compete with mathematics in general in furnishing matter for severe and continued thought. Metaphysical problems may be even more difficult; but then they are far less definite, and, as they rarely lead to any precise conclusion, we miss the power of checking our own operations, and of discovering whether we are thinking and reasoning or merely fancying and dreaming. *The Conflict of Studies, and Other Essays on Subjects Connected With Education*  
Chapter I (p. 13)  
Macmillan & Co Ltd. London, England. 1873

**Tomlinson, Henry Major** 1873–1958  
English novelist

We may doubt the warranty of the priest, but never that of the mathematician. *All Our Yesterdays*  
Part I, Chapter Two (p. 10)  
Harper & Brothers Publishers. New York, New York, USA. 1930

**Truman, Percival Henry**  
No biographical data available

Heretofore the court mathematician’s sole duty had been to ride in state processions, he being allowed at other times to go triangulating among the stars at will, in the hope that in this way the stars might be discovered to be at some time of importance to the kingdom of Nunvalia. In Alfred Dudley Britton, Philip Richards Dunbar and Charles Fisher Hepburn  
*Stories & Verse of Williams*  
Applied Mathematics (pp. 102–103)  
Published by the editors. 1900

**Veblen, Oswald** 1880–1960  
American mathematician

The conclusion seems inescapable: that formal logic has to be taken over by the mathematicians. The fact is that there does not exist an adequate logic at the present time, and unless the mathematicians create one, no one else is likely to do so. *A Century of Mathematics In America* (Volume 2)  
Retiring address of the AMS 1924 (p. 219)  
American Mathematical Society. Providence, Rhode Island, USA. 1989

...let me remind any non-mathematicians...that when a mathematician lays down the elaborate tools by which he achieves precision in his own domain, he is unprepared and awkward in handling the ordinary tools of language. This is why mathematicians always disappoint the expectation that they will be precise and reasonable and clear-cut in their statements about everyday affairs,

and why they are, in fact, more fallible than ordinary mortals.

Geometry and Physics

*Science*, Volume 57, Number 1466, February 2, 1923 (p. 130)

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Mathematicians are like Frenchmen: whatever you say to them they translate into their own language and forthwith it is something entirely different.

*The Maxims and Reflections of Goethe*

Macmillan & Company Limited. London, England. 1908

The mathematician is only in so far complete as he is a complete man, and feels within himself the beauty of truth. Then only will his work be profound, lucid, wise, genuine, pleasant, and even graceful.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 171)

William Blackwood & Sons. Edinburgh, Scotland. 1883

A thorough advocate in a just cause, a penetrating mathematician facing the starry heavens, both alike bear the semblance of divinity.

In JoAnne S. Growney

Are Mathematics and Poetry Fundamentally Similar?

*The American Mathematical Monthly*, Volume 99, Number 2, February, 1992 (p. 131)

The saying that no one who is unacquainted with, or a stranger to, geometry, should enter the school of the philosopher, does not mean that a man must be a mathematician in order to become a sage.

*Criticisms, Reflections, and Maxims of Goethe* (p. 207)

Walter Scott Publishing Company. London, England. 1897

**Walther, Hans**

No biographical data available

Take the mathematician away: He is a stupid augur, blind prophet, a crazy soothsayer. Man may know the present; only God can foresee the future.

In Jan Gullberg

*Mathematics: From the Birth of Numbers* (p. 17)

W.W. Norton & Company, Inc. New York, New York, USA. 1997

**Weaver, Jefferson Hane**

American science author

Whether this apparent inability [of mathematicians] to be affectionate with each other is the result of childhoods spent with parents who were distant and cold or due to the long-term effects of smoking pipes and wearing tweed jackets has never been scientifically investigated.

*Conquering Calculus: The Easy Road to Understanding Mathematics*

Chapter I (p. 11)

Plenum Press. New York, New York, USA. 1998

**Weierstrass, Karl** 1815–97

German mathematician

A mathematician who is not also something of a poet will never be a complete mathematician.

In Oswald Spengler

*The Decline of the West* (Volume 1)

Chapter II, Section iv (p. 62)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

**Weil, André** 1906–98

French mathematician

Rigor is to the mathematician what morality is to man. It does not consist in proving everything, but in maintaining a sharp distinction between what is assumed and what is proved, and in endeavoring to assume as little as possible at every stage.

Mathematical Teaching in Universities

*The American Mathematical Monthly*, Volume 61, Number 1, January, 1954 (p. 35)

But, if logic is the hygiene of the mathematician, it is not his source of food; the great problems furnish the daily bread on which he thrives.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May, 1950 (p. 297)

...the mathematician...believe[s] that he will be able to slake his thirst at the very sources of knowledge, convinced as he is that they will always continue to pour forth, pure and abundant, while others have to have recourse to the muddy streams of a sordid reality.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May, 1950 (p. 306)

...it [the mathematician] be asked why he persists on the high glaciers whither no one but his own kind can follow him, he will answer.... For the honor of the human spirit.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May, 1950 (p. 306)

We know that mathematicians are seldom influenced in their work by philosophical considerations, even when they profess to take them seriously; we know that they have their own way of dealing with foundational matters by an alternation between possibly reckless disregard and the most painful critical attention. Above all, we have learnt the difference between original thinking and the kind of routine reasoning which a mathematician often feels he has to spin out for the record in order to satisfy his peers, or perhaps only to satisfy himself.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

History of Mathematics (p. 210)

Mathematical Association of America. Washington, D.C. 2004

**Weinberg, Steven** 1933–  
American nuclear physicist

It is positively spooky how the physicist finds the mathematician has been there before him or her.  
Lectures on the Applicability of Mathematics  
*Notices of the American Mathematical Society*, October, 1986

**Weyl, Hermann** 1885–1955  
German mathematician

It cannot be denied, however, that in advancing to higher and more general theories the inapplicability of the simple laws of classical logic eventually results in an almost unbearable awkwardness. And the mathematician watches with pain the larger part of his towering edifice which he believed to be built of concrete dissolve into mist before his eyes.

*Philosophy of Mathematics and Natural Science*  
Part I, Chapter II (p. 54)  
Princeton University Press. Princeton, New Jersey, USA. 1949

**Whewell, William** 1794–1866  
English philosopher and historian

We pass with admiration along the great series of mathematicians, by whom the science of theoretical mechanics has been cultivated, from the time of Newton to our own. There is no group of men of science whose fame is higher or brighter. The great discoveries of Copernicus, Galileo, Newton, had fixed all eyes on those portions of human knowledge on which their successors employed their labours. The certainty belonging to this line of speculation seemed to elevate mathematicians above the students of other subjects; and the beauty of mathematical relations, and the subtlety of intellect which may be shown in dealing with them, were fitted to win unbounded applause. The successors of Newton and the Bernoullis, as Euler, Clairaut, D'Alembert, Lagrange, Laplace, not to introduce living names, have been some of the most remarkable men of talent which the world has seen.

*History of the Inductive Sciences from the Earliest to the Present Time*  
(Volume 2) (3rd edition)  
Book VI, Chapter VI (pp. 76–77)  
John W. Parker & Son. London, England. 1857

We may thus, with the greatest propriety, deny to the mechanical philosophers and mathematicians of recent times any authority with regard to their views of the administration of the universe; we have no reason whatever to expect from their speculations any help, when we attempt to ascend to the first cause and supreme ruler of the universe. But we might perhaps go further, and assert that they are in some respects less likely than men employed in other pursuits, to make any clear advance towards such a subject of speculation.

*Astronomy and General Physics*  
Chapter V (p. 251)  
Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

**White, William Frank**  
No biographical data available

Behind the artisan is the chemist, behind the chemist a physicist, behind the physicist a mathematician.  
*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*  
(p. 217)  
Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Wiener, Norbert** 1894–1964  
American mathematician

One of the chief duties of the mathematician in acting as an advisor to scientists...is to discourage them from expecting too much from mathematics.

In Douglas M. Campbell and John C. Higgins  
*Mathematics: People, Problems, Results* (Volume 3)  
In Richard A. de Millo, Richard J. Lipton and Alan J. Perlos  
Social Processes and Proofs of Theorems and Programs (p. 29)  
Wadsworth, Inc. Belmont, California, USA. 1984

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The mathematician is an inventor, not a discoverer.  
*Remarks on the Foundations of Mathematics*  
Appendix I, 167 (p. 47e)  
The MIT Press. Cambridge, Massachusetts, USA. 1967

**Zygmund, Antoni** 1900–92  
Polish-born American mathematician

Concentrate only on the achievements, and ignore the mistakes. When judging a mathematician you should only integrate  $f^+$  and ignore the negative part. Perhaps this should apply more generally to all evaluations of your fellow men.

*A Century of Mathematics in America* Volume 3  
The School of Antoni Zygmund (p. 348)  
American Mathematical Society. Providence, Rhode Island, USA. 1989

## MATHEMATICS

**Adams, Henry Brooks** 1838–1918  
American man of letters

In the one branch he most needed – mathematics – barring the few first scholars, failure was so nearly universal that no attempt at grading could have had value, and whether he stood fortieth or ninetieth must have been an accident or the personal favor of the professor. Here his education failed lamentably. At best he could never have been a mathematician; at worst he would never have cared to be one; but he needed to read mathematics, like any other universal language, and he never reached the alphabet.

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter IV (p. 60)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Adler, Alfred** 1870–1937  
Austrian psychiatrist

Mathematics, like chess, requires too direct and personal a confrontation to allow graceful defeat.

In Douglas M. Campbell and John C. Higgins (eds.) *Mathematics: People, Problems, Results* (Volume 2) Mathematics and Creativity (p. 3)  
Wadsworth, Inc. Belmont, California, USA. 1984

**Allen, Woody** 1935–  
American motion picture director and actor

Standard mathematics has recently been rendered obsolete by the discovery that for years we have been writing the numeral five backward. This has led to a reevaluation of counting as a method of getting from one to ten.

*Getting Even*  
Spring Bulletin (p. 58)  
Random House, Inc. New York, New York, USA. 1971

**Anglin, William S.**  
Canadian philosopher and mathematician

Mathematics is not a careful march down a well-cleared highway, but a journey into a strange wilderness, where the explorers often get lost. Rigor should be a signal to the historian that the maps have been made, and the real explorers have gone elsewhere.

Mathematics and History  
*The Mathematical Intelligencer*, Volume 14, Number 4, Fall, 1992 (p. 10)

**Arago, Francois** 1786–1853  
French physicist

The mathematics have been in all ages the implacable adversaries of scientific romances.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1874*  
Laplace (p. 156)  
Government Printing Office. Washington, D.C. 1875

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

...mathematics make the mind attentive to the objects which it considers. This they do by entertaining it with a great variety of truths, which are delightful and evident, but not obvious.

In Robert Chambers & Robert Carruthers  
*Cyclopaedia of English Literature* (Volume 3) (3rd edition)  
Usefulness of Mathematical Learning (p. 362)  
American Book Exchange. New York, New York, USA. 1879

The mathematics are the friends to religion, inasmuch as they charm the passions, restrain the impetuosity of the imagination, and purge the mind from error and prejudice. Vice is error, confusion and false reasoning; and all truth is more or less opposite to it. Besides, mathematical truth may serve for a pleasant entertainment for those hours

which young men are apt to throw away upon their vices; the delightfulness of them being such as to make solitude not only easy but desirable.

*An Essay on the Usefulness of Mathematical Learning*  
Printed at the Theater in Oxford. 1701

Mathematics makes the mind attentive to the objects which it considers. This they do by entertaining it with a great variety of truths, which are delightful and evident, but not obvious. Truth is the same thing to the understanding as music to the ear and beauty to the eye. The pursuit of it does really as much to gratify a natural faculty implanted in us by our wise Creator as the pleasing of our senses: only in the former case, as the object and faculty are more spiritual, the delight is more pure, free from regret, turpitude, lassitude, and intemperance, that commonly attend sensual pleasures.

*An Essay on the Usefulness of Mathematical Learning*  
Printed at the Theater in Oxford. 1701

**Aristo, Chian**  
No biographical data available

Those who occupy themselves with Mathematics to the neglect of Philosophy, are like the wooers of Penelope, who, unable to attain the mistress, content themselves with the maids.

*Edinburgh Review*, Volume 52, January, 1836 (p. 229)

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

There are things which seem incredible to most men who have not studied mathematics.

In Stanley Gudder  
*A Mathematical Journey* (p. 358)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Asimov, Isaac** 1920–92  
American author and biochemist

I'm saying suppose. In mathematics, we say "suppose" all the time and see if we can end up with something patently untrue or self-contradictory...

*Prelude to Foundation*  
48 (p. 206)  
Doubleday. New York, New York, USA. 1988

**Asquith, Margot** 1864–1945  
Anglo-Scottish socialite, author, and wit

Although I am not stupid, the mathematical side of my brain is like dumb notes upon a damaged piano.

*More or Less About Myself* (p. 290)  
E.P. Dutton. New York, New York, USA. 1934

**Atkins, Peter William** 1940–  
English physical chemist and writer

Buttercups do not think, yet they are also built of mathematics.

*Creation Revisited: The Origin of Space, Time and the Universe*  
Chapter Five (p. 119)  
W. H. Freeman & Company, Oxford, England. 1992

### Author undetermined

Here's to mathematics, may it never be of use to anyone.

Old Cambridge toast

COGDELL, GA – The Cogdell School Board banned the teaching of the controversial “Theory Of Math” in its schools Monday. “We are simply not confident of this mysterious process by which numbers turn, as if by magic, into other numbers,” board member Gus Reese said. “Those mathematicians are free to believe 3 times 4 equals 12, but that dun [sic] give them the right to force it on our children.” Under the new ruling, all math textbooks will carry a disclaimer noting that math is only one of many valid theories of number-manipulation.

*The Onion Ad Nauseam: Complete News Archives* (p. 255)  
Three Rivers Press. New York, New York, USA. 2003

### Bacon, Roger 1214–92

English philosopher, scientist, and friar

There are four great sciences.... Of these sciences the gate and key is mathematics, which the saints discovered at the beginning of the world...

Translated by Robert Belle Burke

*The Opus Majus of Roger Bacon*

Part 4, Chapter. 1 (p. 116)

Oxford University Press, Inc. London, England. 1928

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

For it being the nature of the mind of man (to the extreme prejudice of knowledge) to delight in the spacious liberty of generalities, as in a champaign region, and not in the enclosures of particularity, the mathematics of all other knowledge were the goodliest fields to satisfy that appetite.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VIII, Section 1 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

For many parts of nature can neither be invented with sufficient subtlety nor demonstrated with sufficient perspicuity nor accommodated unto use with sufficient dexterity, without the aid and intervening of the mathematics: of which sort are perspective, music, astronomy, cosmography, architecture, enginery, and divers others.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VIII, Section 2 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The mathematic is either pure or mixed: To pure mathematic belong those sciences which handle quantity entirely severed from matter and from axioms of natural philosophy; these are two, geometry and arithmetic; the one handling quantity continued, the other dissevered.... Mixed Mathematic has for its subject some axioms and parts of natural philosophy, and considers quantity in so far as it assists to explain, demonstrate and actuate these.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter VIII, Section 2 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In mathematics I can report no deficiency, except it be that men do not sufficiently understand the excellent use of the pure mathematics.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Book II, Chapter VIII, Section 2 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...as for the mixed mathematics, I may only make this prediction, that there cannot fail to be more kinds of them, as nature grows farther disclosed.

*The Works of Francis Bacon* (Volume 1)

*Of the Advancement of Learning*

Book II (p. 108)

Printed for W. Baynes & Son

London, England. 1824

Mathematic is either Pure or Mixed. To Pure Mathematic belong those sciences which handle Quantity entirely severed from matter and from axioms of natural philosophy. These are two, Geometry and Arithmetic ; the one handling quantity continued, and the other dissevered.... Mixed Mathematic has for its subject some axioms and parts of natural philosophy, and considers quantity in so far as it assists to explain, demonstrate, and actuate these.

In James Spedding, Robert L. Ellis and Douglas Heath (eds.)

*Works* (Volume 8)

*Advancement of Learning*

Book 2 (p. 519)

Taggard & Thompson. Boston, Massachusetts, USA. 1864

So if a man's wit be wandering, let him study the mathematics; for in demonstrations, if his wit be called away [ever] so little, he must begin again.

*Bacon's Essays*

Of Studies (p. 211)

Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

Histories make men wise; poets, witty; the mathematics, subtle; natural philosophy, deep; moral, grave; logic and rhetoric, able to contend.

*Essays*

Of Studies (p. 74)

Longmans, Green & Co. London, England. 1899.



**Bain, Alexander** 1818–1903  
Scottish philosopher and psychologist

Those that can readily master the difficulties of Mathematics find a considerable charm in the study, sometimes amounting to fascination. This is far from universal; but the subject contains elements of strong interest of a kind that constitutes the pleasures of knowledge. The marvelous devices for solving problems elate the mind with the feeling of intellectual power; and the innumerable constructions of the science leave us lost in wonder.

*Education as a Science*

Chapter 5 (p. 153)

C. Kegan Paul & Company. London, England. 1879

**Barbeyac, Jean** 1674–1744  
French jurist

Never was there seen aught more wretched; and we might be surprised that a *mathematician could reason so ill*, had we not other, and far more illustrious examples, which clearly evince, that the *study of the mathematics does not always render the mind more correct in relation to subjects beyond the sphere of the sciences*.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 291)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Barrow, Isaac** 1630–77  
English clergyman and mathematician

Mathematics – the unshaken Foundation of Sciences, and the plentiful Fountain of Advantage to human affairs.

In Carl B. Boyer

*A History of Mathematics* (p. 404)

John Wiley & Sons, Inc. New York, New York, USA. 1968

**Baum, Lyman Frank.** 1856–919  
American author

...it's merely a question of mathematics. I've seen the professor work lots of sums on the blackboard, and he claimed anything could be done with x's and y's and a's, and such things, by mixing them up with plenty of pluses and minuses and equals, and so forth.

*The Marvelous Land of Oz*

Chapter 19 (p. 224)

The Reilly & Britton Co. Chicago, Illinois, USA. 1904

...Your mathematics seem to me very like a bottle of mixed pickles the more you fish for what you want the less chance you have of getting it.

*The Marvelous Land of Oz*

Chapter 19

The Reilly & Britton Co. Chicago, Illinois, USA. 1904

**Beebe, William** 1877–1962  
American ornithologist

Having an I.Q. in mathematics lower than would be thought possible in any human being alive, my mind is always excited at any simple kindergarten problems.

*High Jungle*

Chapter X (p. 164)

Duell, Sloan & Pearce. New York, New York, USA. 1949

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Even stranger things have happened; and perhaps the strangest of all is the marvel that mathematics should be possible to a race akin to the apes.

*The Development of Mathematics*

Uncertainties and Probabilities (p. 546)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

Just as “beauty is its own excuse for being,” so mathematics needs no apology for existing.

*The Queen of the Sciences*

Chapter VI (p. 82)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

It is customary to call mathematics a science and to place it first in the classification of the sciences. So long as we remember the radical difference between mathematics and the physical or biologic sciences no harm is done in calling mathematics a science. Something of the distinction between the mathematical method and the strictly scientific must be seen before attempting to uncover the mystery of mathematical prophecy in scientific discovery. The matter is extremely simple but none the less profound.

*The Handmaiden of the Sciences*

Chapter 1 (p. 5)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

The longer mathematics lives the more abstract – and therefore, possibly also the more practical – it becomes.

*Men of Mathematics* (p. 525)

Simon & Schuster. New York, New York, USA. 1986

The task of cleaning up mathematics and salvaging whatever can be saved from the wreckage of the past twenty years will probably be enough to occupy one generation.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

...we shall leave to the antiquarians the difficult and delicate task of restoring the roses to the cheeks of mathematical mummies.

*The Development of Mathematics*

To Any Prospective Reader (p. v)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

“Obvious” is the most dangerous word in mathematics.

*Mathematics: Queen and Servant of Science*

Points of View (p. 16)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Mathematics by itself has seldom got very far in the exploration of nature, as is attested by the numerous

attempts of pure mathematicians of the past and present to resolve the universe with pencil and paper.

*Mathematics: Queen and Servant of Science*

A Metrical Universe (p. 211)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

“If it is not abstract it is not mathematics” might be taken as a touchstone for discriminating between mathematics and other departments of precise investigation.

*Mathematics: Queen and Servant of Science*

Abstraction and Prediction (p. 259)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

For my own part I have swallowed mathematics enough in my life to be immune to just one more dose, and I shall continue to get smallpox vaccinations whenever I contemplate a vacation in any of the filthier parts of the North American continent.

*Mathematics: Queen and Servant of Science*

Choice and Chance (p. 381)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Mathematics has a light and wisdom of its own, above any possible applications to science, and it will richly reward any intelligent human being to catch a glimpse of what mathematics means to itself. This is not the old doctrine of art for art’s sake; it is art for humanity’s sake.

In Stanley Gudder

*A Mathematical Journey* (p. 107)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

If a lunatic scribbles a jumble of mathematical symbols it does not follow that the writing means anything merely because to the inexpert eye it is indistinguishable from higher mathematics.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 1)

The Prince of Mathematics (p. 308)

Simon & Schuster. New York, New York, USA. 1956

**Berlinski, David** 1942–

American mathematician

...there is no explaining mathematics without from time to time using mathematics, and the mathematician’s symbolism, which to an outsider looks as inviting as Chinese ...

*A Tour of the Calculus*

A Note to the Reader (p. xv)

Pantheon Books. New York, New York, USA. 1995

**Bers, Lipman** 1914–93

Mathematician

Mathematics develops, somehow, by its own inner laws.

In Donald J. Albers and Constance Reid

An Interview with Lipman Bers

*The College Mathematics Journal*, Volume 18, September, 1987 (p. 288)

I alternate between two attitudes [about attempts to communicate the beauty of mathematics to a wide audience].

Mondays, Wednesdays and Fridays I believe it can be done if we do it properly; Tuesdays, Thursdays and Saturdays I believe it cannot.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations*

Lipman Bers (p. 15)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Berthelot, Marcellin (or Marcelin) Pierre**

**Eugène** 1827–1907

French chemist and politician

Mathematics gives the young man a clear idea of demonstration and accustoms him to form long trains of thought and reasoning methodically connected and sustained by the final certainty of the result; and it has the further advantage, from a purely moral point of view, of inspiring an absolute and fanatical respect for truth.

Science as an Instrument of Education

*Popular Science Monthly*, Volume 51 1897 (p. 253)

**Bishop, Errett** 1928–83

American mathematician

Mathematics belongs to man, not to God. We are not interested in properties of the positive integers that have no descriptive meaning for finite man. When a man proves a positive integer to exist, he should show how to find it. If God has mathematics of his own that need to be done, let him do it himself.

*Foundations of Constructive Analysis*

Chapter 1 (p. 2)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Bloor, David**

No biographical data available

...mathematics like morality is designed to meet the requirements of men, who hold a great deal in common in their physiology and in their physical environment.

*Knowledge and Social Imagery*

Chapter Six (p. 109)

The University of Chicago Press. Chicago, Illinois, USA. 1991

**Boas, Jr., Ralph P.** 1913–92

Mathematician

Some years ago, after I had given a talk, somebody said, “You seem to make mathematics sound like so much fun.” I was inspired to reply, “If it isn’t fun, why do it?” I am proud of the sentiment, even if it is overstated.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 41)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Bôcher, Maxime** 1867–1918

American mathematician

I like to look at mathematics almost more as an art than as a science; for the activity of the mathematician,

constantly creating as he is, guided though not controlled by the external world of senses, bears a resemblance, not fanciful I believe but real, to the activities of an artist, of a painter let us say. Rigorous deductive reasoning on the part of the mathematician may be likened here to technical skill in drawing on the part of the painter. Just as no one can become a good painter without a certain amount of this skill, so no one can become a mathematician without the power to reason accurately up to a certain point. Yet these qualities, fundamental though they are, do not make a painter or mathematician worthy of the name, nor indeed are they the most important factors in the case. Other qualities of a far more subtle sort, chief among which in both cases is imagination, go to the making of a good artist or of a good mathematician.

The Fundamental Conceptions and Methods in Mathematics  
*Bulletin of the American Mathematical Society*, 2nd Series, Volume 11, 1904 (p. 133)

If we have a certain class of objects and a certain class of relations and if the only questions which we investigate are whether ordered groups of these objects do or do not satisfy the relations, the results of the investigations are called mathematics.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
(Volume 1)

The Fundamental Conceptions and Methods of Mathematics (p. 466)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1905

### **Bochner, Salomon** 1899–1982

Galician-born American mathematician

Ours is an age in which scientists are Wise Men, and the root of this Wisdom is in Mathematics.

*The Role of Mathematics in the Rise of Science*

Preface (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1966

What indeed is mathematics? This question, if asked in earnest, has no answer, not a satisfactory one; only part answers and observations can be attempted.

*The Role of Mathematics in the Rise of Science*

Chapter I (p. 13)

Princeton University Press. Princeton, New Jersey, USA. 1966

The word “mathematics” is a Greek word, and, by origin, it means “something that has been learned or understood,” or perhaps “acquired knowledge,” and perhaps even, somewhat against grammar, “acquirable knowledge,” that is, “learnable knowledge,” that is, “knowledge acquirable by learning.”

*The Role of Mathematics in the Rise of Science*

Chapter I (pp. 24–25)

Princeton University Press. Princeton, New Jersey, USA. 1966

If science is viewed as an industrial establishment, then mathematics is an associated power plant which feeds a certain kind of indispensable energy into the establishment.

Why Mathematic Grows

*Journal of the History of Ideas*, Volume 26, Number 1, 1965 (p. 18)

### **Bossut, Charles** 1730–1814

French mathematician

The term mathematics, implying from its etymology discipline, science, represents with justice and precision the high idea that we ought to form of what is signified by it. In fact mathematics are a methodical concatenation of principles, reasonings, and conclusions, always accompanied by certainty as their truth is always evident: an advantage that particularly characterises accurate knowledge, and the true sciences, with which we must be careful not to associate metaphysical notions, conjectures, or even the strongest probabilities.

*A General History of Mathematics from the Earliest Times to the Middle of the Eighteenth Century*

Introduction (p. 1)

Printed for J. Johnson. London, England. 1803

### **Boutroux, Émile** 1845–1921

French philosopher

Science is reduction. Mathematics is its ideal, its form par excellence, for it is in mathematics that assimilation, identification, is most perfectly realized. The universe, scientifically explained, would be a certain formula, one and eternal, regarded as the equivalent of the entire diversity and movement of things.

Translated by Fred Roth Well

*Natural law in Science and Philosophy*

Preface (p. 5)

The Macmillan Co. New York, New York, USA. 1914

### **Boyle, Robert** 1627–91

English natural philosopher and theological writer

Mathematicks may help the naturalist, both to frame hypotheses, and to judge of those that are proposed to them, especially such as relate to mathematical subjects in conjunction with others.

In William Thompson Sedgwick and H.W. Tyler

*A Short History of Science* (p. 335)

The Macmillan Company. New York, New York, USA. 1917

### **Bragdon, Claude Fayette** 1866–1945

American architect, writer, and stage designer

The modern mind has adventured far and fearlessly in the new realms of thought opened up by research and discovery, but it has left no trail of beauty. That it has not done so is the fault of the artist, who has failed to interpret and portray the movement of the modern mind.... The new beauty, which corresponds to the new knowledge, is the beauty of principles...the world order. The world order is most perfectly embodied in mathematics.

In Stanley Gudder

*A Mathematical Journey* (p. 94)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Bridges, Robert Seymour** 1844–1930

English poet

...and see how Mathematick rideth as a queen, cheer'd on her royal progress thru' out nature's realm.

*The Testament of Beauty*

Book IV, l. 856–7

Oxford University Press, Inc. Oxford, England. 1930

**Bridgman, Percy Williams** 1882–1961

American physicist

As at present constructed, mathematics reminds one of the loquacious and not always coherent orator, who was said to be able to set his mouth going and go off and leave it.

*The Logic of Modern Physics*

Chapter II (p. 63)

The Macmillan Company. New York, New York, USA. 1927

**Browne, Sir Thomas** 1605–82

English author and physician

...indeed what reason may not go to School to the wisdom of Bees, Ants, and Spiders? What wise hand teacheth them to do what reason cannot teach us? Ruder heads stand amazed at those prodigious pieces of Nature, Whales, Elephants, Dromedaries and Camels; these, I confess, are the Colossus and Majestick pieces of her hand: but in these narrow Engines there is more curious Mathematicks; and the civility of these little Citizens, more neatly sets forth the Wisdom of their Maker.

In Charles Sayle

*The Works of Sir Thomas Browne* (Volume 1)*Religio Medici*

Section 12 (p. 24)

Grant Richards. London, England. 1904

**Buchanan, Scott** 1895–1968

American educator and philosopher

Mathematics is not a compendium or memorizable formula and magically manipulated figures.

*Poetry and Mathematics*

Chapter I (p. 35)

The University of Chicago Press. Cambridge, England. 1975

Mathematics suffers much, but most of all from its teachers.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas Today* 1974*Poetry and Mathematics* (p. 415)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1975

The structures with which mathematics deals are more like lace, the leaves of trees, and the play of light and shadow on a human face, than they are like buildings and machines, the least of their representatives. The best proofs in mathematics are short and crisp like epigrams, and the longest have swings and rhythms that are like music. The structures of mathematics and the propositions about them are ways for the imagination to travel

and the wings, or legs, or vehicles to take you where you want to go.

*Poetry and Mathematics*

Chapter I (p. 36)

The University of Chicago Press. Chicago, Illinois, USA. 1975

Mathematics...becomes the ladder by which we all may climb into the heavens of perfect insight and eternal satisfaction, and the solution of arithmetic and algebraic problems is connected with and the salvation of our souls.

*Poetry and Mathematics*

Chapter I (p. 37)

The University of Chicago Press. Cambridge, England. 1975

The prestige of the engineer is another accretion to the tradition of mathematics. This more than any other one thing accounts for our present mathematical complex. The engineer is fast taking the position of authority, superseding the priest, the scholar, and the statesman in our organized thought and action.

*Poetry and Mathematics*

Chapter I (pp. 37–38)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Bullock, James O.**

Theoretical cosmologist

Mathematics is not a way of hanging numbers on things so that quantitative answers to ordinary questions can be obtained. It is a language that allows one to think about extraordinary questions.

Literacy in the Language of Mathematics

*The American Mathematical Monthly*, Volume 101, Number 8, October, 1994 (p. 737)**Burger, Edward B.**

American mathematician

**Starbird, Michael**

American mathematician

Mathematics is not constrained by mundane reality. It can build castles in the air and concepts in the mind whose beauty, magnificence, and intrigue are as boundless as the ideas themselves.

*Coincidences, Chaos, and All That Math Jazz*

Part IV (p. 199)

W.W. Norton &amp; Co. New York, New York, USA. 2005

Mathematics and our imaginations have no bounds, no ends, no finish line. Every horizon reached opens new horizons more glorious still.

*Coincidences, Chaos, and All That Math Jazz*

Closing Thoughts (p. 267)

W.W. Norton &amp; Co. New York, New York, USA. 2005

**Burton, Leone** 1936–

Mathematics professor

Three shifts can be detected over time in the understanding of mathematics itself. One is a shift from completeness to

incompleteness, another from certainty to conjecture, and a third from absolutism to relativity.

Femmes et Mathematiques: Y a-t-il une?

*Association for Women in Mathematics Newsletter*, Intersection 18 (November–December, 1988)

**Butler, Nicholas Murray** 1862–1947

American educator and university administrator

Modern mathematics, that most astounding of intellectual creations, has projected the mind's eye through infinite time and the mind's hand into boundless space.

*The Meaning of Education and Other Essays and Addresses*

What Knowledge Is of Most Worth? (p. 44)

The Macmillan Company. London, England. 1898

**Cajori, Florian** 1859–1930

Swiss-born American educator and mathematician

One of the most baneful delusions by which the minds, not only of students, but even of many teachers of mathematics in our classical colleges, have been afflicted is that mathematics can be mastered by the favored few, but lies beyond the grasp and power of the ordinary mind.

*The Teaching and History of Mathematics in the United States*

Chapter III (p. 100)

Government Printing Office. Washington, D.C. 1890

**Carmichael, Robert Daniel** 1879–1967

American mathematician

Mathematics, by exhibiting a body of truth which can live through millenniums without needed connections, and at the same time can grow in magnitude and range and interest, has given the human spirit new ground for believing in itself and for rejoicing in its power of consistent thought.

*The Logic of Discovery*

Chapter IX (pp. 263–264)

The Open Court Publishing. Chicago, Illinois, USA. 1930

**Carus, Paul** 1852–1919

American philosopher

There is no science which teaches the harmonies of nature more clearly than mathematics...

In William Symes Andrews

*Magic Squares and Cubes*

Introduction

The Open Court Publishing Company. Chicago, Illinois, USA. 1908

There is no prophet that preaches the super personal God more plainly than mathematics.

The God Problem

*The Monist*, Volume XVI, Number 1, January, 1906 (p. 147)

**Cassiodorus** ca. 485–585

Roman statesman and author

It is given to us to live for the most part under the guidance of mathematics.... It is impossible to distinguish from other living creatures anyone who does not understand how to quantify.

In David Ewing Duncan

*The Calendar*

Fourth Estate. London, England. 1998

**Casson, Stanley**

No biographical data available

The nearer man approaches mathematics the farther away he moves from the animals.

*Progress and Catastrophe: An Anatomy of Human Adventure*

Chapter VI (p. 93)

Harper & Brothers. New York, New York, USA. 1937

**Cayley, Arthur** 1821–95

English mathematician

Mathematics connect themselves on the one side with common life and the physical sciences; on the other side with philosophy, in regard to our notions of space and time, and in the questions which have arisen as to the universality and necessity of the truths of mathematics, and the foundation of our knowledge of them.

*The Collected Mathematical Papers of Arthur Cayley*

Presidential Address to the British Association, Southport, September, 1883 (p. 430)

At The University Press. Cambridge, England. 1896

**Chan, Tony**

Author, educator, filmmaker, and journalist

Math never gets into the story.... Everyone else gets the credit.

Math Whizzes Want Respect in Equation

*Los Angeles Times*, July 14, 1998 (p. 1)

**Chapman, C. H.**

No biographical data available

There is probably no other science which presents such different appearances to one who cultivates it and one who does not, as mathematics. To [the noncultivator] it is ancient, venerable, and complete; a body of dry, irrefutable, unambiguous reasoning. To the mathematician, on the other hand, his science is yet in the purple of bloom of vigorous youth, everywhere stretching out after the "attainable but unattained," and full of the excitement of nascent thoughts; its logic is beset with ambiguities, and its analytic processes, like Bunyan's road, have a quagmire on one side and a deep ditch on the other, and branch off into innumerable by-paths that end in a wilderness.

*Bulletin of the New York Mathematical Society*, 1892 (p. 61)

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

...the common idea [is] that mathematics is a dull subject whereas the testimony of all those who have any dealings with it shows that it is one of the most thrilling and tantalising and enchanting subjects in the world.

*Lunacy and Letters*

A Defense of Bores (pp. 58–59)

Sneed & Ward, Inc. New York, New York, USA. 1958

**Chrystal, George** 1851–1911

Mathematician and academic

Any conception which is definitely and completely determined by means of a finite number of specifications, say by assigning a finite number of elements, is a mathematical conception. Mathematics has for its function to develop the consequences involved in the definition of a group of mathematical conceptions. Interdependence and mutual logical consistency among the members of the group are postulated, otherwise the group would either have to be treated as several distinct groups, or would lie beyond the sphere of mathematics.

*Encyclopædia Britannica* (9th edition)

Mathematics

Adam &amp; Charles Black. Edinburgh, Scotland. 1879

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

I had a feeling once about Mathematics – that I saw it all. Depth beyond Depth was revealed to me – the Byss and the Abyss. I saw – as one might see the transit of Venus or even the Lord Mayor’s Show – a quantity passing through infinity and changing its sign from plus to minus. I saw exactly why it happened and the tergiversation was inevitable – but it was after dinner and I let it go.

In Clifton Fadiman

*The Mathematical Magpie* (p. 255)

Simon &amp; Schuster. New York, New York, USA. 1962

**Clawson, Calvin C.**

No biographical data available

Frequently, when studying mathematics, one slips into another world, a world of exquisite beauty and truth. This traveling to another plane of mental existence can be so addicting that the practitioner is lost...to ordinary, daily stimulus.

*Mathematical Mysteries: The Beauty and Magic of Numbers*

Introduction (p. 4)

Perseus Books. Cambridge, Massachusetts, USA. 1996

The single most compelling reason to explore the world of mathematics is that it is beautiful, and pondering its intriguing ideas is great fun.

*Mathematical Mysteries: The Beauty and Magic of Numbers***Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Some people have contended that mathematics ought to be taught by making illustrations obvious to the senses. Nothing can be more absurd or injurious: It ought to be our never-ceasing effort to make people think, not feel.

*Lectures and Notes on Shakespeare and Other English Poets*

Lecture II (p. 52)

G. Bell &amp; Sons. London, England. 1907

I have often been surprised that Mathematics, the quintessence of Truth, should have found admirers so few and

so languid. Frequent consideration and minute scrutiny have at length unravelled the cause; viz. that though Reason is feasted, Imagination is starved; whilst Reason is luxuriating in its proper Paradise, Imagination is wearily travelling on a dreary desert.

*The Poetical and Dramatic Works of Samuel Taylor Coleridge*

A Mathematical Poem (p. 22)

Basil Montagu Pickering. London, England. 1877

**Coleridge, Stephen** 1854–1936

English author, barrister, and opponent of vivisection

The binomial theorem, trigonometry, conic sections, and all the rest of the higher mathematics are fields of knowledge that can be acquired with dreary labour by anyone who persistently applies his mind to them.

*The Idolatry of Science*

Chapter IV (pp. 19–20)

John Lane Co. London, England. 1920

**Comte, Auguste** 1798–1857

French philosopher

Mathematics will always necessarily be the last link in the chain of the sciences ...

Translated by Richard Congreve

*The Catechism of Positive Religion*

Second Part, Chapter VI (p. 190)

John Chapman. London, England. 1858

...it is only through Mathematics that we can thoroughly understand what true science is. Here alone can we find in the highest degree simplicity and severity of scientific law, and such abstraction as the human mind can attain.

Translated by Harriet Martineau

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (p. 41)

George Bell &amp; Sons. London, England. 1896

The business of concrete mathematics is to discover the equations which express the mathematical laws of the phenomenon under consideration; and these equations are the starting-point of the calculus, which must obtain from them certain quantities by means of others.

Translated by Harriet Martineau

*Positive Philosophy*

Book I, Chapter II (p. 61)

Calvin Blanchard. New York, New York, USA. 1851

Geometrical and Mechanical phenomena are the most general, the most simple, the most abstract of all – the most irreducible to others, the most independent of them; serving, in fact, as a basis to all others. It follows that the study of them is an indispensable preliminary to that of all others. Therefore must Mathematics hold the first place in the hierarchy of the sciences, and be the point of departure of all Education, whether general or special.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Introduction, Chapter II (p. 33)

John Chapman. London, England. 1853



In mathematics we find the primitive source of rationality; and to mathematics must the biologists resort for means to carry on their researches.

*The Positive Philosophy of Auguste Comte* (Volume 1)  
Book 5, Chapter 1, To Mathematics (p. 321)  
John Chapman. London, England. 1853

In the present state of our knowledge we must regard Mathematics less as a constituent part of natural philosophy than as having been, since the time of Descartes and Newton, the true basis of the whole natural philosophy; though it is, exactly speaking, both the one and the other. To us it is of less value for the knowledge of which it consists, substantial and valuable as that knowledge is, than as being the most powerful instrument that the human mind can employ in the investigation of the laws of natural phenomena.

*The Positive Philosophy of Auguste Comte* (Volume 1)  
Introduction, Chapter II (p. 32)  
John Chapman. London, England. 1853

### **Conant, James Bryant** 1893–1978

American educator and scientist

Mathematics and measurement are not to be unduly worshipped, nor can they be neglected by even the lay observer.

*Science and Common Sense*  
Chapter Six (p. 163)  
Yale University Press. New Haven, Connecticut, USA. 1951

### **Cooley, Hollis R.**

No biographical data available

Because mathematics has left its imprint upon so many aspects of present day civilization, its position in the modern world is a fundamental one, and a knowledge of mathematics is essential for a comprehensive understanding of current life and thought.

*Introduction to Mathematics* (p. 615)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1968

### **Cooper, J. L. B.**

No biographical data available

Everybody knows some mathematics, yet few persons have an idea of what the subject is about, even in the imprecise way in which they know that physics is about matter or zoology about animals.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1961)  
The Main Line of Mathematics (p. 323)  
Government Printing Office. Washington, D.C. 1962

### **Copernicus, Nicolaus** 1473–1543

Polish astronomer

But if perchance there are certain “idle talkers” who take it upon themselves to pronounce judgment although

wholly ignorant of mathematics, and if by shamelessly distorting the sense of some passage in Holy Writ to suit their purpose, they dare to reprehend and to attack my work; they worry me so little that I shall even scorn their judgments as foolhardy.

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Preface and Dedication to Pope Paul, III (p. 503)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...if the worth of the arts were measured by the matter with which they deal, this art – which some call astronomy, others astrology, and many of the ancients the consummation of mathematics – would be by far the most outstanding. This art which is as it were the head of all the liberal arts and the one most worthy of a free man leans upon nearly all the other branches of mathematics. Arithmetic, geometry, optics, geodesy, mechanics, and whatever others, all offer themselves in its service.

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Book One, Introductory (p. 510)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Courant, Richard** 1888–1972

German-born American mathematician

The interplay between generality and individuality, deduction and construction, logic and imagination – this is the profound essence of live mathematics. Anyone or another of these aspects of mathematics can be found at the center of a given achievement. In a far reaching development all of them will be involved. Generally speaking, such a development will start from the “concrete,” then discard ballast by abstraction and rise to the lofty layers of thin air where navigation and observation are easy: after this flight comes the crucial test for learning and reaching specific goals in the newly surveyed low plains of individual “reality.” In brief, the flight into abstract generality must start from and return again to the concrete and specific.

Mathematics in the Modern World  
*Scientific American*, Volume 211, Number 3, September, 1964 (p. 43)

The question “What is mathematics?” cannot be answered meaningfully by philosophical generalities, semantic definitions or journalistic circumlocutions. Such characterizations also fail to do justice to music or painting. No one can form an appreciation of these arts without some experience with rhythm, harmony and structure, or with form, color and composition. For the appreciation of mathematics actual contact with its substance is even more necessary.

Mathematics in the Modern World  
*Scientific American*, Volume 211, Number 3, September, 1964 (p. 42)

Mathematics must take its motivation from concrete specific substance and aim again at some layer of “reality.”

The flight into abstraction must be something more than a mere escape; start from the ground and reentry are both indispensable, even if the same pilot cannot handle all phases of the trajectory.

Quoted in Stanley Gudder

*A Mathematical Journey* (p. 201)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Courant, Richard** 1888–1972

German-born American mathematician

**Robbins, Herbert** 1915–2001

American mathematician

For scholars and layman alike it is not philosophy but active experience in mathematics itself that alone can answer the question: What is mathematics?

*What Is Mathematics?* (p. xix)

Oxford University Press, Inc. London, England. 1941

Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality. Though different traditions may emphasize different aspects, it is only the interplay of these antithetic forces and the struggle for their synthesis that constitute the life, usefulness, and supreme value of mathematical science.

*What Is Mathematics?* (p. xv)

Oxford University Press, Inc. London, England. 1941

**Coxeter, H. S. M.** 1907–2003

Geometer and author

In our times, geometers are still exploring those new Wonder-lands, partly for the sake of their applications to cosmology and other branches of science but much more for the sheer joy of passing through the looking glass into a land where the familiar lines, planes, triangles, circles, and spheres are seen to behave in strange but precisely determined ways.

*Non-Euclidean Geometry*

Committee on the Support of Research in the Mathematical Sciences,

The Mathematical Sciences (p. 58)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Crichton, Michael** 1942–

American novelist

The mathematics of uncontrolled growth are frightening. A single cell of the bacterium *E. coli* would, under ideal circumstances, divide every twenty minutes. That is not particularly disturbing until you think about it, but the fact is that bacteria multiply geometrically: one becomes two, two becomes four, four becomes eight, and so on.

In this way, it can be shown that in a single day, one cell of *E. coli* could produce a super-colony equal in size and weight to the entire planet earth.

*The Andromeda Strain*

Day 4 – Spread (p. 247)

Alfred A. Knopf. New York, New York, USA. 1969

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Mathematics cares neither for science nor for engineering (except as a source of problems) but only about the relationship between abstract entities.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 14 (p. 160)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Cromwell, Oliver** 1599–58

English soldier and statesman

I would have my son mind and understand business, read little history, study the mathematics and cosmography; these are good, with subordination to the things of God.... These fit for public services for which man is born.

*Letters and Speeches of Oliver Cromwell* (Volume 1) (p. 371)

Methuen & Company Ltd. London, England. 1904

**Cundy, H. Martyn**

No biographical data available

**Rollett, A. P.**

No biographical data available

Mathematics is often regarded as the bread and butter of science. If the butter is omitted, the result is indigestion, loss of appetite, or both.

*Mathematical Models*

Chapter 1 (p. 13)

Oxford University Press. Oxford, England. 1961

**D'Alembert, Jean Le Rond** 1717–83

French mathematician

We shall content ourselves with the remark that if mathematics (as is asserted with sufficient reason) only make straight the minds which are without bias, so they only dry up and chill the minds already prepared for this operation by nature.

*Edinburgh Review*, Volume 52, January, 1836 (p. 224)

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

There is no certainty [in science] where one of the mathematical sciences cannot be applied, or in those [sciences] which are not in harmony with mathematics. Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 142)

The Merrymount Press. Boston, Massachusetts, USA. 1906

He who blames the supreme certainty of mathematics feeds on confusion and will never be able to solve the contradiction of sophistical sciences which lead to an everlasting clamour.

Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 142)

The Merrymount Press. Boston, Massachusetts, USA. 1906

Therefore, O students, study mathematics, and do not build without foundations.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 82)

George Braziller. New York, New York, USA. 1958

**Dantzig, Tobias** 1884–1956

Russian mathematician

Mathematics is not only the model along the lines of which the exact sciences are striving to design their structure; mathematics is the cement which holds the structure together.

*Number: The Language of Science* (4th edition)

Chapter Four, 1 (p. 57)

The Macmillan Company. New York, New York, USA. 1954

Banish the infinite process, and mathematics pure and applied is reduced to the state in which it was known to the pre-Pythagoreans.

*Number: The Language of Science* (4th edition)

Chapter Seven, 15 (p. 137)

The Macmillan Company. New York, New York, USA. 1954

...the progress of mathematics has been most erratic, and that intuition has played a predominant role in it. Distant outposts were acquired before the intermediate territory had been explored, often even before the explorers were aware that there was an intermediate territory. It was the function of intuition to create new forms; it was the acknowledged right of logic to accept or reject these forms, *in whose birth it had no part*.

*Number: The Language of Science*

Chapter Nine (p. 180)

Macmillan & Co Ltd. New York, New York, USA. 1954

How then shall mathematical concepts be judged? *They shall not be judged!* Mathematics is the supreme judge; from its decisions there is no appeal.

*Number: The Language of Science* (4th edition)

Chapter Four, 1 (p. 45)

The Macmillan Company. New York, New York, USA. 1954

**Darrow, Karl Kelchner** 1891–1982

American physicist

Mathematics is not a complete and perfected body of doctrine which one goes to seek in the scriptures whenever one has need of it.

*The Renaissance of Physics*

Chapter I (p. 11)

The Macmillan Co. New York, New York, USA. 1936

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

The belief that the underlying order of the world can be expressed in mathematical form lies at the very heart of science. So deep does this belief run that a branch of science is considered not to be properly understood until it can be cast in mathematics.

*The Mind of God: The Scientific Basis for a Rational World*

Chapter 6 (p. 140)

Simon & Schuster. New York, New York, USA. 1992

**Davis, E. W.**

American mathematician

It seems to me that no one science can so well serve to co-ordinate and, as it were, bind together all of the sciences as the queen of them all, mathematics.

*Publications of the Nebraska State Historical Society*, Volume 7

1898 (p. 282)

**Davis, Philip J.** 1923–

American mathematician

One of the endlessly alluring aspects of mathematics is that its thorniest paradoxes have a way of blooming into beautiful theories.

Numbers

*Scientific American*, Volume 211, Number 3, September, 1964 (p. 55)

**Davis, Philip J.** 1923–

American mathematician

**Hersh, Reuben** 1927–

American mathematician

It seems certain that there is a limit to the amount of living mathematics that humanity can sustain at any time. As new mathematical specialties arise, old ones will have to be neglected.

*The Mathematical Experience*

How Much Mathematics Can There Be? (p. 25)

Birkhäuser. Boston, Massachusetts, USA. 1981

In the realm of ideas, of mental objects, those ideas whose properties are reproducible are called mathematical objects, and the study of mental objects with reproducible properties is called mathematics.

*The Mathematical Experience*

Intuition (p. 399)

Birkhäuser. Boston, Massachusetts, USA. 1981

**de Bruijn, N. G.**

No biographical data available

Usually in mathematics one has to choose between saying more and more about less and less on one hand, and saying less and less about more and more on the other.

*Asymptotic Methods in Analysis*

Preface (p. v)

North-Holland Publishing Company. Amsterdam, Netherlands. 1961

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...mathematics always has some essential obscurity that one cannot dissipate, it will lie uniquely, I think, in the direction of the infinite; it is in that direction that mathematics touches on physics, on the innermost nature of bodies about which we know little, and perhaps also on a too lofty metaphysics, of which we are permitted to perceive only some rays.

Quoted in Michael S. Mahoney

In David C. Lindberg and Robert S. Westman (eds.)

*Reappraisals of the Scientific Revolution*

Infinitesimals and Transcendent Relations: The Mathematics of Motion in the Late Seventeenth Century (p. 489, fn 46)

Cambridge University Press. Cambridge, England. 1990

...there is in mathematics, so to speak, only what we have placed there, only the clearest ideas that the human mind can form of magnitude, compared with one another and combined in an infinity of different ways, while Nature could well have used in the construction of the universe some mechanics that escapes us entirely.

Quoted in Michael S. Mahoney

In David C. Lindberg and Robert S. Westman

*Reappraisals of the Scientific Revolution*

Infinitesimals and Transcendent Relations: The Mathematics of Motion in the Late Seventeenth Century (p. 489, fn 46)

Cambridge University Press. Cambridge, England. 1990

**de Pavlovsky, G.**

No biographical data available

In the secular labour of ideas...mathematics plays the part that is played by capital in the history of societies; it is the crystallization of intellectual labour; it represents acquisitions of which we are proud, a security well earned; it may even serve as a basis and a point of departure for new enterprises themselves.

In Maurice Maeterlinck

*The Life of Space*

The Fourth Dimension, VI (p. 21)

Dodd, Mead &amp; Company. New York, New York, USA. 1928

**de Staël (Anne-Louise-Germaine),****Mme.** 1766–1817

French romantic writer

I shall be told, I know, that Mathematics render the attention peculiarly close (appliquee); but they do not habituate to collect, to appreciate, to concentrate; the attention they require is, so to speak, in a straight line; the human mind acts in mathematics as a spring tending in one uniform direction.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (pp. 309–310) Harper &amp; Brothers Publishers. New York, New York, USA. 1861

The mathematics lead us to lay out of account all that is not proved; while the primitive truths, those which sentiment and genius apprehend, are not susceptible of demonstration.

*Edinburgh Review*, Volume 52, January, 1836 (p. 248)**Dehn, Max**

No biographical data available

Mathematics is the only instructional material that can be presented in an entirely undogmatic way.

The Mentality of the Mathematician

*The Mathematical Intelligencer*, Volume 5, Number 2, 1983 (p. 73)**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

But as I considered the matter carefully it gradually came to light that all those matters only were referred to Mathematics in which order and measurement are investigated, and it makes no difference whether it be in numbers, figures, stars, sounds or any other objects that the question of measurement arises.

In *Great Books of the Western World* (Volume 31)*Rules for the Direction of the Mind*

Rule IV (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I am accustomed to distinguish two things in the mathematics, the history and the science. By history I mean what is already discovered, and is committed to books. And by the science, the skill of resolving all questions.

In George Abram Miller

*Historical Introduction to Mathematical Literature*

Chapter 1 (p. 8)

The Macmillan Co. New York, New York, USA. 1916

I was especially delighted with the mathematics, on account of the certitude and evidence of their reasonings: but I had not as yet a precise knowledge of their true use; and, thinking that they but contributed to the advancement of the mechanical arts, I was astonished that foundations so strong and solid should have had no loftier superstructure reared on them.

*Discourse on the Method of Rightly Conducting the Reason, and Seeking Truth in the Sciences*

Part I (p. 50)

Sutherland &amp; Knox. Edinburgh, Scotland. 1850

...all the sciences which have for their end investigations concerning order and measure, are related to mathematics, it being of small importance whether this measure be sought in numbers, forms, stars, sounds, or any other object; that, accordingly, there ought to exist a general science which should explain all that can be known about order and measure, considered independently of any application to a particular subject, and that, indeed, this science has its own proper name, consecrated by long

usage, to wit, *mathematics*; since it contains that in consideration of which the other sciences are said to form a part of mathematics. And a proof that it far surpasses in facility and importance the sciences which depend upon it is that it embraces at once all the objects to which these are devoted and a great many others besides ...

Translated by Henry A.P. Torrey

*The Philosophy of Descartes*

Part I (p. 72)

Henry Holt & Co. New York, New York, USA. 1892

### **Dieudonné, Jean** 1906–92

French mathematician and educator

On foundations we believe in the reality of mathematics, but of course when philosophers attack us with their paradoxes we rush to hide behind formalism and say: “Mathematics is just a combination of meaningless symbols...”

The Works of Nicholas Bourbaki

*The American Mathematical Monthly*, Volume 77, Number 2, February, 1970 (p. 134)

### **Digby, Sir Kenelm** 1603–65

English privateer

It is certain that the abstrusest Mathematics do not much conduce, to say nothing worse of them, to the acquisition of right reasoning, and the illustration of natural phenomena; as everyone is aware that mathematicians, distinguished in the higher branches of their science, are sometimes none of the most clear-sighted in matters beyond its province.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 290)

Harper & Brothers Publishers. New York, New York, USA. 1861

### **Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

Our feeble attempts at mathematics enable us to understand a bit of the universe, and as we proceed to develop higher and higher mathematics we can hope to understand the universe better.

The Evolution of the Physicist's Picture of Nature

*Scientific American*, Volume 208 Number 5 May, 1963 (p. 53)

The steady progress of physics requires for its theoretical formulations a mathematics that gets continually more advanced.

Quantized Singularities in the Electromagnetic Field

*Proceedings of the Royal Society*, Series A, Volume 133, Number A821, 1931 (p. 60)

God used beautiful mathematics in creating the world.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II (p. 191)

Simon & Schuster. New York, New York, USA. 1982

### **Doerner, Celia**

No biographical data available

I love my Love from A to Z,  
As I love Mathematics;  
My inmost soul delights in her,  
As in Cubics and Quadratics.  
I love her dearly with an A,  
As Arcs and Angles, Altitudes;  
And next I love her with a B –  
My pet Binomials this includes – ;  
I love her with a capital C,  
Like Circles, Conies, Calculus;  
I love her through the alphabet,  
As much as Decimals, and plus.  
Dearer she is to me than Loci, Polars, Ellipses, Axes,  
Foci,  
Than Logarithms and Mantissas,  
Or Graphics, Ordinates, Abscissas.  
I love her more than Integration,  
More even than a fine Equation;  
Any, non-Euclidean dreams of Space  
And Four Dimensions have no place  
Within my heart like her sweet face.  
I love her through the X. Y. Z's,  
For even Unknown Quantities  
Cannot boast greater charms than she.  
I love her to Infinity,  
And that's the limit – Q. E. D.

*Little Ripples of Song*

The Mathematician in Love (p. 70)

The Gorham Press. Boston, Massachusetts, USA. 1914

### **Donald Duck (Fictional character)**

Mathematics! That's for eggheads!

*Donald in Mathmagic Land*

Film (1959)

### **Dresden, Arnold** 1882–1954

American mathematician

The application will then, sometimes directly, but more frequently through a chain of intermediate stages, have significant bearing upon the content of human experience and furnish results which may be called true. Their truth then gives, retroactively, a sound basis for belief in the validity of the conclusions of mathematics.

Some Philosophical Aspects of Mathematics

*Bulletin of the American Mathematical Society*, Volume 34 July-August, 1928 (p. 439)

A mathematic may be established through the free choice of a logic, and of primitive ideas and primitive propositions; if this choice is guided by wisdom, the mathematic will be capable of development and application. The application will then, sometimes directly, but more frequently through a chain of intermediate stages, have

significant bearing upon the content of human experience and furnish results which may be called true. The truth then gives, retroactively, a sound basis for belief in the validity of the conclusion of mathematics.

Some Philosophical Aspects of Mathematics

*Bulletin of the American Mathematical Society*, Volume 34, July–August, 1928 (p. 452)

**Dutton, Samuel Train** 1849–1919

American school administrator

Mathematics, while giving one no quick remuneration like the art of Stenography or the craft of bricklaying, does furnish the power for deliberate thought and accurate statement, and to speak the truth is one of the most social qualities a person can possess. Gossip, flattery, slander, deceit, all spring from a slovenly mind that has not been trained in the power of truthful statement, which is one of the highest utilities.

*Social Phases of Education in the School and the Home*

The Social Aspects of the Home and the School (p. 30)

The Macmillan Co. New York, New York, USA. 1899

**Dyson, Freeman J.** 1923–

American physicist and educator

A physicist builds theories with mathematical materials, because the mathematics enables him to imagine more than he can clearly think.

Mathematics in the Physical Sciences

*Scientific American*, Volume 211, Number 3, September, 1964 (p. 133)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The mathematics is not there till we put it there.

*The Philosophy of Physical Science*

Chapter IX, Section I (p. 137)

The Macmillan Company. New York, New York, USA. 1939

**Edwards, Harold M.**

No biographical data available

Mathematics, like philosophy, is virtually inseparable from its history.

In Lynn Arthur Steen

*Mathematics Tomorrow*

Read the Masters! (p. 108)

Springer-Verlag. New York, New York, USA. 1981

**Eilenberger, Gert**

No biographical data available

It isn't our sensory and perceptual activity that forces nature into a strait-jacket of mathematics, it is Nature, which, in the process of our evolutionary development, has impressed mathematics into our reason as a real, existing structure, inherent to herself.

In H.O. Peitgen and P.H. Richter

*The Beauty of Fractals*

Freedom, Science, and Aesthetics (p. 178)

Springer-Verlag. New York, New York, USA. 1986

**Einstein, Albert** 1879–1955

German-born physicist

Physics... is essentially an intuitive and concrete science. Mathematics is only a means for expressing the laws that govern phenomena.

In A.P. French

*Einstein: A Centenary Volume*

Excerpts from a memoir (p. 9)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

One reason why mathematics enjoys special esteem, above all other sciences, is that its laws are absolutely certain and indisputable, while those of all other sciences are to some extent debatable and in constant danger of being overthrown by newly discovered facts.

*Sidelights on Relativity* (p. 27)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

Mathematics are well and good but nature keeps dragging us around by the nose.

In A.P. French

*Einstein: A Centenary Volume*

Chapter 4 (p. 113)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

At this point an enigma presents itself which in all ages has agitated inquiring minds. How can it be that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality?

*Sidelights on Relativity* (p. 28)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

But there is another reason for the high repute of mathematics: it is mathematics that offers the exact natural sciences a certain measure of security which, without mathematics, they could not attain.

In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon & Schuster. New York, New York, USA. 1937

If only I had more mathematics.

In Peter Michelmore

*Einstein, Profile of the Man* (p. 261)

Dodd, Mead & Company New York, New York, USA. 1962

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Well, but now, Casaubon, such deep studies, classics, mathematics, that kind of thing, are too taxing for a woman – too taxing, you know.

*Middlemarch*

Chapter VI (p. 90)

The Century Co. New York, New York, USA. 1910

**Ellis, Havelock** 1859–1939

English sexuality researcher

If mathematics were the only path of science.... Nature would have been illegible for Goethe....



*The Dance of Life*

Chapter III, Section V (p. 137)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

Here, we reach the sphere of mathematics, we are among processes which seem to some the most inhuman of all human activities and the most remote from poetry.

*The Dance of Life*

Chapter III, Section V (pp. 138–139)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Enzensberger, Hans Magnus** 1929–

German author, poet, translator, and editor

Yes, my boy. I often wonder where the mathematics stops and witchcraft begins.

*The Number Devil* (p. 142)

Henry Holt & Co. New York, New York, USA. 1997

**Erdős, Paul** 1913–96

Hungarian mathematician

Every human activity, EXCEPT Mathematics, must come to an end.

In Bela Bollobas

To Prove and Conjecture: Paul Erdos and His Mathematics

*The American Mathematical Monthly*, Volume 105, Number 3, March, 1998 (p. 209)

**Escher, M. C.** 1898–1972

Dutch graphic artist

By keenly confronting the enigmas that surround us, and by considering and analyzing the observations that I had made, I ended up in the realm of mathematics.

In Stanley Gudder

*A Mathematical Journey* (p. 94)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Everett, Edward** 1794–1865

Whig Party politician

Commencing with arithmetic, which, however humble and familiar its processes, is the pivot on which the business of the world turns, either as regards private fortunes or the policies of great states; ascending through algebra and geometry, where lies the broad field of nearly all the applied sciences and many of the mechanical and manufacturing, and some even of the fine arts – or music and drawing and architecture have their mathematical principles – till we reach those transcendental refinements of the calculus by which the great dynamical problems of the Universe are solved and the laws of its phenomena demonstrated, it is evident that no other study can exceed the mathematics, not merely in the variety of their applications to the service of man, but in proper dignity and importance.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 89)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

Beyond the little arithmetic required for the ordinary economies of life, the mass of college-bred men, unless engaged in the business of instruction or in pursuits which directly involve their application, from the time they leave their places of education, of whatever name, give up the Mathematics as a useless and hopeless abstraction.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 89)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

...the Mathematics, like language, (of which indeed they may be considered a species,) comprehending under that designation the whole science of number, space, form, time, and motion, as far as it can be expressed in abstract formulas, are evidently not only one of the most useful, but one of the grandest of studies.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 89)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

The great truths with which it [mathematics] deals, are clothed with an austere grandeur, far above all purposes of immediate convenience or profit. It is in them that our limited understandings approach nearest to the conception of that absolute and infinite, toward which in most other things they aspire in vain.

*Orations and Speeches on Various Occasions* (Volume 3)

Charter XXII (p. 514)

Little, Brown & Co. Boston, Massachusetts, USA.

**Eves, Howard W.** 1911–2004

American mathematician

Mathematics may be likened to a large rock whose interior composition we wish to examine. The older mathematicians appear as persevering stone cutters slowly attempting to demolish the rock from the outside with hammers and chisel. The later mathematicians resemble expert miners who seek vulnerable veins, drill into these strategic places, and then blast the rock apart with well placed internal charges.

*In Mathematical Circles* (Volume 2)

188 (p. 7)

Prindle, Weber & Schmidt. Boston, Massachusetts, USA. 1969

**Fairbairn, A. M.**

No biographical data available

The mathematics which have controlled and guided the Builder of the heavens are identical with the mathematics which the astronomer in his study deduces from the idea of space given his own thoughts, and which he proves by the processes of his own reason.

*The Philosophy of the Christian Religion* (p. 37)

The Macmillan Company. New York, New York, USA. 1902

**Feynman, Richard P.** 1918–88  
American theoretical physicist

To those who do not know Mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty of nature.... If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in.

*The Character of Physical Law*  
Chapter 2 (p. 58)  
BBC. London, England. 1965

...there are many, many aspects of the world that mathematics is unnecessary for, such as love, and which are very delightful and wonderful to appreciate and to feel awed and mysterious about...

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 1 (p. 15)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Now you may ask, “What is mathematics doing in a physics lecture?” We have several possible excuses: first, of course, mathematics is an important tool, but that would only excuse us for giving the formula in two minutes. On the other hand, in theoretical physics we discover that all our laws can be written in mathematical form; and that this has a certain simplicity and beauty about it. So, ultimately, in order to understand nature it may be necessary to have a deeper understanding of mathematical relationships. But the real reason is that the subject is enjoyable, and although we humans cut nature up in different ways, and we have different courses in different departments, such compartmentalization is really artificial, and we should take our intellectual pleasures where we find them.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 22-1 (p. 22-1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Finkel, Benjamin Franklin** 1865–1947  
American mathematician

It will not be denied by any intelligent educator that the so-called “Short Cuts” and “Lightning Methods” are positively injurious to beginners in mathematics. All the “whys” are cut out by these methods and the student robbed of the very object for which he is studying mathematics; viz., the development of the reasoning faculty

and the power to express his thoughts in a forcible and logical manner.

*A Mathematical Solution Book Containing Systematic Solutions to Many of the Most Difficult Problems*  
Preface (p. 1)  
Kibler & Co. Springfield, Missouri, USA. 1888

Mathematics has not only commercial value, but educational and ethical value as well, and that to a degree not excelled by any other science. No other science offers such rich opportunity for original investigation and discovery. So far from being a perfected and complete body of doctrine “handed down from heaven” and incapable of growth, as many suppose, it is a subject which is being developed at such a marvelous rate that it is impossible for any but the best to keep in sight of its ever-increasing and receding boundary.

*A Mathematical Solution Book Containing Systematic Solutions to Many of the Most Difficult Problems* (3rd edition)  
Preface to the Third Edition (p. 5)  
Kibler & Co. Springfield, Missouri, USA. 1888

**Fischer, Martin H.** 1879–1962  
German-American physician

It is unsafe to talk mathematics. Folks don’t understand.  
In Howard Fabing and Ray Marr  
*Fischerisms* (p. 3)  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Forsyth, A. R.**  
Mathematician

It is not so long since, during one of the meetings of the Association, one of the leading English newspapers briefly described a sitting of this Section in the words – Saturday morning was devoted to pure mathematics, and so there was nothing of any general interest”: still, such toleration is better than undisguised and ill-informed hostility. But the attitude of respect, I might almost say of reverence, is even more trying: we mathematicians are supposed to be of a different mould, to live far up the heights above the driving gales of controversy, breathing a rarer intellectual atmosphere, serene in impenetrable calm. It is difficult for us to maintain the gravity of demeanor proper to such superior persons; and perhaps it is best to confess at once that we are of the earth, earthy, that we have our differences of opinion and of judgment, and that we can even commit the Machiavellian crime of making blunders.

*Report of the Sixty-seventh Meeting of the British Association for the Advancement of Science*  
Address Toronto 1897 (p. 542)

Mathematics is one of the oldest of the sciences; it is also one of the most active, for its strength is the vigor of perpetual youth.

Presidential Address British Association for the Advancement of Sciences,  
*Nature*, Section A, Volume 56, Number 1451, August 19, 1897 (p. 378)

**Frankland, A.**

No biographical data available

I am convinced that the future progress of chemistry as an exact science depends very much upon the alliance with mathematics.

Extract of a Letter of Dr. Frankland to Mr. Sylvester  
*American Journal of Mathematics*, Volume 1, Number 4, 1878 (p. 349)

**Franklin, Benjamin** 1706–90

American printer, scientist and diplomat

Mathematics originally signifies any kind of discipline or learning, but now it is taken for that science which teaches or contemplates whatever is capable of being numbered or measured.

*Memoirs of the Life and Writings of Benjamin Franklin* (Volume 5) (2nd edition)

On the Usefulness of Mathematics (p. 87)

Printed for Henry Colburn. London, England. 1819

The usefulness of some particular parts of the mathematics in the common affairs of human life, has rendered some knowledge of them very necessary to a great part of mankind, and very convenient to all the rest that are any way conversant beyond the limits of their own particular callings.

*Memoirs of the Life and Writings of Benjamin Franklin* (Volume 5) (2nd edition)

On the Usefulness of Mathematics (p. 91)

Printed for Henry Colburn. London, England. 1819

There has not been any science so much esteemed and honored as this of the mathematics, nor with so much industry and vigilance become the care of great men, and labored in by the potentates of the world, viz. emperors, kings, princes, &c.

*Memoirs of the Life and Writings of Benjamin Franklin* (Volume 5) (2nd edition)

On the Usefulness of Mathematics (p. 90)

Printed for Henry Colburn. London, England. 1819

What science then can there be more noble, more excellent, more useful for men, more admirably high and demonstrative, than this of the mathematics?

*Memoirs of the Life and Writings of Benjamin Franklin* (Volume 5) (2nd edition)

On the Usefulness of Mathematics (p. 91)

Printed for Henry Colburn. London, England. 1819

**Franklin, W. S.**

No biographical data available

If a healthy minded person takes an interest in science, he gets busy with his mathematics and haunts the laboratory.

In Henry Crew

*General Physics* (p. 54)

The Macmillan Company. New York, New York, USA. 1927

**Frege, Friedrich Ludwig Gottlob** 1848–1925

German logician

The idea of a strictly scientific method in mathematics, which I have attempted to realize, and which might indeed be named after Euclid, I should like to describe as follows. It cannot be demanded that everything be proved, because that is impossible; but we can require that all propositions used without proof be expressly declared as such, so that we can see distinctly what the whole structure rests upon. After that we must try to diminish the number of primitive laws as far as possible, by proving everything that can be proved. Furthermore, I demand – and in this I go beyond Euclid – that all methods of inference employed be specified in advance...

*The Fundamental Laws of Arithmetic* (Volume 1)

Foreword (p. vi)

Publisher undetermined

**Gardner, Martin** 1914–

American writer and mathematics games editor

Mathematics is not only real, but it is the only reality. The entire universe is made out of particles. Now what are the particles made out of? They're not made out of anything. The only thing you can say about the reality of an electron is to cite its mathematical properties. There's a sense in which matter has completely dissolved and what is left is just a mathematical structure.

*Focus – The Newsletter of the Mathematical Association of America*  
December, 1994

**Gassendi, Pierre** 1592–1655

French logician and philosopher

If we know anything we know it by mathematics; but those people have no concern for the true and legitimate science of things! they cling to trivialities!

In Pierre Duhem

*The Aim and Structure of Physical Theory*

Part II, Chapter II (p. 121)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Germain, Sophie** 1545–1612

French mathematician

Let me be permitted to recall that the object of mathematics is not to investigate the causes that one can assign to natural phenomena. This science would lose both its character and credit if, renouncing the support of general well-confirmed facts, it sought within the realm of nebulous conjectures, a realm which has always been a fertile source of error for ways of satisfying the thirst for explanation.

In Louis L. Bucciarelli and Nancy Dwarsky

*Sophie Fermain: An Essay in the History of the Theory of Elasticity*

Chapter 9 (p. 110)

D. Reidel Publishing Company. Dordrecht, Germany. 1980

**Geroch, Robert**

American theoretical physicist

One sometimes hears express the view that some sort of uncertainty principle operates in the interaction between mathematics and physics: the greater the mathematical care used to formulate a concept, the less the physical insight to be gained from that formulation. It is not difficult to imagine how such a viewpoint could come to be popular. It is often the case that essential physical ideas of a discussion are smothered by mathematics through excessive definitions, concern over irrelevant generality, etc. Nonetheless one can make a case that mathematics as mathematics, if used thoughtfully, is almost always useful – and occasionally essential – to progress in theoretical physics..

*Mathematical Physics*

Chapter 1 (p. 1)

University of Chicago Press. Chicago, Illinois, USA. 1985

...it takes a certain amount of effort to learn mathematics...

*Mathematical Physics*

Chapter 1 (p. 1)

University of Chicago Press. Chicago, Illinois, USA. 1985

One takes care at the beginning to be sure that “the mathematics is appropriate for the physics,” that is, that everything in the mathematics has physical meaning and that all of the physics one wishes to talk about is describable in terms of the mathematics.

*Mathematical Physics*

Chapter 15 (p. 86)

University of Chicago Press. Chicago, Illinois, USA. 1985

**Gibbon, Edward** 1737–94

English historian

The mathematics are distinguished by a peculiar privilege, that is, in the course of ages, they may always advance and can never recede.

In *Great Books of the Western World* (Volume 41)*The Decline and Fall of the Roman Empire*

Chapter LII, Section 59 (p. 299)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

I am sure that no subject loses more than mathematics by any attempt to dissociate it from its history.

Opening Address

*Nature*, Volume 42, Number 1089, September 11, 1890 (p. 466)

It would seem at first sight as if the rapid expansion of the region of mathematics must be a source of danger to its future progress. Not only does the area widen, but the subjects of study increase rapidly in number, and the work of the mathematician tends to become more and more specialised. It is of course merely a brilliant exaggeration to say that no mathematician is able to under-

stand the work of any other mathematician, but it is certainly true that it is daily becoming more and more difficult for a mathematician to keep himself acquainted, even in a general way, with the progress of any of the branches of mathematics except those which form the field of his own labours.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*

Presidential address (p. 723)

John Murray. London, England. 1891

**Glanvill, Joseph** 1636–80

English clergyman and philosopher

...the indisputable *Mathematicks*, the only *Science* Heaven hath yet vouchsafed Humanity, have but few Voters among the slaves of the *Stagirite*.

*Scepisis Scientifica*

Chapter XIX (p. 142)

Kegan Paul, Trench &amp; Co. London, England. 1885

**Gleason, Andrew M.** 1921–

American mathematician

It is notoriously difficult to convey a proper impression of the frontiers of mathematics to non-specialists.... Ultimately the difficulty stems from the fact that mathematics is an easier subject than the other sciences.... Consequently, many of the important primary problems of the subject – that is, problems which can be understood by an intelligent outsider – have either been solved or carried to a point where an indirect approach is clearly required. The great bulk of pure mathematical research is concerned with secondary, tertiary or higher-order problems, the very statement of which can hardly be understood until one has mastered a great deal of technical mathematics.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 95)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

Like the great temples of some religions, mathematics may be viewed only from the outside by those uninitiated into its mysteries.

Evolution of an Active Mathematical Theory

*Science*, Volume 145, Number 3631, 31 July, 1964 (p. 457)

If we do run into a paradox, we can probably save the structure of mathematics by patching it.

In Bryan H. Bunch

*Mathematical Fallacies and Paradoxes*

Chapter 5 (p. 110)

van Nostrand Reinhold Company. New York, New York, USA. 1982

**Graham, L. A.**

No biographical data available

Sing a song of sixpence –  
A mathman full of rye.

Four times twenty square feet

Multiplied by n  
 Gives the total ground he covers  
 While weaving an ellipse;  
 His path would have no area,  
 If he had no nips.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 7

Dover Publications, Inc. New York, New York, USA. 1959

### Guillen, Michael

American mathematician and physicist

...mathematics is not a science – it is not capable of proving or disproving the existence of real things. In fact, a mathematician's ultimate concern is that his or her inventions be logical, not realistic.

*Bridges to Infinity: The Human Side of Mathematics*

Introduction (p. 4)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1983

...as measured by the millions of those who speak it fluently...*mathematics* is arguable the most successful global language ever spoken.

*Five Equations That Changed the World*

Introduction (p. 2)

Hyperion. New York, New York, USA. 1995

### Haeckel, Ernst Heinrich Philipp

**August** 1834–1919

German biologist and philosopher

The great regard which mathematics enjoys as an exact science in all branches of knowledge is chiefly due to its formal accuracy, and to the possibility of expressing infallibly spatial and time quantities in number and mass.

Translated by Joseph McCabe

*The Wonders of Life: A Popular Study of Biological Philosophy*

Part IV, Chapter XX (p. 457)

Harper & Brothers Publishers. New York, New York, USA. 1905

### Hall, Granville Stanley 1844–1924

American psychologist and educator

Mathematics...the ideal and norm of all careful thinking.

*Educational Problems* (p. 393)

D. Appleton & Company. New York, New York, USA. 1911

### Halsted, George Bruce 1853–1922

American mathematician

...mathematics, that giant pincers of scientific logic...

Biology and Mathematics

*Science*, Volume 27, Number 554, Friday, August 11, 1905 (p. 162)

### Halmos, Paul R. 1916–2006

Hungarian-born American mathematician

...many people think of mathematics itself as a static art – a body of eternal truth that was discovered by a few ancient, shadowy figures, and upon which engineers and scientists can draw as needed.

Innovation in Mathematics

*Scientific American*, Volume 199, Number 3, September, 1958 (p. 66)

It saddens me that educated people don't even know that my subject exists.

Mathematics as a Creative Art

*American Scientist*, Volume 56, Number 4, Winter 1968 (p. 380)

The only way to learn mathematics is to do mathematics.

*A Hilbert Space Problem Book*

Preface (p. vii)

Springer-Verlag. New York, New York, USA. 1982

Mathematics is abstract thought, mathematics is pure logic, mathematics is creative art. All these statements are wrong, but they are all a little right, and they are all nearer the mark than "mathematics is number" or "mathematics is geometric shapes." For the professional pure mathematician, mathematics is the logical dovetailing of a carefully selected sparse set of assumptions along with their surprising conclusions via a conceptually elegant proof. Simplicity, intricacy, and above all, logical analysis are the hallmarks of mathematics.

Mathematics as a Creative Art

*American Scientist*, Volume 56, Number 4, Winter 1968 (p. 380)

Mathematics is not a deductive science – that's a cliché. When you try to prove a theorem, you don't just list the hypotheses, and then start to reason. What you do is trial and error, experimentation, guesswork.

*I Want to Be A Mathematician* (p. 27)

MAA Spectrum. Washington, D.C. 1985

### Hamilton, Sir William Rowan 1805–65

Anglo-Irish mathematician, physicist, and astronomer

These purely mathematical sciences of algebra and geometry are sciences of the pure reason, deriving no weight and no assistance from experiment, and isolated, or at least isolable, from all outward and accidental phenomena. The idea of order, with its subordinate ideas of number and of figure, we must not indeed call innate ideas, if that phrase be defined to imply that all men must possess them with equal clearness and fullness; they are, however, ideas which seem to be so far born with us, that the possession of them, in any conceivable degree, appears to be only the development of our original powers, the unfolding of our proper humanity.

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton* (Volume 1)

Introductory Lecture on astronomy (p. 643)

Hodges, Figgis & Co. Dublin, Ireland. 1882

### Hamilton, William 1788–1856

Scottish philosopher

Mathematics may distort, but can never rectify, the mind.  
*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 310)

Harper & Brothers Publishers. New York, New York, USA. 1861

Mathematics afford us no assistance, either in conquering the difficulties, or in avoiding the dangers which we

encounter in the great field of probabilities wherein we live and move.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 284)  
Harper & Brothers Publishers. New York, New York, USA. 1861

In mathematics, genus and species are hardly known.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 275)  
Harper & Brothers Publishers. New York, New York, USA. 1861

**Hankel, Hermann** 1839–73

German mathematician

The purely formal sciences, logic and mathematics, deal with those relations which are, or can be, independent of the particular content or the substance of objects. To mathematics in particular fall those relations between objects which involve the concepts of magnitude, of measure and of number.

*Theorie der Complexen Zahlensysteme insbesondere der gemeinen imaginären Zahlen und der Hamilton'schen Quaternionen nebst ihrer geometrischen Darstellung* (p. 1)

Leopold Voss, Leipzig, Germany. 1867

Mathematics, considered as a science, owes its origin to the idealistic needs of the Greek philosophers, and not as fable has it, to the practical demands of Egyptian economics.... Adam was no zoologist when he gave names to the beasts of the field, nor were the Egyptian surveyors mathematicians.

*Die Entwicklung der Mathematik in den letzten Jahrhunderten* (p. 7)

Akademische Antrittsrede. Tübingen, Germany. 1884

Mathematics pursues its own course unrestrained, not indeed with an unbridled license which submits to no laws, but rather with the freedom which is determined by its own nature and in conformity with its own being.

*Die Entwicklung der Mathematik In den letzten Jahrhunderten* (p. 16)

Akademische Antrittsrede. Tübingen, Germany. 1884

In most sciences one generation tears down what another has built and what one has established another undoes. In mathematics alone each generation adds a new story to the old structure.

*Die Entwicklung der Mathematik In den letzten Jahrhunderten* (p. 25)

Akademische Antrittsrede. Tübingen, Germany. 1884

If we consult reason, experience, and the common testimony of ancient and modern times, none of our intellectual studies tend to cultivate *a smaller number of the faculties, in a more partial or feeble manner, than mathematics*. This is acknowledged by every writer on education of the least pretension to judgment and experience.

*Discussions on Philosophy and Literature, Education and University Reform*

Education, I (p. 268)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

The fact is that there are few more “popular” subjects than mathematics. Most people have some appreciation of mathematics, just as most people can enjoy a pleasant tune; and there are probably more people really interested in mathematics than in music. Appearances may suggest the contrary, but there are easy explanations. Music can be used to stimulate mass emotion, while mathematics cannot; and musical incapacity is recognized (no doubt rightly) as mildly discreditable, whereas most people are so frightened of the name of mathematics that they are ready, quite unaffectedly, to exaggerate their own mathematical stupidity.

*A Mathematician's Apology*

Section 10 (p. 86)

Cambridge University Press. Cambridge, England. 1967

A chess problem is genuine mathematics, but it is in some way ‘trivial’ mathematics. However ingenious and intricate, however original and surprising the moves, there is something essential lacking. Chess problems are unimportant. The best mathematics is serious as well as beautiful.

*A Mathematician's Apology*

Section 11 (p. 88)

Cambridge University Press. Cambridge, England. 1967

...I will say only that if a chess problem is, in the crude sense, ‘useless’, then that is equally true of most of the best mathematics; that very little of mathematics is useful practically, and that the little [that is] is comparatively dull.

*A Mathematician's Apology*

Section 11 (p. 89)

Cambridge University Press. Cambridge, England. 1967

...I am interested in mathematics only as a creative art.

*A Mathematician's Apology*

Section 19 (p. 115)

Cambridge University Press. Cambridge, England. 1967

It is undeniable that a good deal of elementary mathematics – and I use the word “elementary” in the sense in which professional mathematicians use it, in which it includes, for example, a fair working knowledge of the differential and integral calculus – has considerable practical utility. These parts of mathematics are, on the whole, rather dull; they are the parts which have the least aesthetic value. The ‘real’ mathematics of the ‘real’ mathematicians, the mathematics of Fermat and Euler and Gauss and Abel and Riemann, is almost wholly ‘useless’ (and this is as true of ‘applied’ as of ‘pure’ mathematics). It is not possible to justify the life of any genuine professional mathematician on the ground of the ‘utility’ of his work.

*A Mathematician's Apology*

Section 21 (pp. 119–120)

Cambridge University Press. Cambridge, England. 1967



There is one comforting conclusion which is easy for a real mathematician. Real mathematics has no effects on war. No one has yet discovered any warlike purpose to be served by the theory of numbers or relativity, and it seems very unlikely that anyone will do so for many years.

*A Mathematician's Apology*

Section 28 (p. 140)

Cambridge University Press. Cambridge, England. 1967

For mathematics is, of all the arts and sciences, the most austere and the most remote, and a mathematician should be of all men the one who can most easily take refuge where, as Bertrand Russell says, "one...of our nobler impulses can best escape from the dreary exile of the actual world."

*A Mathematician's Apology*

Section 28 (p. 143)

Cambridge University Press. Cambridge, England. 1967

### Harish-Chandra 1923–83

Indian-born American mathematician

In mathematics there is an empty canvas before you which can be filled without reference to external reality.

*Biographical Memoirs of Fellows of the Indian National Science Academy* (Volume 12) (p. 202)

Indian National Science Academy

New Delhi, India. 1987

### Harris, William Torrey 1835–1909

American educator and philosopher

Mathematics in its pure form as arithmetic, algebra, geometry, and the application of the analytical method, as well as mathematics applied to matter and force, or statics and dynamics, furnishes us the peculiar study that gives to us, whether as children or as men, the command of Nature in this its quantitative aspect. Mathematics furnishes the instrument, the tool of thought which we wield in this realm.

*Psychologic Foundations of Education*

Chapter XXXVI (pp. 325–326)

D. Appleton & Co. New York, New York, USA. 1898

### Hauffman, Paul

No biographical data available

That Mathematics could be a jewel may come as a surprise to those of us who struggled with multiplication tables as kids and now need help completing W-4 forms.

The Man Who Loves Only Numbers

*The Atlantic Magazine*, Volume 260, Number 5, November, 1987

...mathematics is order and beauty at its purest, order that transcends the physical world.

The Man Who Loves Only Numbers

*The Atlantic Magazine*, Volume 260, Number 5, November, 1987 (p. 66)

### Heaviside, Oliver 1850–1925

English electrical engineer, mathematician, and physicist

There are men of a certain type of mind who are never wearied with gibing at mathematics, at mathematicians, and at mathematical methods of inquiry. It goes almost without saying that these men have themselves little mathematical bent.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 7)

D. van Nostrand Co. New York, New York, USA. 1893

### Heinlein, Robert A. 1907–88

American science fiction writer

Anyone who cannot cope with mathematics is not fully human. At best he is a tolerable subhuman who has learned to wear shoes, bathe, and not make messes in the house.

*Time Enough for Love*

Intermission (p. 265)

G.P. Putnam's Sons. New York, New York, USA. 1973

...mathematics can never prove anything. No mathematics has any content. All any mathematics can do is – sometimes – turn out to be useful in describing some aspects of our so-called "physical universe." That is a bonus; most forms of mathematics are as meaning-free as chess.

*The Number of the Beast*

Chapter V (pp. 45–46)

Fawcett Columbine Books. New York, New York, USA. 1980

### Hempel, Carl G. 1905–97

German philosopher of science

The most distinctive characteristic which differentiates mathematics from the various branches of empirical science, and which accounts for its fame as the queen of the sciences, is no doubt the peculiar certainty and necessity of its results.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 3)

Geometry and Empirical Science (p. 1635)

Simon & Schuster. New York, New York, USA. 1956

### Herbart, Johann Friedrich 1776–1841

German philosopher and educator

The idea that aptitude for mathematics is rarer than aptitude for other subjects is merely an illusion which is caused by belated or neglected beginners.

In Stanley Gudder

*A Mathematical Journey* (p. ix)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

Everything that the greatest minds of all times have accomplished toward the comprehension of forms by means of concepts is gathered into one great science, mathematics.

*Werke*

Pestalozzi's Idee eines A B C der Anschauung, Bd. 1 (p. 163)

Druck und Verlag von Hermann Beyer & Sohne. Langensalza, Germany. 1890

Mathematics, the priestess of definiteness and clearness.

*Werke*

Pestalozzi's Idee eines A B C der Anschauung, Bd. 1 (p. 171)  
Druck und Verlag von Hermann Beyer & Sohne. Langensalza, Germany.  
1890

All that the greatest minds of all the ages have done toward the apperception of form through concepts, we find gathered into a single great science – mathematics.

Translated by William J. Eckoff

*Herbart's ABC of Sense-perception, and Minor Pedagogical Works*

Part ii, Chapter IV (p. 143)

D. Appleton & Co. New York, New York, USA. 1903

...the priestess of definiteness and clearness – Mathematics.

Translated by William J. Eckoff

*Herbart's ABC of Sense-perception, and Minor Pedagogical Works*

Part ii, Chapter IV (p. 157)

D. Appleton & Co. New York, New York, USA. 1903

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

A clever man, shut up alone and allowed unlimited time, might reason out for himself all the truths of mathematics, by proceeding from those simple notions of space and number of which he cannot divest himself without ceasing to think.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part II, Chapter I (p. 76)

Longman, Rees, Orman, Brown & Green. London, England. 1830

**Hersh Reuben** 1927–

American mathematician

Formalized mathematics, to which most philosophizing has been devoted in recent years, is in fact hardly to be found anywhere on earth or in heaven outside the texts and journals of symbolic logic.

In John D. Barrow

*Pi in the Sky: Counting, Thinking, and Being* (p. 140)

Clarendon Press. Oxford, England. 1992

**Hesse, Hermann** 1877–1962

German poet and novelist

You treat world history as a mathematician does mathematics, in which nothing but laws and formulas exist, no reality, no good and evil, no time, no yesterday, no tomorrow, nothing but an eternal, shallow, mathematical present.

*The Glass Bead Game*

Chapter 4

Holt, Rinehart & Winston. New York, New York, USA. 1969

**Hilbert, David** 1862–1943

German mathematician

We hear within us the perpetual call: There is the problem. Seek its solution. You can find it by pure reason, for in mathematics there is no ignorabimus.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2nd Series,

October 1901–July 1902

For mathematics hoch – hoch – hoch [hip, hip hooray]

*Hilbert – Courant*

Hilbert

Chapter XXIII (p. 202)

Springer-Verlag. New York, New York, USA. 1986

Mathematics is not a popular subject, even though its importance may be generally conceded. The reason for this is to be found in the common superstition that mathematics is but a continuation, a further development, of the fine art of arithmetic, of juggling with numbers.

In D. Hilbert and S. Cohen-Vossen

*Geometry and the Imagination* (p. iv)

Chelsea Publishing Company. New York, New York, USA. 1952

Mathematics must be cherished and strengthened as a unified, vital branch in the broad river of science; it dares not trickle away in the sand.

*Hilbert – Courant*

Hilbert

Chapter XXV (p. 220)

Springer-Verlag. New York, New York, USA. 1986

[Mathematics] should be to us a guide post on the mazy paths to hidden truths, and ultimately a reminder of our pleasure in the successful solution.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2nd Series,

October 1901–July 1902

**Hilbert, David** 1862–1943

German mathematician

**Cohn-Vossen, Stephan** 1902–36

Polish mathematician

In mathematics, as in any scientific research, we find two tendencies present. On the one hand, the tendency towards abstraction seeks to crystallize the *logical* relations inherent in the maze of material that is being studied, and to correlate the material in a systematic and orderly manner. On the other hand, the tendency towards *intuitive understanding* fosters a more immediate grasp of the objects one studies, a live *rapport* with them, so to speak,

Translated by P. Nemenyi

*Geometry and the Imagination*

Preface (p. iii)

AMS Chelsea Publishing Co. Providence, Rhode Island, USA. 1999

**Hilbert, David** 1862–1943

German mathematician

The tool which governs the mediation between theory and practice, between thought and observation is mathematics; it builds the bridge and carries more and more of the load. It thereby happens that the basis of our entire present day culture, in so far as it is based on investigations dealing with nature, can be found in mathematics.

*Musings of the Masters: An Anthology of Mathematical Reflections*

Logic and the Understanding of Nature (p. 125)

Mathematical Association of America. Washington, D.C. 2004

**Hill, Thomas**

No biographical data available

The mathematics are usually considered as being the very antipodes of Poesy. Yet Mathesis and Poesy are of the closest kindred, for they are both works of the imagination. ... [They are] the utterance of the same power of imagination, only that in the one case it is addressed to the head, in the other, to the heart.

The Imagination in Mathematics

*North American Review*, Volume 85, July 1857 (pp. 229–230)

**Hobson, Ernest William** 1856–1933

English mathematician

Probably no other department of knowledge plays a larger part outside its own narrower domain than mathematics. Some of its more elementary conceptions and methods have become part of the common heritage of our civilization, interwoven in the every-day life of the people.

Address to the Mathematical and Physical Section of the British Association for the Advancement of Science  
*Science*, N.S. Volume 32, September 23, 1910 (p. 386)

A great department of thought must have its own inner life, however transcendent may be the importance of its relations to the outside. No department of science, least of all one requiring so high a degree of mental concentration as Mathematics, can be developed entirely, or even mainly, with a view to applications outside its own range.

Address to the Mathematical and Physical Section of the British Association for the Advancement of Science  
*Science*, N.S. Volume 32, Number 821, September 23, 1910 (p. 389)

The increased complexity and specialisation of all branches of knowledge makes it true in the present, however it may have been in former times, that important advances in such a department as Mathematics can be expected only from men who are interested in the subject for its own sake, and who, whilst keeping an open mind for suggestions from outside, allow their thought to range freely in those lines of advance which are indicated by the present state of their subject, untrammelled by any preoccupation as to applications to other departments of science.

Address to the Mathematical and Physical Section of the British Association for the Advancement of Science  
*Science*, N.S. Volume 32, Number 821, September 23, 1910 (p. 389)

Perhaps the least inadequate description of the general scope of modern Pure Mathematics – I will not call it a definition – would be to say that it deals with form, in a very general sense of the term; this would include algebraic form, functional relationship, the relations of order in any ordered set of entities such as numbers, and the analysis of the peculiarities of form of groups of operations.

Presidential Address British Association for the Advancement of Science

*Nature*, Volume 84, Number 2131, September 1, 1910 (p. 287)

**Hodges, Wilfrid**

No biographical data available

Mathematics is not a topic that one can easily approach with a virgin mind.

*Building Models by Games* (p. 1)

Cambridge University Press. Cambridge, England. 1985

**Hoffman, Paul** 1956–

American writer and television presenter

In mathematics madness often comes with the territory.

*The Man Who Loved Only Numbers*

*We Mathematicians Are All A Little Crazy* (p. 263)

Hyperion. New York, New York, USA. 1998

**Hogben, Lancelot** 1895–1975

English zoologist

If mathematics is a game, there is no reason why people should play it if they do not want to. With football, it belongs to those amusements without which life would be endurable.

*Mathematics for the Millions*

Chapter I (p. 31)

W.W. Norton & Company, Inc. New York, New York, USA. 1917

**Honsberger, Ross** 1929–

Mathematician

Mathematics abounds in bright ideas. No matter how long and hard one pursues her, mathematics never seems to run out of exciting surprises. And by no means are these gems to be found only in difficult work at an advanced level. All kinds of simple notions are full of ingenuity.

*Mathematical Morsels* (p. vii)

Mathematical Association of America. Washington, D.C. 1978

**Hubbard, John**

No biographical data available

The Mathematicks too our thoughts employ,

Which nobly elevate the Student's joy:

The little Euclids round the table set

And at their rigid demonstrations sweat.

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter I (p. 30)

Government Printing Office. Washington, D.C. 1890

**Hudson, Hilda Phoebe** 1881–1965

Mathematician

To all of us who hold the Christian belief that God is truth, anything that is true is a fact about God, and mathematics is a branch of theology.

In E.T. Bell

*The Magic of Numbers*

Chapter 26 (p. 385)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

The two main divisions of mathematics, analysis and geometry, correspond with some exactness to the two great mysteries of the Christian faith, the Trinity and the Incarnation.

In E.T. Bell  
*The Magic of Numbers*  
Chapter 26 (p. 386)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

But however we think of heaven, it is hard to imagine astronomy and botany surviving as they are, and having much interest or importance there.... On the other hand it is just as hard to imagine pure mathematics not surviving. The laws of thought, and especially of number, must hold good in heaven, whether it is a place or a state of mind; for they are independent of any particular sphere of existence, essential to Being itself, to God's being as well as ours, laws of His mind before we learned them. The multiplication table will hold good in heaven...

In E.T. Bell  
*The Magic of Numbers*  
Chapter 26 (pp. 385–386)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

**Hume, David** 1711–76  
Scottish philosopher and historian

The principal difficulty in the mathematics is the length of inferences and compass of thought, requisite to the forming of any conclusion.

*Essays: Moral, Political, and Literary* (Volume 2)  
*Concerning Human Understanding*  
Section VII (p. 51)  
Longmans, Green & Co. London, England. 1889

**Huntley, Henry Edwin**  
No biographical data available

To the aesthetically minded mathematician much mathematics reads like poetry.

*The Divine Proportion: A Study in Mathematical Beauty*  
Preface (p. vii)  
Dover Publications. New York, New York, USA. 1970

**Huxley, Thomas Henry** 1825–95  
English biologist

Mathematics may be compared to a mill of exquisite workmanship which grinds you stuff of any degree of fineness; but, nevertheless, what you get out depends on what you put in; and as the grandest mill in the world will not extract wheat-flour from peas-cods, so pages of formulae will not get a definite result out of loose data.

*Collected Essays* (Volume 8)  
Geological Reform (p. 333)  
Macmillan & Company Ltd. London, England. 1904

**Issigonis, Sir Alec** 1906–88  
English automobile designer

All creative people hate mathematics. It's the most uncreative subject you can study.

*The Australian*, 5 October, 1988

**Iyer, S. Sandaram**

No biographical data available

There may be truths which outrun common sense, there are none which contradict mathematics.

*Thoughts on the Metaphysics of Theosophy*  
Synthetic Recapulation (p. 91)  
The Calcutta Central Press. Calcutta, India. 1883

**Jacobi, Karl Gustav Jacob** 1804–51  
German mathematician

Mathematics exists solely for the honour of the human mind.

In Walter R. Fuchs  
*Mathematics for the Modern Mind*  
See What the Proof Proves (p. 24)  
The Macmillan Company. New York, New York, USA. 1967

**Jaime Escalante (Fictional character)**

Tough guys don't do math. Tough guys fry chicken for a living.

*Stand and Deliver*  
Film (1988)

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...nature seems very conversant with the rules of pure mathematics, as our mathematicians have formulated them in their studies, out of their own inner consciousness and without drawing to any appreciable extent on their experience of the outer world.

*The Mysterious Universe*  
Chapter V (p. 154)  
The Macmillan Company. New York, New York, USA. 1932

**Jeffers, Robinson** 1887–1962  
American poet

Science and mathematics

Run parallel to reality, they symbolize it, they squint at it, They never touch it...

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 3)  
What's the Best Life for a Man? (p. 425)  
Stanford University Press. Stanford, California, USA. 1988

**Jeffreys, Sir Harold** 1891–1989  
English astronomer and geophysicist

We have to come back to something like ordinary language after all when we want to talk about mathematics!

*Methods of Mathematical Physics*

Chapter 1 (p. 2)

At The University Press. Cambridge, England. 1962

### **Johnston, Francis E.**

Mathematician

...I do not wish to leave you with the impression that mathematics feels it necessary to justify her existence by an appeal to her usefulness. I should like to regard her as the "Queen of the Sciences," rather than as the hand-maiden of the engineer.

The Postulational Treatment of Mathematics

*American Scientist*, Volume 33, Number 1, January, 1945 (p. 54)

### **Jourdain, Philip E. B.** 1879–1919

English logician

The end of very much mathematics and of the work of many eminent men is the simple and, as far as may be, accurate description of things in the world around us, of which we become conscious through our senses.

*The Nature of Mathematics* (Revised edition)

Chapter IV (p. 73)

T.C. & E.C. Jack. London, England. 1919

### **Kac, Mark** 1914–84

Polish mathematician

...there are those who believe that mathematics can sustain itself and grow without any further contact with anything outside itself, and those who believe that nature is still and always will be one of the main (if not the main) sources of mathematical inspiration. The first group is identified as "pure mathematicians" (though "purist" would be more adequate) while the second is, with equal inadequacy, referred to as "applied."

Quoted in Robert W. Ritchie (ed.)

*New Directions in Mathematics* (p. 60)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1963

If doing mathematics or science is looked upon as a game, then one might say that in mathematics you compete against yourself or other mathematicians; in physics your adversary is nature and the stakes are higher.

*Enigmas of Chance*

Introduction (pp. xxiii–xxiv)

Harper & Row Publisher. New York, New York, USA. 1985

### **Kac, Mark** 1914–84

Polish mathematician

### **Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

### **Schwartz, Jacob T.** 1930–

American mathematician

For as long as we have a record of man's curiosity and quest for understanding we find mathematics cultivated and cherished, practiced and taught. Throughout the ages

it has stood as an ultimate in rational thought and as a monument to man's desire to probe the workings of his own mind.

In Marc Kac

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

*Mathematics: Tensions*

Chapter Two (p. 7)

Birkhäuser. Boston, Massachusetts, USA. 1986

To find the simple in the complex, the finite in the infinite – that is not a bad description of the aim and essence of mathematics.

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy*

Chapter Seven (p. 64)

Springer-Verlag. New York, New York, USA. 1992

### **Kant, Immanuel** 1724–1804

German philosopher

But mathematics, certainly, does not play the smallest part in the charm and movement of the mind produced by music. Rather is it only the indispensable condition (*conditio sine qua non*) of that proportion of the combining as well as changing impressions which makes it possible to grasp them all in one and prevent them from destroying one another, and to let them, rather, conspire towards the production of a continuous movement and quickening of the mind by affections that are in unison with it, and thus towards a serene self-enjoyment.

*The Critique of Judgment*

Critique of Aesthetic Judgment, Section 53

Hafner Publishing Company. New York, New York, USA. 1951

In every department of physical science there is only so much science, properly so-called, as there is mathematics.

In Morris Kline

*Mathematics and the Physical World*

Preface (p. vii)

Dover Publications, Inc. New York, New York, USA. 1981

### **Kaplan, Abraham** 1918–93

American philosopher of science, author, and educator

Mathematics is not yet capable of coping with the naiveté of the mathematician himself.

In James Roy Newman (ed.)

*The World of Mathematics* (Volume 2)

Sociology Learns the Language of Mathematics (p. 1301)

Simon & Schuster. New York, New York, USA. 1956

### **Kasner, Edward** 1878–1955

American mathematician

### **Newman, James Roy** 1911–66

Mathematician and mathematical historian

Here, then, in mathematics we have a universal language, valid, useful, intelligible everywhere in place and in time – in banks and insurance companies, on the parchments of the architects who raised the Temple of Solomon, and on the blueprints of the engineers who,

with their calculus of chaos, master the winds. Here is a discipline of a hundred branches, fabulously rich, literally without limit in its sphere of application, laden with honors for an unbroken record of magnificent accomplishment. Here is a creation of the mind, both mystic and pragmatic in appeal. Austere and imperious as logic, it is still sufficiently sensitive and flexible to meet each new need.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 358)

Simon & Schuster. New York, New York, USA. 1940

**Keller, Helen** 1880–1968

American author and lecturer

Now I feel as if I should succeed in doing something in mathematics, although I cannot see why it is so very important...The knowledge doesn't make life any sweeter or happier, does it?

*The Story of My Life*

Letter to Mrs. Laurence Hutton, May 29, 1898 (p. 242)

Grosset & Dunlap, Publishers. New York, New York, USA. 1905

...I've said goodbye to Mathematics forever, and I assure you, I was delighted to see the last of those horrid goblins!

*The Story of My Life*

Letter to Mr. John D. Wright, December 9, 1900 (p. 270)

Grosset & Dunlap, Publishers. New York, New York, USA. 1905

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Do not imagine that mathematics is harsh and crabbed, and repulsive to common sense. It is merely the etherealisation of common sense.

*Popular Lectures and Addresses* (Volume 1)

Presidential Address

Birmingham and Midland Institute

October 3, 1883 (p. 273)

Macmillan & Company Ltd. London, England. 1894

**Keyser, Cassius Jackson** 1862–1947

American mathematician

But for the unattainable ideal of logical perfection, we should be without the miracles of modern Mathematics.

*Mole Philosophy and Other Essays*

Chapter I (p. 3)

E.P. Dutton & Company, Inc. New York, New York, USA. 1927

Every major concern among the intellectual concerns of man is a concern of mathematics.

*Mole Philosophy and Other Essays*

Chapter XVII (p. 93)

E.P. Dutton & Company, Inc. New York, New York, USA. 1927

Mathematics, like any other cardinal activity of the human spirit, has an individuality of its own.

*Mathematics and the Question of Cosmic Mind with Other Essays*

The Meaning of Mathematics (p. 3)

Scripta Mathematica. New York, New York, USA. 1935

It can, you see, be said, with the same approximation to truth, that the whole of science, including mathematics, consists in the study of transformations or in the study of relations.

*Mathematical Philosophy: A Study of Fate and Freedom*

Chapter X (p. 168)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

Mathematics is no more the art of reckoning and computation than architecture is the art of making bricks or hewing wood, no more than painting is the art of mixing colors on a palette, no more than the science of geology is the art of breaking rocks, or the science of anatomy the art of butchering.

*Lectures on Science, Philosophy and Art, 1907–1908*

Mathematics (p. 29)

The Columbia University Press. New York, New York, USA. 1908

It seems indeed as if the entire surface of the world of human consciousness were predestined to be covered over, in varying degrees of luxuriance, by the flora of mathematic science.

*Lectures on Science, Philosophy and Art, 1907–1908*

Mathematics (p. 36)

The Columbia University Press. New York, New York, USA. 1908

But while mathematics may spring up and flourish in any and all experimental and observational fields, it is by no means to be expected that 'experiment and' observation will ever thus be superseded.

*Lectures on Science, Philosophy and Art, 1907–1908*

Mathematics (p. 37)

The Columbia University Press. New York, New York, USA. 1908

Mathematics is, in a word, the study of Fate. Let me hasten to say that the Fate is not physical, it is spiritual – the unbreakable binding thread of destiny runs through the universum of rigorous Thought: the fate is logical Fate.

*Mathematical Philosophy*

Lecture IX (p. 136)

E.P. Dutton & Co. New York, New York, USA. 1922

Mathematics has been often praised by the scientifically incompetent; it has not, so far as I am aware, been dispraised, or its worth challenged or denied, by the scientifically competent.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter I (p. 1)

Columbia University Press. New York, New York, USA. 1916

...mathematics may be viewed either as an enterprise or as a body of achievements. As an enterprise mathematics is characterized by its aim, and its aim is to think rigorously whatever is rigorously thinkable or whatever may become rigorously thinkable in course of the upward striving and refining evolution of ideas. As a body of achievements mathematics consists of all the results that have come, in the course of the centuries, from the prosecution of that enterprise: the truth discovered by it; the doctrines created by it; the



influence of these, through their applications and their beauty, upon the advancement of civilization and the weal of man.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter I (p. 3)  
Columbia University Press. New York, New York, USA. 1916

Mathematics may be legitimately pursued for its own sake or for the sake of its applications or with a view to understanding its logical foundations and internal structure or in the interest of magnanimity or for the sake of its bearings upon the supreme concerns of man as man or from two or more of these motives combined.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter II (p. 30)  
Columbia University Press. New York, New York, USA. 1916

And now what, he [he critic] would ask, is the answer of mathematics? The answer, he would have to say, is this: Transcending the flux of the sensuous universe, there exists a stable world of pure thought, a divinely ordered world of ideas, accessible to man, free from the mad dance of time, infinite and eternal.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter II (p. 58)  
Columbia University Press. New York, New York, USA. 1916

Mathematics is, in many ways, the most precious response that the human spirit has made to the call of the infinite and eternal.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Human Significance of Mathematics (p. 59)  
Columbia University Press. New York, New York, USA. 1925

[The] hope of improvement in mathematics teaching, whether in secondary schools or in colleges, lies mainly in the possibility of humanizing it.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Humanization of Teaching Mathematics (p. 62)  
Columbia University Press. New York, New York, USA. 1916

...the average pupil's interest in mathematics is but slight, is a matter of common knowledge. His lack of interest is, in my opinion, due, not to a lack of the appropriate faculty in him, but to the circumstance that he is a human being, whilst mathematics, though it teems with human interest, is not presented to him in its human guise.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter III (p. 65)  
Columbia University Press. New York, New York, USA. 1916

It [mathematics] is not merely as a giant tree throwing out and aloft myriad branching arms in the upper regions of clearer light, and plunging deep and deeper roots in the darker soil beneath. It is rather an immense forest of such oaks, which, however, literally grow into each other, so that, by the junction and intercrease of root with root and limb with limb, the manifold wood becomes a single living organic whole.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter VI (p. 129)  
Columbia University Press. New York, New York, USA. 1916

Mathematics is no more the art of reckoning and computation than architecture is the art of making bricks or hewing wood, no more than painting is the art of mixing colors on a palette, no more than the science of geology is the art of breaking rocks, or the science of anatomy the art of butchering.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter XV (p. 298)  
Columbia University Press. New York, New York, USA. 1916

What is mathematics? I inquire, not about the word, but about the thing. Many have been the answers of former years, but none has approved itself as final. All of them, by nature belonging to the "literature of knowledge," have fallen under its law and "perished by supersession."

*Mathematics* (p. 9)  
The Columbia University Press. New York, New York, USA. 1907

### **Klein, Felix** 1849–1925

German mathematician

Mathematics in general is fundamentally the science of self evident things.

*Mathematics: Queen and Servant of Science*  
Mathematical Truth (pp. 19–20)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

In fact, mathematics has grown like a tree, which does not start at its tiniest rootlets and grow merely upward, but rather sends its roots deeper and deeper at the same time and rate that its branches and leaves are spreading upward... We see, then, that as regards the fundamental investigation in mathematics, there is no final ending, and therefore on the other hand, no first beginning...

Translated by E.R. Hedrick and C.A. Noble  
*Elementary Mathematics from an Advanced Standpoint*  
Part First, Chapter I, Section 3 (p. 15)  
Dover Publications. New York, New York, USA. 1939

### **Kline, Morris** 1908–92

American mathematics professor and writer

...mathematics has determined the direction and content of much philosophic thought, has destroyed and rebuilt religious doctrines, has supplied substance to economic and political theories, has fashioned major painting, musical, architectural, and literary styles, has fathered our logic, and has furnished the best answers we have to fundamental questions about the nature of man and his universe. As the embodiment and most powerful advocate of the rational spirit, mathematics has invaded domains ruled by authority, custom, and habit, and supplanted them as the arbiter of thought and action. Finally, as an incomparably fine human achievement mathematics offers satisfactions and aesthetic values at least equal to those offered by any other branch of our culture.

*Mathematics in Western Culture*  
Preface (p. ix)

Oxford University Press, Inc. New York, New York, USA. 1953

When we consider the number of fields on which mathematics impinges and the number of these over which it already gives us mastery or partial mastery, we are tempted to call it a method of approach to the universe of physical, mental, and emotional experiences. It is distillation of highest purity that exact thought has extracted from man's efforts to understand nature, to impart order to the confusion of events occurring in the physical world, to create beauty, and to satisfy the natural proclivity of the healthy brain to exercise itself.

*Mathematics in Western Culture*

Chapter XXVIII (pp. 471–472)

Oxford University Press, Inc. New York, New York, USA. 1953

We should drop the ideas that mathematics and what mathematics says about the world are indubitable truths. Today there is no agreement among mathematicians on fundamental principles.... Mathematics is not the universally accepted, precise body of knowledge that it was thought to be 100 years ago when scholars believed that it revealed the design of the universe.

*Mathematics: From Precision to Doubt in 100 Years*

*US News and World Report*, January 26, 1981

The conquest of new domains of mathematics proceeds somewhat as do military conquests. Bold dashes into enemy territory capture strongholds. These incursions must then be followed up and supported by broader, more thorough and more cautious operations to secure what has been only tentatively and insecurely grasped.

*Mathematical Thought from Ancient to Modern Times*

Chapter 19 (p. 400)

Oxford University Press, Inc. New York, New York, USA. 1972

Science provides the understanding of the universe in which we live. Mathematics provides the dies by which science is molded. Our world is to a large extent what mathematics says it is.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

The Meaning of Mathematics (p. 18)

Wadsworth, Inc. Belmont, California, USA. 1984

Perhaps the best reason for regarding mathematics as an art is not so much that it affords an outlet for creative activity as that it provides spiritual values. It puts man in touch with the highest aspirations and loftiest goals. It offers intellectual delight and the exaltation of resolving the mysteries of the universe.

*Mathematics: A Cultural Approach*

Chapter 31–4 (p. 671)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1962

As man's greatest and most successful intellectual experiment, mathematics demonstrates manifestly how powerful our rational faculty is. It is the finest expression of man's intellectual strength. His reason has, for example, far outstripped his imagination. He can think about stars

so distant that only numbers convey any meaning about spaces which cannot be pictured, and about electrons too small to be seen with the most powerful microscopes.

*Mathematics: A Cultural Approach*

Chapter 31–15 (p. 674)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1962

Indeed it is paradoxical that abstractions so remote from reality should achieve so much. Artificial the mathematical account may be, a fairy tale perhaps, but one with a moral.

*Mathematics: A Cultural Approach*

Chapter 31–6 (p. 676)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1962

Mathematics then is a formidable and bold bridge between ourselves and the external world. Though it is a purely human creation it has given us to some domains of nature enable us to progress far beyond all expectations.

The mere fact that there can be alternative geometries was in itself a shock. But the greater shock was that one could no longer be sure which geometry was true or whether anyone of them was true.... Mathematicians were in the position described by Mark Twain: "Man is the religious animal. He's the only one who's got the true religion – several of them."

*Mathematics: The Loss of Certainty*

Chapter IV (p. 88)

Oxford University Press, Inc. New York, New York, USA. 1980

From dust thou are to dust returneth may perhaps not be spoken of the soul but it is well spoken of earthborn mathematics.

*Mathematics and the Physical World*

Chapter 1 (p. 13)

Thomas Y. Crowell Co. New York, New York, USA. 1959

Mathematics may be the queen of the sciences and therefore entitled to royal prerogatives, but the queen who loses touch with her subjects may lose support and even be deprived of her realm. Mathematicians may like to rise into the clouds of abstract thought, but they should and indeed they must, return to earth for nourishing food or else die of mental starvation. They are on safer and saner ground when they stay close to nature. As Wordsworth put it, "Wisdom oft is nearer when we stoop than when we soar."

*Mathematics and the Physical World*

Chapter 27 (p. 475)

Thomas Y. Crowell Co. New York, New York, USA. 1959

### **Kovalevskaya, Sofia** 1850–91

Russian mathematician

Many who have never had an opportunity of knowing anymore about mathematics confound it with arithmetic, and consider it an arid science.

Translated by Isabel f. Hapgood  
 In Lily Wolffsohn  
*Sónya Kovalévsky: Her Recollections of Childhood* (p. 316)  
 The Century Co. New York, New York, USA. 1895

### Krylov, A. N.

Russian mathematician

Mathematics, like a millstone, grinds everything placed under it and, just as you won't get wheat flour by grinding Deadly Nightshade, you won't get the truth from the false premises even if you cover the page with formulae ...

Translated by Valerii Ilyushchenko  
 Quoted in V.I. Denisov and A.A. Logunov  
*Gravitation and Elementary Particle Physics*  
*The Theory of Space-Time and Gravitation* (p. 27)  
 MIR Publishers. Moscow, Russia. 1983

### Lakatos, Imre 1922–74

Hungarian-born philosopher

Mathematics has been trivialized, derived from indubitable, trivial axioms in which only absolutely clear trivial terms figure, and from which truth pours down in clear channels.

*Mathematics, Science and Epistemology* (Volume 2)  
 Chapter 1 (p. 10)  
 Cambridge University Press. Cambridge, England. 1978

Mathematics does not grow through a monotonous increase of the number of indubitably established theorems, but through the incessant improvement of guesses by speculation and criticism.

In Michael Guillen  
*Bridges to Infinity: The Human Side of Mathematics*  
 Part I, A Certain Treasure (p. 19)  
 Jeremy P. Tarcher, Inc. Los Angeles, California. USA. 1983

### Lamb, Sir Horace 1848–1934

English applied mathematician

A traveler who refuses to pass over a bridge until he has personally tested the soundness of every part of it is not likely to go far; something must be risked, even in mathematics.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 468)  
 Oxford University Press, Inc. New York, New York, USA. 1972

### Langer, R. E.

No biographical data available

Rich in its past, dynamic in the present, prodigious for the future, replete with simple and yet profound ideas and methods, surely mathematics can give something to anyone's culture.

The Things I Should Have Done, I Did Not Do  
*The American Mathematical Monthly*, Volume 59, Number 7, August–September, 1952 (p. 445)

### Lasserre, Francois

No biographical data available

Ask a philosopher “What is philosophy?” or a historian “What is history?” and they will have no difficulty in giving an answer. Neither of them, in fact, can pursue his own discipline without knowing what he is searching for. But ask a mathematician “What is mathematics?” and he may justifiably reply that he does not know the answer but that does not stop him from doing mathematics.

In John D. Barrow  
*Pi in the Sky: Counting, Thinking, and Being* (p. 1)  
 Clarendon Press. Oxford, England. 1992

### Lec, Stanislaw 1909–66

Polish poet and aphorist

I don't agree with mathematics; the sum total of zeros is a frightening figure.

Translated by Jacek Galazka  
*More Unkempt Thoughts* (p. 26)  
 Funk & Wagnalls. New York, New York, USA. 1968

### Levitt, Norman

American mathematician

The dictum that everything that people do is “cultural” licenses the idea that every cultural critic can meaningfully analyze even the most intricate accomplishments of art and science.... It is distinctly weird to listen to pronouncements on the nature of mathematics from the lips of someone who cannot tell you what a complex number is!

The Flight from Science and Reason  
*Science*, October 11, 1996 (p. 183)

### Lewes, George Henry 1817–78

English philosopher

...mathematicians and philosophers resist the notion of Mathematics being classed among the sciences of observation and experiment; a classification which is supposed to degrade Mathematics from its supreme position, arid to introduce contingency into its results.

*Problems of Life and Mind* (Volume 1)  
 Problem I, Chapter XIV (p. 384)  
 James R. Osgood & Co. Boston, Massachusetts, USA. 1874

### Libchaber, Albert 1934–

Chaos theorist

A physicist would ask me, How does this atom come here and stick there? And what is the sensitivity to the surface? And can you write the Hamiltonian of the system? And if I tell him, I don't care, what interests me is this shape, the mathematics of the shape and the evolution, the bifurcation from this shape to that shape to this shape, he will tell me, that's not physics, you are doing mathematics.

In James Gleick  
*Chaos: Making a New Science*

The Experimenter (pp. 210–211)  
The Viking Press. New York, New York, USA. 1987

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

Mathematics is truly a splendid science, but mathematicians often are not worth a nickel. . . very often the so-called mathematician expects to be considered a deep thinker; yet the greatest blockheads are among them, unfit for any kind of occupation which requires contemplation if it cannot be done directly through that easy combination of symbols, which is more the work of routine than of thought.

*Tag and Donnerung*

Aphorismen (p. 305)

Publisher undetermined

**Lieber, Lillian R.**

Mathematician

When we learn to drive a car we are able to “go places” easily and pleasantly instead of walking to them with a great deal of effort. And so you will see that the more Mathematics we know the EASIER life becomes, for it is a TOOL with which we can accomplish things that we could not do at all with our bare hands. Thus Mathematics helps our brains and hands and feet, and can make a race of supermen out of us.

*The Education of T.C. Mits*

Part I, Chapter IV (p. 45)

W.W. Norton & Company, Inc. New York, New York, USA. 1944

**Lindsay, R. Bruce**

No biographical data available

Of one thing we may be sure: physics without mathematics will forever be incomprehensible.

On the Relation of Mathematics and Physics

*Scientific Monthly*, Volume 59, December, 1944 (p. 460)

**Lobachevskii, Nikolai Ivanovich** 1792–1856

Russian mathematician

There is no branch of mathematics however abstract which may not someday be applied to phenomena of the real world.

In Stanley Gudder

*A Mathematical Journey* (p. 36)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Locke, John** 1632–1704

English philosopher and political theorist

. . . would you have a man reason well, you must use him to it betimes, exercise his mind in observing the connexion of ideas, and following them in train. Nothing does this better than mathematics, which, therefore, I think should be taught all those who have the time and opportunity; not so much to make them mathematicians, as to make them reasonable creatures; for though we all

call ourselves so, because we are born to it, if we please; yet we may truly say, nature gives us but the seeds of it: we are born to be, if we please, rational creatures; but it is use and exercise only that make us so, and we are, indeed, so no farther than industry and application have carried us.

*An Essay Concerning Human Understanding* (Volume 2)

On the Conduct of the Understanding (p. 220)

Printed for Thomas Tegg. London, England. 1828

**Lucas, William F.**

No biographical data available

Although some older art, music or wines may be better than the newer, it is rather unlikely that this would often apply to science or mathematics.

In Lynn Arthur Steen

*Mathematics Tomorrow*

Growth and New Intuitions: Can We Meet the Challenge? (p. 65)

Springer-Verlag. New York, New York, USA. 1981

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Mathematics may be defined as the economy of counting. There is no problem in the whole of mathematics which cannot be solved by direct counting. But with the present implements of mathematics many operations of counting can be performed in a few minutes, which, without mathematics, would take a lifetime.

In J.W. Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. 184)

Dover Publications. New York, New York, USA. 1955

**MacLane, Saunders** 1909–2005

American mathematician

Mathematics, springing from the soil of basic human experience with numbers and data and space and motion, builds up a far-flung architectural structure composed of theorems which reveal insights into the reasons behind appearances and of concepts which relate totally disparate concrete ideas.

Of Course and Courses

*The American Mathematical Monthly*, Volume 61, Number 3, March,

1954 (p. 152)

**Mazur, Barry** 1937–

American mathematician

The wonderful thing about mathematics is that, in the end as well as in the beginning, it can depend upon no authority other than one’s own (your own) mind; its verification comes from thinking alone, an activity open to anyone. If we have no theoretical equipment, we use the mathematical eyes and ears with which we were born and just experiment with our guesses to see whether we have faith in them.

*Imagining Numbers*

Part II, Chapter 10, Section 57 (p. 188)

Farrar Straus & Giroux. New York, New York, USA. 2003

**McDuff, Dusa** 1945–  
Mathematician

Gel'fand amazed me by talking of mathematics as though it were poetry. He once said about a long paper bristling with formulas that it contained the vague beginnings of an idea which he could only hint at and which he had never managed to bring out more clearly. I had always thought of mathematics as being much more straightforward: a formula is a formula, and an algebra is an algebra, but Gel'fand found hedgehogs lurking in the rows of his spectral sequences!

*Mathematical Notices*, Volume 38, Number 3, March, 1991 (p. 186)

**Mellor, Joseph William** 1863–1938  
Chemist

Higher Mathematics is the art of reasoning about numerical relations between natural phenomena; and the several sections of Higher Mathematics are different modes of viewing these relations.

*Higher Mathematics for Students of Chemistry and Physics*

Prologue

New York, New York, USA. 1902

**Mencke, J. B.** 1674–1732  
Poet

[Mathematics] guides our minds in an orderly way, and furnishes us simple and rational principles by means of which ambiguities are clarified, disorder is converted into order, and complexities are analyzed into their component parts.

*The Charlatanry of the Learned*

Lecture II (p. 152)

Alfred A. Knopf. New York, New York, USA. 1937

[Mathematics] includes much that will neither hurt one who does not know it nor help one who does.

*The Charlatanry of the Learned*

Lecture II (p. 152)

Alfred A. Knopf. New York, New York, USA. 1937

**Mendés, Michel**  
No biographical data available

A talk in mathematics should be one of four things: beautiful, deep, surprising...or short.

Remark, ca. 1986

**Meyer, Walter**  
No biographical data available

In a time when much of the world's geography has been explored, and space exploration is restricted to astronauts, mathematics offers fertile ground for exploring the unknown.

Missing Dimensions of Mathematics

*Humanistic Mathematics Network Journal*, Number 11, February, 1995

**Merriman, Gaylord M.**

Mathematics has probably been variously defined more often than almost any other subject. This multiplicity of definition is not difficult to understand in view of the many heads of this monstrous hydra.

*To Discover Mathematics*

Chapter 2 (p. 19)

John Wiley & Sons. New York, New York, USA. 1942

**Merz, John Theodore** 1840–1922

German-born British chemist, historian, and industrialist

There is an opinion current among many thinking persons who have not occupied themselves with mathematics, mathematical science, though they may be very efficient in calculating and measuring, that there is really nothing new in mathematics, that two and two always make four, that the sum of the angles in a triangle always make two right angles, and that all progress in mathematics is merely a question of intricacy, a never-ending process of increased complication by which you can puzzle even the cleverest calculator.

*A History of European Thought in the Nineteenth Century* (Volume 2)

Chapter XIII (pp. 628–629)

William Blackwood & Sons. Edinburgh, Scotland. 1907

**Metzler, W. H.**

No biographical data available

It is true that the facts of mathematics, elementary and higher, though not of necessity of the greatest importance to the individual, are of prime importance to the race.

The Value of Mathematics

*Journal of Pedagogy*, Volume XVII, Number 4, June, 1905 (p. 281)

**Miller, George Abram** 1863–1951

American mathematician

Mathematics deals mainly with realities and stern facts, and it arms those whose life work is beset with physical difficulties. Hence it appeals especially to the leaders of the common people, and it performs a fundamental function in the education of those who aim to excel in overcoming material difficulties.

*Historical Introduction to Mathematical Literature*

Chapter I (p. 3)

The Macmillan Co. New York, New York, USA. 1916

Mathematics has a large household and there are always rumors of prospective additions despite her age and her supposed austerity.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1912)

Modern Mathematical Research (p. 187)

Government Printing Office. Washington, D.C. 1913

**Mirowski, P.**

No biographical data available

...mathematics does not come to us written indelibly on Nature's Tablets, but rather is the product of a controlled

search governed by metaphorical considerations, the premier instance being the heuristics of the conservation principles.

*More Heat than Light: Economics as Social Physics: Physics as Nature's Economics*

Chapter 1 (p. 7)

Cambridge University Press. Cambridge, England. 1989

**Mivart, St. George Jackson** 1827–1900

English biologist

...the study of that which is thus common to all things, is the study of mathematics; and therefore mathematics, or the science of number, is and must be the most fundamental of all sciences, since it pertains to every other, and no other can be pursued without it.

*An Introduction to the Elements of Science*

Chapter 1 (p. 5)

Little, Brown & Co. Boston, Massachusetts, USA. 1894

**Modjeski, Ralph** 1861–1940

Polish-born American engineer

**Waddell, John Alexander Low** 1854–1938

American bridge engineer

...one does not know a foreign language unless one is able to think in that language; one does not know mathematics unless one is able to think mathematically.

*The Teaching of Mathematics to Students of Engineering*

*Science*, New Series, Volume 28, Number 710, August 7, 1908 (p. 163)

**Morawetz, Cathleen Synge** 1923–

Canadian mathematician

I find that I may have emphasized the need to escape from the devils of mathematics to embark on the pleasures of the real world. But it works both ways, and sometimes the devils of the real world drive one into the pleasures of studying mathematics.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 238)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Mordell, Louis Joel** 1888–1972

English mathematician

...what is mathematics? It has so many different aspects that the difficulties in trying to give a definition are similar to those encountered in trying to determine whether some living organisms are animal or vegetable.

*Reflections of a Mathematician*

Chapter 1 (pp. 1–2)

Canadian Mathematical Congress. 1959

**More, Louis Trenchard**

American educator

The supreme value of mathematics to science is due to the fact that scientific laws and theories have their best, if not their only complete, expression in mathematical formulae; and the degree of accuracy with which we can

express scientific theory in mathematical terms is a measure of the state of a science.

*The Limitations of Science*

Chapter V (p. 150)

Henry Holt & Co. New York, New York, USA. 1915

**Morse, Harold Calvin Marston** 1892–1977

American mathematician

As Durer knew full well, there is a center and final substance in mathematics whose perfect beauty is rational, but rational “in retrospect.” The discovery which comes before, those rare moments which elevate man, and the searchings of the heart which come after are not rational. They are groupings filled with wonder and sometimes sorrow.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematics and the Arts (p. 92)

Mathematical Association of America. Washington, D.C. 2004

**Musès, Charles** 1919–2000

American mathematician, philosopher, and computer scientist

Between what we call the subjective and the objective, mathematics is strangely, fascinatingly ambivalent. It maps, penetrating as nothing else can, both the nature of the observable worlds and that of the mind that perceives the world by means of the body and its senses. Mathematics assumes a fundamental place in science, which represents nothing else than our attempt to understand the world we experience (including our bodies and minds). mathematics can do this because it provides a language by which we can explore, and describe precisely and profoundly, any possible set of characteristics or relationships – sometimes more accurately than words alone.

*Explorations in Mathematics*

UNESCO

Impact of Science on Society

Volume 27, Number 1, 1977

Mathematics penetrates, as nothing else can, both the nature of the observable world and that of the mind that perceives the world by means of the body and its senses. Mathematics assumes a fundamental place in science, which represents nothing else than our attempt to understand the world we experience (including our bodies and minds). Mathematics can do this because it provides a language by which we can explore, and describes precisely and profoundly, any possible set of characteristics or relationships – sometimes more accurately than words alone would allow.

*Science Digest*, April, Volume 83, Number 4, 1978 (p. 33)

**Moultrie, John** 1799–1874

English poet

There’s nothing in the world (that is in Trinity)

To make us poets happy; –

I detest



Your Hebrew, Greek and heathenish Latinity,  
And Mathematics are a bore at best.

*Poems*

Sir Launfal, xii

William Pickering. London, England. 1838

### National Research Council (USA)

Citizens who are bombarded daily with conflicting quantitative information need to be aware of both the power and the limitations of mathematics.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Opportunity (p. 9)

National Academy Press. Washington, D.C. 1989

Without strong mathematics, there can be no strong science.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Opportunity (p. 35)

National Academy Press. Washington, D.C. 1989

To participate fully in the world of the future, America must tap the power of mathematics.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Opportunity (p. 1)

National Academy Press. Washington, D.C. 1989

Everyone depends on the success of mathematics education; everyone is hurt when it fails.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Opportunity (p. 7)

National Academy Press. Washington, D.C. 1989

...each individual's knowledge of mathematics is uniquely personal. Mathematics becomes useful to a student only when it has been developed through a personal intellectual engagement that creates new understanding.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Opportunity (p. 6)

National Academy Press. Washington, D.C. 1989

Mathematics deals with questions that can be answered by thought and only by thought.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 57)

National Academy of Sciences

Washington, D.C. 1972

### Newman, James Roy 1911–66

Mathematician and mathematical historian

Mathematics has its paradoxes, astronomy its uncertainties (about what is being measured), physics having suffered certain metaphysical relapses can survive only by swallowing entire jugs of wholly contradictory measurements. As for psychology, its most brilliant and its most scandalous success has been in a realm of theory in which measurement is as welcome as Macduff at Dunsinane.

*The World of Mathematics* (Volume 2) (p. 1147)

Here, then, in mathematics we have a universal language, valid, useful, intelligible everywhere in place and in time – in banks and insurance companies, on the parchments of the architects who raised the Temple of Solomon, and on the blueprints of the engineers who, with their calculus of chaos, master the winds. Here is a discipline of a hundred branches, fabulously rich, literally without limit in its sphere of application, laden with honors for an unbroken record of magnificent accomplishment. Here is a creation of the mind, both mystic and pragmatic in appeal. Austere and imperious as logic, it is still sufficiently sensitive and flexible to meet each new need.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 358)

Simon & Schuster. New York, New York, USA. 1940

### Nietzsche, Friedrich Wilhelm 1844–1900

German philosopher

...mathematics...would certainly have not originated if it had been known from the beginning that there is no exactly straight line in nature, no real circle, no absolute measure.

Translated by Marion Faber

*Human, All Too Human: A Book for Free Spirits*

Section 1, Number 11 (p. 19)

University of Nebraska Press. Lincoln, Nebraska, USA. 1984

### Nordmann, Charles

Astronomer

...mathematics is not, never was, and never will be, anything more than a particular kind of language, a sort of shorthand of thought and reasoning. The purpose of it is to cut across the complicated meanderings of long trains of reasoning with a bold rapidity that is unknown to the mediaeval slowness of the syllogisms expressed in our words.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Chapter I (pp. 23–24)

Henry Holt & Co. New York, New York, USA. 1922

### Norfolk, Timothy S.

No biographical data available

It is as if mathematics were the vegetables of the academic dinner: Everyone knows that they are good for you, but no one forces you to eat them.

It's Time to Stop

*FOCUS*, February, 1997 (pp. 14–15)

### Northrop, Eugene

No biographical data available

Consider mathematics as a discipline in itself – that is to say, as a body of concepts and methods which constitute a way of thinking. Surely mathematics is such a discipline. It deals almost exclusively with premises and conclusions, and with deductive reasoning, which is one of the

more important methods of drawing conclusions from premises. Moreover, clarity and precision of definitions and assumptions, and rigor in reasoning, can be more nearly attained and more simply studied in mathematics than in the other disciplines. Is this not the real place of mathematics in a liberal education – not simply as a subject matter, or as a discipline applicable only to its own subject matter, but as a discipline which is applicable to almost every intellectual activity of man?

Mathematics in a Liberal Education

*The American Mathematical Monthly*, Volume 52, Number 3, March, 1945 (p. 133)

**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

All Mathematics is, properly speaking, an equation on a great scale for the other sciences.

Quoted in Panthea

*Eclectic Gatherings*

*The Reasoner*, Volume 6 1849 (p. 373)

In music, mathematics appears formally, as revelation, as creative idealism. All enjoyment is musical, consequently mathematical. The highest life is mathematics.

In Kuno Francke and Isidore Singer

*The German Classics: Masterpieces of German Literature Translated Into English*

*Aphorisms* (p. 188)

The German Publication Society. New York, New York, USA. 1914

The life of the Gods is mathematics. All divine messengers must be mathematicians. Pure mathematics is religion. Mathematicians are the only fortunate ones. The mathematician is naturally an enthusiast. Without enthusiasm no mathematics.

In James Byrnie Shaw

*Bulletin of the American Mathematical Society*

Book Review

Volume XIX, February, 1913 (p. 253)

The highest life is mathematics. Without enthusiasm no mathematics. The life of the gods is mathematics. Pure mathematics is religion. It is arrived at only by revelation.

*Main Currents in Nineteenth, Century Literature*

Chapter XII (p. 197)

The Macmillan Co. New York, New York, USA. 1906

**O. Henry (William Sydney Porter)** 1862–10  
American short story writer and journalist

His mathematics carried with it a momentary qualm and a lesson. The thought had not occurred to him that the thought could possibly occur to me not to ride at his side on that red road to revenge and justice. It was the higher calculus. I was booked for the trail. I began to eat more beans.

*Tales of O. Henry*

A Technical Error (p. 1059)

Doubleday & Company, Inc. Garden City, New York, USA. 1953

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Today, it is not only that our kings do not know mathematics, but our philosophers do not know mathematics and – to go a step further – our mathematicians do not know mathematics.

The Tree of Knowledge

*Harper's Magazine*, Volume 217, Number 1301, October, 1958 (p. 55)

**Pappas, Theoni**  
Mathematician

Many people associate cold logic with mathematics. They consider the subject sterile and difficult to comprehend, and those that create it are often perceived as superior... nerdy... strange.

*Mathematical Scandles*

Introduction (p. 4)

Wide World Publishing. San Carlos, California, USA. 1997

**Pascal, Blaise** 1623–62  
French mathematician and physicist

For it is to judgment that perception belongs, as science belongs to intellect. Intuition is the part of judgment, mathematics of intellect.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 4

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Paulos, John Allen** 1945–  
American mathematician

Mathematics is no more computation than writing is typing.

*Bend Numeracy*

Computation and Rote (p. 54)

Alfred A. Knopf. New York, New York, USA. 1991

**Peirce, Benjamin** 1809–80  
American mathematician, astronomer, and educator

Mathematics is not the discoverer of laws, for it is not induction; neither is it the framer of theories, for it is not hypothesis; but it is the judge over both, and it is the arbiter to which each must refer its claims; and neither law can rule nor theory explain without the sanction of mathematics.

Linear Associative Algebra

*American Journal of Mathematics*, Volume 4, 1881 (p. 97)

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

...metaphysics has always been the ape of mathematics.

The Architecture of Theories

*The Monist*, Volume 1, Number 2, January, 1891 (p. 174)

**Peter, Rozas**

No biographical data available

Mathematics can give to the world such worthwhile things – about infinity; and yet how essentially human it is – unlike the dull multiplication table, it bears on it forever the stamp of man’s handiwork.

*Playing With Infinity*

Preface (p. v)

Simon & Schuster. New York, New York, USA. 1962

I love mathematics not only for its technical applications, but principally because it is beautiful; because man has breathed his spirit of play into it and because it has given him his greatest game – the encompassing of the infinite.

*Playing With Infinity*

Preface (p. v)

Simon & Schuster. New York, New York, USA. 1962

### Peterson, Ivars

Mathematics and computer writer and editor

To most outsiders, modern mathematics is unknown territory. Its borders are protected by dense thickets of technical terms; its landscapes are a mass of indecipherable equations and incomprehensible concepts. Few realize that the world of modern mathematics is rich with vivid images and provocative ideas.

*The Mathematical Tourist: Snapshots of Modern Mathematics*

Preface (p. xiii)

W.H. Freeman & Company. New York, New York, USA. 1988

...mystery is an inescapable ingredient of mathematics. Mathematics is full of unanswered questions, which far outnumber known theorems and results. It’s the nature of mathematics to pose more problems than it can solve. Indeed, mathematics itself may be built on small islands of truth comprising the pieces of mathematics that can be validated by relatively short proofs. All else is speculation.

*Islands of Truth: A Mathematical Mystery Cruise*

Preface (p. xvi)

W.H. Freeman & Company. New York, New York, USA. 1990

### Philips, J. D.

No biographical data available

Students must learn that mathematics is the most human of endeavors. Flesh and blood representatives of their own species engaged in a centuries long creative struggle to uncover and to erect this magnificent edifice. And the struggle goes on today. On the very campuses where mathematics is presented and received as an inhuman discipline, cold and dead, new mathematics is created. As sure as the tides.

Mathematics as an Aesthetic Discipline

*Humanistic Mathematics Network Journal*, Number 12, October, 1995

### Poe, Edgar Allan 1809–49

American short story writer

The mathematics are the science of form and quantity, mathematical reasoning is merely logic applied to observation upon form and quantity.

Translated by Jessie Haynes

*The Fall of the House of Usher*

The Purloined Letter (p. 230)

Walter Scott. London, England. 1889

The word “Verse” is used here as the term most convenient for expressing, and without pedantry, all that is involved in the consideration of rhythm, rhyme, meter, and versification...the subject is exceedingly simple; one tenth of it, possibly, may be called ethical; nine tenths, however, appertains to the mathematics.

Quoted in Stanley Gudder

*A Mathematical Journey* (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

### Poiani, Eileen L.

Mathematician

Like it or not, mathematics opens career doors, so it’s downright practical to be prepared.

In Lynn Arthur Steen

*Mathematics Tomorrow*

The Real Energy Crisis (p. 158)

Springer-Verlag. New York, New York, USA. 1981

Mathematics plays the critical filter role not only at the college level, but also in the work force.

In Lynn Arthur Steen

*Mathematics Tomorrow*

The Real Energy Crisis (p. 160)

Springer-Verlag. New York, New York, USA. 1981

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Mathematics has a triple end. It is to furnish an instrument for the study of nature. But that is not all. It has a philosophic end, and I dare say it, an esthetic end.... Those skilled in mathematics find in it pleasure akin to those which painting and music give. They admire the delicate harmony of numbers and of forms; they marvel when a new discovery opens an unexpected perspective; and is this pleasure not esthetic, even though the senses have no part in it?

*Sur les rapports de l’analyse pur et de la physique mathématique*

Report to the Zurich International Congress of Mathematics, 1897

(p. 82)

The true method of forecasting the future of mathematics lies in the study of its history and its present state.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 123)

Government Printing Office. Washington, D.C. 1910

I do not know whether or not I have said somewhere that mathematics is the art of giving the same name to different things.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1909

The Future of Mathematics (p. 128)

Government Printing Office, Washington, D.C. 1910

How does it happen that there are people who do not understand mathematics? If mathematics invokes only the rules of logic, such as are accepted by all normal minds; if its evidence is based on principles common to all men, and that none could deny without being mad, how does it come about that so many persons are here refractory?

*The Foundations of Science*

*Science and Method*, Book I

Chapter III (p. 383)

The Science Press, New York, New York, USA. 1913

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

While applied mathematics is object-directed, pure mathematics has no outside object; being concerned with objects of its own creation, it may be described as “object creating.”

*Personal Knowledge*

Chapter 5, Section 2 (p. 76)

Harper & Row, Publishers, New York, New York, USA. 1962

Nowhere is intellectual beauty so deeply felt and fastidiously appreciated in its various grades and qualities as in mathematics, and only the informal appreciation of mathematical value can distinguish what is mathematics from a welter of formally similar, yet altogether trivial statements and operations.

*Personal Knowledge*

Chapter 6, Section 10 (p. 188)

Harper & Row, Publishers, New York, New York, USA. 1962

All these difficulties are but consequences of our refusal to see that mathematics cannot be defined without acknowledging its most obvious feature: namely, that it is interesting.

*Personal Knowledge*

Chapter 6, Section 10 (p. 188)

Harper & Row, Publishers, New York, New York, USA. 1962

We should declare instead candidly that we dwell on mathematics and affirm its statements for the sake of its intellectual beauty, which betokens the reality of its conceptions and the truth of its assertions. For if this passion were extinct, we would cease to understand mathematics; its conceptions would dissolve and its proofs carry no conviction. Mathematics would become pointless and would lose itself in a welter of insignificant tautologies and of Heath Robinson operations, from which it could no longer be distinguished.

*Personal Knowledge*

Chapter 6, Section 11 (p. 192)

Harper & Row, Publishers, New York, New York, USA. 1962

**Pólya, George** 1887–1985

Hungarian mathematician

The traditional mathematics professor of the popular legend is absentminded. He usually appears in public with a lost umbrella in each hand. He prefers to face a blackboard and to turn his back on the class. He writes a, he says b, he means c, but it should be d.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The Traditional Mathematics Professor (p. 208)

Princeton University Press, Princeton, New Jersey, USA. 1973

Mathematics presented with rigor is a systematic deductive science but mathematics in the making is an experimental inductive science.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, Induction and Mathematical Induction (p. 117)

Princeton University Press, Princeton, New Jersey, USA. 1937

**Pope, Alexander** 1688–1744

English poet

See *Mystery to Mathematics fly!*

*The Complete Poetical Works (Volume 4)*

The Duncaid, Book IV, 1 647

Houghton Mifflin Company, New York, New York, USA. 1903

**Pratter, Frederick**

No biographical data available

Music and higher mathematics share some obvious kinship. The practice of both requires a lengthy apprenticeship, talent, and no small amount of grace. Both seem to spring from some mysterious workings of the mind. Logic and system are essential for both, and yet each can reach a height of creativity beyond the merely mechanical.

How Music and Math Seek Truth in Beauty

*Christian Science Monitor*, May 24, 1995

**Pringsheim, Alfred** 1850–1941

German mathematician

It is true that mathematics, owing to the fact that its whole content is built up by means of purely logical deduction from a small number of universally comprehended principles, has not unfittingly been designated as the science of the self-evident. Experience however, shows that for the majority of the cultured, even of scientists, mathematics remains the science of the incomprehensible.

*Jahresbericht der Deutschen Mathematiker Vereinigung*

Ueber Wert and angeblichen Unwert der Mathematik, 1904 (p. 357)

**Poisson, Simeon-Denis** 1781–1840

French mathematician

Life is good for only two things, discovering mathematics and teaching mathematics.

Filler

*Mathematical Magazine*, Volume 64, Number 1, February, 1991

(p. 44)

**Proclus** 411–485  
Greek philosopher

This, therefore, is mathematics: she reminds you of the invisible form of the soul; she gives life to her own discoveries; she awakens the mind and purifies the intellect; she brings light to our intrinsic ideas; she abolishes oblivion and ignorance which are ours by birth.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 24)  
Oxford University Press, Inc. New York, New York, USA. 1972

**Quine, Willard van Orman** 1908–2000  
American logician and philosopher

Irrefragability, thy name is mathematics.

*The Ways of Paradox and Other Essays*

Chapter 3 (p. 24)

Random House, Inc. New York, New York, USA. 1966

**Reid, Thomas** 1710–96  
Scottish philosopher

The science [mathematics], once fairly established on the foundation of a few axioms and definitions, as upon a rock, has grown from age to age, so as to become the most solid fabric that human reason can boast.

*Essays on the Intellectual Power of Man* (4th edition)

Chapter III (p. 348)

Printed for John Bell. London, England. 1785

In mathematics [sophistry] had no place from the beginning: Mathematicians having had the wisdom to define accurately the terms they use, and to lay down, as axioms, the first principles on which their reasoning is grounded. Accordingly we find no parties among mathematicians, and hardly any disputes.

*Essays on the Intellectual Powers of Man*

Essay I, Chapter I (p. 1)

Printed for John Bell. London, England. 1785

**Röntgen, Wilhelm Conrad** 1845–1923  
German physicist

The physicist in preparing for his work need three things, mathematics, mathematics, and mathematics.

*The Mathematical Gazette*, Volume 22, Number 252, December, 1938, 1225

**Rota, Gian-Carlo** 1932–1999  
Italian-born American mathematician

Of all escapes from reality, mathematics is the most successful ever.

*Indiscrete Thoughts*

Chapter VI (p. 70)

Birkhäuser. Boston, Massachusetts, USA. 1997

Very little mathematics has direct applications – though fortunately most of it has plenty of indirect ones.

*Indiscrete Thoughts*

Chapter XX (p. 213)

Birkhäuser. Boston, Massachusetts, USA. 1997

We thought that the generalization of the notion of space had ended with topoi, but we were mistaken. We probably know less about space now than we pretended to know fifty years ago. As mathematics progresses, our understanding of it regresses.

*Indiscrete Thoughts*

Chapter XX (p. 220)

Birkhäuser. Boston, Massachusetts, USA. 1997

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

**Pringsheim, Alfred** 1850–1941  
German mathematician

We often hear that mathematics consists mainly of “proving theorems.” Is a writer’s job mainly that of “writing sentences?”

In Philip J. Davis and Reuben Hersh

*The Mathematical Experience*

Introduction (p. xviii)

Birkhäuser. Boston, Massachusetts, USA. 1981

**Rózsa, Péter** 1905–77  
Hungarian mathematician

The eternal lesson is that Mathematics is not something static, closed, but living and developing. Try as we may to constrain it into a closed form, it finds an outlet somewhere and escapes alive.

*Playing with Infinity: Mathematical Explorations and Excursions*

Chapter 22 (p. 265)

Dover Publications, Inc. New York, New York, USA. 1961

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

But mathematics takes us...into the region of absolute necessity, to which not only the actual world, but every possible world, must conform...

*Mysticism and Logic and Other Essays*

Chapter IV (p. 69)

Longmans, Green & Company. London, England. 1925

I like mathematics because it is not human and has nothing particular to do with this planet or with the whole accidental universe – because like Spinoza’s God, it won’t love us in return.

Letter To Lady Ottoline Morrell, March, 1912

Source undetermined

...the rules of logic are to mathematics what those of structure are to architecture.

*Mysticism and Logic and Other Essays*

Chapter IV (p. 61)

Longmans, Green & Company. London, England. 1925

The true spirit of delight, the exaltation, the sense of being more than Man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry.

*Mysticism and Logic and Other Essays*

Chapter IV (p. 60)

Longmans, Green & Company. London, England. 1925

Mathematics, rightly viewed, possess not only truth, but supreme beauty – a beauty cold and austere, like that of a sculpture...

*Mysticism and Logic and Other Essays*

Chapter IV (p. 60)

Longmans, Green & Company. London, England. 1925

There was a footpath leading across fields to New Southgate, and I used to go there alone to watch the sunset and contemplate suicide. I did not, however, commit suicide, because I wished to know more of mathematics.

*The Autobiography of Bertrand Russell*

Chapter II (p. 53)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

Pure mathematics consists entirely of asseverations to the effect that, if such and such a proposition is true of anything, then such and such another proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the anything is, of which it is supposed to be true.... If our hypothesis is about anything, and not about some one or more particular things, then our deductions constitute mathematics. Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true.

*Mysticism and Logic and Other Essays*

Chapter V (p. 75)

Longmans, Green & Company. London, England. 1925

The nineteenth century which prides itself upon the invention of steam and evolution, might have derived a more legitimate title to fame from the discovery of pure mathematics.

Recent Work on the Principles of Mathematics

*International Monthly*, Volume 4, July–December, 1901 (p. 83)

Every great study is not only an end in itself, but also a means of creating and sustaining a lofty habit of mind; and this purpose should be kept always in view throughout the teaching and learning of mathematics.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 73)

Longmans, Green & Co. London, England. 1919

If we are considering mathematics as an end in itself, and not as a technical training for engineers, it is very desirable to preserve the purity and strictness of its reasoning.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 65)

Longmans, Green & Co. London, England. 1919

In this respect, the discovery that the true principles [of symbolic logic] are as much a part of mathematics as any of their consequences has very greatly increased the intellectual satisfaction to be obtained. This satisfaction ought not to be refused to learners capable of enjoying it, for it is of a kind to increase our respect for human powers and our knowledge of the beauties belonging to the abstract world.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 68)

Longmans, Green & Co. London, England. 1919

One of the chief ends served by mathematics, when rightly taught, is to awaken the learner's belief in reason, his confidence in the truth of what has been demonstrated, and in the value of demonstration.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 62)

Longmans, Green & Co. London, England. 1919

The discovery that all mathematics follows inevitably from a small collection of fundamental laws is one which immeasurably enhances the intellectual beauty of the whole; to those who have been oppressed by the fragmentary and incomplete nature of most existing chains of deduction this discovery comes with all the overwhelming force of a revelation; like a palace emerging from the autumn mist as the traveler ascends an Italian hill-side, the stately storeys of the mathematical edifice appear in their due order and proportion, with a new perfection in every part.

*Mysticism and Logic: And Other Essays*

Chapter IV (pp. 67–68)

Longmans, Green & Co. London, England. 1919

What is best in mathematics deserves not merely to be learnt as a task, but to be assimilated as a part of daily thought, and brought again and again before the mind with ever-renewed encouragement.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 60)

Longmans, Green & Co. London, England. 1919

...mathematics takes us still further from what is human, into the region of absolute necessity, to which not only the actual world, but every possible world, must conform; and even here it builds a habitation, or rather finds a habitation eternally standing, where our ideals are fully satisfied and our best hopes are not thwarted. It is only when we thoroughly understand the entire independence of ourselves, which belongs to this world that reason finds, that we can adequately realise the profound importance of its beauty.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 69)

Longmans, Green & Co. London, England. 1919



**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

If all the arts aspire to the condition of music, all the sciences aspire to the condition of mathematics.

*Some Turns of Thought of the Modern Mind*

Chapter 3 (p. 80)

At The University Press. Cambridge, England. 1933

**Sarton, May** 1912–5

American poet and novelist

...I see a certain order in the universe and math is one way of making it visible.

*As We Are Now* (p. 38)

W.W. Norton & Co. New York, New York, USA. 1973

**Saunders, Kenneth James**

No biographical data available

Most of us will be forgiven if the pure and sublime beauty of mathematics has eluded us, and the parallel is particularly apt, for whilst the higher mathematics do make their appeal to a few peculiarly constituted minds, they leave the majority of us cold ...

*Gotama Buddha: A Biography (based on the Canonical Books of the Theravādin)*

Chapter VII (p. 93)

Association Press. New York, New York, USA. 1920

**Sawyer, Walter Warwick** 1911–

Mathematician

The scientist who uses mathematics should be aware that much new mathematical knowledge is being discovered; nearly all of it will be irrelevant to his research, but he should keep his eyes open for the small piece that may be of great value to him.

Algebra

*Scientific American*, Volume 211, Number 3, September, 1964 (p. 78)

Any part of modern mathematics is the end-product of a long history. It has drawn on many other branches of earlier mathematics, it has extracted various essences from them and has been reformulated again and again in increasingly general and abstract forms. Thus a student may not be able to see what it is all about, in much the same way that a caveman confronted with a vitamin pill would not easily recognize it as food.

*A First Look at Numerical Functional Analysis*

Chapter 1 (p. 1)

Clarendon Press. Oxford, England. 1978

In other arts, if we see a pattern we can admire its beauty; we may feel that it has significant form, but we cannot say what the significance is. And it is much better not to try.... But in mathematics it is not so. In mathematics, if a pattern occurs, we can go on to ask, Why does it occur? What does it signify? And we can find answers to these

questions. In fact, for every pattern that appears, a mathematician feels he ought to know why it appears.

*Prelude to Mathematics* (p. 23)

Penguin Books. Baltimore, Maryland, USA. 1957

A point that should be borne in mind is that, generally speaking, higher mathematics is simpler than elementary mathematics. To explore a thicket on foot is a troublesome business; from an aeroplane the task is easier.

*Prelude to Mathematics* (p. 11)

Penguin Books. Baltimore, Maryland, USA. 1957

**Schlicter, Dean**

No biographical data available

Go down deep enough into anything and you will find mathematics.

In Margaret Joseph

The Future of Geometry

*The Mathematics Teacher*, Volume XXIX, Number 1, January, 1936 (p. 29)

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

“Mathematics” appears to be at the bottom of everything, since we find it unexpectedly where we have not put it in.

*Nature and the Greeks*

Chapter III (p. 38)

At The University Press. Cambridge, England. 1954

**Schubert, Hermann Cäsar Hannibal** 1848–1911

Enumerative geometer

Whenever, therefore, a controversy arises in mathematics, the issue is not whether a thing is true or not, but whether the proof might not be conducted more simply in some other way, or whether the proposition demonstrated is sufficiently important for the advancement of the science as to deserve especial enunciation and emphasis, or finally, whether the proposition is not a special case of some other and more general truth which is just as easily discovered.

*Mathematical Essays and Recreations*

On the Nature of Mathematical Knowledge (p. 28)

The Open Court Publishing Company. Chicago, Illinois, USA. 1917

**Schützenberger, Marcel-Paul** 1927–96

French mathematician

Ere long mathematics will be as useful to the chemist as the balance.

In J.W. Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. xvii)

Dover Publications. New York, New York, USA. 1955

**Schuyler, A.**

No biographical data available

With mathematics as a key we are enabled to unlock the door of the temple of science, to enter, and to read

therein the profoundest mysteries, and to drink refreshing draughts from the purest fountains.

*The Chautauquan*

The Utility of mathematics

Volume 9, Number 9, June, 1886 (p. 505)

**Serge, Lang** 1927–

Mathematician

I think rather that one does mathematics because one likes to do this sort of thing, and also, much more naturally, because when you have a talent for something, usually you don't have any talent for something else, and you do whatever you have talent for, if you are lucky enough to have it. I must also add that I do mathematics also because it is difficult, and it is a very beautiful challenge for the mind. I do mathematics to prove to myself that I am capable of meeting this challenge, and win it.

*The Beauty of Doing Mathematics: Three Public Dialogues*

What Does A Mathematician Do and Why? (p. 5)

Springer-Verlag. New York, New York, USA. 1985

**Shadwell, Thomas** 1642?–92

English dramatist and poet

Wood to La. Vaine. 'Tis true, Madame, Sir Positive and Poet Ninny are excellent men, and brave Bully-Rocks; but they must grant, that neither of e'm understand Mathematicks but myself.

*The Complete Works of Thomas Shadwell* (Volume 1)

The Sullen Lovers, Act IV (p. 71)

The Fortune Press. London, England. 1927

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Music and poesy used to quicken you;  
The mathematics and metaphysics,  
Fall to them as you find your stomach serves you;  
No profit grows where is no pleasure ta'en:  
In brief, sir, study what you most affect.

*In Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*The Taming of the Shrew*

Act I, Scene i, l. 36

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I do present you with a man of mine,  
Cunning in music and mathematics,  
To instruct her fully in those sciences,  
Whereof, I know, she is not ignorant.

*In Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

*The Taming of the Shrew*

Act II, Scene i, l. 55

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1 856–1950

Irish comic dramatist and literary critic

It is a monstrous thing to force a child to learn Latin or Greek or mathematics on the ground that they are an

indispensable gymnastic for the mental powers. It would be monstrous even if it were true.

*Misalliance*

Preface (p. lxix)

Brentano's, New York, New York, USA, 1904

...the more reasonable a student was in mathematics, the more unreasonable she was in the affairs of real life, concerning which few trustworthy postulates have yet been ascertained.

*An Unsocial Socialist*

Chapter VI (p. 117)

Brentano's, New York, New York, USA, 1904

**Shaw, James Byrnie**

American mathematician

It [mathematics] is not the study simply of forms that the mind imposes upon the helpless universe of sense, nor is it the study of the laws of thought. Nor equally is the spirit of mathematics the goddess Athena, sprung from the head of Zeus – an astounding miracle in the universe of thought – but is rather spirit animating flesh.

*Lectures on the Philosophy of Mathematics*

Chapter I (pp. 10–11)

The Open Court Publishing Co. Chicago, Illinois, USA. 1918

We are today heirs of the whole past in mathematics. Nothing is wasted, nothing is dissipated, but the wealth, the flashing gems of learning, which are the reward of painful toil of men long since dead, are ours today, a capital which enables us to advance the faster and to increase the riches all the more.

*Lectures on the Philosophy of Mathematics*

Chapter XVI (p. 187)

The Open Court Publishing Co. Chicago, Illinois, USA. 1918

...we find a domain for the validity of mathematics in a region that might seem at first remote indeed. But nevertheless the truth in mathematics, a free creation of the imagination incarnated in forms of the reason, guarantees the truth of other free creations of the imagination when they are set forth in the realities of life.

*Lectures on the Philosophy of Mathematics*

Chapter XVI (p. 194)

The Open Court Publishing Co. Chicago, Illinois, USA. 1918

...because mathematics contains truth, it extends its validity to the whole domain of art and the creatures of the constructive imagination. Because it contains freedom, it guarantees freedom to the whole realm of art. Because it is not primarily utilitarian, it validates the joy of imagination for the pure pleasure of imagination.

*Lectures on the Philosophy of Mathematics* (pp. 194–195)

The Open Court Publishing Company. Chicago, Illinois. 1918

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

A professor of chemistry was once commiserating the professor of mathematics on the fewness of his students, and the latter, resenting the implication that popularity

was a proof of good teaching, replied: “The trouble with mathematics is that nothing ever happens. If, when an equation is solved, it would blow up or give off a bad odor, I would get as many students as you.

Great American Universities – XV

*The Independent*, Volume LXVIII, Number 3196, March 3, 1910 (p. 463)

**Smith, David Eugene** 1860–1945  
Mathematician

...if we are to teach mathematics at all, real success is not possible unless we know that the subject is beautiful as well as useful.

*The Poetry of Mathematics and Other Essays*

Chapter I (p. 10)

Scripta Mathematica. New York, New York, USA. 1934

...we cannot convey mathematics to the great mass of people unless we first dwell upon the utility of the subject and imagine what would happen to the world if every trace of mathematics and of mathematical knowledge should cease to exist.

*The Poetry of Mathematics and Other Essays*

Chapter I (p. 10)

Scripta Mathematica. New York, New York, USA. 1934

...I would rather be a dreamer without mathematics, than a mathematician without dreams.

*The Poetry of Mathematics and Other Essays*

Religio Mathematici (p. 30)

Scripta Mathematica. New York, New York, USA. 1934

One thing that mathematics early implants, unless hindered from so doing, is the idea that here, at last, is an immortality that is seemingly tangible – the immortality of a mathematical law.

*The Poetry of Mathematics and Other Essays*

Religio Mathematici (pp. 31–32)

Scripta Mathematica. New York, New York, USA. 1934

Voltaire remarked that “one merit of poetry few persons will deny; it says more in fewer words than prose”; and why may we not with perfect truth continue – “one merit of mathematics no one can deny – it says more in fewer words than any other science in the world”?

*Teachers College Record*

Mathematics in the Training for Citizenship

Volume XVIII, Number 3, May, 1917 (p. 216)

I would teach mathematics for citizenship because it is one of the eternal verities, just as I would lead the youth to a great desert or to the mountains, there to commune with his soul; to a solemn tropical forest, “God’s first temple,” there to feel the uplift of loneliness; to the black silence that surrounds the tomb of Akbar the Great, or to the mists in the cryptomerias that stand guard beside the resting place of Ieyasu. I would lead him to these places because they rouse his soul to a contemplation of the truths that endure.

*Teachers College Record*

Mathematics in the Training for Citizenship

Volume XVIII, Number 3, May, 1917 (p. 217)

**Speiser, A.**

No biographical data available

...mathematics has liberated itself from language; and one who knows the tremendous labor put into this process and its ever-recurring surprising success, cannot help feeling that mathematics nowadays is more efficient in its particular sphere of the intellectual world than, say, the modern languages in their deplorable condition of decay or even music are on their fronts.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 65)

Princeton University Press. Princeton, New Jersey, USA. 1949

Already the pronounced tendency toward tediousness, which seems to be inherent in elementary mathematics, might plead for its late origin, since the creative mathematician would prefer to pay his attention to the interesting and beautiful problems.

In Dirk, J. Struik

*A Concise History of Mathematics*

Chapter I (p. 15)

Dover Publications, Inc. New York, New York, USA. 1967

**Spencer-Brown, George** 1923–

English mathematician and polymath

That mathematics, in common with other art forms, can lead us beyond ordinary existence, and can show us something of the structure in which all creation hangs together, is no new idea. But mathematical texts generally begin the story somewhere in the middle, leaving the reader to pick up the thread as best he can.

*Laws of Form*

A Note on the Mathematical Approach (p. v)

George Allen & Unwin Ltd. London, England. 1969

**Spengler, Oswald** 1880–1936

German philosopher

...mathematics, accessible in its full depth only to the very few, holds a quite peculiar position amongst the creation of the mind. It is a science of the most rigorous kind, like logic but more comprehensive and very much fuller; it is a true art, along with sculpture and music, as needing the guidance of inspiration and as developing under great conventions of form...

*The Decline of the West* (Volume 1)

Chapter II, Section ii (p. 56)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

Gothic cathedrals and Doric temples are mathematics in stone.

*The Decline of the West* (Volume 1)

Chapter II, Section ii (p. 58)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

The mathematic, then, is an art. As such it has its styles and style periods. It is not, as the layman and the philosopher (who is in this matter a layman too) imagine, substantially unalterable, but subject like every art to unnoticed changes from epoch to epoch. The development of the great arts ought never to be treated without an (assuredly not unprofitable) side-glance at contemporary mathematics.

*The Decline of the West* (Volume 1)

Chapter II, Section iv (p. 62)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

And so the development of the new mathematic consists of a long, secret, and finally victorious battle against the notion of magnitude.

*The Decline of the West* (Volume 1)

Chapter II, Section ix (p. 76)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

### **Spottiswoode, William** 1825–83

English mathematician and physicist

Conterminous with space and coeval with time is the kingdom of Mathematics; within this range her dominion is supreme; otherwise than according to her order nothing can exist; in contradiction to her laws nothing takes place. On her mysterious scroll is to be found written for those who can read it that which has been, that which is, and that which is to come.

*Report of the Forty-eighth Meeting of the British Association for the Advancement of Science*

Address of William Spottiswoode (p. 31)

John Murray. London, England. 1879

[The] connexions between Mathematics and other subjects, to prove that hers is not after all such a far-off region, nor so undecipherable an alphabet, and to show that even at unlikely spots we may trace under-currents of thought which having issued from a common source fertilise alike the mathematical and the non-mathematical world.

*Report of the Forty-eighth Meeting of the British Association for the Advancement of Science*

Address of William Spottiswoode (pp. 17–18)

John Murray. London, England. 1879

### **Stallone, Sylvester** 1946–

American actor

If you hang around with nice people you get nice friends, hang around with smart people and you get smart friends, hang around with yo-yos and you get yo-yos for friends. It's simple mathematics.

*Rocky*

Film (1976)

### **Steen, Lynn Arthur**

American mathematician

One of the big misapprehensions about mathematics that we perpetrate [sic] in our classrooms is that the

teacher always seems any problem that is discussed. This gives students the idea that there is a book somewhere with all the right answers to all of the interesting questions, and that teachers know those answers. And if one could get hold of the book, one would have everything settled. That is so unlike the true nature of mathematics.

*Teaching Teachers, Teaching Students* (p. 89)

Birkhäuser. Boston, Massachusetts, USA. 1997

### **Steinbeck, John** 1902–68

American novelist

...I drove up the mountain and found a dairy, bought some milk, and asked permission to camp under an apple tree. The dairy man had a Ph.D. in mathematics, and he must have had some training in philosophy. He liked what he was doing and didn't want to be anywhere else – one of the very few contented people I met in my whole journey.

*Travels with Charley: In Search of America*

Part Two (pp. 25–26)

The Viking Press. New York, New York, USA. 1962

### **Stewart, Ian** 1945–

English mathematician

Many pages have been expended on polemics in favor of rigor over intuition, or of intuition over rigor.

Both extremes miss the point: the power of mathematics lies precisely in the combination of intuition and rigor.

*Concepts of Modern Mathematics*

Chapter 1 (p. 4)

Dover Publications, Inc. New York, New York, USA. 1995

To criticize mathematics for its abstraction is to miss the point entirely. Abstraction is what makes mathematics work. If you concentrate too closely on too limited an application of a mathematical idea, you rob the mathematician of his most important tools: analogy, generality, and simplicity. Mathematics is the ultimate in technology transfer.

*Does God Play Dice: The New Mathematics of Chaos*

Chapter 17 (p. 363)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

Not all ideas are mathematics; but all good mathematics must contain an idea.

*From Here to Infinity*

The Nature of Mathematics (p. 6)

Oxford University Press, Inc. Oxford, England. 1996

Mathematics is not just a collection of isolated facts: it is more like a landscape; it has an inherent geography that its users and creators employ to navigate through what would otherwise be an impenetrable jungle.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*

Chapter 3 (p. 38)

Basic Books. New York, New York, USA. 1995

Mathematics is not a long-dead subject preserved in dusty tomes, in which all the questions have been solved and all the answers are listed at the back of the book. It is a vibrant, lively, ever-growing subject: Indeed, more new mathematics is being created today than ever before. Further, this new mathematics is not just ever-more-complicated answers to bigger and bigger sums. It lies on a far higher conceptual level. Mathematics is the study of patterns, regularities, rules, and their consequences – the science of significant form – and nowhere is form more significant than in biology.

*Life's Other Secret: The New Mathematics of the Living World*  
Chapter 2 (pp. 29–30)  
John Wiley & Sons, Inc. New York, New York, USA. 1998

**Stone, Marshall H.** 1903–89  
American mathematician

...science is reasoning; reasoning is mathematics; and, therefore, science is mathematics.

Mathematics and the Future of Science  
*Bulletin of the American Mathematical Association*, Volume 63, Number 2 March, 1957 (p. 61)

**Strutt, John William (Lord Rayleigh)** 1842–1919  
English physicist

Examples...which might be multiplied ad libitum show how difficult it often is for an experimenter to interpret his results without the aid of mathematics.

In E.T. Bell  
*Men of Mathematics* (p. xvi)  
Simon & Schuster. New York, New York, USA. 1937

**Sylvester, James Joseph** 1814–97  
English mathematician

...there is no study in the world which brings into more harmonious action all the faculties of the mind than the one [mathematics] of which I as the humble representative and advocate. There is none other which prepares so many agreeable surprises for its followers, more wonderful than the transformation scene of a pantomime, or, like this, seems to raise them, by successive steps of initiation to higher and higher states of conscious intellectual being.

A Plea for the Mathematician  
*Nature*, Volume 1, Thursday, January 6, 1870 (p. 261)

Others find its [mathematics] justification, its “raison d’être” in its being either the torch-bearer leading the way, or the handmaiden holding up the train of Physical Science; and a very clever writer in a recent magazine article, expresses his doubts whether it is, in itself, a more serious pursuit, or more worthy of interesting an intellectual human being, than the study of chess problems or Chinese puzzles.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Presidential Address to the British Association (p. 658)  
University Press. Cambridge, England. 1904–12

Some people have been found to regard all mathematics, after the 47th proposition of Euclid, as a sort of morbid secretion, to be compared only with the pearl said to be generated in the diseased oyster, or, as I have heard it described, “une excroissance malade de Tesprit humain.”

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Address to the Mathematical and Physical (p. 658)  
At The University Press. Cambridge, England. 1908

The world of ideas which it [mathematics] discloses or illuminates, the contemplation of divine beauty and order which it induces, the harmonious connexion of its parts, the infinite hierarchy and absolute evidence of the truths with which it is concerned, these, and such like, are the surest grounds of the title of mathematics to human regard, and would remain unimpeached and unimpaired were the plan of the universe unrolled like a map at our feet, and the mind of man qualified to take in the whole scheme of creation at a glance.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Presidential Address to the British Association (p. 659)  
University Press. Cambridge, England. 1904–12

What is it to us, they say, if the three angles of a triangle are equal to two right angles, or if every even number is, or may be, the sum of two primes, or if every equation of an odd degree must have a real root. How dull, stale, flat, and unprofitable are such and such like announcements! Much more interesting to read an account of a marriage in high life, or the details of an international boat-race. But this is like judging of architecture from being shown some of the brick and mortar, or even a quarried stone of a public building, or of painting from the colours mixed on the palette, or of music by listening to the thin and screechy sounds produced by a bow passed haphazard over the strings of a violin.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Address to the Mathematical and Physical (pp. 658–659)  
At The University Press. Cambridge, England. 1908

...I have used the word mathematics in the plural; but I think it would be desirable that this form of word should be reserved for the applications of the science, and that we should use mathematic in the singular number to denote the science itself ...

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Address to the Mathematical and Physical (p. 659)  
Section of the British Association  
At The University Press. Cambridge, England. 1908

Mathematics is not a book confined within a cover, and bound between brazen clasps, whose contents it needs only patience to ransack; it is not a mine, whose treasures may take long to reduce into possession, but which fill only a limited number of veins and lodes; it is not a soil, whose fertility can be exhausted by the yield of successive harvests; it is not a continent or an ocean, whose area can be mapped out, and its contour defined – it is limitless as that space which it finds too narrow for its aspirations; its possibilities are as infinite as the worlds which are forever crowding in and multiplying upon the astronomer’s gaze; it is as incapable of being restricted within assigned boundaries, or being reduced to definitions of permanent validity, as the consciousness, the life, which seems to slumber in each monad, in every atom of matter, in each leaf and bud and cell, and is forever ready to burst forth into new forms of vegetable and animal existence.

Commemoration Day At “Johns Hopkins” University  
*The Educational Times*  
September 1, 1877 (p. 131)

Time was when all the parts of the subject were dissevered, when algebra, geometry, and arithmetic either lived apart or kept up cold relations of acquaintance confined to occasional calls upon one another; but that is now at an end; they are drawn together and are constantly becoming more and more intimately related and connected by a thousand fresh ties, and we may confidently look forward to a time when they shall form but one body with one soul.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)  
Presidential Address to the British Association (p. 659)  
University Press. Cambridge, England. 1904–1912

The object of pure Physic is the unfolding of the laws of the intelligible world; the object of pure Mathematic that of the unfolding the laws of human intelligence.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 3)  
On a Theorem Connected with Newton’s Rule (p. 424)  
University Press. Cambridge, England. 1904–1912

May not Music be described as the Mathematic of Sense, Mathematics as Music of the Reason?

Algebraical Researches, Containing a Disquisition on Newton’s Rule for the Discovery of Imaginary Roots  
*Philosophical Transactions of the Royal Society*, Volume 154, 1864

I think it would be desirable that this form of word [mathematics] should be reserved for the applications of the science, and that we should use mathematic in the singular to denote the science itself, in the same way as we speak of logic, rhetoric, or (own sister to algebra) music.

*Collected Mathematical Papers*  
Presidential Address to the British Association, Exeter British Association Report (1869), (Volume 2) (p. 659)

**Swift, Jonathan** 1667–1745  
Irish-born English writer

The knowledge I had in mathematicks gave me great assistance in acquiring their [the Laputans’] phraseology, which depended much upon that science and musick; and in the latter I was not unskilled. Their ideas are perpetually conversant in lines and figures. If they would, for example, praise the beauty of a woman, or any other animal, they describe it by rhombs, circles, parallelograms, ellipses, and other geometrical terms, or by words of art drawn from music, needless here to repeat. I observed in the king’s kitchen all sorts of mathematical and musical instruments, after the figures of which they cut up the joyns that were served to his Majesty’s table.

*In Great Books of the Western World* (Volume 36)  
*Gulliver’s Travels*  
Part III, Chapter II (p. 97)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Synge, John L.** 1897–1995  
Irish mathematician and physicist

Logic is the railway track along which the mind glides easily. It is the axioms that determine our destination by setting us on this track or the other, and it is in the matter of choice of axioms that applied mathematics differs most fundamentally from pure. Pure mathematics is controlled (or should we say “uncontrolled?”) by a principle of ideological isotropy: any line of thought is as good as another, provided that it is logically smooth. Applied mathematics on the other hand follows only those tracks which offer a view of natural scenery; if sometimes the track dives into a tunnel it is because there is prospect of scenery at the far end.

Postcards on Applied Mathematics  
*The American Mathematical Monthly*, Volume 46, Number 3, March, 1939 (p. 156)

Mathematics begins in bewilderment and ends in bewilderment.

*Kandelman’s Krim* (p. 17)  
Jonathan Cape. London, England. 1957

**Thurston, William Paul** 1946–  
American mathematician

Very little [of mathematics] is easily accessible. But I think a lot more of it can be explained so that a lot more people understand it. On the level we’re talking about. I like to try to make mathematics easy, not to make it hard. I think there is a tendency among mathematicians to try to make it hard. I try to combat that when I see people wrap up their mathematics in formal fancy theories that make it less accessible.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 337)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990



As one reads mathematics, one needs to have an active mind, asking questions, forming mental connections between the current topic and other ideas from other contexts, so as to develop a sense of the structure, not just familiarity with a particular tour through the structure.

*Three-Dimensional Geometry and Topology*

Reader's Advisory (p. ix)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Tobias, Sheila** 1935–  
American academic and activist

...the paradox of our time is that as mathematics becomes increasingly powerful, only the powerful seem to benefit from it.

*Succeed With Math*

Foreword (p. xviii)

College Entrance Examination Board. New York, New York, USA. 1987

...mathematics provides an invisible framework that molds the more visible surfaces of daily life.

*Succeed With Math*

Foreword (p. xvii)

College Entrance Examination Board. New York, New York, USA. 1987

People who don't know what math is don't know what math isn't.

*Overcoming Math Anxiety*

Chapter 1 (p. 33)

W.W. Norton. New York, New York, USA. 1993

**Todhunter, Isaac** 1820–84  
English mathematician

One striking peculiarity of mathematics is its unlimited power of evolving examples and problems. A student may read through a book of Euclid, or a few chapters of Algebra; and within that limited range of knowledge it is possible to set him exercises as real and as interesting as the propositions themselves which he has studied; deductions which might have pleased the Greek geometers, and algebraical properties which Pascal and Fermat would not have disdained to investigate.

*The Conflict of Studies, and Other Essays on Subjects Connected With Education*

Chapter III (p. 82)

Macmillan & Co Ltd. London, England. 1873

...the pursuits of the University mathematics pre-eminently demand selfdenial, patience, and perseverance from youth, precisely at that period when they have liberty to act for themselves, and when on account of obvious temptations habits of restraint and application are peculiarly valuable.

*The Conflict of Studies, and Other Essays on Subjects Connected With Education*

Chapter I (p. 12)

Macmillan & Co Ltd. London, England. 1873

Another great and special excellence of mathematics is that it demands earnest voluntary exertion. It is simply

impossible for a person to become a good mathematician by the happy accident of having been sent to a good school; this may give him a preparation and a start, but by his own individual efforts alone can he reach an eminent position.

*Conflict of Studies and Other Essays*

The Conflict of Studies (p. 11)

Macmillan & Company. London, England. 1873

Nor do I know any study which can compete with mathematics in general in furnishing matter for severe and continued thought. Metaphysical problems may be even more difficult; but then they are far less definite, and, as they rarely lead to any precise conclusion, we miss the power of checking our own operations, and of discovering whether we are thinking and reasoning or merely fancying and dreaming.

*Conflict of Studies and Other Essays*

The Conflict of Studies (p. 13)

Macmillan & Company. London, England. 1873

**Tolstoy, Leo** 1828–1910  
Russian writer

“Mathematics are most important, madam! I don't want to have you like our silly ladies. Get used to it and you'll like it,” and he patted her cheek. “It will drive all the nonsense out of your head.”

*In Great Books of the Western World* (Volume 51)

*War and Peace*

Book One, Chapter XXV (p. 48)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A modern branch of mathematics having acquired the art of dealing with the infinitely small can now yield solutions in other more complex problems of motion which used to appear insoluble. The modern branch of mathematics, unknown to the ancients, when dealing with problems of motion admits the conception of the infinitely small, and so conforms to the chief condition of motion (absolute continuity) and thereby corrects the inevitable error which the human mind cannot avoid when it deals with separate elements of motion instead of examining continuous motion.

*In Great Books of the Western World* (Volume 51)

*War and Peace*

Book Eleven, Chapter I (p. 469)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Trevelyan, George Otto** 1838–1928  
English historian

He gave himself diligently to mathematics, which he liked “vastly.” “I believe they are useful,” he writes, “and I am sure they are entertaining, which is alone enough to recommend them to me.”

*The Early History of Charles James Fox*

Chapter II (p. 50)

Longmans, Green & Company. London, England. 1901

**Turnbull, Herbert Westren** 1885–1961

English mathematician

Mathematics transfigures the fortuitous concourse of atoms into the tracery of the finger of God.

In James Roy Newman

*The World of Mathematics* (Volume 1)

The Great Mathematicians (p. 168)

Simon &amp; Schuster. New York, New York, USA. 1956

The usefulness of mathematics in furthering the sciences is commonly acknowledged; but outside the ranks of the experts there is little inquiry into its nature and purpose as a deliberate human activity. Doubtless this is due to the inevitable drawback that mathematical study is saturated with technicalities from beginning to end.

*The Great Mathematicians*

Preface (p. xi)

New York University Press. New York, New York, USA. 1961

The greatest mathematics has the simplicity and inevitableness of supreme poetry and music, standing on the borderland of all that is wonderful in Science, and all that is beautiful in Art.

In James Roy Newman

*The World of Mathematics* (Volume 1)

The Great Mathematicians (p. 168)

Simon &amp; Schuster. New York, New York, USA. 1956

There is a largeness about mathematics that transcends race and time: mathematics may humbly help in the market-place, but it also reaches to the stars.

In James Roy Newman

*The World of Mathematics* (Volume 1)

The Great Mathematicians (p. 168)

Simon &amp; Schuster. New York, New York, USA. 1956

**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

We could use up two Eternities in learning all that is to be learned about our own world, and the thousands of nations that have risen, and flourished, and vanished from it. Mathematics alone would occupy me eight million years.

In Albert Bigelow Paine

*Mark Twain: A Biography* (Volume 2)

Chapter CL (p. 777)

Harper &amp; Brothers Publishers. New York, New York, USA. 1912

I had been to school...and could say the multiplication table up to six times seven is thirty-five, and I don't reckon I could ever get any further than that if I was to live forever. I don't take no stock in mathematics, anyway.

In Mark Twain

*The Adventures of Huckleberry Finn*

Chapter IV (p. 20)

Grosset &amp; Dunlap Publishers. New York, New York, USA. 1948

I don't take no stock in mathematics, anyway.

*Adventures of Huckleberry Finn*

Chapter III (p. 20)

Harper &amp; Brothers Publishers. New York, New York, USA. 1904

**Ulam, Stanislaw** 1909–84

Polish-born mathematician

Do not lose your faith. A mighty fortress is our mathematics. Mathematics will rise to the challenge, as it always has.

In Heinz R. Pagels

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 3 (p. 94)

Simon &amp; Schuster. New York, New York, USA. 1988

**Venn, John** 1834–1923

English logician and philosopher

Without consummate mathematical skill, on the part of some investigators at any rate, all the higher physical, problems would be sealed to us; and without competent skill on the part of the ordinary student no idea can be formed of the nature and cogency of the evidence on which they rest. Mathematics are here not merely a gate through which we may approach if we please, but they are the only mode of approach to large and important districts of thought.

*Symbolic Logic*

Introduction (p. xix)

Macmillan &amp; Co Ltd. London, England. 1881

**Viereck, George S.** 1884–1962

German American poet and writer

**Eldridge, Paul** 1888–1982

American novelist, poet, and writer

We are two parallel lines drawn very close to each other.... So close indeed that no third line, however thin, could be drawn between them.

Will the two parallel lines ever meet?

Yes, In infinity.

Ali Hasan! I exclaimed, had you ever dreamed that there was so much poetry and pathos and sorrow in mathematics?

*My First Two Thousand Years: The Autobiography of the**Wandering Jew*

Chapter XLIV (p. 218)

Sheridan House. New York, New York, USA. 1963

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

The mathematics will always be a kind of mystery to the bulk of the nation, and consequently will always be an object of veneration.

*The Works of Voltaire: A Contemporary Version With Notes* (Volume 37)

The Profession of Letters (p. 74)

The Werner Co. Akron, Ohio, USA. 1904

...when Newton worked, with the bandage removed from his eyes, on his mathematics, his sight pierced to the utmost limits of nature.

*The Works of Voltaire: A Contemporary Version With Notes* (Volume 37)  
Descartes and Newton (pp. 172–173)  
The Werner Co. Akron, Ohio, USA. 1904

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

I have heard myself accused of being an opponent, an enemy of mathematics, which no one can value more highly than I, for it accomplishes the very thing whose achievement has been denied me.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

Applied to practice, it [mathematics] becomes an art, like RHETORIC. In both these arts the form is everything, the substance nothing. To mathematics it is indifferent whether it reckons pence or pounds; to RHETORIC, whether it defends truth or falsehood.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (pp. 170–171)

William Blackwood & Sons. Edinburgh, Scotland. 1883

I receive mathematics as the most sublime and useful science, so long as they are applied in their proper place; but I cannot commend the misuse of them in matters which do not belong to their sphere, and in which, noble science as they are, they seem to be mere nonsense.

*Conversations of Goethe With Eckermann and Soret*

Wed., Dec. 20 (p. 181)

George Bell & Sons. London, England. 1883

Mathematics, like dialectics, is an instrument of the inner higher understanding. Applied to practice, it becomes an art, like RHETORIC. In both these arts the form is everything, the substance nothing. To mathematics it is indifferent whether it reckons pence or pounds; to RHETORIC, whether it defends truth or falsehood.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (pp. 170–171)

William Blackwood & Sons. Edinburgh, Scotland. 1883

Mathematics can remove no prejudices and soften no obduracy. It has no influence in sweetening the bitter strife of parties; and in the moral world generally its action is perfectly null.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 171)

William Blackwood & Sons. Edinburgh, Scotland. 1883

Mathematics must subdue the flights of our reason; they are the staff of the blind; no one can take a step without them; and to them and experience is due all that is certain in physics.

*Oeuvres Complètes*

t. 35 (p. 219)

Publisher undetermined

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

[In mathematics] we behold the conscious logical activity of the human mind in its purest and most perfect form. Here we learn to realize the laborious nature of the process, the great care with which it must proceed, the accuracy which is necessary to determine the exact extent of the general propositions arrived at, the difficulty of forming and comprehending abstract concepts; but here we learn also to place confidence in the certainty, scope and fruitfulness of such intellectual activity.

*Vorträge und Reden*

Ueber das Verhältniss der Naturwissenschaften zur Gesamtheit der

Wissenschaft, Bd. 1 (p. 176)

Publisher undetermined. 1896

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

While the telescope serves as a means of penetrating space, and of bringing its remotest regions nearer to us, mathematics, by inductive reasoning, have led us onward to the remotest regions of heaven, and brought a portion of them within the range of our possession; nay, in our own times so propitious to extension of knowledge the application of all the elements yielded by the present condition of astronomy has even revealed to the intellectual eye a heavenly body, and assigned to it its place, orbit, and mass, before a single telescope had been directed toward it.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)

Part II (p. 179)

D. Appleton & Co. New York, New York, USA. 1850

**von Neumann, John** 1903–57

Hungarian-American mathematician

...in mathematics you don't understand things. You just get used to them.

In G. Zukav

*The Dancing Wu Li Masters: An Overview of the New Physics*

Part One

I Clutch My Ideas

Chapter 1 (fn, p. 226)

William Morrow. New York, New York, USA. 1979

After all, classical mathematics was producing results which were both elegant and useful, and, even though one could never again be absolutely certain of its reliability, it stood on at least as sound a foundation as, for example, the existence of the electron. Hence, if one was willing to accept the sciences, one might as well accept the classical system of mathematics.

*Collected Works* (Volume 1)

The Works of the Mind. The Mathematician (p. 6)  
Pergamon Press. New York, New York, USA. 1961–1963

...mathematics is not an empirical science, or at least that it is practiced in a manner which differs in several decisive respects from the techniques of the empirical sciences.

*Collected Works* (Volume 1)  
The Works of the Mind, The Mathematician (p. 6)  
Pergamon Press. New York, New York, USA. 1961–1963

There are two ways to teach mathematics. One is to take real pains toward creating understanding visual aids, that sort of thing. The other is the old British system of teaching until you're blue in the face.

*The New York Times Book Review*, Volume 2, September, 1956 (p. 43)

Mathematics falls into a great number of subdivisions, differing from one another widely in character, style, aims, and influence. It shows the very opposite of the extreme concentration of theoretical physics. A good theoretical physicist may today still have a working knowledge of more than half of his subject. I doubt that any mathematician now living has much of a relationship to more than a quarter.

In Cecil M. DeWitt and John A. Wheeler  
*Battelle Recontres 67* (p. ix)

**von Raumer, Karl** 1783–1865  
German geologists and mineralogists

Mathematics are the root and blood of a knowledge of the laws of nature and of art.

Instruction in Natural Science  
*The American Journal of Education*, Number 20, 1860 (p. 135)

**Waismann, Friedrich** 1896–1959  
Austrian mathematician, physicist, and philosopher

We could compare mathematics so formalized to a game of chess in which the symbols correspond to the chessmen; the formulae, to definite positions of the men on the board; the axioms, to the initial positions of the chessmen; the directions for drawing conclusions, to the rules of movement; a proof, to a series of moves which leads from the initial position to a definite configuration of the men.

*Introduction to Mathematical Thinking: The Formation of Concepts in Modern Mathematics*  
Chapter 6 (pp. 76–77)  
Frederick Ungar Publishing Company. New York, New York, USA. 1951

**Waldo, Clarence Abiathar** 1852–1926  
American mathematician, author, and educator

To the workaday world the higher ranges of mathematics have been a sealed book; the man who traverses them successfully a magician – a man whose mental occupations awaken mingled feelings of awe and pity, awe that he can soar so high, pity that he wastes his strength in

such useless flight.

Mathematics and Engineering  
*Proceedings of the American Association for the Advancement of Science*, December 1903–January 1904 (p. 456)

**Walton, Izaak** 1593–1683  
English writer

For Angling may be said to be so like the Mathematicks, that it can never be fully learnt...

*The Complete Angler*  
The Epistle to the Reader (p. 7)  
T.N. Foulis. London, England. 1913

**Warburton, William** 1698–1779  
English critic and churchman

It may seem, perhaps, too much a paradox to say, that long habit in this science (mathematics) incapacitates the mind for reasoning at large, and especially in the search of moral truth. And yet, I believe, nothing is more certain. The object of geometry is demonstration, and its subject admits of it, and is almost the only one that doth. In this science, whatever is not demonstration is nothing, or, at least, below the sublime inquirer's regard. Probability, through its almost infinite degrees from simple ignorance up to absolute certainty, is the terra incognita of the geometrician.

*The Works of the Right Reverend William Warburton* (Volume 8)  
Introduction (p. xiv)  
Printed by Luke Hansard. London, England. 1811

**Weaver, Warren** 1894–1978  
American mathematician

There is a common tendency to consider mathematics so strange, subtle, rigorous, difficult and deep a subject that if a person is a mathematician he is of course a "great mathematician" – their being, so to speak, no small giants. This is very complimentary, but unfortunately not necessarily true.

Lewis Carroll: Mathematician  
*Scientific American*, Volume 194, Number 4, April, 1956 (p. 116)

**Webster, John** 1580?–1625?  
English playwright

Bosola: Didst thou never study mathematics?

Old Lady: What's that, sir?

Bosola: Why, to know the trick how to make many lines met in one centre.

*The Duchess of Malfi*  
Act II, Scene ii  
Chatto & Windus. London, England. 1958

**Weil, André** 1906–98  
French mathematician

When a branch of mathematics ceases to interest any but the specialists, it is very near its death, or at any rate dangerously close to paralysis, from which it can be rescued

only by being plunged back into the vivifying source of the science.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May, 1950 (p. 304)

Mathematics has this peculiarity, that it is not understood by non-mathematicians.

*Oeuvres Scientifiques*

Organisation et désorganisation en mathématique, Volume II (p. 465)  
Springer-Verlag, New York, New York, USA. 1980

**Weil, Simone** 1909–43

French philosopher and mystic

Mathematics alone make us feel the limits of our intelligence. For we can always suppose in the case of an experiment that it is inexplicable because we don't happen to have all the data. In mathematics we have all the data...and yet we don't understand. We always come back to the contemplation of our human wretchedness. What force is in relation to our will, the impenetrable opacity of mathematics is in relation to our intelligence.

Translated by Arthur Wills

*The Notebooks of Simone Weil* (Volume 2) (p. 511)

G.P. Putnam's Sons, New York, New York, USA. 1935

**Westaway, Frederic William**

No biographical data available

Mathematics, like all other subjects, has now to take its turn under the microscope and reveal to the world any weaknesses there may be in its foundations.

In E.T. Bell

*Men of Mathematics* (p. 555)

Simon & Schuster, New York, New York, USA. 1937

**Weyl, Hermann** 1885–1955

German mathematician

Without the concepts, methods and results found and developed by previous generations right down to Greek antiquity one cannot understand either the aims or the achievements of mathematics in the last fifty years.

In Morris Kline

*Mathematical Thought From Ancient to Modern Times* (p. 101)

Oxford University Press, Inc. New York, New York, USA. 1972

Kierkegaard once said religion deals with what concerns man unconditionally. In contrast (but with equal exaggeration) one may say that mathematics talks about the things which are of no concern at all to man. Mathematics has the inhuman quality of starlight, brilliant and sharp, but cold. But it seems an irony of creation that man's mind knows how to handle things the better the farther removed they are from the center of his existence. Thus we are cleverest where knowledge matters least: in mathematics, especially in number theory.

A Half-century of Mathematics

*The American Mathematical Monthly*, Volume 58, Number 8, October, 1951 (p. 523)

The axiomatic approach has often revealed inner relations between, and has made for unification of methods within, domains that apparently lie far apart. This tendency of several branches of mathematics to coalesce is another conspicuous feature in the modern development of our science, and one that goes side by side with the apparently opposite tendency of axiomatization. It is as if you took a man out of a milieu in which he had lived not because it fitted him but from ingrained habits and prejudices, and then allowed him, after thus setting him free, to form associations in better accordance with his true inner nature.

A Half-Century of Mathematics

*The American Mathematical Monthly*, Volume 58, Number 8, October, 1951 (p. 524)

The states of affairs with which mathematics deals are, apart from the very simplest ones, so complicated that it is practically impossible to bring them into full givenness in consciousness and in this way to grasp them completely.

Translated by Stephen Pollard and Thomas Bole

*The Continuum: A Critical Examination of the Foundation of Analysis*  
Chapter 1 (p. 17)

The Thomas Jefferson University Press, Kirksville, Missouri, USA. 1987

Mathematizing may well be a creative activity of man, like language or music, of primary originality, whose historical decisions defy complete objective rationalizations.

Obituary for David Hilbert

*Royal Society Biographies*, Volume 4, 1944

In mathematics the inquiry into the genuineness or non-genuineness of the inner working of our entire western culture urges towards a more rigorous decision than can be attained in the other hazier fields of knowledge.

Gravitation and the Electron, Mathematical Lectures

*The Rice Institute Pamphlet*, Volume 16, Number 4 (p. 246)

**Whewell, William** 1794–1866

English philosopher and historian

In mathematics, the student is rendered familiar with the most perfect examples of strict inference; he is compelled habitually to fix his attention on those conditions on which the cogency of the demonstration depends; and, in the mistaken or imperfect attempts at demonstration made by himself or others, he is presented with examples of the most natural fallacies, which he sees exposed and corrected.

*On the Principles of English University Education* (2nd edition)

Thoughts on the Study of Mathematics as a Part of a Liberal Education  
(p. 12)

John W. Parker, London, England. 1838

I will not suppose, that any person who has paid any attention to mathematics does not see clearly the

difference between necessary truths and empirical facts; between the evidence of the properties of a triangle, and that of the general laws of the structure of plants. The peculiar character of mathematical truth is, that it is necessarily and inevitably true; and one of the most important lessons which we learn from our mathematical studies is a knowledge that there are such truths, and a familiarity with their form and character.

*On the Principles of English University Education* (2nd edition)  
Thoughts on the Study of Mathematics as a Part of a Liberal Education  
(p. 163)  
John W. Parker. London, England. 1838

...the ideas which these sciences involve extend to all the objects and changes which we observe in the external world; and hence the consideration of mathematical relations forms a large portion of many of the sciences which treat of the phenomena and laws of external nature, as Astronomy, Optics, and Mechanics. Such sciences are hence often termed Mixed Mathematics, the relations of space and number being, in these branches of knowledge, combined with principles collected from special observation; while Geometry, Algebra, and the like subjects, which involve no result of experience, are called Pure Mathematics.

*History of Scientific Ideas: Being the First Part of The Philosophy of the*  
(Volume 1) (3rd edition)  
Part I, Book II, Chapter I (p. 89)  
John W. Parker & Son. London, England. 1858

### White, William Frank

No biographical data available

He must be a “practical” man who can see no poetry in mathematics.

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*  
(p. 208)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Mathematics, the science of the ideal, becomes the means of investigating, understanding and making known the world of the real. The complex is expressed in terms of the simple. From one point of view mathematics may be defined as the science of successive substitutions of simpler concepts for more complex...

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays* (p. 215)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

### Whitehead, Alfred North

1861–1947  
English mathematician and philosopher

The first acquaintance which most people have with mathematics is through arithmetic.... Arithmetic, therefore, will be a good subject to consider in order to discover, if possible, the most obvious characteristic of the science. Now, the first noticeable fact about arithmetic is that it applies to everything, to tastes and to sounds, to apples and to angels, to the ideas of the mind and to the bones of the body.

*An Introduction to Mathematics*  
Chapter 1 (p. 2)  
Oxford University Press, Inc. New York, New York, USA. 1958

No part of Mathematics suffers more from the triviality of its initial presentation to beginners than the great subject of series...the general ideas are never disclosed and thus the examples, which exemplify nothing, are reduced to silly trivialities.

*An Introduction to Mathematics*  
Chapter 14 (p. 144)  
Oxford University Press, Inc. New York, New York, USA. 1958

### Wiener, Norbert

1894–1964  
American mathematician

It [mathematics] is a field which has often been compared with chess, but differs from the latter in that it is only one’s best moments that count and not one’s worst.

*Ex-prodigy: My Childhood and Youth* (p. 21)  
Simon & Schuster. New York, New York, USA. 1953

### Willerding, Margaret F.

No biographical data available

It is strange but true that most of the greatest strides in mathematics were made at a time and in an atmosphere when the need for mathematics was the least. Mathematics flourishes when it is free to follow any course it desires and when there is no pressure for practical results limiting its scope and freedom.

The Uselessness of Mathematics  
*School Science and Mathematics*, Part II, Volume LXVIII, Number 6, June, 1968 (p. 495)

### Wittgenstein, Ludwig Josef Johann

1889–1951  
Austrian-born English philosopher

There is no religious denomination in which the misuse of metaphysical expressions has been responsible for so much sin as it has in mathematics.

Translated by Peter Winch  
*Culture and Value* (p. 1e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

With my full philosophical rucksack I can only climb slowly up the mountain of mathematics.

Translated by Peter Winch  
*Culture and Value* (p. 2e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

A mathematical proof must be perspicuous.

*Remarks on the Foundations of Mathematics*  
Appendix II, 1 (p. 65e)  
The MIT Press. Cambridge, Massachusetts, USA. 1967

### Wright, Frank Lloyd

1867–1959  
American architect

...mathematics in co-ordinated Form is architecture.

*Frank Lloyd Wright: An Autobiography*  
Hollyhock House in Hollywood (p. 227)  
Duell, Sloan & Pearce. New York, New York, USA. 1943



**MATHEMATICS AND ART**

**Morse, Harold Calvin Marston** 1892–1977  
American mathematician

I made the same mistake that artists have made since the time of the Greeks, and placed mathematics alongside of the arts as their handmaiden.... But mathematics is the sister, as well as the servant of the arts and is touched with the same madness and genius.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematics and the Arts (p. 85)

Mathematical Association of America. Washington, D.C. 2004

**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

Mathematics is a genuine science, because it contains completed knowledge, products of a spiritual spontaneity – because it genialises methodically. It is also Art; for it has reduced genial experience into rules – it teaches genius to be – it replaces nature by reason.

Quoted in Panthea

Eclectic Gatherings

*The Reasoner*, Volume 6, 1849 (p. 373)

**Zygmund, Antoni** 1900–92  
Polish-born American mathematician

Mathematics and art are quite different. We could not publish so many papers that used, repeatedly, the same idea and still command the respect of our colleagues.

In Peter L. Duren, Richard Askey, Uta C. Merzbach and Harold M. Edwards (eds.)

*A Century of Mathematics in America* Volume 3 (p. 348)

American Mathematical Society. Providence, Rhode Island, USA. 1989

**MATHEMATICS AND BEAUTY**

**Cayley, Arthur** 1821–95  
English mathematician

It is difficult to give an idea of the vast extent of modern mathematics. This word “extent” is not the right one: I mean extent crowded with beautiful detail – not an extent of mere uniformity such as an objectless plain, but of a tract of beautiful country seen at first in the distance, but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower. But, as for anything else, so for a mathematical theory – beauty can be perceived, but not explained.

*The Collected Mathematical Papers of Arthur Cayley* (Volume 11)

#784 (p. 449)

At The University Press. Cambridge, England. 1896

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

Beauty is the first test: there is no permanent place in the world for ugly mathematics.

*A Mathematician's Apology*

Section 10 (p. 85)

Cambridge University Press. Cambridge, England. 1967

**Oman, John** 1860–1939  
English Presbyterian theologian

Beauty...is a conspicuous element in the abstract completeness aimed at in the higher mathematics...

*The Natural and the Supernatural*

Value and Validity (p. 211)

The Macmillan Company. New York, New York, USA. 1931

**MATHEMATICS AND ETHICS**

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Mathematics should be mixed not only with physics but with ethics...

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and the Merrimack Rivers*

Friday (p. 478)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**MATHEMATICS AND LITERATURE**

**Woolf, Virginia** 1882–1941  
English novelist and essayist

When she was rid of the pretense of paper and pen, phrase-making and biography, she turned her attention in a more legitimate direction, though, strangely enough, she would rather have confessed her wildest dreams of hurricane and prairie than the fact that, upstairs, alone in her room, she rose early in the morning or sat up late at night to... work at mathematics. No force on earth would have made her confess that. Her actions when thus engaged were furtive and secretive, like those of some nocturnal animal.... Perhaps the uncommonly nature of the science made her instinctively wish to conceal her love of it. But the more profound reason was that in her mind mathematics were directly opposed to literature. She would not have cared to confess how infinitely she preferred the exactitude, the star-like impersonality, of figures to the confusion, agitation, and vagueness of the finest prose.

*Night and Day* (pp. 45–46)

Hogarth Press. London, England. 1950

**MATHEMATICS AND MUSIC**

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

Mathematics and music! the most glaring possible opposites of human thought! and yet connected, mutually sustained! It is as if they would demonstrate the hidden

consensus of all the actions of our mind, which in the revelations of genius makes us forefeel unconscious utterances of a mysteriously active intelligence.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

On the Physiological Causes of Harmony in Music (p. 62)

D. Appleton & Co. New York, New York, USA. 1897

**Dyson, Freeman J.** 1923–

American physicist and educator

I see some parallels between the shifts of fashion in mathematics and in music. In music, the popular new styles of jazz and rock became fashionable a little earlier than the new mathematical styles of chaos and complexity theory. Jazz and rock were long despised by classical musicians, but have emerged as art-forms more accessible than classical music to a wide section of the public. Jazz and rock are no longer to be despised as passing fads. Neither are chaos and complexity theory. But still, classical music and classical mathematics are not dead. Mozart lives, and so does Euler. When the wheel of fashion turns once more, quantum mechanics and hard analysis will once again be in style.

Book Review of “Nature’s Numbers”

*The American Mathematical Monthly*, Volume 103, Number 7, August–September, 1996 (p. 612)

**Morse, Harold Calvin Marston** 1892–1977

American mathematician

Most convincing to me of the spiritual relations between mathematics and music, is my own very personal experience. Composing in an amateurish way, I get exactly the same elevation from a prelude that has come to me at the piano, as I do from a new idea that has come to me in mathematics.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematics and the Arts (p. 88)

Mathematical Association of America. Washington, D.C. 2004

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

...Pythagoras at the same Time uses the Terms of Music, by calling the Space between the Earth and the Moon a Tone; saying, that from her to Mercury is Half a Tone: and from him to Venus about the same Space. But from her to the Sun so much and a Half more: but from the Sun to Mars a Tone, that is to say, as much as from the Earth to the Moon.

*Pliny’s Natural History*. In Thirty-seven Books

Book II, Chapter XXII (p. 59)

Printed for the Club by G. Barclay. London, England. 1847–1849

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

If all the arts aspire to the condition of music, all the sciences aspire to the condition of mathematics.

*Some Turns of Thought in Modern Philosophy: Five Essays*

Chapter III (p. 80)

Charles Scribner’s Sons. New York, New York, USA. 1933

**Sylvester, James Joseph** 1814–97

English mathematician

May not Music be described as the Mathematic of sense, Mathematic as the Music of the reason? the soul of each the same! Thus the musician feels Mathematic, the mathematician thinks Music – Music the dream, Mathematic the working life – each to receive its consummation from the other when the human intelligence, elevated to its perfect type, shall shine forth glorified in some future Mozart-Dirichlet or Beethoven-Gauss – a union already not indistinctly foreshadowed in the genius and labours of a Helmholtz!

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 2)

On Newton’s Rule for the Discovery of Imaginary Roots (fn, p. 419)

University Press. Cambridge, England. 1904–1912

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Mathematics and music! the most glaring possible opposites of human thought! and yet connected, mutually sustained!

*Popular Lectures on Scientific Subjects*

Lecture III (p. 62)

D. Appleton & Company. New York, New York, USA. 1885

## MATHEMATICS AND PHILOSOPHY

**Hamilton, William** 1788–1856

Scottish philosopher

Mathematics have from the first been triumphant over the husk; Philosophy is still militant for the kernel.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 278)

Harper & Brothers Publishers. New York, New York, USA. 1861

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Mathematicians sometimes speak contemptuously of philosophy; and philosophers sometimes speak contemptuously of mathematics. The contempt thus manifested does not spring from mathematics in the former case, nor from philosophy in the latter; in both cases it springs out of ignorance – philosophical ignorance of mathematicians and mathematical ignorance of philosophers.

*Mathematical Philosophy*

Lecture I (pp. 1–2)

E.P. Dutton & Co. New York, New York, USA. 1922

## MATHEMATICS AND POETRY

**Buchanan, Scott** 1895–1968

American educator and philosopher

...mathematics and poetry move together between two extremes of mysticism, the mysticism of the common-place where ideas illuminate and create facts, and the mysticism of the extraordinary where God, the Infinite, the Real, poses the riddles of desire and disappointment, sin and salvation, effort and failure, question and paradoxical answer...

*Poetry and Mathematics*

Chapter I (p. 42)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Carmichael, Robert Daniel** 1879–1967

American mathematician

Mathematics and poetry lie, if not on, at least not far from the extremes, the one of systematic and the other of unsystematic thought, and thus are about as far removed as possible one from the other.

*The Logic of Discovery*

Chapter IX (p. 244)

The Open Court Publishing. Chicago, Illinois, USA. 1930

**Carus, Paul** 1852–1919

American philosopher

A mathematical theorem and its demonstration are prose. But if the mathematician is overwhelmed with the grandeur and wondrous harmony of geometrical forms, of the importance and universal application of mathematical maxims, or, of the mysterious simplicity of its manifold laws which are so self-evident and plain and at the same time so complicated and profound, he is touched by the poetry of his science; and if he but understands how to give expression to his feelings, the mathematician turns poet, drawing inspiration from the most abstract domain of scientific thought.

*Friedrich Schiller: A Sketch of His Life and an Appreciation of His Poetry*

Schiller, A Philosophical Poet (p. 33)

The Open Court Publishing Co. Chicago, Illinois, USA. 1905

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

...we do not listen with the best regard to the verses of a man who is only a poet, nor to his problems if he is only an algebraist; but if a man is at once acquainted with the geometric foundation of things and with their festal splendor, his poetry is exact and his arithmetic musical.

*Society and Solitude: Twelve Chapters*

Works and Data (p. 171)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1893

**Hill, Thomas**

No biographical data available

The Mathematics are usually considered as being the very antipodes of Poesy. Yet Mathesis and Poesy are of the closest kindred, for they are both works of the imagination. Poetry is a creation, a making, a fiction; and the

Mathematics have been called, by an admirer of them, the sublimest and most stupendous of fictions.

*The North American Review*

The Imagination in Mathematics

Volume LXXXV, Number 176, July, 1857 (p. 229)

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The true spirit of delight, the exaltation, the sense of being more than man, which is the touchstone of the highest excellence, is to be found in Mathematics as surely as in poetry.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 60)

Longmans, Green & Co. London, England. 1919

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

We have heard much about the poetry of mathematics, but very little of it has yet been sung. The ancients had a juster notion of their poetic value than we. The most distinct and beautiful statements of any truth must take at last the mathematical form.

*A Week on the Concord and Merrimack Rivers*

Friday (p. 452)

Thomas Y. Crowell Co. New York, New York, USA. 1911

**Williams, Charles**

No biographical data available

Love was even more mathematical than poetry; it was the pure mathematics of the spirit.

*Descent into Hell*

Chapter Four (p. 69)

William B. Eerdmans. Grand Rapids, Michigan, USA. 1979

## MATHEMATICS AND RELIGION

**Arbuthnot, John** 1667–1735

Scottish mathematician and physician

...the mathematics are friends to religion; inasmuch as they charm the passions, restrain the impetuosity of imagination, and purge the mind from error and prejudice.

In George Atherton Aitken

*The Life and Works of John Arbuthnot, M.D.*

Usefulness of Mathematical Learning (p. 412)

At The Clarendon Press. Oxford, England. 1892

## MATHEMATICS AND SCIENCE

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Their [mathematics and science] combined scope is the two-fold world of the Actual and the logically Possible ...

*The Meaning of Mathematics*

*Scripta Mathematica*, Volume I, Number 1, September, 1932 (p. 26)

**Teller, Edward** 1908–2003  
Hungarian-born American nuclear physicist

**Sylvester, James Joseph** 1814–97  
English mathematician

Science attempts to find logic and simplicity in nature. Mathematics attempts to establish order and simplicity in human thought.

*The Pursuit of Simplicity* (p. 17)  
Pepperdine University Press. Malibu, California, USA. 1980

## MATHEMATICS AND THE ARTS

**Shaw, James Byrnie**  
American mathematician

Poetry, music, painting, sculpture, architecture – may we call them the other fine arts? – create the beautiful and give expression to the longings and hopes of man. But they have been told for centuries that these were but dreams, visions of that which did not exist, sad to say, fictions that one could but view for awhile, then, with a sigh, return to cold reality. Mathematics vindicates the right of all these to stand in the front rank of the pioneers that search the real truth and find it crystallized forever in brilliant gems.

*Lectures on the Philosophy of Mathematics*  
Chapter XVI (p. 194)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1918

## MATHEMATICS AND WOMEN

**Berry, John J.**  
No biographical data available

When, however, we come to mensuration we suddenly find the limitations of the female mind. A deep-rooted hatred of all accuracy in measurements, or, at all events, a total inability to understand the yard-stick or the tables of dry measure, is one of the prominent characteristics of the sex. No woman, for example, can form any correct idea of the distance from her house to any other geographical point.

*Life of David Belden*  
Chapter V (p. 104)  
Beldon Brothers. New York, New York, USA. 1891

**Disraeli, Isaac** 1766–1848  
British writer and scholar

Should a female mathematician be united to a poet, it is probable that she would be left amidst her abstractions, to demonstrate to herself how many a specious diagram fails when brought into its mechanical operation; or while discovering the infinite varieties of a curve, she might take occasion to deduce her husband's versatility. If she becomes as jealous of his books as other wives are of the

mistresses of their husbands, she may act the virago even over his innocent papers.

*Curiosities of Literature: And The Literary Character Illustrated*  
*The Literary Character Illustrated*  
Chapter XIII (p. 434)  
Leavitt & Co. New York, New York, USA. 1851

**Hammond, William A.**  
No biographical data available

The attempt to convert a woman into a mathematician is generally very much like trying to make a hare drink brandy and soda. You may, it is true, sometimes succeed, but then you find not only that the animal has acquired a useless accomplishment, but that the qualities characteristic of a hare have disappeared.

*The North American Review*  
Woman in Politics  
Volume 88, Number 321, August, 1883 (p. 143)

it is true, sometimes succeed

## MATHEMATICS EDUCATION

**Begle, Edward Griffith** 1914–78  
Mathematician

Mathematics education is much more complicated than you expected, even though you expected it to be more complicated than you expected.

*School Mathematics Study Group*  
Research and Evaluation in Mathematics Education  
1971

## MATHEMATICS IS

**Adler, Alfred** 1870–1937  
Austrian psychiatrist

Mathematics is pure language – the language of science.  
In Douglas M. Campbell and John C. Higgins (eds.)  
*Mathematics: People, Problems, Results* (Volume 2)  
Mathematics and Creativity (p. 3)  
Wadsworth, Inc. Belmont, California, USA. 1984

...mathematics is whatever mathematicians are doing.  
In Douglas M. Campbell and John C. Higgins (eds.)  
*Mathematics: People, Problems, Results* (Volume 2)  
Mathematics and Creativity (p. 4)  
Wadsworth, Inc. Belmont, California, USA. 1984

**Apostle, Hippocrates George**  
No biographical data available

That mathematics is a theoretical science is evident from those who have pursued that science; they have been lovers of wisdom and have sought to discover eternal truths... those who have investigated the objects of mathematics have done so not for gain or use but for the sake of truth.

*Aristotle's Philosophy of Mathematics*  
Chapter I (p. 3)  
The University of Chicago Press. Chicago, Illinois, USA. 1952

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Mathematics...is concerned with a wider domain than that domain which it is the object of the natural sciences to describe and categorize. The natural sciences are concerned with the actual world. Mathematics is concerned with “all possible worlds.”

*A Combinatorial Theory of Possibility*  
Part II, Chapter 9, Section iv (p. 126)  
Cambridge University Press. Cambridge, England. 1989

**Atiyah, Sir Michael** 1922–  
English mathematician

Mathematics is always a continuum, linked to its history, the past – nothing comes out of zero.

24th of May 2004 prior to the Abel prize celebrations  
Interview with Michael Atiyah and Isadore Singer  
Martin Raussen and Christian Skau are the interviewers

**Bacon, Roger** 1214–92  
English philosopher, scientist, and friar

Neglect of mathematics works injury to all knowledge, since he who is ignorant of it cannot know the other sciences or the things of this world. And what is worse, men who are thus ignorant are unable to perceive their own ignorance and so do not seek a remedy.

Translated by Robert Belle Burke  
*The Opus Majus of Roger Bacon*  
Part 4, Distinctia Prima, cao. 1  
Oxford University Press, Inc. London, England. 1928

...mathematics is absolutely necessary and useful to other sciences.

Translated by Robert Belle Burke  
*The Opus Majus of Roger Bacon*  
Part 4, Chapter 3 (p. 126)  
Oxford University Press, Inc. London, England. 1928

**Bers, Lipman** 1914–93  
Mathematician

...mathematics is very much like poetry...what makes a good poem – a great poem – is that there is a large amount of thought expressed in very few words. In this sense formulas like  $e^{i\pi} + 1 = 0$ ...are poems.

In D. Albers, G. Alexanderson and C. Reid (eds.)  
*More Mathematical People: Contemporary Conversations*  
Lipman Bers (p. 16)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Birkhoff, George David** 1884–1944  
American mathematician

Mathematics is the codified body of all logical thought.

*George David Birkhoff: Collected Mathematical Papers* (Volume 3)  
Mathematics: Quantity and Order (p. 552)  
Dover Publications, Inc. New York, New York, USA. 1968

**Bochner, Salomon** 1899–1982  
Galician-born American mathematician

[Mathematics] is a form of poetry which transcends poetry in that it proclaims a truth; a form of reasoning which transcends reasoning in that it wants to bring about the truth it proclaims; a form of action, of ritual behavior, which does not find fulfillment in the act but must proclaim and elaborate a poetic form of truth.

*The Role of Mathematics in the Rise of Science*  
Chapter I  
Paraphrasing Henri Frankfort (p. 14)  
Princeton University Press. Princeton, New Jersey, USA. 1966

**Boyer, Carl** 1906–76  
Mathematical historian

Mathematics is neither a description of nature nor an explanation of its operation; it is not concerned with physical motion or with the metaphysical generation of quantities. It is merely the symbolic logic of possible relations, and as such is concerned with neither approximate nor absolute truth, but only with hypothetical truth. That is, mathematics determines what conclusions will follow logically from given premises. The conjunction of mathematics and philosophy, or of mathematics and science is frequently of great service in suggesting new problems and points of view.

*The History of the Calculus and Its Conceptual Development* (p. 308)  
Dover Publications. New York, New York, USA. 1959

...mathematics is an aspect of culture as well as a collection of algorithms.

*The History of the Calculus and Its Conceptual Development*  
Preface to second printing  
Dover Publications. New York, New York, USA. 1959

**Bragdon, Claude Fayette** 1866–1945  
American architect, writer, and stage designer

Mathematics is the handwriting on the human consciousness of the very Spirit of Life itself.

In John D. Barrow  
*Pi in the Sky: Counting, Thinking, and Being* (p. 21)  
Clarendon Press. Oxford, England. 1992

**Brooks, Edward**  
No biographical data available

Mathematics is the instrument by which the engineer tunnels out mountains, bridges our rivers, constructs our aqueducts, erects out factories and makes them musical by the busy hum of spindles. Take away the results of the reasoning of mathematics, and there would go with it nearly all the material achievements which give convenience and glory to modern civilization.

*Mental Science and Culture* (p. 255)  
Normal Publishing. Philadelphia, Pennsylvania, USA. 1891

**Bridgman, Percy Williams** 1882–1961  
American physicist

It is the merest truism, evident at once to unsophisticated observation, that mathematics is a human invention.

*The Logic of Modern Physics*

Chapter II (p. 60)

The Macmillan Company. New York, New York, USA. 1927

**Burger, Edward B.**  
American mathematician

**Starbird, Michael**  
American mathematician

Mathematics is a liberating entertainment. We can discard the kid gloves of reality's restrictions and let our minds play where they will.

*Coincidences, Chaos, and All That Math Jazz*

Closing Thoughts (p. 267)

W.W. Norton & Co. New York, New York, USA. 2005

**Cantor, Georg** 1845–1918  
German mathematician

Mathematics is perfectly free in its development and is subject only to the obvious consideration, that its concepts must be free from contradictions in themselves, as well as definitely and orderly related by means of definitions to the previously existing and established concepts.

*Grundlagen einer allgemeinen Manigfaltigkeitslehre*

Section 8

Publisher undetermined. Leipzig, Germany. 1883

**Comte, Auguste** 1798–1857  
French philosopher

The business of concrete mathematics is to discover the equations which express the mathematical laws of the phenomenon under consideration; and these equations are the starting point of the calculus, which must obtain from them certain quantities by means of others.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter II (p. 47)

John Chapman. London, England. 1853

**Condorcet, Marie Jean** 1743–94  
French philosopher and mathematician

Mathematics is the science that yields the best opportunity to observe the working of the mind...and has the advantage that by cultivating it, we may acquire the habit of a method of reasoning which can be applied afterwards to the study of any subject and can guide us in the pursuit of life's object.

Filler

*The Mathematical Intelligencer*, Volume 10, Number 4, Fall, 1988 (p. 43)

**Dantzig, Tobias** 1884–1956  
Russian mathematician

Mathematics is the supreme judge; from its decisions there is no appeal.

*Number: The Language of Science* (4th edition)

Chapter Twelve, 12 (p. 245)

The Macmillan Company. New York, New York, USA. 1954

**Davis, Chandler** 1926–  
American-born Canadian writer and educator

Mathematics is armchair science.

In R.S. Cohen, J.J. Stachel and M.W. Wartofsky

*Boston Studies in the Philosophy of Science* (Volume 15)

Materialist Mathematics (p. 38)

D. Reidel Publishing Company. Dordrecht, Netherlands.

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

...mathematics is the one subject in which time is irrelevant.

*Descartes' Dream: The World According to Mathematics*

Chapter IV

Of Time and Mathematics (p. 193)

Harcourt Brace Jovanovich. San Diego, California, USA. 1986

**Devlin, Keith** 1947–  
English mathematician and writer

Mathematics is a product – a discovery – of the human mind. It enables us to see the incredible, simple, elegant, beautiful, ordered structure that lies beneath the universe we live in. It is one of the greatest creations of mankind – if it is not indeed the greatest.

*Life By the Numbers* (p. 209)

Wiley. New York, New York, USA. 1998

**Dirac, Paul Adrien Maurice** 1902–84  
English theoretical physicist

Mathematics is the tool specially suited for dealing with abstract concepts of any kind and there is no limit to its power in this field [quantum mechanics].

*The Principles of Quantum Mechanics* (4th edition)

Preface to the First Edition (p. viii)

At The Clarendon Press. Oxford, England. 1956

**Dunham, William**  
American mathematician

Mathematics is the product of real flesh-and-blood human beings whose lives may reflect the inspiration, the tragic, or the bizarre.

*Journey Through Genius*

Preface (p. vi)

Wiley. New York, New York, USA. 1990

**Everett, Charles Carroll** 1829–1900  
American theologian

Mathematics is an instrument of thought. It is a sort of machine by which the crude and imperfect results of thought are taken and disentangled, and arranged in such a way that the thought can act upon them most readily.



*The Science of Thought*  
Second Book (p. 104)  
De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

**Garrity, Thomas A.**  
Mathematician

Math is Hard. Unfortunately, people are just not that good at mathematics. While intensely enjoyable, it also requires hard work and self-discipline. I know of no serious mathematician who finds math easy. In fact, most, after a few beers, will confess as to how stupid and slow they are.

*All the Mathematics You Missed: But Need to Know for Graduate School*

Preface (p. xiii)  
Cambridge University Press. Cambridge, England. 2002

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

Mathematics .. is concerned only with the enumeration and comparison of relations.

Quoted in E.T. Bell  
*The Development of Mathematics*  
Chapter 9 (p. 211)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

Mathematics is the Queen of the Sciences, and Arithmetic the Queen of Mathematics.

In E.T. Bell  
*Men of Mathematics* (p. xv)  
Simon & Schuster. New York, New York, USA. 1937

**Goldberger, Marvin L.**  
Physicist

**Watson, Kenneth Merle**  
No biographical data available

Mathematics is an interesting intellectual sport, but it should not be allowed to stand in the way of obtaining sensible information about physical processes.

*Collision Theory*  
Preface (p. iii)  
Dover Publications. Mineola, New York, USA. 2004

**Grassmann, Hermann** 1809–77  
German polymath

Mathematics is the science of the connection of magnitudes. Magnitude is anything that can be put equal or unequal to another thing. Two things are equal when in every assertion each may be replaced by the other.

*Werke*  
Stücke aus dem Lehrbuche der Arithmetik, Bd. 2 (p. 298)  
Publisher undetermined. Leipzig, Germany. 1904

**Guruprasad, Venkata**  
No biographical data available

Math is a perfect expression, like ballet or shaolin martial art.

In Clifford A. Pickover  
*Keys to Infinity*  
Chapter 18 (p. 147)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

“Mathematics is gibberish.” Little need be said about this statement. It is only worthy of the utterly illiterate.

*Electromagnetic Theory* (Volume 1)  
Chapter I (p. 8)  
D. van Nostrand Co. New York, New York, USA. 1893

Mathematics is an experimental science, and definitions do not come first, but later on.

On Operators in Physical Mathematics, Part II  
*Proceedings of the Royal Society of London*, Volume 54, 1893 (p. 121)

**Herbart, Johann Friedrich** 1776–1841  
German philosopher and educator

Mathematics is the predominant science of our time; its conquests grow daily, though without noise; he who does not employ it for himself, will someday find it employed against himself.

*Werke*  
Bd. 5 (p. 105)  
Druck und Verlag von Hermann Beyer & Sohne. Langensalza, Germany. 1890

**Hilbert, David** 1862–1943  
German mathematician

Mathematics...is nothing more than a game played according to certain simple rules with meaningless marks on a paper.

In E.T. Bell  
*Mathematics: Queen and Servant of Science*  
Mathematical Truth (p. 21)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Hoffman, Paul**  
No biographical data available

Mathematics is a discipline practised in every university in the world, and it is at least as broad a field as biology, in which one researcher tries to understand the AIDS virus while another studies the socialization of wombats.

*Archimedes' Revenge*  
Introduction (p. 2)  
W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Howison, G. H.**  
No biographical data available

Mathematics is the science of the functional laws and transformations which enable us to convert figured extension and rated motion into number.

The Departments of Mathematics, and Their Mutual Relations  
*Journal of Speculative Philosophy*, Volume 5, 1871 (p. 170)

Mathematics is that form of intelligence in which we bring the objects of the phenomenal world under the control of the conception of quantity.

The Departments of Mathematics, and Their Mutual Relations  
*Journal of Speculative Philosophy*, Volume 5, 1871 (p. 164)

**Huxley, Thomas Henry** 1825–95  
English biologist

[Mathematics] is that [subject] which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation.

*Lay Sermons, Addresses and Reviews* (p. 169)

D. Appleton & Company. New York, New York, USA. 1872

**Jacobi, Karl Gustav Jacob** 1804–51  
German mathematician

...mathematics is slow of growth and only reaches the truth by long and devious paths, that the way to its discovery must be prepared for long beforehand, and that then the truth will make its long-deferred appearance as if impelled by some divine necessity...

Cited in Ernst Mach

*Popular Scientific Lectures*

The Part Played by Accident in Invention and Discovery (p. 280)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Janet, Paul** 1823–99  
French philosophical writer

**Séailles, Gabriel** 1852–1922  
French philosopher

Mathematics is merely an auxiliary of science, an appendix to Physics.

Translated by Ada Monahan

*History of the Problems of Philosophy* (Volume 1)

Part I, Chapter I (p. 11)

Macmillan & Co Ltd. London, England. 1902

**Kanigel, Robert** 1946–  
Scientific journalist

Mathematics...is mired in a language of symbols foreign to most of us, [it] explores regions of the infinitesimally small and the infinitely large that elude words, much less understanding. So specialized is mathematics today...that most mathematical papers appearing in most mathematics journals are indecipherable even to most mathematicians.

*The Man Who Knew Infinity: A Life of the Genius Ramanujan*

Prologue (p. 6)

Charles Scribner's Sons. New York, New York, USA. 1991

...mathematics is not best learned passively; you don't sop it up like a romance novel. You've got to go out to it, aggressive, and alert, like a chess master pursuing checkmate.

*The Man Who Knew Infinity: A Life of the Genius Ramanujan*  
Chapter Two (p. 44)

Charles Scribner's Sons. New York, New York, USA. 1991

**Kasner, Edward** 1878–1955  
American mathematician

**Newman, James Roy** 1911–66  
Mathematician and mathematical historian

Mathematics is an activity governed by the same rules imposed upon the symphonies of Beethoven, the paintings of daVinci, and the poetry of Homer. Just as scales, as the laws of perspective, as the rules of metre seem to lack fire, the formal rules of mathematics may appear to be without lustre. Yet ultimately, mathematics reaches pinnacles as high as those attained by the imagination in its most daring reconnoiters. And this conceals, perhaps, the ultimate paradox of science. For in their prosaic plodding both logic and mathematics often outstrip their advance guard and show that the world of pure reason is stranger than the world of pure fancy.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 362)

Simon & Schuster. New York, New York, USA. 1940

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Mathematics is the only good metaphysics.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Symbolic Logic is Mathematics, Mathematics is Symbolic Logic, the twain are one.

*Lectures on Science, Philosophy and Art, 1907–1908*

Mathematics (p. 19)

The Columbia University Press. New York, New York, USA. 1908

Mathematics is, in many ways, the most precious response that the human spirit has made to the call of the infinite and eternal.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter II (p. 60)

Columbia University Press. New York, New York, USA. 1916

Mathematics is precisely the ideal handling of the problems of life, and the central ideas of the science, the great concepts about which its stately doctrines have been built up, are precisely the chief ideas with which life must always deal and which, as it tumbles and rolls about them through time and space, give it its interests and problems, and its order and rationality.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter III (p. 77)

Columbia University Press. New York, New York, USA. 1916

**King, Jerry P.**  
American mathematician

Mathematics is precise or it is nothing...

*The Art of Mathematics*

Introduction (p. 9)

Plenum Press. New York, New York, USA. 1992

**Kingsbury, Donald** 1929–

American–Canadian science fiction author and mathematician

Mathematics is the Queen of Science but she isn't very Pure; she keeps having babies by handsome young upstarts and various frog princes.

*Psychohistorical Crisis*

Chapter 29 (p. 382)

Tom Doherty Associates. New York, New York, USA. 2001

**Kline, Morris** 1908–92

American mathematics professor and writer

Mathematics is a model of exact reasoning, an absorbing challenge to the mind, an esthetic experience for creators and some students, a nightmarish experience to other students, and an outlet for the egotistic display of mental power.

*Mathematics and the Physical World*

Preface (p. vii)

Thomas Y. Crowell Co. New York, New York, USA. 1959

**Lowell, Percival** 1855–1916

American astronomer

...mathematics is merely formalized logic and deals not with the matter concerned but with the manner of its manipulation. If you put peascods into a machine you cannot take out flour, however fine you grind. Or, to drop analogy, if you apply mathematics to physics or optics, you must first be sure your physical data are correct before you proceed to deduce results from them.

The Canals of Mars, Optically and Psychologically Considered

*The Astrophysical Journal*, Volume XXVI, Number 3, October, 1907 (p. 131)

**McKay, Herbert**

No biographical data available

Mathematics is a way of looking at things. No one pretends that it is the only way, but it is an important way. Those who have failed to cultivate the mathematical outlook are missing a good deal, even though they may be unaware of what they are missing. Just as a colour-blind man is unaware of the colours denied to him. The ignorant or unfortunate live in a less interesting world than those who use all their talents.

*The World of Numbers*

Preface

Cambridge University Press. Cambridge, England. 1946

**Miller, George Abram** 1863–1951

American mathematician

Mathematics is the science of saving thought.

Definition of the Term "Mathematics"

*The American Mathematical Monthly*, Volume 15, Number 11, November, 1908 (p. 197)

**Morse, Harold Calvin Marston** 1892–1977

American mathematician

... mathematics is the sister, as well as the servant, of the arts and is touched with the same madness and genius.

In Stanley Gudder

*A Mathematical Journey* (p. 81)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Modjeski, Ralph** 1861–1940

Polish-born American engineer

**Waddell, John Alexander Low** 1854–1938

American bridge engineer

Mathematics is to an engineer what anatomy is to a surgeon, what chemistry is to an apothecary, what the drill is to an army officer.

The Teaching of Mathematics to Students of Engineering

*Science*, New Series, Volume 28, Number 710, August 7, 1908 (p. 161)

**National Research Council (USA)**

Mathematics is the worst curricular villain in driving students to failure in school.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Opportunity (p. 7)

National Academy Press. Washington, D.C. 1989

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

Mathematics is merely the means to a general and ultimate knowledge of man.

Translated by Walter Kaufmann

*The Gay Science*

Third Book

Aphorism 246

Vintage Books. New York, New York, USA. 1974

**Peirce, Benjamin** 1809–80

American mathematician, astronomer, and educator

Mathematics is the science which draws necessary conclusions.

Linear Associative Algebra

*American Journal of Mathematics*, Volume 4, 1881 (p. 97)

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

Mathematics is the most abstract of all the sciences. For it makes no external observations, nor asserts anything as a real fact. When the mathematician deals with facts, they become for him mere "hypotheses"; for with their truth he refuses to concern himself. The whole science

of mathematics is a science of hypotheses; so that nothing could be more completely abstracted from concrete reality.

The Regenerated Logic

*The Monist*, Volume 7, Number 1, October, 1896 (p. 23)

**Pieri, Mario** 1860–1913

Italian mathematician

Mathematics is the hypothetico-deductive science.

In Cassius J. Keyser

*The Pastures of Wonder: The Realm of mathematics and the Realm of Science*

The Realm of Mathematics (p. 24)

Columbia University Press. New York, New York, USA. 1929

**Pólya, George** 1887–1985

Hungarian mathematician

Mathematics is being lazy. Mathematics is letting the principles do the work for you so that you do not have to do the work yourself.

In Marion Walter and Tom O'Brien article

Memories of George Polya

*Mathematics Teaching*, Volume 116, September, 1986 (p. 4)

**Poovey, Mary**

No biographical data available

Mathematics is abused by “consultants” to lend speculations an aura of objectivity and precision that they do not possess.

International Congress of Mathematics 2002

Beijing, August 22, 2002

**Price, Bartholomew** 1818–98

English mathematician and educator

Mathematics is the most powerful instrument, which we possess, for this purpose [to trace into their farthest results those general laws which an inductive philosophy has supplied]: in many sciences a profound knowledge of mathematics is indispensable for a successful investigation. In the most delicate researches into the theories of light, heat, and sound it is the only instrument; they have properties which no other language can express; and their argumentative processes are beyond the reach of other symbols.

*Treatise on Infinitesimal Calculus* (Volume 3) (p. 5)

Oxford University Press, Inc. Oxford, England. 1868

**Richard Feynman (Fictional character)**

Mathematics is a language. It's very difficult. It's subtle. You couldn't say those things any other way – and I can talk to dead people with it. I talk to Copernicus every day.

*Infinity*

Film (1996)

**Richardson, Moses**

No biographical data available

...I propose the following, if not as a definition, then at least as a partial description; mathematics is persistent intellectual honesty.

Mathematics and Intellectual Honesty

*The American Mathematical Monthly*, Volume 59, Number 2, February, 1952 (p. 73)

**Rota, Gian-Carlo** 1932–1999

Italian-born American mathematician

Mathematics is a cruel profession. Solving a mathematical problem is for most mathematicians an arduous and lengthy process which may take years, even a lifetime. The final conquest of the truth comes, if ever, inevitably tinged with disillusion, soured by the realization of the ultimate irrelevance of all intellectual endeavor.

*Indiscrete Thoughts*

Chapter V (p. 60)

Birkhäuser. Boston, Massachusetts, USA. 1997

Mathematics is the study of analogies between analogies. All science is. Scientists want to show that things that don't look alike are really the same. That is one of their innermost Freudian motivations. In fact, that is what we mean by understanding.

*Indiscrete Thoughts*

Chapter XX (p. 214)

Birkhäuser. Boston, Massachusetts, USA. 1997

**Rudin, Mary Ellen** 1924–

American mathematician

Mathematics is obviously something that women should be able to do very well. It's very intuitive. You don't need a lot of machinery, and you don't need a lot of physical strength. You just need stamina, and women often have a great deal of stamina.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 301)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...mathematics is the manhood of logic...

*Introduction to Mathematical Philosophy*

Chapter XVIII (p. 194)

Dover Publications, Inc. New York, New York, USA. 1993

Pure Mathematics is the class of all propositions of the form “p implies q,” where p and q are propositions containing one or more variables, the same in the two propositions, and neither p or q contains any constants except logical constants. And logical constants are all notions definable in terms of a class of the following: Implication, the relation of a term to a class of relation, and such further notions as may be involved in the general notion of propositions of the above form. In addition to these, Mathematics uses a notion which is not a constituent of the propositions which it considers – namely, the notion of truth.

*Principles of Mathematics* (2nd edition)  
Chapter 1 (p. 1)  
W.W. Norton & Company, Inc. New York, New York, USA. 1938.

### Safford, Truman Henry

American calculating prodigy

The modern, and to my mind the true, theory is that mathematics is the abstract form of the natural sciences; and that it is valuable as a training of the reasoning powers, not because it is abstract, but because it is a representative of actual things.

*Mathematical Teaching and Its Modern Methods*  
Introduction (pp. 9–10)  
D.C. Heath & Co. Boston, Massachusetts, USA. 1887

### Sampson, R. A.

Astronomer

...mathematics is much more than a general parable of our view of nature. It is far the most promising engine of research, and almost the only fully reliable one, for separating what is necessary from what is accidental, in any analysis of thought and its method; in affording examples in which logic is incapable of furnishing any single solution to a problem, owing to the conditions being themselves indeterminate; in illustrating what is arbitrary in our connection of cause and effect by showing how our logical steps are in many vital ways a matter of definition; in showing the dangers of argument upon ideas which are ill-defined or which perhaps are impossible to define, by exhibiting the almost endless subtleties to which the full discussion of such simple ideas as those of number lead when investigated thoroughly.

*Mathematics as A Means and As A End*  
*Proceedings of the University of Durham Philosophical Society*, Volume 2, 1907 (pp. 91–92)

### Santayana, George (Jorge Augustín Nicolás

Ruiz de Santillana) 1863–1952

Spanish-born American philosopher

...mathematics is like music, freely exploring the possibilities of form. And yet, notoriously, mathematics holds true of things; hugs and permeates them far more closely than does confused and inconstant human perception; so that the dream of many exasperated critics of human error has been to assimilate all science to mathematics, so as to make knowledge safe by making it, as Locke wished, direct perception of the relations between ideas...

*The Realm of Truth: Book Third of Realms of Being*  
Chapter I (pp. 2–3)  
Constable & Company Ltd. London, England. 1937

### Schwinger, Julian 1918–94

American theoretical physicist

Mathematics is the natural language of theoretical physics. It is the irreplaceable instrument for the penetration

of realms of physical phenomena far beyond the ordinary experience upon which conventional language is based.

*Nobel Lectures, Physics 1963–1970*  
*Relativistic Quantum Field Theory* (p. 140)  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1972

### Shaw, James Byrnie

American mathematician

Mathematics is, on the artistic side, a creation of new rhythms, orders, designs and harmonies, and on the knowledge side, is a systematic study of the various rhythms, orders, designs and harmonies. We may condense this into the statement that mathematics is, on the one side, the qualitative study of the structure of beauty, and on the other side is the creator of new artistic forms of beauty. The mathematician is at once creator and critic.

In W.L. Schaaf (ed.)  
*Mathematics: Our Great Heritage*  
*Mathematics – The Subtle Fine Art* (p. 50)  
Harper & Brothers. New York, New York, USA. 1948

### Simmons, George F.

No biographical data available

There is an old Armenian saying, “He who lacks a sense of the past is condemned to live in the narrow darkness of his own generation.” Mathematics without history is mathematics stripped of its greatness: for, like the other arts – and mathematics is one of the supreme arts of civilization – it derives its grandeur from the fact of being a human creation.

*Differential Equations with Applications and Historical Notes*  
Preface (p. ix)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

### Smith, W. B.

No biographical data available

Mathematics is the universal art apodictic.

In Columbia University  
*Lectures on Science, Philosophy and Art 1907–1908* (p. 13)  
New York, New York, USA. 1908

### Stabler, E. Russell

No biographical data available

Mathematics is the science of number and space. It starts from a group of self-evident truths and by infallible deduction arrives at incontestable conclusions... the facts of mathematics are absolute, unalterable, and eternal truths.

An Interpretation and Comparison of Three Schools of Thought in the Foundations of Mathematics  
*The Mathematics Teacher*, Volume 26, January, 1935 (p. 6)

### Stein, Sherman K.

No biographical data available

Mathematics, like every branch of knowledge, is the product of the interplay between past and present, between

accumulated knowledge and curiosity, between the autonomous structure and the tastes and need of the time.

The Mathematician as an Explorer

*Scientific American*, Volume 204, Number 5, May, 1961 (p. 149)

**Steinmetz, Charles Proteus** 1865–1923

German-American electrical engineer and inventor

Mathematics is the most exact science, and its conclusions are capable of absolute proof. But this is so only because mathematics does not attempt to draw absolute conclusions. All mathematical truths are relative, conditional.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

Mathematics is merely a shorthand method of recording physical intuition and physical reasoning, but it should not be a formalism leading from nowhere to nowhere, as it is likely to be made by one who does not realize its purpose as a tool.

*Transactions of the American Institute of Electrical Engineers*

(Volume 28) Part I

Discussion on The Education of the Electrical Engineer (p. 92)

American Institute of Electrical Engineers

New York, New York, USA. 1909

**Sternberg, Shlomo**

Mathematician

Mathematics is the science of order and mathematicians seek to identify instances of order and to formulate and understand concepts that enable us to perceive order in complicated situations.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 94)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Stewardson, Langdon Cheves** 1850–?

American college president

To be told that mathematics is good training for the mind does not insure either the intelligent or ardent pursuit of this branch of science.

Physical Training And Athletics

*Educational Review*, Volume 34 November, 1907 (p. 387)

**Stewart, Ian** 1945–

English mathematician

Mathematics is to nature as Sherlock Holmes is to evidence.

*Nature's Numbers*

Chapter 1 (p. 2)

BasicBooks. New York, New York, USA. 1995

Mathematics is much like the Mississippi. There are sideshoots and dead ends and minor tributaries; but the mainstream is there, and you can find it where the current – the mathematical power – is strongest. Its delta is research mathematics: it is growing, it is going

somewhere (but it may not always be apparent where), and what today looks like a major channel may tomorrow clog up with silt and be abandoned. Meanwhile a minor trickle may suddenly open out into a roaring torrent. The best mathematics always enriches the mainstream, sometimes by diverting it in an entirely new direction.

*From Here to Infinity*

The Nature of Mathematics (p. 11)

Oxford University Press, Inc. Oxford, England. 1996

Mathematics is to nature as Sherlock Holmes is to evidence.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*

Chapter 1 (p. 2)

Basic Books. New York, New York, USA. 1995

...mathematics is the science of patterns, and nature exploits just about every pattern that there is.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*

Chapter 2 (p. 18)

Basic Books. New York, New York, USA. 1995

**Struik, Dirk J.** 1894–2000

Dutch mathematician

Mathematics is a vast adventure of ideas; its history reflects some of the noblest thoughts of countless generations.

*A Concise History of Mathematics*

Introduction (p. 1)

Dover Publications, Inc. New York, New York, USA. 1967

Mathematics is of profound significance in the universe, not because it exhibits principles that we obey, but because it exhibits principles that we impose.

In William L. Schaff (ed.)

*Mathematics: Our Great Heritage*

Aspects of Science (p. 12)

Harper & Brothers. New York, New York, USA. 1948

**Sylvester, James Joseph** 1814–97

English mathematician

Mathematics is the only true metaphysics.

In S. P. Thompson

*The Life of William Thomson Baron Kelvin of Largs* (Volume 2)

Views and Opinions (p. 1139)

**Szego, Gábor** 1895–1985

Hungarian mathematician

Mathematics is a human activity almost as diverse as the human mind itself.

In Jozef Kurschak

*Hungarian Problem Book I* (p. 6)

Mathematical Association of America. Washington, D.C. 1963

**Thurston, William Paul** 1946–

American mathematician

I think of myself as learning the outskirts of mathematics. I think mathematics is a vast territory. The outskirts



of mathematics are the outskirts of mathematical civilization. Then are certain subjects that people learn about and gather together. Then there is a sort of inevitable development in those fields. You get to the point where a certain theorem is bound to be proved, independent of any particular individual, because it is just in the path of development. I enjoy trying to find mathematical topics that people haven't thought to think about. Then I work there. I like elbow room.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 332)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

Mathematics is a huge and highly interconnected structure...Think of a tinker toy set. The key is the pieces which have holes, allowing you to join them with rods to form interesting and highly interconnected structures. No interesting mathematical topic is self-contained or complete: rather it is full of "holes," or natural questions and ideas not readily answered by techniques native to the topic. These holes often give rise to connections between the given topic and other topics that seem at first unrelated. Mathematical exposition often conceals these holes, for the sake of smoothness – but what good is a tinker toy set if the holes are all filled in with modeling clay?

*Three-Dimensional Geometry and Topology*  
Reader's Advisory (p. ix)  
Princeton University Press. Princeton, New Jersey, USA. 1997

**Ulam, Stanislaw** 1909–84  
Polish-born mathematician

In many cases, mathematics is an escape from reality. The mathematician finds his own monastic niche and happiness in pursuits that are disconnected from external affairs. Some practice it as if using a drug. Chess sometimes plays a similar role. In their unhappiness over the events of this world, some immerse themselves in a kind of self-sufficiency in mathematics.

*Adventures of a Mathematician*  
Chapter 6 (p. 120)  
Charles Scribner's Sons. New York, New York, USA. 1976

**von Helmholtz, Robert**  
No biographical data available

Mathematics is the most convenient instrument in the exact science of nature because it is the tongue in which the latter can express its conclusions in the quickest and most precise way. That is why the exact study of nature becomes more and more mathematical; physics, after astronomy, has made the most progress in this direction...

*Annual Report of the Board of Regents of the Smithsonian Institution, 1889*  
A Memoir of Gustav Robert Kirchhoff (p. 528)  
Government Printing Office. Washington, D.C. 1889

**von Neumann, John** 1903–57  
Hungarian-American mathematician

It is commonplace that mathematics is an excellent school of thinking, that it conditions you to logical thinking, that after having experienced it you can somehow think more validly than otherwise. I don't know whether all these statements are true, the first one is probably least doubtful. However, I think it has a very great importance in thinking in an area which is not so precise. I feel that one of the most important contributions of mathematics to our thinking is, that it has demonstrated an enormous flexibility in the formation of concepts, a degree of flexibility to which it is very difficult to arrive in a nonmathematical mode.

In John A. Taub (ed.)  
*John von Neumann Collected Works*  
Volume VI, The Role of Mathematics in The Sciences and Society (p. 482)  
Pergamon. New York, New York, USA. 1963

Mathematics is nourished by dreamers – as it nourishes them...

*The World of Mathematics* (Volume 1)  
The Rhine Papyrus (p. 170)  
Simon & Schuster. New York, New York, USA. 1956

**von Raumer, Karl** 1783–1865  
German geologists and mineralogists

In the pure mathematics is the point for setting the lever which will move the world; it is the center from which light radiates to innumerable points on the circumference – to innumerable sciences and arts.

Instruction in Natural Science  
*The American Journal of Education*, Number 20 1860 (p. 136)

**von Schlegel, Friedrich** 1772–1829  
German philosopher, critic, and writer

Mathematics is, as it were, a sensuous logic, and relates to philosophy as do the arts, music, and plastic art to poetry.

*Dialogue on Poetry and Literary Aphorisms*  
Selected Aphorisms from the Athenaeum  
Aphorism 365 (p. 147)  
The Pennsylvania State University Press, University Park, Pennsylvania, USA. 1968

**Vooley, Hollis R.**  
No biographical data available

Mathematics is loved by many, disliked by a few, admired and respected by all. Because of their immense power and reliability, mathematical methods inspire confidence in persons who comprehend them and awe in those who do not.

In Samuel Rapport and Helen Wright (eds.)  
*Mathematics*  
Forward (p. ix)  
New York University Press. New York, New York, USA. 1963

**Waldo, Clarence Abiathar** 1852–1926  
American mathematician, author, and educator

The time is passed when mathematics is referred to by the thinkers of the day as being principally a discipline. It is, of course, true that, rightly pursued, mathematics is a discipline, but it is far more, it is a knowledge, a tool, a power, a civilizer.

Mathematics and Engineering

*Proceedings of the American Association for the Advancement of Science*, December 1903–January 1904 (p. 449)

**Wall, Hubert Stanley** 1902–71

American mathematician

Mathematics is a creation of the mind. To begin with, there is a collection of things, which exist only in the mind, assumed to be distinguishable from one another; and there is a collection of statements about these things, which are taken for granted. Starting with the assumed statements concerning these invented or imagined things, the mathematician discovers other statements, called theorems, and proves them as necessary consequences. This, in brief, is the pattern of mathematics. The mathematician is an artist whose medium is the mind and whose creations are ideas.

*Creative Mathematics* (p. 3)

University of Texas Press. Austin, Texas, USA. 1963

**Walpole, Horace** 1717–97

English art historian, writer, antiquarian, and politician

The profound study of mathematics seems to injure the more general and useful mode of reasoning – that by induction. Mathematical truths being, so to speak, palpable, the moral feelings become less sensitive to impalpable truths. As when one sense is carried to great perfection, the others are usually less acute, so mathematical reasoning seems, in some degree, to injure the other modes of ratiocination.

*Walpoliana*

CLXXXII (p. 85)

Printed by C. Whittingham. London, England. 1830

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

Theology, Mr. Fortune found, is a more accommodating subject than mathematics; its technique of exposition allows greater latitude. For instance when you are graveled for matter there is always the moral to fall back upon. Comparisons too may be drawn, leading cases cited, types and antetypes analysed and anecdotes introduced. Except for Archimedes mathematics is singularly naked of anecdotes.

*Mr. Fortune's Maggot*

Mr. Fortune's Maggot (p. 111)

New York Review of Books. New York, New York, USA. 1927

**Waugh, John Hugh W.**

No biographical data available

Mathematics is peculiarly and pre-eminently the science of relations, and whether quantity or direction

may severally form its object, these are never contemplated in characters purely absolute, but invariably in comparison with other objects like themselves; and it is hence that relations once established by the unerring theorems of the science, we are enabled, disregarding magnitude in itself, to pass indifferently from the finite to the infinite, from the limited regions of sense to those of conception, and with all the assurance and all the certainty that even the geometry of the ancients could confer.

*Mathematical Essays*

ESSAY IV (p. 69)

Johnstone & Hunter. Edinburgh, Scotland. 1854

**Weil, André** 1906–98

French mathematician

God exists since mathematics is consistent, and the Devil exists since we cannot prove it.

In John D. Barrow

*The World within The World* (p. 254)

Clarendon Press. Oxford, England. 1988

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

...the new mathematics is a sort of supplement to language, affording a means of thought about form and quantity and a means of expression, more exact, compact, and ready than ordinary language. The great body of physical science, a great deal of the essential facts of financial science, and endless social and political problems are only accessible and only thinkable to those who have had a sound training in mathematical analysis, and the time may not be very remote when it will be understood that for complete initiation as an efficient citizen of one of the new great complex world wide states that are now developing, it is as necessary to be able to compute, to think in averages and maxima and minima, as it is now to be able to read and to write.

*Mankind In the Making*

Chapter VI (p. 204)

Chapman & Hall. London, England. 1906

**Weyl, Hermann** 1885–1955

German mathematician

Only he who knows what mathematics is, and what its function in our present civilization, can give sound advice for the improvement of our mathematical teaching.

*Collected Works* (Volume 1)

Opposite Weyl Photograph

Mathematics is the science of the infinite, its goal the symbolic comprehension of the infinite with human, that is finite, means.

*The Open World: Three Lectures In the Metaphysical Implications of Science*

Lecture I (p. 7)

Yale University Press. New Haven, Connecticut, USA. 1932

**Whetham, Sir William Cecil Dampier** 1867–1952  
English scientific writer

...mathematics is but the higher development of symbolic logic.

*The Recent Development of Physical Science* (p. 34)  
P. Blakiston's Son & Company. Philadelphia, Pennsylvania, USA. 1904

**White, Leslie Alvin** 1900–75  
American anthropologist

Mathematics is a kind of primate behavior as languages, musical systems and penal codes are.

*The Science of Culture: A Study of Man and Civilization* (p. 302)  
Farrar, Straus & Co. New York, New York, USA. 1949

**White, William Frank**  
No biographical data available

Mathematics is the language of definiteness, the necessary vocabulary of those who know. Hence the intimate connection between mathematics and science.

*A Scrap-book of Elementary Mathematics: Notes, Recreations, Essays*  
Preface (p. 7)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1908

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The point of mathematics is that in it we have always got rid of the particular instance, and even of any particular sorts of entities. So that for example, no mathematical truths apply merely to fish, or merely to stones, or merely to colours. So long as you are dealing with pure mathematics, you are in the realm of complete and absolute abstraction.... Mathematics is thought moving in the sphere of complete abstraction from any particular instance of what it is talking about.

*Science and the Modern World*  
Chapter II (pp. 31–32)  
The Macmillan Company. New York, New York, USA. 1929

For mathematics is the science of the most complete abstractions to which the human mind can attain.

*Science and the Modern World*  
Chapter II (p. 51)  
The Macmillan Company. New York, New York, USA. 1929

Mathematics is merely an apparatus for analyzing the deductions which can be drawn from any particular premises, supplied by common sense, or by more refined scientific observation, so far as these deductions depend on the forms of the propositions.

The Organization of Thought  
*Science*, N.S. Volume 44, Number 1134, September 22, 1916 (p. 417)

The essence of applied mathematics is to know what to ignore.

In R. A. Fisher Presidential Address  
Presidential Address, First Indian Statistical Conference  
*Sankhya*, 1938, Volume 4, 1938 (p. 16)

Mathematics in its widest significance is the development of all types of formal, necessary, deductive reasoning.

*A Treatise on Universal Algebra, with Applications*  
Preface (p. vi)  
Hafner Publishing Company. New York, New York, USA. 1960

**Wiener, Norbert** 1894–1964  
American mathematician

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

...mathematics is the science of skillful operations with concepts and rules invented just for this purpose.

The Unreasonable Effectiveness of Mathematics in the Natural Sciences

*Communications on Pure and Applied Mathematics*, Volume XIII, Number 1, February, 1960 (p. 2)

**Wilder, Raymond L.** 1896–1982  
American mathematician

...mathematics is what we make it; not by each of us acting without due regard for what constitutes mathematics in our culture, but by seeking to build up new theories in the light of the old, and to solve outstanding problems generally recognized as valuable for the progress of mathematics as we know it. Until we make it, it fails to "exist." And, having been made, it may at some future time even fail to be "mathematics" any longer.

*Introduction to the Foundations of Mathematics*  
Chapter XII (p. 284)  
John Wiley & Sons, Inc. New York, New York, USA. 1952

**Wiles, Andrew** 1953–  
English-born American research mathematician

Mathematics...is a bit like discovering oil.... But mathematics has one great advantage over oil, in that no one has yet...found a way that you can keep using the same oil forever.

*Notices of the American Mathematical Society*, May, 1997 (p. 588)

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

...mathematics is a MOTLEY of techniques and proofs.

*Remarks on the Foundations of Mathematics*  
Appendix II, 46 (p. 84e)  
The MIT Press. Cambridge, Massachusetts, USA. 1967

**Wright, Will**  
Mathematician

Mathematics is found to be the special, necessary lens through which nature must be observed since nature is defined as being exactly a structure of mathematical entities and relations ...

*Wild Knowledge: Science, Language, and Social Life in a Fragile Environment* (p. 75)  
University of Minnesota Press. Minneapolis, Minnesota, USA. 1992

**Young, Jacob William Albert** 1865–1948  
American mathematician

Mathematics is a type of thought which seems ingrained in the human mind, which manifests itself to some extent with even the primitive races, and which is developed to a high degree with the growth of civilization.

*The Teaching of Mathematics in the Elementary and the Secondary School*  
Chapter II (p. 14)  
Longmans, Green & Co. New York, New York, USA. 1907

**Young, John Wesley**  
Mathematician

Mathematics is a type of thought which seems ingrained in the human mind, which manifests itself to some extent with even the primitive races, and which is developed to a high degree with the growth of civilization.... A type of thought, a body of results, so essentially characteristic of the human mind, so little influenced by environment, so uniformly present in every civilization, is one of which no well-informed mind today can be ignorant.

*The Teaching of Mathematics*  
Chapter II (p. 14)  
Longmans, Green & Company. London, England. 1929

**Zeilberger, Doron**  
Israeli-American mathematician

Mathematics is infinitely wide, while the language that describes it is finite. It follows from the pigeonhole principle that there exist distinct concepts that are referred to by the same name. Mathematics is also infinitely deep and sometimes entirely different concepts turn out to be intimately and profoundly related.

Closed form (pun intended!)  
*Contemporary Mathematics*, Volume 143, 1988

## MATHEMATICS MAJOR

**Heller, Joseph** 1923–99  
American writer

She was a crazy mathematics major from the Wharton School of Business who could not count to twenty-eight each month without getting into trouble.

*Catch-22*  
Chapter Eight (p. 72)  
Dell Publishing Company, Inc. New York, New York, USA. 1985

## MATHEMATICS, ABSTRACT

**Boehm, George A. W.** 1922–93  
American editor and mathematician

Never before have so many people applied such abstract mathematics to so great a variety of problems. To meet the demands of industry, technology, and other sciences, mathematicians have had to invent new branches

of mathematics and expand old ones. They have built a superstructure of fresh ideas that people trained in the classical branches of the subject would hardly recognize as mathematics at all.

*Annual Report of the Board of Regents of the Smithsonian Institution (1959)*  
The New Uses of the Abstract (p. 309)  
Government Printing Office. Washington, D.C. 1960

## MATHEMATICS, APPLICATION OF

**Bernard, Claude** 1813–78  
French physiologist

The application of mathematics to natural phenomena is the aim of all science.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section vi (p. 129)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Merz, John Theodore** 1840–1922  
German-born British chemist, historian, and industrialist

All applications of mathematics consist in extending the empirical knowledge which we possess of a limited number or region of accessible phenomena into the region of the unknown and inaccessible; and much of the progress of pure analysis consists in inventing definite conceptions, marked by symbols, of complicated operations; in ascertaining their properties as independent objects of research; and in extending their meaning beyond the limits they were originally invented for – thus opening out new and larger regions of thought.

*A History of European Thought in the Nineteenth Century (Volume 2)*  
Chapter XIII (p. 698)  
William Blackwood & Sons. Edinburgh, Scotland. 1903

**Tukey, John W.** 1915–2000  
American statistician

Just as there is an applied mathematics of games, genetics, and mechanics, so there should be an applied mathematics (at least in terms of concepts, perhaps with techniques and operations) of the applications of mathematics. When there is, mathematicians will be able to teach the applications of mathematics.

*The Teaching of Concrete Mathematics*  
*The American Mathematical Monthly*, Volume 65, Number 1, January, 1958 (p. 8)

## MATHEMATICS, APPLIED

**Boehm, George A. W.** 1922–93  
American editor and mathematician

Applied mathematicians have been grappling successfully with the world's problems at a time, curiously enough, when pure mathematicians seem almost to have lost touch with the real world.

*Annual Report of the Board of Regents of the Smithsonian Institution (1959)*  
The New Uses of the Abstract (p. 309)  
Government Printing Office. Washington, D.C. 1960

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Applied mathematics is mathematics simply or is not mathematics at all.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Mathematics (p. 35)  
The Columbia University Press. New York, New York, USA. 1908

## MATHEMATICS, APPROXIMATION OF

**Artstein, Zvi**  
Mathematician

Nature is a good approximation of Mathematics.  
*Rutgers University Colloquium*  
December 6, 2002

## MATHEMATICS, BOOK OF

**Holmes, Jr., Oliver Wendell** 1841–1935  
American jurist

The law embodies the story of a nation's development through many centuries, and it cannot be dealt with as if it contained only the axioms and corollaries of a book of mathematics.

*The Common Law*  
Lecture I (p. 1)  
Little, Brown & Company. Boston, Massachusetts, USA. 1923

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The domain of mathematics is the sole domain of certainty.  
*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter VI (p. 138)  
Columbia University Press. New York, New York, USA. 1916

**Smith, David Eugene** 1860–1945  
Mathematician

...in the domain of mathematics, we are surrounded by clouds, and success drives back these clouds a little way, and a discovery is made; then someone makes another discovery and drives them back a little more; and at rare intervals in time a Newton comes and drives them back, what seems a long, long way – and still there is the surrounding mist of mystery. It is a great experience, this piercing the clouds; but try as we may, there is still the mist about us.

*The Poetry of Mathematics and Other Essays*  
Chapter I (p. 11)  
Scripta Mathematica. New York, New York, USA. 1934

## MATHEMATICS, COMPASS OF

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

When we cannot use the compass of mathematics or the torch of experience...it is certain that we cannot take a single step forward.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 614)  
Oxford University Press, Inc. New York, New York, USA. 1972

## MATHEMATICS, CONCEPT OF

**Berlinski, David** 1942–  
American mathematician

The concepts of mathematics, despite their unfamiliarity, are infinitely accessible. At their deaths, those who have minded mathematics will have known the continuous functions better than the crooked human heart. That so abstract a consideration should in the end be so lucid is a source of wonder.

*A Tour of Calculus*  
Chapter 15 (p. 143)  
Pantheon Books. New York, New York, USA. 1995

## MATHEMATICS, ENGINEERING

**Author undetermined**

The first law of Engineering Mathematics: All infinite series converge, and moreover converge to the first term.

Source undetermined

## MATHEMATICS, ESSENCE OF

**Boole, George** 1815–64  
English mathematician

It is not of the essence of mathematics to be conversant with the ideas of number and quantity.

*An Investigation of the Laws of Thought*  
Chapter I (p. 12)  
Walton & Maberly. London, England. 1854

**Cantor, Georg** 1845–1918  
German mathematician

The essence of mathematics lies in its freedom.  
*Mathematische Annalen*  
Bd. 21, 1883 (p. 564)

## MATHEMATICS, FACTS OF

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

The facts of mathematics are verified and presented by the axiomatic method. One must guard, however, against confusing the presentation of mathematics with the content of mathematics. As axiomatic presentation of a mathematical fact differs from the fact that is being

presented as medicine differs from food. It is true that this popular medicine is necessary to keep the mathematician at a safe distance from the self-delusions of the mind. Nonetheless, understanding mathematics means being able to forget the medicine and enjoy the food.

*Indiscrete Thoughts*

Chapter II (p. 96)

Birkhäuser. Boston, Massachusetts, USA. 1997

## MATHEMATICS, FOUNDATION OF

**Kline, Morris** 1908–92

American mathematics professor and writer

The developments in this century bearing on the foundations of mathematics are best summarized in a story. On the banks of the Rhine, a beautiful castle had been standing for centuries. In the cellar of the castle, an intricate network of webbing had been constructed by industrious spiders who lived there. One day a strong wind sprang up and destroyed the web. Frantically, the spiders worked to repair the damage. They thought it was their webbing that was holding up the castle.

*Mathematics: The Loss of Certainty*

Chapter XII (p. 277)

Oxford University Press, Inc. New York, New York, USA. 1980

**Weyl, Hermann** 1885–1955

German mathematician

...it is the function of mathematics to be at the service of the natural sciences.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 61)

Princeton University Press. Princeton, New Jersey, USA. 1949

## MATHEMATICS, GOAL OF

**Graham, Ronald L.** 1935–

American mathematician

**Knuth, Donald E.** 1938–

American computer scientist

The ultimate goal of mathematics is to eliminate all need for intelligent thought.

*Concrete Mathematics: A Foundation for Computer Science*

Chapter 2.6 (p. 56)

Addison-Wesley Publishing. Reading, Massachusetts, USA. 1990

## MATHEMATICS, GOLDEN AGE OF

**Pierpont, James** ?–1938

No biographical data available

We who stand on the threshold of a new century can look back on an era of unparalleled progress. Looking into the future an equally bright prospect greets our eyes; on all sides fruitful fields of research invite our labor and

promise easy and rich returns. Surely this is the golden age of mathematics!

*The History of Mathematics in the Nineteenth Century*

*Bulletin of the American Mathematical Society*, 2nd Series, Volume 11, 1904–1905 (p. 159)

## MATHEMATICS, HISTORY OF

**Cajori, Florian** 1859–1930

Swiss-born American educator and mathematician

The history of mathematics is important also as a valuable contribution to the history of civilization. Human progress is closely identified with scientific thought. Mathematical and physical researches are a reliable record of intellectual progress.

*A History of Mathematics*

Introduction (p. 3)

The Macmillan Company. London, England. 1919

**Hogben, Lancelot** 1895–1975

English zoologist

The history of mathematics is the mirror of civilization.

*Mathematics for the Million*

Chapter I (p. 36)

W.W. Norton & Company, Inc. New York, New York, USA. 1917

**Lakatos, Imre** 1922–74

Hungarian-born philosopher

Under the present dominance of formalism, one is tempted to paraphrase Kant: the history of mathematics, lacking the guidance of philosophy, has become blind, while the philosophy of mathematics, turning its back on the most intriguing phenomena in the of mathematics, has become empty.

*Proofs and Refutations: The Logic of Mathematical Discovery*

Cambridge University Press. Cambridge, England. 1976

**Smith, David Eugene** 1860–1945

Mathematician

The whole history of the development of mathematics has been a history of the destruction of old definitions, old hobbies, old idols.

*American Mathematical Monthly*, Volume 1, Number 1, 1894 (p. 74)

**Sullivan, John William Navin** 1886–1937

Mathematician

...a history of mathematics is largely a history of discoveries which no longer exist as separate items, but are merged into some more modern generalization, these discoveries have not been forgotten or made valueless. They are not dead, but transmuted.

*The History of Mathematics in Europe*

Introduction (p. 10)

Oxford University Press, Inc. New York, New York, USA. 1925



**MATHEMATICS, HUMANIZATION OF**

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

To humanize the teaching of mathematics means so to present the subject, so to interpret its ideas and doctrines, that they shall appeal, not merely to the computatory faculty or to the logical faculty but to all the great powers and interests of the human mind.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Humanization of Teaching Mathematics (p. 62)  
Columbia University Press. New York, New York, USA. 1916

**MATHEMATICS, IDEA OF**

**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

The idea of mathematics is the idea of science in general.

Quoted in Panthea  
Eclectic Gatherings  
*The Reasoner*, Volume 6, 1849 (p. 373)

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The ideal of mathematics should be to erect a calculus to facilitate reasoning in connection with every province of thought, or of external experience, in which the succession of thoughts, or of external experience, in which the succession of thoughts, or of events, can be definitely ascertained and precisely stated. So that all serious thought which is not philosophy, or inductive reasoning, or imaginative literature, shall be mathematics developed by means of a calculus.

*A Treatise on Universal Algebra, with Applications*  
Preface (p. viii)  
Hafner Publishing Company. New York, New York, USA. 1960

...the anxious precision of modern mathematics is necessary for accuracy...it is necessary for research. It makes for clearness of thought and for fertility in trying new combinations of ideas. When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. Its sole criterion for judgment is that the new ideas shall look like the old ones, in other words it can only act by suppressing originality.

*An Introduction to Mathematics*  
Chapter 11 (p. 116)  
Oxford University Press, Inc. New York, New York, USA. 1958

**MATHEMATICS, KNOWLEDGE OF**

**Aleksandrov, Aleksandre Danilovic** 1912–99  
Russian mathematician and physicist

With even a superficial knowledge of mathematics, it is easy to recognize certain characteristic features: its

abstractions, its precision, its logical rigor, the indisputable character of its conclusions, and finally, the exceptionally broad range for its applications.

In A.D. Aleksandrov, A.N. Kolmogorov and M.A. Lavrent'ev (eds.)  
*Mathematics: Its Contents, Methods, and Meaning* (p. 1)  
The MIT Press. Cambridge, Massachusetts. 1963

**Glanvill, Joseph** 1636–80  
English clergyman and philosopher

...the knowledge we have of the Mathematicks, hath no reason to elate us; since by them we know but numbers, and figures, creatures of our own, and are yet ignorant of our Maker's.

*The Vanity of Dogmatizing*  
Chapter XXI (pp. 209–210)  
Printed for Henry Eversden. London, England. 1661

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Admission to [astronomy's] sanctuary, and to the privileges and feelings of a votary, is only to be gained by one means – sound and sufficient knowledge of mathematics, the greatest instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.

*Outlines of Astronomy*  
Part I, Introduction (p. 5)  
Longman, Brown, Green & Longmans. London, England. 1849

**Richardson, David Lester** 1801–65  
Poet and writer

...a knowledge of mathematics is of so little use in daily life that you may know a man intimately for half a century without discovering whether he has mastered the first proposition in Euclid. But ignorance in the elements of a literary education cannot be concealed for a day – not for an hour – not indeed for five minutes, if the ignoramus will only attempt to speak or write.

*Literary Chit-Chat*  
Chapter X (p. 77)  
P.S. D'Rozario and Co. Calcutta, India. 1848

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Philosophers, when they have possessed a thorough knowledge of mathematics, have been among those who have enriched the science with some of its best ideas. On the other hand it must be said that, with hardly an exception, all the remarks on mathematics made by those philosophers who have possessed but a slight or hasty or late-acquired knowledge of it are entirely worthless, being either trivial or wrong.

*An Introduction to Mathematics*  
Chapter 9 (pp. 81–82)  
Oxford University Press, Inc. New York, New York, USA. 1958

**Young, Jacob William Albert** 1865–1948  
American mathematician

Little can be understood of even the simplest phenomena of nature without some knowledge of mathematics, and the attempt to penetrate deeper into the mysteries of nature compels simultaneous development of the mathematical processes.

*The Teaching of Mathematics in the Elementary and the Secondary School*

Chapter II (p. 16)

Longmans, Green & Co. New York, New York, USA. 1907

## MATHEMATICS, LANGUAGE OF

**Bentley, Arthur**

No biographical data available

The every-day language reeks with philosophies.... It shatters at every touch of advancing knowledge. At its heart lies paradox. The language of mathematics, on the contrary, stands and grows in firmness. It gives service to men beyond all other language.

*Linguistic Analysis of Mathematics*

Forward (p. viii)

The Principia press, Inc. Bloomington, Indiana, USA. 1932

**Hill, Thomas**

No biographical data available

The language of Mathesis is special and untranslatable. In its simplest forms it can be translated, as, for instance, we may explain a right angle to mean a square corner. But go a little higher in the science of mathematics, and it is impossible to dispense with a peculiar language. It would defy all the power of Mercury himself to explain to a person ignorant of the science what is meant by the simple phrase “functional exponent.”

*The Imagination in Mathematics*

*The North American Review*, Volume LXXXV, Number 176, July, 1857 (p. 224)

**Sylvester, James Joseph** 1814–97

English mathematician

Little could Plato have imagined, when indulging his instinctive love of the true and beautiful for their own sakes, he entered upon these refined speculations and revealed in a world of his own creation, that he was writing the grammar of the language in which it [mathematics] would be demonstrated in after ages that the pages of the universe are written.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry (p. 7)

University Press. Cambridge, England. 1904–1912

**Thom, René** 1923–2002

French mathematician

Just as, when learning to speak, a baby babbles in all the phonemes of all the languages of the world, but after

listening to its mother’s replies soon learns to babble in only the phenomena of its mother’s language, so we mathematicians babble in all possible branches of mathematics, and ought to listen to mother nature in order to find out which branches of mathematics are natural.

In John Ziman

*Reliable Knowledge*

Chapter 2 (p. 18, fn 14)

Cambridge University Press. Cambridge, England. 1978

**Thomas, Lewis** 1913–93

American physician and biologist

The universal language of the future, in the view of the tiny minority who now use it for their lives, will be mathematics. It could be so. Certainly, no other human endeavor can present so powerful an argument for a long survival in the centuries ahead, nor so solid a case for having already influenced and changed, largely for the better, the human condition. Among the sciences, mathematics has advanced more rapidly and at the same time penetrated the human mind more profoundly than any other field. I would include, most conspicuously, physics, for all the showiness of its accomplishments, and even cosmophysics; these disciplines would still be studying Galileo were it not for events that have happened in just the last three centuries in pure mathematics.

*Et Cetera, Et Cetera: Notes of a Word-Watcher*

Chapter 38 (p. 161)

Little, Brown & Company. Boston, Massachusetts, USA. 1990

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift, which we neither understand nor deserve.

*The Unreasonable Effectiveness of Mathematics in the Natural Sciences Communications on Pure and Applied Mathematics*, Volume XIII, Number 1, February, 1960 (p. 14)

## MATHEMATICS, LITERATURE OF

**Hayes, Brian**

American scientist, columnist, and author

...the collected literature of mathematics is treated as a sacred text to be guarded against corruption and dilution.

Aftermath

*The Emissary*, Fall 1999 (p. 14)

## MATHEMATICS, LIVING

**Hilbert, David** 1862–1943

German mathematician

Living mathematics rests on the fluctuation between the antithesis powers of intuition and logic, the individuality of “grounded” problems and the generality of far-reaching abstractions. We ourselves must prevent

the development being forced to only one pole of the life-giving antithesis.

*Hilbert – Courant*

Hilbert

Chapter XXV (p. 220)

Springer-Verlag. New York, New York, USA. 1986

## MATHEMATICS, LOVE OF

### Lalande, Andre

No biographical data available

The love of mathematics is daily on the increase, not only with us but in the army. The result of this was unmistakably apparent in our last campaigns. Bonaparte himself has a mathematical head, and though all who study this science may not become geometricians like Laplace and Lagrange, or heroes like Bonaparte, there is yet left an influence upon the mind which enables them to accomplish more than they could possibly have achieved without this training.

Translated by Jane and Caroline Lassell

In Karl Bruhns

*Life of Alexander Von Humboldt* (Volume 1)

I, Chapter V (p. 232)

Longmans, Green & Co. London, England. 1873

## MATHEMATICS, LURE OF

### Lindley, David 1956–

English astrophysicist and author

The lure of mathematics is hard to resist. When, by dint of great effort and ingenuity, a previously vague, ill-formed idea is encapsulated in a neat mathematical formulation, it is impossible to suppress the feeling that some profound truth has been discovered. Perhaps it has, but if science is to work properly the idea must be tested, and thrown away if it fails.

*The End of Physics: The Myth of a Unified Theory*

Prologue: The Lure of Numbers (p. 13)

Basic Books, Inc. New York, New York, USA. 1993

## MATHEMATICS, MERIT OF

### Smith, David Eugene 1860–1945

Mathematician

...the merit of mathematics, in all its forms, consists in its truth; truth conveyed to the understanding, not directly by words but by symbols which serve as the world's only universal written language.

*The Poetry of Mathematics and Other Essays*

Chapter I (p. 6)

Scripta Mathematica. New York, New York, USA. 1934

## MATHEMATICS, MODERN

### Peirce, Charles Sanders 1839–1914

American scientist, logician, and philosopher

Modern mathematics is highly artistic. A simple theme is chosen, some conception pretty and charming in itself. Then it is shown that by simply holding this idea up to one's eye and looking through it, a whole forest that before seemed a thick and tangled jungle of bushes and briars is seen to be in reality an orderly garden.

In A.G. Sedgwick

*The 19th Century: A Review of Progress During the Past One Hundred Years in the Chief Departments of Human Activity*

The Century's Great Men in Science (p. 317)

G.P. Putnam's Sons. New York, New York, USA. 1901

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Modern mathematics can be kept alive only by a large number of mathematicians cultivating different parts of the same system of values: a community which can be kept coherent only by the passionate vigilance of universities, journals and meetings, fostering these values and imposing the same respect for them on all mathematicians.

*Personal Knowledge*

Chapter 6, Section 11 (p. 192)

Harper & Row, Publishers. New York, New York, USA. 1962

## MATHEMATICS, OBJECT OF

### Papperitz, E. 1897–1938

No biographical data available

The object of pure mathematics is those relations which may be conceptually established among any conceived elements whatsoever by assuming them contained in some ordered manifold; the law of order of this manifold must be subject to our choice; the latter is the case in both of the only conceivable kinds of manifolds, in the discrete as well as in the continuous.

*Jahresbericht der Deutschen Mathematiker-Vereinigung*

Über das System der rein mathematischen Wissenschaften, Bd. 1 (p. 36)

## MATHEMATICS, PLACE OF

### Dyson, Freeman J. 1923–

American physicist and educator

The place of mathematics in the physical sciences is not something that can be defined once and for all. The interrelations of mathematics with science are as rich and various as the texture of science itself.

*Mathematics in the Physical Sciences*

*Scientific American*, Volume 211, Number 3, September, 1964 (p. 129)

**MATHEMATICS, POTENCY OF****Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

A single curve, drawn in the manner of the curve of prices of cotton, describes all that the ear can possibly hear as a result of the most complicated musical performances.... That to my mind is a wonderful proof of the potency of mathematics.

In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon &amp; Schuster. New York, New York, USA. 1937

**MATHEMATICS, POWER OF****Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Strange as it may sound, the power of mathematics rests on its evasion of all unnecessary thought and on its wonderful saving of mental operations.

In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon &amp; Schuster. New York, New York, USA. 1937

**MATHEMATICS, PROBLEMS OF****Weyl, Hermann** 1885–1955

German mathematician

The problems of mathematics are not isolated problems in a vacuum; there pulses in them the life of ideas which realize themselves in concerto through our human endeavors in our historical existence, but forming an indissoluble whole transcend any particular science.

In K. Chandrasekhar

*Hermann Weyl*

Hermann Weyl Memorabilia (p. 84)

Springer-Verlag. Berlin, Germany. 1986

**MATHEMATICS, PROFESSOR OF****Karpinski, Lewis Charles**

Mathematician

As a professor of mathematics I am practically required by the ethics of the profession to be absent-minded, unmethodical, and inconsistent in many ways fatal to bibliographical excellence.

*Bibliography of Mathematical Works Printed in America Through 1850*

Preface (p. viii)

University of Michigan Press. Ann Arbor, Michigan, USA. 1940

**MATHEMATICS, PROGRESS OF****Black, Max** 1909–88

Anglo-American philosopher

The progress of mathematics is not smooth, nor is the science, as the layman imagines, a collection of subtle principles and infallible results, springing mysteriously yet convincingly into the minds of their inventors.

*The Nature of Mathematics: A Critical Survey*

Section III (p. 169)

Routledge &amp; Kegan Paul. London, England. 1933

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

...I find both a special pleasure and constraint in describing the progress of mathematics, because it has been part of so much speculation: a ladder for mystical as well as rational thought in the intellectual ascent of man.

*The Ascent of Man*

Chapter 5 (p. 155)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1973

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

The steady progress of physics requires for its theoretical formulation a mathematics which get continually more advanced. This is only natural and to be expected. What however was not expected by the scientific workers of the last century was the particular form that the line of advancement of mathematics would take, namely it was expected that mathematics would get more and more complicated, but would rest on a permanent basis of axioms and definitions, while actually the modern physical developments have required a mathematics that continually shifts its foundation and gets more abstract.

*The Collected Works of P.A.M. Dirac, 1924–1948*

Quantised Singularities in the Electromagnetic Field (p. 505)

Cambridge University Press. Cambridge, England. 1995

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

The progress of mathematics can be viewed as progress from the infinite to the finite.

*Indiscrete Thoughts*

Chapter XX (p. 214)

Birkhäuser. Boston, Massachusetts, USA. 1997

**MATHEMATICS, PROPORTIONS OF****Hempel, Carl G.** 1905–97

German philosopher of science

The propositions of mathematics have, therefore, the same unquestionable certainty which is typical of such propositions as “All bachelors are unmarried,” but they also share the complete lack of empirical content which is associated with that certainty: The propositions of mathematics are devoid of all factual content; they convey no information whatever on any empirical subject matter.

*The Philosophy of Carl G. Hempel*  
Part I, Chapter 1 (p. 13)  
Oxford University Press. Oxford, England. 2001

## MATHEMATICS, PURE

**Begley, Sharon** 1956–  
Science editor

Pure mathematics is a sucker's game. It lures the curious and the confident with its seeming simplicity only to make them look like fools.

New Answer for an Old Question  
*Newsweek*, July 5, 1993 (p. 52)

**Cantor, Georg** 1845–1918  
German mathematician

The pure mathematician knows that pure mathematics has an end in itself which is more allied with philosophy.

Translated by Philip Edward Bertrand Jourdain  
*Contributions to the Founding of the Theory of Transfinite Numbers*  
Introduction (p. 2)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1915

**Dillmann, E.**  
No biographical data available

Pure mathematics proves itself a royal science both through its content and form, which contains within itself the cause of its being and its methods of proof. For in complete independence mathematics creates for itself the object of which it treats, its magnitudes and laws, its formulas and symbols.

*Die Mathematik die Fackelträgerin einer neuen Zeit* (p. 94)  
Publisher undetermined. Stuttgart, Germany. 1889

**Einstein, Albert** 1879–1955  
German-born physicist

Pure mathematics is, in its way, the poetry of logical ideas.

Professor Einstein Writes in Appreciation of a Fellow-Mathematician  
*New York Times*, May 5, 1935

**Everett, Edward** 1794–1865  
Whig Party politician

In the pure mathematics we contemplate absolute truths, which existed in the divine mind before the morning stars sang together, and which will continue to exist there, when the last of their radiant host shall have fallen from heaven.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*  
Mr. Everett's Inaugural Address on Academic Education (p. 91)  
Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Fitch, G. D.**  
No biographical data available

Pure mathematics is a collection of hypothetical, deductive theories, each consisting of a definite system of primitive, undefined concepts or symbols and primitive, unproved, but self-consistent assumptions (commonly called axioms) together with their logically deducible consequences followed by rigidly deductive processes without appeal to intuition.

In Henry P. Manning  
*The Fourth Dimension Simply Explained*  
Non-Euclidean Geometry of the Fourth Dimension (p. 58)  
Munn & Company, Inc. New York, New York, USA. 1910

**Glaisher, James Whitbread Lee** 1848–1928  
English mathematician

By pure mathematics I do not mean the ordinary processes of algebra, differential and integral calculus, &c., which every worker in the so-called mathematical sciences should have at his command. I refer to the abstract sciences which do not rest upon experiment in the ordinary sense of the term, their fundamental principles being derived from observations so simple as to be more or less axiomatic.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*  
Presidential Address  
John Murray. London, England. 1891

**Godwin, William** 1756–1836  
English political philosopher

Pure mathematics are concerned only with abstract propositions, and have nothing to do with the realities of nature. There is no such thing in actual existence as a mathematical point, line or surface. There is no such thing as a circle or square. But that is of no consequence. We can define them in words, and reason about them. We can draw a diagram, and suppose that line to be straight which is not really straight, and that figure to be a circle which is not strictly a circle. It is conceived therefore by the generality of observers, that mathematics is the science of certainty.

*Thoughts on Man*  
On Astronomy  
A.M. Kelley. New York, New York, USA. 1969

**Halmos, Paul R.** 1916–2006  
Hungarian-born American mathematician

All of pure mathematics, it is said, comes from the real world, the way geometry, according to legend, comes from measuring the effect of the floods on the Nile. (If that's false, if geometry existed before it was needed, the argument begins on a shaky foundation. If it's true, the

argument tends to prove only that applied mathematics cannot get along without pure [mathematics], as an ant-eater cannot get along without ants, but not necessarily the reverse.)

In Ian Stewart

*The Problems of Mathematics*

Chapter 20 (p. 223)

Oxford University Press, Inc. Oxford, England. 1987

Pure mathematics can be practically useful and applied mathematics can be artistically elegant.

In Lynn Arthur Steen

*Mathematics Tomorrow*

Applied Mathematics Is Bad Mathematics (p. 12)

Springer-Verlag. New York, New York, USA. 1981

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

...pure mathematics is on the whole distinctly more useful than applied. For what is useful above all is technique, and mathematical technique is taught mainly through pure mathematics.

*A Mathematician's Apology*

Chapter 26 (p. 134)

Cambridge University Press. Cambridge, England. 1967

**Iyer, S. Sandaram**

No biographical data available

Pure mathematics exist by themselves; no will produces them, no power can limit them. They are eternal Laws, that no man can infringe, and from which it is impossible to escape.

*Thoughts on the Metaphysics of Theosophy*

Synthetic Recapulation (p. 91)

The Calcutta Central Press. Calcutta, India. 1883

**Keyser, Cassius Jackson** 1862–1947

American mathematician

...pure mathematics is a house of many chambers; he [the mathematician] knows that its foundations lie far beneath the level of common thought; and that the superstructure, quickly transcending the power of imagination to follow it, ascends higher and higher, ever keeping open to the sky; he knows that the manifold chambers – each of them a mansion in itself – are all of them connected in wondrous ways, together constituting a fit laboratory and dwelling for the spirit of men of genius.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter II (p. 31)

Columbia University Press. New York, New York, USA. 1916

**King, Jerry P.**

American mathematician

...pure mathematics is mathematics for mathematics' sake and applied mathematics is mathematics for something else.

*The Art of Mathematics*

Chapter 2 (p. 26)

Plenum Press. New York, New York, USA. 1992

**Lemon, Harvey Brace**

Physicist

...it appears that we may be led to the discovery of new facts not only by direct experimentation, but also through the somewhat mysterious rites and rituals of the symbolism of pure mathematics. In this fact alone would mathematics as a leading science find ample justification in the mind of the experimental investigator – were such justification at all necessary.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Atomic Structure (p. 101)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

Pure mathematics is the intuition of the understanding.

Quoted in Panthea

*Eclectic Gatherings*

*The Reasoner*, Volume 6, 1849 (p. 374)

**Stewart, Dugald** 1753–1828

Scottish philosopher

In pure mathematics, where all the various truths are necessarily connected with each other, (being all necessarily connected with those hypotheses which are the principles of the science,) an arrangement is beautiful in proportion as the principles are few; and what we admire perhaps chiefly in the science, is the astonishing variety of consequences which may be demonstrably deduced from so small a number of premises.

*Elements of the Philosophy of the Human Mind* (Volume 3)

Part Third, Chapter I, Section III (pp. 186–187)

Carey, Lea & Carey. Philadelphia, Pennsylvania, USA. 1827

**Trudeau, Richard J.**

No biographical data available

Pure mathematics is the world's best game. It is more absorbing than chess, more of a gamble than poker, and lasts longer than Monopoly. It's free. It can be played anywhere – Archimedes did it in a bathtub. It is dramatic, challenging, endless, and full of surprises.

*Dots and Lines*

Chapter 1 (p. 9)

The Kent State University Press. Kent, Ohio, USA. 1973

**Whewell, William** 1794–1866

English philosopher and historian

...the ideas which these sciences [Geometry, Theoretical Arithmetic and Algebra] involve extend to all objects and changes which we observe in the external world; and



hence the consideration of mathematical relations forms a large portion of many of the sciences which treat of the phenomena and laws of external nature, as Astronomy, Optics, and Mechanics. Such sciences are hence often termed Mixed Mathematics, the relations of space and number being, in these branches of knowledge, combined with principles collected from special observation; while Geometry, Algebra, and the like subjects, which involve no result of experience, are called Pure Mathematics.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 1)

Part I, Book 2, Chapter I, Section 4 (p. 83)

John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The science of Pure Mathematics, in its modern developments, may claim to be the most original creation of the human spirit.

*Science and the Modern World*

Chapter II (p. 29)

The Macmillan Company. New York, New York, USA. 1929

## MATHEMATICS, PURPOSE OF

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

To those who inquire as to the purpose of mathematics, the usual answer will be that it facilitates the making of machines, the travelling from place to place, and the victory over foreign nations, whether in war or commerce.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 59)

Longmans, Green & Co. London, England. 1919

## MATHEMATICS, RIGOR OF

**Keyser, Cassius Jackson** 1862–1947

American mathematician

...the rigor of mathematics is not absolute – absolute rigor is an ideal, to be, like other ideals, aspired unto, forever approached, but never quite attained, for such attainment would mean that every possibility of error or indetermination, however slight, had been eliminated from idea, from symbol, and from argumentation.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

The Human Significance of Mathematics (pp. 48–49)

Columbia University Press. New York, New York, USA. 1916

## MATHEMATICS, RULES OF

**Hogben, Lancelot** 1895–1975

English zoologist

If the rules of mathematics are rules of grammar, there is no stupidity involved when we fail to see that a mathematical truth is obvious.

*Mathematics for the Millions*

Chapter I (p. 32)

W.W. Norton & Company, Inc. New York, New York, USA. 1917

## MATHEMATICS, SEA OF

**Dawson, John William** 1820–99

Canadian geologist

...as we begin to add and subtract, we have launched ourselves on the boundless sea of mathematics.

*Fossil Men and Their Modern Representatives*

Chapter XI (p. 313)

Hodder and Stoughton. London, England. 1880

## MATHEMATICS, SCIENCE OF

### Author undetermined

The science of mathematics, both pure and mixed, can never cease to be interesting and important to man, as long as the relations of quantity shall exist, as long as ships shall traverse the ocean, as long as man shall measure the surface or heights of the earth on which he lives, or calculates the distances and examine the relations of the planets and stars; and as long as the *iron reign of war* shall demand the discharge of projectiles, or the construction of complicated defences.

Introductory Remarks

*The American Journal of Science*, Volume 1, Number 1, 1819 (p. 8)

## MATHEMATICS, SERVICE OF

**Birkhoff, George David** 1884–1944

American mathematician

The primary service of modern mathematics is that it alone enables us to understand the vast abstract permanences which underlie the flux of things, without requiring us to regard its self-consistent abstractions as more than specific limited instruments of thought.

In J.G. Crowther (ed.)

*Science Today*

Mathematics: Quantity and Order (p. 317)

Eyre & Spottiswoode. London, England. 1934

## MATHEMATICS, SPEAK OF

**Keyser, Cassius Jackson** 1862–1947

American mathematician

It is customary to speak of mathematics, of pure mathematics, and of applied mathematics, as if the first were

a genus owning the other two as species. The custom is unfortunate because it is misleading.

*Mole Philosophy and Other Essays*

Chapter XVIII (pp. 109–110)

E.P. Dutton & Company. New York, New York, USA. 1927

## MATHEMATICS, SPIRIT OF

**Pascal, Blaise** 1623–62

French mathematician and physicist

There is a great difference between the spirit of Mathematics and the spirit of Observation. In the former, the principles are palpable, but remote from common use; so that from want of custom it is not easy to turn our head in that direction; but if it be thus turned ever so little, the principles are seen fully confessed, and it would argue a mind incorrigibly false to reason inconsequentially on principles so obtrusive that it is hardly possible to overlook them.

*Edinburgh Review*, Volume 52, January, 1836 (p. 241)

## MATHEMATICS, STRUCTURE OF

**Buchanan, Scott** 1895–1968

American educator and philosopher

The structure of mathematics and their propositions about them are ways for the imagination to travel and the wings, or legs, or vehicles to take you where you want to go.

*Poetry and Mathematics*

Chapter I (p. 36)

The University of Chicago Press. Cambridge, England. 1975

## MATHEMATICS, STUDENT OF

**Lovett, E. O.**

Mathematician

...the student of mathematics should trust no middleman, but go with his own head to original sources, to the masters themselves. Second-hand ideas are as full of bacteria as second-hand books and clothing.

*Bulletin of the American Mathematical Society*

Volume IV 1898 (p. 552)

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The student of mathematics often finds it hard to throw off the uncomfortable feeling that his science, in the person of his pencil, surpasses him in intelligence – an impression which the great Euler confessed he often could not get rid of. This feeling finds a sort of justification when we reflect that the majority of the ideas we deal

with were conceived by others, often centuries ago. In a great measure it is really the intelligence of other people that confronts us in science.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 196)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

## MATHEMATICS, STRENGTH OF

**Barnett, Percy Arthur** 1858–1941

English educator

The strength of mathematics is derived from the very fact that its truths are detachable by abstraction from the concretes in which they exist for our senses. We argue *in vacuo*, so to speak, without any possibility of error arising from the accidents of individual experience, prejudice, opinion, or the imperfection of our senses.

*Common Sense in Education and Teaching*

Chapter IX (p. 222)

Longmans, Green & Company. London, England. 1899

## MATHEMATICS, STUDY OF

**Chancellor, William Estabrook** 1867–1963

American academic and writer

The motive for the study of mathematics is insight into the nature of the universe. Stars and strata, heat and electricity, the laws and processes of becoming and of being, incorporate mathematical truths. If language imitates the voice of the Creator, revealing His heart, mathematics discloses His intellect, repeating the story of how things came into being. And the value of mathematics, appealing as it does to our energy and to our honor, to our desire to know the truth and thereby to live as of right in the household of God, is that it establishes us in larger and larger certainties. As literature develops emotion, understanding, and sympathy, so mathematics develops observation, imagination, the reason.

*A Theory of Motives, Ideals, and Values in Education*

Chapter XIX (p. 406)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1907

**de Morgan, Augustus** 1806–71

English mathematician and logician

No person commences the study of mathematics without soon discovering that it is of a very different nature from those to which he has been accustomed.

*On the Study and Difficulties of Mathematics*

Chapter I (p. 1)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

**de Staël (Anne-Louise-Germaine),**

**Mme.** 1766–1817

French romantic writer

The study of mathematics, habituating us to certainty, inflames us against all opinions in contradiction with our own, &c.

Quoted in William Hamilton

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 297)  
Harper & Brothers Publishers. New York, New York, USA. 1861

### **Edwards, Tyron** 1809–94

American theologian

The study of mathematics is like climbing up a steep and craggy mountain; when once you reach the top, it fully recompenses your trouble, by opening a fine, clear, and extensive prospect.

*The New Dictionary of Thoughts: A Cyclopaedia of Quotations* (p. 380)  
Standard Book Company. New York, New York, USA. 1948

The study of mathematics cultivates the reason; that of the languages, at the same time, the reason and the taste. The former gives the grasp and power to the mind; the latter both power and flexibility. The former by itself, would prepare us for a state of certainties, which nowhere exists; the later, for a state of probabilities which is that of common life. Each, by itself, does but an imperfect work: in the union of both, is the best discipline for the mind, and the best mental training for the world as it is.

*The New Dictionary of Thoughts: A Cyclopaedia of Quotations* (p. 380)  
Standard Book Company. New York, New York, USA. 1948

### **Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

...the study of mathematics is, if an unprofitable, a perfectly harmless and innocent occupation.

*A Mathematician's Apology*

Section 6 (p. 74)

Cambridge University Press. Cambridge, England. 1967

### **Holliday, Francis**

No biographical data available

In short, the study of the mathematics is not only an agreeable and beneficial amusement in a retired and country life, but is the best expedient for forming the minds of youth, by taking them off from the fruitless and airy exercises of the fancy, and rendering them serious, diligent and inquisitive in the search of knowledge and truth.

In Francis Holliday

*Miscellanea Curiosa Mathematica* (Volume 1)

Preface (p. viii)

Printed for Edward Cave. London, England. 1749

### **Leslie, Sir John** 1766–1832

Scottish physicist and mathematician

The study of mathematics holds forth two capital objectives; while it traces the beautiful relations of figure and quantity, it likewise accustoms the mind to the invaluable

exercise of patient attention and accurate reasoning. Of these distinct objects the last is perhaps the most important in a course of liberal education. For this purpose, the geometry of the ancients is the most powerfully recommended, as bearing the stamp of that acute people, and displaying the finest specimens of logical deduction. Some of the propositions, indeed, might be reached by a sort of algebraic calculation; but such an artificial mode of procedure gives only an apparent facility, and leaves no clear or permanent impression on the mind.

*Elements of Geometry, Geometrical Analysis, and Plane Trigonometry*  
Preface (pp. v–vi)

Printed by James Ballentyne & Company. Edinburgh, Scotland. 1809

### **Locke, John** 1632–1704

English philosopher and political theorist

...the study of mathematics would show them [learned men] the necessity there is in reasoning, to separate all the distinct ideas, and see the habitudes that all those concerned in the present inquiry have to one another, and to lay by those which relate not to the proposition in hand, and wholly to leave them out of the reckoning.

*An Essay Concerning Human Understanding* (Volume 2)

On the Conduct of the Understanding (p. 224)

Printed for Thomas Tegg. London, England. 1828

### **Mann, Thomas** 1875–1955

German-born American novelist

I tell them that if they will occupy themselves with the study of mathematics they will find in it the best remedy against the lusts of the flesh.

*The Magic Mountain*

Chapter VI

Choler and Worse (p. 417)

Alfred A. Knopf. New York, New York, USA. 1966

### **Monboddo, Lord James Burnett** 1714–99

Scottish anthropologist

Those who have studied mathematics much, and no other science, are apt to grow so fond of them, as to believe that there is no certainty in any other science, nor any other axioms than those of Euclid.

*Edinburgh Review*, Volume 52, January 1836 (p. 248)

### **Salat, J.**

No biographical data available

The study of Mathematics, unless special precaution be taken, is rather a hindrance than an aid – For, in so far as the mathematician, accustomed to his own mode of thinking, and ignorant of any other, applies, or does not apply it to the supersensible – what must follow? In the former case, the supersensible world is denied, inasmuch as it cannot be mathematically demonstrated; and, in the latter, affirmed only on the ground of feeling and imagination. Thus, on the one alternative, the mathematician becomes necessarily a Materialist; on the other, a Mystic.

Quoted in William Hamilton  
*Discussions on Philosophy and Literature, Education and University Reform*  
 On the Study of Mathematics as an Exercise of the Mind (p. 294)  
 Harper & Brothers Publishers. New York, New York, USA. 1861

**Smith, David Eugene** 1860–1945  
 Mathematician

I know of nothing which acts as such a powerful antidote that which I ventured to call “opinionatedness,” as a study of mathematics.

*The Poetry of Mathematics and Other Essays*  
 Religio Mathematici (p. 35)  
 Scripta Mathematica. New York, New York, USA. 1934

**Somerville, Mary** 1780–1872  
 English mathematician

That the study of mathematics and their application to astronomy are full of interest will be allowed by all who have devoted their time and attention to these pursuits; and they only can estimate the delight of arriving at truth, whether it be in the discovery of a world, or of a new property of numbers.

*Mechanism of the Heavens*  
 Preliminary Dissertation (p. 2)  
 John Murray. London, England. 1831

**Sylvester, James Joseph** 1814–97  
 English mathematician

I know, indeed, and can conceive of no pursuit so antagonistic to the cultivation of the oratorical faculty...as the study of Mathematics. An eloquent mathematician must, from the nature of things, ever remain as rare a phenomenon as a talking fish, and it is certain that the more anyone gives himself up to the study of oratorical effect the less will he find himself in a fit state to mathematics.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)  
 Address  
 Johns Hopkins University, 22 February, 1877 (p. 72)  
 University Press. Cambridge, England. 1904–1912

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

The study of mathematics is apt to commence in disappointment. The important applications of the science, the theoretical interest of its ideas, and the logical rigor of its methods, all generate the expectation of a speedy introduction to processes of interest. We are told that by its aid the stars are weighed and the billions of molecules in a drop of water are counted. Yet, like the ghost of Hamlet’s father, this great science eludes the efforts of our mental weapons to grasp it.

*An Introduction to Mathematics*  
 Chapter 1 (p. 1)  
 Oxford University Press, Inc. New York, New York, USA. 1958

**Wright, Frank Lloyd** 1867–1959  
 American architect

You can study mathematics all your life and never do a bit of thinking.

In Robert B. Heywood (ed.)  
*The Works of The Mind*  
 The Architect (pp. 57–58)  
 The University of Chicago Press. Chicago, Illinois, USA. 1947

## MATHEMATICS, SYSTEM OF

**Weyl, Hermann** 1885–1955  
 German mathematician

No Hilbert will be able to assure us of consistency forever; we must be content if a simple axiomatic system of mathematics has met the test of our elaborate mathematical experiments so far.... A truly realistic mathematics should be conceived, in line with physics, as a branch of the theoretical construction of the one real world, and should adopt the same sober and cautious attitude toward hypothetic extensions of its foundations as is exhibited by physics.

*Philosophy of Mathematics and Natural Science*  
 Appendix A (p. 235)  
 Princeton University Press. Princeton, New Jersey, USA. 1949

## MATHEMATICS, TEACHER OF

**Buchanan, Scott** 1895–1968  
 American educator and philosopher

In general the teacher of mathematics has been the high priest of an occult ritual, the keeper in many senses of an esoteric doctrine which only his superiors or predecessors have understood.

*Poetry and Mathematics*  
 Chapter I (p. 35)  
 The University of Chicago Press. Cambridge, England. 1975

## MATHEMATICS, TRANSLATING

**Slosson, Edwin E.** 1865–1929  
 American chemist and journalist

Translating mathematics into ordinary language is like translating music. It cannot be done. One could describe in detail a sheet of music and tell the shape of each note and where it is placed on the staff, but that would not convey any idea of how it would sound when played. So, too, I suppose that even the most complicated equation could be described in common words, but it would be so verbose and involved that nobody could get the sense of it.

*Chats on Science*  
 Chapter LXXIV (pp. 226–227)  
 G. Bell & Sons Ltd. London, England. 1924

## MATHEMATICS, UNIVERSE OF

**Stein, Sherman K.**  
 No biographical data available

The universe of mathematics grows out of the world about us like dreams out of the events of the day.

*Mathematics: The Man-Made Universe*

Chapter 19 (p. 471)

Dover Publications. Mineola, New York, USA. 1999

The universe of mathematics is now so vast that in order to have some idea of its nature and extent, it is necessary to divide it into smaller constellations, even though these constellations are not separated by clearcut barriers.

*Mathematics: The Man-Made Universe*

Chapter 19 (p. 471)

Dover Publications. Mineola, New York, USA. 1999

## MATHEMATICS, USEFULNESS OF

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

The enormous usefulness of mathematics in the natural sciences is something bordering on the mysterious.

The Unreasonable Effectiveness of Mathematics in the Natural Sciences

*Communications on Pure and Applied Mathematics*, Volume XIII,

Number 1, February, 1960 (p. 2)

## MATHEMATICS, WHOLE OF

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The whole of Mathematics consists in the organization of a series of aids to the imagination in the process of reasoning.

*A Treatise on Universal Algebra, with Applications*

Chapter I (p. 12)

Hafner Publishing Company. New York, New York, USA. 1960

## MATHEMATICS, WILDS OF

**Weaver, Jefferson Hane**

American science author

To meander through the wilds of mathematics is to engage in a journey for which one must make certain basic preparations. Unlike a safari through the African subcontinent, however, one does not need to take 50 boxes of supplies or hire an entire village of stewards to help carry the load. No, it is possible to travel through the densest thickets of mathematics using only a pencil and paper and an active imagination.

*Conquering Calculus: The Easy Road to Understanding Mathematics*

Chapter 2 (p. 31)

Plenum Press. New York, New York, USA. 1998

## MATHEMATICS, WORLD OF

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The world of mathematics, which you condemn, is really a beautiful world; it has nothing to do with life and death and human sordidness, but is eternal, cold and passionless.

To me pure mathematics is one of the highest forms of art; it has a sublimity quite special to itself, and an immense dignity derived from the fact that its world is exempt from change and time. I am quite serious in this.... [M]athematics is the only thing we know of that is capable of perfection; in thinking about it we become Gods.

In N. Griffin (ed.)

*The Selected Letters of Bertrand Russell* (Volume 1)

Letter Number 98 (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1922

## MATHEMATICS, YOUTHFULNESS OF

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

It is the perennial youthfulness of mathematics itself which marks it off with a disconcerting immortality from the other sciences.

*The Queen of the Sciences* (p. 5)

Strechert. New York, New York, USA. 1938

## MATHIVERSE

**Stewart, Ian** 1945–

English mathematician

The Mathiverse transcends Time and Space...it transcends Intelligence and Extelligence...it transcends Thought; it transcends Transcendence itself.

*Flatterland*

The Visitation (p. 28)

Perseus Publishing. Cambridge, Massachusetts, USA. 2001

## MATTER

There is naught in all that science has disclosed to man more utterly – one might say more hopelessly – mysterious than that power by which in an instant, throughout the whole universe, matter acts on matter.

*Other Suns Than Ours*

Chapter XIX (p. 303)

Longmans, Green & Co. London, England. 1896

**Anaxagoras** ca. 500 BCE–428 BCE

Greek philosopher of nature

The Greeks are wrong to recognize coming into being and perishing; for nothing comes into being nor perishes, but is rather compounded or dissolved from things that are. So they would be right to call coming into being composition and perishing dissolution.

In Geoffrey Stephen Kirk, John Earle Raven and Malcolm Schofield (eds.)

*The Presocratic Philosophers: A Critical History With a Selection of Texts* (2nd edition) (p. 358)

**Andrews, Thomas** 1813–85  
Irish chemist and physicist

We have seen that the gaseous and liquid states are only distant stages of the same condition of matter, and are capable of passing into one another by a process of continuous change. A problem of far greater difficulty yet remains to be solved, the possible continuity of the liquid and solid states of matter. The fine discovery made some years ago by James Thomson, of the influence of pressure on the temperature at which liquefaction occurs, and verified experimentally by Sir W. Thomson, points, as it appears to me, to the direction this inquiry must take: and in the case at least of those bodies which expand in liquefying, and whose melting points are raised by pressure, the transition may possibly be effected. But this must be a subject for future investigation; and for the present I will not venture to go beyond the conclusion I have already drawn from direct experiment, that the gaseous and liquid forms of matter may be transformed into one another by a series of continuous and unbroken changes.

On the Continuity of the Gaseous and Liquid States of Matter  
*Chemical News and Journal of Industrial Science*, March, 1870 (p. 113)

We may indeed live yet to see, or at least we may feel some confidence that those who come after us will see, such bodies as oxygen and hydrogen in the liquid, perhaps even in the solid state, and the question of their metallic or non-metallic nature thereby finally settled.

On the Continuity of the Liquid and Gaseous States of Matter  
*The Journal of the Royal Dublin Society*, Volume 6, Number 40, 1872 (p. 55)

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

I consist of figure and matter: neither of these will be annihilated, as neither of them were created from nothing. Therefore, every part of me, when a change shall take place, will go into something else in the world, and this again will be changed into some other thing, and so on ad infinitum.

In Craufurd Tait Ramage  
*Beautiful Thoughts from Greek Authors* (p. 37)  
Edward Howell. Liverpool, England. 1864

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

For there is nothing more true in nature than the twin propositions, that “nothing is produced from nothing,” and “nothing is reduced to nothing,” but that the absolute quantum or sum total of matter remains unchanged, without increase or diminution.

*The Works of Francis Bacon* (Volume 4)  
The New Organon, Aphorisms, Book II (p. 197)  
Longman & Co. London, England. 1858

...there is no doubt but that the seeds of things, though equal, as soon as they have thrown themselves into

certain groups and knots, completely assume the nature of dissimilar bodies, till those groups or knots are dissolved.

*The Works of Francis Bacon* (Volume 4)  
Part II, Thoughts on the Nature of Things (p. 422)  
Longman & Co. London, England. 1858

**Bicknell, Alexander** ?–1796  
English writer

So when we view a castle-wall  
Rent by a ponderous cannon ball,  
We must conclude from your new rules  
(Our reas'ning fathers being fools),  
That 'tis not solid brick or stone  
Which solid iron has o'erthrown;  
But that a Nothing did attract,  
And had not strength to counteract,  
By its repulsive force the thing,  
(The Thing your pardon Sir, the Nothing).  
*The Putrid Soul. A Poetical Epistle to Joseph Priestley on His Disquisitions Relating to Matter and Spirit* (pp. 8–10)  
Printed for J. Bowen. London, England. 1780

**Bohm, David** 1917–92  
American physicist

Matter is like a small ripple on this tremendous ocean of energy, having some relative stability and being manifest.

Quoted by Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 51)  
Routledge & Kegan Paul. London, England. 1986

**Born, Max** 1882–1970  
German-born English physicist

Living matter and clarity are opposites – they run away from each other.

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*  
Letter to Albert Einstein 1927 (p. 95)  
Walker & Company. New York, New York, USA. 1971

**Boswell, James** 1740–95  
Scottish biographer and diarist

I shall always remember the alacrity with which Johnson answered, striking his foot with mighty force against a large stone, till he rebounded from it – “I refute it thus.”

*Boswell's "Life of Samuel Johnson"*  
6 August, 1763 (p. 333)  
Oxford University Press, Inc. Oxford, England. 1965

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

Proposition 1. *It seems not absurd to conceive that at the first Production of mixt Bodies, the Universal Matter whereof they among other Parts of the Universe consisted, was actually divided into little Particles of Several Sizes and Shapes variously mov'd.*



*The Sceptical Chymist*

The First Part (p. 30)

Printed by H. Hall for R. Davis & B. Took. 1680

**Brady, Nicholas** 1659–1726

Anglican divine and poet

Soul of the World, inspir'd by Thee,  
The jarring Seeds of Matter did agree.  
Thou didst the scattr'd Atoms bind,  
Which, by thy Laws of True Proportion join'd,  
Made up of various Parts  
One Perfect Harmony.

In John Bell

*Bell's Classical Arrangement of Fugitive Poetry* (Volume 3)

Ode for St. Cecelia's Day

Printed by John Bell. London, England. 1793

**Brunstein, Karl A.**

No biographical data available

Matter on this planet has so organized itself that finally, in the form of man, it has now come – for that brief instant of cosmic time represented by the several millennia of human civilization – to contemplate its own properties, its own origin, its own fate.

*Beyond the Four Dimensions*

Chapter Six (p. 118)

Walker & Co. New York, New York, USA. 1979

**Bryson, Bill** 1951–

Author

In three minutes, 98% of all the matter there is or will ever be has been produced. We have a universe. It is a place of the most wondrous and gratifying possibility, and beautiful, too. And it was all done in about the time it takes to make a sandwich.

*A Short History of Nearly Everything*

Chapter 1 (p. 10)

Broadway Books. New York, New York, USA. 2003

**Burroughs, John** 1837–1921

American naturalist and essayist

How many things may be affirmed of the visible, ponderable bodies on the earth's surface which are just the opposite of what is true of the invisible, imponderable bodies of the interior world of matter, and which also do not hold among the bodies of celestial space!

*Under The Apple Tree*

Scientific Faith Once More (p. 159)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Čapek, Milič** 1909–97

Czechoslovakian philosopher and physicist

This concept [matter] has hardly changed from the times of Leucippus to the beginning of the twentieth century: an impenetrable something, which fills completely certain

regions of space and which persists through time even when it changes its location.

*The Philosophical Impact of Contemporary Physics*

Chapter IV (p. 54)

D. van Nostrand Company, Inc. Toronto, Ontario, Canada. 1961

**Chaudhuri, Haridas** 1913–75

Scholar of Indian religions

We know too much about matter today to be materialists any longer.

*The Philosophy of Integralism: The Metaphysical Synthesis of Sri*

*Aurobindo's Teaching* (p. 146)

Sri Aurobindo Ashram. Pondicherry, India. 1967

**Cornforth, John W.** 1917–2004

English organic chemist

...the business of chemists is matter...

Scientists as Citizens

*Australian Journal of Chemistry*, Volume 46, 1993 (p. 268)

**Darling, David** 1953–

Freelance science writer

You are roughly eighteen billion years old and made of matter that has been cycled through the multimillion-degree heat of innumerable giant stars. You are composed of particles that once were scattered across thousands of light-years of interstellar space, particles that were blasted out of exploding suns and that for eons drifted through the cold, starlit vacuum of the Galaxy. You are very much a child of the cosmos.

*Equations of Eternity: Speculations on Consciousness, Meaning, and the Mathematical Rules that Orchestrate the Cosmos*

Introduction (p. xiii)

Hyperion. New York, New York, USA. 1993

**Dastre, A.**

No biographical data available

Between the organic and the inorganic worlds is an apparent abyss.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

The Life of Matter (p. 393)

Government Printing Office. Washington, D.C. 1903

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...with respect to the general cause, it seems manifest to me that it is none other than God himself, who, in the beginning, created matter along with motion and rest, and now by his ordinary concourse alone preserves in the whole the same amount of motion and rest that he then placed in it. For although motion is nothing in the matter moved but its mode, it has yet a certain and determinate quantity, which we easily understand may remain always the same in the whole universe, although it changes in each of the parts of it.

*The Method, Meditations, and Selections from the Principles of Descartes*  
 Note X (p. 291)  
 William Blackwood & Sons. Edinburgh, Scotland. 1907

### Dewar, Redcote

No biographical data available

Some scientists...endeavor to discover what matter is from the point of view of a matterless being, even as metaphysicians endeavor to discover what mind is from the point of view of an eviscerated brain. Both of them are but speculations for bedlam.

*From Matter to Man: A New Theory of the Universe*  
 Chapter III (p. 36)  
 Chapman & Hall, Ltd. London, England. 1898

### Dewey, John 1859–1952

American philosopher and educator

It would be difficult to find a greater distance between any two terms than that which separates “matter” in the Greek-medieval tradition and the technical signification, suitably expressed in mathematical symbols, that the word bears in science today.

In Yervant H. Krikorian (ed.)  
*Naturalism and the Human Spirit*  
 Antinaturalism in extremis (p. 3)  
 Columbia University Press. New York, New York, USA. 1944

### Dirac, Paul Adrien Maurice 1902–84

English theoretical physicist

To get an interpretation of some modern experimental results one must suppose that particles can be created and annihilated. Thus if a particle is observed to come out from another particle, one can no longer be sure that the latter is composite. The former may have been created. The distinction between elementary particles and composite particles now becomes a matter of convenience. This reason alone is sufficient to compel one to give up the attractive philosophical idea that all matter is made up of one kind, or perhaps two kinds of bricks.

*Nobel Lectures, Physics 1922–1941*  
 Nobel lecture for award received in 1933  
 Theory of Electrons and Positrons (p. 321)  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1965

### Dyson, Freeman J. 1923–

American physicist and educator

We have learned that matter is weird stuff. It is weird enough, so that it does not limit God’s freedom to make it do what he pleases.

*Infinite in All Directions*  
 Part One, Chapter One (p. 8)  
 Harper Collins Publisher, Inc. New York, New York, USA. 1988

### Elliot, Hugh Samuel Roger 1881–1930

No biographical data available

In the physicist’s mind, the properties of matter are numberless. It is divided up into molecules and atoms, too

small by a millionfold to be perceived by any microscope, and these are divided up again into particles still smaller. That is to say, the number of sensations, or possible sensations, bound together in the physicist’s mind under the title of matter show little trace of the humble origin from which they started to evolve.

*Modern Science and Materialism* (p. 178)  
 Longmans, Green & Co. London, England. 1919

### Frost, Robert 1874–1963

American poet

It was in a state  
 Of Atomic One  
 Matter was begun –  
 And in fact complete  
 One and yet discrete  
 To conflict and pair.

Everything was there  
 Every single thing  
 Waiting was to bring  
 Clear from hydrogen  
 All the way to men.

*Complete Poems of Robert Frost*  
 A Never Naught Song  
 Henry Holt & Company. New York, New York, USA. 1949

### Gould, Stephen Jay 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Darwin applied a consistent philosophy of materialism to his interpretation of nature. Matter is the ground of all existence; mind, spirit, and God as well, are just words that express the wondrous results of neuronal complexity.

*Ever Since Darwin: Reflections in Natural History*  
 Prologue (p. 13)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1977

[Darwin’s notebooks] include many statements showing that he espoused but feared to expose something he perceived as far more heretical than evolution itself: philosophical materialism – the postulate that matter is the stuff of all existence and that all mental and spiritual phenomena are its by-products.

*Ever Since Darwin: Reflections in Natural History*  
 Chapter 1. Darwin’s Delay (p. 24)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1977

### Hawking, Stephen William 1942–

English theoretical physicist

The point is that the new raw material doesn’t really have to come from anywhere.... The universe can start off with zero energy and still create matter.

In Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 51)  
 Routledge & Kegan Paul. London, England. 1986

### Heaviside, Oliver 1850–1925

English electrical engineer, mathematician, and physicist

Even if we resolve all matter into one kind, that kind will need explaining, and so on forever and ever deeper and deeper into the pit at whose bottom truth lies, without ever reaching it, for the pit is bottomless.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 10 (p. 133)

Longmans, Green & Company. London, England. 1967

### **Hegel, Georg Wilhelm Friedrich** 1770–1831

German philosopher

Motion is the process, the transition of Time into Space and of Space into Time: Matter, on the other hand, is the relation of Space and Time as a peaceful identity.

*Hegel's Philosophy of Nature*

Section 261 (p. 44)

Clarendon Press. Oxford, England. 1970

### **Herbert, Nick**

American physicist

The world is one substance. As satisfying as this discovery may be to philosophers, it is profoundly distressing to physicists as long as they do not understand the nature of that substance. For if quantum stuff is all there is and you don't understand quantum stuff, your ignorance is complete.

*Quantum Reality: Beyond the New Physics*

Chapter 3 (p. 40)

Anchor Press. Garden City, New York, USA. 1985

### **Hilton, Harold**

No biographical data available

It is now generally assumed that *matter is not continuous but course grained*, i.e. that matter is composed of atoms which are practically indivisible and are situated at very small but not infinitesimal distances apart.

*Mathematical Crystallography and the Theory of Groups of Movements*

Part II, Chapter XII (p. 113)

Clarendon Press. Oxford, England. 1903

### **Holbach, Paul Henri Thiry** 1723–89

French philosopher

...as all the world are nearly agreed that matter can, never be totally annihilated, or cease to exist, how can we understand, that that which cannot cease to be. could ever have had a beginning?

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*

(Volume 1)

Chapter 2 (p. 21)

J.P. Mendum

Boston, Massachusetts, USA. 1889

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If there is anything more wonderful than matter in the sheer versatility of its behavior, I have yet to hear tell of it.

*Frontiers of Astronomy*

Chapter Twelve (p. 224)

Harper & Row, Publishers. New York, New York, USA. 1955

### **Huxley, Julian** 1887–1975

English biologist, philosopher, and author

I am Matter. I am the condensation,  
The Kink in empty space that provides resistance,  
Precious inertia – mine the sole foundation  
On which swift Energy's flow of fluid emanation  
Fraternally builds reality into existence.

*The Captive Shrew and Other Poems of a Biologist*

Matter, Energy, Time and Space

Harper & Brothers. New York, New York, USA. 1933

### **Huxley, Thomas Henry** 1825–95

English biologist

...there are three great problems of our time.... One of these is that doctrine concerning the constitution of matter which, for want of a better name, I'll call "molecular"; the second is the doctrine of the conservation of energy; the third is the doctrine of evolution.

*Collected Essays* (Volume 1)

Method and Result

The Progress of Science (p. 66)

Macmillan & Company Ltd. London, England. 1904

Living matter differs from other matter in degree and not in kind; the microcosm repeats the macrocosm; and one chain of causation connects the nebulous original of suns and planetary systems with the protoplasmic foundation of life and organisation.

In Michael Foster and E. Ray Lankester

*The Scientific Memoirs of Thomas Henry Huxley* (Volume 4)

Chapter XXVIII (p. 506)

Macmillan & Co Ltd. London, England. 1902

...matter and force are the two names of the one artist who fashions the living as well as the lifeless.

*Lay Sermons, Addresses and Reviews*

The Origin of Species (p. 288)

Macmillan & Company Ltd. London, England. 1870

### **Jastrow, Robert** 1925–

American space scientist

Such clouds [gaseous matter] are the stuff out of which stars and planets are made. Appearing, disappearing, and appearing again in endless succession since the beginning of time in the Cosmos, they mark the first step on the path to life.

*Until the Sun Dies*

Chapter 6 (p. 54)

W.W. Norton & Co. New York, New York, USA. 1977

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...matter being nothing but a sort of congealed radiation travelling at less than its normal speed.

*The Mysterious Universe*

Chapter III (p. 93)

The Macmillan Co. New York, New York, USA. 1952

**Joule, James Prescott** 1818–89

English physicist

Matter is endowed with an exceedingly great variety of wonderful properties, some of which are common to all matter, while others are present variously, so as to constitute a difference between one body and another.

*Memoir of James Prescott Joule*

Chapter I (p. 3)

Manchester Literary and Philosophical Society. Manchester, England. 1892

In our notion of matter two ideas are generally included, namely those of *impenetrability* and *extension*. By the extension of matter we mean the space which it occupies; by its impenetrability we mean that two bodies cannot exist at the same time in the same place. Impenetrability and extension cannot with much propriety be reckoned among the *properties* of matter, but deserve rather to be called its *definitions*, because nothing that does not possess the two qualities bears the name of matter. If we conceive of impenetrability and extension we have the idea of matter, and of matter only.

*The Scientific Papers of James Prescott Joule*

On Matter, Living Forces and Heat (p. 265)

Taylor & Francis. London, England. 1884

**Kant, Immanuel** 1724–1804

German philosopher

Give me matter and I will construct a world out of it!

In W. Hastie (ed.)

*Kant's Cosmogony*

Preface (p. 17)

Greenwood Publishing Corporation. New York, New York, USA. 1968

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

If the motion of every particle of matter in the universe were precisely reversed at any instant, the course of nature would be simply reversed forever after. The bursting bubble of foam at the foot of a waterfall would reunite and descend into the water; the thermal motions would reconcentrate their energy, and throw the mass up the fall in drops reforming in a close column of ascending water...living creatures would grow backwards, with conscious knowledge of the future, but no memory of the past, and would become again unborn.

In John D. Barrow

*The World Within The World* (p. 126)

Clarendon Press. Oxford, England. 1988

**Kline, Morris** 1908–92

American mathematics professor and writer

...where is the good, old-fashioned, solid matter that obeys precise, compelling mathematical laws? The stone that Dr. Johnson once kicked to demonstrate the reality of matter has become dissipated in a diffuse distribution of mathematical probabilities.

*Mathematics in Western Culture*

Chapter XXIV (p. 382)

Oxford University Press, Inc. New York, New York, USA. 1953

**Lodge, Sir Oliver** 1851–1940

English physicist

There seems to be a regular gradation of size [of cosmic matter], therefore, ranging from Sirius to dust; and apparently we must regard all space as full of these cosmic particles—stray fragments, as it were, perhaps of some older world, perhaps going to help to form a new one someday.

*Pioneers of Science*

Lecture XVI (p. 332)

Macmillan & Co Ltd. London, England. 1905

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

Matter is the miracle of miracles, the most mystical of all things mystical.

*Science, Matter and Immortality*

Chapter XVI (p. 196)

William & Norgate. London, England. 1909

**Marett, Robert Randolph** 1866–1943

Social anthropologist

Matter moves. Life evolves.

*Anthropology*

Chapter I (p. 14)

Henry Holt & Co. New York, New York, USA. 1912

**Marshall, Roy K.** 1907–

No biographical data available

When we start to wonder about the ultimate structure of matter, we get involved in what is at once the most fascinating and the most provoking field of modern science. We very glibly describe, in words and pictures, the internal structure of an atom, as though we knew what we were talking about.

*The Nature of Things* (2nd edition)

Chapter 1 (p. 1)

Macmillan & Company Ltd. London, England. 1981

**Maxwell, James Clerk** 1831–79

Scottish physicist

Science is incompetent to reason upon the creation of matter itself out of nothing. We have reached the utmost

limit of our thinking faculties when we have admitted that because matter cannot be eternal and self-existent it must have been created.

Molecules

*Nature*, September, 1873 (p. 441)

### **Mendeleyev, Dmitry Ivanovich** 1834–1907

Russian chemist

By gradually studying matter, people finally take command of it. Their predictions concerning it, proved by the facts, become ever more accurate. They use it more widely and more frequently to satisfy their needs. There are no grounds to think that knowledge and our mastery over matter have bounds.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneerson

Progress Publishers. Moscow, Russia. 1979

### **Momerie, Alfred Williams** 1848–1900

No biographical data available

To the vulgar man, matter is but another name for dirt: to the man who is a physicist and only a physicist, it is a curious combination of atoms; but to poets and philosophers it is the Shechinah of infinite mystery.

*The Origin of Evil* (6th edition)

The Supernaturalness of Nature (p. 249)

William Blackwood & Sons. Edinburgh, Scotland. 1890

### **Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The quantity of matter is the measure of the same, arising from its density and bulk conjointly.

*In Great Books of the Western World* (Volume 34)

*Mathematical Principles of Natural Philosophy*

Definitions, Definition 1 (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It seems to me, that if the matter of our Sun and Planets and all ye matter in the Universe was evenly scattered throughout all the heavens, and every particle had an innate gravity towards all the rest and the whole space throughout which this matter was scattered was but finite: the matter on ye outside of this space would by its gravity tend towards all ye matter on the inside and by consequence fall down to ye middle of the whole space and there compose one great spherical mass. But if the matter was evenly diffused through an infinite space, it would never convene into one mass.

*Four Letters from Sir Isaac Newton to Doctor Bentley*

Letter to Richard Bentley, 10 December, 1692

Printed for R. & J. Dodsley. London, England. 1756

And much harder it is to suppose that all ye particles in an infinite space should be so accurately poised one among another as to stand still in a perfect equilibrium. For I reckon this as hard as to make not one needle only

but an infinite number of them (so many as there are particles in an infinite space) stand accurately poised upon their points.

*Four Letters from Sir Isaac Newton to Doctor Bentley*

Letter to Richard Bentley, 10 December, 1692

Printed for R. & J. Dodsley. London, England. 1756

As to your first query, it seems to me that if the matter of our sun and planets and all the matter of the universe were evenly scattered throughout all the heavens, and every particle had an innate gravity toward all the rest, and the whole space throughout which this matter was scattered was but finite, the matter on the outside of this space would, by its gravity, tend toward all the matter on the inside and, by consequence, fall down into the middle of the whole space and there compose one great spherical mass.

*Four Letters from Sir Isaac Newton to Doctor Bentley*

Letter to Richard Bentley, 10 December, 1692 (p. 211)

Printed for R. & J. Dodsley. London, England. 1756

...it seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable, moveable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them; and that these primitive particles being solids, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break in pieces; no ordinary power being able to divide what God himself made one in the first creation.

*In Great Books of the Western World* (Volume 34)

*Optics*

Book II, Part I (very near the end)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Nichols, Ernest Fox** 1869–1924

American physicist

Matter has two indisputable hallmarks, two properties in the possession of which all the infinitely varied forms of matter unite, inertia and weight.

*Physics*

Lecture (p. 8)

The Columbia University Press. New York, New York, USA. 1907

### **Poe, Edgar Allan** 1809–49

American short story writer

...Matter exists only as Attraction and Repulsion – in other words that Attraction and Repulsion are matter ...

*Poems and Essays of Edgar Allan Poe*

Eureka (p. 210)

W.J. Widdleton, Publisher. New York, New York, USA. 1881

### **Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

When matter is becoming disturbed by non-equilibrium conditions it organizes itself, it wakes up. It happens that our world is a non-equilibrium system.

In Renée Weber  
*Dialogues with Scientists and Sages: The Search For Unity* (p. 51)  
 Routledge & Kegan Paul. London, England. 1986

**Reeves, Hubert** 1932–  
 Canadian astrophysicist

The organization of the universe demands that matter abandon itself to the games of chance.

*Atoms of Silence*  
 Chapter 16 (p. 177)  
 The MIT Press. Cambridge, Massachusetts, USA. 1984

**Rorty, Richard** 1931–  
 American philosopher

[When] we tell our Whiggish stories about how our ancestors gradually crawled up the mountain on whose (possibly false) summit we stand, we need to keep some things constant throughout the story. The forces of nature and the small bits of matter, as conceived by current physical theory, are good choices for this role.

*Philosophy and the Mirror of Nature*  
 Chapter VII (p. 344)  
 Princeton University Press. Princeton, New Jersey, USA. 1979

**Rubbia, Carlo** 1934–  
 Italian physicist

When you dive inside matter it's as exciting as making an infinitely long interplanetary journey.

In Lewis Wolpert and Alison Richards  
*Passionate Minds*  
 Asking Nature (p. 198)  
 Oxford University Press. Oxford, England. 1977

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

“Matter” is a convenient formula for describing what happens where it isn't.

*An Outline of Philosophy*  
 Chapter XV (p. 165)  
 The World Publishing Company. Cleveland, Ohio, USA. 1960

Everyone knows that ‘mind’ is what an idealist thinks there is nothing else but, and ‘matter’ is what a materialist thinks the same about.

*History of Western Philosophy*  
 Book Three, Part I (p. 658)  
 Simon & Schuster. New York, New York, USA. 1945

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952  
 Spanish-born American philosopher

...and the animate world must needs concern the physicist, since it is the crown of nature, the focus where matter concentrates its fires and best shows what it is capable of doing.

*The Realm of Matter*  
 Chapter VIII (p. 141)  
 Charles Scribner's Sons. New York, New York, USA. 1930

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

What stuff 'tis made of, whereof it is born, I am to learn...

*In Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
*The Merchant of Venice*  
 Act I, Scene I  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Alexander died, Alexander was buried, Alexander returneth into dust: the dust is earth; of earth we make loam: and why of that loam, whereto he was converted, might they not stop a beer-barrel? Imperious Caesar, dead and turned to clay, Might stop a hole to keep the wind away. O, that that earth, which kept the world in awe, Should patch a wall to expel the winter's flaw!

**Shelley, Percy Bysshe** 1792–1822  
 English poet

I change but I cannot die.  
*The Complete Poetical Works of Percy Bysshe Shelley*  
 The Cloud, l. 76  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Silver, Brian L.**  
 Israeli professor of physical chemistry

Matter is the flesh of the universe; chemical and nuclear change is its soul.

*The Ascent of Science*  
 Preface (p. xvii)  
 Solomon Press Book. New York, New York, USA. 1998

**Spencer, Theodore**  
 No biographical data available

Matter whose movement moves us all  
 Moves to its random funeral,  
 And Gresham's law that fits the purse  
 Seems to fit the universe.

In Helen Plotz  
*Imagination's Other Place*  
 Entropy (p. 90)  
 Thomas Y. Crowell Company. New York, New York, USA. 1955

**Tait, Peter Guthrie** 1831–1901  
 Scottish physicist and mathematician

Nothing is so preposterously unscientific than to assert... that with the utmost strides attempted by science we should necessarily be sensibly nearer to a conception of the ultimate nature of matter.

*Lectures on Some Recent Advances in Physical Science* (p. 284)  
 Macmillan & Company Ltd. London, England. 1876

Only sheer ignorance could assert that there is any limit to the amount of information which human beings may in time acquire of the constitution of matter. However far we may manage to go, there will still appear before us



something further to be assailed. The small separate particles of a gas are each, no doubt less complex in structure than the whole visible universe, but the comparison is a comparison of two infinities.

*Lectures on Some Recent Advances in Physical Science*  
Lecture XII (pp. 288–289)  
Macmillan & Company Ltd. London, England. 1876

An exact or adequate conception of matter itself, could we obtain it, would almost certainly be something extremely unlike any conception of it which our senses and our reason will ever enable us to form.... [T]he discovery of the ultimate nature of matter is probably beyond the range of human intelligence.

*Properties of Matter* (2nd edition)  
Chapter I (pp. 13, 16)  
Adam & Charles Black. Edinburgh, Scotland. 1890

**Teilhard de Chardin, Pierre** 1881–1955  
French Jesuit, paleontologist, and biologist

...the more we split and pulverise matter artificially, the more insistently it proclaims its fundamental unity.

*The Phenomenon of Man*  
Book One, Chapter I, Section 1 (p. 41)  
Harper & Brothers Publishers. New York, New York, USA. 1959

We do not get what we call matter as a result of the simple aggregation and juxtaposition of atoms. For that, a mysterious identity must absorb and cement them, an influence at which our mind rebels in bewilderment at first, but which in the end must perforce accept.

*The Phenomenon of Man*  
Book One, Chapter I, Section 2 (p. 42)  
Harper & Brothers Publishers. New York, New York, USA. 1959

**Tesla, Nikola** 1865–1943  
Electrical engineer and inventor

...but now a mechanism of a finite number of parts and few at that, cannot perform an infinite number of definite motions, hence the impulses which govern its movements must come from the environment. So the atom, the ulterior element of the Universe's structure is tossed about in space eternally, a play of external influences, like a boat in a troubled sea. Were it to stop its motion it would die. Matter at rest, if such a thing could exist, would be matter dead. Death of matter! Never has a sentence of deeper philosophical meaning been uttered.... There is no death of matter, for throughout the infinite universe, all has to move to vibrate, that is, to live.

*Lectures, Patents, Articles*  
On light and other high frequency phenomena, delivered before the Franklin Institute, Philadelphia, February, 1893.  
N. Tesla Museum, Beograd, Yugoslavia, 1956

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

Cell and tissue, shell and bone, leaf and flower, are so many portions of matter, and it is in obedience to the laws

of physics that their particles have been moved, molded and conformed. They are no exceptions to the rule that God always geometrizes. Their problems of form are in the first instance mathematical problems, their problems of growth are essentially physical problems, and the morphologist is, ipso facto, a student of physical science.

*On Growth and Form* (Volume 1)  
Chapter I (p. 10)  
At The University Press. Cambridge, England. 1951

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

...when we pass from ordinary sight to scientific vision, how subtle and ethereal matter becomes! What pictures modern physics gives us of a restless activity suggestive of life!

*The System of Animate Nature* (Volume 1)  
Lecture II (p. 67)  
William & Norgate. London, England. 1920

**Thomson, Sir Joseph John** 1856–1940  
English physicist

From the point of view of the physicist, a theory of matter is a policy rather than a creed; its object is to connect or co-ordinate apparently diverse phenomena, and above all to suggest, stimulate and direct experiment. It ought to furnish a compass which, if followed, will lead to observer further and further into previously unexplored regions.

*The Corpuscular Theory of Matter*  
Chapter I (p. 1)  
Charles Scribner's Sons. New York, New York, USA. 1907

It [a theory] ought to furnish a compass which, if followed, will lead the observer further and further into previously unexplored regions. Whether these regions will be barren or fertile experience alone will decide; but, at any rate, one who is guided in this way will travel onward in a definite direction, and will not wander aimlessly to and fro.

*The Corpuscular Theory of Matter*  
Chapter I (p. 1)  
Charles Scribner's Sons. New York, New York, USA. 1907

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Talk of mysteries! – Think of our life in nature – daily to be shown matter, to come in contact with it – rocks, trees, wind on our cheeks! the *solid* earth! the *actual world!* the *common sense!* *Contact!* *Contact!* *Who* are we? *Where* are we?

*The Maine Woods*  
15th Ktaadn (p. 71)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1884

**Updike, John** 1932–  
American novelist, short story writer, and poet

There is infinitely more nothing in the universe than anything else.

*The Poorhouse Fair*

Chapter II (p. 93)

Random House, Inc. New York, New York, USA. 2004

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

...we cannot triumph over the machinery of matter by ignoring it; we can triumph over it only by subordinating it to the aims of our moral intelligence. We must familiarise ourselves with its levers and pulleys, fatal though it be to poetic contemplation, in order to be able to govern them after our own will, and therein lies the complete justification of physical investigation, and its vast importance for the advance of human civilisation.

In David Cahan (ed.)

*Science and Culture: Popular and Philosophical Essays*

On Goethe's Scientific Researches

Lecture, 1853 (p. 17)

The University of Chicago Press. Chicago, Illinois, USA. 1995

**Ward, Henshaw**

No biographical data available

Every particle of matter large enough to be seen is composed of quadrillions of regions of electrical energy.... And each one of the regions is a complication of secrets that are quite unfathomable.

In Frederick Houk Law

*Science in Literature*

A Drop of Water (pp. 276, 277)

Harper & Brothers Publishers. New York, New York, USA. 1929

**Weyl, Hermann** 1885–1955

German mathematician

Not the state of rest, but the states of uniform translation form an objectively distinguished class of motions, and this puts an end to the substantial ether. Finally, and fourthly, the general relativity theory re-endows this metric world structure with the capacity of reacting to the forces of matter. Thus, in a sense, the circle is closed.

*Philosophy of Mathematics and Natural Science*

Part II, Chapter III (p. 176)

Princeton University Press. Princeton, New Jersey, USA. 1949

And now, in our time, there has been unloosed a cataclysm which has swept away space, time and matter, hitherto regarded as the firmest pillars of natural science, but only to make place for a view of things of wider scope, and entailing a deeper vision.

Translated by Henry L. Brose

*Space – Time – Matter*

Introduction (p. 2)

Dover Publications, Inc. New York, New York, USA. 1922

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Thus, to a really learned man, matter exists in test tubes, animals in cages, art in museums, religion in churches, knowledge in libraries.

*Essays in Science and Philosophy*

Part III, Harvard: The Future, Section IV (p. 215)

Philosophical Library. New York, New York, USA. 1947

**Young, Edward** 1683–1765

English poet and dramatist

Has Matter innate Motion? Then each Atom,  
Asserting its indisputable Right

To dance, would form an Universe of Dust:

Has Matter none? Then whence these glorious Forms,  
And boundless Flights, from Shapeless, and Repos'd?

*Night Thoughts*, l. 1472–1476

Printed by R. Nobels for R. Edwards. London, England. 1797

## MATTER, ATOMIC THEORY OF

**Dalton, John** 1766–1844

English chemist and physicist

...observations [of matter]...have tacitly led to the conclusion which seems universally adopted, that all bodies of sensible magnitude, whether solid or liquid, are constituted of a vast number of extremely small particles bound together by a force of attraction ...

In Henry Enfield Roscoe

*John Dalton and the Rise of Modern Chemistry*

Chapter VI (pp. 129–130)

The Macmillan Co. New York, New York, USA. 1895

## MAXIM

**Davy, Sir Humphry** 1778–1829

English chemist

The maxim of a chemical investigator should be that adopted in the motto of an illustrious society, 'To rely on the word of no master.'

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 218)

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

With the growth of knowledge our ideas must from time to time be organised afresh. The change takes place usually in accordance with new maxims as they arise, but it always remains provisional.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#525 (p. 186)

The Macmillan Co. New York, New York, USA. 1906

**MAXWELL'S THEORY**

**Hertz, Heinrich** 1857–94  
German physicist

To this question, "What is Maxwell's theory?" I cannot give any clearer or briefer answer than the following: Maxwell's theory is the system of Maxwell's equations.

*Electric Waves: Being Researches on the Propagation of Electric Action With Finite Velocity through Space* (p. 23)  
Macmillan & Company Ltd. London, England. 1893

**MEAN**

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

The phenomena of nature are most often enveloped by so many strange circumstances, and so great a number of disturbing causes mix their influence, that it is very difficult to recognize them. We may arrive at them only by multiplying the observations or the experiences, so that the strange effects finally destroy reciprocally each other, the mean results putting in evidence those phenomena and their divers elements.

*A Philosophical Essay on Probabilities*  
Chapter IX (p. 73)  
John Wiley & Sons. New York, New York, USA. 1902

**MEAN VALUE THEOREM**

**Varberg, Dale E.**  
American mathematician

**Purcell, Edwin Joseph**  
Mathematician

The Mean Value Theorem is the midwife of calculus – often helping to deliver other theorems that are of major significance.

*Calculus With Analytic Geometry* (p. 208)  
Prentice-Hall, Inc. New York, New York, USA.

**MEANING**

**Synge, John L.** 1897–1995  
Irish mathematician and physicist

A statement acquires meaning (and truth or falsehood) only when interpreted against a background.

*Kandelman's Krim*  
Chapter Four (p. 83)  
Jonathan Cape. London, England. 1957

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

The same word is used with many meanings, and, like a tool put to many uses, becomes blunted and fallacious.

*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* Volume 2  
Lecture XI (p. 354)  
Henry Holt & Co. New York, New York, USA. 1920

**MEASURE****Author undetermined**

To a 2-L jacketed round reactor vessel (reactor #1) with an overall heat transfer coefficient of about 100 Btu/F-ft<sup>2</sup>-h, add ingredients one, two and three with constant agitation. In a second 2-L reactor vessel with a radial flow impeller operating at 100 rpm, add ingredients four, five, six, and seven until the mixture is homogenous. To reactor #2, add ingredient eight, followed by three equal volumes of the homogenous mixture in reactor #1. Additionally, add ingredient nine and ten slowly, with constant agitation. Care must be taken at this point in the reaction to control any temperature rise that may be the result of an exothermic reaction.

Source undetermined

Chocolate Chip Cookies:  
Ingredients:

1. 532.35 cm<sup>3</sup> gluten
2. 4.9 cm<sup>3</sup> NaHCO<sub>3</sub>
3. 4.9 cm<sup>3</sup> refined halite
4. 236.6 cm<sup>3</sup> partially hydrogenated tallow triglyceride
5. 177.45 cm<sup>3</sup> crystalline C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>
6. 177.45 cm<sup>3</sup> unrefined C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>
7. 4.9 cm<sup>3</sup> methyl ether of protocatechuic aldehyde
8. Two calcium carbonate-encapsulated avian albumen-coated protein
9. 473.2 cm<sup>3</sup> theobroma cacao
10. 236.6 cm<sup>3</sup> de-encapsulated legume meats (sieve size #10)

Source undetermined

**Beyer, Robert W.**

No biographical data available

- 10<sup>-6</sup> phones = 1 microphone
- 10<sup>-2</sup> pedes = 1 centipede
- 10<sup>6</sup> phones = 1 megaphone
- 10<sup>-12</sup> boos = 1 picoboo
- 10<sup>-18</sup> boys = 1 attoboy
- 10<sup>-2</sup> mental = 1 centimental
- 10<sup>-1</sup> cards = 1 decacards
- 10<sup>12</sup> bulls = 1 terrabul
- 2 gorics = 1 paragoric
- 10<sup>9</sup> los = 1 gigolo
- 10<sup>-1</sup> mates = 1 decimate
- 10<sup>-3</sup> cans = 1 millican
- 2 × 10<sup>2</sup> with its = 2 hecto with it
- 10<sup>1</sup> dents = 1 decadent

$10^{-3}$  Nanetts = 1 nonoo Nanette

$2 \times 10^3$  mockingbirds = 2 kilomockingbird

$10^{-3}$  taries = 1 military

$10^3$  monjaros = 1 kilomanjara

$10^{12}$  fermis = 1 terra fermi

$10^{-6}$  fish = 1 microfish

Humor Rumor: It Helps!

*The Physics Teacher*, Volume 15, Number 9, December, 1977 (p. 575)

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

It is in vain to attempt to measure a quantity which escapes our notice, and which history cannot ascertain; and we might just as well attempt to measure the distance of the stars without a parallax, as to calculate the destruction of the solid land without a measure corresponding to the whole.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section IV (p. 190)

H.R. Engelmann & Weldon & Wesley, Weinheim, Germany. 1959

**Jaki, Stanley L.** 1924

Benedictine priest and physicist

An interaction that cannot be measured exactly, cannot take place exactly.

*The Limits of a Limitless Science: And Other Essays*

Chapter 3 (p. 41)

ISI Books, Wilmington, Delaware, USA 2000

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

In Robert Montgomery Bird

*Modern Science Reader: With Special Reference to Chemistry*

Electrical Units of Measurements (p. 149)

The Macmillan Co. New York, New York, USA. 1911

**Lagrange, Joseph Louis** 1736–1813

Italian/French mathematician and astronomer

In general, nothing measurable can be measured except by fractions expressing the result of the measurement, unless the measure be contained an exact number of times in the thing to be measured.

Translated by Thomas J. McCormack

*Lectures on Elementary Mathematics* (2nd edition) (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1901

**Suess, Eduard** 1831–1914

English-born Austrian geologist and paleontologist

... we are prone to forget that the planet may be measured by man, but not *according* to man.

Translated by William Johnson Sollas

*The Face of the Earth* (Volume 1)

Chapter I (p. 17)

At The Clarendon Press. Oxford, England. 1904

## MEASUREMENT

**Adams, George** 1750–95

English instrument maker

Most of our philosophical instruments are measures of effects. The progress made in natural philosophy increases every day by the number of these measures; by these it still continues to be improved.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture VI (p. 265)

Printed by R. Hindmarsh. London, England. 1794

**Asimov, Isaac** 1920–92

American author and biochemist

... we must remember that measures were made for man and not man for measures.

*Time and Space and Other Things*

Of Part II, of Other Things (p. 143)

Doubleday & Company, Inc. Garden City, New York, USA. 1965

## Author undetermined

One accurate measurement is worth a thousand expert opinions.

Source undetermined

What the measurements will not do, is to get you out of the crisis you are already in.

Source undetermined

**Balfour, Arthur James** 1848–1930

British prime minister

Science depends upon measurement, and things not measurable are therefore excluded, or tend to be excluded, from its attention.

In William H. George

Address

*The Scientist in Action: A Scientific Study of His Methods*

Some Problems in Theorizing (pp. 263–264)

William & Norgate. London, England. 1936

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

All measurements in science are statistical in character.

*The Handmaiden of the Sciences*

Chapter 1 (p. 8)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Bell, J. A.**

No biographical data available

The concept of “measurement” becomes so fuzzy on reflection that it is quite surprising to have it appearing in physical theory at the most fundamental level.

*Speakable and Unspeakable in Quantum Mechanics*

Chapter 15 (p. 117)

Cambridge University Press. Cambridge, England. 1987

### **Berry, John J.**

No biographical data available

Every man who has entrusted to a woman the work of manufacturing a shirt has had painful experience of her inability to comprehend the importance of accurate measurement. Mr. Smith, for example, permits Mrs. Smith to make a new shirt, to be modeled precisely after an old one which measures, say fifteen inches around the neck. When the new garment is completed Mr. Smith finds that it chokes him, and calls his wife’s attention to the fact. She declares that it measures precisely the same as the model, and, appealing to the tape-measure in proof of her assertion, finds that the new shirt measures only thirteen inches around the neck. Under these circumstances a male shirt-maker would confess that he had made a mistake. Not so Mrs. Smith. She exclaims with every appearance of triumph, “There, what did I tell you. One is almost exactly the same size as the other. There isn’t two inches difference between them.” Nothing could illustrate more forcibly woman’s total inability to grasp the importance of accurate measurements.

*Life of David Belden*

Chapter V (p. 104)

Beldon Brothers. New York, New York, USA. 1891

### **Bondi, Sir Hermann** 1919–2005

English mathematician and cosmologist

A quantity like time, or any other physical measurement, does not exist in a completely abstract way. We find no sense in talking about something unless we specify how we measure it. It is the definition by the method of measuring a quantity that is the one sure way of avoiding talking nonsense...

*Relativity and Common Sense: A New Approach to Einstein*

Chapter VII (p. 65)

Doubleday & Company, Inc. Garden City, New York. 1964

### **Brouwer, L. E. J.**

No biographical data available

It is well to notice in this connection [the mutual relations between the results of counting and measuring] that a natural law, in the statement of which measurable magnitudes occur, can only be understood to hold in nature with a certain degree of approximation; indeed natural laws as a rule are not proof against sufficient refinement of the measuring tools.

Intuitionism and Formalism

*Bulletin of the American Mathematical Society*, Volume 20, November, 1913 (p. 82)

### **Deming, William Edwards** 1900–93

American statistician, educator, and consultant

It is important to realize that it is not the one measurement, alone, but its relation to the rest of the sequence that is of interest.

*Statistical Adjustment of Data* (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1938

### **Dewey, John** 1859–1952

American philosopher and educator

Insistence upon numerical measurement when it is not inherently required by the consequence to be effected, is a mark of respect for the ritual of scientific practice at the expense of its substance.

*Logic: The Theory of Inquiry*

Chapter XI (p. 205)

Henry Holt & Company. New York, New York, USA. 1938

### **Dickens, Charles** 1812–70

English novelist

The intervals between the ultimate particles of bodies will probably ever remain beyond our ken and measurement, visible only to the eye of the mind.

*The Universe*

*All the Year Round: A Weekly Journal*, Volume 2, June 5 to November 27, 1869 (p. 12)

With a rule and a pair of scales, and the multiplication table always in his pocket, sir, ready to weigh and measure any parcel of human nature, and tell you exactly what it comes to.

*Hard Times*

Book I, Chapter II (p. 206)

Chapman & Hall, Ltd. London, England. 1858

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I really cannot tell you anything about it, if you will not let me make measurements of any kind. Measurement is my only means of finding out about nature. I am not a metaphysicist.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Prologue (p. 2)

At The University Press. Cambridge, England. 1921

Measurement is my only means of finding out about nature. I am not a metaphysicist.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Prologue (p. 2)

At The University Press. Cambridge, England. 1921

### **Ellis, Brian**

No biographical data available

Measurement is the link between mathematics and science.

*Basic Concepts of Measurement*

Introduction (p. 1)

At The University Press. Cambridge. 1966

**Ferguson, Kitty**

Science writer

Measuring is one of the more practical uses of mathematics, but the ability and desire to measure aren't always wrapped up with the need to know useful answers.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*

Prologue (p. 3)

Walker &amp; Company. New York, New York, USA. 1999

**Fox, Russell**

No biographical data available

**Gorbunov, Max**

No biographical data available

Measurement has meaning only if we can transmit the information without ambiguity to others.

*The Science of Science*

Part II, 4 (p. 31)

Walker &amp; Company. New York, New York, USA. 1997

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

If it were not for our conception of weights and measures we would stand in awe of the firefly as we do before the sun.

*Sand and Foam: A Book of Aphorisms* (p. 52)

Alfred A. Knopf. New York, New York, USA. 1959

**Hales, Stephen** 1677–1761

English physiologist and clergyman

Since we are assured that the all-wise Creator has observed the most exact proportions of number, weight and measure in the make of all things, the most likely way therefore to get any insight into the nature of those parts of the Creation which come within our observation must in all reason be to number, weigh and measure.

*Vegetable Statics*

The Introduction (p. xxxi)

The Scientific Book Guild. London, England. 1961

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Astronomical distances have the air of a conjuring trick. The vastness of cosmic dimensions fills us with astonishment. Yet like a conjuring trick it all looks very obvious when we see how it is done. The methods of measurement are indeed of a very mundane character.

*Frontiers of Astronomy*

Chapter Ten (p. 163)

Harper &amp; Row, Publishers. New York, New York, USA. 1955

**Jevons, William Stanley** 1835–82

English economist and logician

There is little use in obtaining exact measurements of an effect unless we can also exactly measure its conditions.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XX (p. 441)

Macmillan &amp; Co Ltd. London, England. 1887

**Jones, William** 1746–94

English philologist and student of ancient India

There is no part of mathematical science more truly calculated to interest and surprize mankind, than the measurement of the relative positions and distances of inaccessible objects.

*Astronomical and Geographical Essays* (6th edition)

Essay IV (p. 435)

W. &amp; S. Jones. London, England. 1812

**Kaplan, Abraham** 1918–93

American philosopher of science, author, and educator

One of the subjects of Kinsey's study of sexual behavior in the human male afterwards complained bitterly of the injury to his masculine ego. "No matter what I told him," he explained, "he just looked me straight in the eye and asked, "How many times?"...The principle, "Let's get it down to something we can count!" does not always formulate the best research strategy.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter V, Section 20 (p. 171)

Chandler Publishing Company. San Francisco, California, USA. 1964

Proleptically [anticipatively], I would say that whether we can measure something depends, not on that thing, but on how we have conceptualized it, on our knowledge of it, above all on the skill and ingenuity which we can bring to bear on the process of measurement which our inquiry can put to use.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter V, Section 20 (p. 176)

Chandler Publishing Company. San Francisco, California, USA. 1964

Measurement, we have seen, always has an element of error in it. The most exact description or prediction that a scientist can make is still only approximate. If, as sometimes happens, a perfect correspondence with observation does appear, it must be regarded as accidental, and, as Jevons ...remarks, it "should give rise to suspicion rather than to satisfaction."

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter VI, Section 25 (p. 215)

Chandler Publishing Company. San Francisco, California, USA. 1964

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Measurement is a means, not an end.

Address to the British Association

*Life*, Volume 2, 1871 (p. 200)

Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than



looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long contained labor in the minute sifting of numerical results.

*Report of the British Association For the Advancement of Science*, Volume 41, xci, 1871

**Lewis, Gilbert Newton** 1875–1946

American chemist

I have no patience with attempts to identify science with measurement, which is but one of its tools, or with any definition of the scientist which would exclude a Darwin, a Pasteur, or a Kekulé.

*The Anatomy of Science*

Chapter I (p. 6)

Yale University Press. New Haven, Connecticut, USA. 1926

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

We are ourselves the measure of the miraculous; if we should find a universal measure, the miraculous elements would disappear, and all things would be of equal size.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 27)

Jonathan Cape. London, England. 1969

**Onnes, Heike Kamerlingh** 1853–1926

Dutch physicist

Through measure to knowing is the motto I would like to write above every physics laboratory.

In Arno Laesecke

Through Measurement to Knowledge: The Inaugural Lecture of Heike Kamerlingh Onnes (1882)

*Journal of Research of the National Institute of Standards and Technology*, Volume 107, Number 3, May–, 2002 (p. 264)

**Peter, Lawrence J.**

No biographical data available

Coomb's Law. If you can't measure it, I'm not interested.

Peter's People

*Human Behavior*, August, 1976 (p. 9)

**Planck, Max** 1858–1947

German physicist

The ideal aim before the mind of the physicist is to understand the external world of reality. But the means which he uses to attain this end are what are known in physical science as measurements, and these give no direct information about external reality. are only a register or representation of reactions to physical phenomena. As such they contain no explicit information and have to be interpreted.

Translated by James Murphy

*Where Is Science Going?*

Chapter III (p. 84)

Norton. New York, New York, USA. 1932

Every measurement first acquires its meaning for physical science through the significance which a theory gives it.

Translated by James Murphy

*Where Is Science Going?*

Chapter III (p. 92)

Norton. New York, New York, USA. 1932

**Plato** 428 BCE–347 BCE

Greek philosopher

The points that I mean are length and shortness, excess and defect, with all of which the art of measurement is conversant.

*In Great Books of the Western World* (Volume 7)

*Statesman*

Section 283 (p. 594)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Rankine, William John Macquorn** 1820–72

Scottish engineer and physicist

A party of astronomers went measuring of the earth,  
And forty million meters they took to be its girth;  
Five hundred million inches, though, go through from  
pole to pole;  
So let's stick to inches, feet, and yards, and the good old  
three-foot rule.

*Songs and Fables*

The Three-Foot Rule, Stanza III

J. Maclehose. Glasgow, Scotland. 1874

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...measurement demands some one-one relations between the numbers and magnitudes in question – a relation which may be direct or indirect, important or trivial, according to circumstances.

*The Principles of Mathematics*

Chapter XXI (p. 176)

W.W. Norton & Company. New York, New York, USA. 1938

**Read, Herbert** 1893–1968

English poet

Beauty had been born, not, as we so often conceive it nowadays, as an ideal of humanity, but as measure, as the reduction of the chaos of appearances to the precision of linear symbols. Symmetry, balance, harmonic division, mated and mensurated intervals – such were its abstract characteristics.

*Icon and Idea: The Function of Art in the Development of Human Consciousness*

Chapter IV (p. 75)

Harvard University Press. Cambridge, Massachusetts, USA. 1955

**Reynolds, H. T.**

No biographical data available

Crude measurement usually yields misleading, even erroneous conclusions no matter how sophisticated a technique is used.

*Analysis of Nominal Data*

Chapter 3 (p. 56)

Sage Publications. Beverly Hills, California, USA. 1977

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

The rejection of realism has logical consequences. In general, a variable has no definite value before I measure it; then measuring it does not mean ascertaining the value that it has. But then what does it mean? There must still be some criterion as to whether a measurement is true or false, a method is good or bad, accurate, or inaccurate – whether it deserves the name of measurement process at all.

The Present Situation in Quantum Mechanics

*Proceedings of the American Philosophical Society*, Volume 124, 1980

**Schwinger, Julian** 1918–94

American theoretical physicist

Microscopic measurement has no meaning apart from a theory, and the idealized measurement concepts that are implicit in a particular theory must be accepted or rejected in accordance with the final success or failure of that theory to fulfill its avowed aims.

*Nobel Lectures, Physics 1963–1970*

Relativistic Quantum Field Theory (p. 142)

Elsevier Publishing Co. Amsterdam, The Netherlands. 1972

**Singer, Charles** 1876–1960

Historian of science and medicine

Galileo showed men of science that weighing and measuring are worthwhile. Newton convinced a large proportion of them that weighing and measuring are the only investigations that are worthwhile.

*A Short History of Medicine*

Chapter V, Section 1 (p. 138)

At The Clarendon Press, Oxford, England. 1928

**Sophocles** 496 BCE–406 BCE

Greek playwright

Nay, if these measures give any ground of confidence, we think that thy design is not amiss.

*In Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

*Trachiniae*, l. 587

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Spearman, Charles** 1863–1945

English psychologist

...great as may be the potency of this [the experimental method], or of the preceding methods, there is yet another one so vital that, if lacking it, any study is thought by

many authorities not to be scientific in the full sense of the word. This further and crucial method is that of measurement...

*Psychology Down the Ages* (Volume 1) (p. 89)

Macmillan & Company Ltd. London, England. 1937

**Standen, Anthony**

Anglo-American science writer

If the idols of scientists were piled on top of one another in the manner of a totem pole the topmost would be a grinning fetish called Measurement.

*Science Is a Sacred Cow*

Chapter III (p. 82)

E.P. Dutton & Company, Inc. New York, New York, USA. 1950

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Science begins with measurement and there are some people who cannot be measurers; and just as we distinguish carpenters who can work to this or that fraction of an inch of accuracy, so we must distinguish ourselves and our acquaintances as able to observe and record to this or that degree of truthfulness.

*Introduction to Science*

Chapter I (p. 19)

Henry Holt & Co. New York, New York, USA. 1911

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Search for measurable elements among your phenomena, and then search for relations between these measures of physical quantities.

*Science and the Modern World*

Chapter III (p. 66)

The Macmillan Company. New York, New York, USA. 1929

**Wilson, O. C.**

No biographical data available

The measurement of distance is still a fundamental problem at every level of astronomy.

A New Scale of Stellar Distances

*Scientific American*, Volume 204, Number 1, January, 1961 (p. 107)

**Wordsworth, William** 1770–1850

English poet

I've measured it from side to side:

'Tis three feet long, and two feet wide.

*The Complete Poetical Works of William Wordsworth*

The Thorn, iii (Early Reading)

Crowell. New York, New York, USA. 1888

**MECHANICAL**

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

I would that all other natural phenomena might similarly be deduced from mechanical principles. For many things move me to suspect that everything depends upon certain forces in virtue of which the particles of bodies, through forces not yet understood, are either impelled together so as to cohere in regular figures, or are repelled and recede from one another.

*Mathematical Principles of Mathematical Philosophy*

Preface

## MECHANICAL SKILL

**von Liebig, Justus** 1803–73

German organic chemist

The success of an experiment, or of a process, depends far less upon mechanical skill, than upon knowledge. Failure is the result of ignorance, and discoveries are made, not by manual dexterity, but by skill in combination, and by that intellectual power which creates new thoughts.

In John Blyth (ed.)

*Familiar Letters on Chemistry*

Letter I (p. 12)

Walton & Maberly. London, England. 1859

## MECHANICS

**Adams, George** 1750–95

English instrument maker

The knowledge of mechanics is one of those things that contribute to distinguish civilized nations from barbarians. From it the works of art derive much of their beauty and value; without it we can make very little progress in the knowledge of the works of nature. By this science we are enabled to improve every power and force in nature, and render the motions of the elements water, air, and fire, subservient to the purposes of life.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXXI (p. 257)

Printed by R. Hindmarsh. London, England. 1794

### Author undetermined

A book on mechanics which does not mention friction is like a work on astronomy which takes no notice of refraction or precession.

Young's Elements of Mechanics

*The Quarterly Journal of Education*, Volume IV, Number 7, July, 1832 (p. 121)

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

Mechanics, for instance, is a diamond of many facets and scintillates with different colors for the mathematician, the student of pure physics, the student of cosmic physics or the engineer.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Mechanics is the paradise of the mathematical sciences because by means of it one comes to the fruit of mathematics.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Mathematics (p. 613)

George Braziller. New York, New York, USA. 1958

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

And there are absolutely no judgments (or rules) in Mechanics which do not also pertain to Physics, of which Mechanics is a part or type: and it is as natural for a clock, composed of wheels of a certain kind, to indicate the hours, as for a tree, grown from a certain kind of seed, to produce the corresponding fruit. Accordingly, just as when those who are accustomed to considering automata know the use of some machine and see some of its parts, they easily conjecture from this how the other parts which they do not see are made: so, from the perceptible effects and parts of natural bodies, I have attempted to investigate the nature of their causes and of their imperceptible parts.

Translated by Valentine Rodger Miller and Reese P. Miller

*Principles of Philosophy*

Part IV (pp. 285–286)

Kluwer Academic Publishers. Dordrecht, The Netherlands. 1983

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I am standing on the threshold about to enter a room. It is a complicated business. In the first place I must shove against an atmosphere pressing with a force of fourteen pounds on every square inch of my body. I must make sure of landing on a plank traveling at twenty miles a second round the sun – a fraction of a second too early or too late, the plank would be miles away. I must do this whilst hanging from a round planet, head outward in space, and with a wind of aether blowing at no one knows how many miles a second through every instance of my body.

*The Nature of the Physical World*

Chapter XV (p. 342)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

Just now I am teaching the foundations of poor deceased mechanics, which is so beautiful. What will her successor look like? With that question I torment myself incessantly.

In Keith Hannabuss

*An Introduction to Quantum Theory*

Letter to Heinrich Zangger, November 14, 1911 (p. 246)

Oxford University Press, Inc. Oxford, England. 1997

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

Proper is it that in the gradual development of a science, and in the instruction of individuals, the easy should precede the difficult, the simple the complex, the special the general, yet the mind, when once it has reached a higher point of view, demands the contrary course, in which all statics shall appear simply as a special case of mechanics.

In Ernst Mach

*History and Root of the Principle of the Conservation of Energy*

Chapter II (p. 34)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

### **Gregory, Olinthus** 1774–1841

English mathematician

The science of mechanics, whether considered in its theory as a subject of curious and refined speculations, calculated for the learned, ingenious, and contemplative, or in practice as contribution to the conveniences and elegancies of life, and the wealth of nations, may be ranked the first and most important of all human acquirements.

A Treatise of Mechanics

*American Journal of Science*, Volume 7, 1824 (p. 72)

### **Haeckel, Ernst Heinrich Philipp**

**August** 1834–1919

German biologist and philosopher

...all natural phenomena, without exception, from the motions of the celestial bodies to the growth of plants and the consciousness of men.... Are ultimately to be reduced to atomic mechanics.

In St. George Jackson Mivart

*Essays and Criticisms*

Chapter 11 (p. 338)

James R. Osgood & Co. London, England. 1892

### **Hertz, Heinrich** 1857–94

German physicist

All physicists agree that the problem of physics consists in tracing the phenomena of nature back to the simple laws of mechanics.

In D.E. Jones and J.T. Walley

*The Principles of Mechanics Presented in a New Form*

Preface (p. xxi)

Dover Publications, Inc. New York, New York, USA. No date

### **Jamin, E. V.**

No biographical data available

Physics will one day form a chapter of general mechanics.

In L. Poincaré

*The New Physics and Its Evolution*

Chapter I (pp. 9–10)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

### **Kirchoff, Gustav Robert** 1824–87

German physicist

The highest object to which the natural sciences are constrained to aim, but which they will never reach, is the determination of the forces, which are present in nature, and of the state of matter at any given moment – that is, the reduction of all the phenomena of nature to mechanics.

Über das Ziel der Naturwissenschaften (p. 24)

*Prorektoratsrede*, s. 9, 1865 (p. 24)

If we were acquainted with all the forces of nature and knew what is the state of matter at a certain moment of time, we should be able to deduce by means of mechanics its state at every subsequent moment, and to deduce how the various natural phenomena follow and accompany each other. The highest goal the natural sciences must strive to attain is the realization of the just mentioned supposition – viz, the reduction of all natural phenomena to mechanics. We shall never attain the goal of the natural sciences, but even the fact that it is recognized as such offers us certain satisfaction, and in approximating to it lies the highest pleasure to be derived from the study of natural phenomena.

In Robert von Helmholtz

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1889

A Memoir of Gustav Robert Kirchoff (p. 538)

Government Printing Office. Washington, D.C. 1889

Mechanics is the science of motion; its object may be stated to be to describe in the most *complete and simple way* the motion that takes place in nature.

In Robert von Helmholtz

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1889

A Memoir of Gustav Robert Kirchoff (p. 538)

Government Printing Office. Washington, D.C. 1889

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

No one is competent to predicate things about facts, absolute space and absolute motion; they are pure things of thought, pure mental constructs, that cannot be produced in experience. All our principles of mechanics are, as we have shown in detail, experimental knowledge concerning the relative positions and motions of bodies. Even in the provinces in which they are now recognised as valid, they could not, and were not, admitted without previously being subjected to experimental tests. No one is warranted in extending these principles beyond the boundaries of experience. In fact, such an extension is meaningless, as no one possesses the requisite knowledge to make use of it.

Translated by Thomas Joseph McCormick

*The Science of Mechanics: A Critical and Historical Account of Its Development of Mechanics*

Chapter II, Section VI (p. 229)

The Open Court Publishing Co. Chicago, Illinois, USA. 1919

That branch of physics which is at once the oldest and the simplest and which is therefore treated as introductory to other departments of this science, is concerned with the motions and equilibrium of masses. It bears the name of mechanics.

*The Science of Mechanics* (5th edition)

Introduction (p. 1)

The Open Court Publishing Company, La Salle, Illinois, USA. 1942

Purely mechanical phenomena do not exist...are abstractions, made, either intentionally or from necessity, for facilitating our comprehension of things. The science of mechanics does not comprise the foundations, no, nor even a part of the world, but only an aspect of it.

*The Science of Mechanics* (5th edition)

Chapter V, Part I, Section 1 (p. 597)

The Open Court Publishing Company, La Salle, Illinois, USA. 1942

### **Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The ancients considered mechanics in a twofold respect; as rational, which proceeds accurately by demonstration; and practical. To practical mechanics all the manual arts belong, from which mechanics took its name. But as artificers do not work with perfect accuracy, it comes to pass that mechanics is so distinguished from geometry, that what is perfectly accurate is called geometrical; what is less so, is called mechanical. But the errors are not in the art, but in the artificers. He that works with less accuracy is an imperfect mechanic; and if any could work with perfect accuracy, he would be the most perfect mechanic of all; for the description of right lines and circles, upon which geometry is founded, belongs to mechanics. Geometry does not teach us to draw these lines, but requires them to be drawn; for it requires that the learner should first be taught to describe these accurately, before he enters upon geometry; then it shows how by these operations problems may be solved. To describe right lines and circles are problems, but not geometrical problems. The solution of these problems is required from mechanics; and by geometry the use of them, when so solved, is shown; and it is the glory of geometry that from those few principles, brought from without, it is able to produce so many things. Therefore geometry is founded in mechanical practice, and is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measuring.

Translated by Andrew Motte

*Newton's Principia: Mathematical Principles of Mathematical Philosophy*

Preface (p. 65)

Daniel Adee. New York, New York, USA. 1848

### **Oliver, David**

No biographical data available

Mechanics is the wellspring from which physics flows...

*The Shaggy Steed of Physics: Mathematical Beauty in the Physical World*

Preface (p. xi)

Springer-Verlag, New York, New York, USA. 2004

Mechanics is the vehicle of all physical theory. Mechanics is the vehicle of war. The two have been inseparable.

*The Shaggy Steed of Physics: Mathematical Beauty in the Physical World*

Preface (p. xii)

Springer-Verlag, New York, New York, USA. 2004

The sword of mechanics proclaims the profane. But the plowshare of mechanics parts the earth revealing the sacred in matter.

*The Shaggy Steed of Physics: Mathematical Beauty in the Physical World*

Preface (p. xiv)

Springer-Verlag, New York, New York, USA. 2004

### **Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The ultimate aim of celestial mechanics is to solve the great question whether Newton 'a law alone will explain all astronomical phenomena.

In James Byrnie Shaw

Henri Poincaré as An Investigator

*Popular Science Monthly*, March, 1913 (p. 215)

### **Schwinger, Julian** 1918–94

American theoretical physicist

Classical mechanics is a determinate theory. Knowledge of the state at a given time permits precise prediction of the result of measuring any property of the system. In contrast, quantum mechanics is only statistically determinate.

*Nobel Lectures, Physics 1963–1970*

Relativistic Quantum Field Theory (p. 142)

Elsevier Publishing Co. Amsterdam, The Netherlands. 1972

### **von Helmholtz, Hermann** 1821–94

German scientist and philosopher

...the ultimate aim of physical science must be to demonstrate the movements which are the real causes of all other phenomena and discover the motive powers on which they all depend; in other words, to merge itself into mechanics.

*Popular Lectures on Scientific Subjects*

Lecture VIII (p. 375)

D. Appleton & Company, New York, New York, USA. 1885

The aim of the natural sciences is to resolve themselves into mechanics.

In St. George Jackson Mivart

*Essays and Criticisms*

Chapter 11 (p. 338)

James R. Osgood & Co. London, England. 1892

## MECHANICS, TEACHING OF

**Planck, Max** 1858–1947  
German physicist

In my opinion the teaching of mechanics will still have to begin with Newtonian force, just as optics begins in the sensation of colour and thermodynamics with the sensation of warmth, despite the fact that a more precise basis is substituted later on.

*The Universe in the Light of Modern Physics* (p. 69)

## MECHANISM

**Pearson, Karl** 1857–1936  
English mathematician

...although we cannot definitely assert that life is a mechanism until we know more exactly what we mean by the term mechanism as applied to organic corpuscles, there still seems little doubt that some of the generalisations of physics – notably the great principle of the conservation of energy – do describe at least part of our perceptual experience of living organisms.

*The Grammar of Science* (2nd edition)

Chapter XII (p. 528)

Adam & Charles Black. London, England. 1900

## MEDIAN

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

The median isn't the message.

The Median Isn't the Message

*Discover*, June, 1985 (p. 40)

## MEDICAL CONSPIRACY

**Shaw, George Bernard** 1856–1950  
Irish playwright

[All professions] are all conspiracies against the laity; and I do not suggest that the medical conspiracy is either better or worse than the military conspiracy, the legal conspiracy, the sacerdotal conspiracy, the pedagogic conspiracy, the royal and aristocratic conspiracy, the literary and artistic conspiracy, and the innumerable industrial, commercial, and financial conspiracies, from the trade unions to the great exchanges, which make up the huge conflict which we call society. But it is less suspected.

*The Doctor's Dilemma*

Preface (p. 16)

Penguin Books. Baltimore, Maryland, USA. 1954

## MEDICAL EDUCATION

**Flexner, Abraham** 1866–1959  
American educator

It follows that in other respects, too, the clinical professors will be on the common university basis: salaried, as other professors are. Of course, their salaries will be inadequate, i.e., less than they can earn outside – all academic salaries paid to the right men are. But there is no inherent reason why a professor of medicine should not make something of the financial sacrifice that the professor of physics makes: both give up something – less and less, let us hope, as time goes on – in order to teach and to investigate.

*Medical Education in the United States and Canada*

Chapter VI (p. 102)

The Carnegie Foundation. New York, New York, USA. 1910

## MEDICAL ETHICS

**Shaw, George Bernard** 1856–1950  
Irish playwright

Nobody supposes that doctors are less virtuous than judges; but a judge whose salary and reputation depended on whether the verdict was for plaintiff or defendant, prosecutor or prisoner, would be as little trusted as a general in the pay of the enemy.... It is simply unscientific to allege or believe that doctors do not under existing circumstances perform unnecessary operations and manufacture and prolong lucrative illnesses.

*The Doctor's Dilemma*

Preface (p. 9)

Penguin Books. Baltimore, Maryland, USA. 1954

## MEDICAL FAME

**Burton, Sir Richard Francis** 1821–90  
English explorer

Here there is no such royal road to medical fame. You must begin by sitting with the porter, who is sure to have bleary eyes, into which you drop a little nitrate of silver, whilst you instil into his ear the pleasing intelligence that you never take a fee from the poor. He recovers; his report of you spreads far and wide, crowding your door with paupers...

A Pilgrimage to Medinah and Mecca

*Eclectic Magazine*, November, 1855 (p. 957)

## MEDICAL KNOWLEDGE

**Abernethy, John** 1680–1740  
Irish Presbyterian minister, theologian, and dissenter

There is no short cut, nor 'royal road' to the attainment of medical knowledge. The path which we have to pursue is



long, difficult, and unsafe. In our progress, we must frequently take up our abode with death and corruption, we must adopt loathsome diseases for our familiar associates, or we shall never be acquainted with their nature and dispositions; we must risk, nay, even injure our own health, in order to be able to preserve, or restore that of others.

*The Hunterian Oration, for the Year 1819* (pp. 33–34)  
 Publisher undetermined. 1819

## MEDICAL MEN

**Bigelow, Jacob** 1787–1879  
 American Physician

The death of medical men is an occurrence which eminently demands our attention, for it speaks to us of our science, and of ourselves. It reminds us, that we, in turn, are to become victims of the incompetency of our own art.

*Nature in Disease, Illustrated in Various Discourses and Essays*  
 On Self-limited Diseases (p. 1)  
 Ticknor & Fields. Boston, Massachusetts, USA. 1854

## Jewett, Sarah Orne

The practical medical men are the juries who settle all the theories of the hour, as they meet emergencies day after day.

*A Country Doctor*  
 Chapter IX (p. 110)  
 Houghton Mifflin Co. Boston, Massachusetts, USA. 1884

## MEDICAL PRACTICE

**DeBakey, Lois**  
 Professor of Scientific Communication

In a highly regimented, regulated, or restrictive environment, medical practice can frustrate, oppress, and enslave – unless the physician holds his noble purpose uppermost in mind. In a humanitarian and intellectually stimulating environment, on the other hand, medicine can be intriguing, exhilarating, and engrossing. It is the continual search for ways to maintain or restore health and well-being to patients and the achievement of that goal that preserve the passion for medicine.

In Lois Debakery and Phil R. Manning  
*Medicine: Preserving the Passion in the 21st Century*  
 Chapter 1 (p. 1)  
 Springer-Verlag. Berlin, Germany. 2004

## MEDICAL PROFESSION

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
 English novelist

...I might have got into some stupid draught-horse work or other, and lived always in blinkers. I should never have been happy in any profession that did not call forth

the highest intellectual strain, and yet keep me in good warm contact with my neighbors. There is nothing like the medical profession for that: one can have the exclusive scientific life that touches the distance and befriend the old fogies in the parish too.

*The Works of George Eliot* (Volume 6)  
*Middlemarch*  
 Book Two, Chapter IV (p. 239)  
 The Century Co. New York, New York, USA. 1910

**Osler, Sir William** 1849–1919  
 Canadian physician and professor of medicine

The greatest art is in the concealment of art, and I may say that we of the medical profession excel in this respect.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
 Chapter VII (p. 124)  
 P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

## MEDICAL SCHOOL

**MacPhail, Sir Andrew** 1864–1938  
 Professor of the history of medicine

Scientific research in itself will not make a medical school, graduate or undergraduate; but a medical school without research is like a ship without a compass.

In students of William Osler  
*Contributions to Medical and Biological Research*  
 The Education of Graduates (p. 131)  
 Paul B. Hoeber. New York, New York, USA. 1919

## MEDICAL SCIENCE

**Ace, Goodman** 1899–1982  
 American radio writer and performer

A rule of thumb in the matter of medical advice is to take everything any doctor says with a grain of aspirin.

*The Fine Art of Hypochondria*  
 Only Sick People Go to the Doctors (p. 44)  
 Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Adams, Samuel Hopkins** 1871–1958  
 American author

Medicine would be the ideal profession if it did not involve giving pain.

*The Health Master*  
 Chapter I  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

With the exception of lawyers, there is no profession which considers itself above the law so widely as the medical profession.

*The Health Master*  
 Chapter I  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

**Albright, Fuller** 1900–69  
 American physician and endocrinologist

One cannot possibly practice good medicine and not understand the fundamentals underlying therapy. Few if any rules for therapy are more than 90 per cent correct. If one does not understand the fundamentals, one does more harm in the 10 per cent of instances to which the rules do not apply than one does good in the 90 per cent to which they do apply.

In Russell L. Cecil and Robert F. Loeb

*Textbook of Medicine*

Diseases of the Ductless Glands

Introduction

W.B. Saunders Company. Philadelphia, Pennsylvania, USA. 1979

**Armstrong, John** 1709–79

American civil engineer and soldier

For want of timely care

Millions have died of medicable wounds.

*The Art of Preserving Health*

Book III, I. 515 (p. 92)

Printed by Hosea Sprague. Boston, Massachusetts, USA. 1802

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Surely every medicine is an innovation, and he that will not apply new remedies must expect new evils...

*Bacon's Essays*

Of Innovations (p. 114)

Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

The poets did well to conjoin music and medicine in Apollo, because the office of medicine is but to tune this curious harp of man's body and to reduce it to harmony.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 2 (p. 51)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Medicine is a science which hath been, as we have said, more professed than laboured, and yet more laboured than advanced: the labour having been in my judgment, rather in circle than in progression.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 3 (pp. 51–52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Berkenhout, John** 1730–91

Physician

I do not deny that many lives might be saved by the skillful administration of proper medicine; but a thousand indisputable facts convince me that the present established practice of physic in England is infinitely destructive of the lives of his Majesty's subjects. I prefer the practice of old women, because they do not sport with edged tools; being unacquainted with the powerful articles of the *Materia Medica*.

In Roy Porter

*The Greatest Benefit to Mankind: A Medical History of Humanity* (p. 262)

W.W. Norton & Company, Inc. New York, New York, USA. 1998

**Bernard, Claude** 1813–78

French physiologist

To conserve health and to cure disease: Medicine is still pursuing a scientific solution of this problem, which has confronted it from the first.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 1)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bigelow, Jacob** 1786–1879

Physician

Most men form an exaggerated estimate of the powers of medicine, founded on the common acceptance of the name, that medicine is the art of curing diseases. That this is a false definition is evident from the fact that many diseases are incurable, and that one such disease must at last happen to every living man. A far more just definition would be that medicine is the art of understanding diseases, and of curing or relieving them when possible.

*Nature in Disease*

Chapter 2 (p. 69)

Phillips, Sampson & Company. Boston, Massachusetts, USA. 1859

**Bloom, Samuel W.**

No biographical data available

Art and science march hand in hand through the history of medicine, each taking turns at the lead. A century or more ago science became the dominant partner and has remained so ever since. The art of medicine meanwhile, like an honored but neglected wife, walked behind, passive and obedient to call at those odd moments when the master needed a change of pace.

*The Doctor and His Patient: A Sociological Interpretation*

Chapter I (p. 33)

Russell Sage Foundation. New York, New York, USA. 1963

**Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

Medicine is not an exact and positive science but a science based on conjectures and observations. I would have more confidence in a physician who has not studied the natural sciences than in one who has.

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (p. 139)

Columbia University Press. New York, New York, USA. 1955

**Bryce, John**

No biographical data available

Medicine [is] the only profession that labours incessantly to destroy the reason for its own existence.

Address

At dinner for General W.C. Gorgas

March 23, 1914

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Learn'd he was in medic'nal lore,  
For by his side a pouch he wore,  
Replete with strange hermetic powder  
That wounds nine miles point-blank would solder.

*The Poetical Works of Samuel Butler* (Volume 1)

Part I, Canto II, l. 223–6

Bell & Daldy. London, England. 1835

**Charles, Prince of Wales** 1948–  
Heir apparent to British throne

The whole imposing edifice of modern medicine is like  
the celebrated tower of Pisa – slightly off balance.

*Observer*, 2 January, 1983

### **Charlie Chan (Fictional character)**

To describe bitter medicine will not improve its flavor.

*Charlie Chan in the City of Darkness*

Film (1939)

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

Medicine is my lawful wife and literature is my mistress.  
When I get tired of one I spend the night with the other.

*Letters on the Short Story, the Drama, and Other Literary Topics*

Letter to A.S. Souvorin, September 11, 1888 (p. 42)

Minton, Balch & Company. New York, New York, USA. 1924

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

I have been inclined to feel from time to time that there  
ought to be a hagiology of medical science and that we  
ought to have saints' days to commemorate the great dis-  
coveries which have been made for all mankind, and per-  
haps for all time – or for whatever time may be left to us.  
Nature, like many of our modern statesmen, is prodigal  
of pain. I should like to find a day when we can take a  
holiday, a day of jubilation, when we can fête good Saint  
Anaesthesia and chaste and pure Saint Antiseptic.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Speech, Guildhall, London, September 10, 1947 (p. 59)

George Allen & Unwin Ltd. London, England. 1956

I do not profess to be very deeply acquainted with the  
science of medicine. I am not a surgeon myself. My  
experiences in medicine have been vivid and violent, and  
completely absorbing while they were going on. Nev-  
ertheless, I cannot claim that they have given me that  
broad, detached, general experience which, I believe, is  
the foundation for all correct scientific action.

Speech

March 2, 1944, Royal College of Physicians

**Colman, George (The Younger)** 1762–1836  
English playwright

When taken,  
To be well shaken.

*Broad Grins*

The Newcastle Apothecary, Stanza 12

Printed for M'Creery. London, England. 1819

**Croll, Oswald** 1560–1609  
German chemist and physician

The choice also of the Medicines must always be consid-  
ered, and their preparations and compositions made by  
the Physitian himself, and not carelessly left to others.  
He is truly a genuine Physitian who can tell how (not  
only by Reason, as mear Rationall Physitians doe, but)  
by their own hand to prepare the medicaments...

*Philosophy Reformed and Improved in Four Profound Tractates*

(pp. 151–152)

Printed by M.S. for Lodowick Lloyd. London, England. 1657

**Crookshank, Francis Graham** 1873–1933  
English chemist and physicist

Medicine is today an Art or Calling, to whose exercise  
certain Sciences are no doubt ancillary; but she has for-  
feited pretension to be deemed a Science, because her  
Professors and Doctors decline to define fundamentals  
or to state first principles, and to refuse to consider, in  
express terms, the relations between Things, Thoughts  
and Words involved in their communications to others.

In C.K. Ogden and I.A. Richards

*The Meaning of Meaning*

Supplement II, The Importance of a Theory of Signs and a Critique of  
Language in the Study of Medicine (p. 338)

Harcourt, Brace & Company. New York, New York, USA. 1949

**da Costa, J. Chalmers** 1863–1933  
American physician

A medical man in the plumage of pretense resembles the  
humming bird, which, when stripped of its plumage, is  
not larger than the bumble bee.

*The Trials and Triumphs of the Surgeon*

Stepping Stones and Stumbling Blocks, Part III (p. 230)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**de Cervantes, Miguel** 1547–1616  
Spanish novelist, playwright, and poet

...God who sends the wound sends the salve.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part II, Chapter 19 (p. 262)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Guevara, Antonio** 1481–1545  
Spanish chronicler and moralist

Medicine is to be praised when it is in the hands of a  
Physitian that is learned, grave, wise, stayed and of  
experience...

*The Familiar Epistles of Sir Anthonie of Guevara of Seven Notable*

*Benefits of Proceeding From the Good Physitian* (p. 285)

Printed by Ralph Newberie. London, England. 1584

**de Madariaga, Salvador** 1886–1978  
Spanish writer and statesman

There is no medicine; there are only medicine-men.

*Essays with a Purpose*

On Medicine (p. 172)

Hollis & Carter. London, England. 1954

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

The mind is so intimately dependent upon the condition and relation of the organs of the body, that if any means can ever be found to render men wiser and more ingenious than hitherto, I believe that it is in medicine they must be sought for.

*A Discourse on Method*

Part IV

J.M. Dent & Sons Ltd. London, England. 1912

**Dickens, Charles** 1812–70

English novelist

Some medical beast had revived tar-water in those days as a fine medicine, and Mrs. Joe always kept a supply of it in the cupboard; having a belief in its virtues correspondent to its nastiness. At the best of times, so much of this elixir was administered to me as a choice restorative, that I was conscious of going about, smelling like a new fence.

*Great Expectations*

Chapter II (p. 10)

Rinehart & Company, Inc. New York, New York, USA. 1948

**Dickinson, Emily** 1830–86

American lyric poet

It knew no Medicine –

It was not Sickness – then –

Nor any need of Surgery –

And therefore – 'twas not Pain –

*The Complete Poems of Emily Dickinson*

No. 559 (p. 271)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

Is Heaven a physician?

They say that He can heal;

But medicine posthumous

Is unavailable.

*The Complete Poems of Emily Dickinson*

No. 1270 (p. 555)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There are one or two elementary rules to be observed in the way of handling patients, he remarked, seating himself on the table and swinging his legs. The most obvious

is that you must never let them see that you want them. It should be pure condescension on your part seeing them at all; and the more difficulties you throw in the way of it, the more they think of it. Break your patients in early, and keep them well to heel.

*The Stark Munro Letters*

Letter VII (p. 152)

D. Appleton & Company. New York, New York, USA. 1895

Dr. Munro, sir, said he, I am a walking museum. You could fit what isn't the matter with me on to the back of a visiting card. If there's any complaint you want to make a special study of, just you come to me, sir, and see what I can do for you. It's not everyone that can say that he has had cholera three times, and cured himself by living on red pepper and brandy.

*The Stark Munro Letters*

Letter XII (p. 278)

D. Appleton & Company. New York, New York, USA. 1895

And now, Doctor, perhaps you would kindly attend to my thumb, or rather to the place where my thumb used to be.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of the Engineer's Thumb* (p. 210)

Wings Books. New York, New York, USA. 1967

**Drake, Daniel** 1785–1852

American physician

Medicine is not a science of meditations, but of observation.

*An Introductory Lecture, on the Means of Promoting the Intellectual*

*Improvement of the Students* (p. 13)

Prentice & Wessinger. Louisville, Kentucky, USA. 1844

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Better to hunt in Fields, for Health unbought,

Than fee the Doctor for a nauseous Draught.

The Wise, for Cure, on Exercise depend;

God never made his Work for Man to mend.

*The Poems of John Dryden* (Volume 4)

To John Dryden, of Chesterton, l. 92–95 (p. 1532)

Longman. London, England. 1995

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Throughout history, and whatever the level of civilization, the structure of medicine has been determined not only by the state of science but also by religious and philosophical beliefs. This is just as true of the most evolved urban and industrialized societies as it is of the most primitive populations. Like his Stone Age ancestors, modern man lives by myths.

*Man, Medicine, and Environment* (p. 53)

Frederick A. Praeger. New York, New York, USA. 1968

**Flexner, Abraham** 1866–1959  
American educator

The student...does not have to be a passive learner, just because it is too early for him to be an original explorer. He can actively master and securely fix scientific technique and method in the process or acquiring the already known.... The undergraduate student of medicine will for the most part acquire the methods, standards, and habits of science by working over territory which has been traversed before, in an atmosphere freshened by the search for truth.  
*Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching Bulletin 4* (p. 57)  
The Carnegie Foundation. New York, New York, USA. 1910

**Galsworthy, John** 1867–1933  
English novelist and dramatist

I'm bad, he said, pouting – been bad all the week; don't sleep at night. The doctor can't tell why. He's a clever fellow, or I shouldn't have him, but I get nothing out of him but bills.  
*The Forsyte Saga*  
Book I, Part I, Chapter I (p. 11)  
Charles Scribner's Sons. New York, New York, USA. 1948

**Garth, Sir Samuel** 1661–1719  
English physician and poet

The Patient's Ears remorseless he assails,  
Murders with Jargon where his Med'cine fails.  
*The Dispensary*  
Canto II, l. 96  
Printed by J. Lister, at St. John's Gate. London, England. 1768

**Gregory, John** 1724–73  
Scottish physician and philosopher

People may dispute, whether physick, on the whole, does more good or harm to mankind; just as they may dispute, whether the faculty of reason, considering how it is often perverted, really contributes to make human life more or less happy...  
*Lectures on the Duties and Qualifications of a Physician* (p. 3)  
W. Strahan. London, England. 1772

**Gull, Sir William Withey** 1816–90  
English physician

The study of Medicine is an object lesson; the object, man's body in health and disease.  
*A Collection of the Published Writings* (Volume 2) (p. lix)  
New Sydenham Society. London, England. 1896

**Haggard, Howard W.**  
Physician

Mystery, magic, and medicine: in the beginning they were one and the same.

*Mystery, Magic and Medicine: The Rise of Medicine from Superstition to Science* (p. 9)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Herophilus** 325 BCE–255 BCE  
Greek physician

Medicines are nothing in themselves, if not properly used, but the very hands of the gods, if employed with reason and prudence.  
In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 28)  
The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Heschel, Abraham J.** 1907–72  
Jewish theologian

Medicine is more than a profession. Medicine has a soul, and its calling involves not only the application of knowledge and the exercise of skill but also facing a human situation. It is not an occupation for those to whom career is more precious than humanity or for those who value comfort and serenity above service to others. The doctor's mission is prophetic.  
*The Insecurity of Freedom*  
The Patient as a Person (p. 28)  
Farrar, Straus & Giroux. New York, New York, USA. 1966

**Hess, Elmer**  
No biographical data available

There is no great reward in our profession than the knowledge that God has entrusted us with the physical care of His people. The Almighty has reserved for Himself the power to create life but He has assigned to a few of us the responsibility of keeping in good repair the bodies in which this life is sustained.  
Do Doctors Charge Too Much?  
*American Weekly*, April 24, 1955

**Hewitt, Barnard**  
No biographical data available

Still I wish I knew a half a dozen good long medical terms to give an authentic air of learning to my conversation.  
*The Doctor in Spite of Himself*  
Act III (p. 67)  
Row, Peterson & Company. Evanston, Illinois, USA. 1941

**Hoffmann, Friedrich** 1660–1742  
German physician

In physics experience can best be sought from mathematics and mechanics, chemistry, and anatomy; in medical practice experience derives most abundantly from the observations of diseases, and from more accurate histories and cures.  
*Fundamenta Medicinæ*  
Physiology, Chapter I, 8 (p. 5)  
American Elsevier. New York, New York, USA. 1971

To live in a medical fashion, that is, according to the strict and academic rules of the physicians, is to live miserably and uncomfortably.

*Fundamenta Medicinæ*

Medical Hygiene, Chapter I, 10 (p. 103)

American Elsevier. New York, New York, USA. 1971

### **Hippocrates** 460 BCE–377 BCE

Greek physician

For the art of Medicine would not have been invented at first, nor would it have been made a subject of investigation (for there would have been no need of it) if when men [were] indisposed, the same food and other articles of regimen which they eat and drink when in good health were proper for them, and if no others were preferable to these. But now necessity itself made medicine to be sought out and discovered by men.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On Ancient Medicine, 3 (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Let us inquire then regarding what is admitted to be Medicine; namely, that which was invented for the sake of the sick, which possesses a name and practitioners.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On Ancient Medicine, 2 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The physician must be able to tell the antecedents, know the present, and foretell the future – must mediate these things, and have two special objects in view with regard to diseases, namely, to do good or to do no harm. The art consists in three things – the disease, the patient, and the physician. The physician is the servant of the art, and the patient must combat the disease along with the physician.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

Of the Epidemics, 5 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Medicine is of all the Arts the most noble, but, owing to the ignorance of those who practice it, and of those who, inconsiderately, form a judgment of them, it is at present far behind all the other arts. Their mistakes appear to me to arise principally from this, that in the cities there is no punishment connected with the practice of medicine (and with it alone)...

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Law, 1 (p. 144)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Instruction in medicine is like the culture of the productions of the earth. For our natural disposition is, as it were, the soil; the tenets of our teacher are, as it were, the seed in the ground at the proper season; the place where

the instruction is communicated is like the food imparted to vegetables by the atmosphere; diligent study is like the cultivation of the fields; and it is time which imparts strength to all things and brings them to maturity.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Law, 3 (p. 144)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hoffmann, Friedrich** 1660–1742

German physician

As far as medicine uses the principles of physics, it can be properly called a science; as far as it relies on practice, it can be called an art.

*Fundamenta Medicinæ*

Physiology, Chapter I, 9 (p. 6)

American Elsevier. New York, New York, USA. 1971

Frequent changes of medicines proclaims the ignorance of the physician and is calamitous for the patients.

*Fundamenta Medicinæ*

Therapeutics, Chapter I, 37 (p. 137)

American Elsevier. New York, New York, USA. 1971

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I firmly believe that if the whole *materia medica* could be sunk to the bottom of the sea, it would be all the better for mankind and all the worse for the fishes.

Address to the Harvard Medical School

May 30, 1860

### **Hulme, Keri** 1947–

New Zealand writer

What is your objection to hospitalisation and treatment? The doctor is curious but dispassionate. Primarily, that I forgo control over myself and my destiny. Secondly, medicine is in a queer state of ignorance. It knows a lot, enough to be aware that it is ignorant, but practitioners are loath to admit that ignorance to patients. And there is no holistic treatment. Doctor does not confer with religious who does not confer with dietician who does not confer with psychologist.... What you are saying basically is that you have no trust in doctors or current medicine? Right on.

*The Bone People*

IV, 12 (pp. 415–416)

Spiral in association with Hodder & Stoughton, Auckland, New Zealand.

1985

### **Hurston, Zora Neale** 1891–1960

American writer and anthropologist

...if science ever gets to the bottom of Voodoo in Haiti and Africa, it will be found that some important medical secrets, still unknown to medical science, give it its power, rather than the gestures of ceremony.



*Dust Tracks on a Road*

Chapter X (p. 205)

University of Illinois Press. Urbana, Illinois, USA. 1984

**Hutchison, Sir Robert Grieve** 1871–1960  
English radiologist

It is unnecessary – perhaps dangerous – in medicine to be too clever.

*Lancet*, Volume 2, 1938 (p. 61)

**Huth, Edward Janavel** 1923–  
American physician

Two functions are central to medicine: caring and knowing.... To survive we need to be able to read the world around us, to deduce what may harm us, to deduce what may help us. This is knowing. When we ask physicians to care for us, we expect them to know what they need to know to help us survive. They need a special knowledge of the world...

Science, Information Systems, and the Future of Medical Practice  
*The Pharos*, Volume 49, Summer, 1986

**Huxley, Thomas Henry** 1825–95  
English biologist

...“medicine” not merely denotes a kind of knowledge, but it comprehends the various applications of that knowledge to the alleviation of the sufferings, the repair of the injuries, and the conservation of health, of living beings.

*Science and Culture and Other Essays*

Chapter XIII (p. 325)

Macmillan & Company Ltd. London, England. 1881

**Jerome, Jerome K.** 1859–1927  
English author

It is a most extraordinary thing, but I never read a patent medicine advertisement without being impelled to the conclusion that I am suffering from the particular disease therein dealt with in its most virulent form.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 1 (p. 2)

Time Incorporated. New York, New York, USA. 1964

**Kipling, Rudyard** 1865–1936  
British writer and poet

Cure them if they have fever, but by no means work charms.

*Kim*

Chapter Twelve (p. 254)

The Modern Library. New York, New York, USA. No date

To discuss medicine before the ignorant is of one piece with teaching the peacock to sing...

*Kim*

Chapter Twelve (p. 261)

The Modern Library. New York, New York, USA. No date

**Kraus, Karl** 1874–1936  
Austrian essayist and poet

Medicine – “Your money and your life!”

In Harry Zohn (ed.)

*Half-Truths & One-and-a-Half Truths*

Lord, Forgive Them (p. 111)

The University of Chicago Press. Chicago, Illinois, USA. 1990

**Kubler-Ross, Elisabeth** 1926–2004  
Swiss-born psychiatrist

What happens in a changing field of medicine, where we have to ask ourselves whether medicine is to remain a humanitarian and respected profession or a new but depersonalized science in the service of prolonging life rather than diminishing human suffering?

*On Death and Dying*

Chapter 2 (p. 11)

The Macmillan Company. New York, New York, USA. 1969

**Lewis, Denslow** 1856–1913  
Physician

It is a happy sign of the times when medical men understand that they must study sociology, that they must appreciate economic conditions, that they must face the facts and know life as it is, and not as their wishes would have it to be.

*The Social Evil*

*Buffalo Medical Journal*, Volume 62, 1906

**Lyly, John** 1554?–1606  
English dramatist

Oh ye Gods, have ye ordeyned for every malady a medicine, for every sore a salve, for every paine a plaster...

*Euphues* (p. 61)

At The University Press. Cambridge, England. 1957

**Maugham, W. Somerset** 1874–1965  
English novelist and playwright

The medical profession is the only one which a man may enter at any age with some chance of making a living.

*Of Human Bondage*

Chapter LV (p. 243)

Doubleday & Company, Inc. Garden City, New York, USA. 1936

**Manning, P. E.**  
No biographical data available

**DeBakey, L.**  
No biographical data available

An inquiring, analytical mind; an unquenchable thirst for new knowledge; and a heartfelt compassion for the ailing – these are prominent traits among the committed clinicians who have preserved the passion for medicine.

*Medicine: Preserving the Passion*

Precedes First Chapter

Springer-Verlag. New York, New York, USA. 1987

### **Martin, Walter**

No biographical data available

The very success of medicine in a material way may now threaten the soul of medicine. Medicine is something more than the cold mechanical application of science to human disease. Medicine is a healing art. It must deal with individuals, their fears, their hopes and their sorrows. It must reach back further than a disease that the patient may have to those physical and emotional environmental factors which condition the individual for the reception of disease.

Inaugural Address

American Medical Association, news report of June, 23, 1954

### **Mather, Cotton** 1663–1728

American minister and religious writer

...[there is an] angelical conjunction of medicine with divinity.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter III (p. 69)

Clarendon Press. Oxford, England. 1925

### **Mayo, Charles Horace** 1865–1939

American physician

While medicine is a science, in many particulars it cannot be exact, so baffling are the varying results of varying conditions human life.

*Collected Papers of the Mayo Clinic & Mayo Foundation (1905–1909)*

President's Address

W.B. Saunders Company. Philadelphia, Pennsylvania, USA. 1909

It would seem that the study of medicine does not always contribute to broadmindedness, as men who choose medicine as a profession are apt to lose rather than gain breadth of perception. It could be said rather that medicine develops individualism.

The Value of Broadmindedness

*Medical Life*, Volume 34, April, 1927

Medicine can be used only as people are educated to its accomplishments.

International Medical Progress

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 23, 1931

### **Mayo, William J.** 1861–1939

American physician

The aim of medicine is to prevent disease and prolong life; the ideal of medicine is to eliminate the need of a physician.

The Aims and Ideals of the American Medical Association

*Proceedings of the National Education Association*, Volume 66, 1928

The church and the law deal with the yesterdays of life; medicine deals with the tomorrows.

The Preliminary Education of the Clinical Specialist

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 23, 1931

### **Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

The aim of medicine is surely not to make men virtuous; it is to safeguard and rescue them from the consequences of their vices. The true physician does not preach repentance; he offers absolution.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#3942 (p. 219)

Harper & Row, Publishers. New York, New York, USA. 1969

One of the chief objects of medicine is to save us from the natural consequences of our vices and follies. The moment it becomes moral it becomes quackery. A scientific physician should have no opinion about the ethical standards and deserts of his patient.

*Minority Report: H.L. Mencken's Notebooks*

Number 7 (p. 7)

Alfred A. Knopf. New York, New York, USA. 1956

### **Merck, George** 1894–1957

American scientist

Medicine is for the patient. Medicine is for the people. It is not for the profits.

*Time*, November 3, 1952

### **Minot, George R.** 1885–1950

American physician

Medicine disregards international boundaries. The physician studies for the benefit of mankind.

*Les Prix Nobel. The Nobel Prizes in 1934*

Nobel banquet speech for award received in 1934

Nobel Foundation. Stockholm, Sweden. 1935

### **Morgan, John**

No biographical data available

As the most precious metals in a state of ore are mixed with dross, so the choice truths of Medicine are frequently blended with a heap of rubbish.

*A Discourse upon the Institution of Medical Schools in America* (p. 48)

William Bradford. Philadelphia, Pennsylvania, USA. 1765

### **Mumford, E.**

No biographical data available

Medicine is the science of uncertainty and an art of probability.

*From Students to Physicians* (p. 158)

Harvard University Press. Cambridge, Massachusetts, USA. 1970

### **Morris, Joseph F.**

No biographical data available

Medical reporter – Staph writer.

*Quote, the Weekly Digest*, July 21, 1968 (p. 57)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Every medical student should remember that his end is not to be a chemist, or a physiologist or an anatomist, but to learn how to recognize and treat disease, to become a practical physician.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter X (p. 100)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

The critical sense and skeptical attitude of the Hippocratic school laid the foundation of modern medicine on broad lines, and we owe to it: first, the emancipation of medicine from the shackles of priestcraft and of caste; secondly, the conception of medicine as an art based on accurate observation, and as a science, an integral part of the science of man and of nature; thirdly, the high moral ideals, expressed in that “most memorable of human documents” (Gomperz), the Hippocratic oath; and fourthly, the conception and realization of medicine as the profession of a cultivated gentleman.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 266)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The [medical] student often resembles the poet – he is born, not made.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Student Life (p. 397)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

...medicine, unlike law and theology, is a progressive science...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter VI (p. 129)

Clarendon Press. Oxford, England. 1925

The desire to take medicine is perhaps the greatest feature which distinguishes man from animal.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XIV (p. 342)

Clarendon Press. Oxford, England. 1925

**Ovid** 43 BCE–17 AD

Roman poet

The healing art knows not how to remove crippling gout, it helps not the fearful dropsy.

In Arthur Leslie Wheeler

*Ovid with an English Translation*

Ex Ponto, Book I, iii (pp. 281, 283)

Harvard University Press. Cambridge, Massachusetts, USA. 1924

...the same object will both wound and cure me.

In Arthur Leslie Wheeler

*Ovid with an English Translation*

Tristia, Book II, l. 20

Harvard University Press. Cambridge, Massachusetts, USA. 1924

Medicine sometimes removes, sometimes bestows safety, showing what plant is healthful, what harmful.

In Arthur Leslie Wheeler

*Ovid with an English Translation*

Tristia, Book II, l. 269

Harvard University Press. Cambridge, Massachusetts, USA. 1924

For the sharp medic’cine is the patient’s cure.

*The Art of Love*

Amores, Book III, Elegy XI, l. 21

Publisher undetermined

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541

Swiss alchemist and mystic

The art of medicine cannot be inherited nor can it be copied from books.

*Das Zweite Buch der Grossen Wundarznei*

Foreword

Publisher undetermined

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Only by passing through the fire of experiment will medicine as a whole become what it should be, namely a conscious and, hence, always purposefully acting science.

*Experimental Psychology and Other Essays*

Fusion of Principal, Branches of Medicine in Modern Experimentation as Demonstrated by the Example of Digestion (p. 493)

Philosophical Library. New York, New York, USA. 1957

**Peabody, Francis Weld** 1881–1927

Physician

Medicine is not a trade to be learned but a profession to be entered.

*The Care of the Patient*

The Care of the Patient (p. 9)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

There is no more contradiction between the science of medicine and the art of medicine than between the science of aeronautics and the art of flying.

*The Care of the Patient*

The Care of the Patient (p. 10)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Petrarch (Francesco Petrarca)** 1304–74

Italian poet and humanist

When we see how doctors themselves live, how their slight illnesses turn to tragic ends, we may well suspect that this thing called medicine, whatever it may be in itself, is yet among men a certain art of deception,

invented to men's peril, to enrich a few and endanger many. Or we may think it a true art, contrived for useful ends, but little understood by men of our time. Or perhaps better, it may be understood, but hardly applicable to men's natures, in their infinite and incredible variety.

*Letters from Petrarch*

Letters; Book XII, 2

To Giovanni Dondi of Padua (p. 283)

Indiana University Press. Bloomington, Indiana, USA. 1966

**Porter, Roy** 1946–2002

English historian

Medicine is a notoriously messy mix of laboratory research and clinical crisis, the itch for knowledge and the need to act. Different experts contribute diverse skills, and the whole has been likened to a jigsaw [puzzle] being pieced together by total strangers, each of whom is only guessing at the picture.

Offering Resistance: The Checkered History and Contemporary Travails of Cancer Immunotherapy

*The New York Times*, 29 June, 1997 (p. 9)

**Proust, Marcel** 1871–1922

French novelist

For, medicine being a compendium of the successive and contradictory mistakes of medical practitioners, when we summon the wisest of them to our aid, the chances are that we may be relying on a scientific truth the error of which will be recognized in a few years' time.

Translated by Mark Treharne

*The Guermantes Way*

Part I, My Grandmother's Illness (p. 292)

The Penguin Group. New York, New York, USA. 1888

**Renard, Jules**

No biographical data available

There is nothing so sickening as to leaf through a medical dictionary.

In Evan Esar

*20,000 Quips and Quotes* (p. 511)

Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Robinson, Victor** 1886–1947

Physician

Medicine is a natural art, conceived in sympathy and born of necessity...

*The Story of Medicine*

Chapter I (p. 1)

The New York Home Library. New York, New York, USA. 1943

**Romains, Jules** 1885–1972

French author

Medicine is a rich soil but it doesn't yield its harvest unaided.

*Knock*

Act 1 (p. 11)

Barron's Educational Series, Inc. Great Neck, New York, USA. 1962

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

The desire to live is the best medicine of all.

*Encyclopedia of Thoughts*

Aphorisms 2048

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Good medicine is man's salvation;

Excessive use gives aggravation.

*Encyclopedia of Thoughts*

Couplets

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Sacks, Oliver W.** 1933–

American neurologist and author

We rationalize, we dissimilate, we pretend: we pretend that modern medicine is a rational science, all facts, no nonsense, and just what it seems. But we have only to tap its glossy veneer for it to split wide open, and reveal to us its roots and foundations, its old dark heart of metaphysics, mysticism, magic and myth.

*Awakenings*

Prologue (p. 28)

Vintage Books. New York, New York, USA. 1990

**Sammonicus, Serenus** ? 2nd century

Roman savant

Thou shalt on paper write the spell divine,  
Abracadabra called, in many a line;  
Each under each in even order place,  
But the last letter in each line efface.  
As by degrees the elements grow few  
Still take away, but fix the residue,  
Till at the last one letter stands alone  
And the while dwindles to a tapering cone.  
Tie this about the neck with flaxen string;  
Mighty the good 'twill to the patient bring.  
Its wondrous potency shall guard his head –  
And drive disease and death far from his bed.

In Victor Robinson

*The Story of Medicine*

Chapter VII (p. 194)

The New York Home Library. New York, New York, USA. 1943

**Scarlett, Earle P.**

Physician

Their lot has always been much the same. Hard work, long hours, poor accommodation for the majority, a sharp meeting with reality at a relatively young age, a long grind of years – these have prevailed in every generation.

In C.G. Roland (ed.)

*In Sickness and in Health: Reflections on the Medical Profession* (p. 3)

McClelland & Stewart. Toronto, Ontario, Canada. 1972

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

It is not the fault of our doctors that the medical service of the community, as at present provided for, is a murderous absurdity. That any sane nation, having observed that you could provide for the supply of bread by giving bakers a pecuniary interest in baking for you, should go on and give a surgeon a pecuniary interest in cutting off your leg, is enough to make one despair of political humanity.

*The Doctor's Dilemma*

Preface on Doctors (p. v)

Brentano's. New York, New York, USA. 1920

Doctoring is not even the art of keeping people in health (no doctor seems able to advise you what to eat any better than his grandmother or the nearest quack): it is the art of curing illnesses.

*The Doctor's Dilemma*

Preface on Doctors

Are Doctors Men of Science? (p. xxx)

Brentano's. New York, New York, USA. 1920

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

What physician can heal his patient on a flying visit?

*Ad Lucilium Epistulae Morales* (Volume 1)

Epistle xl, Section 4

It is medicine, not scenery, for which a sick man must go a-searching.

Translated by Richard M. Gummere

*Ad Lucilium Epistulae Morales* (Volume 3)

Epistle civ, Section 18 (p. 201)

Harvard University Press. Cambridge, Massachusetts, USA. 1925

...not even medicine can master incurable diseases.

Translated by Richard M. Gummere

*Ad Lucilium Epistulae Morales* (Volume 3)

Epistle xciv, Section 24 (p. 27)

Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Not poppy, nor mandragora,

Nor all the drowsy syrups of the world,

Shall ever medicine thee to that sweet sleep

Which thou ow'st yesterday.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Othello, The Moor of Venice*

Act III, Scene iii, l. 331–334

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Out, loathed medicine! hated potion, hence!

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*A Midsummer-Night's Dream*

Act III, Scene ii, l. 264

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Great griefs, I see medicine the less.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Cymbeline*

Act IV, Scene ii, l. 244

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smollett, Tobias George** 1721–71

Scottish novelist

...Sir, the practice of medicine is one of the most honourable professions exercised among the sons of men; a profession which hath been revered at all periods and in all nations, and even held sacred in the most polished ages of antiquity.

*The Life and Adventures of Sir Launcelot Greaves*

Chapter XXIV (p. 192)

Oxford University Press, Inc. London, England. 1973

**Starr, Paul** 1949–

Professor of sociology

Modern medicine is one of those extraordinary works of reason: an elaborate system of specialised knowledge, technical procedures, and rules of behavior.

*The Social Transformation of American Medicine*

Introduction (p. 3)

Basic Books, Inc., Publishers. New York, New York, USA. 1982

The medical profession has had an especially persuasive claim to authority. Unlike the law and the clergy, it enjoys close bonds with modern science, and at least for most of the last century, scientific knowledge has held a privileged status in the hierarchy of belief.

*The Social Transformation of American Medicine*

Introduction (p. 4)

Basic Books, Inc., Publishers. New York, New York, USA. 1982

The organizational culture of medicine used to be dominated by the ideals of professionalism and volunteerism which softened the underlying acquisitive activity. The restraint exercised by these ideals now grows weaker, the health center of one era is the profit center of the next.

*The Social Transformation of American Medicine* (p. 448)

Basic Books, Inc., Publishers. New York, New York, USA. 1982

**Steinbeck, John** 1902–68

American novelist

The medical profession is unconsciously irritated by lay knowledge.

*East of Eden*

Chapter 54, Section 1 (p. 589)

The Viking Press. New York, New York, USA. 1952

**Sydenham, Thomas** 1624–89

English physician

Inasmuch as the structure of the human frame has been so set together by Nature, that it is unable, from the continuous flux of particles, to remain unchanged; whilst, from

the action of external causes, it is subjected to influences beyond its own: and since, for these reasons, a numerous train of diseases has pressed upon the earth since the beginning of time; so without doubt the necessity of investigations into the Art of Healing has exercised the wit of mankind for many ages.

*The Works of Thomas Sydenham, MD* 3rd ed., (Volume 1)  
Classics of Medicine Library, Birmingham. 1979

**Szasz, Thomas** 1920–  
Hungarian-born American psychiatrist

Formerly, when religion was strong and science weak, men mistook magic for medicine; now, when science is strong and religion weak, men mistake medicine for magic.

*The Second Sin*  
Science and Scientism (p. 128)  
Anchor Press/Doubleday. Garden City, New Jersey, USA. 1974

**Thomas, Lewis** 1913–93  
American physician and biologist

There is within medicine, somewhere beneath the pessimism and discouragement resulting from the disarray of the health-care system and its stupendous cost, an undercurrent of almost outrageous optimism about what may lie ahead for the treatment of human disease if we can only keep learning.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
Medical Lessons from History (p. 166)  
The Viking Press. New York, New York, USA. 1979

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Any mummery will cure if the patient's faith is strong in it.

*A Connecticut Yankee in King Arthur's Court*  
Chapter XXVI (p. 234)  
Harper & Brothers Publishers. New York, New York, USA. 1899

**Virchow, Rudolf Ludwig Karl** 1821–1902  
German pathologist and archaeologist

...practical medicine is never the same thing as scientific medicine but rather, even in the hands of the greatest master, an application of it.

Translated by Lelland J. Rather  
*Disease, Life, and Man*  
Standpoints in Scientific Medicine (p. 27)  
Stanford University Press. Stanford, California, USA. 1958

No physiologist or practitioner ought ever to forget that medicine unites in itself all knowledge of the laws which apply to the body and the mind.

Translated by Lelland J. Rather  
*Disease, Life, and Man*  
Scientific Method and Therapeutic Standpoints (p. 66)  
Stanford University Press. Stanford, California, USA. 1958

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Medicine's spirit one can grasp with ease.  
The great and little world you study though  
To let things finally their course pursue  
As God may please.

In *Great Books of the Western World* (Volume 47)  
*Faust*  
The First Part  
Auerbach's Cellar, l. 2011–2014  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Williams, William Carlos** 1883–1963  
American physician and poet

My "medicine" was the thing that gained me entrance to these secret gardens of the self. It lay there, another world, in the self. I was permitted by my medical badge to follow the poor, defeated body into these gulfs and grottos.

In M.L. Rosenthal  
*The William Carlos Williams Reader* (p. 307)  
New Directions. New York, New York, USA. 1966

**Young, Edward** 1683–1765  
English poet and dramatist

Will toys amuse, when med'cines cannot cure?

*Night Thoughts*  
Night II, l. 67 (p. 21)  
Printed by R. Nobels for R. Edwards. London, England. 1797

## MEDICINE

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Medicine is a science which hath been (as we have said) more professed than laboured, and yet more laboured than advanced; the labour having been, in my judgment, rather in circle than in progression.

In James Spedding, Robert Leslie Ellis and Douglas Denon Heath  
*The Works of Francis Bacon* (Volume 2)  
Of the Advancement of Learning (p. 373)  
Longman & Co. London, England. 1857

**Bartlett, Elisha** 1804–55  
American physician

The hold which medicine has so long held upon the popular mind is loosened; there is a wide-spread skepticism as to the power of its curing diseases, and men are everywhere to be found who deny its pretensions as a science, and reject the benefits and blessings which it proffers them as an art.

In William E. Stempsey  
*Elisha Bartlett's Philosophy of Medicine*  
Part II, Chapter XII (p. 146)  
Springer-Verlag. Dordrecht, The Netherlands. 2005



The first essential and fundamental condition of all therapeutical science, is to fix as far as possible – its variable and fluctuating element. The problem to be solved is this: given a certain pathological condition or process, and a certain substance or agent, or a combination of substances and agencies of the *materia medica* – to find the true relation between them – to ascertain the changes effected in the former by the latter.

In William E. Stempsey

*Elisha Bartlett's Philosophy of Medicine*

The Philosophy in Therapeutics (p. 201)

Springer-Verlag, Dordrecht, The Netherlands. 2005

The science of medicine issues finally in the end of therapeutics. This is its consummation – its great end and purpose. Anatomy, physiology, pathology – the entire natural history of disease – *materia medica* – all are preliminary, more or less direct and essential, for the cure or mitigation of disease.

In William E. Stempsey

*Elisha Bartlett's Philosophy of Medicine*

The Philosophy in Therapeutics (pp. 211–212)

Springer-Verlag, Dordrecht, The Netherlands. 2005

### **Bigelow, Jacob** 1787–1879

American Physician

Most men form an exaggerated estimate of the powers of medicine, founded on the common acceptance of the name, that medicine is the art of curing diseases. That this is a false definition, is evident from the fact that many diseases are incurable, and that one such disease must at last happen to every living man. A far more just definition would be, that medicine is the art of understanding diseases, and of curing or relieving them when possible.

*Nature in Disease, Illustrated in Various Discourses and Essays*

On the Treatment of Disease (p. 64)

Ticknor & Fields. Boston, Massachusetts, USA. 1854

### **Brinton, William**

English physician

It is the especial character of the science of Medicine, that it interests all classes; and that, even if we may not claim for it in its original meaning, the celebrated dictum, “the proper study of mankind is man,” we may at least assert of it, that, in some form or other, it is essential to the application of all kinds of knowledge, and reacts upon every subject of scientific inquiry.

Introductory Lecture

*The London Lancet*, Volume 2, Number 6, December, 1857 (p. 433)

### **DeBakey, Lois**

Professor of Scientific Communication

At once one of the most demanding and most rewarding of all professions, medicine can be tyrannizing or exhilarating.

In Lois Debakery and Phil R. Manning

*Medicine: Preserving the Passion in the 21st Century*

Chapter 1 (p. 1)

Springer-Verlag, Berlin, Germany. 2004

The practice of medicine is admittedly a strict taskmaster, requiring daily decisions about puzzling, often life-threatening illnesses, as well as constant awareness of the newest, most authentic information.

In Lois Debakery and Phil R. Manning

*Medicine: Preserving the Passion in the 21st Century*

Chapter 1 (p. 1)

Springer-Verlag, Berlin, Germany. 2004

### **Huxley, Thomas Henry** 1825–95

English biologist

Medicine was the foster-mother of Chemistry, because it has to do with the preparation of drugs and the detection of poisons; of Botany, because it enabled the physician to recognise medicinal herbs; of Comparative Anatomy and Physiology, because the man who studied Human Anatomy and Physiology for purely medical purposes was led to extend his studies to the rest of the animal world.

*Science and Education: Essays*

Universities: Actual and Ideal (pp. 215–216)

D. Appleton & Co. New York, New York, USA. 1896

### **Latham, Peter Mere** 1789–1875

English physician

Of the great cosmogony of medicine there are several departments, and each professor never fails to magnify his own, by counting the cost of time and labour, which you must be prepared to bestow if you wish to make any reasonable progress in it.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture I (p. 9)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

...in so far as it [medicine] is certain, in so far as it has taken the form of a science at all, it is built upon the same foundation with all other sciences; namely, upon facts: and in so far as it is uncertain, beyond what, in its own nature, it ever need to have been; in so far as it has not deserved the name of a science, it is raised upon a foundation which never would have been deemed sufficient for any other department of human knowledge.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture V (pp. 114–115)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

### **Lewis, Sir Thomas** 1881–1945

No biographical data available

In no science, in the true sense of the word, is there the almost open vaunting of and reliance upon personal skill, in no science is there the veneration of supposed manipulative dexterity which we discover in our realm of medicine.

*The Mechanism and Graphic Registration of the Heart Beat*  
 Preface (p. v)  
 Shaw & Sons. London, England. 1920

**Norton, William Harmon** 1856–1944  
 American geologist

Medicine no longer attacks disease with charm, exorcism and nostrum; she obtains her weapons from the armory of science.

*The Proceedings of the Iowa Academy of Science*  
 Presidential Address  
 Volume 8 1901 (p. 18)

**Osler, Sir William** 1849–1919  
 Canadian physician and professor of medicine

...it must be confessed that the practice of medicine among our fellow creatures is often a testy and choleric business.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
 Chapter XIV (p. 303)  
 P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

As the practice of medicine is not a business and can never be one the education of the heart – the moral side of the man – must keep pace with the education of the head. Our fellow creatures cannot be dealt with as man deals in corn and coal; “the human heart by which we live” must control our professional relations.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
 Chapter XVII (p. 350)  
 P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

Use your five senses. The art of the practice of medicine is to be learned only by experience; 'tis not an inheritance; it cannot be revealed. Learn to see, learn to hear, learn to feel, learn to smell, and know that by practice alone can you become expert.

In W.S. Thayer  
*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*  
 Osler, The Teacher (p. 51)  
 The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Timiriazeff, C. A.**  
 Russian botanist

Medicine is the art under whose wing the physiology of animals developed.

Translated by Anna Sheremeteva  
*Die Sinne der Pflanzen*  
 Chapter I (p. 7)  
 Longmans, Green & Co. London, England. 1912

**Trousseau, Armand** 1801–67  
 French internist

Literature, painting and music, do not yield an enjoyment more keen than that which is afforded by the study

of medicine, and whoever does not find in it, from the commencement of his career, an almost irresistible attraction, ought to renounce the intention of following our profession.

Translated by John Rose Cormack  
*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)  
 Introduction (pp. 4–5)  
 Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

**Whittaker, James Thomas**

No biographical data available

The study of medicine is peculiarly excellent in developing the mental faculties. Having elements in it belonging to both literature and science – the bride and her spouse in modern education – it most happily blends the virtues and balances the faults, pertaining to a purely literary or a purely scientific pursuit.

*Physiology*  
 Lecture I (p. 22)  
 Chancy R. Murry. Cincinnati, Ohio, USA. 1879

## MEDICINE AND ART

**Dubos, René Jules** 1901–82  
 French-born American microbiologist and environmentalist

Directly or indirectly, the various forms of art reflect the strivings, the struggles, and the sufferings of mankind. The state of health and the ills of a society are recorded not only in the writings of its physicians and scholars but also in the themes and moods of its artists and poets.

*Mirage of Health*  
 Chapter VII (p. 215)  
 Harper & Brothers Publishers. New York, New York, USA. 1959

## MEDICINE, HISTORY OF

**Professor Jacobs (Fictional character)**

The history of medicine is the history of the unusual.  
*Tarantula*  
 Film (1955)

## MEDICINE, SCIENTIFIC

**Flexner, Abraham** 1866–1959  
 American educator

Scientific medicine...brushes aside all historic dogma. It gets down to details immediately. No man is asked in whose name he comes – whether that of Hahnemann, Rush, or of some more recent prophet. But all are required to undergo rigorous cross-examination. Whatsoever makes good is accepted, becomes in so far part, and organic part, of the permanent structure.

*Medical Education in the United States and Canada* Bulletin  
Number Four  
Chapter X (p. 157)  
The Carnegie Foundation. New York, New York, USA. 1910

## MEDITATION

**Everett, Edward** 1794–1865

Whig Party politician

Immeasurably above all the delights of sense is the serene rapture of meditation, the calm ecstasy of pure thought, sounding the depths of its own consciousness, and ruling all else which is subject to man, in the heaven above and the earth beneath, with the sovereign mastery of mind.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academical Education (p. 76)  
Little, Brown & Co. Boston, Massachusetts, USA. 1857

## MEMORY

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

The general root of superstition is that men observe when things hit, and not when they miss and commit to memory the one, and pass over the other.

In James Spedding, Robert Leslie Ellis and Douglas Denon Heath  
In James

*The Works of Francis Bacon* (Volume 2)

*Philosophical Works*

Volume II (p. 668)

Longmans & Co. London, England. 1876

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Memory plays strange pranks with facts. The rocks and fissures and gullies of the mountain-side melt quickly into the smooth, blue outlines of the distant panorama. Viewed through the perspective of memory, an unrecorded observation, the vital details long since lost, easily changes its countenance and sinks obediently into the frame fashioned by the fancy of the moment.

*Sir William Osler, Bart.*

Osler, The Teacher (p. 51)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Thorne, Kip S.** 1940–

American theoretical physicist

Memories are fallible; different people, experiencing the same events, may interpret and remember them in very different ways.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 19)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

## MENSTRUATION

**Butler, Brett**

No biographical data available

I would like it if men had to partake in the same hormonal cycles to which we're subjected monthly. Maybe that's why men declare war – because they have a need to bleed on a regular basis.

In Roz Warren

*Glibquips* (p. 107)

Crossing Press, Freedom, California, USA. 1994

**Crimmins, Cathy**

Humorist

A period is just the beginning of a lifelong sentence.

In Roz Warren

*Glibquips* (p. 107)

Crossing Press, Freedom, California, USA. 1994

**Harrison, R. J.**

No biographical data available

**Montagna, William**

Dermatological researcher

The specific purpose of menstruation is obscure. Not least of its imponderables is why it should occur only in certain primates. It would seem to be a waste of tissue and essential substances such as iron. Several hundred milliliters of blood are lost each month and this is obviously a drain on a woman's reserves and a constant call on her blood-forming bone marrow. Apart from its social disadvantages and discomfort, it often leads to tiredness, bad temper and anemia. From a biological point of view, menstruation should not occur at all!

*Man* (p. 326)

Appleton-Century-Crofts. New York, New York, USA. 1973

**Paglia, Camille** 1947–

American social critic, intellect, and writer

It is not menstrual blood per se which disturbs the imagination – unstaunchable as that red flood may be – but rather the albumen in the blood, the uterine sheds, placental jellyfish of the female sea. This is the chthonian matrix from which we rose. We have an evolutionary revulsion from slime, our site of biological origins. Every month, it is woman's fate to face the abyss of time and being, the abyss which is herself.

*Sexual Personae. Art and Decadence from Nefertiti to Emily Dickinson*

Yale University Press. New Haven, Connecticut, USA. 1990

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

But nothing could easily be found that is more remarkable than the monthly flux of women. Contact with it

turns new wine sour, crops touched by it become barren, grafts die, seeds in gardens are dried up, the fruit of trees falls off, the bright surface of mirrors in which it is merely reflected is dimmed, the edge of steel and the gleam of ivory are dulled, hives of bees die, even bronze and iron are at once seized by rust...

*Natural History*

Volume II, Book VII, sec 64

Harvard University Press. Cambridge, Massachusetts, USA. 1947

## MENTAL EYE

**Jefferies, Richard** 1848–87

English naturalist and author

...how can words depict the glowing wonder, the marvelous beauty of all the plant, the insect, the animal life, which presses upon the mental eye?

*The Hills and the Vale*

Nature and Eternity (p. 294)

Duckworth & Co. London, England. 1909

## MENTAL PROCESS

**Huxley, Thomas Henry** 1825–95

English biologist

So, the vast results obtained by Science are won, by no mystical faculties, by no mental processes, other than those which are practised by everyone of us, in the humblest and meanest affairs of life. A detective policeman discovers a burglar from the marks made by his shoe, by a mental process identical with that by which Cuvier restored the extinct animals of Montmartre from fragments of their bones.

*Science and Education: Essays*

Of the Educational Value of the Natural History of Science (pp. 45–46)

D. Appleton & Co. New York, New York, USA. 1896

**Tyndall, John** 1820–93

Irish-born English physicist

Two distinct mental processes are linked in the treatment of such a question [about the Parallel Roads of Glen Roy]. Firstly, the faithful and sufficient observation of the data; and secondly, that higher mental process in which the constructive imagination comes into play, connecting the separate facts of observation with their common cause, and weaving them into an organic whole.

*Fragments of Science: A Series of Detached Essays, Addresses, and*

*Reviews* (Volume 1)

Chapter VIII (p. 207)

D. Appleton & Co. New York, New York, USA. 1896

## MERIT

**Bossut, Charles** 1730–1814

French mathematician

Experience shows, that there is more danger in humbling ourselves too much, than ridiculousness in proclaiming our own merits.

*A General History of Mathematics from the Earliest Times to the Middle of the Eighteenth Century*

Author's Preface (p. xx)

Printed for J. Johnson. London, England. 1803

## METAL

**Agricola, Georgius** 1494–1555

German mineralogist

...the earth does not conceal metals in her depths because she does not wish that men should dig them out, but because provident and sagacious Nature has appointed for each thing its place.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (p. 12)

The Mining magazine

London, England. 1912

...If we remove metals from the service of man, all methods of protecting and sustaining health and more carefully preserving the course of life are done away with. If there were no metals, men would pass a horrible and wretched existence in the midst of wild beasts; they would return to the acorns and fruits and berries of the forest. They would feed upon the herbs and roots which they plucked up with their nails. They would dig out caves in which to lie down at night, and by day they would rove in the woods and plains at random like beasts, and inasmuch as this condition is utterly unworthy of humanity, with its splendid and glorious natural endowment, will anyone be so foolish or obstinate as not to allow that metals are necessary for food and clothing and that they tend to preserve life?

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (p. 14)

The Mining magazine

London, England. 1912

**Baker, Russell** 1925–

American writer and journalist

So there he is at last. Man on the moon. The poor magnificent bungler. He can't even get to the office without undergoing the agonies of the damned, but give him a little metal, a few chemicals, some wire and \$20 or \$30 billion dollars and, vroom!

*Resource Recovery Act of 1969* (p. 1231)

Hearings, Ninety-first Congress

US Congress. Senate. Committee on Public Works. Subcommittee on

Air and Water Pollutions

US Government Printing Office. Washington, D.C. 1969

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

I think it may be of Corinthian brass  
Which was a mixture of all metals, but  
The brazen uppermost.

*The Complete Poetical Works of Byron*

Don Juan

Canto VI, 56–58

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Flaubert, Gustave** 1821–90

French novelist

**Bronze.** Metal of the classic centuries.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Henry, William**

No biographical data available

The metals are not presented immediately to the hand of man, like the objects of the animal and vegetable kingdoms, but, they are, for the most part, buried in darkness, in the bowels of the earth, where they are so much disguised, by a combination of mixture with other substances, that they often appear entirely unlike themselves.

*The Elements of Experimental Chemistry* (Volume 2)

Notes (p. 389)

Thomas & Andres. Boston, Massachusetts, USA. 1814

**Hutton, W.**

No biographical data available

When we penetrate the dark and subterraneous magazine of Nature, we find veins fraught with the richest Metals; from hence comes that which gives value to the monarch's crown, and weight to his sceptre; which, formed into coins, gives energy and life to traffic, rewards the toils of labour, and puts it in the power of the affluent to warm the bosom of adversity, and make the widow and the orphan sing for joy, or, beaten out into an inconceivable thinness, is made to cover with a transcendent lustre some of the coarsest of nature's productions, and render them ornamental in the palace of the great.

*The Book of Nature Laid Open, in a Popular Survey of the Phenomena and Constitution of the Universe*

Chapter II (p. 8)

J. Milligan. Georgetown, District of Columbia. 1822

**Lavoisier, Antoine Laurent** 1743–94

French chemist

One will not deny me, I trust, all the theory of oxidation and combustion; the analysis and decomposition of air by metals and combustible bodies ...

*Mémoires de Chimie* (Volume 2) (p. 87)

Dupont. Paris, France. 1803

**Rawlings, Majorie Kinnan** 1896–1953

American writer

Cast iron is so superior for cooking utensils to our modern aluminum that I not only cannot grieve for the pioneer hardship of cooking in iron over the hearth, but shall retire if necessary to the back yard with my two Dutch ovens, turning over all my aluminum cookers for airplanes with a secret delight.

*Cross Creek*

Charles Scribner's Sons. New York, New York, USA. 1942

## METAL INDUSTRY

**Agricola, Georgius** 1494–1555

German mineralogist

Many persons hold the opinion that the metal industries are fortuitous and that the occupation is one of sordid toil, and altogether a kind of business requiring not so much skill as labour.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (p. 1)

The Mining magazine

London, England. 1912

## METAMATHEMATICS

**Hofstadter, Douglas R.** 1945–

American academic

All the limitative Theorems of metamathematics and the theory of computation suggest that once the ability to represent your own structure has reached a certain critical point, that is the kiss of death: it guarantees that you can never represent yourself totally. Gödel's Incompleteness Theorem, Church's Undecidability Theorem, Turing's Halting Problem, Tarski's Truth Theorem – all have the flavour of some ancient fairy tale which warns you that “To seek self-knowledge is to embark on a journey which...will always be incomplete, cannot be charted on a map, will never halt, cannot be described.”

*Gödel, Escher, Bach*

Part II, Chapter XX (p. 697)

Basic Books, Inc. New York, New York, USA. 1999

## METAMORPHOSIS

**Carpenter, George Herbert**

Zoologist

Among the manifold operations of living creatures few have more strongly impressed the casual observer or more deeply interested the thoughtful student than the transformations of insects.

*The Life-story of Insects*

Chapter I (p. 1)

G.P. Putnam's Sons. New York, New York, USA. 1913

### **Peeples, Elizabeth K.**

No biographical data available

This is the worm,  
That ate the leaves,  
That grew on the tree,  
That stands in front of my house.

This is the cocoon,  
Spun by the worm,  
That ate the leaves,  
That grew on the tree,  
That stands in front of my house.

This is the moth,  
From out the cocoon,  
Spun by the worm,  
That ate the leaves,  
That grew on the tree,  
That stands in front of my house.

These are the eggs,  
Laid by the moth,  
From out the cocoon,  
Spun by the worm,  
That ate the leaves,  
That grew on the tree,  
That stands in front of my house.

Adventures with Caterpillars

*Nature Magazine*, Volume II, Number 4, October, 1923 (pp. 244, 250)

### **Pouchet, Félix Archimède** 1800–72

French biologist

Born in one shape the insect dies in another, and the metamorphoses which it undergoes are the most important act of its life, and the most extraordinary phenomenon in physiology.

*The Universe*

The Animal Kingdom, Book III (p. 137)

Blackie & Son. London, England. 1870

## **METAPHOR**

### **Bergson, Henri** 1859–1941

French philosopher

The metaphor never goes very far, anymore than a curve can long be confused with its tangent.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter III (p. 213)

Henry Holt & Co. New York, New York, USA. 1913

### **Bullock, James O.**

Theoretical cosmologist

Mathematical metaphors are not different from other forms of human understanding. They may provide some significant insights, but are not a holy grail of ultimate truth....Despite our desires to the contrary, nature is not obligated to limits complexity to the confines of the human imagination.

Literacy in the Language of Mathematics

*American Mathematical Monthly*, Volume, Number 8, October, 1994 (p. 739)

### **Calvin, William H.** 1939–

Theoretical neurophysiologist

Kant said that our metaphors comprise the conceptual spectacles through which we view the world.... If we are to have meaningful, connected experiences; ones that we can comprehend and reason about; we must be able to discern patterns to our actions, perceptions, and conceptions. Underlying our vast network of interrelated literal meanings (all of those words about objects and actions) are those imaginative structures of understanding such as schema and metaphor, such as the mental imagery that allows us to extrapolate a path, or zoom in on one part of the whole, or zoom out until the trees merge into a forest.

*The Cerebral Code* (pp. 159–160)

The MIT Press. 1996

### **Capra, Fritjof** 1939–

Austrian-born American physicist

Gradually, physicists began to realize that nature, at the atomic level, does not appear as a mechanical universe composed of fundamental building blocks, but rather as a network of relations, and that, ultimately, there are no parts at all in this interconnected web. Whatever we call a part is merely a pattern that has some stability and therefore captures our attention.

*The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism* (p. 329)

Shambhala. Boston, Massachusetts, USA. 1991

### **Cole, K. C.** 1942–

American science writer

So much of science consists of things we can never see: light “waves” and charged “particles”; magnetic “fields” and gravitational “forces”; quantum “jumps” and electron “orbits.” In fact, none of these phenomena is literally what we say it is. Light waves do not undulate through empty space in the same way that water waves ripple over a still pond; a field is only a mathematical description of the strength and direction of a force; an atom does not literally jump from one quantum state to another, and electrons do not really travel around the atomic nucleus in orbits. The words we use are merely metaphors.

On Imagining the Unseeable

*Discover Magazine*, December, 1982 (p. 70)



**Davy, Sir Humphry** 1778–1829  
English chemist

...the tropes and metaphors of the speaker were like the brilliant wild flowers in a field of corn, very pretty, but which did very much hurt to the corn.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (p. 253)  
J. Murray. London, England. 1830

The works of scientific men are like the atoms of gold, of sapphire and diamonds, that exist in the mountain; they form no perceptible part of the mass of the mountain; they are neglected and unknown when it is entire; they are covered with vegetable mould, and by forests. But when time has sapped its foundation – when its fragments are scattered abroad by the elements, and its decayed materials carried down the rivers, then they glitter, and are found; then their immortality is known, and they are employed to ornament the diadems of emperors and the scepters of kings.

*The Collected Works of Sir Humphry Davy* (Volume 1)  
Memories of the Life of Sir Humphry Davy  
Chapter IV (p. 218)  
London, England. 1839–1849

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

...the facts of Nature are best brought home and explained to the understanding, and to the intelligence of man, by stating them in terms of the relation which they obviously bear to the familiar operations of our own mind and spirit.

*The Unity of Nature*  
Chapter 8 (p. 174)  
G.P. Putnam's Sons. New York, New York, USA. 1885

**Flammarion, Camille** 1842–1925  
French astronomer and writer

O popes of the Aryans! O priests of the Incas! O therapeutists of Egypt! and you philosophers of Greece, alchemists of the Middle Ages, scientists of modern times! O thinkers of all ages! you should be dumb before the sublime star! What is our voice in nature? We may pile up metaphors on metaphors, we shall only lower these magnitudes to our own size. We are but pigmies pretending to scale the sky.

Translated by John Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter VIII (p. 247)  
Chatto & Windus. London, England. 1907

**Fulford, Robert**  
No biographical data available

Metaphor, the life of language, can be the death of meaning. It should be used in moderation, like vodka. Writers

drunk on metaphor can forget they are conveying information and ideas.

*Globe & Mail (Toronto)*, December 4, 1996

**Goleman, Daniel** 1946–  
American writer and psychologist

The logic of the emotional mind is associative; it takes elements that symbolize a reality, or trigger a memory of it, to be the same as that reality. That is why similes, metaphors and images speak directly to the emotional mind.... If the emotional mind follows this logic and its rules, with one element standing for another, things need not necessarily be defined by their objective identity: what matters is how they are perceived; things are as they seem.... Indeed, in emotional life, identities can be like a hologram in the sense that a single part evokes the whole.

*Emotional Intelligence* (p. 294)  
Bloomsbury. London, England. 1996

**Goodwin, Brian Carey** 1931–  
Biologist

The point...is not to conclude that there is something wrong with Darwin's theory because it is clearly linked to some very powerful cultural myths and metaphors. All theories have metaphorical dimensions which I regard as not only inevitable but also extremely important. For it is these dimensions that give depth and meaning to scientific ideas, that add to their persuasiveness, and colour the way we see reality.

*How the Leopard Changed Its Spots: The Evolution of Complexity* (p. 32)  
Phoenix. London, England. 1994

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

If we must deal in metaphors [when discussing evolution], I prefer a very broad, low and uniform slope. Water drops randomly at the top and usually dries before flowing anywhere. Occasionally, it works its way downslope and carves a valley to channel future flows. The myriad valleys could have arisen anywhere on the landscape. The current positions are quite accidental. If we could repeat the experiment, we might obtain no valleys at all, or a completely different system. Yet we now stand at the shore line contemplating the fine spacing of valleys and their even contact with the sea. How easy it is to be misled and to assume that no other landscape could possibly have arisen.

*The Panda's Thumb: More Reflections in Natural History*  
Chapter 12 (p. 140)  
W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Harré, Rom**  
No biographical data available

Metaphor and simile are the characteristic tropes of scientific thought, not formal validity of argument.

*Varieties of Realism*  
Part I (p. 7)  
Basil Blackwell. Oxford, England. 1986

**Hazen, Robert M.**

No biographical data available

Nature is not governed by our metaphors, however cherished they may be.

*Gen e sis*

Chapter 7 (p. 106)

Joseph Henry Press. Washington, D.C. 2005

**Klarreich, E.**

No biographical data available

Berry isn't speaking in metaphors. I've tried to play this music by putting a few thousand primes into my computer, he says but it's just a horrible cacophony. You'd actually need billions or trillions – someone with a more powerful machine should do it.

Prime Time

*New Scientist*, 11/11/00**McLuhan, Marshall** 1911–80

Canadian educator, philosopher, and scholar

**McLuhan, Eric**

No biographical data available

...all words are metaphor...

*The Laws of Media: The New Science*

Chapter 3 (p. 120)

University of Toronto Press. Toronto, Ontario, Canada. 1988

**McPhee, John** 1931–

American journalist and nonfiction writer

It [geology] was a fountain of metaphor – of isostatic adjustments and degraded channels, of angular unconformities and shifting divides, of rootless mountains and bitter lakes. Streams eroded headward, digging from two sides into mountain or hill, avidly struggling toward each other until the divide between them broke down, and the two rivers that did the breaking now became confluent (one yielding to the other, giving up its direction of flow and going the opposite way) to become a single stream.

*Basin and Range* (p. 24)

Farrar, Straus, Giroux. New York, New York, USA. 1981

**Moore, James R.**

No biographical data available

Clever metaphors die hard. Their tenacity of life approaches that of the hardiest micro-organisms. Living relics litter our language, their *raison d'être* forever past, ignored if not forgotten, and their present fascination seldom impaired by the confusions they may create.

*The Post-Darwinian Controversies: A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America*

Chapter 1 (p. 19)

Cambridge University Press. Cambridge, England. 1979

**Poynting, John Henry** 1852–1914

English physicist

To take an old but never-worn-out metaphor, the physicist is examining the garment of Nature, learning of how many, or rather of how few different kinds of thread it is woven, finding how each separate thread enters into the pattern, and seeking from the pattern woven in the past to know the pattern yet to come.

*Collected Scientific Papers*

Presidential Address

The Mathematical and Physical Section

The British Association (Dover) 1899 (p. 603)

At The University Press. Cambridge, England. 1920

**METAPHYSICAL****More, Louis Trenchard**

American educator

A metaphysical hypothesis, valuable solely for its utility, is always dangerous, for by constant use we tend inevitably to give an objective reality to things which in the beginning we knew to exist only in our own minds. And this tendency is especially deplorable in science, which does little for education if it does not recognize clearly the limits of our knowledge and distinguish accurately between reality and speculation.

*The Limitations of Science*

Chapter 1 (p. 16)

Henry Holt &amp; Co. New York, New York, USA. 1915

**Whewell, William** 1794–1866

English philosopher and historian

...metaphysical discussions are not to be put in opposition to the study of facts; but are to be stimulated, nourished and directed by a constant recourse to experiment and observation.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2)

Book XIII, Chapter IV (p. 379)

John W. Parker. London, England. 1847

**METAPHYSICIAN****Elliot, Hugh Samuel Roger** 1881–1930

No biographical data available

A metaphysician is like the man who wishes to teach us the geography of the other side of the moon.

*Modern Science and the Illusions of Professor Bergson*

Preface (pp. 6–7)

Longmans, Green &amp; Co. New York, New York, USA. 1912

**METAPHYSICS****Barrett-Browning, Elizabeth** 1806–61

English poet

I walked on, musing with myself ...  
whether, after all, A larger metaphysics might not help  
Our physics ...

*Aurora Leigh*

Aurora Leigh

C.S. Francis & Co. New York, New York, USA. 1857

**Bradley, Francis Herbert** 1846–1924

English philosopher

Metaphysics is the finding of bad reasons for what we believe upon instinct, but to find these reasons is no less an instinct.

*Appearance and Reality: A Metaphysical Essay*

Preface (p. xiv)

Swan Sonnenschein & Co. London, England. 1893

We may agree, perhaps, to understand by Metaphysics an attempt to know reality as against mere appearance, or the study of first principles or ultimate truths, or again the effort to comprehend the universe, not simply piecemeal or by fragments, but somehow as a whole.

*Appearance and Reality: A Metaphysical Essay* (2nd edition)

Introduction (p. 1)

Swan Sonnenschein & Co. London, England. 1908

Metaphysical knowledge... may be possible theoretically, and even actual, if you please, to a certain degree; but, for all that, it is practically no knowledge worth the name.

*Appearance and Reality: A Metaphysical Essay*

Introduction (p. 2)

Swann Sonnenschein & Co. London, England. 1893

... when the sense of mystery and enchantment no longer draws the mind to wander aimlessly and to love it knows not what; when, in short, twilight has no charm – then metaphysics will be worthless.

*Appearance and Reality: A Metaphysical Essay*

Introduction (pp. 3–4)

Swann Sonnenschein & Co. London, England. 1893

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

There is no drawing the line between physics and metaphysics. If you examine every day facts at all closely, you are a physicist; but if you press your physics at all home, you become a metaphysician; if you press your metaphysics at all home, you are in a fog.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 259)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Carus, Paul** 1852–1919

American philosopher

Many a scientist is inclined simply to ignore the pretensions of metaphysics, but that will not do; for there is a truth at the bottom of its vagaries which should not be neglected, and the declaration that the nature of knowledge of any kind, in matters philosophical or scientific, is a description of facts will not be satisfactory until we understand the full importance of this definition.

*The Surd of Metaphysics*

Things-in-Themselves (p. 6)

The Open Court Publishing Co. Chicago, Illinois, USA. 1903

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

The study of the mathematics, like the Nile, begins in minuteness, but ends in magnificence; but the study of metaphysics begins with a torrent of tropes, and a copious current of words, yet loses itself at last, in obscurity and conjecture, like the Niger in his barren deserts of sand.

*Lacon: Or, Many Things in Few Words*

CCCXLII (p. 162)

Longman, Rees, Orme, Brown & Green. London, England. 1826

**Darwin, Charles Robert** 1809–82

English naturalist

Origin of man now proved – Metaphysics must flourish – He who understands [the] baboon would do more towards metaphysics than Locke.

*M Notebook*

84e, 16 August, 1838

**Douglas, James** 1753–1819

No biographical data available

Metaphysical truths can only be established by producing effects from corresponding causes; and though we may confront such demonstrative evidence with the immutable laws of mathematical decision, we must be sensible that there will still remain some pretense for doubt; thus the basis of that knowledge, which on these principles we have been long labouring to accomplish, will become an endless toil, an endless force for controversy: and having the passions and the prejudices of mankind to combat, which mathematical certainty can alone effectually suppress, we must content ourselves only with making converts of those who have minds sufficiently expansive without the shackles of Euclid, and the vanity of displaying their own learning and pedantry.

*A Dissertation on the Antiquity of the Earth*

Preface (pp. i–ii)

Printed at the Logographic Press. London, England. 1785

**Elliot, Hugh Samuel Roger** 1881–1930

No biographical data available

Metaphysical systems generally, however we may admire their wonderful ingenuity and subtlety, can have no interest for science unless they are founded on gross material facts, which can be examined and verified. As a rule their beautifully interwoven gossamer threads are of far too fine a texture to bear contact with the brutal hardness and reality of a fact. They can float gaily in the air without any solid support: while thus floating, they have no practical interest for us, who are compelled to crawl painfully along the earth. But when one of these ethereal systems attempts to take root on solid ground, it is apt to

get mangled and torn, wherever it touches earth; and the best chance of safety for the superstructure is to float off again into the rarified atmosphere whence it came.

*Modern Science and the Illusions of Professor Bergson*  
Chapter I (p. 1)

Longmans, Green & Co. New York, New York, USA. 1912

### Frank, Philipp

No biographical data available

...metaphysics divides people and science and unites them.

*Modern Science and Its Philosophy* (p. 276)

Harvard University Press. Cambridge, Massachusetts, USA. 1949

### Herrick, Charles Judson 1868–1960

American neurologist

If, now, a naturalist or anybody else wishes to speculate about what may lie beyond the range of possible human experience, that is his privilege. The scientist cannot object to it provided these excursions into transcendentalism do not invade his own domain. It is legitimate to extrapolate from the known facts into the unknown but not to reverse the procedure. Our metaphysics must not be divorced from our physics and from veridical knowledge.

*The Evolution of Human Nature*

Epilogue: The Unknown God (p. 463)

University of Texas Press. Austin, Texas, USA. 1956

### Kant, Immanuel 1724–1804

German philosopher

Time was, when she [metaphysics] was the *queen* of all the sciences; and, if we take the will for the deed, she certainly deserves, so far as regards the high importance of her object-matter, this title of honor. Now, it is the fashion of the time to heap contempt and scorn upon her...

Translated by J.M.D. Meiklejohn

*Critique of Pure Reason*

Preface to the First Edition (pp. 13–14)

P.F. Collier & Son. New York, New York, USA. 1901

### Leighton, Joseph Alexander

No biographical data available

Metaphysics, the heart of philosophy, seeks by persistent reflection to see things steadily and to see them whole; in Goethe's words, "Im Ganzen, Guten, Wahren resolut zu leben." In other words, metaphysics seeks a consistent and total interpretation of experience.

*Man and the Cosmos: An Introduction to Metaphysics*

Chapter I (p. 3)

D. Appleton & Co. New York, New York, USA. 1922

### Lewes, George Henry 1817–78

English philosopher

Few researches can be conducted in anyone line of inquiry without sooner or later abutting on some metaphysical problem, were it only that of Force, Matter, or Cause; and since Science will not, and Metaphysic cannot solve it,

the result is a patchwork of demonstration and speculation very pitiable to contemplate.

*Problems of Life and Mind* (Volume 1)

Part I, Chapter I (p. 9)

Trübner & Co. London, England. 1874–75

### Morris, Robert Tuttle 1857–1945

American surgeon

Metaphysics is a bower of safety in the garden of a fool's paradise. If men can run to such a bower whenever they encounter difficulties, there is lack of incentive to face genuine scientific labor bravely. A bower which gives protection is often chosen, instead of a steed which carries one to the winning front of battle.

*Microbes and Men*

Chapter I (p. 13)

Doubleday Page & Co. Garden City, New York, USA. 1916

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

Metaphysics, or the attempt to conceive the world as a whole by means of thought, has been developed, from the first, by the union and conflict of two very different human impulses, the one urging men towards mysticism, the other urging them towards science.

*Mysticism and Logic: And Other Essays*

Chapter I (p. 1)

Longmans, Green & Co. London, England. 1919

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

There are not a few problems in the natural sciences of which a man cannot speak justly without calling metaphysics to his aid; not technical words about knowing and being, such as make a show in the schools, but that wisdom of thought which was before all physics, lives with it, and will endure after it.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (pp. 160–161)

William Blackwood & Sons. Edinburgh, Scotland. 1883

### von Mises, Richard 1883–1953

Austrian-born American mathematician

There is no field that will always remain the special province of metaphysics and into which scientific research can never carry any light; there are no "eternally unexplorable" areas.

*Positivism: A Study in Human Understanding*

Chapter 21 (p. 273)

Harvard University Press. Cambridge, Massachusetts, USA. 1951

## METEOR

### Author undetermined

Far better 'tis, to die  
the death that flashes gladness,

than alone, in frigid dignity,  
to line on high.  
Better, in burning sacrifice,  
be thrown against the world  
to perish, than the sky  
to circle endlessly  
a barren stone.

Nature and Science in Poetry

*Nature*, Volume 132, Number 3330, August 26, 1933 (p. 295)

A rock from space that falls to earth is called a meteorite. However, if it lands to the left of you it's called a meteorite.

Source undetermined

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

This hairy meteor did denounce  
The fall of Scepters and of Crowns.

*The Poetical Works of Samuel Butler* (Volume 1)

First Part, Canto I, l. 245–246

Bell & Daldy. London, England. 1835

**Caithness, James Balharric**

No biographical data available

Wonderful, shimmering trail of light,  
Falling from whence on high!  
Flooding the world in thy moment's flight  
With the sense of a mystery!  
Softly thy radiance works a spell,  
Night is enhanced, as a note may swell  
From a simple melody.

*Pastime Poems*

The Meteor

E. Macdonald. London, England. 1924

**Darwin, Erasmus** 1731–1802

English physician and poet

Ethereal Powers! you chase the shooting stars,  
Or yoke the vollied lightnings to your cars.

*The Botanic Garden*

Part I, Canto I, II, l. 115

Jones & Company. London, England. 1825

**Devaney, James** 1890–1976

Australian poet, novelist, journalist, and teacher

The coming of this lovely night  
Lifted the world's great roof of blue  
And bared the awful Infinite –  
So grand an hour, so vast a view,  
Abashed I stand each night anew:  
When out of unimagined deeps  
Spectacular you burst upon  
The dark, and down the starry steeps  
A trail of whitest fire you shone

One breathless moment – and were gone.

*Where the Wind Goes*

To a Falling Star

Angus & Robertson. Sydney, Australia. 1939

**Dodd, Robert** 1936–

No biographical data available

It is much too early to tell whether the idea of periodic impacts by extraterrestrial objects will blossom into a still grander view of the Earth's relation to the other members of the Sun's family or will wither before a fiery blast of new data, but it shows that the romance between geology and planetary astronomy that began with the manned space program is far from over.

*Thunderstones and Shooting Stars*

Chapter 11 (p. 186)

Harvard University Press. Cambridge, Massachusetts, USA. 1986

**Dorman, Imogen**

No biographical data available

Down thru the cold blue depths you've gone  
A wanderer lone  
Bearing a message written on  
Metallic stone.

Cast from the planet of your birth

Thru cold you've flown,

Cold such as mortals on the earth

Have never known.

Heat you have found in wintry skies

Earth's atmosphere

Set you aflame, to many eyes

An omen drear.

Lucky the ones who, searching, read

Your message true,

Wanderer of the lightning speed

Down from the blue.

The Meteor

*Popular Astronomy*, Volume 38, Number 3, March, 1930 (p. 133)

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

And oft, before tempestuous winds arise,  
The seeming stars fall headlong from the skies,  
And shooting through the darkness, gild the night  
With sweeping glories and long trails of light.

*The Poetical Works of Dryden*

Virgil's Georgics, Book I, l. 501–504

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I would rather believe in ghosts than in hyperbolic meteors.

In David H. Levy

*The Man Who Sold the Milky Way* (p. 8)

University of Arizona Press. Tucson, Arizona. 1993

**Frost, Robert** 1874–1963

American poet

Have I not walked without an upward look  
It was a risk I had to take – and took.

*Complete Poems of Robert Frost*

Bravado

Henry Holt &amp; Company. New York, New York, USA. 1949

Did you stay up last night (the Magi did)  
To see the star shower known as Leonid  
That once a year by hand or apparatus  
Is so mysteriously pelted at us?

*Complete Poems of Robert Frost*

A Loose Mountain (Telescopic)

Henry Holt &amp; Company. New York, New York, USA. 1949

**Hoffman, Jeffrey** 1944–

American astronaut

Suddenly I saw a meteor go by underneath me. A moment  
later I found myself thinking, That can't be a meteor. Mete-  
ors burn up in the atmosphere above us; this was below us.  
Then, of course, the realization hit me [I was in space].

In Kevin W. Kelley

*The Home Planet*

With Plate 10

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.  
1988**Holmes, Charles N.**

No biographical data available

Across the darkened dome of night  
Where sun-kings reign till break of dawn,  
A shooting star darts fast and bright,  
Then like a spectral light is gone;  
It fades from sight, and leaves behind  
No more a trace than passing wind.

*The Shooting Star*

Source undetermined

**Jeffers, Robinson** 1887–1962

American poet

It was like the glittering night last October  
When the earth swam through a comet's tail, and fiery  
serpents  
Filled half of heaven.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 283)

Stanford University Press. Stanford, California, USA. 1988

**Jefferson, Thomas** 1743–1826

3rd president of the USA

We certainly are not to deny whatever we cannot  
account for. A thousand phenomena present themselves

daily which we cannot explain, but where facts are sug-  
gested, bearing no analogy with the laws of nature as  
yet known to us, their verity needs proof proportioned  
to their difficulty. A cautious mind will weigh the  
opposition of the phenomenon to everything hitherto  
observed, the strength of the testimony by which it is  
supported, and the error and misconceptions to which  
even our senses are liable. It may be very difficult to  
explain how the stone you possess came into the posi-  
tion in which it was found. But is it easier to explain  
how it got into the clouds from whence it is supposed  
to have fallen? The actual fact however is the thing to  
be established.

In Andrew A. Lipscomb (ed.)

*The Writings of Thomas Jefferson* (Volume 11) (p. 440)

Thomas Jefferson Memorial Association. Washington, D.C. 1905

I could more easily believe that two Yankee professors  
would lie than that stones would fall from the heaven.

In R.V. Jones

*The Natural Philosophy of Flying Saucers**Physics Bulletin*, Volume 19, 1968 (p. 225)**Joule, James Prescott** 1818–89

English physicist

You have, no doubt, frequently observed what are called  
*shooting-stars*, as they appear to emerge from the dark  
sky of night, pursue a short and rapid course, burst, and  
are dissipated in shining fragments. From the velocity  
with which these bodies travel, there can be little doubt  
that they are small planets which, in the course of their  
revolution round the sun, are attracted and drawn to the  
earth.

*The Scientific Papers of James Prescott Joule*

On Matter, Force, and Heat (p. 272)

Taylor &amp; Francis. London, England. 1884

**London, Jack** 1876–16

American author

I would rather be a meteor, every atom of me in magnifi-  
cent glow, than a sleepy and permanent planet.

*StarDate*, May/June, 1955 (p. 3)**Martin, Florence Holcomb**

No biographical data available

Slashed by the earth the comets orbit glares  
With tiny meteors; each fiery tail  
Now into incandescence sparks and flares  
In earth's rare upper atmosphere.

The Riddle of the Skies

*The Scientific Monthly*, Volume LXXV, Number 2, August, 1952 (p. 119)**Melville, Herman** 1819–91

American novelist



On nights when meteors play  
And light the breakers dance ...

*John Marr and Other Poems*

The Haglets (p. 62)

Princeton University Press, Princeton, New Jersey, USA. 1922

**Mitchell, Maria** 1818–89

American astronomer and educator

...a meteor seems to come like a messenger from  
departed spirits.

In Eve Merriam

*Growing Up Female in America*

Maria Mitchell (p. 81)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

### Mooch (Fictional character)

You mean that this little pebble's been out there hot-  
roddin' around the universe?

*The Blob*

Film (1958)

### Narrator

From time immemorial the Earth has been bombarded by  
objects from outer space. Bits and pieces of the Universe  
piercing our atmosphere in an invasion that never ends.  
Meteor, the shooting stars on which so many earthly  
wishes have been born! Of the thousands that plummet  
toward us, the greater part are destroyed in a fiery flash  
as they strike the layers of the air that encircle us. Only  
a small percentage survives. Most of those fall into the  
water which covers two-thirds of our world. But from  
time to time from the beginning of time a very few  
meteors have struck the crust of the Earth and formed  
craters – craters of all sizes sought after, poured over by  
scientists of all nations for the priceless knowledge bur-  
ied within them. In every moment of every day they come  
from planets belonging to stars whose dying light is too  
far away to be seen. From infinity they come. Meteors!  
Another strange calling card from the limitless regions  
of space – its substance unknown, its secrets unexplored.  
The meteor lies dormant in the night – waiting!

*The Monolith Monsters*

Film (1957)

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

Stars are also seen to shoot hither and thither, but never  
to any purpose ...

*Pliny's Natural History. In Thirty-seven Books*

Book II, Chapter XXXVI (p. 72)

Printed for the Club by G. Barclay. London, England. 1847–1849

### Plum, David

No biographical data available

Then bear us, O Earth, with our eyes upward gazing,  
To the place where the Star-God his fireworks displays;

When countless as snowflakes are meteors blazing  
With their red, green and orange and amber-like rays.

Meteors

*New York Evening Post*, November 20, 1866

**Proctor, Richard Anthony** 1837–88

English astronomer

If the interstellar depths are crowded with meteor flights,  
we have to ask whence the meteor flights came. To say  
that fish which have been drawn from the sea were origi-  
nally swimming about in the sea, is surely not to add  
much to our knowledge about fish.

Whence Came the Comets?

*The Twentieth Century*, Volume 29, Number 111, May, 1886 (p. 692)

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

And certain stars shot madly from their spheres.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*A Midsummer-Night's Dream*

Act II, Scene i, l. 153

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Silliman, G. S.**

No biographical data available

It seems not in accordance with ascertained science to  
ascribe mysterious appearances on the earth, or in its  
atmosphere, to causes preceding from the planets, or  
spheres, moving in space, independent of the earth and  
its system.... Is it not more in harmony with the integrity  
and perfection of His work that this phenomenon [mete-  
orites] should originate in a meteorological process, than  
that the symmetry of the creation should be violated by  
a visit to the earth of a lone, foreign intruder from the  
depths of space?

*On the Origin of Aerolites*

W.C. Bryant. New York, New York, USA. 1859

**Smythe, Daniel** 1908–81

American poet

A curve of fire traces the dark

And warns us of a visitor.

It makes an unfamiliar mark

And then is seen no more.

*The Meteor*

*Nature Magazine*, Volume 50, Number 9, November, 1957 (p. 493)

**Teasdale, Sara** 1884–1933

American writer and poet

I saw a star slide down the sky,  
Blinding the north as it went by,  
Too burning and too quick to hold,  
Too lovely to be bought or sold,  
Good only to make wishes on  
And then forever to be gone.

*The Collected Poems of Sara Teasdale*

The Falling Star (p. 198)

Collier Books. New York, New York, USA. 1966

**Tennyson, Alfred (Lord)** 1809–92

English poet

Now slides the silent meteor on, and leaves

A shining furrow, as thy thoughts in me.

*Alfred Tennyson's Poetical Works*

The Princess, VII

Oxford University Press, Inc. London, England. 1953

### The Bible (King James Version)

I saw a star fall from heaven unto the earth...

Revelation 9:1

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

As oft, from heaven unfix'd, shoot flying stars,

And trail their locks behind them.

In *Great Books of the Western World* (Volume 13)

*The Aeneid*

Book V, l. 528–529 (pp. 200–201)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

When it struck our earth there was to be a magnificent spectacle, no doubt, for those who were on the right side of our planet to see; but beyond that nothing. It was doubtful whether we were on the right side. The meteor would loom larger and larger in the sky, but with the umbra of our earth eating its heart of brightness out, and at last it would be the whole sky, a sky of luminous green clouds, with a white brightness about the horizon west and east. Then a pause – a pause of not very exactly definite duration – and then, no doubt, a great blaze of shooting stars. They might be of some unwonted colour because of the unknown element that line in the green revealed. For a little while the zenith would spout shooting stars. Some, it was hoped, would reach the earth and be available for analysis.

*Seven Famous Novels by H.G. Wells*

*In the Days of the Comet*

Book I, Chapter 5 (p. 774)

Alfred A. Knopf. New York, New York, USA. 1934

**Winchell, Alexander** 1824–91

American geologist

That mysterious visitant which paints its luminous streak along the evening sky – sudden, brilliant, but evanescent.

*World-life; Or, Comparative Geology* (3rd edition)

Part I, Chapter I (p. 4)

S.C. Griggs & Co. Chicago, Illinois, USA. 1889

...let us not lose sight of the matter [meteor] which underwent ignition; it is not annihilated; it has not been returned to the regions beyond our atmosphere; those are physical impossibilities. Unseen, unheard, millions of

particles of cooled vapor remain floating in our air. Being ponderable, being mineral and mostly metallic, they must settle toward the earth. They are plunged into the vortices of the winds; they are soaked up by aqueous vapors; they are floated by clouds, they are washed down by rains and added to the volume of the globe.

*World-life; Or, Comparative Geology* (3rd edition)

Part I, Chapter I (p. 6)

S.C. Griggs & Co. Chicago, Illinois, USA. 1889

Could our vision be unsealed, we should behold the infinite firmament dotted with meteors hurrying to and fro, as snow-flakes in the wildest wintry storm.

*World-life; Or, Comparative Geology* (3rd edition)

Part I, Chapter I (p. 22)

S.C. Griggs & Co. Chicago, Illinois, USA. 1889

These meteoric matters are samples of the stuff which exists in the far regions where the stars are shining. It comes to us and we handle it and investigate it, and find it exactly like the stuff from which our world is made. We are not isolated, as we had thought, from the starry realm. Even the meteors are messengers – flaming messengers – bringing us these tidings from distant provinces, and assuring us that the government whose details are administered upon our earth is loyally recognized in the regions lying on the distant verge of the visible universe.

*World-life; Or, Comparative Geology* (3rd edition)

Part I, Chapter I (p. 23)

S.C. Griggs & Co. Chicago, Illinois, USA. 1889

## METEORITE

**Alexander, William**

No biographical data available

**Street, Arthur**

No biographical data available

Meteorites usually consist of an alloy of iron with about 8 per cent of nickel, with a small amount of cobalt. No doubt primitive man, whose local culture was thus by accident raised from the level of the stone age to that of the iron age, thought metallic meteorites were valuable gifts from the gods. Nowadays, however, meteorites are hardly regarded as a useful source of iron. For one thing the delivery service is erratic and the unheralded arrival of a meteorite in one's back garden would be more embarrassing than profitable.

*Metals In the Service of Man*

Penguin Books Ltd. Harmondsworth, England. 1945

**Chlandni, E. F. F.**

No biographical data available

If the planets had a beginning, then either they must have formed from pieces of matter in an unconsolidated and chaotic state, which had been dispersed throughout a vast space before gravitational attraction gathered them into large masses; or else new planetary bodies were

formed from the fragments of much larger ones that were broken to pieces, either by some external impact or by an internal explosion.... [I]t seems likely that many of these original pieces would not have joined the larger accumulating planets, because they were too far from them or traveling at excessive velocities, but would have remained independent...continuing their journeys in space until each entered the sphere of attraction of some planet, whereupon it would fall, giving rise to the meteoritic phenomenon.

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 5 (p. 77)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Clinton, William Jefferson** 1946–  
42nd president of the USA

Today, rock 84001 speaks to us across all those billions of years and millions of miles. It speaks of the possibility of life. If this discovery is confirmed, it will surely be one of the most stunning insights into our universe that science has ever uncovered. Its implications are as far-reaching and awe-inspiring as can be imagined. Even as it promises answers to some of our oldest questions, it poses still others even more fundamental.

The White House

Office of the Press Secretary August 7, 1996

**Frost, Robert** 1874–1963  
American poet

Never tell me that not one star of all  
That slipped from heaven at night and softly fall  
Has been picked up with stones to build a wall.

*Complete Poems of Robert Frost*

A Star in a Stone-Boat

Henry Holt & Company. New York, New York, USA. 1949

**Hamilton, W.**  
No biographical data available

The outside of every stone that has been found [in the Siennese territory], and has been ascertained to have fallen from the cloud near Sienna, is evidently freshly vitrified, and is black, having every sign of having passed through an extreme heat; when broken, the inside is of a light-gray color mixed with black spots, and some shining particles, which the learned here have decided to be pyrites....

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 2 (p. 13)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless, seed-bearing meteoric

stones moving about through space. If at the present instant no life existed upon this Earth, one such stone falling upon it might, by what we blindly call natural causes, lead to its becoming covered with vegetation.... The hypothesis that life originated on this Earth through moss-grown fragments from the ruins of another world may seem wild and visionary: all I maintain is that it is not unscientific.

*Address of Sir William Thomson, Knt., L.L.D., F.R.S., President*

Taylor & Francis. London, England. 1871

**Meunier, M. S.**  
No biographical data available

[I have concluded that] the meteorites are pieces of debris from a disrupted planet. Now just as one can, from exhumed remains of extinct animals, reconstruct the beings of past epochs, so it should be possible by examining meteorites to reconstruct the celestial body that supplies these fossil vestiges....

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 3 (p. 29)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Paneth, F. A.**  
No biographical data available

As is well known, the most exact way of determining the ages of rocks depends on the regularity of radioactive decay processes. Obviously the same method can be applied to meteorites.... In our present state of ignorance of how they were formed, we must admit the possibility that there may be meteorites substantially older than the oldest strata of the earth.

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 4 (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

Of all the astronomical events, the fall of a meteorite is the most unnerving and yet the most reassuring. Reassuring because it proves to us that the depths of space are inhabited by bodies made of the same elements we have here on earth, that, at rock bottom, a man and a star are built of the same stuff.

*An Almanac for Moderns*

August Eleventh (p. 155)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Must my day be dark by reason, O ye Heavens, of your boundless nights, Rush of Suns, and roll of systems, and your fiery clash of meteorites?

*The Works of Alfred Lord Tennyson, Poet Laureate*

God and the Universe (p. 868)

The Macmillan Co. New York, New York, USA. 1898

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...there are no imports [into the world] but meteorites, and no exports at all.

*The Works of H.G. Wells* (Volume 9)  
*A Modern Utopia*  
section 2 (p. 73)

T. Fisher Unwin. London, England. 1924

## METEOROLOGICAL INSTRUMENTS

**Daniell, John Frederic** 1790–1845  
English chemist

Many and ingenious are the instruments which the science [meteorology] of modern ages has constructed for the accurate appreciation of these perpetual changes; and diligent have been the observers who have dedicated their time to the science of meteorology: but, from the first contrivance of the barometer to the present day, the great and unceasing fluctuations of the vast aerial ocean, denoted by that instrument, are unexplained.

*Meteorological Essays and Observations*

An Essay on the Constitution of the Atmosphere (p. 2)

Printed for Thomas & George Underwood. London, England. 1823

## METEOROLOGIST

**Daniell, John Frederic** 1790–1845  
English chemist

Man may almost with propriety be said to be a meteorologist by nature: he is naturally placed in such a state of dependance upon the elements, that to watch their vicissitudes and anticipate their disturbances, becomes a necessary portion of the labour to which he is born.

*Meteorological Essays and Observations*

An Essay on the Constitution of the Atmosphere (p. 1)

Printed for Thomas & George Underwood. London, England. 1823

## Scott, Robert Henry

...the meteorologist is like a mussel or an oyster, anchored to one spot, and obliged to make the best of such nutriment as may chance to be swept within his reach.

*Elementary Meteorology* (6th edition)

Chapter I (p. 3)

Kegan Paul, Trench, Trubner & Co. La Salle, Indiana, USA. 1893

## METEOROLOGY

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Meteorology, so far as the prediction of the weather is concerned (which most persons consider, very erroneously, to be its only practical object), may be regarded as a science still in its infancy; though if such be the case, to judge from the voluminous nature of its records, and the multitude of books which have been written on it, its maturity, if ever attained, would promise to be gigantic indeed; were it not that the progress of all real science is towards compression and condensation, and its whole aim to supersede the endless detail of individual cases by the announcement of easily remembered and readily applicable laws.

*Familiar Lectures on Scientific Subjects*

Lecture IV (p. 144)

George Routledge & Sons. New York, New York, USA. 1871

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Meteorology constantly and persistently aims at prophecy, and it will never stand in a place of honor until it can certainly foretell.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1902)

The Discovery of the Future (p. 384)

Government Printing Office. Washington, D.C. 1903

## METHOD

**Bernard, Claude** 1813–78  
French physiologist

...good methods can teach us to develop and use to better purpose the faculties with which nature has endowed us, while poor methods may prevent us from turning them to good account. Thus the genius of inventiveness, so precious in the sciences, may be diminished or even smothered by a poor method, while a good method may increase and develop it.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section ii (p. 35)

Henry Schuman, Inc. New York, New York, USA. 1927

**Billroth, Theodor** 1829–84  
No biographical data available

The method of research, however, of posing the questions and solving the questions posited, is invariably the same, whether we have before us a blooming rose, a diseased grape-vine, a shining beetle, the spleen of a leopard, a bird's feather, the intestines of a pig, the brain of a poet or philosopher, a sick poodle, or a hysterical princess.

*The Medical Sciences in the German Universities (Part II)*

The Descriptive Sciences (p. 53)

The Macmillan Company. New York, New York, USA. 1924

**Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

When one has no character one has to apply a method.

*The Fall* (p. 11)

Alfred A. Knopf. New York, New York, USA. 1958

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

The method employed I would gladly explain,  
While I have it so clear in my head,  
If I had but the time and you had but the brain –  
But much yet remains to be said.

*The Complete Works of Lewis Carroll*

*The Hunting of the Snark*

Fit the Fifth (p. 771)

The Modern Library. New York, New York, USA. 1936

**Chapin, Charles Value** 1856–1941

American physician and public health officer

Science can never be a closed book. It is like a tree,  
ever growing, ever reaching new heights. Occasionally  
the lower branches, no longer giving nourishment to the  
tree, slough off. We should not be ashamed to change our  
methods; rather we should be ashamed never to do so.

Science and Public Health

*American Journal of Public Health* Volume XVII, Number 11, November, 1927 (p. 1115)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The availability of a large number of established methods  
serves in modern science often as a surrogate of thought.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part III

Science or an Obsession (p. 170)

Rockefeller University Press. New York, New York, USA. 1978

**Cohen, Morris Raphael** 1880–1947

American philosopher

...the safety of science depends on there being men who  
care more for the justice of their methods than for any  
results obtained by their use.

*An Introduction to Logic and Scientific Method*

Chapter XX, Section 2 (p. 402)

Harcourt, Brace & Company. New York, New York, USA. 1934

**Committee on the Conduct of Science**

The fallibility of methods means that there is no cookbook  
approach to doing science, no formula that can be applied  
or machine that can be built to generate scientific knowl-  
edge.... The skillful application of methods to a challeng-  
ing problem is one of the great pleasures of science.

*On Being a Scientist*

The Nature of Scientific Research (p. 6)

National Academy Press. Washington, D.C. 1989

Some methods, such as those governing the design of  
experiments or the statistical treatment of data, can be  
written down and studied. But many methods are learned  
only through personal experience and interactions with  
other scientists. Some are even harder to describe or  
teach. Many of the intangible influences on scientific  
discovery – curiosity, intuition, creativity – largely defy  
rational analysis, yet they are often the tools that scien-  
tists bring to their work.

*On Being a Scientist*

The Nature of Scientific Research (p. 6)

National Academy Press. Washington, D.C. 1989

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Method consists entirely in the order and disposition of  
the objects towards which our mental vision must be  
directed if we would find out any truth.

In *Great Books of the Western World* (Volume 31)

*Rules For the Direction of the Mind*

Rule V (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

You know my method. It is founded upon the observation  
of trifles.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Bascombe Valley Mystery* (p. 148)

Wings Books. New York, New York, USA. 1967

Pon my word Watson, you are coming along wonder-  
fully. We have really done very well indeed. It is true that  
you have missed everything of importance, but you have  
hit upon the method...

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Case of Identity* (p. 411)

Wings Books. New York, New York, USA. 1967

**Egler, Frank E.** 1911–96

American botanist and ecologist

Concepts are games we play with our heads; methods  
are games we play with our hands, which at times are so  
handy they can be played without a head.

*The Way of Science*

Holism (p. 34)

Hafner Publishing Company. New York, New York, USA. 1970

For all their value, the application of a method, alone, is  
not science, anymore than a pile of bricks is architecture.  
I would sooner trust a good mind without a method than  
a good method without a mind.

*The Way of Science*

Methodology of Science (p. 36)

Hafner Publishing Company. New York, New York, USA. 1970

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The method of nature: who could ever analyze it?

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

The Method of Nature (p. 119)

The Library of America. New York, New York, USA. 1983

**Fuller, Thomas** 1608–61

English clergyman and author

Marshal thy notions into a handsome method – One will carry twice more weight trussed and packed up in bundles, than when it lies towardly flapping and hanging about his shoulders.

*The Holy State, and the Profane State*

Chapter X (p. 167)

Printed for Thomas Tegg. London, England. 1841

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

We are convinced that exactitude in experiments is less the outcome of faithful observation of the divisions of an instrument than of exactitude of method.

In Maurice Crosland

*Gay-Lussac: Scientist and bourgeois*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1978

**Greenstein, George** 1940–

American astronomer

The scientist immersed in research is more bound up by the methods he employs than by the object of his study.

*Frozen Star*

Chapter 1 (p. 6)

Freundlich Books. New York, New York, USA. 1983

**Hertz, Heinrich** 1857–94

German physicist

For the moment I am blundering without precise method. I repeat old experiments in this field and demonstrate others which pass through my head...I hope that, among the hundred remarkable phenomena which I come across, some light will shine from one or another.

In René Taton

*Reason and Chance in Scientific Discovery*

Chapter III (p. 4)

Philosophical Library. New York, New York, USA. 1957

**Hilbert, David** 1862–1943

German mathematician

...for he who seeks for methods without having a definite problem in mind seeks for the most part in vain.

Hilbert: Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902 (p. 444)

**Hubble, Edwin Powell** 1889–1953

American astronomer

The methods of science may be described as the discovery of laws, the explanation of laws by theories, and the testing of theories by new observations. A good analogy is that of the jigsaw puzzle, for which the laws are the individual pieces, the theories local patterns suggested by a few pieces, and the tests the completion of these patterns with pieces previously unconsidered.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 11)

The Huntington Library, San Marino, California, USA. 1954

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The knowledge of the method which has guided a man of genius is not less serviceable to the progress of the sciences, and even to his own glory, than his discoveries...

*The System of the World* (Volume 2)

Book V, Chapter V (p. 347)

Printed for Richard Phillips. London, England. 1809

**Lewis, Sir Thomas** 1881–1945

No biographical data available

A physical sign or method, for lack of better, may serve the purpose of the moment, it serves no purpose in the pursuit of science till the measure of its fallibility is taken, clinical observers, for the most part, do not yet recognise that many methods which they regularly employ, useful as they may be in the practice of an art, are inadmissible to the science.

*The Mechanism and Graphic Registration of the Heart Beat*

Preface (p. vi)

Shaw & Sons. London, England. 1920

**Lonergan, Bernard J. F.** 1904–84

Canadian philosopher, theologian, and educator

It is in the measure that special methods acknowledge their common core in transcendental method, that norms common to all the sciences will be acknowledged, that a secure basis will be attained for tackling interdisciplinary problems, and that the sciences will be mobilized within a higher unity of vocabulary, thought and orientation, in which they will be able to make their quite significant contribution to the solution of fundamental problems.

*Method in Theology*

Chapter 1 (p. 23)

Herder & Herder. New York, New York, USA. 1972

**Maxwell, James Clerk** 1831–79

Scottish physicist

...though the professed aim of all scientific work is to unravel the secrets of nature, it has another effect, not less valuable, on the mind of the worker. It leaves him in possession of methods which nothing but scientific work could have led him to invent, and it places him in a position from which many regions of nature, besides that which he has been studying, appear under a new aspect.

Molecules

*Nature*, September, 1873 (p. 440)



**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It is a layman's illusion that in science we caper from pinnacle to pinnacle of achievement and that we exercise a Method which preserves us from error. Indeed we do not; our way of going about things takes it for granted that we guess less often right than wrong, but at the same time ensures that we need not persist in error if we earnestly and honestly endeavor not to do so.

*The Limits of Science* (p. 101)

Harper &amp; Row Publishers. New York, New York, USA. 1984

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Everything is in the method, in the chances of attaining a steadfast, lasting truth...

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Chapter 3 (p. 83)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

With a good method even a rather untalented person can accomplish much.

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Chapter 3 (p. 101)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Pearson, Karl** 1857–1936

English mathematician

The insight into method and the habit of dispassionate investigation which follow from acquaintance with the scientific classification of even some small range of natural facts, give the mind an invaluable power of dealing with other classes of facts as the occasion arises.

*The Grammar of Science* (2nd edition)

Chapter I (p. 7)

Adam &amp; Charles Black. London, England. 1900

**Pólya, George** 1887–1985

Hungarian mathematician

What is the difference between a method and device? A method is a device which you use twice.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The Traditional Mathematics Professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

My method to overcome a difficulty is to go round it.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The traditional mathematics professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In science the man of real genius is the man who invents a new method. The notable discoveries are often made

by his successors, who can apply the method with fresh vigor, unimpaired by the previous labour of perfecting it; but the mental caliber of the thought required for their work, however brilliant, is not so great as that required by the first inventor of the method.

*Mysticism and Logic and Other Essays*

Chapter II, Section II (p. 41)

Longmans, Green &amp; Company. London, England. 1925

**Sagan, Carl** 1934–96

American astronomer and author

The method of science, as stodgy and grumpy as it may seem, is far more important than the findings of science.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 1 (p. 22)

Random House, Inc. New York, New York, USA. 1995

**Sir Joseph (Fictional character)**

Method is everything in archaeology, my boy. Why, we always deal with our finds in order.

*The Mummy*

Film (1940)

**Swift, Jonathan** 1667–1745

Irish-born English writer

Method is good in all things. Order governs the world.

In Frederick Ryland

*Journal to Stella, A.D. 1710–1713* (Volume II)

Letter II (p. 40)

George Bell &amp; Sons. London, England. 1908

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Content without method leads to fantasy; method without content to empty sophistry; matter without form to unwieldy erudition, form without matter to hollow speculation.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 306)

Suhrkamp. New York, New York, USA. 1988

**Walker, Kenneth** 1882–1966

Physician

To understand the true function of science and to be able to evaluate its theories it will first be necessary to have a very clear idea of the method by which it works.

*Meaning and Purpose*

Chapter II (p. 16)

Jonathan Cape. London, England. 1944

**Wilson, Edwin B.** 1879–1964

American statistician

A method is a dangerous thing unless its underlying philosophy is understood, and none [is] more dangerous than the statistical. Our aim should be, with care, to avoid in the main erroneous conclusions. In a mathematical and strictly logical discipline the care is one of

technique; but in the natural science and in statistics the care must extend not only over the technique but to the matter of judgment, as is necessarily the case in coming to conclusions upon any problem of real life where the complications are great. Over-attention to technique may actually blind one to the dangers that lurk about on every side – like the gambler who ruins himself with his system carefully elaborated to beat the game. In the long run it is only clear thinking, experienced methods, that win the strongholds of science.

The Statistical Significance of Experimental Data  
*Science*, Volume 58, Number 1493, 10 August, 1923 (p. 94)

## METHOD OF DIFFERENCES

**Babbage, Charles** 1792–1871

English mathematician

“Pray, Mr. Babbage, can you explain to me in two words what is the principle of this machine?” Had the querist possessed a moderate acquaintance with mathematics I might in four words have conveyed to him the required information by answering, “The method of differences.”

*Passages from the Life of a Philosopher*

Chapter V (p. 67)

Longman, Green, Longman, Roberts & Green. London, England. 1864

## METRICS

**Lederman, Leon** 1922–

American high-energy physicist

In the 1990s the USA, not to be left too far behind, is inching toward the metric system.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 4 (p. 108)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

## MICROBE

### Author undetermined

Sing a song of microbes,  
Dainty little things,  
Eyes and ears and horns and tails,  
Claws and fangs and stings.  
Microbes in the carpet,  
Microbes in the wall,  
Microbes in the vestibule,  
Microbes in the hall.  
Microbes on my money,  
Microbes in my hair,  
Microbes on my meat and bread,  
Microbes everywhere.  
Microbes in the butter,  
Microbes in the cheese,

Microbes on the knives and forks,  
Friends are little microbes,  
Enemies are big,  
Life among the microbes is –  
Nothing ‘*infra dig.*’  
Fussy little microbes,  
Millions at a birth,  
Make our flesh and blood and bones,  
Keep us on the earth.

In Rennie Wilbur Doane

*Insects and Disease: A Popular Account of the Way in which Insects May*

Chapter I (p. 10)

Henry Holt & Co. New York, New York, USA. 1910

In the nineteenth century men lost their fear of God and acquired a fear of microbes.

Source undetermined

**Donaldson, T. B.**

No biographical data available

He, who fights Microbes Away  
Will be an Immune, some fine Day.

*An Apropos Alphabet with Immoral Conclusions by an Absent-Minded*

*Beggar in Red & Blue*

Letter K

W.S. Sterling & Company. New York, New York, USA. 1900

**Dunne, Finley Peter** 1867–1936

American journalist and humorist

...microbes is a vigitable, an' ivry man is like a conservatory full iv millyons iv these potted plants.

*Mr. Dooley's Opinions*

Christian Science (p. 5)

Harper. New York, New York, USA. 1906

**Gillilan, Strickland** 1869–1954

American poet-humorist

Adam Had 'em.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#79 (p. 5)

Harper & Row, Publishers. New York, New York, USA. 1969

**Huxley, Aldous** 1894–1963

English writer and critic

...think of the inexpugnable retreats for microbes prepared by Michelangelo in the curls of Moses' beard!

*Time Must Have a Stop*

Chapter III (p. 36)

The Sun Dial Press. Garden City, New York, USA. 1944

**Kingsley, Charles** 1819–75

English clergyman and author

...you are literally filled with the fruit of your own devices, with rats and mice and such small deer, paramecia, and entomostracese, and kicking things with horrid

names, which you see in microscopes at the Polytechnic, and rush home and call for brandy – without the water – with stone, and gravel, and dyspepsia, and fragments of your own muscular tissue tinged with your own bile ...

The Water Supply of London

*The North British Review*, Volume XV, Number 29, July, 1851 (p. 246)

**Morris, Robert Tuttle** 1857–1945

American surgeon

The microbe is the keystone of the arch of all organic life.

*Microbes and Men*

Chapter I (p. 5)

Doubleday Page & Co. Garden City, New York, USA. 1916

A man is only what his microbes make him.

*Microbes and Men*

Chapter I (p. 5)

Doubleday Page & Co. Garden City, New York, USA. 1916

**Muir, John** 1838–1914

American naturalist

And surely all God's people, however serious and savage, great or small, like to play. Whales and elephants, dancing, humming gnats, and invisibly small mischievous microbes – all are warm with divine radium and must have lots of fun in them.

*My Boyhood and Youth*

Chapter V (pp. 149–150)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

**Nobel, Alfred** 1833–96

Swedish chemist, engineer, inventor, and industrialist

The advance in scientific research and its ever widening sphere stirs the hope in us that the microbes, those of the soul as well as of the body, will gradually disappear, and that the only war humanity will wage in the future will be one against these microbes.

Quoted in Selman A. Waksman

*Les Prix Nobel. The Nobel Prizes in 1952*

Nobel banquet speech for award received in 1952

Nobel Foundation. Stockholm, Sweden. 1953

**Sonneberg, Walter**

No biographical data available

The microbe is more frightful than the Megalosaurus.

*Social Eccentricities*

Social Eccentricities (p. 6)

Broadway Publishing Co. New York, New York, USA. 1906

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

...nowadays the serpent that bites Man's heel is in nine cases out of ten microscopic ...

*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* (Volume I)

Lecture I (p. 7)

Henry Holt & Co. New York, New York, USA. 1920

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

In war the microbe kills more than the bullet.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 2) (p. 427)

Clarendon Press. Oxford, England. 1925

**Waksman, Selman A.** 1888–1973

Ukrainian-born American biochemist

With the removal of the danger lurking in infectious diseases and epidemics, society can face a better future, can prepare for a time when other diseases not now subject to therapy will be brought under control. Let us hope that in contributing the antibiotics, the microbes will have done their part to make the world a better place to live in.

*Les Prix Nobel. The Nobel Prizes in 1952*

Nobel banquet speech for award received in 1952

Nobel Foundation. Stockholm, Sweden. 1953

**Wolfe, Humbert** 1885–1940

Poet and civil servant

The doctor lives by chicken pox,  
by measles, and by mumps.  
He keeps a microbe in a box  
and cheers him when he jumps.

*Cursory Rhymes*

Poems Against Doctors II

E. Benn Limited. London, England. 1927

## MICROBIOLOGY

**Collard, Patrick**

No biographical data available

Microbiology, like all the sciences, is founded upon the twin pillars of craft technique and philosophical speculation.

*The Development of Microbiology*

Chapter 1 (p. 1)

Cambridge University Press. London, England. 1976

## MICROCOSM

**Forbes, A.**

No biographical data available

[A lake] is a little world within itself, a microcosm in which all the elemental forces are at work and the play of life goes on in full, but on a scale so small as to be easily grasped.

In F.E. Clements and V.E. Shelford

*Bio-Ecology*

Chapter I (p. 14)

John Wiley & Sons, Inc. New York, New York, USA. 1939

## MICROFLORA

**Leopold, Aldo** 1886–1948  
American naturalist

The existence of the term microflora implies, to the layman, that science knows all the citizens of the underground community, and is able to push them around at will. As a matter of fact, science knows little more than that the community exists, and that it is important. In a few simple communities like alfalfa, science knows how to add certain bacteria to make the plants grow. In a complex forest, science knows only that it is best to let well enough alone.

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God* (p. 293)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

## MICROPALAEONTOLOGY

**Lipps, Jere**  
No biographical data available

Micropaleontology is a strange subject. It is not easily defined, its history is fairly dull, and it seems to focus only on geologic topics. Biologists by and large ignore those organisms that when fossilized become microfossils. Evolutionary biologists disdain them. Paleobiologists snub them, and “micropaleontologists” seem not to know what to do with them as once living animals or plants. Most “micropaleontologists” are not trained in biology, and the literature of micropaleontology is an enormous edifice testifying to that fact. Although not a mere flunky of geology, micropaleontology is nevertheless largely a servant of geology, albeit an extremely powerful one.

What, If Anything, Is Micropaleontology?  
*Paleobiology*, Volume 7, Number 2, 1981

## MICROSCOPE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

A superficial familiarity with the microscope gives no idea of the exhausting kind of labor which the naturalist must undergo who would make an intimate microscopic study of these [ovarian egg] minute living spheres.

*Methods of Study in Natural History*  
Chapter XVI (p. 296)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

By it [the microscope] Men have pursued Nature into its most retired recesses; so that now it can hardly anymore hide its greatest Mysteries from us.

*An Essay on the Usefulness of Mathematical Learning* (3rd edition) (p. 25)  
Printed for J. Barrett  
London, England. 1745

**Bajer, Francis J.**  
No biographical data available

The curiosity of man remains undaunted since the dawn of civilization. It has manifested itself in many ways, not the least of which has been the burning desire to see but a little more or a little more clearly. Surely this is understandable when one realizes that almost all knowledge is first gleaned through visual inspection and observation.

Scanning a Tiny World's Wonders with the Magic of Electron Microscopy  
*Science Digest*, Volume 83, Number 3, March, 1978 (p. 42)

**Baker, Henry** 1698–1774  
English naturalist

When you employ the Microscope, shake off all Prejudice, nor harbor any favorite Opinions; for, if you do, 'tis not unlikely Fancy will betray you into Error, and make you see what you wish to see.

*The Microscope Made Easy*  
Part I, Chapter XV, Cautions in Viewing Objects (p. 62)  
Printed for R. Dodsley. London, England. 1743

**Damon, William E.**  
No biographical data available

The invisible is often more curious than that which meets the eye, and a microscope of even moderate power will reveal in sea-water the marvelous resources of Nature in furnishing the minutest creations with organs as perfectly adapted to their mode of life as are those of the gigantic whale or the vertebrate land animals.

*Ocean Wonders: Companion for the Seaside*  
Preface (pp. v–vi)  
D. Appleton & Co. New York, New York, USA. 1879

**Darby, William Arthur**  
No biographical data available

The Microscope brings up the minute world of Nature, and astonishes us with evidences of the Divine wisdom, power, and goodness, far away down into what we have often considered veritable nothingness, and at every step down we are startled into amazement to discover and explore world on world of new creatures ...

*The Astronomical Observer, A Handbook to the Observatory and the Common Telescope*  
Introduction (p. x)  
Robert Hardwick. London, England. 1864

**de Laubenfels, M. W.**

O why embark on distant seas  
Your taste for novel sights to please?  
There's nothing there that's strange or new  
But only just what's in the Zoo  
Much better visit a fairyland  
Where dragons writhe on every ,  
Where elves and goblins gallop by,  
And gaudy gems delight the eye.

Impossible? Don't give up hope,  
You merely need a microscope.

Fairyland Discovered in Julian D. Corrington  
Under the Microscope  
*Nature Magazine*, Volume 43, Number 1, January, 1950 (p. 110)

**Dickens, Charles** 1812–70  
English novelist

Yes, I have a pair of eyes, replied Sam, and that's just it.  
If they was a pair o' patent double million magnifyin'  
gas microscopes of hextra power, p'raps I might be able  
to see through a flight o' stairs and a deal door; but bein'  
only eyes, you see my wision's limited.

*The Posthumous Papers of the Pickwick Club*  
Chapter XXXIV (p. 415)  
Dodd, Mead & Company. New York, New York, USA. 1944

**Dickinson, Emily** 1830–86  
American lyric poet

Faith is a fine invention  
For gentlemen who see;  
But microscopes are prudent  
In an emergency.

*The Complete Poems of Emily Dickinson*  
No. 185 (p. 87)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

...very close and diligent looking at living creatures,  
even through the best microscope, will leave room for  
new and contradictory discoveries.

*Felix Holt, The Radical*  
Chapter XXII (p. 226)  
William L. Allison Company. New York, New York, USA. No date

**Gilliam, Charles Edgar**

A microscope creates  
Gigantic miracles  
Of wide-eyed mites,  
That peering up may see,  
Haloed in lights  
Against the wall,  
Man as he is –  
Small.

Two-Way Tube  
*Nature Magazine*, Volume 43, Number 1, January, 1950 (p. 56)

**Hendrick, Ellwood**  
American chemical engineer

The world beyond the microscope is as vast as that  
beyond the telescope.

*Everyman's Chemistry*  
Chapter II (p. 16)  
Harper & Brothers Publishers. New York, New York, USA. 1917

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

I was sitting with my microscope,  
upon my parlor rug,  
With a very heavy quarto and a very lively bug;  
The true bug had been organized  
with only two antennae,  
But the humbug in the copperplate would have them  
twice as many.

*The Complete Poetical Works of Oliver Wendell Holmes*  
Nux Postcoenatica, Stanza 1  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Hooke, Robert** 1635–1703  
English physicist

...me thinks it seems very probable, that nature has  
in these passages, as well as in those of Animal bod-  
ies, very many appropriated Instruments and contriv-  
ances, whereby to bring her designs and end to pass,  
which 'tis not improbable, but that some diligent  
Observer, if help'd with better Microscopes, may in  
time detect.

*Micrographia*  
Observation, XVIII (p. 116)  
Printed by Jo. Martyn & Ja. Allestry. London, England. 1665

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Where the telescope ends, the microscope begins, and  
which of the two has the grandest sight?

*Les Miserables*  
Volume IV, Book III, Chapter 3 (p. 67)  
The Heritage Press. New York, New York, USA. 1938

**Kingsley, Charles** 1819–75  
English clergyman and author

I have seen the cultivated man, craving for travel and for  
success in life, pent up in the drudgery of London work,  
and yet keeping his spirit calm, and perhaps his morals  
all the more righteous, by spending over his microscope  
*Glaucaus; Or, The Wonders of the Shore* (p. 55)  
Macmillan & Co Ltd. London, England. 1890

**Lambert, Johann Heinrich** 1728–77  
Swiss-German mathematician and astronomer

In a grain of sand, in a drop of water, we discover worlds  
and inhabitants; besides, our best microscopes only shew  
us the whales and elephants of those worlds; they are still  
far from reaching the insects.

Translated by James Jacque  
*The System of the World*  
Part I, Chapter III (p. 12)  
Printed for Vernor & Hood. London, England. 1800

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

Microscopes should be invented for every kind of investigation and, where that is impossible, experiments should be conducted on a large scale. This is the only direct road to new discovery.

In J.P. Stern

*Lichtenberg: A Doctrine of Scattered Occasions*

Further Excerpts from Lichtenberg's Notebooks (p. 294)

Indiana University Press. Bloomington, Indiana, USA. 1959

**Mayo, William J.** 1861–1939  
American physician

**Powers, Henry**

No biographical data available

Of all the Inventions none there is Surpasses  
the Noble Florentine's Dioptrick Glasses  
For what a better, fitter guift Could bee  
in this World's Aged Luciosity.  
To help our Blindnesse so as to devize  
a paire of new & Articial eyes  
By whose augmenting power wee now see more  
than all the world Has ever down Before.

In S. Bradbury

*The Microscope Past and Present*

In Commendation of ye Microscope (p. v)

Printed for R. Dodsley. London, England. 1743

**Molyneux, William** 1656–98  
Irish astronomer

I have been often delighted with the curious Appearance of many Objects seen through the Microscope. But none ever surprised me more, than the visible Circulation of the Blood in Water-Newts (*Lacerta aquatica*) to be seen as plainly as Water running in a River, and proportionably much more rapid.

*Dioptrica Nova* (p. 261)

Printed for Benjamin Tooke. London, England. 1692

**O'Brien, Fitz James** 1828–62  
Author

Accompanying it was a small treatise on the microscope – its history, uses, and discoveries. I comprehended then for the first time the “Arabian Nights’ Entertainments.” The dull veil of ordinary existence that hung across the world seemed suddenly to roll away, and to lay bare a land of enchantments-. I felt towards my companions as the seer might feel towards the ordinary masses of men. I held conversations with nature in a tongue which they could not understand. I was in daily communication with living wonders, such as they never imagined in their wildest visions. I penetrated beyond the external portal of things, and roamed through the sanctuaries.

In William Winter

*The Diamond Lens*

Chapter I (p. 4)

Charles Scribner's Sons. New York, New York, USA. 1885

**Pouchet, Félix Archimède** 1800–72  
French biologist

The torch of anatomy has shed a flood of light upon the organization of the inferior animals, and the microscope, by allowing us to pry into the most inaccessible nooks of it, has unfolded before our eyes a horizon as vast as it was unexpected.

*The Universe*

The Animal Kingdom, Book II (p. 99)

Blackie & Son. London, England. 1870

**Selye, Hans** 1907–82  
Austrian-American endocrinologist

The microscope can see things the naked eye cannot, but the reverse is equally true.

*From Dream to Discovery: On Being a Scientist*

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shiple, Arthur Everett** 1861–1927  
Zoologist

If you have a microscope and a drop or two of the right kind of dirty water you can enter a new world of interest.

*Hunting Under the Microscope* (p. 50)

The Macmillan Company. New York, New York, USA. 1928

**Strindberg, Johann** 1849–1912  
Swedish dramatist and novelist

Then, is it reasonable to think that one can see, by looking in a microscope, what is going on in another planet?

*Chief Contemporary Dramatists; Twenty Plays from the Recent Drama of England, Ireland, America, Germany, France, Belgium, Norway, Sweden, and Russia*

Translated by N. Erichsen

The Father (p. 608)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**van Leeuwenhoek, Antony** 1632–1723  
Dutch biology researcher and microscope developer

I have oft-times been besought, by divers gentlemen, to set down on paper what I have beheld through my newly invented Microscopia: but I have generally declined: first, because I have no style, or pen, wherewith to express my thoughts properly; secondly, because I have not been brought up to languages or arts, but only to business; and in the third place, because I do not gladly suffer contradiction or censure from others.

Observations Communicated to the Publisher in a Dutch Letter of the 9th of October, 1676

*Philosophical Transactions of the Royal Society of London*, Volume 12, 1677



**Whewell, William** 1794–1866  
English philosopher and historian

...if the discoveries made by the Telescope should excite in anyone's mind, difficulties respecting those doctrines of Natural Religion – the adequacy of the Creator to the support and guardianship of all the animal life which may exist in the universe – the discoveries of the Microscope may remove such difficulties: but...that train of thought which leads men to dwell upon such difficulties does not seem to be common.

*Of the Plurality of Worlds*

Chapter IV (p. 30)

John W. Parker & Son. London, England. 1853

**Wood, John George** 1827–1889  
English writer on natural history

...even to those who aspire to no scientific eminence, the microscope is more than an amusing companion, revealing many of the hidden secrets of Nature, and unveiling endless beauties which were heretofore enveloped in the impenetrable obscurity of their own minuteness...a good observer will discover with a common pocket magnifier many a secret of nature which has escaped the notice of a whole array of dilettanti microscopists in spite of all their expensive and accurate instruments.

*Common Objects of the Microscope*

Chapter I (p. 2)

George Routledge & Sons. London, England. 1861

## MICROSCOPIC

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

...nowadays, except in the outskirts of civilisation, there are few wild beasts that worry man much, the serpent that bites his heel is usually more or less microscopic ...

*Darwinism and Human Life: The South African Lectures for 1909*

Chapter VI (p. 213)

Henry Holt & Co. New York, New York, USA. 1910

## MICROSCOPIST

**O'Brien, Fitz James** 1828–62  
Author

I was like one who, having discovered the ancient Eden still existing in all its primitive glory, should resolve to enjoy it in solitude, and never betray to mortal the secret of its locality. The rod of my life was bent at this moment. I destined myself to be a microscopist.

In William Winter

*The Diamond Lens*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1928

## MIDDLE AGE

**Whewell, William** 1794–1866  
English philosopher and historian

Men [during the middle ages] forgot, or feared, to consult nature, to seek for new truths, to do what the great discoverers of other times had done; they were content to consult libraries, to study and defend old opinions, to talk of what great geniuses had said. They sought their philosophy in accredited treatises, and dared not question such doctrines as they there found.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book IV, Chapter IIV (p. 238)

John W. Parker & Son. London, England. 1857

## MIGRATION

**Allen, Glover M.** 1879–1942  
American zoologist

Mankind delights in a mystery of whatever sort, that thrill of something unknown to be discovered. For long years the migration of birds has stood as a delightful and mysterious riddle of Nature, but now bids fair to clear away and unfold more wonderful things than we dreamed of.

*Birds and Their Attributes*

Chapter XIII (p. 277)

Marshall Jones Co. Boston, Massachusetts, USA. 1925

**O'Neill, Gerard K.** 1927–92  
American physicist

Every star around us is a favorable target for human migration. You don't have to wait for just those stars that happen to have earthlike planets; they may be very few and far between.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Cosmic Colonies (p. 297)

Ticknor & Fields. New York, New York, USA. 1984

## MIMIC

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

...all this masquerade is only skin deep. The mimic never becomes the model, anymore than the walking-stick insect becomes the twig. The mask may fool the mimic's enemies, but it will not deceive a zoologist.

Is Man Alone in Space?

*Scientific American*, Volume 189, Number 1, July, 1953 (p. 84)

## MIND

**Tyndall, John** 1820–93  
Irish-born English physicist

...the human mind began its operations among the powers of Nature; winning first a little knowledge and a little strength, and then turning the knowledge and the strength so won back upon Nature, with the view of winning more. Action and reaction have thus gone on from prehistoric ages to the present time. The result is that stored body of scientific knowledge, and that developed power of scientific investigation, which have revolutionised philosophy, and begotten those marvels of practical Science in the midst of which we dwell.

*Heat A Mode of Motion* (6th edition) (pp. 1–2)

**Adams, George** 1750–95  
English instrument maker

The human mind, like a mirror, must be smoothed and polished, freed from false imaginations and perverted notions, before it is fit to receive and reflect the light of truth, and just information.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XIV (p. 101)  
Printed by R. Hindmarsh. London, England. 1794

**Albert Einstein (Fictional character)**

My mind is my office, and I take it with me wherever I go. At dinner parties, lectures, concerts – I often part company with those around me and adjourn to my office.

In Willard Simms  
*Einstein: A Stage Portrait* (p. 16)  
The Dramatic Publishing Co.

**Beck, Stanley D.**  
No biographical data available

If the human mind were to become so sluggish that it was uninterested in the mysteries of nature, insensitive to the staggering challenge of the unknown, but involved only in a menial existence of food, drink, sleep, and reproduction, man would be distinguishable from the mammalian beasts only automatically.

*The Simplicity of Science*  
Chapter I (p. 10)  
Doubleday & Company, Inc. Garden City, New York, USA. 1959

**Bernard, Claude** 1813–78  
French physiologist

The nature of our mind leads us to seek the essence or the *why* of things.

Translated by Henry C. Greene  
*An Introduction to the Study of Experimental Medicine*  
Chapter III  
Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

It is true that much time and effort is devoted to training and equipping the scientist's mind, but little attention is paid to the technique of making the best use of it.

*The Art of Scientific Investigation*  
Preface (p. iv)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

Elaborate apparatus plays an important part in the science of today, but I sometimes wonder if we are not inclined to forget that the most important instrument in research must always be the mind of man.

*The Art of Scientific Investigation*  
Preface (p. ix)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Blaise, Clarke**  
No biographical data available

Our minds soar with instant connection, but our feet are stuck in temporal boots.

*Time Lord*  
Chapter 1 (p. 19)  
Weidenfeld & Nicolson. London, England. 2000

**Boas, George** 1891–1980  
American philosopher

Though the solution of a problem may flash into the mind of the person without his knowing how it arose, nevertheless he has always done a good bit of thinking, puzzling, wondering about it before the flash occurs.

*The Inquiring Mind*  
Chapter XV (p. 397)  
Open Court Publishing Company. La Salle, Illinois, USA. 1959

**Boole, George** 1815–64  
English mathematician

To unfold the secret laws and relations of those high faculties of thought by which all beyond the merely perceptive knowledge of the world and of ourselves is attained or matured, is an object which does not stand in need of commendation to a rational mind.

*An Investigation of the Laws of Thought*  
Chapter I (p. 3)  
Walton & Maberly. London, England. 1854

**Burroughs, John** 1837–1921  
American naturalist and essayist

A mind that has a lively fancy and a sense of mystery will interpret phenomena quite differently from a mind in which these things are absent.

*Under The Apple Tree*  
Literature and Science (p. 176)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

...the great mind, like the small, experiments with different alternatives, works out their consequences for some distance, and thereupon guesses (much like a chess

player) that one move will generate richer possibilities than the rest.... It still remains to ask how the great mind comes to guess better than another, and to make leaps that turn out to lead further and deeper than yours or mine. We do not know.

*The Identity of Man* (p. 126)

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

When a supremely great creative mind is kindled, it leaves a blazing trail that remains a beacon for centuries.

Newton and Michelangelo

*Current Science*, Volume 67, Number 7, 10 October, 1994 (p. 499)

**Cobbold, Thomas Spencer** 1828–86  
English man of science

The average mind, being either essentially commercial or ridiculously sentimental, as the case may be, is totally incapable of comprehending the motive power that animates and guides the votary of science.

*Parasites*

Preface (p. vii)

J.&A. Churchill. London, England. 1879

**Darwin, Charles Robert** 1809–82  
English naturalist

My mind seems to have become a kind of machine for grinding general laws out of large collections of facts...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II, Autobiography (p. 81)

D. Appleton & Company. New York, New York, USA. 1896

But then arises the doubt, can the mind of man, which has, as I full believe, been developed from a mind as low as that possessed by the lowest animals, be trusted when it draws such grand conclusions?

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VIII (p. 282)

D. Appleton & Company. New York, New York, USA. 1896

...the difference in mind between man and the higher animals, great as it is, certainly is one of degree and not of kind.

*The Descent of Man, and Selection in Relation to Sex*

Part I, Chapter IV (p. 193)

John Murray. London, England. 1901

**Davy, Sir Humphry** 1778–1829  
English chemist

By accustoming the mind to strict reasoning, and minute observation as to matters of fact, the judgment is strengthened, and rendered more acute and distinct in its application to common affairs. Unhealthy

sensibilities are destroyed, and the imagination refined and exalted.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**de La Bruyère, Jean** 1645–96  
French philosopher, moralist, and writer

The mind, like all other things, will become impaired, the sciences are its food – they nourish, but at the same time they consume it.

Quoted in Henry Thomas Loomis

*Spelling and Letter Writing: For Use in Commercial School, Normal*

*Schools, Colleges, Academies and High Schools*

Lesson 84 (p. 60)

The Practical Textbook Company

Cleveland, Ohio, USA 1902

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

The greatest minds, as they are capable of the highest excellencies, are open likewise to the greatest aberrations ...

*Discourse on the Method of Rightly Conducting the Reason, and Seeking Truth*

Part I (p. 45)

Sutherland & Knox. Edinburgh, Scotland. 1850.

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

To a great mind, nothing is little.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Study in Scarlet*, Chapter 6 (p. 187)

Wings Books. New York, New York, USA. 1967

The true scientific mind is not to be tied down by its own conditions of time and space. It builds itself an observatory erected upon the border line of present, which separates the infinite past from the infinite future. From this sure post it makes its sallies even to the beginning and to the end of all things.

*The Poison Belt*

Chapter III

...the ideal scientific mind should be capable of thinking out a point of abstract knowledge in the interval between its owner falling from a balloon and reaching the earth. Men of this strong fiber are needed to form the conquerors of nature and the bodyguard of truth.

*The Poison Belt*

Chapter III

**Dyson, Freeman J.** 1923–  
American physicist and educator

It appears to me that the tendency of mind to infiltrate and control matter is a law of nature. The infiltration of mind into the universe will not be permanently halted by any catastrophe or by any barrier that I can imagine.

If our species does not choose to lead the way, others will do so, or may have already done so. If our species is extinguished, others will be wiser or luckier. Mind is patient. Mind has waited for 3 billion years on this planet before composing its first string quartet. It may have to wait for another 3 billion years before it spreads all over the galaxy. I do not expect that it will have to wait so long. But if necessary, it will wait. The universe is like a fertile soil spread out all around us, ready for the seeds of mind to sprout and grow. Ultimately, late or soon, mind will come into its heritage.

*Infinite in All Directions*

Part One, Chapter Six (p. 118)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

I do not make any clear distinction between mind and God. God is what mind becomes when it is passed beyond the scale of our comprehension. God may be considered to be either a world-soul or a collection of world-souls. We are the chief inlets of God on this planet at the present stage of his development.

*Infinite in All Directions*

Part One, Chapter Six (p. 119)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Scientific theories have blundered no doubt in the past; they blunder no doubt today; yet we cannot doubt that along with the error there come gleams of a truth for which the human mind is impelled to strive.

*Science and the Unseen World*

Chapter II (p. 22)

The Macmillan Company. New York, New York, USA. 1929

If we are to discern controlling laws of Nature not dictated by the mind it would seem necessary to escape as far as possible from the cut-and-dried framework into which the mind is so ready to force everything that it experiences.

*The Nature of the Physical World*

Chapter X (p. 210)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

The human mind is not capable of grasping the Universe. We are like a little child entering a huge library. The walls are covered to the ceiling with books in many different tongues. The child knows that something must have written these books. It does not know who or how. It does not understand the languages in which they are written. But the child notes a definite plan in the arrangement of the books – a mysterious order which it does not comprehend, but only dimly suspects.

In M. Taube

*Evolution of Matter and Energy*

Chapter 1 (p. 1)

Springer-Verlag. New York, New York, USA. 1985

It seems that the human mind has first to construct forms independently before we can find them in things.

*Essays in Science*

Johannes Kepler (p. 27)

Philosophical Library. New York, New York, USA. 1934

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The trained mind, alone, more discerning than our retina, sees clearly that which defies the perceptive faculties of the eye.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Appendix (p. 386)

Dodd, Mead & Co. Boston, Massachusetts, USA. 1917

**Farrar, Frederic William** 1831–1903

English clergyman and author

The mind is not only an instrument for advancing science, but, what is more to our present point, science is an instrument for advancing the mind.

*Essays on a Liberal Education* (2nd edition)

Essay Six (p. 250)

Macmillan & Co Ltd. London, England. 1868

**Feynman, Richard P.** 1918–88

American theoretical physicist

This law [the Law of Gravitation] has been called “the greatest generalization achieved by the human mind”, and you can guess already from my introduction that I am interested not so much in the human mind as in the marvel of a nature which can obey such an elegant and simple law as this law of gravitation. Therefore our main concentration will not be on how clever we are to have found it all out, but on how clever nature is to pay attention to it.

*The Character of Physical Law*

Chapter 1 (p. 14)

BBC. London, England. 1965

In this chapter we shall discuss one of the most far-reaching generalizations of the human mind. While we are admiring the human mind, we should take some time off to stand in awe of a nature that could follow with such completeness and generality such an elegantly simple principle as the law of gravitation.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

The Theory of Gravitation (p. 89)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Fiske, John** 1842–1901

American philosopher and historian

The human mind, however “scientific” its training, must often recoil from the conclusion that this is all; and there are moments when one passionately feels that this cannot be all. On warm June mornings in green country lanes,

with sweet pine-odours wafted in the breeze which sighs through the branches, and cloud-shadows flitting over far-off blue mountains, while little birds sing their love-songs, and golden-haired children weave garlands of wild roses; or when in the solemn twilight we listen to wondrous harmonies of Beethoven and Chopin that stir the heart like voices from an unseen world; at such times one feels that the profoundest answer which science can give to our questionings is but a superficial answer after all.

*The Unseen World, and Other Essays*

The Unseen World (p. 56)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1899

### **Flammarion, Camille** 1842–1925

French astronomer and writer

I have fitted your mind, my dear old friend, to receive such strange impressions as no earthly spectacle has produced or could produce.

Translated by S.R. Crocker

*Stories of Infinity: Lumen – History of a Comet – In Infinity*

Fourth Story (p. 103)

Roberts Brothers. Boston, Massachusetts, USA. 1873

The human mind is insatiable for knowledge. It is of its essence to desire to penetrate into the nature of things, and to make conjectures on all points which it cannot thoroughly comprehend.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter IV (p. 113)

Chatto & Windus. London, England. 1894

### **Fletcher, Colin** 1922–2007

English backpacker and writer

In that first moment of shock, with my mind already exploding beyond old boundaries, I knew that something had happened to the way I looked at things.

*The Man Who Walked Through Time*

The Dream (p. 6)

Alfred A. Knopf. New York, New York, USA. 1967

### **Frazer, Sir James George** 1854–1941

Scottish classicist and anthropologist

The mind of man refuses to acquiesce in the phenomena of sense. By an instinctive, an irresistible impulse it is driven to seek something beyond, something which it assumes to be more real and abiding than the shifting phantasmagoria of this sensible world.

*The Worship of Nature* (Volume 1)

Chapter I (p. 1)

Macmillan & Company Ltd. London, England. 1926

### **Galilei, Galileo** 1564–1642

Italian physicist and astronomer

And who can doubt that it will lead to the worst disorders when minds created free by God are compelled to submit slavishly to an outside will? When we are told to

deny our senses and subject them to the whim of others? When people devoid of whatsoever competence are made judges over experts and are granted authority to treat them as they please? These are the novelties which are apt to bring about the ruin of commonwealths and the subversion of the state.

Quoted in Charles Coulston Gillispie

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*

Chapter I (p. 53)

Princeton University Press. Princeton, New Jersey, USA. 1966

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

Astronomy and Pure Mathematics are the magnetic poles toward which the compass of my mind ever turns.

In Franz Schmidt and Paul Stäckel (eds.)

*Briefwechsel zwischen Carl Friedrich Gauss und Wolfgang Bolyai*

Letter XXIII, Letter to Bolyai, June 30, 1803 (p. 55)

B.G. Teubner. Leipzig, Germany. 1899

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

I shall not, either in this forum or anywhere, resolve the age-old riddle of epistemology: How can we “know” the “realities” of nature? I will, rather, simply end by restating a point well recognized by philosophers and self-critical scientists, but all too often disregarded at our peril. Science does progress toward more adequate understanding of the empirical world, but no pristine, objective reality lies “out there” for us to capture as our technologies improve and our concepts mature. The human mind is both an amazing instrument and a fierce impediment – and the mind must be interposed between observation and understanding.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Four, Chapter 16 (p. 214)

Random House, Inc. New York, New York, USA. 1995

### **Gray, David** 1838–61

Scottish poet

...does not the mind, fed with the solid acquisitions of science, or stimulated by its splendid discoveries, grow less and less tolerant of imaginings which add nothing to stock of knowledge, and melodies which convey no information?

*Letters, Poems and Selected Prose Writings of David Gray*

Science and Poetry (p. 324)

The Courier Co. Buffalo, New York, USA. 1888

### **Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

Many men have been laughed at...for gazing heavenward when their minds might have been occupied with affairs of earth. There will always be the mind that strives to reach to the skies, and the scoffer who regards all such aspirations as folly.

Two men stood looking through the bars,  
One saw mud, the other saw the stars.

*Discovery; or, The Spirit and Service of Science*

Chapter I (pp. 21–22)

Macmillan & Company Ltd. London, England. 1918

**Guillemin, Amédée** 1826–93

French journalist and scientific writer

The human mind seems so organised that it attaches itself with more obstinacy and perseverance to the pursuit of those questions which it is impossible to solve than to those which are more accessible. At the risk of a kind of intellectual vertigo, it loves to lean over the cliffs of those abysses of thought, at the bottom of which lie in confusion the solutions of so many grave problems, the origin and the end of all things, the essence of the first cause, and many other questions which are rather in the domain of metaphysics than of science.

In Norman Lockyer and Richard Anthony Proctor

*The Heavens: An Illustrated Handbook of Popular Astronomy*

(7th edition)

Part the third, V (p. 391)

Richard Bentley & Son. London, England. 1878

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Every mind should receive fair development (in good directions) for what it is capable of doing fairly well.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 8)

D. van Nostrand Co. New York, New York, USA. 1893

People who do not cultivate their minds have no conception of what they lose. They become mere eating and drinking and money-grabbing machines. And yet they seem happy! There is some merciful dispensation at work, no doubt.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 8)

D. van Nostrand Co. New York, New York, USA. 1893

**Herrick, Charles Judson** 1868–1960

American neurologist

We already know enough about our natural cosmos to be humbled by the stupendous magnitude and splendor of it and to be inspired by the realization that the human population of it plays a part in cosmic evolution that is by no means insignificant. For the mind of man, with its capacity for intelligent control of his own cultural development and of the natural resources which are available for his use, is nature's noblest product so far as we know.

*The Evolution of Human Nature*

Epilogue: The Unknown God (p. 465)

University of Texas Press. Austin, Texas, USA. 1956

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

A mind which has once imbibed a taste for scientific inquiry, and has learnt the habit of applying its principles readily to the cases which occur, has within itself an inexhaustible source of pure and exciting contemplations...

*The Cabinet of Natural Philosophy*

Part I, Chapter I, Section 11 (p. 14)

Longman, Rees, Orme, Brown & Green. London, England. 1831

**Hey, Nigel S.** 1936–

American science writer

Think of the myriad interconnected cells that we call a human being – living, dying and regenerating almost without our knowledge.... Think of the richness of their connectivity with the rest of creation. Think of their uncountable linkages with all the molecules – for example in air, in food, in water – that encounter us and enter into us almost without our knowledge, and leave us again, transformed, to visit some other resident, living or nonliving, of the world, the galaxy, the cosmos. This beautiful dance is what I see through the telescope of my mind.

*Why People Need Space*

Lecture, National Space Centre, October, 2002

**Hickok, Laurens Perseus** 1798–1888

No biographical data available

Nothing can make the journey easy to a mind that refuses to go alone and waits to be carried.

*Rational Cosmology: Or, The Eternal Principles and the Necessary*

*Laws of the Universe*

Preface (p. 7)

D. Appleton & Co. New York, New York, USA. 1858

**Hobson, Ernest William** 1856–1933

English mathematician

The habits of mind and the ideals of the mathematician and of the physicist cannot be of an identical character. The concepts of the mathematician necessarily lack, in their pure form, just that element of concreteness which is an essential condition of the success of the physicist, but which to the mathematician would often only obscure those aspects of things which it is his province to study.

Address to the Mathematical and Physical Section of the British Association for the Advancement of Science

*Science*, New Series, Volume 32, September 23, 1910 (p. 388)

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Every now and then a man's mind is stretched by a new idea or sensation, and never shrinks back to its former dimensions.

*The Autocrat of the Breakfast-Table*

Chapter XI (p. 266)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Nothing more clearly separates a vulgar from a superior mind, than the confusion in the first between the little that



it truly knows, on the one hand, and what it half knows and what it thinks it knows on the other.

*Medical Essays: 1842–1882*

Essay IV (p. 211)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

The mind, like Nature, abhors a vacuum.

*The Novels and Poems of Victor Marie Hugo* (p. 262)

Dumont, New York, New York, USA. 1896

**Humphrey, Heman**

No biographical data available

It is the intelligent and immortal mind, which pre-eminently distinguishes man from the countless forms of animated nature around him.

*Miscellaneous Discourses and Reviews*

Inaugural Discourse (p. 231)

J.S. & C. Adams. Amherst, Massachusetts, USA. 1834

...it [the mind] may be likened to a quarry of fine marble, or to a mine of the precious metals. The former never starts up spontaneously into Cyprian Venuses, nor does the latter, of its own accord, assume the shape and value of a shining currency.

*Miscellaneous Discourses and Reviews*

Inaugural Discourse (p. 232)

J.S. & C. Adams. Amherst, Massachusetts, USA. 1834

**Huxley, Thomas Henry** 1825–95

English biologist

The mind is so constituted that it does not willingly rest in facts and immediate causes, but seeks always after a knowledge of the remoter links in the chain of causation.

*Discourses Biological and Geological*

On a Piece of Chalk

D. Appleton & Company, New York, New York, USA. 1897

**Jevons, William Stanley** 1835–82

English economist and logician

Summing up, then, it would seem as if the mind of the great discoverer must combine contradictory attributes. He must be fertile in theories and hypotheses, and yet full of facts and precise results of experience. He must entertain the feeblest analogies, and the merest guesses at truth, and yet he must hold them as worthless till they are verified in experiment. When there are any grounds of probability he must hold tenaciously to an old opinion, and yet he must be prepared at any moment to relinquish it when a clearly contradictory fact is encountered.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XXVI (p. 592)

Macmillan & Company Ltd. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

...the truth is, that the knowledge of external nature, and the sciences which that knowledge requires or includes, are not the great or the frequent business of the human mind.

In Arthur Murphy

*The Works of Samuel Johnson* (Volume 2)

*Milton* (p. 25)

Alexander van Blake, Publisher. New York, New York, USA. 1838

**Kepler, Johannes** 1571–1630

German astronomer

A mind accustomed to mathematical deduction, when confronted with the faulty foundations [of astrology] resists a long, long time, like an obstinate mule, until compelled by beating and curses to put its foot into that dirty puddle.

In Arthur Koestler

*The Sleepwalkers*

Part Four, Chapter I, Section 5 (p. 243)

The Macmillan Company. New York, New York, USA. 1966

**Klein, Felix** 1849–1925

German mathematician

Apart from the fact that pure mathematics cannot be supplanted by anything else as a means for developing the purely logical powers of the mind, there must be considered here as elsewhere the necessity of the presence of a few individuals in each country developed in a far higher degree than the rest, for the purpose of keeping up and gradually raising the general standard. Even a slight raising of the general level can be accomplished only when some few minds have progressed far ahead of the average.

*The Evanston Colloquium: Lectures on Mathematics Delivered from*

*Aug. 28 to Sept. 9, 1893*

Lecture VI (p. 49)

American Mathematical Association. New York, New York, USA. 1911

**Land, Edwin** 1909–91

American scientist and inventor

Each stage of human civilization is defined by our mental structures: the concepts we create and then project upon the universe. They not only redescribe the universe but also in so doing modify it, both for our own time and for subsequent generations. This process – the revision of old cortical structures and the formulation of new cortical structures whereby the universe is defined – is carried on in science and art by the most creative and talented minds in each generation...

Remarks at Opening of New American Academy of Arts and Sciences

Cambridge, Massachusetts April 2, 1979

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The mind has its illusions as the sense of sight; and in the same manner that the sense of feeling corrects the latter, reflection and calculation correct the former.

Translated by Frederick Wilson Truscott and Frederick Lincoln  
*A Philosophical Essay on Probabilities*  
 Chapter XVI (p. 160)  
 John Wiley & Sons. New York, New York, USA. 1902

**Lorentz, Hendrik Antoon** 1853–1928  
 Dutch physicist

We wish to obtain a representation of phenomena and form an image of them in our minds. Till now, we have always attempted to form these images by means of the ordinary notions of time and space. These notions are perhaps innate; in any case they have been developed by our daily observations. For me, these notions are clear, and I confess that I am unable to gain any idea of physics without them.... For me, an electron is a corpuscle which at any given instant is situated at a determinate point of space, and if I believe that at the following instant this corpuscle is situated elsewhere, I attempt to imagine its path, which is a line in space. And if this electron meets an atom and penetrates into its interior and, after several adventures, leaves the atom, I attempt to construct a theory in which this electron has retained its individuality... I would like to retain this ideal of other days and describe everything that occurs in this world in terms of clear pictures.

In A. d'Abro  
*The Rise of the New Physics* (Volume One)  
 Chapter XIII (p. 108)  
 Dover Publications, Inc. New York, New York, USA. 1951

**Lovecraft, H. P. (Howard Phillips)** 1890–1937  
 American writer of fantasy, horror, and science fiction

The most merciful thing in the world, I think, is the inability of the human mind to correlate all its contents. We live on a placid island of ignorance in the midst of black seas of infinity, and it was not meant that we should voyage far. The sciences, each straining in its own direction, have hitherto harmed us little; but someday the piecing together of dissociated knowledge will open such terrifying vistas of reality, and of our own frightful position therein, that we shall either go mad from the revelation or flee from the deadly light into the peace and safety of a new dark age.

*The Call of Cthulhu*  
 The Horror in Clay (p. 139)  
 Penguin Books. New York, New York, USA. 1999

**Lucretius** ca. 99 BCE–55 BCE  
 Roman poet

Give your mind now to the true reasoning I have to unfold. A new fact is battling strenuously for access to your ears. A new aspect of the Universe is striving to reveal itself. But no fact is so simple that it is not harder to believe than to doubt at the first presentation.

*On the Nature of the Universe*  
 Book II, l. 1023  
 Penguin Books. New York, New York, USA. 1994

**Lyell, Sir Charles** 1797–1875  
 English geologist

...although we are mere sojourners on the surface of the planet, chained to a mere point in space, enduring but for a moment of time, the human mind is not only enabled to number worlds beyond the unassisted ken of mortal eye, but to trace the events of indefinite ages before the creation of our race, and is not even withheld from penetrating into the dark secrets of the ocean, or the interior of the solid globe ...

*Principles of Geology*  
 Chapter IX (p. 166)  
 John Murray. London, England. 1830

**Mach, Ernst** 1838–1916  
 Austrian physicist and philosopher

When the human mind, with its limited powers, attempts to mirror in itself the rich life of the world, of which it is itself only a small part, and which it can never hope to exhaust, it has every reason for proceeding economically.

*Popular Scientific Lectures*  
 The Economical Nature of Physical Inquiry (p. 186)  
 The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**McCormick, Leander Hamilton** 1859–1934  
 American author, inventor, and scientist

The home of the reasoning mind is out among the stars, in the vast unknown.

*Characterology*  
 Chapter XXVI (p. 599)  
 Rand McNally & Co. Chicago, Illinois, USA. 1920

**Mellor, Joseph William** 1863–1938  
 Chemist

It requires a mind disciplined like a soldier to avoid the natural inclination to look away from unwelcome facts.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
 (Volume 1)  
 Chapter I (p. 7)  
 Longman, Green & Co. London, England. 1922

**Mitchel, Ormsby MacKnight** 1805–62  
 American astronomer

...the mind is ever inquisitive, ever ready to attempt to scale the most rugged steeps. Wake up its enthusiasm – fling the light of hope on its pathway, and no matter how rough, and steep, and rocky it may prove, onward! is the word which charms its willing powers.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Agronomy*  
 Introductory lecture (p. 20)  
 Baker & Scribner. New York, New York, USA. 1848

**Moore, Benjamin** 1745–1816  
 Episcopal writer and professor of rhetoric

Whether the human mind be dealing with the problems of some branch of natural science, or constructing systems

of ethics, philosophy, or religion, it is equally essential to clothe its thoughts in language derived from those things in the material world which appeal to the human senses.

*The Origin and Nature of Life*

Chapter I

Henry Holt & Co. New York, New York, USA.

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

But to reason and to arrange are very different occupations of the mind; and a man may deserve praise as a mineralogist, who is but ill qualified for the researches of geology.

*Illustrations of the Huttonian Theory of the Earth*

Section 422 (p. 482)

Dover Publications, Inc. New York, New York, USA. 1964

**Puiseux, P.**

No biographical data available

It is an illogical peculiarity of the human mind that while it cannot comprehend an infinite universe it readily refuses to limit it.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1912*

The Year's Progress in Astronomy (p. 135)

Government Printing Office. Washington, D.C. 1913

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

The powers of the human mind, if not infinite, may admit of infinite culture. What is supposed to be “unknowable” may, therefore, become known. However this may be, there is no divine injunction which prescribes a limit to human possibilities.

*Nature and Culture*

Chapter 1 (p. 7)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**Rosseland, Svein** 1894–1985

Norwegian astronomer

Who has not experienced the mysterious thrill of spring-time in a forest, with sunbeams flickering through the foliage, and the low humming of insect life? It is the feeling of unity with nature, which is the counterpart of the attitude of the scientist, analysing the sunbeams into light quanta and the soft rustling of the dragon-fly into condensations and rarefactions of the air. But what is lost in fleeting sentiment is more than regained in the feeling of intellectual security afforded by the scientific attitude, which may grow into a trusting devotion, challenging the peace of the religious mystic. For in the majestic growth of science, analytical in its experimental groping for detail, synthetic in its sweeping generalizations, we are watching at least one aspect of the human mind, which may be believed to have a future of dizzy heights and nearly unlimited perfectibility.

*Theoretical Astrophysics: Atomic Theory and the Analysis of Stellar Atmospheres and Envelopes*

Introduction (p. xi)

At The Clarendon Press. Oxford, England. 1936

**Rowland, Henry Augustus** 1848–1901

American physicist

I value in a scientific mind, most of all, that love of truth, that care in its pursuit, and that humility of mind which makes the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it today offers to the world the most complete monument to human reason.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (pp. 26–27)

Macmillan & Company Ltd. London, England. 1918

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The mind of the most rational among us may be compared to a stormy ocean of passionate convictions based upon desire, upon which float perilously a few tiny boats carrying a cargo of scientifically tested beliefs. Nor is this to be altogether deplored: life has to be lived, and there is no time to rest rationally all the beliefs by which our conduct is regulated. Without a certain wholesome rashness, no one could long survive. Scientific Method, therefore, must in its very nature, be confined to the more solemn and official of our opinions.

*The Scientific Outlook* (p. 14)

**Smollett, Tobias George** 1721–71

Scottish novelist

I find my spirits and my health affect each other reciprocally – that is to say, everything that decomposes my mind produces a correspondent disorder in my body; and my bodily complaints are remarkably mitigated by those considerations that dissipate the clouds of mental chagrin.

*The Works of Tobias Smollett* (Volume 6)

*The Expedition of Humphry Clinker* (p. 2340)

John D. Morris & Company. Philadelphia, Pennsylvania, USA. 1902

**Spencer, Herbert** 1829–1903

English social philosopher

If we imagine that into a gorgeously-decorated hall a rush-light is brought, and being held near to some part of the wall, makes visible the pattern over a small area of it, while everything else remains in darkness; arid if, instead of this, we imagine that electric lights turned on reveal simultaneously the whole room with its varied contents; we may form some idea of the different appearance under which Nature is contemplated by

the utterly uncultured mind and by the highly cultured mind.

*The Inductions of Ethics: And The Ethics of Individual Life*

(pp. 517–518)

D. Appleton & Co. New York, New York, USA. 1892

**Stewart, Dugald** 1753–1828

Scottish philosopher

In mathematics, on the other hand, and in natural philosophy since mathematics was applied to it, we see the noblest instances of the force of the human mind, and of the sublime heights to which it may rise by cultivation.

*Elements of the Philosophy of the Human Mind*

Part Third, Chapter I, Section III (p. 182)

Carey, Lea & Carey. Philadelphia, Pennsylvania, USA. 1827

**Stokes, Sir George** 1819–1903

English mathematician and physicist

When from the phenomena of life we pass on to those of mind, we enter a region still more profoundly mysterious. We can readily imagine that we may here be dealing with phenomena altogether transcending those of mere life, in some such way of those of life transcend, as I have endeavored to infer, those of chemistry and molecular attractions, or as the laws of chemical affinity in their turn transcend those of mere mechanics. Science can be expected to do but little to aid us here, since the instrument of research is itself the object of investigation. It can but enlighten us as to the depth of our ignorance, and lead us to look to a higher aid for that which most nearly concerns our well-being.

British Association, Meeting at Exeter

*Journal of Botany, British and Foreign*, Volume 7 1869 (p. 288)

**Thompson, Sir J. Arthur** 1861–93

Scottish biologist

The simple and open mind is always impressed by the bigness of Nature.

*The Bible of Nature*

Chapter I (p. 9)

Charles Scribner's Sons. New York, New York, USA. 1908

**Thomson, Sir Joseph John** 1856–1949

English physicist

There is a widespread belief that the mind itself is desperately speculative, that it is only kept from wild imaginings by the control of its stolid and prosaic partner, the physical facts. The true state of affairs is, I think, that it is the mind which acts as the brake in this combination, that the impulsive partner is the facts, and that these spur on the mind to take leaps which it would shudder at when not under the influence of this stimulus.

*The Atomic Theory* (p. 4)

Clarendon Press. 1914

**Tyndall, John** 1820–93

Irish-born English physicist

The mind of man may be compared to a musical instrument with a certain range of notes, beyond which in both directions we have an infinitude of silence.

*Fragments of Science for Unscientific People*

Chapter IV (p. 93)

D. Appleton & Co. New York, New York, USA. 1875

As the eye is formed to see, and the ear to hear, so the human mind is formed to explore and understand the basis and relationship of natural phenomena.

*Heat a Mode of Motion* (6th edition)

Lecture I (p. 1)

D. Appleton & Co. New York, New York, USA. 1915

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

That which, in the vagueness of our impressions, loses all distinctness of form, like some distant mountain shrouded from view by a veil of mist, is clearly revealed by the light of mind, which, by its scrutiny into the causes of phenomena, learns to resolve and analyze their different elements, assigning to each its individual character.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (pp. 33–34)

Harper & Brothers, Publishers. New York, New York, USA. 1869

When the human mind first attempts to subject to its control the world of physical phenomena, and strives by meditative contemplation to penetrate the rich luxuriance of living nature, and the mingled web of free and restricted natural forces, man feels himself raised to a height from whence, as he embraces the vast horizon, individual things blend together in varied groups, and appear as if shrouded in a vapory veil.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Delineation of Nature. General Review of Natural Phenomena (p. 79)

Harper & Brothers. New York, New York, USA. 1869

...besides the pleasure derived from acquired knowledge, there lurks in the mind of man, and tinged with a shade of sadness, an unsatisfied longing for something beyond the present – a striving towards regions yet unknown and unopened.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Delineation of Nature. General Review of Natural Phenomena (p. 80)

Harper & Brothers, Publishers. New York, New York, USA. 1869

**von Liebig, Justus** 1803–73

German organic chemist

Every experimental method comes to an end when the senses are no longer sufficient for the perception of facts; when no new circumstance is presented to the senses for perception; when, in short, everything has been tried, and the facts resulting from such trials have been adopted into the particular art or trade. Further progress can then only be looked for, if hidden facts are sought out, the senses are sharpened for their perception, and the means of investigation are improved. But such a course is not

possible without reflection, without the mind also taking its share in the operation.

In John Blyth

*Letters on Modern Agriculture*

Letter I (p. 5)

Walton & Maberly. London, England. 1859

**von Schelling, Friedrich Wilhelm Joseph** 1775–1854  
German philosopher

When the human mind first attempts to subject to its control the world of physical phenomena, and strives by meditative contemplation to penetrate the rich luxuriance of living nature, and the mingled web of free and restricted natural forces, man feels himself raised to a height from whence, as he embraces the vast horizon, individual things blend together in varied groups, and appear as if shrouded in a vapory veil.

In Alexander von Humboldt

*Cosmos* (Volume I)

Chapter I (p. 62)

Henry G. Bohn. London, England. 1849

**Waddington, Conrad Hal** 1905–75  
British biologist and paleontologist

We are part of nature, and our mind is the only instrument we have, or can conceive of, for learning about nature or about ourselves.

*The Nature of Life*

Chapter 5 (p. 124)

Harper & Row, Publishers. New York, New York, USA. 1960

**Weidlein, Edward Ray**  
Chemical engineer

The endless frontiers of science now stretching to the stars can provide rich opportunities for the best creative minds.

Cooperation – A Responsibility of the Scientist

*American Scientist*, March, 1962 (p. 35)

**Weinberg, Steven** 1933–  
American nuclear physicist

...I do not believe that scientific progress is always best advanced by keeping an altogether open mind. It is often necessary to forget one's doubts and to follow the consequences of one's assumptions wherever they may lead – the great thing is not to be free of theoretical prejudices, but to have the right theoretical prejudices. And always, the test of any theoretical preconception is where it leads.

*The First Three Minutes*

Chapter V (p. 119)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

## MIND AND MATTER

**Dircks, Henry** 1806–73  
English engineer

Every sentient being, from the first dawn of intelligence, recognises the existence of mind and matter; of an inner and an outer world ; or, to adopt the quaint phraseology of the past, a microcosm and a macrocosm.

*Nature-study*

Chapter I (p. 1)

E. Moxon, Son & Co. London, England. 1869

## MIND, HUMAN

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Does the harmony the human intelligence thinks it discovers in nature exist outside of this intelligence? No, beyond doubt, a reality completely independent of the mind which conceives it, sees or feels it, is an impossibility.

Translated by George Bruce Halsted

*The Value of Science*

Introduction (p. 14)

The Science Press. New York, New York, USA. 1907

## MIND, PEASANT'S

**Newton, Charles Thomas** 1816–94  
English archaeologist

The peasant's mind reflects what has been rather than what is. It revolves in the same circle as the more cultivated mind of the nation, but at a much slower rate. On the great dial-plate of time, one is the hour-hand while the other is the minute-hand.

*Essays on Art and Archaeology*

On the Studies of Archaeology (p. 6)

Macmillan & Company Ltd. London, England. 1880

## MIND, SCIENTIFIC HABIT OF

**Pearson, Karl** 1857–1936  
English mathematician

The scientific habit of mind is one which may be acquired by all, and the readiest means of attaining to it ought to be placed within the reach of all.

*The Grammar of Science* (2nd edition)

Chapter I (p. 7)

Adam & Charles Black. London, England. 1900

## MIND, UNSCIENTIFIC

**Rowland, Henry Augustus** 1848–1901  
American physicist

...the unscientific mind differs from the scientific in this, that it is willing to accept and make statements of which it has no clear conception to begin with and of

whose truth it is not assured. It is an irresponsible state of mind without clearness of conception, where the connection between the thought and its object is of the vaguest description. It is the state of mind where opinions are given and accepted without ever being subjected to rigid tests, and it may have some connection with that state of mind where everything has a personal aspect and we are guided by feelings rather than reason.

*The Physical Papers of Henry Augustus Rowland*

The Physical Laboratory in Modern Education (p. 615)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

## MIND'S EYE

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The first look at the world, by the mind's eye, as well as by the bodily organs of vision, conveys no distinct impression, either to our heads or to our hearts. We see things without perceiving them, and it takes a long time before we learn to understand the things we see.

Translated by Otto Wenckstern

*Goethe's Opinions on the World, Mankind, Literature, Science, and Art* (p. 23)

John W. Parker & Son. London, England. 1853

## MIND-STUFF

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...the stuff of the world is mind-stuff.... The mind-stuff is not spread in space and time...

*The Nature of the Physical World*

Chapter XIII (pp. 276, 277)

The University Press. New York, New York, USA. 1929

## MINE

**Agricola, Georgius** 1494–1555

German mineralogist

...of all ways whereby great wealth is acquired by good and honest means, none is more advantageous than mining; for although from fields which are well tilled (not to mention other things) we derive rich yields, yet we obtain richer products from mines; in fact, one mine is often much more beneficial to us than many fields.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Preface (p. xxv)

The Mining magazine

London, England. 1912

## MINER

**Agricola, Georgius** 1494–1555

German mineralogist

...a miner must have the greatest skill in his work, that he may know first of all what mountain or hill, what valley or plain, can be prospected most profitably, or what he should leave alone; moreover, he must understand the veins, stringers and seams in the rocks. Then he must be thoroughly familiar with the many and varied species of earths, juices, gems, stones, marbles, rocks, metals, and compounds.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (p. 1)

The Mining magazine

London, England. 1912

...there are many arts and sciences of which a miner should not be ignorant. First there is Philosophy, that he may discern the origin, cause, and nature of subterranean things; for then he will be able to dig out the veins easily and advantageously, and to obtain more abundant results from his mining. Secondly, there is Medicine, that he may be able to look after his diggers and other workmen, that they do not meet with those diseases to which they are more liable than workmen in other occupations, or if they do meet with them, that he himself may be able to heal them or may see that the doctors do so. Thirdly follows Astronomy, that he may know the divisions of the heavens and from them judge the direction of the veins. Fourthly, there is the science of Surveying that he may be able to estimate how deep a shaft should be sunk to reach the tunnel which is being driven to it, and to determine the limits and boundaries in these workings, especially in depth. Fifthly, his knowledge of Arithmetical Science should be such that he may calculate the cost to be incurred in the machinery and the working of the mine. Sixthly, his learning must comprise Architecture, that he himself may construct the various machines and timber work required underground, or that he may be able to explain the method of the construction to others. Next, he must have knowledge of Drawing, that he can draw plans of his machinery. Lastly, there is the Law, especially that dealing with metals, that he may claim his own rights, that he may undertake the duty of giving others his opinion on legal matters, that he may not take another man's property and so make trouble for himself, and that he may fulfill his obligations to others according to the law.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (pp. 3–4)

The Mining magazine

London, England. 1912

Those who think mining of no advantage to the men who follow the occupation assert, first, that scarcely one in a hundred who dig metals or other such things derive profit there from; and again, that miners, because they entrust their certain and well-established wealth to dubious and slippery fortune, generally deceive themselves, and as a



result, impoverished by expenses and losses, in the end spend the most bitter and most miserable of lives.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (pp. 4–5)

The Mining magazine

London, England. 1912

**Simonin, Louis** 1830–86

French mineralogist

See those men who emerge from the shaft in the dusk of the evening, walking with heavy tread, with blackened faces, with clothes and hats wet and covered with mud. Where are they going? They rejoin their families in calmness and silence. Recognize in them the obscure and manly combatants of the abyss, the pioneers of the subterranean world.

*Underground Life: or, Mines and Miners*

Chapter XI (p. 230)

Chapman & Hall. London, England. 1869

## MINERAL

**Agricola, Georgius** 1494–1555

German mineralogist

The earth does not conceal and remove from our eyes those things which are useful and necessary to mankind, but on the contrary, like a beneficent and kindly mother she yields in large abundance from her bounty and brings into the light of day the herbs, vegetables, grains, and fruits, and the trees. The minerals on the other hand she buries far beneath in the depth of the ground; therefore, they should not be sought. But they are dug out by wicked men who, as the poets say, are the products of the Iron Age.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (pp. 6–7)

The Mining magazine

London, England. 1912

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

These [clay, lime and flint] being what we have usually to deal with, Nature seems to have set herself to make these three substances as interesting to us, and as beautiful for us, as she can. The clay, being a soft and changeable substance, she doesn't take much pains about, as we have seen, till it is baked; she brings the colour into it only when it receives a permanent form. But the limestone and flint she paints, in her own way, in their native state: and her object in painting them seems to be much the same as in her painting of flowers; to draw us, careless and idle human creatures, to watch her a little, and see what she is about ...

*The Complete Works of John Ruskin*

*Iron, in Nature, Art, and Policy* (p. 109)

Rehwee, Wattle & Walsh. Philadelphia, Pennsylvania, USA. 1891

## Smith, Godfrey

Human life would certainly have enjoyed more innocence and satisfaction, were it not for the riches and luster which nature dazzles their eyes with, and makes them indefatigable searchers into the innermost recesses of the earth, to her hidden treasures.

*The Laboratory; or, School of Arts*

Appendix

Of Mines and How to Discover Them

Printed by C. Whittingham. London, England. 1799

## Streeter, Edwin William

No biographical data available

It is a familiar fact that Organic Nature does not present an equal development of life in every part of the world. Each country – or at least each zone of climate – has its own fauna and flora – Its peculiar assemblage of animals and plants. No one needs to be reminded that the animals and plants of the tropics are widely different from those of temperate zones, while these again differ from those of the Polar regions. But when we turn to the Inorganic world, we fail to detect any similar laws of distribution. Climate, so far as we know, is without sensible effect on the development of minerals and rocks.

*Precious Stones and Gems: Their History, Sources and Characteristics*

(6th edition)

Section I, Chapter II (p. 5)

George Bell & Sons. London, England. 1898

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

ADAMANT, n. A mineral frequently found beneath a corset. Soluble in solicitate of gold.

*The Collected Works of Ambrose Bierce*

*The Devil's Dictionary* (p. 19)

The Neale Publishing Co. New York, New York, USA. 1911

## FICTITIOUS MINERALS

### ADAMANT

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

ADAMANT, n. A mineral frequently found beneath a corset. Soluble in solicitate of gold.

*The Collected Works of Ambrose Bierce*

*The Devil's Dictionary* (p. 19)

The Neale Publishing Co. New York, New York, USA. 1911

## BILITERIUM

### de Fourestier, Jeffrey

No biographical data available

A scarce lucent crystalline aggregate which can be transformed into a powerful explosive using an antimatter converter.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 9)

**BORONITE****de Fourestier, Jeffrey**

No biographical data available

A rare mineral used to construct Vostigye space stations. It is the only raw material that can be used to create Omega molecules.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 9)

**CAVORITE****Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

On the 14th of October 1899 this [Cavorite an artificial mineral that possesses anti-gravity properties] incredible substance was made!

*The First Men in the Moon*

Chapter II (p. 28)

George Newnes. London, England. 1901

**DENIVAN CRYSTAL****de Fourestier, Jeffrey**

No biographical data available

Valuable and illicit iridescent white crystals. They form sprays of sharply terminated elongate opaque crystals.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 10)

**DILITHIUM****de Fourestier, Jeffrey**

No biographical data available

Rare and incalculably valuable crystalline mineral used as the primary element in the matter/antimatter reactors necessary for warp speed travel.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 10)

**FORTANIUM****de Fourestier, Jeffrey**

No biographical data available

A mineral that occurs in the core of a comet.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 11)

**KEMACITE****de Fourestier, Jeffrey**

No biographical data available

Hazardous, unpredictable substance associated with temporal incidents, which if exploded, can send someone back in time.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 12)

**NEUTRONIUM****de Fourestier, Jeffrey**

No biographical data available

A naturally occurring, very dense and strong mineral composed of densely packed neutrons held together by gravity.

The Mineralogy of Star Trek

*Axis*, Volume 1, Number 3, 2005 (p. 13)

**REAL MINERALS****ALABASTER****Flaubert, Gustave** 1821–90

French novelist

Alabaster. Its use is to describe the most beautiful parts of a woman's body.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**AMBER****Herrick, Robert** 1591–1674

English poet

I saw a flie within a beade

Of amber cleanly buried.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

The Amber Bead

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Pope, Alexander** 1688–1744

English poet

Pretty! in amber to observe the forms

Of hairs, or straws, or dirt, or grubs, or worms!

The things, we know, are neither rich nor rare,

But wonder how the devil they got there.

*The Complete Poetical Works*

Epistle to Arbuthnot, l. 169

Houghton Mifflin Company. New York, New York, USA. 1903

**AMETHYST****The Bible (King James Version)**

And the foundations of the wall of the city were garnished with all manner of precious stones. The first foundation

was jasper; the second, sapphire; the third, a chalcedony; the fourth, an emerald;... the twelfth, an amethyst.

Revelation 21:19–20

## CHALK

**Huxley, Thomas Henry** 1825–95

English biologist

A great chapter of the history of the world is written in the chalk. Few passages in the history of man can be supported by such an overwhelming mass of direct and indirect evidence as that which testifies to the truth of the fragment of the history of the globe.... Let me add, that few chapters of human history have a more profound significance for ourselves. I weigh my words well when I assert, that the man who should know the true history of the bit of chalk which every carpenter carries about in his breeches-pocket, though ignorant of all other history, is likely, if he will think his knowledge out to its ultimate results, to have a truer, and therefore a better, conception of this wonderful universe, and of man's relation to it, than the most learned student who is deep-read in the records of humanity and ignorant of those of Nature.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 4)

Macmillan & Company Ltd. London, England. 1904

The earth, from the time of the chalk to the present day, has been the theater of a series of changes as vast in their amount as they were slow in their progress. The area on which we stand has been first sea and then land for at least four alterations and has remained in each of these conditions for a period of great length.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 29)

Macmillan & Company Ltd. London, England. 1904

A small beginning has led us to a great ending. If I were to put the bit of chalk with which we started into the hot but obscure flame of burning hydrogen, it would presently shine like the sun. It seems to me that this physical metamorphosis is no false image of what has been the result of our subjecting it to a jet of fervent, though nowise brilliant, thought to-night. It has become luminous, and its clear rays, penetrating the abyss of the remote past, have brought within our ken some stages of the evolution of the earth. And in the shifting "without haste, but without rest" of the land and sea, as in the endless variation of the forms assumed by living beings, we have observed nothing but the natural product of the forces originally possessed by the substance of the universe.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 36)

Macmillan & Company Ltd. London, England. 1904

## COAL

**Huxley, Thomas Henry** 1825–95

English biologist

The position of the beds which constitute the coal-measures is infinitely diverse. Sometimes they are tilted up vertically, sometimes they are horizontal, sometimes curved into great basins; sometimes they come to the surface, sometimes they are covered up by thousands of feet of rock. But, whatever their present position, there is abundant and conclusive evidence that every under-clay was once a surface soil. Not only do carbonized root-fibers frequently abound in these under-clays; but the stools of trees, the trunks of which are broken off and confounded with the bed of coal, have been repeatedly found passing into radiating roots, still embedded in the under-clay. On many parts of the coast of England, what are commonly known as "submarine forests" are...seen at low water. They consist, for the most part, of short stools of oak, beech, and fir-trees, still fixed by their long roots in the bed of blue clay in which they originally grew. If one of these submarine forest beds should be gradually depressed and covered up by new deposits, it would present just the same characters as an under-clay of the coal, if the *Sigillaria* and *Lepidodendron* of the ancient world were substituted for the oak, or the beech, of our own times.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On the Formation of Coal (p. 147)

Macmillan & Company Ltd. London, England. 1904

## CRYSTAL

**Bergman, Torbern Olaf** 1735–84

Swedish chemist and naturalist

Crystals are bodies which, though destitute of organic structure, yet externally resemble geometrical figures more or less regular.

Quoted in Joseph William Mellor

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry* (Volume 1)

Chapter XI (p. 597)

Longman, Green, & Co. London, England. 1922

**Čapek, Karel** 1890–1938

Czechoslovakian author

There are crystals as big as cathedral pillars, delicate as mildew and sharp as needles; plain, blue, green like nothing in the world, of fiery colours or black; mathematical, perfect, like the contrivances of queer and bewildered sages; or recalling livers, hearts, gigantic human organs and animal fluids.

*Letters from England* (p. 44)

Doubleday, Page & Co. Garden City, New York, USA. 1924

**Davidson, John** 1857–1909  
Scottish poet

“Who affirms that crystals are alive?”  
I affirm it, let who will deny:  
Crystals are engendered, wax and thrive,  
Wane and wither; I have seen them die.

*Fleet Street: And Other Poems*

Snow

Grant Richards. London, England. 1909

**Hauy, Abbé René Just** 1743–1822  
French mineralogist

A casual glance at crystals may lead to the idea that they were sports of nature, but this is simply an eloquent way of declaring our ignorance. With a thoughtful examination of them, we discover laws of arrangement.... How variable, and at the same time how precise and regular are these laws! How simple they are ordinarily, without losing anything of their significance.

*Traité de Minéralogie* (p. xiii)

Chez Louis. Paris, France. 1801

**Hearn, Lafcadio** 1850–1904  
Writer, translator, and teacher

I feel like a white granular mass of amorphous crystals – my formula appears to be isomeric with Spasmotoxin. My aurochloride precipitates into beautiful prismatic needles. My Platinochloride develops octohedron crystals, with fine blue florescence. My physiological action is not indifferent. One millionth of a grain injected under the skin of a frog produced instantaneous death accompanied by an orange blossom odor.

In Elizabeth Bisland

*The Life and Letters of Lafcadio Hearn* (Volume 1)

Letter to George M. Gould, 1889 (p. 462)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Mann, Thomas** 1875–1955  
German-born American novelist

I shall never forget the sight. The vessel of crystallization was three-quarters full of slightly muddy water – that is, dilute water-glass – and from the sandy bottom there strove upwards a grotesque little landscape of variously colored growths: a confused vegetation of blue, green, and brown shoots which reminded one of algae, mushrooms, attached polyps, also moss, then mussels, fruit pods, little trees or twigs from trees, here, and there of limbs. It was the most remarkable sight I ever saw, and remarkable not so much for its profoundly melancholy nature.”

*Doktor Faustus*

Chapter III (p. 19)

Alfred A. Knopf. New York, New York, USA. 1948

**Marx, Carl M.**  
No biographical data available

In these crystalline structures, the formative forces of the earth seem to manifest themselves most directly, as if they were merely slumbering lightly beneath the rigid surface, resting from the first day of creation.

In Norman E. Emerton

*The Scientific Reinterpretation of Form*

Chapter One (p. 19)

Cornell University Press. Ithaca, New York, USA. 1984

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

The mineral crystals group themselves neither in succession, nor in sympathy; but great and small recklessly strive for place, and deface or distort each other as they gather into opponent asperities. The confused crowd fills the rock cavity, hanging together in a glittering, yet sordid heap, in which nearly every crystal, owing to their vain contention, is imperfect, or impure. Here and there one, at the cost and in defiance of the rest, rises into unwarped shape or unstained clearness.

*Modern Painters* (Volume 5)

Chapter IV, Part 6 (p. 33)

John Wiley & Sons. New York, New York, USA. 1879

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Tyndall declared that he saw in Matter the promise and potency of all forms of life, and with his Irish graphic lucidity made a picture of a world of magnetic atoms, each atom with a positive and a negative pole, arranging itself by attraction and repulsion in orderly crystalline structure. Such a picture is dangerously fascinating to thinkers oppressed by the bloody disorders of the living world. Craving for purer subjects of thought, they find in the contemplation of crystals and magnets a happiness more dramatic and less childish than the happiness found by mathematicians in abstract numbers, because they see in the crystals beauty and movement without the corrupting appetites of fleshly vitality.

*Back to Methuselah*

Preface (pp. lxii–lxiii)

Constable & Company Ltd. London, England. 1921

**Thompson, Sir D’Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

Crystals lie outside the province of this book; yet snow-crystals, and all the rest besides, have much to teach us about the variety, the beauty and the very nature of form.

*On Growth and Form* (Volume 2)

Chapter IX (p. 696)

At The University Press. Cambridge, England. 1951

**DIAMOND**

**Crookes, Sir William** 1832–1919  
English chemist and physicist

I think, without exception, the diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence.

In James Samuelson and William Crookes  
Chapter IV

Modern Physics in High Vacua  
*The Journal of Science, and Annals of Astronomy, Biology, Geology,*  
Volume 1, (Third series) June, 1879 (p. 426)

**Fleming, Ian** 1908–64  
English author, journalist, and ex-Navy Commander

It was domination by a beauty so pure that it held a kind of truth, a divine authority before which all other material things turned, like the bit of quartz, to clay. In these few minutes Bond understood the myth of diamonds, and he knew that he would never forget what he had suddenly seen inside the heart of this stone.

*Diamonds Are Forever*  
Film (1971)

Bond put down the piece of quartz and gazed again into the heart of the diamond. Now he could understand the passion that diamonds had inspired through the centuries.... It was domination by a beauty so pure that it held a kind of truth, a divine authority before which all other material things turned, like the bit of quartz, to clay. In these few minutes Bond understood the myth of diamonds, and he knew that he would never forget what he had suddenly seen inside the heart of this stone.

*Diamonds are Forever*  
Chapter II (p. 10)  
The Macmillan Co. New York, New York, USA. 1956

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

Perhaps time's definition of coal is the diamond.  
*Sand and Foam: A Book of Aphorisms* (p. 55)  
Alfred A. Knopf. New York, New York, USA. 1959

**Hershey, Willard**  
No biographical data available

From the earliest times the diamond has fascinated mankind. The diamond is the best known and most admired ornament which Nature has provided for man, "a thing of beauty and a joy forever." Of many of her beauties, Nature gives us glimpses only. The diamond sparkles and flashes whenever and wherever the light finds it, while the generations which successively enjoy its beauty fade and are forgotten.

*Book of the Diamond*  
Chapter I (p. 9)  
Hearthside Press. New York, New York, USA. 1940

**King, Charles William** 1818–88  
English writer

The Diamond, true king of gems, not content with its own inimitable purity, takes a pleasure, as it were, to assume in turns the proper colours of its subject-classes, and again to surpass each one in its own peculiar excellence.

*The Natural History, Ancient and Modern, of Precious Stones and Gems, and of the Precious Metals*  
Adamus (p. 60)  
Bell & Daldy. London, England. 1867

**McCarthy, James Remington**  
No biographical data available

...out of this heat and pressure came what are known as igneous rocks and out of these rocks – although of this no man is sure – came something else, the product of Time and Nature, which kept crowding carbon atoms together in a compact mass, trapping them in molten lava and then, through the same relentless heat and pressure, forcing them to burst through the earth's crust from enormous depths – cool crystals of unquenchable flame.

*Fire in the Earth: The Story of the Diamond*  
Chapter I (p. 2)  
Harper & Brothers Publishers. New York, New York, USA. 1942

**Meydendauer, A.**  
German mineralogist

The diamond can only be of cosmic origin, having fallen as a meteorite at later periods of the earth's formation. The available localities of the diamond contain the residues of not very compact meteoric masses, which may, perhaps, have fallen in the prehistoric ages, and which have penetrated more or less deeply, according to the more or less resistant character of the surface where they fell. Their remains are crumbling away on exposure to the air and sun, and the rain has long ago washed away all prominent masses. The enclosed diamonds have remained scattered in the river-beds, while the fine, light matrix has been swept away.

In Frederick Houk Law  
*Science in Literature*  
The Romance of the Diamonds (p. 109)  
Harper & Brothers. New York, New York, USA. 1929

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Now, a year or so ago, I had occupied my leisure in taking a London science degree, so that I have a smattering of physics and mineralogy. The thing was not unlike an uncut diamond of the darker sort, though far too large, being almost as big as the top of my thumb. I took it, and saw it had the form of a regular octahedron, with the curved faces peculiar to the most precious of minerals. I took out my penknife and tried to scratch it – vainly.

Leaning forward towards the gas-lamp, I tried the thing on my watch-glass, and scored a white line across that with the greatest ease.

*Best Science Fiction Stories of H.G. Wells*  
*The Diamond Maker*

Dover Publications, Inc. New York, New York, USA. 1966

## EMERALD

### Salzberg, Hugh W.

No biographical data available

Take white lead, one part, and of any glass you choose, two parts, fuse together in a crucible and then pour the mixture. To this crystal, add the urine of an ass and after forty days you will find emeralds.

*From Caveman to Chemist*

Chapter III (p. 36)

American Chemical Society. Washington, D.C. 1991

## FLINT

### Bierce, Ambrose 1842–1914

American newspaperman, wit, and satirist

FLINT, n. A substance much in use as a material for hearts. Its composition is silica, 98.00; oxide of iron, 0.25; alumina, 0.25; water, 1.50. When an editor's heart is made, the water is commonly left out; in a lawyer's more water is added – and frozen.

*The Enlarged Devil's Dictionary* (p. 96)

Doubleday & Company, Inc. Garden City, New York, USA. 1967

## GRANITE

### Cloos, Hans 1885–1951

German geologist

However silent, these large, simple shapes have a wordless language. They say that the granite has grown in secure and secluded depths, guided wholly by its own laws; and that no disturbing outside influence has intervened in the slow tranquil growth of the crystals.

*Conversation with the Earth* (p. 105)

Alfred A. Knopf. New York, New York, USA. 1953

### Hutton, James 1726–97

Scottish geologist, chemist, and naturalist

Granite, considered by itself, does not appear to have any claim to originality in its nature. It is composed of bodies which are capable of being analysed; and these are then found to be compositions of different substances, which are also sometimes variously proportioned.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter IV (p. 312)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

## JADE

### Author undetermined

When I think of a wise man, he seems like jade. Wise men have seen in jade all different virtues. It is soft, smooth and shining like kindness. It is hard, fine and strong like intelligence. Its edges seem sharp but do not cut, like justice. It hangs down to the ground like humility. When struck, it gives a clear, ringing sound, like music. The stains in it, which are not hidden and which add to its beauty, are like thoughtfulness. Its brightness is like heaven while its firm substance, born of the mountain and the waters, is like the earth. That is why wise men love jade.

In Joan M. Hartman

*Chinese Jade of Five Centuries*

C.E. Tuttle Company. Rutland, Vermont, USA. 1969

## LOADSTONE

### Gilbert, William 1544–1603

English scientist and physician

...the more advanced one is in the science of the loadstone, the more trust he has in the hypotheses, and the greater the progress he makes; nor will one reach anything like certitude in the magnetic philosophy, unless all, or at all events most, of its principles are known to him.

In *Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Preface (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## MARBLE

### Ruskin, John 1819–1900

English writer, art critic, and social reformer

This rock [marble], then, is prepared by Nature for the sculptor and architect, just as paper is prepared by the manufacturer for the artist, with as great – nay, with greater – care, and more perfect adaptation of the material to the requirements.

*The Stones of Venice* (Volume 2)

Chapter I (p. 33)

Bernhard Touchnitz. Leipzig, Germany. 1906

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Verily it is one thing to have cash and another to know how to spend it. The man ought to die a violent death that put it into people's heads to try to make cherished, beloved, sacred homes out of such cold, ghostly, unfeeling stuff as marble – a material which God intended for



only gravestones. You can build a house out of it, and put a door-plate on it, and call it a dwelling, but it isn't any use – it is bound to look like a mausoleum, after all. Stewart's house looks like a stately tomb, now, and after it is finished it will never look entirely natural without a hearse in front of it.

Letter to San Francisco  
*Alta California*, July 28, 1867

## OPAL

**Wilcox, Ella Wheeler** 1850–1919

American poet and journalist

And lo! The beautiful Opal,  
That rare and wondrous gem,  
Where the moon and sun blend into one,  
Is the child that was born to them.

*How Salvador Won & Other Recitations*  
The Birth of the Opal  
Edgar S. Werner. New York, New York, USA. 1891

## PEARL

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

A pearl is a temple built by pain around a grain of sand.

*Sand and Foam: A Book of Aphorisms* (p. 4)  
Alfred A. Knopf. New York, New York, USA. 1959

Perhaps the sea's definition of a shell is the pearl.

*Sand and Foam: A Book of Aphorisms* (p. 55)  
Alfred A. Knopf. New York, New York, USA. 1959

**Verne, Jules** 1828–1905

French novelist

...to the poet the pearl is a tear of the ocean; to the Orientals it is a drop of solidified dew; to the ladies it is a jewel of an oblong form, of a glass-like brilliancy, of a mother-of-pearl substance, which they wear on their fingers, their necks, or their ears; to the chemist it is a mixture of phosphate and carbonate of lime, with a little gelatine; and, lastly, to naturalists it is simply an unhealthy secretion of the organ which produces mother-of-pearl in certain bivalves.

*Twenty Thousand Leagues Under The Sea*  
Part II, Chapter II (p. 158)  
Ward, Lock & Co., Ltd. London, England. n.d.

## SALT

### Author undetermined

A Salt is a substance which has been naturalized.

Classroom Emanations  
*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

**Boerhaave, Herman** 1668–1738

Dutch chemist, physician, and botanist

Whomsoever is not acquainted with the taste of Salts will never arrive at the knowledge of our Arcana.

*Elements of Chemistry* (Volume 1)  
Part III (p. 438)  
Printed for J. & J. Pemberton. London, England. 1735

**Darwin, Erasmus** 1731–1802

English physician and poet

Hence with diffusive salt old Ocean steeps  
His emerald shallows, and his sapphire deeps.  
Oft in wide lakes, around their warmer brim  
In hollow pyramids the crystals swim;  
Or, fused by earth-born fires, in cubic blocks  
Shoot their white forms, and harden into rocks.

*The Botanic Garden*  
Part I, Canto II, V  
Canto II, l. 120–125 (pp. 29–30)  
Jones & Company. London, England. 1825

**Sagan, Carl** 1934–96

American astronomer and author

But let us look a little more deeply at our microgram of salt. Salt happens to be a crystal in which, except for defects in the structure of the crystal lattice, the position of every sodium and chlorine atom is predetermined. If we could shrink ourselves into this crystalline world, we would see rank upon rank of atoms in an ordered array, a regularly alternating structure – sodium, chlorine, sodium, chlorine, specifying the sheet of atoms we are standing on and all the sheets above us and below us. An absolutely pure crystal of salt could have the position of every atom specified by something like 10 bits of information. (Chlorine is a deadly poison gas employed in European battlefields in World War I. Sodium is a corrosive metal which burns upon contact with water. Together they make a placid and unpoisonous material, table salt. Why each of these substances has the properties it does is a subject called chemistry, which requires more than 10 bits of information to understand.) This would not strain the information-carrying capacity of the brain.

*Broca's Brain: Reflections on the Romance of Science*  
Part I, Chapter 2 (p. 15)  
Random House, Inc. New York, New York, USA. 1979

If the universe had natural laws that governed its behavior to the same degree of regularity that determines a crystal of salt, then, of course, the universe would be knowable. Even if there were many such laws, each of considerable complexity, human beings might have the capability to understand them all. Even if such knowledge exceeded the information-carrying capacity of the brain, we might store the additional information outside our bodies – in books, for example,

or in computer memories – and still, in some sense, know the universe.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 15)

Random House, Inc. New York, New York, USA. 1979

## SANDSTONE

**Abbey, Edward** 1927–89

American environmentalist and nature writer

The sandstone walls rise higher than ever before, a thousand, two thousand feet above the water, rounding off on top as half-domes and capitols, golden and glowing in the sunlight, a deep radiant red in the shade.

*Desert Solitaire*

Down the River (p. 205)

Ballantine Books. New York, New York, USA. 1968

## SAPPHIRE

**Gübelin, Eduard**

No biographical data available

In the close mesh of fiction and truth sapphire is more closely ensnared than any of its noble peers. Out of mankind's long acquaintance with it, towers of Babylonian dimensions have pressed heavily on its brazen back, built out of the tough ashlar of pagan and Christian magic, which sought to make use of supernatural powers through the stone of heavenly blue.

*The Color Treasury of Gemstones*

Sapphire: Lord Keeper of the Seals in the Gem Kingdom (p. 46)

Crowell. New York, New York, USA. 1975

## MINERALOGIST

**Landes, K. K.**

No biographical data available

Let there be more geological mineralogists! The only requirements, outside of educational background, are a prodigious curiosity, a vivid imagination, and a thick skin.

*Geological Mineralogy*

*American Mineralogist*, Volume 31, Number 3 & 4, March–April, 1946 (p. 134)

**Levi, Primo** 1919–87

Italian writer and chemist

In running through a list of names of minerals one is confronted by an orgy of personalities. It would seem that no mineralogist was ever resigned to ending his career without linking his name to a mineral, adding to the ending *-ite* as a laurel wreath: garnierite, senarmontite, and thousands of others.

Translated by Raymond Rosenthal

*Other People's Trades*

The Language of Chemistry (II) (p. 119)

Summit Books. New York, New York, USA. 1989

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

If you ask a mathematician, a mineralogist, a historian, or any other man of learning, what definite body of truths has been ascertained by his science, his answer will last as long as you are willing to listen.

*The Problems of Philosophy*

Chapter XV (p. 154)

Oxford University Press, Inc. London, England. 1959

**Trimmer, Joshua** 1795–1857

English geologist

It has been said that a man may be too consummate a mineralogist to make a good geologist, or, in other words, that the constant study of minute details, necessary for the discrimination of individual minerals, unfits the mind for the apprehension of the sublime generalizations of geology; but, on the other hand, it is no less true, that a certain amount of mineralogical knowledge is an essential requisite to the successful study of that science.

*Practical Geology and Mineralogy*

Preface (p. vii)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1842

## MINERALOGY

### Author undetermined

Mineralogy is the Alphabet of Geology.

In William Knight

*Facts and Observations Towards Forming a New Theory of the Earth*

Introduction (p. 3)

**Kett, Henry** 1761–1825

English college teacher and writer

The curiosity of man, still restless and active, continues its progress along the paths of nature with unabating ardour. After he has surveyed the wonders of the animal and vegetable kingdoms, he proceeds to those masses of unorganized matter, which are either found upon the surface, or concealed in the recesses of the earth; and thus he is led to mineralogy.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 127)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Richardson, George Fleming** 1796–1848

Man of letters, lecturer, and geological curator

How fascinating is mineralogy! how instructive that science which, from the icicle to the diamond, and from the drop of water to the starry orbs above us, teaches the laws

which regulate form, and which are as prevalent as they are powerful, as simple as they are sublime!

*Geology for Beginners* (2nd edition)

Conclusion (p. 568)

Longman, Brown, Green & Longmans. London, England. 1843

**Verne, Jules** 1828–1905

French novelist

I loved mineralogy, I loved geology. To me there was nothing like pebbles – and if my uncle had been in a little less of a fury, we should have been the happiest of families.

*A Journey to the Center of the Earth*

Chapter 1 (p. 6)

The Limited Editions Club. New York, New York, USA. 1966

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...mineralogy is a science for the Understanding, for practical life; for its subjects are something dead which cannot rise again, and there is no room for synthesis.

In Johann Peter Eckermann

*Conversations with Goethe*

Friday, February 13, 1829 (p. 294)

J.M. Dent & Sons Ltd. London, England. 1970

## MINING

**Agricola, Georgius** 1494–1555

German mineralogist

Since there has always been the greatest disagreement amongst men concerning metals and mining, some praising, others utterly condemning them, therefore I have decided that before imparting my instruction, I should carefully weigh the facts with a view to discovering the truth in this matter.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (p. 4)

The Mining magazine

London, England. 1912

[I]f mining is a shameful and discreditable employment for a gentleman because slaves once worked mines, then agriculture also will not be a very creditable employment, because slaves once cultivated the fields, and even today do so among the Turks; nor will architecture be considered honest, because some slaves have been found skilful in that profession; nor medicine, because not a few doctors have been slaves; nor will any other worthy craft, because men captured by force of arms have practised it.

*De Re Metallica*

Book I (p. 23)

Dover Publications, Inc. New York, New York, USA. 1950

[I]nasmuch as the chief callings are those of the moneylender, the soldier, the merchant, the farmer, and the

miner, I say, inasmuch as usury is odious, while the spoil cruelly captured from the possessions of the people innocent of wrong is wicked in the sight of God and man, and inasmuch as the calling of the miner excels in honour and dignity that of the merchant trading for lucre, while it is not less noble though far more profitable than agriculture, who can fail to realize that mining is a calling of peculiar dignity?

*De Re Metallica*

Book I (p. 24)

Dover Publications, Inc. New York, New York, USA. 1950

**Hoover, Herbert** 1874–1964

26th president of the USA

I told him that as nearly as I can determine from my two months' experience in mining, the difference between mining and geology is like that between the old-time bear-hunters and the city man. When they came upon bear tracks the old hunter became excited and started to tear through the brush on a dead run after the bear. But the city man finally gasped out, 'What are you doing? Let's go back up the tracks and see where he came from!

In Rose Wilder Lane

*The Making of Herbert Hoover*

Chapter VI (pp. 181–182)

The Century Co. New York, New York, USA. 1920

The investor who wants to eliminate all risk in mining is like a man who expects to go bathing without getting wet.

In T.A. Rickard

*The Economics of Mining* (2nd edition)

Mining Investment (p. 69)

Hill Publishing Co. New York, New York, USA. 1907

**Muir, John** 1838–1914

American naturalist

Mining discoveries and progress, retrogression and decay, seem to have been crowded more closely against each other here than on any other portion of the globe.

*Steep Trails*

Chapter XVI (p. 198)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

The drifts and tunnels in the rocks may perhaps be regarded as the prayers of the prospector, offered for the wealth he so earnestly craves; but like the prayers of any kind not in harmony with nature, they are unanswered.

*Steep Trails*

Chapter XVI (p. 203)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## MIRACLE

**Bradbury, Ray** 1920–

American writer

We live in miracles which cannot be explained. The scientist, the theologian, the artist – each attempts impossible explanations.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan  
*Mars and the Mind of Man*  
 Ray Bradbury (p. 139)  
 Harper & Row, Publishers. New York, New York, USA. 1973

**Buchner, Ludwig** 1824–99  
 German physician and philosopher

We have the fullest right, and are scientifically correct, in asserting there is no such thing as a miracle; everything that happens, does so in a natural way ...

*Force and Matter*  
 Chapter VI (p. 34)  
 Trübner & Co  
 London, England. 1864

We should only waste words in our endeavor to prove the natural impossibility of a miracle. No educated, much less a scientific person, who is convinced of the immutable order of things, can now-a-days believe in miracles.

*Force and Matter*  
 Chapter VI (p. 36)  
 Trübner & Co  
 London, England. 1864

**Davis, Andrew Jackson**  
 No biographical data available

The thinking mind knows too much of the laws of matter to believe in miracles. *The more we know the less we believe!*

*The Present Age and Inner Life* (3rd edition)  
 A Survey of Human Needs (p. 7)  
 W. White & Co. Boston, Massachusetts, USA. 1873

**Dawkins, Richard** 1941–  
 English ethologist, evolutionary biologist, and popular science writer

Evolution is very possibly not, in actual fact, always gradual. But it must be gradual when it is being used to explain the coming into existence of complicated, apparently designed objects, like eyes. For if it is not gradual in these cases, it ceases to have any explanatory power at all. Without gradualness in these cases, we are back to miracle, which is simply a synonym for the total absence of explanation.

*River Out of Eden: A Darwinian View of Life*  
 Chapter 3 (p. 83)  
 Basic Books. New York, New York, USA. 1995

**Dürrenmatt, Friedrich** 1921–90  
 Swiss playwright and novelist

...in the realm of science there is nothing more repugnant than a miracle.

Translated by James Kirkup  
*The Physicists*  
 Act One (p. 48)  
 Grove Press, Inc. New York, New York, USA. 1964

**Einstein, Albert** 1879–1955  
 German-born physicist

That this [analogy of the atom with the solar system] insecure and contradictory foundation was sufficient to enable a man of Bohr's unique instinct and tact to discover the major laws of the spectral lines and of the electron shells of the atoms together with their significance to chemistry appeared to me like a miracle – and appears to me as a miracle even today. This is the highest form of musicality in the sphere of thought.

In Paul Arthur Schlipp (ed.)  
*Albert Einstein: Philosopher-Scientist*  
 Autobiographical Notes (pp. 45, 47)  
 The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Haldane, J. S. (John Scott)** 1860–1936  
 Scottish physiologist

The more we discover as to physiological activity and inheritance, the more difficult does it become to imagine any physical or chemical description or explanation which could in any way cover the facts as to the persistent co-ordination. From the standpoint of the physical sciences the maintenance and reproduction of a living organism is nothing less than a standing miracle, and for that reason the co-ordinated maintenance of structure and activity is inconsistent with the physical conception of self-existent matter and energy.

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*  
 Lecture I, Mechanistic Biology (p. 11)  
 Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Hume, David** 1711–76  
 Scottish philosopher and historian

A miracle is a violation of the laws of nature ...

*Essays and Treatises on Several Subjects*  
 Of Miracles (p. 346)  
 A. Millar. London, England. 1758

**Leibniz, Gottfried Wilhelm** 1646–1716  
 German philosopher and mathematician

Miracles are not to be multiplied beyond necessity.

Quoted in Guido de Ruggiero  
*Modern Philosophy* (p. 51)  
 The Macmillan Co. New York, New York, USA. 1921

**Novalis (Friederich von Hardenberg)** 1772–1801  
 German poet

Miracles, as unnatural facts, are unmathematical; but there are no miracles of this kind, and what passes by that name is exactly that which becomes comprehensible through mathematics, for nothing is wonderful to mathematics.

Quoted in Panthea  
 Eclectic Gatherings  
*The Reasoner*, Volume 6 1849 (p. 374)

**MIRAGE**

**Strobridge, Idah Meacham** 1855–1932  
American writer

The mirage is, in very truth, a part of the Desert itself – just as the sagebrush, and the coyote, and the little horned toads, and the sand-storms are part. To those who know Desert-land, the picture would be incomplete without them.

*In Miners' Mirage-land*

Mirages of the Desert (p. 2)

Baumgardt Publishing Co. Los Angeles, California, USA. 1904

**MIRROR**

**Durell, Clement V.** 1882–1968  
English mathematician

...a reception was held and the science departments were on view. A young lady, entering the physical laboratory and seeing an inverted image of herself in a large concave mirror, naively remarked to her companion: "They have hung that looking glass upside down."

*Readable Relativity*

Chapter II (p. 12)

Harper & Brothers. New York, New York, USA. 1960

**Woodbury, David Oakes**

The figure of a mirror is rather like the figure of a woman-a curve that is not only beautiful but exactly adapted to its purpose. No sculptor ever smoothed the contours of a statue with more loving care than the optician who works a lustrous surface upon glass down to the perfect parabolic curve which will capture not only the admiration of his fellows but the secrets of the stars.

*The Glass Giant of Palomar* (p. 75)

**MISERY**

**Darwin, Charles Robert** 1809–82  
English naturalist

...if the misery of our poor be caused not by the laws of nature, but by our institutions, great is our sin...

*The Voyage of the Beagle*

Chapter XXI (p. 500)

Heron Books. 1968

I am the most miserable, bemuddled, stupid dog in all England, and am ready to cry with vexation at my blindness and presumption.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to J.D. Hooker, July 14, 1857? (p. 461)

D. Appleton & Company. New York, New York, USA. 1896

**MISQUOTATION**

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

My response to nearly all misquotation is the effective retort of preference: utter silence. (Honorable intellectual disagreement should always be addressed; misquotation should be ignored, when possible and politically practical).

*Eight Little Piggies: Reflections in Natural History*

Chapter 2 (p. 45)

W.W. Norton & Co. New York, New York, USA. 1993

**MISSING LINK**

**Wasmann, Erich** 1859–1931  
Jesuit biologist

If man were really descended from a prehistoric ancestor, common to him and to the apes of the present day, there must surely be some fossil trace left of his branch of the genealogical tree, and not only traces of the branch leading to apes!

Translated by A.M. Buchanan

*Modern Biology and the Theory of Evolution* (3rd edition)

Chapter X (p. 404)

B. Herder Book Co. St. Louis, Missouri, USA. 1923

**MISTAKE**

**Bayliss, Sir William Maddock** 1860–1925  
English physiologist

...there must never be the least hesitation in giving up a position the moment it is shown to be untenable. It is not going too far to say that the greatness of a scientific investigator does not rest on the fact of his having never made a mistake, but rather on his readiness to admit that he has done so, whenever the contrary evidence is cogent enough.

*Principles of General Physiology* (3rd edition)

Preface (pp. xvi–xvii)

Longmans, Green, & Co. London, England. 1920

**Braddon, Mary Elizabeth** 1837–1915  
English novelist

We spend the best part of our lives in making mistakes, and the poor remainder in reflecting how very easily we might have avoided them.

*Aurora Floyd* (p. 241)

Ward, Lock & Tyler. London, England. 1875

**Charlie Chan (Fictional character)**

Even wisest man sometimes mistake bumblebee for blackberry.

*The Black Camel*

Film (1931)

**Editor**

In common affairs a mistake may have but a short life, but in the study of nature an imperfect observation may cause infinite trouble to thousands. Accuracy  
*The Chemical News and Industrial News*, Volume XIX, Number 474, January 1, 1869 (p. 3)

**Faraday, Michael** 1791–1867

English physicist and chemist

I think it likely that I have made many mistakes in the preceding pages, for even to myself, my ideas on this point appear only as the shadow of a speculation, or as one of those impressions on the mind which are allowable for a time as guides to thought and research. He who labours in experimental inquiries knows how numerous these are, and how often their apparent fitness and beauty vanish before the progress and development of real natural truth.

*Experimental Researches in Chemistry and Physics*

On Ice and Freezing Water (p. 372)

Richard Taylor & William Francis. London, England. 1859

**Gombrich, Ernst Hans** 1909–2001

English art historian and scholar

In order to learn, we must make mistakes, and the most fruitful mistakes which nature could have implanted in us would be the assumption of even greater simplicities than we are likely to meet in this bewildering world of ours.... To probe a hole we first use a straight stick to see how far it takes us. To probe the visible world we use the assumption that things are simple until they prove to be otherwise.

In John Pottage

*Geometrical Investigations* (p. 15)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1983

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

There cannot be a greater mistake, than that of looking superciliously upon practical applications of science. The life and soul of science is its practical application, and just as the great advances in mathematics have been made through the desire of discovering the solution of problems which were of a highly practical kind in mathematical science; so in physical science many of the greatest advances that have been made, from the beginning of the world to the present time, have been made in the earnest desire to torn the knowledge of the properties of matter to some purpose useful to mankind.

In Robert Montgomery Bird

*Modern Science Reader: With Special Reference to Chemistry*

Electrical Units of Measurements (pp. 151–152)

The Macmillan Co. New York, New York, USA. 1911

**Mayr, Ernst** 1904–2005

German-born American biologist

In science one learns not only by one's own mistakes but by the history of the mistakes of others.

*The Growth of Biological Thought: Diversity, Evolution and Inheritance*  
Chapter 1 (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1982

**Miller, Henry George**

No biographical data available

The more distinguished the doctor the more terrible the mistakes he has made – or will admit to.

Henry Millerisms

*World Neurology*, 9 April, 1968 (p. 8)

**Obruchev, Vladimir** 1863–1956

Russian geologist and geographer

Be persistent and persevering, but never stubborn. Do not cling to your judgments. Remember that there are many clever people in the world liable to spot your mistakes. If they are right, be not reluctant to agree with them.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

If a mistake is not a stepping stone, it is a mistake.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #139 (p. 39)

Definition Press. New York, New York, USA. 1972

**Smiles, Samuel** 1812–1904

Scottish author and reformer

We often discover what will do, by finding out what will not do; and probably he who never made a mistake never made a discovery.

*Self-Help*

Chapter XII (p. 339)

John Murray. London, England. 1876

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

**Talley, Wilson**

No biographical data available

If there was ever a misnomer, it is “exact science.” Science has always been full of mistakes. The present day is no exception. And our mistakes are good mistakes; they require a genius to correct them.

*Conversations on the Dark Secrets of Physics*

Chapter 3 (p. 37)

Plenum Press. New York, New York, USA. 1991



**MITOCHONDRION**

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Surely, the mitochondrion that first entered another cell was not thinking about the future benefits of cooperation and integration; it was merely trying to make its own living in a tough Darwinian world.

*Wonderful Life: The Burgess Shale and the Nature of History*  
Chapter V (p. 310)  
W.W. Norton & Company, Inc. New York, New York, USA. 1989

**MIXTURE**

**Huxley, Thomas Henry** 1825–95  
English biologist

Mix salt and sand, and it shall puzzle the wisest of men, with his mere natural appliances, to separate all the grains of sand from all the grains of salt; but a shower of rain will effect the same object in ten minutes.

*Collected Essays* (Volume 2)  
*Darwiniana*  
The Origin of Species (p. 76)  
Macmillan & Company Ltd. London, England. 1904

**MODEL**

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Most students no longer study nature; they test models.  
*Heraclitean Fire: Sketches from a Life before Nature* (p. 106)  
The Rockefeller University Press. New York, New York, USA. 1978

**Andrewartha, H. G.** 1907–  
Australian ecologist

Model-making, the imaginative and logical steps which precede the experiment, may be judged the most valuable part of scientific method because skill and insight in these matters are rare. Without them we do not know what experiment to do. But it is the experiment which provides the raw material for scientific theory. Scientific theory cannot be built directly from the conclusions of conceptual models.

*Introduction to the Study of Animal Population* (p. 181)  
The University of Chicago Press. Chicago, Illinois, USA. 1961

**Ball, John**

No biographical data available

To make progress in understanding all this, we probably need to begin with simplified (oversimplified?) models and ignore the critics' tirade that the real world is more complex. The real world is always more complex, which has the advantage that we shan't run out of work.

Memes as Replicators  
*Ethology and Sociobiology*, Volume 5, Number 3, 1984 (p. 159)

**Bianco, Margery Williams** 1880–1944  
English-American author

The Rabbit could not claim to be a model of anything, for he didn't know that real rabbits existed; he thought they were all stuffed with sawdust like himself, and he understood that sawdust was quite out-of-date and should never be mentioned in modern circles.

*The Velveteen Rabbit: Or How Toys Become Real*  
Athenaeum Books for Young Readers. New York, New York, USA. 2002

**Born, Max** 1882–1970  
German-born English physicist

All great discoveries in experimental physics have been due to the intuition of men who made free use of models, which were for them not products of the imagination, but representatives of real things.

Physical Reality  
*Philosophical Quarterly*, Volume 3, Number 11, April, 1953 (p. 140)

**Box, George E. P.** 1919–  
English statistician

All models are wrong but some are useful.  
Apocryphal

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

The pre-eminence of astronomy rests on the peculiarity that it can be treated mathematically; and the progress of physics, and most recently biology, has hinged equally on finding formulations of their laws that can be displayed as mathematical models.

*The Ascent of Man*  
Chapter 5 (p. 165)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Models – in contrast to those who sat for Renoir – improve with age.

*Heraclitean Fire: Sketches from a Life before Nature*  
Part III  
Science as a Profession (p. 171)  
Rockefeller University Press. New York, New York, USA. 1978

**Cheeseman, Peter**  
Australian computer scientist

The apparent simplicity of a model is due to a failure of imagination and limited data, unless the domain really is simple. If the world were really random, chemistry, cooking, and credit would not be possible, so our models cannot be figments of our imagination.

In J. Shrager and P. Langley (eds.)  
*Computational Models of Scientific Discovery and Theory Formation*  
On Finding the Most Probable Model (p. 91)  
Morgan Kaufmann Publishers. San Mateo, California, USA. 1990

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

...no good model ever accounted for all the facts, since some data was bound to be misleading if not plain wrong. A theory that did fit all the data would have been “carpentered” to do this and would thus be open to suspicion.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 5 (p. 60)  
Basic Books, Inc. New York, New York, USA. 1988

**Dampier, Sir William Cecil** 1867–1952  
English scientific writer

we can only study Nature through our senses – that is... we can only study the model of Nature that our senses enable our minds to construct; we cannot decide whether that model, consistent though it be, represents truly the real structure of Nature; whether, indeed, there be any Nature as an ultimate reality behind its phenomena.

*The Recent Development of Physical Science*  
Chapter I (p. 14)  
John Murray. London, England. 1904

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

When it comes to very highly organized systems, such as a living cell, the task of modeling by approximation to simple, continuous and smoothly varying quantities is hopeless. It is for this reason that attempts by sociologists and economists to imitate physicists and describe their subject matter by simple mathematical equations is rarely convincing.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*  
Chapter 3 (p. 22)  
Simon & Schuster. New York, New York, USA. 1988

The incorporation of imaginary elements into physical theories is one of the most difficult practices for a professional physicist to justify to the layman. Of course, if a particular feature, such as isotopic spin symmetry, renders the model a brilliant success, then the physicist can simply reply, “I put it in because it works!”

*Superforce: The Search for a Grand Unified Theory of Nature*  
Chapter 4 (pp. 66–67)  
Simon & Schuster. New York, New York, USA. 1984

A model of the universe does not require faith, but a telescope. If it is wrong, it is wrong.

*Space and Time in the Modern Universe*  
Chapter 7 (p. 201)  
Cambridge University Press. Cambridge, England. 1977

**Deutsch, Karl W.** 1912–92  
Czech-born American international political scientist

Men think in terms of models.  
Mechanism, Organism and Society  
*Philosophy of Science*, Volume 18, Number 3, July, 1951 (p. 230)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Our model of Nature...should be like an engine with movable parts. We need not fix the position of anyone lever; that is to be adjusted from time to time as the latest observations indicate. The aim of the theorist is to know the train of wheels which the lever sets in motion – that binding of the parts which is the soul of the engine.

*The Internal Constitution of Stars*  
*Nature*, Volume 106, Number 2603, 2 September, 1920 (p. 20)

**Eigen, Manfred** 1927–  
German biophysicist

A theory has only the alternative of being right or wrong. A model has a third possibility: it may be right, but irrelevant.

In J. Mehra (ed.)  
*The Physicist's Conception of Nature: Symposium on the Development of the Physicist's Conception of Nature in the Twentieth Century*  
Chapter 30 (p. 618)  
Reidel. Boston, Massachusetts, USA. 1973

**Ferris, Timothy** 1944–  
American science writer

The model of the natural world we build in our minds by such a process will forever be inadequate, just a little cathedral in the mountains. Still it is better than no model at all.

*The Red Limit: The Search for the Edge of the Universe*  
Preface (p. 8)  
William Morrow & Company, Inc. New York, New York, USA. 1977

**Feynman, Richard P.** 1918–88  
American theoretical physicist

...the more you see how strangely Nature behaves, the harder it is to make a model that explains how even the simplest phenomena actually work. So theoretical physics has given up on that.

*QED: The Strange Theory of Light and Matter*  
Chapter 3 (p. 82)  
Princeton University Press. Princeton, New Jersey, USA. 1985

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

I do not know that my view is more correct; I do not even think that “right” and “wrong” are good categories for assessing complex mental models of external reality – for models in science are judged [as] useful or detrimental, not as true or false.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Three, Chapter 8 (p. 96)  
Random House, Inc. New York, New York, USA. 1995

**Greedman, D. A.**  
No biographical data available

**Navidi, W. C.**

No biographical data available

Models are often used to decide issues in situations marked by uncertainty. However statistical differences from data depend on assumptions about the process which generated these data. If the assumptions do not hold, the inferences may not be reliable either. This limitation is often ignored by applied workers who fail to identify crucial assumptions or subject them to any kind of empirical testing. In such circumstances, using statistical procedures may only compound the uncertainty.... Statistical modeling seems likely to increase the stock of things you think you know that ain't so.

Regression Models for Adjusting the 1980 Census  
*Statistical Science*, Volume 1, Number 1, 1986 (p. 3)

**Gribbin, John** 1946–

English science writer

No matter how beautiful the whole model may be, no matter how naturally it all seems to hang together now, if it disagrees with experiment, then it is wrong.

*Almost Everyone's Guide to Science*

Chapter Eleven (p. 220)

Yale University Press. New Haven, Connecticut, USA. 1999

**Greenwood, H. J.**

No biographical data available

Let us not grace loose thinking with the word "model."

On Models and Modeling

*Canadian Mineralogist*, Volume 27, 1989

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The making of models or pictures to explain mathematical formulae and the phenomena they describe is not a step towards, but a step away from reality; it is like making graven images of a spirit.... All the same, the mathematical physicist is still busily at work making graven images of the concepts of the wave-mechanics.

*The Mysterious Universe*

Chapter V (pp. 176, 177)

The Macmillan Company. New York, New York, USA. 1932

...we have found out that nature does not function in a way that can be made comprehensible to the human mind through models or pictures.

*Physics and Philosophy*

Chapter I (p. 10)

Dover Publications. Mineola, New York, USA. 1981

**Kaplan, Abraham** 1918–93

American philosopher of science, author, and educator

The words "model" and "mode" have, indeed, the same root; today, model building is science a la mode.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter VII, Section 30 (p. 258)

Chandler Publishing Company. San Francisco, California, USA. 1964

**Karlin, Samuel**

No biographical data available

The purpose of models is not to fit the data but to sharpen the questions.

11th R. A. Fisher Memorial Lecture

Royal Society 20 April, 1983

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

I never satisfy myself until I can make a mechanical model of a thing. If I can make a mechanical model, I understand it.

*Baltimore Lectures on Molecular Dynamics, and the Wave Theory of Light* (p. 270)

C.J. Clay & Sons. London, England. 1904

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

To try to ferret out the important and interesting objects from the multitude of things in the sky, every cosmologist looks at the universe through a filter of a model, for without the conceptual framework of a model the staggering number of things in the universe would overwhelm anyone.

*Blind Watchers of the Sky*

Chapter Eleven (p. 285)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

If you want to know whether you should take a model seriously or just regard it as a calculational tool, you can imagine that you are building a wall out of stones. For instance, if the stones represent models for various phenomena seen in the sky, and the wall represents all of astronomy, then choosing a model to explain a phenomenon is like choosing a stone to be incorporated into the wall. Sometimes the stone seems to fit naturally into a space in the wall; more often it has to be trimmed a bit to fit in. But it is impossible to judge whether it is a "beautiful" stone or the "correct" stone for that place in the wall when it is first inserted, because the true beauty or utility of the stone can't be judged in isolation from the rest of the wall. The two real criteria to judge the stone are whether it is one on which other stones can be placed and whether it exists harmoniously with the surrounding stones. If the stone not only fulfills the function of taking up spaces in the wall but also provides a platform on which to place other stones, it a beautiful stone.

*Blind Watchers of the Sky*

Chapter Ten (pp. 287–288)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1996

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

It is not impossible that our own Model will die a violent death, ruthlessly smashed by an unprovoked assault of

new facts... But I think it is more likely to change when, and because, far-reaching changes in the mental temper of our descendants demand that it should. The new Model will not be set up without evidence, but the evidence will turn up when the inner need for it becomes sufficiently great. It will be true evidence. But nature gives most of her evidence in answer to the questions we ask her. Here, as in the courts, the character of the evidence depends on the shape of the examination, and a good cross-examiner can do wonders.

*The Discarded Image: An Introduction to Medieval and Renaissance Literature*

Epilogue (pp. 222–223)

University Press. Cambridge, England. 1964

**Lewis, Gilbert Newton** 1875–1946

American chemist

As we continue the great adventure of scientific exploration our models must often be recast. New laws and postulates will be required, while those that we already have must be broadened, extended and generalized in ways that we are now hardly able to surmise.

*The Anatomy of Science*

Chapter VIII (p. 219)

Yale University Press. New Haven, Connecticut, USA. 1926

**Lindley, David** 1956–

English astrophysicist and author

There is no guarantee that any simple model will be able to explain everything.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 4 (p. 131)

Basic Books. New York, New York, USA. 1993

**Lloyd, David**

No biographical data available

**Volkov, Evgenii I.**

No biographical data available

One good experiment is worth a thousand models...; but one good model can make a thousand experiments unnecessary.

In C. Mosekilde and L. Mosekilde (eds.)

*Complexity, Chaos, and Biological Evolution*

The Ultradian Clock: Timekeeping for Intracellular Dynamics (p. 51)

Plenum Press. New York, New York, USA. 1991

**Maxwell, James Clerk** 1831–79

Scottish physicist

As long as the training of a naturalist enables him to trace the action only of a particular material system, without giving him the power of dealing with the general properties of all such systems, he must proceed by the method so often described in histories of science – he must imagine model after model of hypothetical apparatus, till he finds one which will do the required work. If this apparatus should afterwards be found capable of accounting for many of

the known phenomena, and not demonstrably inconsistent with any of them, he is strongly tempted to conclude that his hypothesis is a fact, at least until an equally good rival hypothesis has been invented.

Tait's Thermodynamics

*Nature*, Volume XVII, Number 431, January 31, 1878 (p. 258)

**Miall, Andrew**

No biographical data available

There are those who try to generalize, synthesize, and build models, and there are those who believe nothing and constantly call for more data. The tension between these two groups is a healthy one; science develops mainly because of the model builders, yet they need the second group to keep them honest.

*Principles of Sedimentary Basin Analysis*

Chapter 8 (p. 363)

Springer-Verlag. New York, New York, USA. 1984

**Milton, John** 1608–74

English poet

Hereafter, when they come to model Heav'n  
And calculate the Stars, how they will wield  
The mightier frame, how build, unbind, contrive  
To save appearances, how gird the Shear  
With Centric and Eccentric scribbled ore,  
Cycle and Epicycle, Orb in Orb.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VIII, l. 79–84

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Morrison, Foster**

No biographical data available

Much of the technical literature is difficult to read, even for scientists and engineers. Even the best books tend to dwell on the mathematical models and don't give the slightest hint what to do if one is lucky enough to have some data.

*The Art of Modeling Dynamic Systems: Forecasting for Chaos, Randomness & Determinism*

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1991

**Oreskes, Naomi**

No biographical data available

**Belitz, K.**

No biographical data available

A model, like a novel, may resonate with nature, but it is not a "real" thing. Like a novel, a model may be convincing – it may "ring true" if it is consistent with our experience of the natural world. But just as we may wonder how much the characters in a novel are drawn from real life and how much is artifice, we might ask the same of a model: How much is based on observation and measurement of accessible phenomena, how much is

convenience? Fundamentally, the reason for modeling is a lack of full access, either in time or space, to the phenomena of interest.

*Science*, Volume 263, 1944

**Paulos, John Allen** 1945–

American mathematician

The once-surprising existence of non-Euclidean models of Euclid's first four axioms can be seen as a sort of mathematical joke.

*Once Upon a Number: The Hidden Mathematical Logic of Stories*

Appendix: Humor and Computation (p. 132)

Basic Books. New York, New York, USA. 1998

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

We should always aim toward the economy of thought. It is not enough to give models for imitation. It must be possible to pass beyond these models and, in place of repeating their reasoning at length each time, to sum this in a few words.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 128)

Government Printing Office. Washington, D.C. 1910

**Poynting, John Henry** 1852–1914

English physicist

...while the building of Nature is growing spontaneously from within, the model of it, which we seek to construct in our descriptive science, can only be constructed by means of scaffolding from without, a scaffolding of hypotheses. While in the real building all is continuous, in our model there are detached parts which must be connected with the rest by temporary ladders and passages, or which must be supported till we can see how to fill in the understructure. To give the hypotheses equal validity with facts is to confuse the temporary scaffolding with the building itself.

*Collected Scientific Papers*

Part VII, Article 52 (p. 607)

At The University Press. Cambridge. 1920

**Sciama, Dennis** 1926–99

English physicist

Since we find it difficult to make a suitable model of a certain type, Nature must find it difficult too. This argument neglects the possibility that Nature may be cleverer than we are. It even neglects the possibility that we may be cleverer tomorrow than we are today.

In Neil de Grasse Tyson

Galactic Engines

*Natural History*, Volume 106, Number 4, May, 1997 (p. 71)

**Sophocles** 496 BCE–406 BCE

Greek playwright

Nay, Knowledge must come through action; thou canst have no test which is not fanciful, save by trial.

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

*Trachiniai*, l. 589

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Stewart, Ian** 1945–

English mathematician and science writer

Construction of models, I said, was an art. On this occasion the art is conjuring: I can do no better than wave the magic wand and extract the rabbit from the hat.

*Concepts of Modern Mathematics*

Chapter 8 (p. 120)

Dover Publications, Inc. New York, New York, USA. 1995

**Stocking, Martha**

No biographical data available

Building statistical models is just like this. You take a real situation with real data, messy as this is, and build a model that works to explain the behavior of real data.

*New York Times*, February 10, 2000

**von Neumann, John** 1903–57

Hungarian-American mathematician

To begin, we must emphasize a statement which I am sure you have heard before, but which must be repeated again and again. It is that the sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct which, with the addition of certain verbal interpretations, describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work – that is, correctly to describe phenomena from a reasonably wide area. Furthermore, it must satisfy certain aesthetic criteria – that is, in relation to how much it describes, it must be rather simple.

*The Neumann Compendium*

Method in the Physical Sciences (p. 628)

World Scientific. Singapore. 1995

**Walker, Marshall John**

American physicist

Scientists have learned by humiliating experience that their model is not reality.

*The Nature of Scientific Thought*

Chapter XIV (p. 158)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

What is a model? A model is like an Austrian timetable. Austrian trains are always late. A Prussian visitor asks the Austrian conductor why they bother to print timetables. The conductor replies "If we did not, how would we know how late the trains are?"

In H. Frauenfelder and E.M. Henley  
*Subatomic Physics*  
 Part V (p. 351)  
 Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1974

## MODESTY

**Bossut, Charles** 1730–1814  
 French mathematician

Modesty is a desertion of ourselves, a kind of avowal .of inferiority, at which mediocrity catches greedily as a source of consolation, which it endeavors to interpret in the literal sense, and which it frequently employs as a weapon to keep at a distance the timid man of genius,  
*A General History of Mathematics from the Earliest Times to the Middle of the Eighteenth Century*  
 Author's Preface (p. xx)  
 Printed for J. Johnson. London, England. 1803

## MOLAR SOLUTION

### Author undetermined

A molar solution is one which contains one g.m.w. [gram molecular weight] per liter.  
 Classroom Emanations  
*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

## MOLECULAR BIOLOGIST

**Chargaff, Erwin** 1905–2002  
 Austrian biochemist

The extreme dislike, and therefore ignorance, of chemistry I have often encountered among molecular biologists are puzzling.  
*Voices in the Labyrinth: Nature, Man and Science* (p. 57)  
 The Seabury Press. New York, New York, USA. 1977

## MOLECULAR BIOLOGY

### Atsbury, W. T.

No biographical data available

We are at the dawn of a new era, the era of 'molecular biology' as I like to call it, and there is an urgency about the need for more intensive application of physics and chemistry, and specially of structure analysis, that is still not sufficiently appreciated.  
 On the Structure of Biological Fibres and the Problem of Muscle  
*Proceedings of the Royal Society of London, Series B, Biological Sciences*, Volume 134, Number 876, July 2, 1947 (p. 326)

**Chargaff, Erwin** 1905–2002  
 Austrian biochemist

...molecular biology [is] the practice of biochemistry without a license.

*Essays on Nucleic Acids*  
 Amphisbaena  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1963

The definition of molecular biology is the practice of biochemistry without a license.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 140)  
 The Rockefeller University Press. New York, New York, USA. 1978

**Crick, Francis Harry Compton** 1916–2004  
 English biochemist

...molecular biology can be defined as anything that interests molecular biologists.  
 Molecular Biology in the Year 2000  
*Nature*, Volume 228, Number 5272, November 14, 1970 (p. 613n)

**Dobzhansky, Theodosius** 1900–75  
 Russian-American scientist

Molecular biology is Cartesian in its inspiration.

*The Biology of Ultimate Concern*  
 Chapter 2 (p. 20)  
 The New American Library, Inc. New York, New York, USA. 1967

**Kornberg, Arthur** 1918–  
 American biochemist

Molecular biology falters when it ignores the chemistry of the DNA blueprint – the enzymes and proteins, and their products – the integrated machinery and framework of the cell.

The Two Cultures: Chemistry and Biology  
*Biochemistry*, Volume 26, Number 22, November 3, 1987 (p. 6890)

**Ludwig, Carl Friedrich Wilhelm** 1816–95  
 German physiologist

Whenever the body of an animal is subdivided to its ultimate parts, one always finally arrives at a limited number of chemical atoms.... One draws the conclusion in harmony with this observation, that all forms of activity arising in the animal body must be a result of the simple attractions and repulsions which would be observed in the coming together of those elementary objects.  
*Quarterly Review*, 2nd ed., Winter, 1858

**Luria, Salvador Edward** 1912–91  
 Italian-American microbiologist

Molecular biology deals with questions of molecular structure, and therefore is biochemistry; but it is not the classical biochemistry that emerged earlier in the twentieth century out of the concerns of medical, agricultural, and industrial researchers. Molecular biology is genetics because it deals with genes, their functions, and their products; but, in contrast with classical genetics, it has



dealt mainly with organisms such as bacteria and viruses rather than peas, maize or fruit flies, whose study had established the classical rules of genetics.

*A Slot Machine, a Broken Test Tube: An Autobiography*

The Science Path: II. The High Reaches (pp. 83–84)

Harper & Row, Publishers. New York, New York, USA. 1984

**Maddox, John Royden** 1925–

Welsh chemist and physicist

...coffee-breaks in molecular laboratories are as marked by speculation as in any other field, but the published literature gives the impression that its authors are more concerned with the correctness of their observations than with their significance. Those with the good fortune to have the time to think about the data accumulated in the literature would probably reap a rich harvest of understanding. The explanation of the unreflective state of molecular biology is easily accounted for: competitiveness.

The Dark Side of Molecular Biology

*Nature*, Volume 363, Number 6424, 6 May, 1993 (p. 13)

**Wolpert, Lewis** 1929–

British embryologist

...the revolution in molecular biology changed the paradigm from metabolism to information.

*The Unnatural Nature of Science*

Chapter 5 (p. 93)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

## MOLECULAR HYPOTHESIS

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

There must be something in this molecular hypothesis and that as a mechanical symbol it is certainly not a mere hypothesis, but a reality.

*Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light*

Lecture I (p. 15)

At The University Press. Cambridge, England. 1905

## MOLECULAR PHYSICS

**Huxley, Thomas Henry** 1825–95

English biologist

...we live in the hope and in the faith that, by the advance of molecular physics, we shall by and by be able to see our way as clearly from the constituents of water to the properties of water, as we are now able to deduce the operations of a watch from the form of its parts and the manner in which they are put together.

*Autobiography and Selected Essays*

On the Physical Basis of Life (p. 112)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1909

## MOLECULAR SCIENCE

**Maxwell, James Clerk** 1831–79

Scottish physicist

...molecular science teaches us that our experiments can never give us anything more than statistical information, and that no law deduced from them can pretend to absolute precision. But when we pass from the contemplation of our experiments to that of the molecules themselves, we leave the world of chance and change, and enter a region where everything is certain and immutable.

Molecules

*Nature*, September, 1873 (p. 440)

## MOLECULE

**Aldersey-Williams, Hugh** 1959–

English author and journalist

A molecule is a messy thing. It has a gangling skeleton whose bones are chemical bonds and whose joints are its component atoms.

*The Most Beautiful Molecule*

Chapter 1 (p. 11)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Ball, Philip** 1962–

English science writer

...molecules are the smallest units of meaning in chemistry. It is through molecules, not atoms, that one can tell stories in the sub-microscopic world. They are the words: atoms are just the letters... And in molecules, as in words, the order in which the component parts are put together matters: “save” and “vase” do not mean the same thing.

*Stories of the Invisible*

Chapter 1 (p. 13)

Oxford University Press, Inc. Oxford, England. 2001

Once upon a time molecular scientists had to deduce all they knew about molecules from measurements made on many billions of them simultaneously. This can be a risky business, since we cannot always be sure how such measurements are related to the properties of individual molecules, just as the noise that emanates from a football stadium or theatre hall reveals nothing of the individual conversations people are having. But advances in experimental techniques that enable studies of single molecules...what they look like, how they interact, how they move...have over the past two decades opened up an entirely new realm of molecular studies. We are starting to get to know molecules in person.

*Stories of the Invisible*

Chapter 5 (p. 127)

Oxford University Press, Inc. Oxford, England. 2001

**Barrow, Gordon M.**

Chemist

The chemist must learn to live in, and to feel at home in, the world of molecules. It is not enough that he knows the chemical constitution and chemical reactions of the materials around him. To be really effective and successful, he must also develop an intimacy with the molecular world. He must fit himself into the molecular scale of things. He must put that first drummed-in chemical fact that molecules are small in the very back of his mind and replace it by a consciousness that molecules are real, intricate, structural arrangements of atoms in space.

*The Structure of Molecules*

Introduction (p. 1)

W.A. Benjamin, Inc. New York, New York, USA. 1964

**Brown, Samuel** 1817–56

Chemist

[The theory of molecules is an] ideal conception, placed by the mind like another Atlas underneath a measureless world of facts, to give them intelligible cohesion and hold them up to view.

*Lectures on the Atomic Theory and Essays Scientific and Literary*

(Volume I)

The Atomic Theory Before Christ and Since (p. 126)

Thomas Constable &amp; Co. Edinburgh, Scotland. 1858

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Chemists do not have to bother about the sociology of molecules.

*Voices in the Labyrinth: Nature, Man and Science* (p. 5)

The Seabury Press. New York, New York, USA. 1977

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

...we look forward to the time when the structure and motions in the inside of a molecule will be so well known that some future Kant or Laplace will be able to make an hypothesis about the history and formation of matter.

In Leslie Stephen and Frederick Pollock (eds.)

*Lectures and Essays* (Volume 1)

Atoms (p. 190)

Macmillan &amp; Company Ltd. London, England. 1879

**Collins, Wilkie** 1824–89

English novelist

We were all monkeys before we were men, and molecules before we were monkeys!

*Law and the Lady*

Chapter XXXIX (p. 282)

Harper &amp; Brothers Publishers. New York, New York, USA. 1875

**Cooke, Josiah Parsons** 1827–94

American chemist

[If] we would become imbued with the spirit of the new philosophy of chemistry, we must begin by believing in molecules ...

*The New Chemistry*

Lecture III (p. 77)

D. Appleton &amp; Co. New York, New York, USA. 1897

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Almost all aspects of life are engineered at the molecular level, and without understanding molecules we can only have a very sketchy understanding of life itself.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 5 (p. 61)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

[Molecules of living things] are put together in much more complicated patterns than the molecules of nonliving things, and this putting together is done following programs, sets of instructions for how to develop, which the organisms carry around inside themselves. Maybe they do vibrate and throb and pulsate with “irritability,” and glow with “living” warmth, but these properties all emerge incidentally. What lies at the heart of every living thing is not a fire, not warm breath, not a “spark of life.” It is information, words, instructions. If you want a metaphor, don’t think of fire and sparks and breath. Think instead of a billion discrete, digital characters carved in tablets of crystal. If you want to understand life, don’t think about vibrant, throbbing gels and oozes, think about information technology.

*The Blind Watchmaker*

Chapter 5 (p. 112)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1986

**Dennett, Daniel Clement** 1942–

American philosopher

Any assortment of objects, especially “sticky” objects like molecules, randomly stirred for long enough will give rise to every conceivable possible combination.

*Consciousness Explained* (p. 11)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1991

**Frankel, Felice** 1945–

Science photographer

**Whitesides, George M.**

American chemist

Molecules – like ants, lemmings, herring, people – are happiest when surrounded by their own kind.

*On the Surface of Things: Images of the Extraordinary in Science*

Introduction (p. 7)

Chronicle Books. San Francisco, California, USA. 1997

**Harrison, George R.**

No biographical data available

A farm is a factory where the energy of light is used to make cheap simple molecules into valuable complex molecules.

When Physics Goes Farming  
*The Atlantic Monthly*, July 1937

**Hoffmann, Roald** 1937–

Polish-born American chemist

It's a wild dance floor there at the molecular level.

In Philip Ball

*Designing the Molecular World: Chemistry at the Frontier* (p. 83)  
Princeton University Press. Princeton, New Jersey, USA. 1994

Men (and women) are not as different from molecules as they think.

*The Metamict State*

Men and Molecules (p. 43)  
University of Central Florida Press. Orlando, Florida, USA. 1987

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

If we assume that the last breath of, say, Julius Caesar has by now become thoroughly scattered through the atmosphere, then the chances are that each of us inhales one molecule of it with every breath we take.

*An Introduction to the Kinetic Theory of Gases*

Chapter II (p. 32)  
At The University Press. Cambridge, England. 1940

**Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

The molecule becomes a particle of the universe on a microscopic scale – a microcosmos which lives the same life.

Recent Science

*Nineteenth Century*, Volume 34, 1893 (p. 252)

**Latham, Peter Mere** 1789–1875

English physician

The very existence of ultimate molecules, or atoms, with the qualities which we so confidently assign to them, is a matter of the purest conjecture; it is entirely a fiction of the mind.

*An Essay on the Philosophy of Medical Science*

Part I, Chapter 4  
Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

...molecules of different elements throb in different ways, and thus produce different light waves, which, when analysed by a spectroscope...give definite characteristic colours...we can discover what any substance is by heating it so as to agitate its molecules, and then

analysing, by a spectroscope, the ripples of light caused by the throbbing molecules. In this way we may be said to be able to tell any substance by feeling its pulse, or by listening to its heart, and the spectroscope may be compared to a stethoscope.

*Science, Matter and Immortality*

Chapter 4 (p. 55)  
William & Norgate. London, England. 1909

Life in living tissue is like nothing perhaps so much as a candle-flame. In the candle-flame the molecules are composed and decomposed, yet the candle-flame keeps always the same shape; but let us change the environment of these dancing, partner-changing molecules – let us conduct away their heat by means of some copper wire, or let us deprive the flame of oxygen – and out goes the candle.

Protoplasm is only a slow flame, easily extinguished. It is easy to understand how a little thing – a needle, a few grains of poison – may destroy a large organism when we remember how intricately correlated it is in its minutest parts. Break but a single thread in the warp and woof of life and the whole wonderful web, with its pictures and patterns, all comes asunder. Take but a single brick out of the great house of life and it falls into ruin. The construction of the wonderful organisms of vegetables and animals is a miracle and mystery, but their death is merely a chemical or mechanical commonplace.

*Science, Matter and Immortality*

Chapter 21 (p. 268)  
William & Norgate. London, England. 1909

**Mann, Thomas** 1875–1955

German-born American novelist

For the molecule was composed of atoms, and the atom was nowhere near large enough even to be spoken of as extraordinarily small. It was so small, such a tiny, early, transitional mass, a coagulation of the unsubstantial, of the not-yet-substantial and yet substance-like, of energy, that it was scarcely possible yet – or, if it had been, was now no longer possible – to think of it as material, but rather as mean and border-line between the material and immaterial.

Translated by H.T. Lowe-Poeter

*The Magic Mountain*

Chapter V (p. 283)  
Alfred A. Knopf. New York, New York, USA. 1966

**Maxwell, James Clerk** 1831–79

Scottish physicist

[Molecular science is] one of those branches of study which deal with things invisible and imperceptible by our senses, and which cannot be subjected to direct experiment.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 361)  
At The University Press. Cambridge, England. 1890

As long as we have to deal with only two molecules, and have all the data given us, we can calculate the result of their encounter; but when we have to deal with millions of molecules, each of which has millions of encounters in a second, the complexity of the problem seems to shut out all hope of a legitimate solution.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 373)

At The University Press. Cambridge, England. 1890

...though in the course of ages catastrophes have occurred and may yet occur in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built – the foundation-stones of the material universe – remain unbroken and unworn.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 377)

At The University Press. Cambridge, England. 1890

I come from empyrean fires  
From microscopic spaces,  
Where molecules with fierce desires,  
Shiver in hot embraces  
The atoms clash, the spectra flash,  
Projected on the screen,  
The double D, magnesian b,  
And Thallium's living green.

*The Life of James Clerk Maxwell*

To the Chief Musician upon Nabla: A Tyndallic Ode (p. 634)

Macmillan & Company Ltd. London, England. 1882

Each molecule...throughout the universe bears impressed upon it the stamp of a metric system as distinctly as does the metre of the Archives at Paris, or the double royal cubit of the temple of Karnac.

Quoted in Frederick Soddy

*The Interpretation of Radium and the Structure of the Atom*

Chapter X (p. 215)

J. Murray. London, England. 1909

An atom is a body which cannot be cut in two. A molecule is the smallest possible portion of a particular substance. No one has ever seen or handled a single molecule. Molecular science, therefore, is one of those branches of study which deal with things invisible and imperceptible by our senses, and which cannot be subjected to direct experiment.

A Discourse on Molecules

*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Volume XLVI, December, 1873 (p. 453)

We have now to conceive the molecules of the air in this hall flying about in all directions, at a rate of about seventeen miles in a minute.

A drop of water, to return to our former example, may be divided into a certain number, and no more, of portions

similar to each other. Each of these the modern chemist calls a molecule of water. But it is by no means an atom, for it contains two different substances, oxygen and hydrogen, and by a certain process the molecule may be actually divided into two parts, one consisting of oxygen and the other of hydrogen. According to the received doctrine, in each molecule of water there are two molecules of hydrogen and one of oxygen. Whether these are or are not ultimate atoms I shall not attempt to decide.

We now see what a molecule is, as distinguished from an atom.

Molecules

*Nature*, September, 1873 (p. 437)

If all these molecules were flying in the same direction, they would constitute a wind blowing at the rate of seventeen miles a minute, and the only wind which approaches this velocity is that which proceeds from the mouth of a cannon. How, then, are you and I able to stand here? Only because the molecules happen to be flying in different directions, so that those which strike against our backs enable us to support the storm which is beating against our faces. Indeed, if this molecular bombardment were to cease, even for an instant, our veins would swell, our breath would leave us, and we should, literally, expire.

Molecules

*Nature*, September, 1873 (p. 438)

If we wish to form a mental representation of what is going on among the molecules in calm air, we cannot do better than observe a swarm of bees, when every individual bee is flying furiously, first in one direction, and then in another, while the swarm, as a whole, either remains at rest, or sails slowly through the air.

Molecules

*Nature*, September, 1873 (p. 438)

...molecular science teaches us that our experiments can never give us anything more than statistical information, and that no law deduced from them can pretend to absolute precision. But when we pass from the contemplation of our experiments to that of the molecules themselves, we leave the world of chance and change, and enter a region where everything is certain and immutable.

Molecules

*Nature*, September, 1873 (p. 440)

...in the heavens we discover by their light, and by their light alone, stars so distant from each other that no material thing can ever have passed from one to another, and yet this light, which is to us the sole evidence of the existence of these distant worlds, tells us also that each of them is built up of molecules of the same kinds as those which we find on earth. A molecule of hydrogen, for example, whether in Sirius or in Arcturus, executes its vibrations in precisely the same time.

Molecules

*Nature*, Volume VIII, Number 204, September 25, 1873 (p. 441)

None of the processes of Nature, since the time when Nature began, have produced the slightest difference in the properties of any molecule. We are therefore unable to ascribe either the existence of the molecules or the identity of their properties to the operation of any of the causes which we call natural.

Molecules

*Nature*, Volume VIII, Number 204, September 25, 1873 (p. 441)

They [molecules] continue this day as they were created, perfect in number and measure and weight, and from the ineffaceable characters impressed on them we may learn that those aspirations alter accuracy in measurement, truth in statement, and justice in action, which we reckon among our noblest attributes as men, are ours because they are essential constituents of the image of Him Who in the beginning created, not only the heaven and the earth, but the materials of which heaven and earth consist.

Molecules

*Nature*, Volume VIII, Number 204, September 25, 1873 (p. 441)

Natural causes, as we know, are at work, which tend to modify, if they do not at length destroy, all the arrangements and dimensions of the earth and the whole solar system. But though in the course of ages catastrophes have occurred, and may yet occur, in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built – the foundation-stones of the material universe – remain unbroken and unworn.

The Theory of Molecules

*The Popular Science Monthly*, Volume IV, January, 1874 (p. 290)

### Meldola, R.

No biographical data available

The present position of structural chemistry may be summed up in the statement that we have gained an enormous insight into the anatomy of molecules, while our knowledge of their physiology is as yet in a rudimentary condition.

*Report of the Sixty-fifth Meeting of the British Association for the Advancement of Science*

The State of Chemical Science in 1851 (p. 648)

John Murray. London, England. 1895

### Montague, James J.

No biographical data available

Though men may boast of brain or brawn  
And maids of soft attractions,  
Such qualities depend upon  
Their chemical reactions.  
When Daniel, placid and serene,  
Defied a den of lions,  
He owed his calm, unflinching mien  
To molecules and ions.

What's the Use of Worrying?

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 20, 1932 (p. 257)

### Morrison, Jim 1943–71

American singer, song writer, and poet

Love hides in molecular structures.

*Absolutely Live*

Love Hides

Sung by The Doors

July 1969

### Newman, Joseph S. 1892–1960

American poet

There's none to say how carbon first  
Conceived it ocy-hydric thirst –  
How nitrogen, in right proportion,  
And sulphur joined the strange consortion –  
But close upon the tenuous verge  
Where shadows end, does life emerge,  
And from these elemental five  
Sprang proteid molecules alive!

*Poems for Penguins and Other Lyrical Lapses*

Biochemistry

Greenburg. New York, New York, USA. 1941

Quite recently to be exact,  
Within a billion years, in fact.  
Some time before the glacial drift  
Had given the planet's face a lift,  
A group of shameless molecules  
Broke all the inorganic rules  
And (C.I.O. epitomized!)  
Spontaneously organized.

*Poems for Penguins and Other Lyrical Lapses*

Biology

Greenburg. New York, New York, USA. 1941

### O'Brien, Flann 1911–66

Irish novelist and political commentator

Did you ever study the Mollycule Theory when you were a lad? he asked. Mick said not, not in any detail.

That is a very serious defalcation and an abstruse exacerbation, he said severely, but I'll tell you the size of it. Everything is composed of small Mollycules of itself, and they are flying around in concentric circles and arcs and segments and innumerable various other routes too numerous to mention collectively, never standing still or resting but spinning away and darting hither and thither and back again, all the time on the go.

...

Mollycules is a very intricate theorem and can be worked out with algebra but you would want to take it by degrees with rulers and cosines and familiar other instruments and then at the wind-up not believe what you had proved at all.

*The Dalkey Archive*

Chapter 9 (pp. 87–88)

Hart-Davis, MacGibbon. London, England. 1968

**von Baeyer, Hans Christian** 1938–  
Physicist and author

Coiled serpents capture the essence of the molecule that is missing from mechanical models – the element of mystery. They remind us that just beneath the surface of the dazzling atomic landscape recorded by modern technology, the paradoxes of quantum mechanics lurk like venomous snakes.

*Taming the Atom*

Chapter 5 (p. 88)

Random House, Inc. New York, New York, USA. 1992

**Wald, George** 1906–97  
American biologist and biochemist

I have lived much of my life among molecules. They are good company. I tell my students to try to know molecules, so well that when they have some question involving molecules, they can ask themselves, What would I do if I were that molecule? I tell them, Try to feel like a molecule; and if you work hard, who knows? Someday you may get to feel like a big molecule!

*Les Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

**Weinberg, R. A.**  
No biographical data available

Can – and should – life be described in terms of molecules? For many, such description seems to diminish the beauty of Nature. For others of us, the wonder and beauty of nature are nowhere more manifest than in the submicroscopic plan of life.

The Molecules of Life

*Scientific American*, Volume 253, Number 4, October, 1985 (p. 57)

**Weiss, Paul A.** 1898–1985  
Chemist

...there is no phenomenon in a living system that is not molecular, but there is none that is only molecular, either.

*Within the Gates of Science and Beyond*

The Living System: Determinism Stratified (p. 270)

Hafner Publishing Company. New York, New York, USA. 1971

## MOMENTUM

### Author undetermined

A rolling stone gathers momentum.  
Source undetermined

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

We must consider motion in its two causes, the primary and universal cause, to which is due all the motion that is in the world, and the particular cause to which it is

due that various portions of matter acquire the movements which before they had not. As to the former, it is evident to me that it must be attributed to God Himself, who in the beginning created matter along with motion and rest, and ever since has preserved these in the same quantity. For, though motion is nothing but a mode in the thing which is moved, yet it is of a definite amount that remains constant for the whole universe, though it varies in regard to the several parts.

*Principles of Philosophy*

Part II, 36, 42

E. Mellen Press. Lewistown, New York, USA. 1988

**Duhem, Pierre-Maurice-Marie** 1861–1916  
French physicist and mathematician

If one wishes to draw a line of separation between the realm of ancient and modern science, it must be drawn at the instant when Jean Buridan conceived his theory of momentum, when he ceased to think of stars as kept in motion by certain divine beings and proclaimed that motions, celestial and terrestrial, are each controlled by the same mechanical laws.

*Études, sur Leonardo da Vinci*

A. Hermann. Paris, France. 1906–09

**Gilmore, Robert**  
No biographical data available

If you want to be a force in the community and to push things around, then you have to be able to transfer momentum.

*Alice in Quantum Land*

Chapter 6 (p. 95)

Springer-Verlag. New York, New York, USA. 1955

## MONEY

**Mitchell, Maria** 1818–89  
American astronomer and educator

The chemist should have had a laboratory, and the observatory should have had an astronomer; but we are too apt to bestow money where there is no man, and to find a man where there is no money.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 184)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

## MONKEYS AND TYPEWRITERS

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

...If I let my fingers wander idly over the keys of a typewriter it might happen that my screed made an intelligible sentence. If an army of monkeys were strumming on typewriters they might write all the books in the British



Museum. The chance of their doing so is decidedly more favourable than the chance of the molecules returning to one half of the vessel.

*The Nature of the Physical World*

Chapter IV (p. 72)

The Macmillan Company. New York, New York, USA. 1930

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

It was, I think, Huxley, who said that six monkeys, set to strum unintelligently on typewriters for millions of millions of years, would be bound in time to write all the books in the British Museum. If we examined the last page which a particular monkey had typed, and found that it had chanced, in its blind strumming, to type a Shakespeare sonnet, we should rightly regard the occurrence as a remarkable accident, but if we looked through all the millions of pages the monkeys had turned off in untold millions of years, we might be sure of finding a Shakespeare sonnet somewhere amongst them, the product of the blind play of chance. In the same way, millions of millions of stars wandering blindly through space for millions of millions of years are bound to meet with every sort of accident, and so are bound to produce a certain limited number of planetary systems in time. Yet the number of these must be very small in comparison with the total number of stars in the sky.

*The Mysterious Universe*

Chapter I (p. 4)

The Macmillan Company. New York, New York, USA. 1932

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Neo-Darwinism does indeed carry the nineteenth-century brand of materialism to its extreme limits – to the proverbial monkey at the typewriter, hitting by pure chance on the proper keys to produce a Shakespeare sonnet.

*The Case of the Midwife Toad* (p. 30)

New York, New York, USA. 1972

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

There is a special department of hell for students of probability. In this department there are many typewriters and many monkeys. Every time that a monkey walks on a typewriter, it types by chance one of Shakespeare's sonnets.

*Nightmares of Eminent Persons*

The Metaphysician's Nightmare (p. 29)

The Bodley Head. London, England. 1954

**Russo, Richard** 1949–

American novelist

In a novel, two characters discuss the glitch in a computer which causes it to scroll an endless series of meaningless

symbols: He sighs. "It casts serious doubt on the old theory that an infinite number of monkeys at an infinite number of typewriters would eventually write the Great American Novel, doesn't it?"

*Straight Man* (p. 129)

Random House, Inc. New York, New York, USA. 1996

**Synge, John L.** 1897–1995

Irish mathematician and physicist

"But not the sonnets?" asked the Orc, quizzically. "Yes, of course," retorted the Plumber, "The sonnets too. And the Bible. And the Koran. And that poem of mine which you have just recited...."

"But suppose," said the Orc, "that our monkey became very fond of some particular word, perhaps some naughty little four-letter word, and went on typing that word over and over again and never any other. I cannot see, in that case, how he would type even one play." "That would be quite an exceptional case," answered the Plumber. "Eddington had in mind a haphazard performance. The monkey types the keys at random, and the outcome is governed by pure chance. And by pure chance the plays of Shakespeare emerge, after a long time of course." "Doubtless, doubtless," muttered the Orc, reflectively. "Poor monkey! How bored he would get! For he would reproduce the plays of Shakespeare not once but many times, in fact an infinite number of times."

*Kandelman's Krim*

Chapter Eleven (p. 145)

Jonathan Cape. London, England. 1957

## MONOGRAPH

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

"Oh, didn't you know?" he cried, laughing. "Yes, I have been guilty of several monographs. They are all upon technical subjects. Here, for example, is one 'Upon the Distinction between the Ashes of the Various Tobaccos.' In it I enumerate a hundred and forty forms of cigar, cigarette, and pipe tobacco, with coloured plates illustrating the difference in the ash. It is a point which is continually turning up in criminal trials, and which is sometimes of supreme importance as a clue. If you can say definitely, for example, that some murder has been done by a man who was smoking an Indian lunkah, it obviously narrows your field of search. To the trained eye there is as much difference between the black ash of a Trichinopoly and the white fluff of bird's-eye as there is between a cabbage and a potato."

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Sign of the Four*, Chapter 1 (p. 612)

Wings Books. New York, New York, USA. 1967

## MONOPOLE

**Dirac, Paul Adrien Maurice** 1902–84  
English theoretical physicist

From the theoretical point of view one would think that monopoles [magnets with one pole] should exist, because of the prettiness of the mathematics. Many attempts to find them have been made, but all have been unsuccessful. One should conclude that pretty mathematics by itself is not an adequate reason for nature to have made use of a theory. We still have much to learn in seeking for the basic principles of nature.

In Heinz R. Pagels

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Three, Chapter 1 (p. 284)  
Simon & Schuster. New York, New York, USA. 1985

**Gamow, George** 1904–68  
Russian-born American physicist

Two Monopoles worshipped each other,  
And all of their sentiments clicked.  
Still, neither could get to his brother,  
Dirac was so fearfully strict!

*Thirty Years That Shook Physics*

Second Part (p. 202)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

## MONSTER

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

...the night comes on, and the shadows of the woods and rocks deepen: there are uncouth sounds along the beach and in the forest; and new monsters of yet stranger shape are dimly discovered moving amid the uncertain gloom.

*Sketch-Book of Popular Geology*

Lecture Forth (p. 151)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

## MONSTROSITIES OF DICTION

### DEFINITION

Exit is the portion of a means of egress which is separated from all other spaces of the building or structure by construction or equipment as required in this subpart to provide a protected way to travel to the exit discharge ...

*Engineering Education*, April, 1972 (p. 779)

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

...the stream lines are as represented in the annexed diagram, in which the region of translational velocity greater than wave-propagational velocity is separated from the region of translational velocity less than wave-

propagational velocity by a cat's-eye border pattern of elliptic-whirls.

*Report of the Fiftieth Meeting of the British Association for the Advancement of Science*

On. a Disturbing Infinity in Lord Rayleigh's Solution 'for Waves in a Plane Vortex Stratum (p. 493)

John Murray. London, England. 1880

**Kirkman, Thomas Penyngton** 1806–95  
English rector and mathematician

Change is a perichoretical synechy of pamparallagmatic and porroteroporeumatical differentiations and integrations.

In P.G. Tait

Prof. Tait on the Formula of Evolution  
*Nature*, November 25, 1881 (p. 81)

Evolution is a change from a nohowish untalkaboutable all-alikeness, to a somehowish and in-general-talk-aboutable not-all-alikeness, by continuous somethin-gelsificationsand sticktogetherations.

*Philosophy Without Assumptions*

Chapter XIII (p. 292)

Longmans, Green & Co. London, England. 1876

### May, John

No biographical data available

### Marten, Michael

No biographical data available

In the days when zoomancy and zoolatry were common, the zoic anthologies had a strongly zoophobic or zootheistic basis. But the zeal of zoologists, zoographers, and the zonomy and zoometry of zootomistists has changed all that. We now recognize that each of us, every individual of every species – and the whole zeotrope itself – began as a single zooblast. So our definitions are wider and the alphabetical zootaxy of this zoographia runs from the simplest zochronic zoobiotics to the largest zoophagic zoons, including ourselves, the human zoons.

*The Book of Beasts*

XYZ (p. 186)

The Viking Press. New York, New York, USA. 1982

## Occupational Safety and Health Administration

...the exit is the portion of a means of egress which is separated from all other spaces of the building or structure by construction or equipment as required in this subpart to provide a protected way to travel to the exit discharge ...

*Engineering Education*, April, 1972 (p. 779)

### Sladeczek, V.

No biographical data available

It can be stated in terms used in saprobiology that the polysaprobry was changed in alpha-messoaprobry.

A Note on the Phytoplankton Zooplankton Relationship

*Ecology*, Volume 39 July 1958 (p. 547)

**Spencer, Herbert** 1829–1903  
English social philosopher

Evolution is a change from an indefinite, incoherent homogeneity, to a definite, coherent heterogeneity; through continuous differentiations and integrations.

*First Principles of a New System of Philosophy*

The Law of Evolution, Continued (p. 216)

D. Appleton & Company. New York, New York, USA. 1865

## MONTE CARLO

**Monod, Jacques** 1910–76  
French biochemist

The universe was not pregnant with life nor the biosphere with man. Our number came up in the Monte Carlo game.

*Chance and Necessity* (p. 145)

Alfred A Knopf. New York, New York, USA. 1971

## MONUMENT

**Lyell, Sir Charles** 1797–1875  
English geologist

...it is probable that a greater number of monuments of the skill and industry of man will, in the course of ages, be collected together in the bed of the ocean, than will exist at anyone time on the surface of the continents.

*Principles of Geology* (Volume 2)

Book III, Chapter XVI (p. 150)

James Kay, Jun. & Brother. Philadelphia, Pennsylvania, USA. 1837

## McCoy, Lee Herbert

Man as man is a very interesting study, and we can trace his history only by the monuments he has left behind him, whether intentionally or unintentionally. These monuments may take the form varying from a potsherd to the Great Pyramid at Cheops, but it is all markings of the advancement of man.

*Origin of Architectural Design*

Introduction (p. 8)

The Antiquarian Publishing Co. Benton Harbor, Michigan, USA. 1912

## MOON

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

The old moon, like a worn and ancient coin, is still hanging in the west when I awake.

*Desert Solitaire*

Terra Incognita: Into the Maze (p. 289)

Ballantine Books. New York, New York, USA. 1968

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

Soon as the evening shades prevail,  
The moon takes up the wondrous tale,

And nightly to the listening earth  
Repeats the story of her birth.

In John Matthews Manley (ed.)

*English Poetry*

Hymn (p. 220)

Ginn & Company. Boston, Massachusetts, USA. 1907

**Alger, William R.** 1822–1905  
Unitarian minister and author

The moon is a silver pin-head vast,  
That holds the heaven's tent-hangings fast.

*Poetry of the Orient*

The Use of the Moon

Roberts Brothers. Boston, Massachusetts, USA. 1866

**Blake, William** 1757–1827  
English poet, painter, and engraver

The moon like a flower  
In heaven's high bower,  
With silent delight  
Sits and smiles on the night.

*The Complete Poetry and Prose of William Blake*

The Moon

University of California Press. Berkeley, California, USA. 1982

**Borman, Frank** 1928–  
American astronaut

The moon is a different thing to each of us.

From Apollo VIII

December 24, 1968

**Brewster, David** 1781–1868  
Scottish scientist, inventor, and writer

Had the moon been destined to be merely a lamp to our earth, there was no occasion to variegate its surface with lofty mountains and valleys and extinct volcanoes, and cover it with large patches of matter, that reflect different quantities of light, and give its surface the appearance of continents and seas.

*More Worlds Than One: The Creed of the Philosopher and the Hope of the Christian*

114

Robert Carter & Brothers. New York, New York, USA. 1854

**Bronte, Charlotte** 1816–55  
English author

Where, indeed, does the moon not look well? What is the scene, confined or expansive, which her orb does not follow? Rosy or fiery, she mounted now above a not distant bank; even while we watched her flushed ascent, she cleared to gold, and in a very brief space, floated up stainless into a now calm sky.

*Life and Works of the Sisters Brontë* (Volume 3)

Villette La Terrasse (p. 214)

AMS Press Inc. New York, New York, USA. 1973

**Burroughs, John** 1837–1921  
American naturalist and essayist

I saw the moon run over a poor little star to-night. I suppose it will never open its eye again.

*The Heart of Burroughs's Journals*

Jan. 30, 1858 (p. 10)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Burton, Robert** 1577–1640  
English clergyman and scholar

Doth the moon care for the barking of a dog?

*The Anatomy of Melancholy* (Volume 2)

Part II, Sect. III, Memb. VII (p. 231)

AMS Press, Inc. New York, New York, USA. 1973

**Burton, Sir Richard Francis** 1821–90  
English explorer

That gentle Moon, the lesser light, the Lover's lamp, the Swain's delight,

A ruined world, a globe burnt out, a corpse upon the road of night.

*The Kasidah of Haji Abdu El-Yezdi* (p. 10)

McBride. New York, New York, USA. 1929

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

He made an instrument to know

If the moon shine at full or no;

That would, as soon as e'er she shone straight,

Whether 'twere day or night demonstrate;

Tell what her d'iameter to an inch is,

And prove that she's not made of green cheese.

*The Poetical Works of Samuel Butler* (Volume 1)

Part II, Canto III, l. 261

Bell & Daldy. London, England. 1835

The moon pull'd off her veil of light,

That hides her face by day from sight

(Mysterious veil, of brightness made,)

That's both her lustre and her shade),

And in the lantern of the night,

With shining horns hung out her light.

*The Poetical Works of Samuel Butler* (Volume 1)

Part II, Canto I, l. 905

Bell & Daldy. London, England. 1835

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

The moon was shining sulkily,

Because she thought the sun

Had got no business to be there

After the day was done –

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter IV (p. 183)

The Modern Library. New York, New York, USA. 1936

**Cawein, Madison Julius** 1865–14  
American poet

Into the sunset's turquoise marge

The moon dips, like a pearly barge;

Enchantment sails through magic seas,

To fairland Hesperides,

Over the hills and away.

*Poems*

At Sunset, Stanza 1

The Macmillan Company. New York, New York, USA. 1911

**Case, Paul Foster** 1884–1954  
American occultist

...the waxing moon is like a caravan coming into sight, the full moon is like its rest at a city, the waning moon suggests its gradual disappearance in the distance, and the dark of the moon corresponds to the time the camels are out of sight.

Chapter V

*The Secret Doctrine of the Tarot*

*The Word: A Monthly Magazine Devoted to Philosophy, Science,*

*Religion*, Volume XXIII (p. 163)

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Like Great Britain, the Moon has no climate – only weather.

*The Exploration of Space*

Chapter 10 (p. 108)

Harper & Brothers Publishers. New York, New York, USA. 1951

**Collins, Michael** 1880–1922  
Irish soldier and politician

It was a totally different moon than I had ever seen before.

The moon that I knew from old was a yellow flat disk, and this was a huge three-dimensional sphere, almost a ghostly blue-tinged sort of pale white. It didn't seem like a very friendly place or welcoming place. It made one wonder whether we should be invading its domain or not.

In Kevin W. Kelley

*The Home Planet*

With Plate 39

Addison-Wesley Publishing, Inc. Reading, Massachusetts, USA. 1988

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

There is something haunting in the light of the moon; it has all the dispassionateness of a disembodied soul, and something of its inconceivable mystery.

*Lord Jim*

Chapter XXIV (p. 213)

Rinehart & Company, Inc. New York, New York, USA. 1957

**Croly, George** 1780–1860  
Irish poet, novelist, and divine

How like a queen comes forth the lonely Moon  
From the slow opening curtains of the clouds

Walking in beauty to her midnight throne!

*Gems, Principally from the Antique*

Diana

Printed for Hurst, Robinson & Company. London, England. 1822

**Darwin, Erasmus** 1731–1802

English physician and poet

And hail their queen, fair regent of the night.

*The Botanic Garden*

Part I, Canto II, III, l. 90

Jones & Company. London, England. 1825

**Darwin, Sir George Howard** 1845–1912

English astronomer and mathematician

The origin and earliest history of the moon must always remain highly speculative, and it seems fruitless to formulate exact theories on the subject.

*The Tides and Kindred Phenomena in the Solar System*

Chapter XX (p. 360)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1898

**de Bergerac, Cyrano** 1619–55

French dramatist

Our Eyes being fixed upon that stately Planet [the moon], everyone spoke what he thought of it: One would needs have it be a Garret Window of Heaven; another presently affirmed, That it was the Pan whereupon Diana smoothed Apollo's Bands; whilst another was of Opinion, That it might very well be the Sun himself, who putting his Locks up under his Cap at Night, peeped through a hole to observe what was doing in the World during his absence.

*A Voyage to the Moon*

Chapter I (p. 10)

Doubleday & McClure Co. New York, New York, USA. 1849

...I believe that the Moon is a World like ours, to which this of ours serves likewise for a Moon.

*A Voyage to the Moon*

Chapter I (p. 11)

Doubleday & McClure Co. New York, New York, USA. 1849

**Empedocles of Acragas** ca. 490 BCE–430 BCE

Greek pre-Socratic philosopher

A borrowed light, circular in form, it revolves about the earth, as if following the track of a chariot.

In Arthur Fairbanks

*The First Philosophers of Greece*

Book I

Fragment 154 (p. 177)

Charles Scribner's Sons. New York, New York, USA. 1898

**Fitz-Gerald, Charles Egerton**

English physician

There are probably few of us who, when abroad on a moonlight night, have not speculated as to the nature

of that beautiful and mysterious looking body which is inundating the landscape with its pure and silvery light.

*Semi-scientific Lectures*

Ten Minutes in the Moon (p. 1)

J. English. Folkstone, England. 1880

**Flammarion, Camille** 1842–1925

French astronomer and author

It is the delightful hour when all Nature pauses in the tranquil calm of the silent night.

The Sun has cast his farewell gleams upon the weary Earth. All sound is hushed. And soon the stars will shine out one by one in the bosom of the somber firmament. Opposite to the sunset, in the east, the Full Moon rises slowly, as it were calling our thoughts toward the mysteries of eternity, while her limpid night spreads over space like a dew from Heaven.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Chapter IX (p. 232)

D. Appleton & Co. New York, New York, USA. 1915

The silent star of night is the first halting-place on a voyage towards the infinite.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter I (p. 81)

Chatto & Windus. London, England. 1894

Orb of dream and mystery, pale sun of the night, solitary globe wandering in the silent firmament, the moon has in all times and among all nations peculiarly attracted attention and thought.

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter VI (p. 145)

Chatto & Windus. London, England. 1894

Nothing could be more beautiful, nothing purer, and more celestial, than this lunar globe floating in the silence of space, and sending back to us as in some fairy dream the solar illumination that floods it.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Chapter IX (p. 257)

D. Appleton & Co. New York, New York, USA. 1915

**Frost, Robert** 1874–1963

American poet

The Moon for all her light and grace  
Has never learned to know her place.

The notedest astronomers  
Have set the dark aside for hers.

*Complete Poems of Robert Frost*

Two Leading Lights

Henry Holt & Company. New York, New York, USA. 1949

**Fry, Christopher** 1907–2005  
English playwright

...the moon is nothing  
But a circumambulating aphrodisiac  
Divinely subsidized to provoke the world  
Into a rising birth-rate.  
*The Lady's Not for Burning*  
Act Three (p. 66)  
Oxford University Press, Inc. New York, New York, USA. 1950

**Haggard, H. Rider** 1856–1925  
English novelist

The sky aft was dark as pitch, but the moon still shone brightly ahead of us and lit up the blackness. Beneath its sheen a huge white-topped breaker, twenty feet high or more, was rushing on to us. It was on the break – the moon shone on its crest and tipped its foam with light. On it rushed beneath the inky sky, driven by the awful squall behind it.  
*The Favorite Novels of H. Rider Haggard*  
She (p. 195)  
Blue Ribbon Books, Inc. New York, New York, USA. 1928

**Hawthorne, Nathaniel** 1804–64  
American novelist and short story writer

By this time the sun had gone down, and was tinting the clouds toward the zenith with those bright hues which are not seen there until sometime after sunset, and when the horizon has quite lost its richer brilliancy. The moon, too, which had long been climbing overhead, and unobtrusively melting its disk into the azure – like an ambitious demagogue who hides his aspiring purpose by assuming the prevalent hue of popular sentiment – now began to shine out, broad and oval, in its middle pathway.  
*The House of the Seven Gables* (p. 251)  
Scott, Foresman & Co. Chicago, Illinois, USA. 1919

**Homer** fl. 750 BCE  
Greek poet

As when the stars shine clear, and the moon is bright – there is not a breath of air, not a peak nor glade nor jutting headland, but it stands out in the ineffable radiance that breaks from the serene of heaven...  
In *Great Books of the Western World* (Volume 4)  
*The Iliad of Homer*  
Book VIII, l. 555 (p. 56)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hood, Thomas** 1582–98  
English poet and editor

Mother of light! how fairly dost thou go  
Over those hoary crests, divinely led!  
Art thou that huntress of the silver bow  
Fabled of old? Or rather dost thou tread  
Those cloudy summits thence to gaze below,  
Like the wild chamois from her Alpine snow,

Where hunters never climbed – secure from dread?  
*The Complete Poetical Works of Thomas Hood*  
Ode to the Moon  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

By death the moon was gathered in  
Long ago, ah long ago;  
Yet still the silver corpse must spin  
And with another's light must glow.  
Her frozen mountains must forget  
Their primal hot volcanic breath,  
Doomed to revolve for ages yet,  
Void amphitheatres of death.  
*The Captive Shrew and Other Poems of a Biologist*  
Cosmic Death  
Harper & Brothers. New York, New York, USA. 1933

**Ingelow, Jean** 1820–97  
English poet and novelist

Such a slender moon, going up and up,  
Waxing so fast from night to night,  
And swelling like an orange flower-bud, bright,  
Fated, methought, to round as to a golden cup,  
And hold to my two lips life's best of wine.  
*The Poetical Works of Jean Ingelow*  
Songs of the Night Watches  
The First Watch, pt. II  
John B. Alden. New York, New York, USA. 1883

**Jastrow, Robert** 1925–  
American space scientist

**Newell, Homer E.**  
No biographical data available

The moon is the Rosetta stone of the solar system, and to the student of the origin of the earth and planets, this lifeless body is even more important than Mars and Venus.  
Why Land on the Moon?  
*The Atlantic Monthly*, Volume 211, Number 2; August, 1963 (p. 43)

**Jonson, Ben** 1573?–1637  
English dramatist and poet

Queen and huntress, chaste and fair,  
Now the sun is laid to sleep,  
Seated in thy silver car,  
State in wonted manner keep.  
Hesperus entertains thy light  
Goddess, excellently bright!  
*Hymn*  
To Cynthia

**Keats, John** 1795–1821  
English Romantic lyric poet

The moon put forth a little diamond peak  
No bigger than an unobserved star,



Or tiny point of fairy scimitar.

*The Complete Poetical Works and Letters of John Keats*

Endymion

Book IV, l. 499

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

...when we have seen the pock-marked face of the moon in scientific photographs, need that be the end of the moon for us? Even rationally? I think not. It is a great blow: but the imagination can recover from it. Even if we have to believe the pock-marked photographs, even if we believe in the cold and snow and utter deadness of the moon – which we *don't* quite believe – the moon is not therefore a dead nothing. The moon is a white strange world, great, white, soft-seeming globe in the night sky, and what she actually communicates to me across space I shall never fully know.

In Edward D. McDonald (ed.)

*Phoenix*

Preface to 'The Dragon of the Apocalypse' (pp. 299–300)

The Viking Press. New York, New York, USA. 1936

The Moon is a white strange world, great, white, soft-seeming globe in the night sky, and what she actually communicates to me across space I shall never fully know. But the Moon that pulls the tides, and the Moon that controls the menstrual periods of women, and the Moon that touches the lunatics, she is not the mere dead lump of the astronomist.... When we describe the Moon as dead, we are describing the deadness in ourselves. When we find space so hideously void, we are describing our own unbearable emptiness.

*Phoenix*

Introduction to 'The Dragon'

The Viking Press. New York, New York, USA. 1936

**Lear, Edward** 1812–88

English humorist and artist

They dined on mince, and slices of quince,  
Which they ate with a runcible spoon;  
And hand in hand, on the edge of the sand,  
They danced by the light of the moon,  
The moon, the moon,  
They danced by the light of the moon.

In Tony Palazzo

*Edward Lear's Nonsense Book*

The Owl and the Pussycat

Garden City Books. Garden City, New York, USA. 1956

**Lightner, Alice**

No biographical data available

Queen of Heaven, fair of face,  
Undeified by alien feet;  
Where the sun's untrammelled heat

Meets the cold of outer space;  
Soon no more the Queen of Night,  
For your conquest is in sight.

To the Moon

*Nature Magazine*, April, 1957 (p. 213)

**Longfellow, Henry Wadsworth** 1807–82

American poet

Saw the moon rise from the water,  
Rippling, rounding from the water,  
Saw the flecks and shadows on it,  
Whispered, "What is that, Nokomis?"  
And the good Nokomis answered,  
"Once a warrior very angry,  
Seized his grandmother and threw her  
Up into the sky at midnight;  
Right against the moon he threw her;  
'Tis her body that you see there."

*The Poetical Works of Henry Wadsworth Longfellow*

Hiawatha, Hiawatha's Childhood

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Lovell, James A.** 1928–

American astronaut

The moon is essentially gray, no color. It looks like plaster of Paris, like dirty beach sand with lots of footprints in it.

*Washington Post*, 25 December, 1968

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

moon you re as cold as a frozen  
skin of yellow banan  
that sticks in the frost and ice  
on top of a garbage can  
*the lives and time of archy & mehitabel*  
mehitabel dances with boreas (p. 127)  
Doubleday Doran & Co. Garden City, New York, USA. 1934

**Milton, John** 1608–74

English poet

...now glow'd the firmament  
With living sapphires; Hesperus, that led  
The starry host, rode brightest, till the moon,  
Rising in clouded majesty, at length  
Apparent queen, unveil'd her peerless light,  
And o'er the dark her silver mantle threw.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book IV, l. 604–609

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Moore, Thomas** 1779–1852

Irish poet

The moon looks  
On many brooks,

The brook can see no moon but this.

*The Poetical Works of Thomas Moore*

While Gazing on the Moon's Light

Lee & Shepard. Boston, Massachusetts, USA. 1873

**Muir, John** 1838–1914

American naturalist

The moon is looking down into the canon, and how marvelously the great rocks kindle to her light! Every dome, and brow, and swelling boss touched by her white rays, glows as if lighted with snow.

*Steep Trails*

Chapter II (p. 23)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

...the Moon, being the last of all, most familiar with the Earth, and devised by Nature for the Remedy of Darkness, exceedeth the Admiration of all the rest. She with her changing in many Shapes, hath troubled much the Minds of Beholders, angry because that of this Star, the nearest of all, they should be the most ignorant; growing as it doth, or else wasting continually.

*Pliny's Natural History. In Thirty-seven Books*

Book II, Chapter IX (p. 42)

Printed for the Club by G. Barclay. London, England. 1847–1849

**Rankin, William H.**

No biographical data available

Someday I would like to stand on the moon, look down through a quarter of a million miles of space and say, "There certainly is a beautiful earth out tonight."

*The Man Who Rode the Thunder*

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1960

**Rives, Hallie Erminie** 1876–1956

Author

The moon drowsed between the trees like a great yellow moth ...

*The Valiants of Virginia*

Chapter XXXVI (p. 324)

The Bobbs-Merrill Co. Indianapolis, Indiana, USA. 1912

**Robbins, Tom** 1936–

American writer

Our Moon has surrendered none of its soft charm to technology. The pitter-patter of little spaceboots has in no way diminished its mystery.

*Even Cowgirls Get the Blues*

Chapter 19 (p. 60)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Ross, Sir Ronald** 1857–1932

English bacteriologist

O Moon! When I look at thy beautiful face,  
Careening along through the boundaries of space

The thought has quite frequently come to my mind  
If ever I'll gaze on thy glorious behind.

In Harriet Monroe (ed.)

*Poetry*

O Moon

Modern Poetry Association. Chicago, Illinois, USA.

**Sappho** 630 BCE–570 BCE

Greek lyric poet

Stars near the lovely moon cover their own bright faces  
when she is roundest and lights up the earth with her silver.

*Poems by Sappho* (p. 4)

Charles Scribner's Sons. New York, New York, USA. 1924

**Serviss, Garrett Putnam** 1851–1921

American science fiction writer

The imagination of mankind has never resisted the fascination of the moon.

*Astronomy with the Naked Eye*

Chapter XVIII (p. 226)

Harper & Brothers. New York, New York, USA. 1908

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Therefore the moon, the governess of floods,  
Pale in her anger, washes all the air,  
That rheumatic diseases do abound.  
And thorough this distemperature we see  
The seasons alter: hoary-headed frosts  
Fall in the fresh lap of the crimson rose,  
And on old Hiems' thin and icy crown  
An odorous chaplet of sweet summer buds  
Is, as in mockery, set.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*A Midsummer-Night's Dream*

Act II, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is the very error of the moon;  
She comes more nearer earth than she was wont,  
And drives men mad.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume Two)

*Othello, The Moor of Venice*

Act V, Scene ii, l. 107–111

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

...the moon gazed on my midnight labours, while, with  
unrelaxed and breathless eagerness, I pursued nature to  
her hiding-places.

*Frankenstein*

Chapter 4 (p. 43)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**Shelley, Percy Bysshe** 1792–1822

English poet

The young moon has fed  
Her exhausted horn  
With the sunset's fire.

*The Complete Poetical Works of Percy Bysshe Shelley*

Hellas Semi-Chorus II

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Tancock, Ernest Osborne**

No biographical data available

It has been well said that the Sun is a laboratory, while the Moon is a museum – that is to say, the Sun is the scene of chemical change resulting in the continual formation of new substances, while the Moon is like stones under a glass case – always presenting the same appearance year after year.

*The Elements of Descriptive Astronomy* (2nd edition)

Chapter III (p. 25)

At The Clarendon Press. Oxford, England. 1919

**Tennyson, Alfred (Lord)** 1809–92

English poet

All night, through archways of the bridged pearl  
And portals of pure silver, walks the moon.

*Alfred Tennyson's Poetical Works*

Sonnet

Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

I never tire of the beauty of certain epithets which the ages have slowly bestowed, as the – Hunters moon and the Harvest moon. There is something pleasing in the fact that the irregularity in the rising of these two moons, and their continuing to rise nearly at the same time for several nights should have been observed by the husbandman before it attracted the attention of Science.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2) (p. 53)

Princeton University Press. Princeton, New Jersey, USA. 1984

**Thurber, James** 1894–1961

American writer and cartoonist

“The moon is 300,000 miles away,” said the Royal Mathematician. “It is round and flat like a coin, only it is made of asbestos, and it is half the size of this kingdom. Furthermore, it is pasted on the sky.”

*Many Moons*

Harcourt Brace &amp; Company. San Diego, California, USA. 1971

**Tolstoy, Alexei** 1882–1945

Russian writer

“Which is more useful, the Sun or the Moon?” asks Kuzma Prutkov, the renowned Russian philosopher, and

after some reflection he answers himself: “The Moon is the more useful, since it gives us its light during the night, when it is dark, whereas the Sun shines only in the daytime, when it is light anyway.”

Quoted by George Gamow

*The Birth and Death of the Sun*

Chapter I (p. 1)

The Viking Press. New York, New York, USA. 1945

**Verne, Jules** 1828–1905

French novelist

There is no one among you, my brave colleagues, who has not seen the Moon, or at least, heard speak of it.

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter II (p. 12)

A.L. Burt Company. New York, New York, USA. 1890

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

It's [the moon] dead – dead! Vast extinct volcanoes, lava wildernesses, tumbled wastes of snow, or frozen carbonic acid, or frozen air, and everywhere landslip seams and cracks and gulfs. Nothing happens. Men have watched this planet systematically with telescopes for over two hundred years. How much change do you think they have seen? None.

*The First Men in the Moon*

Chapter V (pp. 65–66)

George Newnes, Ltd. London, England. 1901

**Willard, Samuel**

No biographical data available

Every night there glides along above us in the sky the corpse of a dead world. Sometimes shrouded in the glare of sunshine, she dimly appears in the sky of day; sometimes full and round, she is bright with a cold splendor; sometimes wan and shorn of her beams, she rises late and chill, forerunning the sun; sometimes following his departing light, she delights us with the graceful crescent and its nightly growing radiance; sometimes coming between earth and sun, she casts that baleful shade which made the heart of the elder world to quake, and still smites uncultured nations with fear.

The Destiny of the Universe

*The Century*, Volume XXVII, Number 6, April, 1884 (p. 914)**Williams, Dafydd (Dave) Rhys** 1954–

Canadian physician and retired CSA astronaut

We'll go back to the moon, this time for a much longer period of time. We'll build lunar outposts. We'll send a crew to Mars. There are no ifs around it. It's going to happen.

Ground Control to Dr. Dave

*The McGill Reporter*, Volume 31, Number 3, 8 October, 1998

**PHOEBE****Author undetermined**

Phoebe, Phoebe, whirling high In our neatly-plotted sky,  
Listen, Phoebe, to my lay: Won't you whirl the other  
way?

All the other stars are good And revolve the way they  
should. You alone, of that bright throng, Will persist in  
going wrong.

Never mind what God has said –

We have made a Law instead. Have you never heard of  
this Neb-u-lar Hy-poth-e-sis?

In Clarence Day

*The Crow's Nest*

To Phoebe (p. 49)

Alfred A. Knopf. New York, New York, USA. 1922

**MOON LANDING**

**Armstrong, Neil A.** 1930–

American astronaut

That's one small step for a man, one giant leap for man-  
kind.

Men Walk on Moon

*New York Times*, L5, column 3, 21 July 1969

**Beckett, Chris**

No biographical data available

The Moon landings were not about gathering data or  
testing hypotheses; they were about theatre, about the  
enactment of many mythical themes that were fed and  
nurtured by such a spectacular event. It was about the  
power of humankind, the power of technology, our abil-  
ity to overcome the apparently impossible and to con-  
quer not just Earth but the whole Universe. And yet at  
the same time it was about the smallness of humankind,  
our vulnerability the fact that we inhabit a single small  
planet, surrounded by emptiness...

*New Scientist*, November 11, 1989

**Crew of Apollo 11**

Here Men from The Planet Earth

First Set Foot upon The Moon

July, 1969 AD

We Came in Peace for All Mankind.

*Plaque left behind on the moon's surface*

**Hoffer, Eric** 1902–83

American longshoreman and philosopher

Our passionate preoccupation with the sky, the stars, and  
a God somewhere in outer space is a homing impulse. We  
are drawn back to where we came from.

Reactions to Man's Landing on the Moon Show Broad Variations in  
Opinions

*New York Times*, A6, column 2, 21 July 1969

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Prometheus is reaching out for the stars with an empty  
grin on his face.

Reactions to Man's Landing on the Moon Show Broad Variations in  
Opinions

*New York Times*, A6, column 6, 21 July 1969

**Nabokov, Vladimir Vladimirovich** 1899–1977

Russian-born American novelist

Treading the soil of the moon, palpating its pebbles, tast-  
ing the panic and splendor of the event, feeling in the  
pit of one's stomach the separation from terra...these  
form the most romantic sensation an explorer has ever  
known...this is the only thing I can say about the matter.  
The utilitarian results do not interest me.

Reactions to Man's Landing on the Moon Show Broad Variations in  
Opinions

*New York Times*, A6, column 5, 21 July 1969

**MOON, PHASES OF**

**King, Leonard William** 1869–1919

English archaeologist

The Moon-god he caused to shine forth, the night he  
entrusted to him.

He appointed him, a being of the night, to determine the days;  
Every month without ceasing with the crown he covered  
him, saying:

“At the beginning of the month, when thou shinest upon  
the land,

Thou commandest the horns to determine six days,

And on the seventh day to divide the crown.

On the fourteenth day thou shalt stand opposite, the  
half...

Translated by Thorkild Jacobson

*Enuma Elish*

The Fifth Tablet, 12

Kessinger Publications. Whitefish, Montana, USA. 2004

**MORAL**

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Many animals are delightfully good, but only man is moral.

*The Bible of Nature*

Man's Place in Nature (p. 187)

Charles Scribner's Sons. New York, New York, USA. 1908

**MORAL REPROOF**

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

Narrow and loose habits of thought, prejudiced atti-  
tudes towards evidence, bias from previous opinions and

feelings, shallowness and superficiality in observation, and carelessness in reasoning are appropriate subjects of moral reproof.

The Ethical Functions of Scientific Study

*The Journal of Geology*, Volume 2, Number 6, December, 1888 (p. 380)

## MORALS

**Bernard, Claude** 1813–78

French physiologist

...we must not deceive ourselves: morals do not forbid making experiments on one's neighbour or one's self; in everyday life, men do nothing but experiment on one another.

Translated by Henry Copley Green

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter 4 (p. 102)

Henry Schuman, Inc. New York, New York, USA. 1949

## MORPHOLOGY

**Goodsir, John** 1814–67

Scottish anatomist

As morphology deals with forms and relations of position, it demands a careful selection of terms, and a methodised nomenclature.

*The Anatomical Memoirs of John Goodsir* (Volume 2)

Chapter V (pp. 83–84)

Adam & Charles Black. Edinburgh, Scotland. 1868

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The flowering of functional morphology has yielded a panoply of elegant individual examples and few principles beyond the unenlightening conclusion that animals work well...Newtonian procedures yield Newtonian answers, and who doubts that animals tend to be well designed.

The Promise of Paleobiology as a Nomothetic, Evolutionary Discipline.

*Paleobiology*, Volume 6 1980 (p. 101)

**Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

The waves of the sea, the little ripples on the shore, the sweeping curve of the sandy bay between the headlands, the outline of the hills, the shape of the clouds, all these are so many riddles of form, so many problems of morphology.

*On Growth and Form* (Volume 1)

Chapter I (p. 10)

At The University Press. Cambridge, England. 1951

## MOTHER NATURE

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Our old mother Nature has pleasant and cheery tones enough for us when she comes in her dress of blue and gold over the eastern hill-tops; but when she follows us up-stairs to our beds in her suit of black velvet and diamonds, every creak of her sandals and every whisper of her lips is full of mystery and fear.

*The Professor at the Breakfast-table*

Chapter VII (p. 237)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

## MOTION

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

...I am apt to think, that men will never be able to explain the phenomena of nature, while they endeavor to deduce them only from the presence and proportion of such or such material ingredients, and consider such ingredients or elements as bodies in a state of rest; whereas indeed the greatest part of the affections of matter, and consequently of the phenomena of nature, seems to depend upon the motion and the contrivance of the small parts of bodies. For 'tis by motion that one part of matter acts upon another; and 'tis, for the most part, the texture of the body upon which the moving parts strike, that modifies the motion or impression, and concurs with it to the production of those effects which make up the chief part of the naturalists theme.

*The Sceptical Chymist*

The Fifth Part (pp. 178–179)

J.M. Dent & Sons. London, England. 1911

**Brooke, Frances** 1724–89

English novelist, essayist, playwright, and translator

A state of rest is ungraceful; all nature is most beautiful in motion: trees agitated by the wind, a ship under sail, a horse in the course, a fine woman dancing.

*Emily Montague* (Volume 1)

Chapter I (p. 45)

Printed for J. Dodsley. London, England. 1769

**Brown, Carrie**

No biographical data available

He thought of all the infinitesimal motions of the world, the obstinate, heartbreaking progress of an earthworm, eating its own route forward.

*Rose's Garden: A Novel*

Chapter Nine (p. 165)

Algonquin Books of Chapel Hill. Chapel Hill, North Carolina, USA. 1998

**Burton, Robert** 1577–1640

English clergyman and scholar

The heavens themselves run continually round, the sun riseth and sets, the moon increaseth, stars and planets keep their constant motions, the air is tossed by the

winds, the waters ebb and flow, to their conservation no doubt, to teach us that we should ever be in motion.

*The Anatomy of Melancholy* (Volume 2)

Part II, Sect. II, Memb. IV (p. 80)

AMS Press, Inc. New York, New York, USA. 1973

**Butterfield, Herbert** 1900–79

English historian and philosopher of history

Of all the intellectual hurdles which the human mind has confronted and has overcome in the last fifteen hundred years, the one which seems to me to have been the most amazing in character and the most stupendous in the scope of its consequences is the one relating to the problem of motion...

*The Origins of Modern Science*

Chapter One (p. 3)

The Macmillan Company. New York, New York, USA. 1961

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“Well, in our country,” said Alice, still panting a little, “you’d generally get to somewhere else – if you ran very fast for a long time, as we’ve been doing.”

“A slow sort of country!” said the Queen. “Now here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that.”

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter II (p. 166)

The Modern Library. New York, New York, USA. 1936

**Dee, John** 1527–1609

English mathematician and occultist

Whatever is in the universe is continuously moved by some species of motion.

Translated by Wayne Schumaker

*John Dee on Astronomy*

XVI (p. 129)

University of California Press. Berkeley, California, USA. 1978

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...God always preserves in the world just so much motion as He impressed on it at its first creation.

*Principles of Philosophy*

Part II, 36, 42

E. Mellen Press. Lewistown, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

We not merely deduce [a] three-dimensional world; we see it. But we have no such aid in synthesising different motions. Perhaps if we had been endowed with two eyes moving with different velocities our brains would have developed the necessary faculty; we should have perceived a kind of relief in the fourth dimension so as to

combine into one picture the aspect of things seen with different motions.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter II (p. 32)

At The University Press. Cambridge, England. 1921

It is curious that the philosophical denial of absolute motion is readily accepted, whilst the denial of absolute simultaneity appears to many people revolutionary.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 51)

At The University Press. Cambridge, England. 1921

**Flammarion, Camille** 1842–1925

French astronomer and writer

Thus perpetual motion bears the world along! The sun moves through space; the earth moves round him, letting herself be carried along in his flight; the moon moves, circulating round us, while we gravitate round the radiant hearth which precipitates itself into the eternal void.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter III (p. 109)

Chatto & Windus. London, England. 1894

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

My purpose is to set forth a very new science dealing with a very ancient subject. There is, in nature, perhaps nothing older than motion, concerning which the books written by philosophers are neither very few nor small; nevertheless, I have discovered by experiment some properties of it which are worth knowing and which have not hitherto been either observed or demonstrated.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Third Day, Change of Position (p. 197)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...so far as I know, no one has yet pointed out that the distances traversed, during equal intervals of time, by a body falling from rest, stand to one another in the same ratio as the odd numbers beginning with unity,

Translated by Henry Crew and Alfonso de Salvio

*Dialogues Concerning Two New Sciences*

Third Day (p. 153)

The Macmillan Co. New York, New York, USA. 1914

...we have decided to consider the phenomena of bodies falling with an acceleration such as actually occurs in nature and to make this definition of accelerated motion exhibit the essential features of observed accelerated motions.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Third Day, Naturally Accelerated Motion (p. 200)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**Grove, William Robert** 1811–96  
Judge and physical scientist

Of absolute rest Nature gives us no evidence: all matter, as far as we can ascertain, is ever in movement, not merely in masses, as with the planetary spheres, but also molecularly, or throughout its most intimate structure: thus every alteration of temperature produces a molecular change throughout the whole substance heated or cooled; slow chemical or electrical actions, actions of light or invisible radiant forces, are always at play, so that as a fact we cannot predicate of any portion of matter that it is absolutely at rest.

*The Correlation and Conservation of Forces*  
The Correlation of Physical Forces (pp. 26–27)  
D. Appleton & Co. New York, New York, USA. 1865

**Herschel, Friedrich Wilhelm**  
(**Sir William**) 1738–1822  
English astronomer

“Does it not seem natural that these observations should cause a strong suspicion that most probably every star in the heavens is more or less in motion?” For though their proper motions could not cause all these changes, yet we may well suppose that motion is in some way concerned.

On the Proper Motion of the Sun and Solar System  
*Philosophical Transactions of the Royal Society of London*,  
Volume 73, 1783 (p. 259)

If the proper motion of the stars be admitted, who can deny that of our sun? Admitting this for granted, the greatest difficulty will be to discern the proper motion of the sun between so many other motions of the stars. This is an arduous task indeed, but we are not to be discouraged in the attempt. Let us at all events endeavor to lay a good foundation for those who are to come after us.

On the Proper Motion of the Sun and Solar System  
*Philosophical Transactions of the Royal Society of London*,  
Volume 73, 1783 (p. 260)

**Hobbes, Thomas** 1588–1679  
English philosopher and political theorist

...when a thing lies still, unless somewhat else stir it, it will lie still forever, is a truth that no man doubts of. But that when a thing is in motion, it will eternally be in motion, unless somewhat else stay it, though the reason be the same, namely, that nothing can change itself, is not so easily assented to.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (2nd edition)  
Chapter II (p. 16)  
George Routledge & Sons. London, England. 1886

**Hume, David** 1711–76  
Scottish philosopher and historian

The idea of motion necessarily supposes that of a body moving.

*A Treatise of Human Nature* Book 1  
Part IV, Section IV (p. 228)  
Printed for John Noon. London, England. 1888

**Hutton, W.**  
No biographical data available

Motion is the soul of the universe...

*The Book of Nature Laid Open*  
Chapter XV (p. 173)  
Joseph Milligan, Georgetown. 1822

**Huxley, Thomas Henry** 1825–95  
English biologist

In nature, nothing is at rest, nothing is amorphous; the simplest particle of that which men in their blindness are pleased to call “brute matter” is a vast aggregate of molecular mechanisms performing complicated movements of immense rapidity, and sensitively adjusting themselves to every change in the surrounding world.

*Science and Education: Essays*  
Chapter XIV (p. 371)  
D. Appleton & Co. New York, New York, USA. 1896

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

It is inconceivable to doubt that light consists in the motion of some sort of matter. For when one considers its production, one sees that here upon the earth it is chiefly engendered by fire and flame which contain without doubt bodies that are in rapid motion, since they dissolve and melt many other bodies, even the most solid; or when one considers its effects, one sees that when light is collected, as by concave mirrors, it has the property of burning as a fire does, that is to say, it disunites the particles of bodies. This is assuredly the mark of motion, at least in the true philosophy, in which once conceives the cause of all natural effects in terms of mechanical motions. This, in my opinion, we must necessarily do, or else renounce all hopes of ever comprehending anything in physics.

In *Great Books of the Western World* (Volume 34)  
*Treatise on Light*  
Chapter One. On Rays Propagated in Straight Lines (p. 553)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...the laws which nature obeys are less suggestive of those which a machine obeys in its motion than of those which a musician obeys in writing a fugue, or a poet in composing a sonnet. The motions of electrons and atoms do not resemble those of the parts of a locomotive so much as those of the dancers in a cotillion. And if the “true essence of substances” is forever unknowable, it does not matter whether the cotillion is danced at a ball in real life, or on a cinematography screen, or in a story of Boccaccio.

*The Mysterious Universe*

Chapter V (p. 168)

The Macmillan Company. New York, New York, USA. 1932

The motion of the stars over our heads is as much an illusion as that of the cows, trees and churches that flash past the windows of our train.

*The Stars in Their Courses*

Chapter 1 (p. 3)

The Macmillan Co. New York, New York, USA.

**Le Marquis de Sade** 1740–1814

French aristocrat, revolutionary, politician, and writer

If matter acts, is moved by combinations unknown to us, if movement is inherent in Nature; if, in short, she alone, by reason of her energy is able to create, produce, preserve, maintain, hold in equilibrium within the immense plains of space all the spheres that stand before our gaze and whose uniform march, unvarying, fills us with awe and admiration, what then becomes of the need to seek out a foreign agent, since this active faculty is essentially to be found in Nature herself, who is naught else than matter in motion?

*Justine, Philosophy in the Bedroom, and other Writings*

*Philosophy in the Bedroom* (pp. 210–211)

Grove Press. New York, New York, USA. 1990

**Leacock, Stephen** 1869–1944

Canadian humorist

It was Einstein who made the real trouble. He announced in 1905 that there was no such thing as absolute rest. After that there never was.

*The Boy I Left Behind Me*

Chapter VI (p. 171)

The Bodely Head. London, England. 1947

**Locke, John** 1632–1704

English philosopher and political theorist

The parts of pure space are immovable, which follows from their inseparability; motion being nothing but change of distance between any two things; but this cannot be between parts that are inseparable; which therefore must needs be at perpetual rest one amongst other.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter XIII, Section 14 (p. 151)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...let us suppose the matter of the next pebble we meet with, eternal, closely united, and the parts firmly at rest together; if there were no other being in the world, must it not eternally remain so, a dead, inactive lump? Is it possible to conceive it can add motion to itself, being purely matter, or produce anything? Matter then, by its own strength, cannot produce in itself so much as motion: the motion it has, must also be from eternity, or else be produced, and added to matter by some other being more powerful than matter: matter, as is evident, having not power to produce motion in itself.

*An Essay Concerning Human Understanding*

24th Book IV, Chapter 10 (p. 544)

Printed for William Baynes & Son. London, England. 1823

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

For whenever bodies fall through water and thin air, they must quicken their descents in proportion to their weights, because the body of water and subtle nature of air cannot retard everything in equal degree, but more readily give way [when] overpowered by the heavier...

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book Two, l. 230–234 (p. 18)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Collecting all that has been presented, we see that there is contained in the principle of virtual displacements simply the recognition of a fact that was instinctively familiar to us long previously, only that we had not apprehended it so precisely and clearly. This fact consists in the circumstance that heavy bodies, of themselves, move only downwards.

Translated by Thomas McCormack

*The Science of Mechanics: A Critical and Historical Account of Its Development* (4th edition)

Chapter I (p. 74)

The Open Court Publishing Co. Chicago, Illinois, USA. 1902

**Maxwell, James Clerk** 1831–79

Scottish physicist

Absolute space is conceived as remaining always similar to itself and immovable. The arrangement of the parts of space can no more be altered than the order of the portions of time. To conceive them to move from their places is to conceive a place to move away from itself.

*Matter and Motion*

Chapter I, Section 18

Dover. New York, New York, USA. 1953

**Meredith, George** 1828–1909

English novelist and poet

So may we read, and little find them cold:

Not frosty lamps illuminating dead space,

Not distant aliens, not senseless Powers.

The fire is in them whereof we are born;

The music of their motion may be ours.

*A Reading of Earth*

Meditation under Stars (p. 120)

Macmillan & Company Ltd. London, England. 1888

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjointly.

*Mathematical Principles of Natural Philosophy*

Definitions, Definition II

E.P. Dutton &amp; Company, Inc. New York, New York, USA. 1922

The whole difficulty of philosophy seems to me to lie in investigating the forces of nature from the phenomena of motion, and in demonstrating that from these forces other phenomena will ensue.

*Mathematical Principles of Mathematical Philosophy*

Preface

**Plato** 428 BCE–347 BCE

Greek philosopher

Motion... has many forms, and not one only; two of them are obvious enough even to wits no better than ours; and there are others, as I imagine, which may be left to wiser persons.

In *Great Books of the Western World* (Volume 7)*The Republic*

Book VII, Section 530 (p. 396)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

Once during mass, Galileo in church

Conducted a major scientific search.

He measured with his pulse how a lamp did swing

That was to the ceiling tied with a string.

A Fable for Physicists, The Pendulum Period

*The Physics Teacher*, Volume 18, Number 7, October, 1990 (p. 488)**Regnault, Noël** 1702–62

Jesuit mathematician

Nothing seems more clear at first than the Idea of Motion, and yet nothing is more obscure when one comes to search thoroughly into it.

*Philosophical Conversations* (Volume 1)

Conversation VI (p. 58)

Printed for W. Innyes, C. Davis &amp; N. Prevost. London, England. 1731

**Sarpi, Fra Paolo** 1552–1623

Venetian patriot, scholar, and church reformer

To give us the science of motion God and Nature have joined hands and created the intellect of Galileo.

In Morris Kline

*Mathematics and the Physical World*

Chapter 12 (p. 181)

Dover Publications, Inc. New York, New York, USA. 1981

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Two stars keep not their motion in one sphere.

In *Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)*The First Part of King Henry the Fourth*

Act V, Scene iv

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Steele, Joel Dorman** 1836–86

American educator and textbook writer

Rest is nowhere. The winds that come and go, the ocean that uneasily throbs along the shore, the earth that revolves about the sun, the light that darts through space – all tell of a universal of Nature. The solidest body hides within it inconceivable velocities. Even the molecules of garnet and iron have their orbits as do the stars, and move as ceaselessly.

*Popular Physics*

Chapter II (p. 19)

American Book Company. New York, New York, USA. 1896

**Thierry, Paul Henri, Baron d’Holbach** 1723–89

German-born French philosopher

Everything in the universe is in motion; the essence of nature is to act; and if we consider attentively its parts, we shall see that there is not a particle which enjoys absolute repose.

Translated by M. Mirabaud

*System of Nature or, The Laws of the Moral and Physical World*

(Volume First)

Part First, Chapter II (p. 27)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thomson, Thomas**

No biographical data available

Substances may either be examined in a state of rest, or as acting upon each other and producing changes on each other. The knowledge derived from the first of these views, is called Natural History; that which we can obtain by the second, is distinguished by the name Science. But bodies cannot act upon each other without producing motion, and the motions produced by such actions are of two kinds; either so great as to be visible to our senses, and capable of being measured by the space passed over; or so small as not to be distinguishable by our senses, except by the effects produced. The phenomena connected with the first of these kinds of motions constitute what is called Natural Philosophy or Mechanical Philosophy in this country, and on the Continent, Physics. The phenomena connected with the imperceptible motion belong to the science called Chemistry.

*History of the Royal Society from Its Institution to the End of the Eighteenth Century*

Book III (p. 311)

Printed for Robert Baldwin. London, England. 1812

**Tolstoy, Leo** 1828–1910

Russian writer

Absolute continuity of motion is not comprehensible to the human mind. Laws of motion of any kind become comprehensible to man only when he examines arbitrarily selected elements of that motion; but at the same time, a large proportion of human error comes from the

arbitrary division of continuous motion into discontinuous elements.

*Great Books of the Western World* (Volume 51)  
*War and Peace*

Book XI, Chapter I (p. 469)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tyndall, John** 1820–93  
Irish-born English physicist

But is it in the human mind to imagine motion without at the same time imagining something moved? Certainly not. The very conception of motion includes that of a moving body.

*Light and Electricity* (pp. 123–124)  
D. Appleton & Company. New York, New York, USA. 1873

Slowly, and with difficulty, the notion of natural forces took root in the human mind. Slowly, and with difficulty, the science of mechanics had to grow out of this notion; and slowly at last came the full application of mechanical principles to the motions of the heavenly bodies.

*Six Lectures on Light Delivered in America in 1872–1873*  
Lecture I (p. 5)  
D. Appleton & Co. New York, New York, USA. 1901

**Walters, Marcia C.**  
No biographical data available

The fact that the photon gets mass from its motion is a widely accepted Einsteinian notion, This doesn't apply to we mortals, alas – For the smaller our motion the greater our mass.

Filler  
*The Physics Teacher*, Volume 5, Number 8, November, 1967 (p. 384)

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

“And here,” he said, and opened the hand that held the glass. Naturally I winced, expecting the glass to smash. But so far from smashing, it did not even seem to stir; it hung in mid-air – motionless. “Roughly speaking,” said Gibberne, “an object in these latitudes falls 16 feet in the first second. This glass is falling 16 feet in a second now. Only, you see, it hasn't been falling yet for the hundredth part of a second. That gives you some idea of the pace of my Accelerator.”

*28 Science Fiction Stories of H.G. Wells*  
*The New Accelerator* (p. 863)  
Dover Publications, Inc. New York, New York, USA. 1952

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

The universe is a procession with measured and beautiful motion.

*Complete Poetry and Collected Prose*  
Leaves of Grass  
The Library of America. New York, New York, USA. 1982

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The fact that we can describe the motions of the world using Newtonian mechanics tells us nothing about the world. The fact that we do, does tell us something about the world.

In John D. Barrow  
*The World Within the World* (p. 77)  
Clarendon Press. Oxford, England. 1988

**Young, Joshua**  
No biographical data available

Said the earth to a ball falling free,  
“You're enjoying this falling, I see.”  
The ball widened its eyes  
And remarked with surprise,  
“But it's you who is falling, not me!”

Physics Poems  
*The Physics Teacher*, Volume 20, Number 9, December, 1982 (p. 587)

## MOTIVE

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

When we try to ascertain the motives which have led men to the investigation of philosophical questions, we find that, broadly speaking, they can be divided into two groups, often antagonistic, and leading to very divergent systems. These two groups of motives are, on the one hand, those derived from religion and ethics, and, on the other hand, those derived from science.

*Mysticism and Logic: And Other Essays*  
Chapter VI (p. 97)  
Longmans, Green & Co. London, England. 1919

## MOUNTAIN

**Austen, Jane** 1775–1817  
English writer

What are men to rocks and mountains?  
*Pride and Prejudice*  
Chapter 27  
G. Allen. London, England. 1894

**Austin, Mary Hunter** 1868–1934  
American novelist and essayist

Who shall say what another will find most to his liking in the streets of the mountains. As for me, once set above the country of the silver firs, I must go on until I find white columbine.

*The Land of Little Rain*  
The Streets of the Mountain (pp. 194–195)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Avicenna** 908–1037  
Islamic physician

Mountains may be due to two different causes. Either they are effects of upheavals of the crust of the earth, such as might occur during a violent earthquake, or they are the effect of water, which, cutting for itself a new route, has denuded the valleys, the strata being of different kinds, some soft, some hard. The winds and waters disintegrate the one, but leave the other intact. Most of the eminences of the earth have had this latter origin. It would require a long period of time for all such changes to be accomplished, during which the mountains themselves might be somewhat diminished in size. But that water has been the main cause of these effects is proved by the existence of fossil remains of aquatic and other animals on many mountains.

In John William Draper  
*History of the Intellectual Development of Europe* (Volume 1)  
Chapter XIII (pp. 410–411)  
Harper & Brothers. New York, New York, USA. 1876

**Boswell, James** 1740–95  
Scottish biographer and diarist

Boswell: “There,” said I, “is a mountain like a cone.” “no sir,” said he [Johnson]. “it is indeed pointed at the top but one side of it is much longer than the other.” Another Mountain I called “immense.” “No,” said he, “but ‘tis a considerable protuberance.

*Journal of a Tour of the Herbrides* (p. 107)  
The Viking Press. New York, New York, USA. 1936

**Bourdillon, Francis William** 1852–1921  
British poet and translator

I suppose this ideal love of mountains – this love that we may almost call a platonic love, since it seeks no selfish gain – really exists in most or all of us; and is at the root of the instinct certainly of the climber, possibly even of the tourist. We have all of us had our ‘moments,’ either on the mountains, or perhaps in some distant view of them, when life and joy have assumed new meanings, and the world’s horizons suddenly broken down and shown us realms of dream beyond and yet beyond.

*Alpine Journal*, Volume 24

**Brewster, Edwin Tenney** 1866–1960  
Educator

[M]ountains are always the children of the sea.  
*This Puzzling Planet*  
Chapter XIII (p. 217)  
The Bobbs-Merrill Company, Indianapolis, Indiana. 1928

**Bucke, Charles** 1781–1846  
English writer

A Country destitute of mountains may be rich, well cultivated, and even beautiful, but it can in no instance be

sublime or transporting; and to what a degree boldness of scenery has the power of elevating the fancy, may be in some measure conceived from an anecdote recorded of a celebrated poet.

*On the Beauties, Harmonies, and Sublimities of Nature*  
Mountain (p. 41)

Harper & Brothers Publishers. New York, New York, USA. 1841

**Burnet, Thomas** 1635–1715  
English cleric and scientist

Look upon those great ranges of Mountains in Europe or in Asia, whereof we have given a short survey, in what confusion do they lie? They have neither form nor beauty, nor shape, nor order, no more than the Clouds in the Air. Then how barren, how desolate, how naked are they? how they stand neglected by Nature? neither the Rains can soften them, nor the Dews from Heaven make them fruitful.

*The Sacred Theory of the Earth* (2nd edition)  
Book I, Chapter XI (p. 111)  
Printed by R. Norton. London. 1691

The greatest objects of Nature are, methinks, the most pleasing to behold; and next to the great Concave of the Heavens, and those boundless Regions where the Stars inhabit, there is nothing that I look upon with more pleasure than the wide Sea and the Mountains of the Earth.... And yet these Mountains we are speaking of, to confess the truth, are nothing but great ruins; but such as show a certain magnificence in Nature; as from old Temples and broken Amphitheatres of the Romans we collect the greatness of that people. But the grandeur of a Nation is less sensible to those that never see the remains and monuments that they have left, and those that never see the mountainous parts of the Earth, scarce ever reflect upon the causes of them, or what power in Nature could be sufficient to produce them.

*The Sacred Theory of the Earth* (2nd edition)  
Book I, Chapter XI, Concerning the Mountains of the Earth (p. 109)  
Printed by R. Norton. London. 1691

There is nothing in Nature more shapeless and ill-figur’d than an old Rock or a Mountain, and all that variety that is among them is but the various modes of irregularity; so as you cannot make a better character of them, in short, than to say they are of all forms and figures, except regular.

*The Sacred Theory of the Earth* (2nd edition)  
Book I, Chapter XI (p. 112)  
Printed by R. Norton. London. 1691

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

Where rose the mountains, there to him were friends ...

*The Complete Poetical Works of Byron*  
Childe Harold  
Canto III Stanza 13

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

Above me are the Alps,  
The palaces of Nature, whose vast walls  
Have pinnacled in clouds their snowy scalps,  
And throned Eternity in icy halls ...  
*The Complete Poetical Works of Byron*  
Childe Harold  
Canto III Stanza 62  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

High mountains are a feeling ...  
*The Works of Lord Byron Complete in One Volume*  
*Child Harold's Pilgrimage*  
Canto III, stanza 72  
Printed by and for H.L. Broenner. 1826

### Carr, William H.

No biographical data available

...the mountains are but the brothers of the hills.  
*The Stir of Nature*  
Chapter One (p. 26)  
Oxford University Press, Inc. New York, New York, USA. 1930

### Freshfield, Douglas W.

1845–1934  
British barrister, mountaineer, writer, poet, and geographer

Of all natural objects the most impressive is a vast snowy peak rising as a white island above the waves of green hills – a fragment of the arctic world left behind to commemorate its past predominance – and bearing on its broad shoulders a garland of the Alpine flora that has been destroyed on the lower ground by the rising tide of heat and drought that succeeded the last glacial epoch.

*Annual Report of the Board of Regents of the Smithsonian Institution (1904)*  
On Mountains and Mankind (p. 337)  
Government Printing Office. Washington, D.C. 1905

...for us creatures of a day the mountains stand fast.  
*Annual Report of the Board of Regents of the Smithsonian Institution (1904)*  
On Mountains and Mankind (p. 354)  
Government Printing Office. Washington, D.C. 1905

### Hare, Julius Charles

1795–1855  
English theological writer

### Hare, Augustus William

Mountains never shake hands. Their roots may touch: they may keep together some way up: but at length they part company, and rise into individual, insulated peaks.  
*Guesses at Truth* (p. 185)  
Macmillan & Company Ltd. London, England. 1876

### Hawthorne, Nathaniel

1804–64  
American novelist and short story writer

Mountains are Earth's undecaying monuments.  
Mosses from an Old Manse  
Sketches from Memory (p. 478)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1886

### Howitt, William

1792–1879  
English author

Mountains! how one's heart leaps up at the very word! There is a charm connected with mountains so powerful, that the merest mention of them, the merest sketch of their magnificent features kindles the imagination, and carries the spirit at once into the bosom of their enchanted regions.

*The Book of the Seasons*  
September (p. 323)  
Henry Colburn & Richard Bentley. London, England. 1831

Thanks be to God for mountains! The variety which they impart to the glorious bosom of our planet were no small advantage; the beauty which they spread out to our vision in their woods and waters; their crags and slopes, their clouds and atmospheric hues were a splendid gift; the sublimity which they pour into our deepest souls from their majestic aspects; the poetry which breathes from their streams, and dells, and airy heights, from the sweet abodes, the garbs and manners of their inhabitants, the songs and legends which have awoken in them, were a proud heritage to imaginative minds; but what are all these when the thought comes, that without mountains the spirit of man must have bowed to the brutal and the base, and probably have sunk to the monotonous level of the unvaried plain.

*The Book of the Seasons*  
September (p. 328)  
Henry Colburn & Richard Bentley. London, England. 1831

### Hutchinson, Thomas

1711–80  
Royal governor of the British North American Province of Massachusetts Bay

I told him his nerves were affected: Every molehill was a mountain.

*Diary*

### Hutton, W.

No biographical data available

Deformities, indeed, they [mountains] cannot be called; for if the human mind delights in variety, these inequalities present us with a variety the most pleasing and picturesque; and if the contemplative philosopher is captivated by the multiplicity of nature's productions, these furnish food for the most keen researcher into the wonders of creation.

*The Book of Nature Laid Open, in a Popular Survey of the Phenomena and Constitution of the Universe*  
Chapter III (p. 16)  
J. Milligan. Georgetown, District of Columbia. 1822

### King, Thomas Starr

1824–64  
American Unitarian clergyman

Going close to a great mountain is like going close to a powerfully painted picture; you see only the roughnesses,



the blotches of paint, the coarsely contrasted hues, which at the proper distance alone are grouped into grandeur and mellowed into beauty.

*The White Hills: Their Legends, Landscape, and Poetry*  
The Four Balleys (p. 6)  
Crosby & Ainsworth. Boston, Massachusetts, USA. 1866

The majesty of a mountain is determined by the outlines of its bulk; its expression depends on the distance, and the states of the air through which it is seen.

*The White Hills: Their Legends, Landscape, and Poetry*  
The Four Balleys (p. 6)  
Crosby & Ainsworth. Boston, Massachusetts, USA. 1866

...in rushing so fast as many of us do through the mountains, the mountains do not have time to come to us.

*The White Hills: Their Legends, Landscape, and Poetry*  
The Four Balleys (p. 19)  
Crosby & Ainsworth. Boston, Massachusetts, USA. 1866

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

On low ground one may be in the clouds, but not above them. But as we look down from mountains and see the clouds floating far below us, we almost seem as if we were looking down on earth from one of the heavenly bodies.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter VI (p. 213)  
Macmillan & Company Ltd. London, England. 1903

Geography moreover acquires a new interest when we once realise that mountains are no mere accidents, but that for every mountain chain, for every peak and valley, there is a cause and an explanation.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter VI (pp. 214–215)  
Macmillan & Company Ltd. London, England. 1903

**Malan, Solomon Caesar** 1812–94  
British divine and orientalist

Every mountain has distinct features, as characteristic and as marked as those of the human face.

*Aphorisms on Drawing*  
LXI (p. 56)  
Longman, Brown, Green, Longmans & Roberts. London, England. 1856

**Marvell, Andrew** 1621–78  
English metaphysical poet

Here learn, ye mountains more unjust, Which to abrupter greatness thrust, Which do, with your hook-shoulder'd height, The earth deform, and heaven fright, For whose excrescence, ill design'd, Nature must a new centre find, Learn here those humble steps to tread, Which to securer glory lead.

*The Poetical Works of Andrew Marvell*  
Upon the Hill and Grove at Billborow  
Andrew Murray. London, England. 1870

**Moore, Dudley** 1935–2002  
English actor and pianist

**Cook, Peter** 1937–1995  
English comedian

DUDLEY: And will this wind be so mighty as to lay low the mountains of the earth?

PETER: No. It will not be quite as mighty as that. That is why we have come up on the mountain, you stupid nit. Up here we shall be safe – safe as houses.

*Beyond the Fringe*  
The End of the World  
British stage comedy revue. 1961

**Cyrano Jones (Fictional character)**

Twice nothing is still nothing.

*Star Trek*  
The Trouble with Tribbles  
Television program, Season 2, 1967

**Muir, John** 1838–1914  
American naturalist

Thousands of God's wild blessings will search you and soak you as if you were a sponge, and the big days will go by uncounted.

*Our National Parks*  
Chapter I (p. 17)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The time will not be taken from the sum of your life. Instead of shortening, it will indefinitely lengthen it and make you truly immortal. Nevermore will time seem short or long, and cares will never again fall heavily on you, but gently and kindly as gifts from heaven.

*Our National Parks*  
Chapter I (p. 19)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you and the storms their energy, while care will drop off like autumn leaves.

*Our National Parks*  
Chapter II (p. 56)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Fear not, therefore, to try the mountain-passes. They will kill care, save you from deadly apathy, set you free, and call forth every faculty into vigorous, enthusiastic action. Even the sick should try these so-called dangerous passes, because for every unfortunate they kill, they cure a thousand.

*Mountains of California*  
Chapter V (p. 79)  
The Century Company. New York, New York, USA. 1911

The mountains are fountains not only of rivers and fertile soil, but of men.

*Steep Trails*

Chapter III (p. 47)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

...perhaps more than all, I was animated by a mountaineer's eagerness to get my feet in the snow once more, and my head into the clear sky, after lying dormant all winter at the level of the sea.

*Steep Trails*

Chapter IX (p. 128)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Here I could stay tethered forever with just bread and water, nor would I be lonely; loved friends and neighbors, as love for everything increased, would seem all the nearer however many the miles and mountains between us.

*My First Summer in the Sierra*

June 6 (p. 29)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Nicolson, Marjorie Hope** 1894–1981

Professor of English

Theology, philosophy, geology, astronomy – basic and radical changes in all these occurred before the 'Mountain Gloom' gave way to 'Mountain Glory.'

*Mountain Gloom and Mountain Glory*

Introduction (p. 3)

University of Washington Press. Seattle, Washington, USA. 1997

**Peattie, Roderick** 1891–1955

Geographer and romanticist

To a large extent, then, a mountain is a mountain because of the part it plays in popular imagination. It may be hardly more than a hill; but if it has distinct individuality, or plays a more or less symbolic role to the people, it is likely to be rated a mountain by those who live about its base.

*Mountain Geography* (p. 4)

Harvard University Press. Cambridge, Massachusetts, USA. 1936

**Pouchet, Félix Archimède** 1800–72

French biologist

It is in the midst of lofty mountains that Nature develops her most magnificent scenes. Their winding-sheets of eternal snow, their diadems of ice, and their burning volcanoes, by turns strike and astonish the traveller.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book III (p. 323)

Blackie &amp; Son. London, England. 1892

**Rice, Cale Young** 1872–1943

American poet and dramatist

Under the sea, which is their sky, they rise

To watery altitudes as vast as those

Of far Himalayan peaks ...

*Collected Plays and Poems* (Volume 1)

Submarine Mountains (p. 326)

Doubleday &amp; Co., Inc. Garden City, New York, USA. 1915

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

[Mountains] seem to have been built for the human race, as at once their schools and cathedrals; full of treasures of illuminated manuscript for the scholar, kindly in simple lessons to the worker, quiet in pale cloisters for the thinker, glorious in holiness for the worshipper. ... [G]reat cathedrals of the earth, with their gates of rock, pavements of cloud, choirs of stream and stone, altars of snow, and vaults of purple traversed by the continual stars...

*Selections from the Works of John Ruskin*

The Mountain Glory (p. 16)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

One of the principal charms of mountain scenery is its solitude.

*The Poetry of Architecture: Cottage, Villa, Etc*

The Cottage (p. 42)

John Wiley &amp; Sons. New York, New York, USA. 1877

...mountains are the beginning and the end of all natural scenery ...

*Modern Painters*

Chapter XX (p. 353)

Smith, Elder &amp; Co. London, England. 1873

**Semple, Ellen Churchill** 1863–1932

American geographer

The important characteristic of plains is their power to facilitate every phase of historical movement; that of mountains is their power to retard, arrest, or deflect it. Man, as part of the mobile envelope of the earth, like air and water feels always the pull of gravity.

*Influences of Geographic Environment***Sedgwick, Adam** 1854–1913

English geologist

My present objective is to convey some notion of the structure of the great mountain masses, and to show how the several parts are fitted one to another. This can only be done after great labour. The cliffs where the rocks are laid bare by the sea, the clefts and fissures in the hills and valleys, the deep grooves through which the water flows – all must in turn be examined; and out of such seeming confusion order will at length appear. We must, in imagination, sweep off the drifted matter that clogs the surface of the ground; we must suppose all the covering of moss and heath and wood to be torn away from the sides of the mountains, and the green mantle that lies near their feet to be lifted up; we may see the muscular integuments and sinews and bones of our mother Earth, and so judge of the parts played by each of them during those old convulsive movements whereby her limbs were contorted and drawn up into their present positions.

In John Hudson  
*Complete Guide to the Lakes*  
 Second Letter  
 Longman & Company. London, England. 1842

**Simler, Josias** 1530–56  
 Swiss theologian and classicist

...lofty mountains are most worth of deep study. For everywhere you turn, they present to every sense a multitude of objects to excite and delight the mind. They offer problems to our intellect; they amaze our souls. They remind us of the infinite variety of creation, and offer an unequalled field for the observation of the processes of nature.

*De Alpibus Commentarius*

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

The tops of mountains are among the unfinished parts of the globe, whither it is a slight insult to the gods to climb and pry into their secrets, and try their effects upon our humanity.

*The Writings of Henry David Thoreau* (Volume 3)

*The Maine Woods*

Ktaadn (p. 85)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Science knows that the isolated mountains in the horizon are but portions of an unseen range.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2) (p. 40)

Princeton University Press. Princeton, New Jersey, USA. 1984

**Tyndall, John** 1820–93  
 Irish-born English physicist

The aspects of Nature are more varied and impressive in Alpine regions than elsewhere. The mountains in their setting of deep-blue sky; the glow of firmament and peaks at sunrise and sunset; the formation and distribution of clouds; the descent of rain, hail, and snow; the stealthy slide of glaciers and the rush of avalanches and rivers; the fury of storms; thunder and lightning, with their occasional accompaniment of blazing woods – all these things tend to excite the feelings and to bewilder the mind.

*Fragments of Science for Unscientific People*

Chapter II (p. 35)

D. Appleton & Co. New York, New York, USA. 1875

## MOUNTAIN RANGE

**King, Clarence** 1842–1901  
 American geologist and mountaineer

The western margin of this continent [North America] is built of a succession of mountain chains folded in broad

corrugations, like waves of stone upon whose seaward base beat the mild, small breakers of the Pacific.

*Mountaineering in the Sierra Nevada*

Chapter I (p. 1)

Charles Scribner's Sons. New York, New York, USA. 1905

## MOUNTAIN, LUNAR

**Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

From these observations I believe it is evident that the height of the lunar mountains in general is greatly over-rated; and that when we have excepted a few, the generality do not exceed half a mile in their perpendicular elevation.

Astronomical Observations Relating to the Mountains of the Moon

*Philosophical Transactions of the Royal Society of London*,

Volume 70, 1780 (p. 517)

## MOVEMENT

**Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

It is evident, however, that not only does reaction itself consist of movements, but that in the compound formed (in the molecules) the elements (atoms) forming it are in harmonious stable movement (like the planets in the solar system), and this movement will affect the stability and capacity for reaction, and therefore these depend not only on the affinity of the participating substances, but also on the conditions of reaction which change the state of movement of the elements in the molecules, as well as on the nature, form, and intensity of those movements which the elements have in their given state. In a word, the mechanical side of chemical action must be exceedingly complex.

Translated by George Kamensky

*The Principles of Chemistry* (Volume 1)

Introduction (p. 84)

Longmans, Green & Co. London, England. 1891

## MUCOUS

**Pain, Roger H.**

No biographical data available

If it is love that makes the world go round, then it is surely mucus and slime which facilitate its translational motion.

In Steven Vogel

*Life's Devices: The Physical World of Animals*

Chapter 9 (p. 177)

Princeton University Press. Princeton, New Jersey, USA. 1988

**MUD**

**Geikie, Sir Archibald** 1835–1924  
English geologist

I know no recent observation in physical geography more calculated to impress deeply the imagination than the testimony of this presumably meteoric iron from the most distant abysses of the ocean. To be told that mud gathers on the floor of these abysses at an extremely slow rate conveys but a vague notion of the tardiness of the process. But to learn that it gathers so slowly. that the very star-dust which falls from outer space forms an appreciable part of it, brings home to us, as hardly anything else could do, the idea of undisturbed and excessively slow accumulation.

*Geological Sketches at Home and Abroad*

Chapter XIII (p. 282)

Macmillan & Co. New York, New York, USA. 1882

To be told that mud gathers on the floor of these abysses at an extremely slow rate conveys but a vague notion of the tardiness of the process. But to learn that it gathers so slowly. that the very star-dust which falls from outer space forms an appreciable part of it, brings home to us, as hardly anything else could do, the idea of undisturbed and excessively slow accumulation.

*Geological Sketches at Home and Abroad*

Chapter XIII (p. 282)

The Macmillan Co. New York, New York, USA. 1882

**MULTITUDE**

**Thompson, Sir J. Arthur** 1861–93  
Scottish biologist

Whether we gather shells on the shore or collect snow crystals; whether we study birds or brambles, hydroids or hawkweeds, we get the same impression of an overflowing form-fountain, of prodigal multiplicity, of endless resources.

*The Bible of Nature*

Chapter I (p. 11)

Charles Scribner's Sons. New York, New York, USA. 1908

**MUMMY**

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

“See, genteelmen! – Mummy! Mummy!” The eye-glass came up as calmly, as deliberately as ever. “Ah, – Ferguson – what did I understand you to say the gentleman’s name was?”

“Name? – he got no name! – Mummy! – ‘Gyptian mummy!’”

“Yes, yes. Born here?”

“No! ‘Gyptian mummy!’”

“Ah, just so. Frenchman, I presume?”

“No! – *not* Frenchman, not Roman! – born in Egypta!!”

“Born in Egypta. Never heard of Egypta before. Foreign locality, likely. Mummy – mummy. How calm he is – how self-possessed. Is, ah – is he dead?”

*The Innocents Abroad* (Volume 1) (p. 372)

The American Publishing Co. Hartford, Connecticut, USA. 1901

**MUON**

**Penman, Sheldon**

No biographical data available

For the time being, however, the muon itself qualifies as a “riddle wrapped in a mystery inside an enigma.”

The Muon

*Scientific American*, Volume 205, Number 1, July 1961 (p. 55)

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

Who ordered that?

Attributed, upon learning of the muon

**MUSE**

**Tennyson, Alfred (Lord)** 1809–92

English poet

These are Astronomy and Geology, terrible Muses!

*The Works of Alfred Lord Tennyson, Poet Laureate*

Parnassus – By An Evolutionist (p. 810)

The Macmillan Co. New York, New York, USA. 1898

**MUSEUM**

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The Dodo used to walk around,

And take the sun and air,

The sun yet warms his native ground –

The Dodo is not there!

The voice which used to squawk and squeak

Is now forever dumb –

You may you see his bones and beak

All in the Mu-se-um.

*Complete Verse*

The Dodo (p. 238)

G. Duckworth. London, England. 1970

**Burroughs, John** 1837–1921

American naturalist and essayist

I seldom... go into a natural history museum without feeling as if I were attending a funeral. There lie the birds and animals stark and stiff, or else, what is worse, stand

up in ghastly mockery of life, and the people pass along and gaze at them through the glass with the same cold and unprofitable curiosity that they gaze upon the face of their dead neighbor in his coffin.

*Indoor Studies*

Science and Literature (p. 49)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1904

### Edwards, R. Y.

No biographical data available

The physical heart of a museum is its collection, in fact having a collection is what makes a museum a museum, and most activity in most museums is involved with the acquisition, care, understanding, and use of their collections.

Research: A Museum Cornerstone

*Occasional Papers of the British Columbia Provisional Museum,*

Volume 25, 1985 (p. 1)

### Flower, Sir William Henry 1831–99

English zoologist

A museum is like a living organism; it requires constant and tender care; it must grow or it will perish.

In Archie F. Key

*Beyond Four Walls: The Origins and Development of Canadian Museums*

Chapter 6 (p. 52)

McClelland & Stewart Ltd. Toronto, Ontario, Canada. 1973

### Goode, George Brown

No biographical data available

A finished museum is a dead museum, and a dead museum is a useless museum.

In Museums Association

*The Principles of Museum Administration*

*Report of Proceedings*, Newcastle, 1895 (p. 78)

### Levi, Primo 1919–87

Italian writer and chemist

As happens with all well-structured exhibits, indeed as happens anytime one partakes of spiritual food, one leaves the exhibit nourished and at the same time hungrier than before.

Translated by Raymond Rosenthal

*Other People's Trades*

Butterflies (p. 16)

Summit Books. New York, New York, USA. 1989

### St. Clair, George

No biographical data available

The crust of the earth, with its embedded fossils, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals.

*Darwinism and Design, or, Creation by Evolution*

Chapter III (p. 52)

Hodder & Stoughton. London, England. 1873

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

I hate museums – there is nothing so weighs upon my spirits. They are the catacombs of nature.... They are dead nature collected by dead men. I know not whether I muse most – at the bodies stuffed with cotton and sawdust – or those stuffed with bowels and fleshy fibre outside the cases.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2) (p. 77)

Princeton University Press. Princeton, New Jersey, USA. 1984

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

A museum of natural history always seems to me like the tombs of Egyptian kings, in which various sorts of beasts and plants are preserved in mummified rigidity.

In John Stuart Blackie

*The Wisdom of Goethe*

Nature – Natural History (p. 183)

William Blackwood & Sons. Edinburgh, Scotland. 1883

## MUTATION

### Crow, J. F.

American geneticist

...we could still be sure on theoretical grounds that mutants would usually be detrimental. For a mutation is a random change of a highly organized, reasonably smoothly functioning human body. A random change in the highly integrated system of chemical processes which constitute life is certain to impair – just as a random interchange of connections in a television set is not likely to improve the picture.

Genetic Effects of Radiation

*Bulletin of the Atomic Scientists*, Volume 14, Number 1, January 14,

1958 (pp. 19, 20)

### Dobzhansky, Theodosius 1900–75

Russian-American scientist

...a majority of mutations, both those arising in laboratories and those stored in natural populations, produce deteriorations of...viability, hereditary disease and monstrosities. Such changes it would seem, can hardly serve as evolutionary building blocks.

*Genetics and the Origin of Species*

Chapter III (p. 73)

Columbia University Press. New York, New York, USA. 1951

...the mutation process alone, not corrected and guided by natural selection, would result in degeneration and extinction rather than improved adaptiveness.

On Methods of Evolutionary Biology and Anthropology

*American Scientist*, Volume 45, 1957 (p. 385)

### Heinlein, Robert A. 1907–88

American science fiction writer

“Mutation” is never an explanation; it is simply a name for an observed fact.

*Time Enough for Love*

Chapter IX (p. 246)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

One would expect that any interference with such a complicated piece of chemical machinery as the genetic constitution would result in damage. And, in fact, this is so: the great majority of mutant genes are harmful in their effects on the organism.

*Evolution in Action*

Chapter 2 (p. 39)

Harper & Brothers. New York, New York, USA. 1953

**Muller, Hermann Joseph** 1890–1967

American geneticist

It is entirely in line with the accidental nature of natural mutations that extensive tests have agreed in showing the vast majority of them detrimental to the organism in its job of surviving and reproducing, just as changes accidentally introduced into any artificial mechanism are predominantly harmful to its useful operation.

How Radiation Changes the Genetic Constitution

*Bulletin of the Atomic Scientists*, Volume 11, Number 9, November, 1955 (p. 331)

**Pauling, Linus** 1901–94

American chemist

Every species of plant and animal is determined by a pool of germ plasm that has been most carefully selected over a period of hundreds of millions of years. We can understand now why it is that mutations in these carefully selected organisms almost invariably are detrimental. The situation can be suggested by a statement by Dr. J.B.S. Haldane: "My clock is not keeping perfect time. It is conceivable that it will run better if I shoot a bullet through it; but it is much more probable that it will stop altogether." Professor George Beadle, in this connection, has asked: "What is the chance that a typographical error would improve Hamlet?"

*No More War!*

Chapter 4 (p. 53)

Dodd, Mead & Company. New York, New York, USA. 1958

## MUTUALISM

**Pound, Roscoe** 1870–1964

American jurist

It is not necessary...in order to establish mutualism to show that the organisms do no injury to each other. Mutualism of the kind we meet with in the vegetable kingdom involves sacrifice on the part of the host. The parasite is not there gratuitously. It is there to steal from its host the living it is hereditarily and constitutionally indisposed to make for itself. If the host gains any advantage from the

relation, it can only do so by sacrificing – by giving the parasite the benefit of its labor that it may subsist.

Symbiosis and Mutualism

*The American Naturalist*, Volume XXVII, Number 318, June, 1893 (p. 519)

## MYRMECOLOGIST

**Hölldobler, Bert** 1936–

German myrmecologist

**Wilson, Edward O.** 1929–

American biologist and author

Like all myrmecologists...we are prone to view the Earth's surface idiosyncratically, as a network of ant colonies. We carry a global map of these relentless little insects in our heads. Everywhere we go their ubiquity and predictable natures makes us feel at home, for we have learned to read part of their language and we understand certain designs of their social organization better than anyone understands the behavior of our fellow humans.

*Journey to the Ants: A Story of Scientific Exploration*

The Dominance of Ants (p. 1)

Harvard University Press. Cambridge, Massachusetts, USA. 1994

## Robert Graham (Fictional character)

Myrmecologist. You see that's what I mean. Why can't we all speak English?

*Them*

Film (1954)

## MYSTERY

**Asimov, Isaac** 1920–92

American author and biochemist

The mysteries of the universe and the questions that scientists strive to answer never come to an end. For that we should be grateful. A universe in which there were no mysteries for curious men to ponder would be a very dull universe indeed.

*The Search for the Elements*

Chapter 16 (p. 152)

Basic Books. New York, New York, USA. 1962

## Author undetermined

"Give me the facts," said My Lord Judge, "thy conclusions are but the guess-work of imagination; which puzzle the brain, and tend not to solve the mystery."

In Colin Mackenzie

*One Thousand Experiments in Chemistry*

On Cover page

Printed for Sir Richard Phillips & Company. London, England. 1821

**Barrow, John D.** 1952–

English theoretical physicist

A mystery lurks beneath the magic carpet of science, something that scientists have not been telling, something



too shocking to mention except in rather esoterically refined circles: that at the root of the success of twentieth-century science there lies a deeply 'religious' belief – a belief in an unseen and perfect transcendental world that controls us in an unexplained way, yet upon which we seem to exert no influence whatsoever.

*Pi in the Sky*

Chapter 1 (p. 1)

Back Bay Books. 1993

### Bray, Henry Truro

No biographical data available

The universe is full of mystery. Wherever mystery is found, there is a natural desire to fathom it; and though we often fail in our attempts, nevertheless to continue the search after the truth, is better for the advancement of man than to have discovered it.

*The Living Universe* (3rd edition)

Elucidative (p. 1)

The Truro Publishing Co. Chicago, Illinois, USA. 1914

### Burnham, Sarah Maria 1818–1901

No biographical data available

A desire to penetrate the hidden mysteries of nature's operations is innate in man, and has led to some of the grandest and the most useful achievements of the human mind.

*Precious Stones in Nature, Art and Literature*

Chapter I (p. 6)

Bradley Whidden. Boston, Massachusetts, USA. 1886

### Burroughs, John 1837–1921

American naturalist and writer

...after science has done its best the mystery is as great as ever, and the imagination and the emotions have just as free a field as before.

*Indoor Studies Science and Literature*

Science and Literature (pp. 51–52)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1889

### Chargaff, Erwin 1905–2002

Austrian biochemist

It is the sense of mystery that, in my opinion, drives the true scientist: the same force, blindly seeing, deafly hearing, unconsciously remembering, that drive the larvae into the butterfly. If he has not experienced, at least a few times in his life, this cold shudder down his spine, this confrontation with an immense, invisible face whose breath moves him to tears, he is not a scientist. The blacker the night, the brighter the light.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part II

In the Light of Darkness (p. 114)

Rockefeller University Press. New York, New York, USA. 1978

### Dana, James Dwight 1813–95

American geologist, mineralogist, and naturalist

Science, while it penetrates deeply the system of things about us, sees everywhere, in the dim limits of vision, the word mystery.

*Corals and Coral Islands* (3rd edition)

Chapter I (pp. 17–18)

Dodd, Mead & Co. New York, New York, USA. 1890

### Dawkins, Richard 1941–

English ethologist, evolutionary biologist, and popular science writer

There is mystery in the universe, beguiling mystery, but it isn't capricious, whimsical, frivolous in its changeability. The universe is an orderly place and, at a deep level, regions of it behave like other regions, times behave like other times.

*Science, Delusion and the Appetite for Wonder*

Richard Dimpleby Lecture, BBC1 Television, November 12th, 1996

Newton, Keats agreed with Lamb, had destroyed all the poetry of the rainbow, by reducing it to the prismatic colours.... Newton's dissection of the rainbow into light of different wavelengths led on to Maxwell's theory of electromagnetism and thence to Einstein's theory of special relativity. If you think the rainbow has poetic mystery, you should try relativity.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter 3 (p. 39)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

Mysteries do not lose their poetry when solved. Quite the contrary; the solution often turns out more beautiful than the puzzle and, in any case, when you have solved one mystery you uncover others, perhaps to inspire greater poetry.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter 3 (p. 41)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

The real universe has mystery enough to need no help from obscurantist hucksters.

The Real Romance in the Stars

*The Independent*, 31 Dec 1995

### de Quincey, Thomas 1785–1859

English author

Great is the mystery of Space, greater is the mystery of Time. Either mystery grows upon man, as man himself grows; and either seems to be a function of the godlike which is in man. In reality, the depths and the heights which are in man, the depths by which he searches, the heights by which he aspires, are but projected and made objective externally in the three dimensions of space which are outside of him.

In *Last Days of Immanuel Kant and Other Essays*

*The Works of Thomas de Quincey*

*System of the Heavens as Revealed by Lord Rosse's Telescope* (p. 176)

Adam & Charles Black. Edinburgh, Scotland. 1871

**Dircks, Henry** 1806–73  
English engineer

To ordinary minds all creation is mystery; to cultivated minds there is much that is *not* quite inexplicable.

*Nature-study*

Chapter I (p. 1)

E. Moxon, Son & Co. London, England. 1869

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

All is mystery, but he is a slave who will not struggle to penetrate the dark veil.

*Contarini Fleming: A Romance*

Chapter XVIII (p. 295)

Bernh. Leipzig, Germany. 1846

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

It is a mistake to confound strangeness with mystery.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Study in Scarlet*, Chapter 7 (p. 194)

Wings Books. New York, New York, USA. 1967

As a rule, said Holmes, the more bizarre a thing is the less mysterious it proves to be.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Red Headed League* (p. 429)

Wings Books. New York, New York, USA. 1967

**Einstein, Albert** 1879–1955

German-born physicist

The most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science. Whoever does not know it and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed.

*Ideas and Opinions*

The World As I See It (p. 11)

Crown Publishers, Inc. New York, New York, USA. 1954

I claim credit for nothing. Everything is determined, the beginning as well as the end, by forces over which we have no control. It is determined for the insect as well as for the star. Human beings, vegetables, or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible player.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 117)

**Feynman, Richard P.** 1918–88

American theoretical physicist

We choose to examine a phenomenon which is impossible, absolutely impossible to explain in any classical way, and which has in it the heart of quantum mechanics.

In reality, it contains the only mystery.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 37-1 (p. 37-2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...the idea that it [science] takes away mystery or awe or wonder in nature is wrong. It's quite the opposite. It's much more wonderful to know what something's really like than to sit there and just simply, in ignorance, say, "Oooh, isn't it wonderful!"

In Christopher Sykes

*No Ordinary Genius: The Illustrated Richard Feynman*

Chapter Four (p. 108)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

With more knowledge comes a deeper, more wonderful mystery, luring one on to penetrate deeper still. Never concerned that the answer may prove disappointing, with pleasure and confidence we turn over each new stone to find unimagined strangeness leading on to more wonderful questions and mysteries – certainly a grand adventure.

*What Do You Care What Other People Think?*

The Value of Science (p. 243)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

[The law of gravity] is not exact; Einstein had to modify it, and we know it is not quite right yet, because we have still to put the quantum theory in. That is the same with all our other laws – they are not exact. There is always an edge of mystery, always a place where we have some fiddling around to do yet. This may or may not be a property of Nature, but it certainly is common to all the laws as we know them today. It may be only a lack of knowledge.

*The Character of Physical Law*

Chapter 1 (p. 33)

BBC. London, England. 1965

It is a great adventure to contemplate the universe, beyond man, to contemplate what it would be like without man, as it was in a great part of its long history and as it is in a great majority of places. When this objective view is finally attained, and the mystery and majesty of matter are fully appreciated, to then turn the objective eye back on man viewed as matter, to view life as part of this universal mystery of greatest depth, is to sense an experience which is very rare, and very exciting. It usually ends up in laughter and a delight in the futility of trying to understand what this atom in the universe is, this thing – atoms with curiosity – that looks at itself and wonders why it wonders.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter II (p. 39)

Perseus Books. Reading, Massachusetts, USA. 1998

[T]hese scientific views end in awe and mystery, lost at the edge in uncertainty, but they appear to be so deep and so impressive that the theory that it is all arranged as a

stage for God to watch man's struggle for good and evil seems inadequate.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter II (p. 39)  
Perseus Books. Reading, Massachusetts, USA. 1998

...I can live with doubt and uncertainty and not knowing. I think it's much more interesting to live not knowing than to have answers which might be wrong. I have approximate answers and possible beliefs and different degrees of certainty about different things, but I'm not absolutely sure of anything and there are many things I don't know anything about, such as whether it means anything to ask why we're here...I don't have to know an answer, I don't feel frightened by not knowing things, by being lost in a mysterious universe without any purpose, which it is the way it really is so far as I can tell. It doesn't frighten me.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 1 (pp. 24–25)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Fosdick, Harry Emerson** 1878–1969  
American clergyman and educator

I would rather live in a world where my life is surrounded by mystery than live in a world so small that my mind could comprehend it.

*Riverside Sermons*  
The Mystery of Life (p. 22)  
Harper & Brothers Publishers. New York, New York, USA. 1958

**Frater, Alexander**  
Travel writer and journalist

Each veil lifted revealed a multitude of others. They perceived a chain of interlocking and interdependent mysteries, the meteorological equivalent of DNA and the double helix.

*Chasing the Monsoon* (p. 190)  
Alfred A. Knopf. New York, New York, USA. 1991

**Gregory, Sir Richard Arman** 1864–1952  
English scientific writer and journalist

Mystery is...not destroyed by knowledge but removed to a higher plane.

The Message of Science  
*Science*, Volume LIV, Number 1402, November, 1921 (p. 452)

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

When you call a thing mysterious, all that means is that you don't understand it.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*

Chapter IV (p. 56)  
Macmillan & Company Ltd. London, England. 1918

**Lightman, Alan** 1948–  
Physicist, novelist, and essayist

A painter paints a sunset, and a scientist measures the scattering of light. The beauty of nature lies in its logic as well as appearance. And we delight in that logic: The square of the orbital period of each planet equals the cube of its distance from the sun; the shape of a raindrop is spherical, to minimize the area of its surface. Why it is that nature should be logical is the greatest mystery of science. But it is a wonderful mystery.

*Great Ideas in Physics*  
Introduction (p. 1)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1997

**Lindbergh, Anne Morrow** 1906–2001  
American aviator and writer

Today's mystery is not the old veiling by superstition of the things man does not understand, but a new unblinking gaze at the mysteries of the universe that may never be unveiled.

*Earth Shine*  
Back to Earth (pp. 42–43)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Lowell, Percival** 1855–1916  
American astronomer

Discoveries in science have a fatal facility for lying lost in the technical publications which record them. Few persons attend to what is not alluring and columns of figures form but an uninviting protocol to the learning within. Yet these very people would take the keenest interest in scientific progress could its beauty and real simplicity be adequately set out for them. For the whole object of science is to explain and make comprehensible the universe around us. Science consists in solving mysteries not, as the layman might imagine, in making them.

In William Graves Hoyt  
*Lowell and Mars*  
Chapter 7 (p. 96)  
University of Arizona Press. Tucson, Arizona, USA. 1976

**Margenau, Henry** 1901–97  
American physicist

I recognize no subjects and no facts which are alleged to be forever closed to inquiry or understanding: a mystery is but a challenge.

*Open Vistas*  
Chapter III Section 3 (p. 76)  
Yale University Press. New Haven, Connecticut, USA. 1961

**Pearson, Karl** 1857–1936  
English mathematician

Does science leave no mystery? On the contrary, it proclaims mystery where others profess knowledge. There is mystery enough in the universe of sensation and in its capacity for containing those little corners of consciousness which project their own products, of order and law and reason, into an unknown and unknowable world. There is mystery enough here, only let us clearly distinguish it from ignorance within the field of possible knowledge. The one is impenetrable, the other we are daily subduing.

*The Grammar of Science*

Chapter VII (pp. 111–112)

Meridian Books. New York, New York, USA. 1957

**Penrose, Roger** 1931–

English mathematical physicist

...once you have put more and more of your physical world into a mathematical structure, you realize how profound and mysterious this mathematical structure is. How you can get all these things out of it is very mysterious...

In Alan Lightman and Robert Brawer (eds.)

*Origins: The Lives and Worlds of Modern Cosmologists*

Roger Penrose (p. 433)

Harvard University Press. Cambridge, Massachusetts, USA. 1990

**Peterson, Ivars**

Mathematics and computer writer and editor

The voyage of discovery into our own solar system has taken us from clockwork precision into chaos and complexity. This still unfinished journey has not been easy, characterized as it is by twists, turns, and surprises that mirror the intricacies of the human mind at work on a profound puzzle. Much remains a mystery. We have found chaos, but what it means and what its relevance is to our place in the universe remains shrouded in a seemingly impenetrable cloak of mathematical uncertainty.

*Newton's Clock: Chaos in the Solar System*

Chapter 12 (p. 293)

W.H. Freeman & Company. New York, New York, USA. 1993

**Proctor, Mary** 1862–1957

American popularizer of astronomy

In vain do we strive to penetrate the mysteries which surround us on all sides, for around us and before us, and extending into the infinite depths of space, we find still greater mysteries.

The Silver River of Heaven

*The Chautauquan*, Volume 21, Number 4, July, 1895 (p. 460)

**Proctor, Richard Anthony** 1837–88

English astronomer

...men found more and more of mystery as they learned more and more of actual facts, until *now* that which of old was confidently explained is found to be utterly

inexplicable, save as a part – an infinitely minute part – of the mysterious Infinity and Eternity we call The Universe.

*Mysteries of Time and Space*

Preface

R. Worthington

New York, New York, USA. 1883

**Richards, Theodore William** 1868–1928

American chemist

No one can predict how far we shall be enabled by means of our limited intelligence to penetrate into the mysteries of a universe immeasurably vast and wonderful; nevertheless, each step in advance is certain to bring new blessings to humanity and new inspiration to greater endeavor.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1911*

(Faraday Lecture) The Fundamental Properties of the Elements (p. 215)

Government Printing Office. Washington, D.C. 1912

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

Mysteries which we have driven outside of the boundaries of our knowledge and which we have located and encompassed, such mysteries which will not harm us; on the contrary they will stimulate and inspire us in many ways; the dangerous mysteries are those which are hopelessly mingled with our knowledge, and of which we are perhaps unaware.

*The History of Science and the New Humanism*

Chapter I (p. 60)

H. Holt & Co. New York, New York, USA. 1931

**Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Mystery ever is that which lies broad open to all men; Circles you round and round, yet not a body observes.

*The Poems of Schiller*

To the Mystics (p. 310)

H. Holt & Co. New York, New York, USA. 1902

**Shah, Idries** 1924–96

Persian author and teacher in the Sufi tradition

People who know nothing, or know very little and should be studying instead of teaching, are fond of creating an air of mystery.

*Thinkers of the East*

Mystery (p. 98)

Jonathan Cape. London, England. 1971

**Smullyan, Raymond** 1919–

American mathematician and logician

...I certainly believe that some things may in principle be mysteries, but of what use is a hypothesis for explaining a mystery when the very hypothesis raises another mystery just as baffling as the one it explains?

*5000 B.C. and Other Philosophical Fantasies*

Chapter 13 (p. 165)  
St. Martin's Press. New York, New York, USA. 1983

**Snyder, Carl** 1869–1946  
American economist and statistician

There can never be in human knowledge any such thing as finality. Always at the end there is a mystery; it will always be there.

*The World Machine: The First Phase the Cosmic Mechanism*  
Chapter XXXIII (p. 445)  
Longmans Green. London, England. 1904

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Mysteries are not necessarily miracles.

Translated by Otto Wenckstern  
*Goethe's Opinions on the World, Mankind, Literature, Science, and Art*  
(p. 114)  
John W. Parker & Son. London, England. 1853

We all walk in mysteries. We are surrounded by an atmosphere of which we do not know what is stirring in it, or how it is connected with our own spirit.

In John Stuart Blackie  
*The Wisdom of Goethe*  
Philosophy, Metaphysics, Logic, Truth and Science (p. 151)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

**Wilson, Edward O.** 1929–  
American biologist and author

The unsolved mysteries of the rain forest are formless and seductive. They are like unnamed islands hidden in the blank spaces of old maps, like dark shapes glimpsed descending the far wall of a reef into the abyss.

*The Diversity of Life*  
Chapter One (p. 7)  
W.W. Norton & Company, Inc. New York, New York, USA. 1992

Our sense of wonder grows exponentially: the greater the knowledge, the deeper the mystery and the more we seek knowledge to create new mystery.

*Biophilia*  
Bernhardsdorp (p. 10)  
Harvard University Press. Cambridge, Massachusetts, USA. 1984

**Young, John Zachary** 1907–97  
English zoologist

The scientist is in a better position than anyone else to see that we are set about with mysteries. It is his business to grapple with ghosts every day of his life and he must refuse to allow them to be laid by the process of labeling them with a primitive nomenclature. The mysteries of the universe are too great to be expressed by such simple comparisons as are implicit in either the words "spirit" or "matter."

*Doubt and Certainty in Science: A Biologist's Reflections on the Brain*  
Comment on the First Lecture (p. 23)  
Oxford University Press, Inc. Oxford, England. 1960

## MYSTICISM

**Capra, Fritjof** 1939–  
Austrian-born American physicist

Science does not need mysticism and mysticism does not need science, but man needs both. Mystical experience is necessary to understand the deepest nature of things, and science is essential for modern life. What we need, therefore, is not a synthesis, but a dynamic interplay between mystical intuition and scientific analysis.

*The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism*  
Epigraph (p. 297)  
Shambhala. Berkeley, California, USA. 1975

**Hawking, Stephen William** 1942–  
English theoretical physicist

The universe of Eastern mysticism is an illusion, A physicist who attempts to link it with his own work has abandoned physics.

Quoted in John Boslough  
*Beyond the Black Hole: Stephen Hawking's Universe*  
The Anthropic Principle (p. 115)  
1989

**Whewell, William** 1794–1866  
English philosopher and historian

Experience collected her stores in vain, or ceased to collect them, when she had only to pour them into the flimsy folds of the lap of Mysticism; who was, in truth, so much absorbed in looking for the treasures which were to fall from the skies, that she heeded little how scantily she obtained, or how loosely she held, such riches as might be found near her.

*History of the Inductive Sciences from the Earliest to the Present Time*  
(3rd edition)  
Book IV, Chapter III (p. 236)  
John W. Parker & Son. London, England. 1857

## MYTH

**Bernal, John Desmond** 1901–71  
Irish-born physicist and X-ray crystallographer

Science, in one aspect, is ordered technique; in another, it is rationalized mythology.

*Science in History*  
Preface (p. ix)  
Watts. London, England. 1957

**Clift, Wallace B.**  
No biographical data available

However, for most of us, science functions like myth in that we have no personal experience in the matter.

We put our trust in the scientific view given us by our culture and enshrined in its myths. If asked why leaves are green, most of us would probably mutter something about “chlorophyll.” But unless we were specialists, we would simply be repeating the story of someone else’s experience.

*Jung and Christianity* (pp. 62–63)  
 Publisher undetermined

**Hubbard, Ruth** 1924–  
 American biologist

The mythology of science asserts that with many different scientists all asking their own questions and evaluating the answers independently, whatever personal bias creeps into their individual answers is canceled out when the large picture is put together. This might conceivably be so if scientists were women and men from all sorts of different cultural and social backgrounds who came to science with very different ideologies and interests. But since, in fact, they have been predominantly university-trained white males from privileged social backgrounds, the bias has been narrow and the product often reveals more about the investigator than about the subject being researched.

*Women Look at Biology Looking at Women  
 Have Only Men Evolved?* (p. 31)  
 Schenkman Publishing Company. Cambridge, Massachusetts, USA. 1979

**Jacob, François** 1920–  
 French biologist

...myths and science fulfill a similar function: they both provide human beings with a representation of the world and the forces that are supposed to govern it.

*The Possible and the Actual*  
 Myth and Science (p. 9)  
 Pantheon Books. New York, New York, USA. 1982

**Koestler, Arthur** 1905–83  
 Hungarian-born English writer

Myths grow like crystals, according to their own, recurrent pattern; but there must be a suitable core to start their growth.

*The Sleep Walkers: A History of Man’s Changing Vision of the Universe*  
 Chapter 1 (p. 27)  
 The Macmillan Co. New York, New York, USA. 1959

**Lerner, Eric J.** 1947–  
 American popular science book

The ability of a scientific theory to be refuted is the key criterion that distinguishes science from metaphysics. If a theory cannot be refuted, if there is *no* observation that will disprove it, then nothing can prove it – it cannot predict anything, it is a worthless myth.

*The Big Bang Never Happened*  
 Chapter 1 (p. 54)  
 Time Books. New York, New York, USA. 1991

**Mahadeva, M.**  
 No biographical data available

Myths are errors that result [both from] scientists bringing societal preconceptions into science and...scientists feeding society ideas that masquerade as science.

From *Misinterpretations to Myths*  
*Science Teacher*, Volume 56, Number 4, 1989

**Popper, Karl R.** 1902–94  
 Austrian/British philosopher of science

Thus science must begin with myths – and with the criticism of myths...

In C.A. Mace (ed.)  
*British Philosophy in the Mid-Century*  
 Philosophy of Science: A Personal Report, VII (p. 177)

Science never starts from scratch; it can never be described as free from assumptions; for at every instant it presupposes a horizon of expectations – yesterday’s horizon of expectations, as it were. Today’s science is built upon yesterday’s science (and so it is the result of yesterday’s searchlight); and yesterday’s science, in turn, is based on the science of the day before. And the oldest scientific theories are built on pre-scientific myths, and these, in their turn, on still older expectations.

*Objective Knowledge: An Evolutionary Approach*  
 Appendix (pp. 346–347)  
 Clarendon Press. Oxford, England. 1972

Science must begin with myths, and with the criticism of myths ...

*Conjectures and Refutations*  
 Chapter 1 (p. 66)  
 Routledge. London, England. 2002

**Rota, Gian-Carlo** 1932–99  
 Italian-born American mathematician

We take offense at those truths that threaten any of the myths we profess to believe in. Taking offense is an effective way we have of shutting off some unpleasant truth. It works. It enables us to restore a hold on our dearest myths, to last until the next offending myth comes along.

*Indiscrete Thoughts*  
 Introduction (p. xix)  
 Birkhäuser. Boston, Massachusetts, USA. 1997

**von Goethe, Johann Wolfgang** 1749–1832  
 German poet, novelist, playwright, and natural philosopher

Neither myths nor legends are to be tolerated in science; let us then leave to the poet, whose province it is, to use them for the benefit and amusement of the world. The scientific man should limit himself to the nearest and clearest material that lies before him. If, however, he chooses occasionally to come forth in the oratorical vein, this also may be allowed him, provided he remembers what he is about.



In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 159)

William Blackwood & Sons. Edinburgh, Scotland. 1883

**Whyte, Lancelot Law** 1896–1972

Scottish physicist

In the ultimate analysis science is born of myth and religion, all three being expressions of the ordering spirit of the human mind.

*The Unconscious Before Freud*

Chapter V (pp. 82–83)

Julian Friedmann Publishers. London, England. 1978

## MYTHOLOGY

**Pearson, Karl** 1857–1936

English mathematician

If the reader has once fully grasped that science is an intellectual résumé of past experience and a mental balancing of the probability of future experience, he will be in no danger of contrasting the “mechanical explanation” of science with the “intellectual description” of mythology.

*The Grammar of Science* (2nd edition)

Chapter IV (pp. 113–114)

Adam & Charles Black. London, England. 1900

## N

### NAME

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

...the itch for naming things is almost as bad as the itch for possessing things.

*Desert Solitaire*  
Terra Incognita: Into the Maze (p. 288)  
Ballantine Books. New York, New York, USA. 1968

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The first thing to be determined about a new specimen is not its name, but its most prominent character. Until you know an animal, care not for its name.

In James Orton  
*Comparative Zoology; Structural and Systematic*  
Preceding Chapter I (p. 18)  
Harper & Brothers. New York, New York, USA. 1877

Every art and science has a language of technical terms peculiar to itself. With those terms every student must make himself familiarly acquainted at the outset; and first of all, he will desire to know the names of the objects about which he is to be engaged.

*Principles of Zoology*  
Introduction (p. xiii)  
Gould, Kendall & Lincoln. Boston, Massachusetts, USA. 1848

Nothing is more to be deprecated than an over-appreciation of technicalities, valuing the name more highly than the thing; but some knowledge of this scientific nomenclature is necessary to every student of Nature.

*Methods of Study in Natural History*  
Chapter II (p. 18)  
Ticknor & Fields. Boston, Massachusetts, USA. 1863

The names of objects in Natural History are double; that is to say, they are composed of two terms. Thus, we speak of the white-bear, the black-bear, the hen-hawk, the sparrow-hawk; or, in strictly scientific terms, we have *Felis leo*, the lion, *Felis tigris*, the tiger, *Felis catus*, the cat, *Canis lupus*, the wolf, *Canis vulpes*, the fox, *Canis familiaris*, the dog, &c.

*Principles of Zoology*  
Introduction (p. 17)  
Gould & Lincoln. Boston, Massachusetts, USA. 1867

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

**Gould, Augustus Addison** 1805–66  
American conchologist

Every art and science has a language of technical terms peculiar to itself. With those terms every student must make himself familiarly acquainted at the outset; and, first of all, he will desire to know the names of the objects about which he is to be engaged.

*Principles of Zoology*  
Introduction (p. 17)  
Gould & Lincoln. Boston, Massachusetts, USA. 1867

**Bates, Marston** 1906–74  
American zoologist

...most technical names still have a queer, foreign, pedantic sound, and if we see very many of them in a stretch of print we get frightened off and hastily look for something else to read.

*The Nature of Natural History*  
Chapter 1 (p. 10)  
Scribner. New York, New York, USA. 1950

**Borland, Hal** 1900–78  
American writer

There is folk poetry in the common names; but science, devoted to order and systematic knowledge, insists on classifying and defining. The poet's buttercup is the botanist's Ranunculus. If you would walk with scientist as well as poet, learn both languages.

*Beyond Your Doorstep: A Handbook to the Country*  
Chapter 15 (p. 359)  
Alfred A. Knopf. New York, New York, USA. 1962

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

"What's the use of their having names," the Gnat said, "if they won't answer to them?"

"No use to them," said Alice; "but it's useful to the people that name them, I suppose."

*The Complete Works of Lewis Carroll*  
*Through the Looking-Glass*  
Chapter III (p. 173)  
The Modern Library. New York, New York, USA. 1936

"My name is Alice...."

"It's a stupid name enough!" Humpty Dumpty interrupted impatiently. "What does it mean?"

"Must a name mean something?" Alice asked doubtfully.

"Of course it must," Humpty Dumpty said with a short laugh; "my name means the shape I am.... With a name like yours, you might be any shape, almost."

*The Complete Works of Lewis Carroll*  
*Through the Looking-Glass*  
Chapter VI (p. 209)  
The Modern Library. New York, New York, USA. 1936

**Darwin, Charles Robert** 1809–82  
English naturalist

...I have lately been trying to get up an agitation (but I shall not succeed, and indeed doubt whether I have time and strength to go on with it), against the practice of Naturalists appending for perpetuity the name of the first describer to species. I look at this as a direct premium to hasty work, to naming instead of describing. A species ought to have a name so well known that the addition of the author's name would be superfluous, and a [piece] of empty vanity.... Why should Naturalists append their own names to new species, when Mineralogists and Chemists do not do so to new substances?

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Letter to J.D. Hooker, October 6, 1848 (pp. 332–333)  
 D. Appleton & Company. New York, New York, USA. 1896

I do not think more credit is due a man for defining a species, than to a carpenter for making a box. But I am foolish and rabid against species-mongers, or rather against their vanity; it is useful and necessary work which must be done; but they act as if they had actually made the species, and it was their own property.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Letter to Hugh Strickland, February 4, 1849 (pp. 338–339)  
 D. Appleton & Company. New York, New York, USA. 1896

How dreadfully difficult it is to name plants.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Letter to J.D. Hooker, June 5, 1855 (p. 418)  
 D. Appleton & Company. New York, New York, USA. 1896

**de Montaigne, Michel Eyquem** 1533–92

French Renaissance writer

There is the name and the thing; the name is a sound, which sets a mark on and denotes the thing. The name is no part of the thing nor of its substance; 'tis an extraneous piece joined to the thing, and outside of it.

Translated by Charles Cotton  
 In William Carew Hazlitt  
*Essays of Montaigne* (Volume 2)  
 Chapter XVI (p. 390)  
 Reeves & Turner  
 London, England. 1877

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Man, it's Witchcraft! Where in the name of all that is wonderful did you get those names?

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Valley of Fear*  
 Part I, Chapter 1 (p. 476)  
 Wings Books. New York, New York, USA. 1967

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

The mere fact of naming an object tends to give definiteness to our conception of it – we have then a sign that at once calls up in our minds the distinctive qualities which mark out for us that particular object from all others.

*The George Eliot Letters* (Volume 11) (p. 251)  
 Yale University Press. New Haven, Connecticut, USA. 1954–78

**Ellis, Havelock** 1859–1939

English sexuality researcher

For even the most sober scientific investigator in science, the most thoroughgoing Positivist, cannot dispense with fiction; he must at least make use of categories, and they are already fictions, analogical fictions, or labels, which give us the same pleasure as children receive when they are told the “name” of a thing.

*The Dance of Life*  
 Chapter III, Section II (p. 94)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Everett, Charles Carroll** 1829–1900

American theologian

[Science] must have a name for everything – some fixed, hard word, that shall stand for this one thing, and for nothing else. Thus, at first sight, any science is a mass of terms.

*The Science of Thought*  
 Second Book (p. 304)  
 De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

**Faraday, Michael** 1791–1867

English physicist and chemist

...I am fully aware that names are one thing and science another.

*Experimental Researches in Electricity* (Volume 1)  
 Seventh Series, 666 (p. 198)  
 Richard and John Edward Taylor. London, England. 1839–1855

**Ferris, G. F.**

No biographical data available

The proper aim is not to *name* species but to *know* them.

*Stanford University Publications: Biological Studies* (Volume 5)  
 The Principles of Systematic Entomology (p. 105)  
 Stanford University. Stanford, California, USA. 1920–53

**Gahan, A. B.**

No biographical data available

Objects without names cannot well be talked about or written about; without descriptions they cannot be identified and such knowledge as may have accumulated regarding them is sealed.

The Role of the Taxonomist in Present Day Entomology  
*Entomological Society of Washington Proceedings*, Volume 25, 1923 (p. 73)

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

A Pseudo-science consists of a nomenclature, with a self-adjusting arrangement, by which all positive evidence, or such as favors its doctrines, is admitted, and all negative evidence, or such as tells against it, is excluded. It is invariably connected with some lucrative practical application.

*The Professor at the Breakfast Table*

Chapter VIII (p. 249)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

### Isidorus

No biographical data available

If you know not the names, the knowledge of things is wasted.

In Carl von Linné

*Critica Botanica*

Generic Names (p. 1)

The Ray Society. London, England. 1938

### Juster, Norton 1929–

American architect and writer

Words and numbers are of equal value, for, in the cloak of knowledge, one is warp and the other woof. It is no more important to count the sands than it is to name the stars.

*The Phantom Tollbooth*

Chapter 6 (p. 77)

Alfred A. Knopf. New York, New York, USA. 1989

### Lavoisier, Antoine Laurent 1743–94

French chemist

The impossibility of separating the nomenclature of a science from the science itself, is owing to this, that every branch of physical science must consist of three things; the series of facts which are the objects of the science, the ideas which represent these facts, and the words by which these ideas are expressed.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xiv)

Printed for William Creech. Edinburgh, Scotland. 1790

### Le Févre, Nicholas 1615–69

No biographical data available

This Principle, as well as the others, hath received several names; for it is called Oil, Natural Fire, Light, Vital Fire, Balsom of Life and of Sulphur, and besides, many other appellations have been given by the Sons of Art, which we will not fill up this Section: According to our usual custom, we will content ourselves, with examining the nature of the thing, leaving the niceties of Names to the over-curious.

*A Complete Body of Chymistry*

Chapter III, Section IV (p. 25)

Printed for O. Pullyn. London, England. 1640

### Levi, Primo 1919–87

Italian writer and chemist

To give a name to a thing is as gratifying as giving a name to an island, but it is also dangerous: the danger consists in one's becoming convinced that all is taken care of and that once named, the phenomenon has also been explained.

Translated by Raymond Rosenthal

*Other People's Trades*

The Force of Amber (p. 138)

Summit Books. New York, New York, USA. 1989

### Linnaeus, Carl (von Linné) 1707–78

Swedish botanist

The first step of science is to know one thing from another. This knowledge consists in their specific distinctions; but in order that it may be fixed and permanent distinct names must be given to different things, and those names must be recorded and remembered.

In Sir James Edward Smith

*A Selection of the Correspondence of Linnaeus and Other Naturalists*

from the Original Manuscripts (Volume 2) (p. 460)

Longman, Hurst, Rees, Orme and Brown. London, England. 1821

The first step in wisdom is to know the things themselves; this notion consists in having the true idea of the object; objects are distinguished and known by their methodical classification and appropriate naming; therefore Classification and Naming will be the foundation of our Science.

In P. F. Stevens

*The Development of Biological Systematics: Antoine-Laurent de*

*Jussieu, Nature and the Natural System*

Chapter Nine (p. 201)

Columbia University Press. New York, New York, USA. 1994

For, even though the knowledge of the true and genuine Tree of Life, which might have delayed the coming of old age, is lost, still herbs remain and renew their flowers, and with perennial gratitude will always breathe forth the sweet memory of your names, and make them more enduring than marble, to outlive the names of kings and heroes. For wealth disappears, the most magnificent houses fall into decay, the most numerous family at some time or other comes to an end: the greatest states and the most prosperous kingdoms can be overthrown: but the whole of Nature must be blotted out before the race of plants passes away, and he is forgotten who in Botany held up the torch.

*Critica Botanica*

Generic Names (p. 68)

The Ray Society. London, England. 1938

Name and plant are two ideas, which ought to be so closely united that they cannot possibly be separated: in order to secure this, the plant ought to lend a hand to the name, and the name in its turn to the plant, while the name in its turn rejoices in the sound principle on which it was given: since there is no connexion between botanist and plant, there is also no sound principle in naming it after him: and so the naming is bad.

*Critica Botanica*

Generic Names (p. 61)

The Ray Society, London, England. 1938

### Lloyd, C. G.

No biographical data available

Botanists meet and pass rules for the naming of plants, but they cannot agree on any set of rules, and never will as long as the members are vitally interested in the particular rules that perpetuate their own names and the plant names that have been proposed by themselves.

Personal Names in Nomenclature

*The American Botanist*, Volume 4, Number 3, March, 1903 (p. 48)

### Melville, Herman 1819–91

American novelist

I wonder whether mankind could not get along without all those names which keep increasing every day, and hour, and moment; till at last the very air will be full of them; and even in a great plain men will be breathing each other's breath, owing to the vast multitude of words they use that consume all of the air.... But people seem to have a great love for names; for to know a great many names seems to look like knowing a good many things.

*Redburn*

Chapter XIII

A. & C. Boni. New York, New York, USA. 1924

### Mill, John Stuart 1806–73

English political philosopher and economist

Mankind in all ages have had a strong propensity to conclude that wherever there is a name, there must be a distinguishable separate entity corresponding to the name ...

*A System of Logic, Ratiocinative and Inductive*

Book V, Chapter III (p. 463)

Harper & Brothers Publishers. New York, New York, USA. 1867

### Page, Jake

No biographical data available

To name something is, in a sense, to own it.... [It] has been said that it is only by its name that anything can enter into thought and discourse. Naming, in other words, is a serious business.

*Pastorale: A Natural History of Sorts*

What Is in a Name? (p. 119)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

### Savory, Theodore

No biographical data available

...words are in themselves among the most interesting objects of study, and the names of animals and plants are worthy of more consideration than Biologists are inclined to give them.

*Naming the Living World: An Introduction to the Principles of Biological Nomenclature*

Preface (p. vii)

English Universities Press. London, England. 1962

### Sylvester, James Joseph 1814–97

English mathematician

Perhaps I may without immodesty lay claim to the appellation of Mathematical Adam, as I believe that I have given more names (passed into general circulation) of the creatures of the mathematical reason than all the other mathematicians of the age combined.

Notes on a Proposed Addition to the Vocabulary of Ordinary Arithmetic  
*Nature*, Volume 37, Number 946, December 15, 1887 (p. 152, fn 1)

### Turnbull, Charles D.

No biographical data available

According to Genesis, "Adam gave names to all cattle and to the fowl of the air and to every beast of the field," and we have therefore authority to declare that although Father Adam named both birds and beasts, he woefully neglected the flower, and left the task to the fancy and haphazard desires of his descendants.

Concerning Nomenclature

*The American Botanist*, Volume 4, Number 3, March, 1903 (p. 45)

### Twain, Mark (Samuel Langhorne Clemens) 1835–1910

American author and humorist

Names are not always what they seem. The common Welsh name Bzjxxlwep is pronounced Jackson.

*Following the Equator* (Volume 1)

Chapter XXXVI (p. 339)

Harper & Brothers. New York, New York, USA. 1899

### Whitehead, Alfred North 1861–1947

English mathematician and philosopher

...in the garden of Eden God saw the animals before he named them; in the traditional system [of education] children named the animals before they saw them.

*Science and the Modern World*

Chapter XIII (p. 285)

The Macmillan Company. New York, New York, USA. 1929

## NATURAL HISTORY

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

...Natural History must in good time become the analysis of the thoughts of the Creator of the Universe as manifested in the animal and vegetable kingdoms, as well as in the inorganic world.

*Essay on Classification*

Chapter I, Section XXXII (p. 137)

Harvard University Press. Cambridge, Massachusetts, USA. 1962

A laboratory of Natural History is a sanctuary where nothing profane should be tolerated. I feel less agony at improprieties in churches than in a scientific laboratory.

In David Stair Jordan

*Popular Science Monthly*, Volume 40, 1891

**Borlase, William** 1696–1772  
Cornish antiquary

Natural History is the handmaid to Providence, collects into a narrow space what is distributed through the Universe, arranging and disposing the several Fossils, Vegetables and Animals, so as the mind may more readily examine and distinguish their beauties, investigate their causes, combinations, and effects, and rightly know how to apply them to the calls of private and public life.

*The Natural History of Cornwall*

The Air, Climate, Waters, Rivers, Lakes, Seas and Tides, to the Nobility and Gentry of the County of Cornwall (p. iv)  
Publisher undetermined

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

In one moment I've seen what has hitherto been  
Enveloped in absolute mystery,  
And without extra charge I will give you at large  
A Lesson in Natural History.

*The Complete Works of Lewis Carroll*

*The Hunting of the Snark*

Fit the Fifth (p. 771)

The Modern Library. New York, New York, USA. 1936

**Darwin, Charles Robert** 1809–82  
English naturalist

What a splendid pursuit Natural History would be if it  
was all observing and no writing!

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 11)

Letter to J.D. Hooker, February 3, 1868 (p. 258)

D. Appleton & Company. New York, New York, USA. 1896

Nobody but a person fond of Natural History can imagine the pleasure of strolling under cocoa-nuts in a thicket of bananas and coffee-plants, and an endless number of wildflowers.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VI (pp. 201–202)

D. Appleton & Company. New York, New York, USA. 1896

**Fitz-Gerald, Charles Egerton**  
English physician

If a love of Natural History be once awakened, its study becomes the most fascinating of pursuits; every surrounding object, however familiar and commonplace, assumes a new interest; it is like the first dawn of love in the human breast, when every object takes a more roseate and lovely hue, and unlike, too often, the grosser passion, the love of nature lasts until the termination of our life.

*Semi-scientific Lectures*

First Annual Address (p. 20)

J. English. Folkstone, England. 1880

**Fleming, Donald**  
No biographical data available

For the colonial investigator himself, natural history was the ideal refuge from the more perilous enterprise of embarking upon theoretical constructions by which he would be pitched into naked competition with the best scholars of all countries. To be a forager for Linnaeus or correspondent of the Hookers might be an identity in science purchased by bondage to the local and particular; but it was also a shelter against the more bracing winds that would promptly blow upon any man who tried to grapple with undifferentiated Nature in physics.

*Proceedings of the 10th International Congress of the History of Science, Ithaca, 1962*

Science in Australia, Canada, and the United States: Some Comparative Remarks (p. 182)

Cornell University Press. Ithaca, New York, USA. 1964

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Natural History...is either the beginning or the end of physical science.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part III, Chapter I (p. 221)

Longman, Brown, Green & Longmans. London, England. 1845

Natural history may be considered in two very different lights: either, first, as a collection of facts and objects presented by nature, from the examination, analysis, and combination of which we acquire whatever knowledge we are capable of attaining both of the order of nature, and of the agents she employs for producing her ends, and from which, therefore, all sciences arise; or, secondly, as an assemblage of phenomena to be explained; of effects to be deduced from causes; and of materials prepared to our hands, for the application of our principles to useful purposes.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part III, Chapter I (p. 221)

Longman, Brown, Green & Longmans. London, England. 1845

**Hobbes, Thomas** 1588–1679  
English philosopher and political theorist

The register of *knowledge of fact* is called history.... [Natural history] is the history of such facts, or effects of nature, as have no dependence on man's *will*; such as are the histories of *metals, plants, animals, regions*, and the like.

*The English Works of Thomas Hobbes of Malmesbury* (Volume 3)

The First Part, Chapter 9 (p. 71)

John Bohn. London, England. 1839

**Huxley, Thomas Henry** 1825–95  
English biologist

To a person uninstructed in natural history, his country or sea-side stroll is a walk through a gallery filled with wonderful works of art, nine-tenths of which have their faces turned to the wall. Teach him something of natural history, and you will place in his hands a catalogue of



those which are worth turning around.

*Lay Sermons, Addresses and Reviews*

On the Educational Value of the Natural History Sciences (p. 91)

D. Appleton & Company. New York, New York, USA. 1872

**Smellie, William** 1740–95

Scottish encyclopedist

Natural History is the most extensive, and perhaps the most instructive and entertaining of all the sciences.

It is the chief source from which human knowledge is derived. To recommend the study of it from motives of utility were to affront the understanding of mankind. Its importance, accordingly, in the arts of life, and in storing the mind with just ideas of external objects, as well as of their relations to the human race, was early perceived by all nations in their progress from rudeness to refinement.

In Buffon, Comte de Georges, Louis Leclerc

*Natural History, General and Particular* (Volume 1)

Preface by the Translator (p. ix)

T. Caldwell and W. Davies. London, England. 1812

## NATURAL HISTORY SURVEY

**Forbes, S. A.**

No biographical data available

I cannot too strongly emphasize the fact...that a comprehensive survey of our entire natural history is absolutely essential to a good *working knowledge* of those parts of it which chiefly attract popular attention – that is, its edible fishes, its injurious and beneficial insects, and its parasitic plants. Such a survey, however, should not stop with a study of the dead forms of nature, ending in mere lists and descriptions. To have an *applicable* value, it must treat the life of the region as an organic unit, must study it in action, and direct principal attention to the laws of its activity.

*Bulletin Illinois State Laboratory of Natural History*

The First Food of the Common Whitefish

1883

## NATURAL LAW

**Adams, George** 1750–95

English instrument maker

The end of natural philosophy is to increase either the knowledge or power of man, and enable him to understand the ways and procedure of nature. By discovering the laws of nature, he acquires knowledge, and obtains power; for when these laws are discovered, he can use them as rules of practice, to equal, subdue, or even excel nature by art.

*Lectures on Natural and Experimental Philosophy* (Volume 2)

Lecture XIV (pp. 100–101)

Printed by R. Hindmarsh. London, England. 1794

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Dismiss the idea that natural law may swallow up religion; it cannot even tackle the multiplication table single-handed.

*Science and the Unseen World*

Lecture V (p. 58)

The Macmillan Co. New York, New York, USA. 1929

**Hopper, Grace Murray** 1906–92

American mathematician and computer scientist

If you do something once, people will call it an accident.

If you do it twice, they call it a coincidence. But do it a third time and you've just proven a natural law.

In Ethlie Ann Vare and Greg Ptacek

*Mothers of Invention: From the Bra to the Bomb*

From Eggbeaters to Eggheads (p. 187)

Morrow. New York, New York, USA. 1988

**Jevons, William Stanley** 1835–82

English economist and logician

The truth or untruth of a natural law, when carefully investigated, resolves itself into a high or low degree of probability, and this is the case whether or not we are capable of producing precise numerical data.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter X (p. 217)

Macmillan & Company Ltd. London, England. 1892

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

Amid all the revolutions of the Globe, the economy of nature has been uniform and her laws are the only things which have resisted the general movement. The rivers and the rocks, the seas and the continents have been changed in all their parts; but the laws which direct those changes, and the rules to which they are subject, have remained invariably the same.

*The Works of John Playfair* (Volume 1)

Note XIX (p. 415)

Printed for Archibald Constable & Co. Edinburgh, Scotland 1822

**Vogt, Carl** 1817–95

German physician and naturalist

The natural laws are rude unbending powers, which have neither morals nor heart.

In Ludwig Buchner

*Force and Matter*

Chapter VI (p. 35)

Trubner & Company. London, England. 1864

**Whewell, William** 1794–1866

English philosopher and historian

When we speak of material nature as being governed by laws, it is sufficiently evident that we use the term in a manner somewhat metaphorical.

*The Bridgewater Treatises on the Power, Wisdom, and Goodness of God as Manifested in the Creation (Treatise III)*

Astronomy and General Physics Considered with Reference to Natural Theology

Chapter II (p. 17)

Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

## NATURAL LIFE

**Lowell, Percival** 1855–1916

American astronomer

To all forms of life of which we have any conception, two things in nature are vital, air and water. A planet must possess these two requisites to be able to support any life at all upon its surface. For there is no creature, no plant, no anything endowed with the possibility of that kind of change we call life, which is not in some measure dependent upon both of them.

*Mars*

Chapter II (p. 31)

Longmans, Green & Co. London, England. 1896

## NATURAL PHILOSOPHER

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

For my part I always admired the old fashioned term “natural philosopher.” It was so dignified, and raised up visions of the portraits of Count Rumford, Young, Herschel, Sir H. Davy, &c., usually highly respectable-looking elderly gentlemen, with very large bald heads, and much wrapped up about the throats, sitting in their studies pondering calmly over the secrets of nature revealed to them by their experiments. There are no natural

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 5)

D. van Nostrand Co. New York, New York, USA. 1893

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Accustomed to trace the” operation of general causes, and the exemplification of general laws, in circumstances where the uninformed and unenquiring eye perceives neither novelty nor beauty, he [the natural philosopher] walks in the midst of wonders: every object which falls in his way elucidates some principle, affords some instruction, and impresses him with a sense of harmony and order.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (p. 15)

Longman, Brown, Green & Longmans. London, England. 1845

To the natural philosopher there is no natural object unimportant or trifling.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (p. 14)

Longman, Brown, Green & Longmans. London, England. 1845

**Schoedler, Friedrich Karl Ludwig** 1813–84

No biographical data available

To the natural philosopher to whom the whole extent of nature belongs, all the individual branches of science constitute the links of an endless chain, from which not a single link can be detached without destroying the harmony of the whole.

*The Book of Nature: An Elementary Introduction to the Sciences of Physics*

Astronomy (p. 140)

Sheldon & Co. Publishers. New York, New York, USA. 1870

**Swann, William Francis Gray** 1884–1962

English physicist

The place of the mathematician, of the dreamer, in natural philosophy, is not always apparent to the layman.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1928)

Three Centuries of Natural Philosophy (p. 238)

Government Printing Office. Washington, D.C. 1929

## NATURAL SCIENCE

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

We need scarcely add that the contemplation in natural science of a wider domain than the actual leads to a far better understanding of the actual.

*The Nature of the Physical World*

Chapter XXII (pp. 266–267)

The Macmillan Company. New York, New York, USA. 1930

**Faraday, Michael** 1791–1867

English physicist and chemist

I do not think that the study of natural science is so glorious a school for the mind that, with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 13)

Macmillan & Company Ltd. London, England. 1918

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Natural science always presupposes man, and we must become aware of the fact that...we are not only spectators but also always participants on the stage of life.

*Daedalus*

The Representation of Nature in Contemporary Physics Summer 1958 (p. 100)

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...science conceived as resting on mere sense-perception, with no other source of observation, is bankrupt, so far as

concerns its claim to self-sufficiency. Science can find no individual enjoyment in nature: Science can find no aim in nature: Science can find no creativity in nature; it finds mere rules of succession. These negations are true of Natural Science. They are inherent in its methodology.

*Modes of Thought*

Chapter III, Lecture Eight (p. 211)

The Macmillan Company. New York, New York, USA. 1938

## NATURAL SCIENCE, STUDENT OF

**Eliot, Charles William** 1834–1926

American academic

The student of natural science scrutinizes, touches, weighs, measures, analyzes, dissects, and watches things. By these exercises his powers of observation and judgment are trained, and he acquires the precious habit of observing the appearances, transformations, and processes of nature. Like the hunter and the artist, he has open eyes and an educated judgment in seeing. He is at home in some large tract of nature's domain.

*Educational Reform: Essays and Addresses*

What is a Liberal Education? (p. 110)

The Century Co. New York, New York, USA. 1905

## NATURAL SELECTION

**Bateson, William** 1861–1926

English biologist and geneticist

Natural Selection is stern, but she has her tolerant moods.

In A.C. Seward

*Darwin and Modern Science*

Heredity and Variation in Modern Lights (p. 100)

University Press. Cambridge, England. 1910

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Once we have become adjusted to the idea that we are here because we have evolved from simple chemical compounds by a process of natural selection, it is remarkable how many of the problems of the modern world take on a completely new light.

*Of Molecules and Men*

The Prospect Before Us (p. 93)

University of Washington Press. Seattle, Washington, USA. 1966

**Darwin, Charles Robert** 1809–82

English naturalist

To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter VI (p. 185)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

We can no longer argue that, for instance, the beautiful hinge of a bivalve must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings, and in the action of natural selection, than in the course which the wind blows.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VIII (p. 279)

D. Appleton & Company. New York, New York, USA. 1896

When we descend to details, we can prove that no one species has changed (*i.e.*, we cannot prove that a single species has changed); nor can we prove that the supposed changes are beneficial, which is the groundwork of the theory. Nor can we explain why some species have changed and others have not.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter IV (p. 210)

Letter to G. Bentham, May 22, 1863

D. Appleton & Company. New York, New York, USA. 1887

But then arises the doubt, can the mind of man, which has, as I fully believe been developed from a mind as low as that possessed by the lowest animal, be trusted when it draws such grand conclusions?

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VIII (p. 282)

D. Appleton & Company. New York, New York, USA. 1896

I could show fight on natural selection having done and doing more for the progress of civilization than you seem inclined to admit. Remember what risk the nations of Europe ran, not so many centuries ago of being overwhelmed by the Turks, and how ridiculous such an idea now is! The more civilised so-called Caucasian races have beaten the Turkish hollow in the struggle for existence. Looking to the world at no very distant date, what an endless number of the lower races will have been eliminated by the higher civilized races throughout the world.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Religion (p. 285)

Letter To W. Graham, July 3rd, 1881

D. Appleton & Company. New York, New York, USA. 1887

It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its

organic and inorganic condition of life. We see nothing of these slow changes in progress, until the hand of time has marked the long lapse of ages...

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter IV (p. 42)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Slow though the process of selection may be, if feeble man can do much by artificial selection, I can see no limit to the amount of change, to the beauty and complexity of the coadaptations between all organic beings, one with another and with their physical conditions of life, which may have been effected in the long course of time through nature's power of selection...

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter IV (p. 52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

As buds give rise by growth to fresh buds, and these, if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever branching and beautiful ramifications.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter IV (p. 64)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...extinction and natural selection go hand in hand.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter VI (p. 80)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter VI (p. 87)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But just in proportion as this process of extermination has acted on an enormous scale, so must the number of intermediate varieties, which have formerly existed, be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory. The explanation lies, as I believe, in the extreme imperfection of the geological record.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter X (p. 152)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

By the theory of natural selection all living species have been connected with the parent-species of each genus by differences not greater than we see between the varieties of the same species at the present day; and these parent-species, now generally extinct, have in their turn been similarly connected with more ancient species; and so on backwards, always converging to the common ancestor of each great class. So that the number of intermediate and transitional links, between all living and extinct species, must have been inconceivably great. But assuredly, if this theory be true, such have lived upon this earth.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter X (p. 153)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He who rejects this view of the imperfection of the geological record, will rightly reject the whole theory. For he may ask in vain where are the numberless transitional links which must formerly have connected the closely allied or representative species found in the successive stages of the same great formation?

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XI (p. 179)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

As natural selection acts solely by accumulating slight, successive, favorable variations, it can produce no great or sudden modification; it can act only by very short and slow steps. Hence the canon of "*Natura non facit saltum*" [Nature does not make jumps], [to] which every fresh addition to our knowledge tends to conform, is on this theory simply intelligible.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XV (p. 235)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

[Evolution by natural selection] absolutely depends on what we in our ignorance call spontaneous or accidental variability. Let an architect be compelled to build an edifice with uncut stones, fallen from a precipice. The shape of each fragment may be called accidental. Yet the shape of each has been determined...by events and circumstances, all of which depend on natural laws; but there is no relation between these laws and the purpose for which each fragment is used by the builder. In the same manner the variations of each creature are determined by fixed and immutable laws; but these bear no relation to the living structure which is slowly built up through the power of selection.

*The Variation of Animals and Plants Under Domestication*

Chapter XXI (p. 236)

D. Appleton & Company. New York, New York, USA. 1896

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

All appearances to the contrary, the only watchmaker in nature is the blind forces of physics, albeit deployed in a very special way. A true watchmaker has foresight: he designs his cogs and springs, and plans their interconnections, with a future purpose in his mind's eye. Natural selection, the blind, unconscious, automatic process which Darwin discovered, and which we now know is the explanation for the existence and apparently purposeful form of all life, has no purpose in mind. It has no mind and no mind's eye. It does not plan for the future. It has no vision, no foresight, no sight at all. If it can be said to play the role of the watchmaker in nature, it is the blind watchmaker.

*The Blind Watchmaker*

Chapter 1 (p. 5)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1986

As an academic scientist I am a passionate Darwinian, believing that natural selection is, if not the only driving force in evolution, certainly the only known force capable of producing the illusion of purpose which so strikes all who contemplate nature.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 10)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

It is forever true that DNA is a double helix, true that if you are a chimpanzee (or an octopus or a kangaroo) [and] trace your ancestors back far enough you will eventually hit a shared ancestor. To a pedant, these are still hypotheses which might be falsified tomorrow. But they never will be.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (pp. 17–18)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

Darwin's achievement, like Einstein's, is universal and timeless.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 79)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

Maybe we are neo-Darwinists today, but let us spell neo with a very small n! Our neo-Darwinism is very much in the spirit of Darwin himself.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 80)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

Natural selection is the only workable explanation for the beautiful and compelling illusion of "design" that pervades every living body and every organ. Knowledge of evolution may not be strictly useful in everyday commerce. You can live some sort of life and die without ever hearing the name of Darwin. But if, before you die, you want to understand why you lived in the first place, Darwinism is the one subject that you must study.

In John Maynard Smith

*The Theory of Evolution*

Forward (p. xvi)

Penguin Books Ltd. Harmondsworth, England. 1958

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The law of natural selection impresses me with the vastness of its scope; but, whenever I try to apply it to actual facts, it leaves me whirling in space, with nothing to help me to interpret realities. It is magnificent in theory, but it is a mere gas-bubble in the face of existing conditions. It is majestic, but sterile. Then where is the answer to the riddle of the world? Who knows? Who will ever know?

Translated by Alexander Teixeira de Mattos

*Bramble Bees and Others*

Chapter 1 (p. 30)

Dodd, Mead &amp; Co. New York, New York, USA. 1915

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

Natural Selection is not Evolution. Yet, ever since the two words have been in common use, the theory of Natural Selection has been employed as a convenient abbreviation for the Theory of Evolution by means of Natural Selection.... This has had the unfortunate consequences that the theory of Natural Selection itself has scarcely ever, if ever, received separate consideration.

*The Genetical Theory of Natural Selection*

Preface (p. vii)

Dover Publications, Inc. New York, New York, USA. 1958

We may consequently state the fundamental theorems of Natural Selection in the form:

The rate of increase in fitness of any organism at any time is equal to its genetic variance in fitness at that time.

*The Genetical Theory of Natural Selection*

Chapter II (p. 37)

Dover Publications, Inc. New York, New York, USA. 1958

The million, million, million...to one chance happens once in a million, million, million...times no matter how surprised we may be that it results in us.

In K. Mather

*Heredity*, Volume 30, 1973

...it was Darwin's chief contribution, not only to Biology but to the whole of natural science, to have brought to light a process by which contingencies a priori improbable, are given, in the process of time, an increasing probability, until it is their non-occurrence rather than their occurrence which becomes highly improbable.... Let the reader...attempt to calculate the prior probability that a hundred generations of his ancestry in the direct male line should each have left at least one son. The odds against such a contingency as it would have appeared to his hundredth ancestor (about the time of King Solomon) would require for their expression forty-four figures of the decimal notation; yet this improbable event has certainly happened.

In J.S. Huxley, A.C. Hardy and E.B. Ford (eds.)

*Evolution as a Process*

Retrospect of Criticisms of the Theory of Natural Selection (p. 91)

George Allen &amp; Unwin Ltd. London, England. 1954



**Ford, E. B.** 1901–88  
English ecological geneticist

...organisms automatically generate their own cycles of abundance and rarity and...the changes in selection pressures with which these are associated may greatly increase the speed of evolution.

*Ecological Genetics*

Chapter 3 (p. 34)

Chapman & Hall Ltd. London, England. 1971

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Natural selection can only produce adaptation to immediately surrounding (and changing) environments. No feature of such local adaptation should yield any expectation of general progress (however such a vague term be defined). Local adaptation may as well lead to anatomical simplification as to greater complexity.

*Full House*

Chapter 12 (p. 139)

Harmony Books. New York, New York, USA. 1996

The theory of natural selection would never have replaced the doctrine of divine creation if evident, admirable design pervaded all organisms. Charles Darwin understood this, and he focused on features that would be out of place in a world constructed by perfect wisdom.... Darwin even wrote an entire book on orchids to argue that the structures evolved to ensure fertilization by insects are jerry-built of available parts used by ancestors for other purposes. Orchids are Rube Goldberg machines; a perfect engineer would certainly have come up with something better.

This principle remains true today. The best illustrations of adaptation by evolution are the ones that strike our intuition as peculiar or bizarre.

*Ever Since Darwin: Reflections in Natural History*

Chapter 10. Organic Wisdom or Why Should a Fly Eat Its Mother from Inside (p. 91)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Hamilton, William D.** 1936–

English ethologist, evolutionary biologist, and popular science writer

To express the matter more vividly, in the world of our model organisms, whose behavior is determined strictly by genotype, we expect to find that no one is prepared to sacrifice his life for any single person, but that everyone will sacrifice it when he can thereby save more than two brothers, or four half-brothers, or eight first-cousins...

*The Genetical Evolution of Social Behavior*

*The Journal of Theoretical Biology*, Volume 7, 1964 (p. 16)

With very few exceptions, the only parts of the theory of natural selection which have been supported by mathematical models admit to no possibility of the evolution of any characters which are on average to the disadvantage of the individuals possessing them. If natural selection

followed the classical model exclusively, species would not show any behavior more positively social than the coming together of the sexes and parental care.

*The Genetical Evolution of Social Behavior*

*The Journal of Theoretical Biology*, Part I, Volume 7, 1964

**Jacob, François** 1920–

French biologist

Natural selection has no analogy with any aspect of human behavior. However, if one wanted to play with a comparison, one would have to say that natural selection does not work as an engineer works. It works like a tinkerer – a tinkerer who does not know exactly what he is going to produce ...

*Science*, Volume 196, Number 4295, 10 June, 1977 (p. 1163)

**Monod, Jacques** 1910–76

French biochemist

Drawn out of the realm of pure chance, the accident enters into that of necessity, of the most implacable certainties. For natural selection operates at the macroscopic level, the level of organisms.... In effect natural selection operates upon the products of chance and can feed nowhere else; but it operates in a domain of very demanding conditions, and from this domain chance is barred. It is not to chance but to these conditions that evolution owes its generally progressive course, its successive conquests, and the impression it gives of a smooth and steady unfolding.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Chapter VII (pp. 118–119)

Vintage Books. New York, New York, USA. 1972

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

For “Natural Selection” has no moral significance: it deals with that part of evolution which has no purpose, no intelligence, and might more appropriately be called accidental selection, or better still, Unnatural Selection, since nothing is more unnatural than an accident. If it could be proved that the whole universe had been produced by such Selection, only fools and rascals could bear to live.

*Back to Methuselah*

Preface (p. liv)

Constable & Company Ltd. London, England. 1921

**Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

The meaning of natural selection can be epigrammatically summarized as “the survival of the fittest.” Here “survival” does not, of course, mean the bodily advance of a single individual outliving Methuselah. It implies, in its present-day interpretation, perpetuation as a source for future generations. That individual “survives” best which



leaves the most offspring. Again, to speak of an animal as “fittest” does not necessarily imply that it is stronger or most healthy, or would win a beauty competition. Essentially it denotes nothing more than leaving most offspring. The general principle of natural selection, in fact, merely amounts to the statement that the individual which leaves most offspring are those which leave most offspring. It is a tautology.

*The Strategy of the Genes: A Discussion of Some Aspects of Theoretical Biology*

Chapter 3 (pp. 64–65)

George Allen & Unwin Ltd. London, England. 1957

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

The proof that there is a selective agency at work is, I think, to be found in the general stability of species during the period of human observation, notwithstanding the large amount of variability that has been proved to exist. If there were no selection constantly going on, why should it happen that the kind of variations that occur so frequently under domestication never maintain themselves in a state of nature? Examples of this class are white blackbirds or pigeons, black sheep, and unsymmetrically marked animals generally. These occur not unfrequently, as well as such sports as six-toed or stumptailed cats, and they all persist and even increase under domestication, but never in a state of nature; and there seems no reason for this but that in the latter case they are quickly eliminated through the struggle for existence – that is, by natural selection.

Variation and Natural Selection

*Nature*, Volume 44, Number 1144, October 1, 1891 (p. 518)

**Wallin, Ivan E.** 1883–1969

American biologist

Natural Selection, by itself, is not sufficient to determine the direction of organic evolution.... Natural Selection can only deal with that which has been formed; it has no creative powers. Any directing influence that Natural Selection may have in organic evolution, must, in the nature of the process, be secondary to some other unknown factor.

*Symbioticism and the Origin of Species*

Chapter I (p. 5)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**Weismann, August** 1834–1914

German biologist

It has lately become the fashion, at least among the younger school of biologists, to attach small value to natural selection, if not, indeed, to regard it as a superseded formula; mathematical proofs are demanded or, at any rate, desired.

Translated by J. Arthur Thomson and Margaret R. Thomson

*The Evolution Theory* (Volume 2)

Chapter XXXVI (p. 391)

Edward Arnold. London, England. 1904

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Has anything arisen to show...that where the life and breeding of every individual of a species is about equally secure, a degenerative process must not inevitably supervene?...Natural Selection grips us more grimly than it ever did, because the doubts thrown upon the inheritance of acquired characteristics have deprived us of our trust in education as a means of redemption for decadent families. In our hearts we wish that the case were not so, we all hate Death and his handiwork; but the business of science is not to keep up the courage of men, but to tell the truth.

Bio-Optimism

*Nature*, Volume 52, Number 1348, August 29, 1895 (p. 411)

**Wright, Robert**

American journalist and author

...natural selection “wants” us to behave in certain ways. But, so long as we comply, it doesn’t care whether we are made happy or sad in the process, whether we get physically mangled, even whether we die. The only thing natural selection ultimately “wants” to keep in good shape is the information in our genes, and it will countenance any suffering on our part that serves this purpose.

*The Moral Animal: Why We Are the Way We Are*

Chapter 7 (pp. 162–163)

Vintage Books. New York, New York, USA. 1994

## NATURAL THEOLOGY

**Butler, Joseph** 1692–1752

English bishop and exponent of natural theology

...the only distinct meaning of the word “natural” is stated, fixed, or settled; since what is natural as much requires and presupposes an intelligent agent to render it so, *i.e.*, to effect it continually or at stated times, as what is supernatural or miraculous [requires] to effect it for once.

*The Analogy of Religion, Natural and Revealed to the Constitution and Course of Nature*

Part 2, Chapter I (p. 105)

Harper & Brothers. New York, New York, USA. 1880

## NATURAL UNITS

**Wilson, Edward O.** 1929–

American biologist and author

And so the search proceeds relentlessly for natural units until, like the true grail, they are found and all rejoice. Scientific fame awaits those who discover the lines of

fracture and the processes by which lesser natural units are joined to create larger natural units.

*The Diversity of Life*

Chapter Four (pp. 37–38)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

## NATURALISM

**Dembski, William A.** 1960–

Mathematician and philosopher

Naturalism is the view that the physical world is a self-contained system that works by blind, unbroken natural laws. Naturalism doesn't come right out and say there's nothing beyond nature. Rather, it says that nothing beyond nature could have any conceivable relevance to what happens in nature. Naturalism's answer to theism is not atheism but benign neglect. People are welcome to believe in God, though not a God who makes a difference in the natural order.

*The Design Revolution: Answering the Toughest Questions About Intelligent Design*

Preface (p. 21)

InterVarsity Press. Downers Grove, Illinois, USA. 2004

**Johnson, Philip**

Law professor

The assumption of naturalism is the realm of speculative philosophy, and the rule against negative argument is arbitrary. It is as if a judge were to be charged with the crime.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October, 1990

Scientists committed to philosophical naturalism do not claim to have found the precise answer to every problem, but they characteristically insist that they have the important problems sufficiently well in hand that they can narrow the field of possibilities to a set of naturalistic alternatives.

Absent that insistence, they would have to concede that their commitment to naturalism is based upon faith rather than proof. Such a concession could be exploited by promoters of rival sources of knowledge, such as philosophy and religion, who would be quick to point out that faith in naturalism is no more "scientific" (i.e., empirically based) than any other kind of faith.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October, 1990

The worldview of scientific naturalism preserves a place for beliefs: a place, that is, among things to be explained by science. The Christian religion thus enters the university with a status precisely that of other comparable religious systems – say, the Aztec system of human sacrifice. Any individual, even a person of eminence in science, can make a personal choice to be "religious."

Such choices are made on the basis of "faith," meaning subjective preference. A problem arises only if the Aztecs or the Christians claim access to knowledge. If they do that they are claiming that their own beliefs are normative for unbelievers. Only scientists can claim that kind of authority, because what the scientific community endorses constitutes knowledge, not belief. That is why Darwinian evolution can be taught in schools as fact, however strongly parents or students object, whereas a simple prayer acknowledging God as our Creator is deemed unacceptable – because somebody might object.

How the Universities Were Lost

*First Things*, March, 1995

## NATURALIST

**Abbey, Edward** 1927–89

American environmentalist and nature writer

For I am not a naturalist.... If a label is required say that I am one who loves unfenced country. The open range. Call me a ranger... The only higher honor I've ever heard of is to be called a man.

*The Journey Home: Some Words in Defense of the American West*

Introduction (p. xiii)

E.P. Dutton. New York, New York, USA. 1977

I am – really am – an extremist, one who lives and loves by choice far out on the very verge of things, on the edge of the abyss, where this world falls off into the depths of another. That's the way I like it.

*The Journey Home: Some Words In Defense of the American West*

Introduction (p. xiv)

E.P. Dutton & Company. New York, New York, USA. 1977

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

The education of a naturalist now consists chiefly in learning how to compare.

*Methods of Study in Natural History*

Chapter II (p. 23)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Allen, Grant** 1848–99

Naturalist

There are two kinds of naturalists, you know.... The superior class live in London or Paris, examine everything minutely with a big microscope, tack on inches of Greek nomenclature to an insignificant mite or bit of moss, and split hairs against anybody with marvelous dexterity. That's science. It dwells in a museum. For my part I detest it. The inferior class live in Europe, Asia, Africa or America, as fate or fancy carries; and, instead of looking at everything in a dried specimen, go out into the woods with rifle on shoulder, or box in hand, and observe the birds, and beasts, and green things of the earth, as God made them, in their own

natural and lovely surroundings. That's natural history, old-fashioned, simple, commonplace natural history; and I, for my part, am an old-fashioned naturalist.

*The Tents of Shem*

Chapter I (p. 8)

Chatto & Windus. London, England. 1890

### **Barrett, Edward**

American scientist

The naturalist studies nature in all its relations in its own habitat – the woods, the field, the water, the air. The scientist removes nature from its own realm and studies it in the laboratory under the microscope.

*Famous Living Americans, With Portraits*

John Burroughs (p. 82)

Charles Webb & Co. Greencastle, Indiana, USA. 1915

### **Beard, Dan** 1850–1941

American illustrator, writer and social reformer

To the young nature student it often seems as if the old naturalists and professors who write books lie awake nights to think of difficulties which they may put in the path of the amateur. They rummage among their Latin and Greek dictionaries to find long and impossible names to hitch on to the tiniest and smallest of creatures, names which no small boy may pronounce and which no big boy loves.

*The American Boys' Book of Bugs, Butterflies and Beetles*

Chapter Three (p. 56)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1915

### **Bürgel, Bruno Hans** 1875–1948

German astronomer

A naturalist must be fitted out with a gift for shrewd observation, with a logical and preeminently philosophical mind that does not lose itself in the narrowness of his own special branch of science, but endeavors to keep a wide grasp of the whole material, fitting his deductions at the proper time and place into the great general mass.

Translated by Stella Bloch

*Astronomy for All*

Chapter II (p. 21)

Cassell & Co., Ltd. London, England. 1911

### **Darwin, Charles Robert** 1809–82

English naturalist

A naturalist's life would be a happy one if he had only to observe, and never to write.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

C. Darwin to C. Lyell, June 1st [1867] (p. 248)

D. Appleton & Company. New York, New York, USA. 1896

It is well to remember that Naturalists value observations far more than reasoning...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Farrar, November 26, 1868 (p. 453)

D. Appleton & Company. New York, New York, USA. 1896

### **Darwin, Charles Galton** 1809–82

English naturalist

...nothing can be more improving to a young naturalist than a journey in distant countries.

*A Naturalist's Voyage*

Chapter XXI (p. 603)

John Murray. London, England. 1889

### **Einstein, Albert** 1879–1955

German-born physicist

In every naturalist there must be a kind of religious feeling; for he cannot imagine that the connections into which he sees have been thought of by him for the first time. He rather has the feeling of a child, over whom a grown-up person rules.

*Cosmic Religion, with Other Opinions and Aphorisms*

On Science (pp. 100–101)

Covici-Fiede. New York, New York, USA. 1931

### **Fitz-Gerald, Charles Egerton**

English physician

What greater difference can there be then between the dull “constitutional” along an uninteresting road, taken perhaps at the urgent instigation of some tyrannical doctor, and the happy “ramble” of the Naturalist, to whom every blade of grass, every peeping wild flower or graceful fern, every stone becomes an object of rational interest, to whom every little pond swarms with curious and interesting life ...

*Semi-scientific Lectures*

First Annual Address (p. 20)

J. English. Folkstone, England. 1880

### **Forbes, Edward** 1815–54

English naturalist

The naturalists of yore esteemed the ocean to be a treasury of wonders, and sought therein for monstrosities and organisms contrary to the law of nature, such as they interpreted it. The naturalists of our own time hold equal faith in the wonders of the sea, but seek therein rather for the links of nature's chain than for apparent exceptions.

*The Natural History of the European Seas*

Chapter I (pp. 4–5)

John van Voorst. London, England. 1859

### **Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

...the real object of true naturalists, in Sir W. Thomson's meaning of the word, when they employ mathematics to assist them, is not to make mathematical exercises (though that may be necessary), but to find out the connections of known phenomena, and by deductive reasoning, to obtain a knowledge of hitherto unknown phenomena.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 2)

D. van Nostrand Co. New York, New York, USA. 1893

**Himstedt, Franz** 1852–1933  
German physicist

The naturalist of today is not pessimistic. If at first we are allowed to lift only a little corner of the veil with which nature has so carefully concealed the secret we pursue, we will not relinquish hope ...

*Annual Report of the Board of Regents of the Smithsonian Institution (1906)*  
Radioactivity (p. 130)  
Government Printing Office. Washington, D.C. 1907

**Hornaday, William Temple** 1854–1937  
American naturalist

The librarian who expects to store ten thousand books in such a manner that each one may be instantly available, wisely provides twenty-five alcoves and two hundred and fifty shelves; and thereafter each new accession of books is a source of joy, because the place for each volume is ready. The young naturalist without a zoological foundation is like a librarian who has no shelves and must create a place for each new book.

In Francis Rolt-Wheeler  
*The Science-history of the Universe*  
Introduction (p. xiii)  
The Current Literature Publishing Co. New York, New York, USA. 1909

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

To a naturalist nothing is indifferent; the humble moss that creeps upon the stone is equally interesting as the lofty pine which so beautifully adorns the valley or the mountain: but to a naturalist who is reading in the face of rocks the annals of a former world, the mossy covering which obstructs his view, and renders undistinguishable the different species of stone, is no less than a serious subject of regret.

*Theory of the Earth: With Proofs and Illustrations* (Volume 3)  
Chapter V (p. 46)  
Geological Society. London, England. 1899

How valuable for science to have naturalists who can distinguish properly what they see, and describe intelligibly that which they distinguish.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter IV (p. 354)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Jones, Thomas Rymer** 1810–80  
English zoologist

And now, gentle reader, let to hasten to the beach: the tide is near its ebb, and yonder rocks, baring their shoulders to the sunshine, seem to rest themselves in grim repose. This is the time for work. Come, boy! the fishing basket and the muslin landing-net – a hammer and an iron chisel. Mind, too, you don't forget the large glass jar with handles made of rope, wherein to put what specimens we find.

*The Aquarian Naturalist: A Manual for the Sea-side*  
Chapter I (p. 27)  
John van Voorst. London, England. 1858

**Kett, Henry** 1761–1825  
English college teacher and writer

It is the object of the naturalist to examine all the visible works of the creation; he is therefore employed in the most extensive province of human knowledge, as nature appears to have fixed no bounds to her productions.

*Elements of General Knowledge* (Volume 2)  
Chapter IV (p. 90)  
Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist and explorer

After he [the traveler] has commenced his journey and has become transplanted, so to speak, into a new world, he should consider it his duty to observe everything, not carelessly or at random, but so that nothing will escape his keen vision and alert attention. In describing objects he must endeavor to depict nature so faithfully that he who reads the description must needs believe he is beholding the very things himself.

In A.G. Nathorst  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
Carl von Linné as a Geologist (p. 711)  
Government Printing Office. Washington, D.C. 1909

**Lydekker, Richard** 1849–1915  
English naturalist and geologist

To the more observant class of sportsmen the stay-at-home naturalist is, of necessity, indebted for most of his information with regard to the habits of large animals and their adaptation to their inanimate environment.

*Mostly Mammals, Zoological Essays*  
Part I (p. 8)  
Dodd, Mead & Co. New York, New York, USA. 1903

**Montagu, George**  
No biographical data available

As natural history has, within the last half century, occupied the attention and pens of the ablest philosophers of the more enlightened parts of the globe, there needs no apology for the following sheets; since the days of darkness are now past, when the researches of the naturalist were considered as trivial and uninteresting.

*Testacea Britannica*  
Introduction (p. 1)  
J. White. London, England. 1803

**Muir, John** 1838–1914  
American naturalist

Like Thoreau they see forests in orchards and patches of huckleberry brush, and oceans in ponds and drops of dew.

*Our National Parks*  
Chapter I (p. 2)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

For the naturalist everything lies in the method, in the chance of obtaining an unshakeable, lasting truth; and solely from this point of view, which for him is obligatory, the soul, as a naturalistic principle, is not only unnecessary but even harmful to his work, in vain limiting his courage and the depth of his analysis.

*Experimental Psychology and Other Essays*  
Experimental Psychology and Psychopathology in Animals (p. 168)  
Philosophical Library. New York, New York, USA. 1957

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

When a naturalist is thoroughly comfortable and settled, it is time to uproot him.

*Flowering Earth*  
Chapter 13 (p. 162)  
G.P. Putnam's Sons. New York, New York, USA. 1939

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

A great naturalist, as well as I can make out, is a man whose capacious skull allows of his being on the alert to a hundred different things at once, this same alertness being connected with a power of seeing the relations between different complicated sets of phenomena when they are presented in their entirety.

In A.G. Sedgwick  
*The 19th Century: A Review of Progress During the Past One Hundred Years in the Chief Departments of Human Activity*  
The Century's Great Men in Science (p. 321)  
G.P. Putnam's Sons. New York, New York, USA. 1901

**Pouchet, Félix Archimède** 1800–72  
French biologist

When we read the works of naturalists, and see them penetrating so deeply into the most hidden secrets of the anatomy and manners of beings, the mere existence of which the eye could not lead us to suspect, we are apt to

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book I (p. 8)  
Blackie & Son. London, England. 1870

**Riley, James Whitcomb** 1849–1916  
American poet

In gentlest worship has he bowed  
To Nature. Rescued from the crowd  
And din of town and thoroughfare,  
He turns him from all worldly care  
Unto the sacred fastness of

The forest, and the peace and love  
That beats there prayer-like in the breeze.  
*The Complete Works of James Whitcomb Riley* (Volume 7)  
*The Naturalist*

P.F. Collier & Son, Company. New York, New York, USA. 1916

**Roberts, Mary** 1788–1864  
English botanist and author

The objects which engage the attention of the naturalist, succeed each other like the moving pictures in La Fata Morgana of the Sicilians.

*The Sea-side Companion; or, Marine Natural History*  
Letter V (p. 36)  
Printed for Whittaker & Co. London, England. 1835

**Rolt-Wheeler, Francis** 1876–1960  
No biographical data available

The young naturalist without a zoological foundation is like a librarian who has no shelves and must create a place for each new book.

*The Science-history of the Universe*  
Introduction (p. xiii)  
The Current Literature Publishing Co. New York, New York, USA. 1910

**Rowland, Henry Augustus** 1848–1901  
American physicist

The only qualifications required for the study of Nature's story-book are devotion to truth, and sincerity of spirit; all the other qualities will come to the possessor of these, and a habit of mind will be developed that tries to face all facts squarely and honestly, despises shams and false conventions, and exposes superstition whenever it is encountered.

*Discovery, Or, The Spirit and Service of Science*  
Chapter III (p. 44)  
Macmillan & Co Ltd. London, England. 1916

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Man cannot afford to be a naturalist, to look at Nature directly, but only with the side of his eye. He must look through and beyond her. To look at her is as fatal as to look at the head of Medusa. It turns the man of science to stone.

*The Journal of Henry David Thoreau*  
March 23, 1853 (p. 43)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

**Whately, Richard** 1787–1863  
English theologian

Most naturalists arrange the volumes of the great book of nature, and then forget to peruse them.

In Elizabeth Jane Whately  
*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D.*  
Apothegm 29 (p. 3)  
Longman, Green, Longman, Roberts & Green. London, England. 1865

**Wilson, Edward O.** 1929–  
American biologist and writer

For the naturalist every entrance into a wild environment rekindles an excitement that is childlike in spontaneity,



often tinged with apprehension – in short, the way life ought to be lived, all the time.

*The Future of Life*

Chapter 6 (p. 146)

Alfred A. Knopf. New York, New York, USA. 2002

## NATURE

**Abbey, Edward** 1927–89

American environmentalist and nature writer

I am here not only to evade for a while the clamor and filth and confusion of the cultural apparatus but also to confront, immediately and directly, if it's possible, the bare bones of existence, the elemental and fundamental, the bedrock which sustains us. I want to be able to look at and into a juniper tree, a piece of quartz, a vulture, a spider, and see it as it is in itself, devoid of all humanly ascribed qualities, anti-Kantian, even the categories of scientific description. To meet God or Medusa face to face, even if it means risking everything human in myself. I dream of a hard and brutal mysticism in which the naked self merges with a nonhuman world and yet somehow survives still intact, individual, separate. Paradox and bedrock.

*Desert Solitaire*

The First Morning (p. 6)

Ballantine Books. New York, New York, USA. 1968

There are no vacant lots in nature.

*Desert Solitaire*

Down the River (p. 189)

Ballantine Books. New York, New York, USA. 1968

There are enough cathedrals and temples and altars here for a Hindu pantheon of divinities. Each time I look up one of the secretive little side canyons I half expect to see not only the cottonwood tree rising over its tiny spring – the leafy god, the desert's liquid eye – but also a rainbow-colored corona of blazing light, pure spirit, pure being, pure disembodied intelligence, about to speak my name. If a man's imagination were not so weak, so easily tired, if his capacity for wonder not so limited, he would abandon forever such fantasies of the supernal. He would learn to perceive in water, leaves and silence more than sufficient of the absolute and marvelous, more than enough to console him for the loss of the ancient dreams.

*Desert Solitaire*

Down the River (p. 200)

Ballantine Books. New York, New York, USA. 1968

**Ackerman, Diane** 1948–

American writer

Nature neither gives nor expects mercy.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 4 (pp. 239–240)

Random House, Inc. New York, New York, USA. 1991

Just because we have evolved minds that crave order doesn't mean that nature is orderly. Evolution is a sleeping watchdog. It is possible for us to disturb it, or it may wake on its own. Either way, expect commotion.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Introduction (p. xii)

Vintage Books. New York, New York, USA. 1997

[N]ature is also great fun. To pretend that nature isn't fun is to miss much of the joy of being alive...

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Introduction (p. xx)

Vintage Books. New York, New York, USA. 1997

**Ackoff, Russell Lincoln** 1919–

American operations research and systems scientist

Nature is not organized in the same way that universities are.

Toward an Idealized University

*Management Science*, Volume 15, December, 1970 (p. B-127)

**Adams, George** 1750–95

English instrument maker

Man has before him all nature, the whole world with which he is surrounded for the object of his view, and the subject of his consideration; but his capacity is so circumscribed, his knowledge so straightened, his powers so limited, that he can by no means conceive the mechanism of so vast and complicate a structure.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXXV (p. 510)

Printed by R. Hindmarsh. London, England. 1794

**Addison, Joseph** 1672–1719

English essayist, poet, and statesman

If there's a power above us, (and that there is all nature cries aloud through all her works) he must delight in virtue.

*Cato*

Act V, Scene 1

J. Dicks. London, England. 1883

...when Nature is in her desolation, and presents us with nothing but bleak and barren prospects, there is something unspeakably cheerful in a spot of ground which is covered with trees that smile amidst all the rigors of winter, and give us a view of the most gay season in the midst of that which is the most dead and melancholy.

*The Spectator*, Volume VII, Number 477, September 6, 1712 (pp. 19–20)

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

As long as men inquire, they will find opportunities to know more upon these topics than those who have gone before them, so inexhaustibly rich is nature in the innermost diversity of her treasures of beauty, order, and intelligence.

*Essay on Classification*

Chapter II, Section I (p. 141)

Harvard University Press. Cambridge, Massachusetts, USA. 1962



...it must be for truth's sake, and not even for the sake of its usefulness to humanity, that the scientific man studies Nature.

*Methods of Study in Natural History*

Chapter II (p. 24)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

...Nature does not open her sanctuary without exacting due penance from her votaries.

*Methods of Study in Natural History*

Chapter XVI (p. 297)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

**Aldrich Thomas Bailey** 1836–1907

American writer and editor

Nature, who loves to do a gentle thing even in her most savage moods, had taken one of those empty water-courses and filled it from end to end with forget-me-nots.

*Queen of Sheba*

IX (p. 205)

J.R. Osgood & Company. Boston, Massachusetts, USA. 1877

**Allen, Grant** 1848–99

Canadian-born writer

...Nature as a whole is intensely utilitarian; each kind fights for its own hand alone, and regards as little the feelings of other kinds as the fisherman regards the feelings of herrings, or as the fishmonger minds the objection of lobsters to be boiled alive for our human convenience.

*Flashlights on Nature*

Chapter IV (p. 70)

Doubleday, Page & Co. New York, New York, USA. 1905

**Anderson, Lorraine**

American nature writer

Nature has been for me, for as long as I can remember, a source of solace, inspiration, adventure, and delight; a home, a teacher, a companion.

*Sisters of the Earth: Women's Prose and Poetry About Nature*

Preface

Vintage Books. New York, New York, USA. 1991

**Areopagus**

If the structure of the world with all its order and beauty is only an effect of matter left to its own universal laws of motion, and if the blind mechanics of the natural forces can evolve so glorious a product out of chaos, and can attain to such perfection of themselves, then the proof of the Divine Author which is drawn from the spectacle of the beauty of the universe wholly loses its force. Nature is thus sufficient for itself; the Divine government is unnecessary; Epicurus lives again in the midst of Christendom, and a profane philosophy tramples underfoot the faith which furnishes the clear light needed to illuminate it.

Translated by W. Hastie

Quoted in Kant's *Cosmogony*

*Kant's Cosmogony*

Preface (p. 18)

James Maclehose & Sons. Glasgow, Scotland. 1900

**Aristotle** 384 BCE–322 BCE

Greek philosopher

Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie.

In *Great Books of the Western World* (Volume 8)

*History of Animals*

Book VIII, Chapter 1

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

No one finds fault with defects which are the result of nature.

In *Great Books of the Western World* (Volume 8)

*Ethics*

Book III, Chapter 5

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Arnold, Matthew** 1822–88

English poet and critic

Nature's great law,  
and law of all men's minds? –

To its own impulse every creature stirs;

Live by thy light, and earth will live by hers!

*The Poetical Works of Matthew Arnold*

Religious Isolation

Stanza 4

Oxford University Press, Inc. New York, New York, USA. 1950

Man must begin, know this, where Nature ends; Nature and man can never be fast friends.

*The Poetical Works of Matthew Arnold*

In *Harmony with Nature*, l. 12–13

Oxford University Press, Inc. New York, New York, USA. 1950

Know, man hath all which Nature hath, but more,  
And in that more lie all his hopes of good.

Nature is cruel, man is sick of blood;

Nature is stubborn, man would fain adore.

*The Poetical Works of Matthew Arnold*

In *Harmony with Nature*

Oxford University Press, Inc. New York, New York, USA. 1950

**Atwater, Caleb** 1778–1867

American educator and archaeologist

Nature has already done her part, for this region, and man has done, is doing and will continue to do his, to make it all that man can ever desire it to be, forever ...

*A History of the State of Ohio, Natural and Civil*

Part I, Little Miami (p. 49)

Glezen & Shephard. Cincinnati, Ohio, USA. 1838

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

From Nature! – How often are these words used, when at a glance he who has seen the perfect and beautiful forms of birds, quadrupeds or other objects, as they have come from the hand of Nature, discovers that the representation is not that of living Nature!

*Ornithological Biography* (Volume 1)  
The Yellow-Billed Cuckoo (p. 18)  
Adam Black. Edinburgh, Scotland. 1831

**Austen, Jane** 1775–1817  
English novelist

...how astonishing a variety of nature! In some countries we know the tree that sheds its leaf is the variety, but that does not make it less amazing, that the same soil and the same sun should nurture plants differing in the first rule and law of their existence.

*Mansfield Park*  
Chapter IV (p. 185)  
Richard Bentley. London, England. 1833

### Author undetermined

The heavens and the earth are as nothing to man, if they do not excite his awe and call forth his thanksgiving. We might almost suppose that it is for this purpose that the sea rolls its waves on the shore, and the violet smiles by the wayside, and the moon floods the night with its silver radiance.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I  
T. Nelson & Sons. London, England. 1889

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Those who become practically versed in nature are, the mechanic, the mathematician, the physician, the alchemist, and the magician, but all (as matters now stand) with faint efforts and meager success.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 5 (p. 107)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...we can command nature only by obeying her...

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 129 (p. 135)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In nature things move violently to their place, and then calmly in their place.

*Bacons Essays*  
Of Great Places (p. 27)  
The Macmillan Company. New York, New York, USA. 1930

...men should frequently call upon nature to render her account; that is, when they perceive that a body which was before manifest to the sense has escaped and disappeared, they should not admit or liquidate the account before it has been shown them where the body has gone to, and into what it has been received.

In James Spedding, Robert Leslie Ellis and Douglas Denon Heath  
*The Works of Francis Bacon* (Volume 5)  
Part II, Thoughts on the Nature of Things (p. 427)  
Longman & Co. London, England. 1858

**Bailey, Philip James** 1816–1902  
English poet

Nature means Necessity.

*Festus: A Poem*  
Dedication  
George Routledge & Sons, Ltd. London, England. 1893

**Baker, Henry** 1698–1774  
English naturalist

That Man is certainly the happiest, who is able to find out the greatest Number of reasonable and useful Amusements, easily attainable and within his Power: and, if so, he that is delighted with the Works of Nature, and makes them his Study must undoubtedly be happy, since every Animal, Flower, Fruit, or Insect, nay, almost every Particle of Matter, affords him an Entertainment.

*The Microscope Made Easy*  
The Introduction (pp. xii–xiv)  
Printed for R. Dodsley. London, England. 1743

**Barbauld, Anna Laetitia** 1743–1825  
English writer, essayist, and poet

All those who love Nature she loves in return, and will richly reward, not perhaps with the good things, as they are commonly called, but with the best things, of this world; not with money and titles, horses and carriages, but with bright and happy thoughts, contentment and peace of mind.

*The Works of Anna Laetitia Barbauld*  
To Mrs. P\*\*\*\*\* (p. 7)  
David Reed. Boston, Massachusetts, USA. 1826

### Baron von Frankenstein (Fictional Character)

Nothing in nature is terrifying when one understands it.  
*The Son of Frankenstein*  
Film (1939)

**Barrell, Joseph** 1869–1919  
American geologist

Nature vibrates with rhythms, climatic and diastrophic, those finding stratigraphic expression ranging in period from the rapid oscillation of surface waters, recorded in ripple-mark, to those long-deferred stirrings of the deep imprisoned titans which have divided earth history into periods and eras. The flight of time is measured by the weaving of composite rhythms – day and night, calm and storm, summer and winter, birth and death – such as these are sensed in the brief life of man. But the career of the earth recedes into a remoteness against which these lesser cycles are as unavailing for the measurement of that abyss of time as would be for human history the beating of an insect's wing. We must seek out, then, the nature of those longer rhythms whose very existence was unknown until man by the light of science sought

to understand the earth. The larger of these must be measured in terms of the smaller, and the smaller must be measured in terms of years.

Rhythm and the Measurement of Geologic Time  
*Bulletin of the Geological Society of America*, Volume 28 1917 (p. 746)

**Beaumont, Francis** 1584–1616  
English playwright and dramatic poet

**Fletcher, John** 1579–1625  
Jacobean playwright

Nature too unkind;  
That made no medicine for a troubled mind!

*Philaster*  
Act III, Scene 1  
D.C. Heath. Boston, Massachusetts, USA. 1906

**Berkeley, George** 1685–1753  
Irish prelate and metaphysical philosopher

Oh nature! the genuine beauty of pure nature!

*The Works of George Berkeley* (Volume 2)  
First Dialogue (p. 57)  
At The Clarendon Press. Oxford, England. 1901

**Beston, Henry** 1888–1968  
American writer

The three great elemental sounds in nature are the sound of rain, the sound of wind in a primeval wood, and the sound of the outer ocean on a beach. I have heard them all, and of the three elemental voices, that of ocean is the most awesome, beautiful, and varied.

*The Outermost House*  
Chapter III (p. 43)  
Rinehart & Company. New York, New York, USA. 1928

A year indoors is a journey along a paper calendar; a year in outer nature is the accomplishment of a tremendous ritual.

*The Outermost House*  
Chapter IV (p. 59)  
Rinehart & Company. New York, New York, USA. 1928

As well expect Nature to answer to your human values as to come into your house and sit in a chair.

*The Outermost House*  
Chapter X (p. 221)  
Rinehart & Company. New York, New York, USA. 1928

**Bishop, Elizabeth** 1911–79  
American poet and writer

Nature repeats herself, or almost does: repeat, repeat, repeat, revise, revise, revise.

*North Haven*, l. 19–20  
Farrar, Straus & Giroux. New York, New York, USA. 1984

**Bloomfield, Robert** 1766–1823  
English poet

Strange to the world, he wore a bashful look,  
The fields his study, nature was his book.

In John Aikin  
*Selected Works of the British Poets: In a Chronological Series from Falconer to Sir Walter Scott*  
The Farmer's Boy, Spring, l. 31  
Thomas Wardle. Philadelphia, Pennsylvania, USA. 1838

**Boethius, Anicius Manlius Severinus** ca. 475–524  
Roman philosopher and statesman

The strength which potent Nature brings  
To reins which guide the world along ...

*The Consolation of Philosophy*  
Book III, Second Poem (p. 43)  
Oxford University Press. Oxford, England. 2000

**Bohm, David** 1917–92  
American physicist

In nature nothing remains constant. Everything is in a perpetual state of transformation, motion, and change.

*Causality and Chance in Modern Physics*  
Chapter One (p. 1)  
University of Pennsylvania Press. Philadelphia, Pennsylvania, USA. 1957

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our experiences.

*Atomic Theory and the Description of Nature*  
Introductory Survey (p. 18)  
Cambridge University Press. Cambridge, England. 1934

**Borland, Hal** 1900–78  
American writer

Nature seems to look after her own only up to a certain point; beyond that they are supposed to fend for themselves.

*The Enduring Pattern*  
Life – Flesh and Blood: Amphibians (p. 185)  
Simon & Schuster. New York, New York, USA. 1959

Nothing in nature is as simple as it sometimes seems when reduced to words.

*The Enduring Pattern*  
Life – Flesh and Blood: Reptiles (p. 189)  
Simon & Schuster. New York, New York, USA. 1959

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

Nature always looks out for the preservation of the universe.

In Edward B. Davis and Michael Hunter (eds.)  
*A Free Enquiry into the Vulgarly Received Notions of Nature*  
Section IV (p. 31)  
Cambridge University Press. Cambridge, England. 1996

It is one thing to be able to help nature to produce things, and another thing to understand well the nature of the things produc'd.

*The Sceptical Chymist*

The Third Part (p. 95)

Dawsons of Pall Mall. London, England. 1965

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Nature flips the coin with a “Heads I win – tails you lose.” She offers her children stagnation and degeneracy on the one hand, or over-specialization and extinction on the other.

*Parade of the Living*

Part III, Chapter XX (p. 290)

Coward-McCann, Inc. New York, New York, USA. 1930

**Brewster, George**

No biographical data available

She [nature] speaks the language of uniformity and consistency throughout her wide dominions, and you will never find her conduct, one time, or in one respect, at variance with her conduct in another.

*A New Philosophy of Matter, Showing the Identity of All the Imponderables*

Lecture II (p. 22)

Crocker & Brewster. Boston, Massachusetts, USA. 1843

There is no deception in nature. She is no coquette. She speaks the language of uniformity and consistency throughout her wide dominions, and you will never find her conduct, at one time, or in one respect, at variance with her conduct in another.

*A New Philosophy of Matter, Showing the Identity of All the Imponderables* (3rd edition)

Chapter IV (p. 40)

Edward H. Fletcher. New York, New York, USA. 1858

**Bridgman, Helen Bartlett**

Nature seems positively to enjoy playing pranks which turn all preconceived notions topsy-turvy.

*Gems*

How It Began (p. 5)

Brooklyn, New York, USA. 1916

**Bridgman, Percy Williams** 1882–1961

American physicist

...our conviction that nature is understandable and subject to law arose from the narrowness of our horizons, and that if we sufficiently extend our range we shall find that nature is intrinsically and in its elements neither understandable nor subject to law...

The New Vision of Science

*Harper's Magazine*, Volume 158, March, 1929 (p. 444)

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

A new conception was being made...that whatever fundamental units the world is put together from, they are more delicate, more fugitive, more startling than we catch in the Butterfly Net of our senses.

*The Ascent of Man*

Chapter 11 (p. 364)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Bronte, Charlotte** 1816–55

English author

The universal mother, Nature.

*Jane Eyre*

Chapter XXVIII (p. 320)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

**Brooks, William Keith** 1848–1908

American zoologist

Nature, as we know it, consists, in the main of permutations and combinations.

*The Foundations of Zoology*

Lecture VI (p. 128)

The Macmillan Co. New York, New York, USA. 1899

**Brown, William Hill** 1765–93

American novelist

Nature is everywhere liberal in dispensing her beauties and her variety...

*The Power of Sympathy and The Coquette*

Chapter 19 (p. 38)

Rowman & Littlefield. Lanham, Maryland, USA. 1970

**Browne, Sir Thomas** 1605–82

English writer and physician

All things are artificial, for nature is the art of God.

*Religio Medici*

Part I, Section xvi (p. 29)

Elliot Stock. London, England. 1883

There are no grotesques in nature; not anything framed to fill up empty cantons, and unnecessary spaces.

*Religio Medici*

Part XV

Elliot Stock. London, England. 1883

Now nature is not at variance with art, nor art with nature; they being both the servants of his providence. Art is the perfection of nature. Were the world now as it was the sixth day, there were yet a chaos. Nature hath made one world, and art another. In brief, all things are artificial; for nature is the art of God.

*Religio Medici*

Section 16

Elliot Stock. London, England. 1883

**Browning, Robert** 1812–89

English poet

I trust in Nature for the stable laws  
Of beauty and utility. Spring shall plant  
And Autumn garner to the end of time.  
I trust in God – the right shall be the right  
And other than the wrong, while he endures;  
I trust in my own soul, that can perceive

The outward and the inward, Nature's good  
And God's.

*The Poems and Plays of Robert Browning*

A Soul's Tragedy, Act I (p. 458)

The Modern Library. New York, New York, USA. 1934

...what I call God.

...fools call Nature...

*The Poems and Plays of Robert Browning*

The Pope, l. 1073–1074

The Modern Library. New York, New York, USA. 1934

### Bryan, J. Ingram

No biographical data available

Nature does not tolerate the whimsical and the inane; all  
her structures are on principles, and she allows no others.

*The Interpretation of Nature in English Poetry*

Chapter I (p. 6)

Kaitakusha. Tokyo, Japan. 1932

### Bryant, William Cullen 1794–1878

American poet

To him who in the love of Nature holds  
Communion with her visible forms, she speaks  
A various language.

*Poems*

Thanatopsis

D. Appleton & Company. New York, New York, USA. 1874

Go forth under the open sky, and list

To Nature's teachings.

*Poems*

Thanatopsis

D. Appleton & Company. New York, New York, USA. 1874

### Buchner, Ludwig 1824–99

German physician and philosopher

Wherever fire and water meet, vapours must arise and  
exert their irresistible power. Where the seed falls in  
the ground, there it will grow; where the thunderbolt is  
attracted, there it will strike. Can there exist any doubt  
as to these truths? No one who has only superficially  
observed the phenomena by which he is surrounded, who  
knows only superficially the results of science, can fail to  
be convinced of the necessity and unchangeableness of  
the laws of nature.

*Force and Matter*

Chapter VI (p. 35)

Trübner & Co. London, England. 1864

### Bucke, Charles 1781–1846

English writer

As there are in nature many contrasts, there are, also,  
many resemblances, though there are no likenesses.

*On the Beauties, Harmonies, and Sublimities of Nature* (Volume 3) (2nd  
edition)

Book VII, Chapter I (p. 1)

G. & W.B. Whittaker. London, England. 1823

### Burke, Edmund 1729–97

English statesman and philosopher

Nature is never more truly herself, than in her grandest  
form.

*The Works of the Right Hon. Edmund Burke: With a Biographical and  
Critical Introduction*

Letters on a Regicide Peace (p. 324)

Holdsworth & Ball. London, England. 1834

Never, no never, did nature say one thing and wisdom  
say another.

nature

*The Works of the Right Hon. Edmund Burke: With a Biographical and  
Critical Introduction* (Volume 2)

Letters on a Regicide Peace (p. 324)

Holdsworth & Ball. London, England. 1834

### Burney, Fanny 1752–1840

English novelist and diarist

...the lifeless symmetry of architecture, however beauti-  
ful the design and proportion, no man would be so mad  
as to put in competition with the animated charms of  
nature.

*Evelina*

Letter XXIII (p. 100)

J.M. Dent & Sons Ltd. London, England. 1909

### Burroughs, John 1837–1921

American naturalist and writer

Originality is Nature expressed, imitation is Nature sup-  
pressed.

*The Heart of Burroughs's Journals*

May 15, 1857 (p. 9)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

Nature exists for man no more than she does for mon-  
keys, and is as regardless of his life or pleasure or success  
as she is of the fleas. Her waves will drown him, her fire  
burn him, and her earth devour him, her storms and light-  
nings smite him, as if he were only a dog.

*The Heart of Burroughs's Journals*

Jan. 17, 1866 (p. 45)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

What is size? What is time, distance, etc., to Nature?  
Nothing. She knows no time, no space, no great, no  
small, no beginning, no end, no life, no death; that is, she  
works without reference to these things.

*The Heart of Burroughs's Journals*

Jan. 17, 1866 (p. 46)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

Nature will not be conquered, but gives herself freely to  
her true lover – to him who revels with her, bathes in her  
seas, sails her rivers, camps in her woods, and, with no  
mercenary ends, accepts all.

*The Heart of Burroughs's Journals*

Jan. 17, 1866 (p. 47)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

You find in Nature only what you bring to her. If you are joyful, she is joyful; if you are sad, she is sad. The religious soul find Nature very religious. To the scientist she means science, and to the poet she means picture and parable. She is all things to all men.

*The Heart of Burroughs's Journals*

November 27, 1878 (p. 72)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

Nature works with such simple means! A little more or a little of this or that, and behold the difference!

*The Breath of Life*

Chapter III (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

Nature teaches more than she preaches. There are no sermons in stone. It is easier to get a spark out of a stone than a moral.

*Time and Change*

The Gospel of Nature (p. 247)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

Nature exists to the mind not as an absolute realization, but as a condition, as something constantly becoming.... It is suggestive and prospective; a body in motion, and not an object at rest.

Expression

*The Atlantic Monthly*, Volume 6, Number XXXVII, November, 1860 (p. 572)

Nature comes home to one most when he is at home; the stranger and traveler finds her a stranger and traveler also.

*Signs and Seasons*

Chapter I (p. 5)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

One goes to Nature only for hints and half truths. Her facts are crude until you have absorbed them or translated them. Then the ideal steals in and lends a charm in spite of one. It is not so much what we see as what the thing seen suggests. We all see about the same; to one it means much, to another little.

*Signs and Seasons*

Chapter I (p. 36)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

Man can have but one interest in nature, namely, to see himself reflected or interpreted there, and we quickly neglect both poet and philosopher who fail to satisfy, in some measure, this feeling.

*Signs and Seasons*

Chapter I (p. 37)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

She [Nature] works with reference to no measure of time, no limit of space, and with an abundance of material not expressed by exhaustless.

*Birds and Poets With Other Papers*

Touches of Nature (p. 62)

David Douglas Edinburgh, Scotland. 1884

Nature does not work by prefixes and suffixes, but by unfolding and ever unfolding, or developing out of latent innate powers and possibilities ...

*Studies in Nature and Literature*

The Devine Soil (p. 77)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1908

Nature does not guard against waste or delay. All time and all matter are hers, and her losses and gains are all one.

*Under The Apple Tree*

Life and Chance (p. 235)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Burton, Sir Richard Francis** 1821–90

English explorer

much to learn!

Old Nature's ways

Of glee and gloom with rapt amaze

To study, probe, and paint – brown earth,

Salt sea, blue heavens, their tilth and dearth, Birds,

grasses, trees – the natural things

That throb or grope or poise on wings.

*Memorial Day*

So Much to Learn (p. 8)

Copeland & Day. Boston, Massachusetts, USA. 1847

**Burton, Robert** 1577–1640

English clergyman and scholar

See one promontory, said Socrates of old, one mountain, one sea, one river, & see all.

*The Anatomy of Melancholy* (Volume 1)

Part I, Sect. II, Memb. IV, Subsec. 7 (p. 422)

AMS Press, Inc. New York, New York, USA. 1973

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

That one great lie she told about the earth being flat, when it was round all the time – and again how she stuck to it that the sun went round us when it was we who are going round her – this double falsehood has irretrievably ruined my confidence in her. There is no lie which she will not tell and stick to like a Gladstonian. How plausibly she told her tale, and how many ages was it before she was so much as suspected, and then when things did begin to look bad for her, how she brazened it out and what a desperate business it was to bring all her shifts and prevarications to book.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 74)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English romantic poet and satirist

There is a pleasure in the pathless woods,

There is a rapture on the lonely shore,



There is society, where none intrudes,  
By the deep sea, and music in its roar:  
I love not man the less, but nature more.

*Childe Harold's Pilgrimage*  
Canto IV, clxxvii–clxxxiv  
Cassell. London, England. 1886

**Cable, George W.** 1844–1925

American writer and reformer

Shall we ever subdue Nature and make her always sub-  
missive and compliant? Who knows what man may do  
with her when once he has got self, the universal self,  
under perfect mastery?

*Bonaventure*  
Book III, XVIII (p. 291)  
Charles Scribner's Sons. New York, New York, USA. 1888

**Campbell, Jeremy C.**

No biographical data available

Evidently nature can no longer be seen as matter and  
energy alone. Nor can all her secrets be unlocked with  
the keys of chemistry and physics, brilliantly successful  
as these two branches of science have been in our cen-  
tury. A third component is needed for any explanation  
of the world that claims to be complete. To the powerful  
theories of chemistry and physics must be added a late  
arrival: a theory of information. Nature must be inter-  
preted as matter, energy, and information.

*Grammatical Man: Information, Entropy, Language and Life*  
Chapter 1 (p. 16)  
Simon & Schuster. New York, New York, USA. 1982

**Campbell, Thomas** 1777–1844

Scottish poet

There shall be love, when genial morn appears,  
Like pensive Beauty smiling in her tears,  
To watch the brightening roses of the sky,  
And muse on Nature with a poet's eye.

*The Complete Poetical Works*  
The Pleasures of Hope, Part ii, 1. 98–101  
Chadwyck-Healey. Cambridge, England. 1992

**Carlyle, Thomas** 1795–1881

English historian and essayist

Nature admits no lie; most men profess to be aware of  
this, but few in any measure lay it to heart.

*Letter-Day Pamphlets*  
No. 5 (p. 170)  
Chapman & Hall. London, England. 1850

**Cawein, Madison Julius** 1865–14

American poet

I am a part of all you see  
In Nature: part of all you feel:  
I am the impact of the bee  
Upon the blossom; in the tree

I am the sap – that shall reveal  
The leaf, the bloom – that flows and flutes  
Up from the darkness through its roots.

*Poems*  
Penetralia  
The Macmillan Company. New York, New York, USA. 1911

**Chaisson, Eric J.** 1946–

American astrophysicist

Without a brainy seat of consciousness and its inherent  
awareness of self and environment, galaxies would twirl  
and stars would shine, but no one or thing could compre-  
hend the majesty of the reality that is nature.

*The Life Era: Cosmic Selection and Conscious Evolution*  
Chapter 1 (p. 43)  
The Atlantic Monthly Press. New York, New York, USA. 1987

**Chant, A. C.**

No biographical data available

Every year we hear of large numbers of people making  
trips at the expense of much money and a great deal  
of time, in order to look upon the far-famed dress of  
Nature, or to gaze at and study the wonderful produc-  
tions, ancient And modern, of daring skilful architect or  
revered masterpainter. And I do not think that this is to  
be deplored; but, nevertheless, there is no reason why the  
most of us, who cannot afford such a great outlay, should  
sit aside and bemoan the fact; for, if ever there was a true  
saying, it is the statement that all about us, beneath our  
feet, above our head, on the right hand, on the left – yes,  
everywhere – are to be found subjects which are as well  
worth our careful attention as in the loveliest combina-  
tion of water, hill and dale that the earth can show, or, as  
is the most cleverly carved sculpture that the hand of man  
has produced.

*Papers Read Before the Mathematical and Physical Society of Toronto  
during the Year 1890–91*  
The Structure of Matter (p. 31)  
Rowsell & Hutchison. Toronto, Ontario, Canada. 1891

We manipulate nature as if we were stuffing an Alsatian  
goose. We create new forms of energy; we make new  
elements; we kill crops; we wash brains. I can hear them  
in the dark sharpening their lasers.

*The Paradox of Biochemistry*  
*Columbia Forum*, Volume 12, Number 2, Summer, 1969 (p. 18)

To the scientist nature is like a mirror that breaks every thirty  
years; and who cares about the broken glass of past times.

*Voices in the Labyrinth: Nature, Man and Science* (p. 24)  
The Seabury Press. New York, New York, USA. 1977

**Chaucer, Geoffrey** 1343–1400

English poet

Nature, the vicaire of the almyghty Lord...

*The Complete Works of Geoffrey Chaucer*  
*The Parliament of Fowls*, l. 379  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Cherry, Colin** 1914–79  
English cognitive scientist

There is a belief amongst laymen that science purports to represent a system of absolute truth, which is furthermore wholly independent of language; that the world behaves in such and such a way according to “blind immutable laws” – forgetting that such laws are man-made and expressed in human language. Scientific laws are not sets of rules that Nature must obey...they are rules which we ourselves must accept, if we are to communicate with one another in scientific discussion.

*On Human Communication* (p. 253)  
John Wiley & Sons. New York, New York, USA. 1957

**Chiras, Daniel D.**  
No biographical data available

In nature, virtually nothing is wasted.  
*Lessons from Nature: Learning to Live Sustainably on the Earth*  
Chapter 2 (pp. 31–32)  
Island Press. Washington, D.C. 1992

**Chown, Marcus**  
English writer

...nature, as we are so often reminded, is under no obligation to make things simple just for our convenience.  
*The Magic Furnace*  
Prologue (p. 2)  
Oxford University Press. Oxford, England. 2001

**Churchill, Charles** 1731–64  
English poet and satirist

Not without art, but yet to Nature true.  
*The Rosicad and the Apology*  
The Rosciad, I. 699  
Lawrence & Bullen. London, England. 1891

It can't be nature, for it is not sense.  
*The Poems of Charles Churchill* (Volume 2)  
The Farewell, I. 201  
Eyre & Spottiswoode Ltd. London, England. 1933

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

...*ab interitu naturam abhorre*re.  
...nature shrinks from destruction.  
Translated by H. Rackham  
*Cicero: De Finibus Bonorum, Et Malorum*  
De Finibus  
V, XI, 31 (p. 427)  
William Heinemann. London, England. 1931

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

...Nature always balances her books...  
*2061: Odyssey Three*  
Chapter 37 (p. 177)  
Ballantine Books. New York, New York, USA. 1987

Nature never gives us something for nothing: in fact she usually takes more than she gives back.

*The Exploration of Space*  
Chapter 4 (p. 30)  
Harper & Brothers Publishers. New York, New York, USA. 1951

**Cleomedes**  
Greek astronomer

...the cosmos is not unlimited, but is limited, as is clear from its being administered throughout by Nature. For it is impossible for Nature to belong to anything unlimited, since Nature must control what it belongs to.

Translated by Alan C. Bowen and Robert B. Todd  
*Cleomedes' Lectures on Astronomy: A Translation of the Heavens*  
Chapter I (p. 21)  
University of California Press. Berkeley, California, USA. 2004

**Close, Frank**  
Writer and physicist

**Marten, Michael**  
No biographical data available

**Sutton, Christine**  
No biographical data available

Even at subatomic level nature presents images of itself that reflect our own imaginings.  
*The Particle Explosion*  
Chapter 1 (p. 15)  
Oxford University Press, Inc. Oxford, England. 1987

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

And what if all of animated nature  
Be but organic harps diversely fram'd,  
That tremble into thought, as o'er them sweeps,  
Plastic and vast, one intellectual breeze,  
At once the soul of each, and God of all?  
*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)  
The Eolian Harp, Stanza 4  
The Clarendon Press. Oxford, England. 1912

In nature there is nothing melancholy.  
*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)  
The Nightingale, Stanza I, l. 15  
The Clarendon Press. Oxford, England. 1912

A poet ought not to pick nature's pocket: let him borrow, and so borrow as to repay by the very act of borrowing. Examine nature accurately, but write from recollection; and trust more to your imagination than to your memory.  
*The Complete Works of Samuel Taylor Coleridge* (Volume 6)  
Dialogue between Demosius and Mystes (pp. 345–346)  
Harper & Brothers Publishers. New York, New York, USA. 1884

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

...Nature was no longer a sphinx asking man riddles; it was man that did the asking, and Nature, now, that he

put to the torture until she gave him the answer to his questions.

*An Autobiography* (p. 78)

Oxford University Press. Oxford, England. 1939

**Collins, Wilkie** 1824–89

English novelist

Nature has so much to do in this world, and is engaged in generating such a vast variety of co-existent productions, that she must surely be now and then too flurried and confused to distinguish between the different processes that she is carrying on at the same time.

*The Woman in White*

Part I, Chapter VIII (p. 40)

Harper & Brothers. New York, New York, USA. 1873

**Colman, George (The Younger)** 1762–1836

English playwright

All argument will vanish before one touch of nature.

*The Poor Gentleman*

Act V, 1

J. Dicks. London, England. 1883

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

My beloved planet has reminded me of my lowly and inconsequential place in her affairs, and I have no answer fit to offer, no excuses to give, no apologies I know how to phrase.

*The Endless Adventure*

The Off-Shore Islands (p. 9)

Henry Regnery Company. Chicago, Illinois, USA. 1972

Nature is neither harsh nor cruel nor sentimentally sweet and kind.

*The Endless Adventure*

From Mushrooms to Bats (p. 19)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

Nature knows best.

*The Closing Circle: Nature, Man & Technology*

Chapter 2 (p. 41)

Alfred A. Knopf. New York, New York, USA. 1971

**Connell, Joseph**

No biographical data available

**Sousa, Wayne**

No biographical data available

If a balance of nature exists, it has proved exceedingly hard to demonstrate.

On the Evidence Needed to Judge Ecological Stability or Persistence

*The American Naturalist*, Volume 121, Number 6, June, 1983 (p. 808)

**Conrad, Joseph** 1857–1924

Polish-born English novelist

...Nature – the balance of colossal forces.... Nature – the great artist.

*Lord Jim*

Chapter XIX (p. 179)

Rinehart & Company, Inc. New York, New York, USA. 1957

**Cooke, Josiah Parsons** 1827–94

American chemist

Nature at once manifests and conceals an Infinite Presence: her methods and orderly successions are the manifestations of Omnipotent Will; her contrivances and laws the embodiment of Omniscent Thought.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 8)

D. Appleton & Co. New York, New York, USA. 1855

The path to the great truths which Nature hides often leads through a far denser and a more bewildering forest...but then there is not infrequently a “blaze” on the trees which points out the way, although it may require a sharp eye in a clear head to see the marks.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 15)

D. Appleton & Co. New York, New York, USA. 1855

**Cousins, Norman** 1912–90

American editor and writer

It is unscientific to say that within the many billions of galactic systems, ours is the only planet that supports life in advanced form. Nature shuns one of a kind as much as it abhors a vacuum. Given infinite time and space, anything that occurs at one place or time in the universe will occur elsewhere or “elsewhen.”

Rendezvous with Infinity

*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979 (p. 30)

**Cowper, William** 1731–1800

English poet

Nature, exerting an unwearied power,  
Forms, opens, and gives scent to every flower;  
Spreads the fresh verdure of the field, and leads  
The dancing Naiads through the dewy meads.

*The Poetical Works of William Cowper*

Table Talk, l. 690

John W. Lovell Company. New York, New York, USA. No date

Nor rural sights alone, but rural sounds,  
Exhilarate the spirit, and restore  
The tone of languid Nature.

*The Poetical Works of William Cowper*

The Task

Book I, The Sofa, l. 181

John W. Lovell Company. New York, New York, USA. No date

Nature indeed looks prettily in rhyme.

*The Poetical Works of William Cowper*

Retirement, l. 576

John W. Lovell Company. New York, New York, USA. No date

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

The basic trouble is that nature is so complex that many quite different theories can go some way to explaining the results.... [W]hat constraints can be used as a guide through the jungle of possible theories? It seems to me that the only useful constraints are contained in the experimental evidence.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (p. 141)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Crookes, Sir William** 1832–1919  
English chemist and physicist

...Nature – the word that stands for the baffling mysteries of the Universe. Steadily, unflinchingly, we strive to pierce the inmost heart of Nature, from what she is to reconstruct what she has been, and to prophesy what she yet shall be. Veil after veil we have lifted, and her face grows more beautiful, august, and wonderful, with every barrier that is withdrawn.

In William Walker Atkinson  
*Practical Mind Reading*  
Lesson I (p. 9)  
Address  
British Association for the Advancement of Science, Bristol, England  
Advanced Thought Publishing Company. Chicago, Illinois, USA. 1908

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Whoever flatters himself that he can retain in his memory all the effects of Nature is deceived, for our memory is not so capacious: therefore consult Nature for everything.

*A Treatise on Painting*  
#365 (p. 156)  
J.B. Nichols and Son. London, England. 1835

Necessity is the theme and the inventress of nature, the curb and law and theme.

In Jean Paul Richter  
*The Literary Works of Leonardo da Vinci* (Volume 2)  
Philosophical Maxims, 1135 (p. 237)  
University of California Press. Berkeley, California, USA. 1977

In nature there is no effect without cause; once the cause is understood there is no need to test it by experience.

In Jean Paul Richter  
*The Literary Works of Leonardo da Vinci* (Volume 2)  
Philosophical Maxims, 1148B (p. 239)  
University of California Press. Berkeley, California, USA. 1977

Nature is constrained by the order of her own law which lives and works within her.

...  
Nature never breaks her own law.  
*Leonardo da Vinci's Note Books*  
Book I, Life (p. 55)  
Duckworth & Company. London, England. 1906

In the study of the sciences which depend on mathematics, those who do not consult nature, but authors, are not the children of nature; they are only her grandchildren. Nature alone is the master of true genius.

Quoted in David Brewster  
*The Life of Sir Isaac Newton*  
Chapter XVIII (p. 295)  
J. & J. Harper. New York, New York, USA. 1833

**Damon, William E.**  
No biographical data available

Nature throws her choicest treasures at their [visitors to the seaside] feet, but they walk over them disregardful and insensible; while it is true that some even of the commonest productions of the sea productions which are unnoticed from their very abundance would well repay careful study and patient investigation.

*Ocean Wonders:*  
*Companion for the Seaside*  
Preface (p. v)  
D. Appleton & Co. New York, New York, USA. 1879

**Darwin, Charles Robert** 1809–82  
English naturalist

Nature will tell you a direct lie if she can.

In W.I.B. Beveridge  
*The Art of Scientific Investigation*  
Chapter Two (p. 25)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

Nature...cares nothing for appearances, except insofar as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter IV (p. 41)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The more I study Nature, the more I become impressed with ever-increasing force that the contrivances and beautiful adaptations slowly acquired through each part, occasionally varying in a slight degree, but in many ways, with the preservation of those variations which were beneficial to the organism under complex and ever-varying conditions of life, transcend in an incomparable manner the contrivances and adaptations which the most fertile imagination of man could invent.

*The Various Contrivances by which Orchids are Fertilised by Insects*  
Chapter IX (p. 285)  
John Murray. London, England. 1904

**Darwin, Erasmus** 1731–1802  
English physician and poet

Nature may seem to have been niggardly to mankind in bestowing upon them so few senses; since a sense to have perceived electricity, and another to have perceived magnetism might have been of great service to them, many

ages before these fluids were discovered by accidental experiment, but it is possible an increased number of senses might have incommoded us by adding to the size of our bodies.

*The Botanic Garden*

Part I, Canto I (p. 19, fn l. 365)

Jones & Company, London, England. 1825

In earth, sea, air, around, below, above,  
Life's subtle woof in Nature's loom is wove,  
Points glued to points in living line extends,  
Touch'd by some goad approach the bending ends.

*The Botanic Garden*

Production of Life, Canto I, IV, l. 251–4

Jones & Company, London, England. 1825

**Davies, William H.** 1871–1940

English poet

When a man gives his whole heart to Nature, and has no cares outside, it is surprising how observant he becomes, and how curious he is to know the cause of things.

*Nature*

Chapter I (p. 15)

B.T. Batsford, Ltd. London, England. 1914

**Davy, Sir Humphry** 1778–1829

English chemist

Oh, most magnificent and noble Nature!  
Have I not worshipped thee with such a love  
As never a mortal man before displayed?  
Adored thee in thy majesty of visible creation,  
And searched into thy hidden and mysterious ways  
As Poet, as Philosopher, as Sage?

In J. Davy

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter I (p. 14)

John Churchill. London, England. 1858

Nature is beautiful, and you [J. King] are in her bosom. That the voice of comfort which speaks in the breezes of morning, may visit your mind, that the delightful influences which the green leaves, the blue sky, the moonbeams and the clouds of the evening diffuse over the universe, may in their powers of soul-healing, visit your day visions, is my desire and hope.

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 64)

John Churchill. London, England. 1858

**Dawson, Sir John William** 1820–99

Canadian geologist and educator

Few words are used among us more loosely than “nature.” Sometimes it stands for the material universe as a whole. Sometimes it is personified as a sort of goddess, working her own sweet will with material things. Sometimes it expresses the forces which act on matter, and again it stands for material things themselves. It is spoken of as

subject to law, but just as often natural law is referred to in terms which imply that nature itself is the lawgiver.

*Some Salient Points in the Science of the Earth*

Chapter XVIII (p. 481)

Hodder & Stroughton. London, England. 1893

**de Fontenelle, Bernard le Bovier** 1657–1757

French writer

There is no need of fance...do but trust your eyes, and you will easily perceive how nature diversifies her works in these several worlds.

*Conversations on the Plurality of Worlds*

The Third Evening (p. 95)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Montaigne, Michel Eyquem** 1533–92

French Renaissance writer

Let us a little permit Nature to take her own way; she better understands her own affairs than we.

Translated by Charles Cotton

In *Great Books of the Western World* (Volume 25)

*The Essays of Michel Eyquem de Montaigne*

Essays III, Chapter 13 (p. 528)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Dehan, Richard (Clothilde Graves)** 1863–1932

Irish writer

Well, there's nothink lower than Nature, *An She Goes As 'Igh As 'Eaven!*

*One Braver Thing*

Chapter LXXI (p. 597)

Duffield & Co. New York, New York, USA. 1910

**Delacroix, Eugene** 1798–1863

French romantic painter

The true wisdom of the philosopher ought to consist in enjoying everything. Yet we apply ourselves to dissecting and destroying everything that is good in itself, that has virtue, albeit the virtue there is in mere illusions. Nature gives us this life like a toy to a weak child. We want to see how it all works; we break everything. There remains in our hands and before our eyes, stupid and opened too late, the sterile wreckage, fragments that will not again make a whole. The good is so simple.

Translated by Walter Pach

*The Journal of Eugene Delacroix*

Tuesday, June 1, 1824 (p. 92)

Covici. New York, New York, USA. 1937

**Desaguliers, J. T.** 1683–1744

French-born English natural philosopher

Nature compell'd, his piercing Mind obeys,  
And gladly shows him all her secret Ways;  
'Gainst Mathematicks she has no Defence,  
And yields t' experimental Consequence.

In H.N. Fairchild

*Religious Trends in English Poetry* (Volume 1)

The Newtonian System of the World (p. 357)

Columbia University Press. New York, New York, USA. 1939



**Dickens, Charles** 1812–70  
English novelist

It is not easy to walk alone in the country without musing upon something.

*Little Dorrit*

Book the First, Chapter XVI (p. 178)

Bradbury & Evans. London, England. 1857

...nature gives to every time and season some beauties of its own, and from morning to night, as from the cradle to the grave, is but a succession of changes so gentle and easy, that we can scarcely mark their progress.

*Nicholas Nickleby*

Chapter XXII (p. 234)

Dodd, Mead & Company. New York, New York, USA. 1944

...we are all children of one great mother, Nature.

*Bleak House (Part II)*

Chapter XLIII (p. 605)

P.F. Collier & Son. New York, New York, USA. 1911

...there is always a charm in nature.

*Dombey and Son (Volume 1)*

Chapter XXVI (p. 408)

John Wiley. New York, New York, USA. 1848

**Dickinson, Emily** 1830–86  
American lyric poet

Nature – the Gentlest Mother is,  
Impatient of no Child –  
The feeblest – or the waywardest –  
Her Admonition mild –

*The Complete Poems of Emily Dickinson*

No. 790 (p. 385)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

How Strange that Nature does not knock, and yet does not intrude!

*Letters of Emily Dickinson*

Letter to Mrs. J.S. Cooper (p. 395)

Robert Brothers. Boston, Massachusetts, USA. 1894

**Dickinson, G. Lowes** 1862–1932  
English historian and political activist

I'm not much impressed by the argument you attribute to Nature, that if we don't agree with her we shall be knocked on the head. I, for instance, happen to object strongly to her whole procedure: I don't much believe in the harmony of the final consummation...and I am sensibly aware of the horrible discomfort of the intermediate stages, the pushing, kicking, trampling of the host, and the wounded and dead left behind on the march. Of all this I venture to disapprove; then comes Nature and says, "but you ought to approve!" I ask why, and she says, "Because the procedure is mine." I still demur, and she comes down on me with a threat – "Very good, approve or no, as you like; but if you don't approve you will be eliminated!" "By all means," I say, and cling to my old

opinion with the more affection that I feel myself invested with something of the glory of a martyr.... In my humble opinion it's nature, not I, that cuts a poor figure!

*The Meaning of Good*

Good as the End of Nature (p. 46)

Brimley Johnson & Ince. London, England. 1906

**Diderot, Denis** 1713–84

French encyclopedist and materialist philosopher

Man is merely a common product, the monster an uncommon product; both equally natural, equally necessary, equally part of this universal and general order of things.... And what is astonishing about this?... All creatures intermingle with each other, consequently all species...everything is in perpetual flux.... Every animal is more or less man; every mineral is more or less plant; every plant more or less animal. There is nothing precise in nature...

Translated by Jean Stewart and Jonathan Kemp

*Diderot: Interpreter of Nature*

D'Alembert's Dream (pp. 78–79)

International Publishers. New York, New York, USA. 1938

...Nature, equal in her distributions, entirely destitute of malice, follows only necessary and immutable laws, when she either produces beings or destroys them, when she causes those to suffer, whose construction creates sensibility; when she scatters among them good and evil; when she subjects them to incessant change ...

Translated by H. D. Robinson

*System of Nature or, The Laws of the Moral and Physical World*

(Volume 1)

Chapter I (p. 13)

J.P. Mendum. Boston, Massachusetts, USA. 1889

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

Nature will try anything once. This is what the sign of the insects says. If you're dealing with organic compounds, then let them combine. If it works, if it quickens, set it clacking in the grass; there's always room for one more...

*Pilgrim at Tinker Creek*

Chapter 4, II (p. 65)

Harper's Magazine Press. New York, New York, USA. 1974

In nature, improbabilities are the one stock in trade.

*Pilgrim at Tinker Creek*

Chapter 8, II (p. 144)

Harper's Magazine Press. New York, New York, USA. 1974

Certainly nature seems to exult in abounding radicality, extremism, anarchy. If we were to judge nature by its common sense or likelihood, we wouldn't believe the world existed. In nature, improbabilities are the one stock in trade. The whole creation is one lunatic fringe. If creation had been left up to me, I'm sure I wouldn't have had the imagination or courage to do more than shape a



single, reasonably sized atom, smooth as a snowball, and let it go at that. No claims of any and all revelations could be so far-fetched as a single giraffe.

*Pilgrim at Tinker Creek*

Chapter 7 (p. 146)

Harper's Magazine Press. New York, New York, USA. 1974

The creator is no puritan.... There is something that profoundly fails to be exuberant about these crawling, translucent lice and white, fat-bodied grubs, but there is an almost manic exuberance about a creator who turns them out, creature after creature after creature, and sets them buzzing and lurking and flying and flying and swimming about.

*Pilgrim at Tinker Creek*

Chapter 13, II (p. 233)

Harper's Magazine Press. New York, New York, USA. 1974

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

It has become increasingly evident in recent times, however, that nature works on a different plan. Her fundamental laws do not govern the world as it appears in our mental picture in any very direct way, but instead they control a substratum of which we cannot form a mental picture without introducing irrelevancies.

*The Principles of Quantum Mechanics*

Preface to the First Edition (p. vi)

At the Clarendon Press. Oxford, England. 1935

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

One may detest nature and despise science, but it becomes more and more difficult to ignore them. Science in the modern world is not an entertainment for some devotees. It is on its way to becoming everybody's business.

*The Biology of Ultimate Concern*

Chapter 1 (p. 9)

The New American Library, Inc. New York, New York, USA. 1967

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

I look out at the sunrise – that fateful sunrise which will shine upon an unpeopled world. The human race is gone, extinguished in a day, but the planets swing round and the tides rise or fall, and the wind whispers, and all nature goes her way, down, as it would seem, to the very amoeba, with never a sign that he who styled himself the lord of creation had ever blessed or cursed the universe with his presence.

*The Poison Belt*

Chapter IV (p. 132)

Hodder & Stroughton. London, England. 1913

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

For Art may err, but Nature cannot miss.

*The Poetical Works of Dryden*

The Cock and the Fox, I. 452

The Riverside Press. Cambridge, Massachusetts, USA. 1949

By viewing nature, nature's handmaid, art,  
Makes mighty things from small beginnings grow;  
That fishes first to shipping did impart,  
Their tail the rudder, and their head the prow.

*The Poetical Works of Dryden*

Annus Mirabilis

Stanza 155

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**du Bartas, Guillaume de Salluste** 1544–90

French poet

Out of the book of Nature's learned breast.

*Divine Weeks and Works*

Second week, fourth day, Book III. 566

Humfrey Lownes. London, England. 1611

**de Spinoza, Baruch** 1632–77

Dutch philosopher

...Nature has set no end before herself, and...all final causes are nothing but human fictions.

Translated by William Hale White

*Ethic: Demonstrated in Geometrical Order and Divided into Five Parts*

Section 8 (p. 41)

Trubner & Company, London, England. 1883

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Nature does not know how to deal with situations that have no precedents in the evolutionary past.

Humanizing the Earth

*Science*, Volume 179, Number 4075, February 23, 1973 (p. 770)

**Duke of Argyll (George Douglas**

**Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

The first and, so to speak, the lowest sense in which law is applied to natural phenomena is that in which it is used to express simply "an observed order of facts" that is to say, facts which under the same conditions always follow each other in the same order.

*The Reign of Law* (4th American edition)

Chapter 2 (p. 66)

George Routledge & Sons. New York, New York, USA. 1873

Those who, by special study, have laid their minds alongside the mind of Nature in any of her provinces have generally imparted to them a true sense, so far as it goes, in the interpretation of her mysteries.

*The Reign of Law* (4th American edition)

Chapter 5 (p. 231)

George Routledge & Sons. New York, New York, USA. 1873

**Dulbecco, Renato** 1914–

Italian-born American virologist

Nature does not abide by hard and fast rules – it follows opportunity.

*The Design of Life*

Chapter 4 (p. 88)

Yale University Press. New Haven, Connecticut, USA. 1987

In biology, once a door is opened, the space behind it is quickly filled.

*The Design of Life*

Chapter 9 (p. 190)

Yale University Press. New Haven, Connecticut, USA. 1987

**Dunbar, Paul Laurence** 1872–06

African-American poet

There is no rebel like Nature. She is an iconoclast.

*The Uncalled*

VI (p. 57)

International Association of Newspapers and Authors. New York, New York, USA, 1901

**Durell, Clement V.** 1882–1968

English mathematician

The scientists, in playing their game with Nature, are meeting an opponent on her own ground, who has not only made the rules of the game to suit herself, but may have even queered the pitch or cast a spell over the visiting team.

*Readable Relativity*

Chapter II (p. 11)

Harper & Brothers. New York, New York, USA. 1960

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The future is not predetermined, and Nature has no need to protect herself from giving away plans which she has not yet made.

*New Pathways in Science*

Chapter V, Section II (p. 102)

At The University Press. Cambridge, England. 1947

Philosophically the notion of a beginning of Nature is repugnant to me.

The End of the World: From the Standpoint of Mathematical Physics

*Nature*, Supplement, Volume 127, Number 3203, March 21, 1931 (p. 447)

So far as broader characteristics are concerned we see in Nature what we look for or are equipped to look for.

*The Nature of the Physical World*

Chapter XV (p. 330)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

What I see in Nature is a magnificent structure that we can comprehend only imperfectly, and that must fill a thinking person with a feeling of “humility.” This is a genuinely religious feeling that has nothing to do with mysticism.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives* (p. 39)

Princeton University Press. Princeton, New Jersey, USA. 1979

Nature is not an engineer or contractor...

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 12 November, 1930 (p. 92)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Nature has her language, and she is not ungenerous; but we don't know all the intricacies of her syntax just yet, and in a hasty reading we may happen to extract the very opposite of her real meaning.

*Adam Bede*

Chapter XV (p. 142)

Dodd, Mead & Company. New York, New York, USA. 1947

Nature repairs her ravages – repairs them with her sunshine, and with human labor. ... Nature repairs her ravages, but not all. The upturned trees are not rooted again; the parted hills are left scarred; if there is a new growth, the trees are not the same as the old, and the hills underneath their green vesture bear the marks of the past rending. To the eyes that have dwelt on the past, there is not thorough repair.

*Mill on the Floss*

Book VII, Conclusion (p. 472)

The Heritage Press. New York, New York, USA. 1963

...the presence of Nature in all her awful loveliness.

*The Lifted Veil and Brother Jacob*

Chapter I (p. 20)

Bernhard Tauchnitz. Leipzig, Germany. 1878

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

What power does Nature not owe to her duration, of amassing infinitesimals into cosmical forces!

*Emerson's Complete Works: Letters and Social Aims*

Resources (p. 136)

Houghton, Mifflin Company. Boston, Massachusetts, USA. 1889

To the intelligent, nature converts itself into a vast promise, and will not be rashly explained. Her secret is untold. Many and many an Oedipus arrives: he has the whole mystery teeming in his brain.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

Nature (p. 554)

The Library of America. New York, New York, USA. 1983

The first steps in Agriculture, Astronomy, Zoology (those first steps which the farmer, the hunter, and the sailor take,) teach that nature's dice are always loaded; that in her heaps and rubbish are concealed sure and useful results.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Discipline (p. 27)

The Library of America. New York, New York, USA. 1983

The great mother Nature will not quite tell her secret to the coach or the steamboat, but says, One to one, my dear, is my rule also, and I keep my enchantments and oracles for the religious soul coming alone, or as good as alone, in true-love.

In James Elliot Cabot

*A Memoir of Ralph Waldo Emerson* (Volume 2)

Letter to Mrs. Emerson, 20 May, 1871 (p. 650)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1888

Nature, like a cautious testator, fires up her estate so as not to bestow it all on one generation, but has a forelooking tenderness and equal regard to the next and the next, and the fourth and the fortieth age.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Society and Solitude*

Farming (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Nature never hurries: atom by atom, little by little, she achieves her work.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

*Society and Solitude*

Farming (p. 139)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

Everything in nature contains all the powers of nature.

In Eva March Tappan

*Select Essays and Poems*

Compensation (p. 7)

Allyn & Bacon. Boston, Massachusetts, USA. 1898

By fate, not option, frugal Nature gave  
One scent to hyson and to wall-flower,  
One sound to pine-groves and to waterfalls,  
One aspect to the desert and the lake.

It was her stern necessity.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

*Xenophanes* (p. 137)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Nature does not like to be observed, and likes that we should be her fools and playmates.

*Essays (Second Series)*

Experience (p. 46)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1889

Nature does not cocker us: we are children, not pets: she is not fond: everything is dealt to us without fear or favor, after severe universal laws.

*Essays (Second Series)*

Experience (p. 131)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1889

...all natural objects make a kindred impression, when the mind is open to their influence. Nature never wears a mean appearance.

*Essays, Orations and Lectures*

*Nature*

Chapter I (p. 3)

William Tegg & Co. London, England. 1848

Nature never became a toy to a wise spirit. The flowers, the animals, the mountains, reflected all the wisdom of his best hour, as much as they had delighted the simplicity of his childhood.

*Essays, Orations and Lectures*

*Nature*

Chapter I (p. 3)

William Tegg & Co. London, England. 1848

### **Fermi, Enrico** 1901–54

Italian-born American physicist

Whatever nature has in store for mankind, unpleasant as it may be, men must accept, for ignorance is never better than knowledge.

In Laura Fermi

*Atoms in the Family*

Part II, Chapter 23 (p. 244)

The University of Chicago Press. Chicago, Illinois, USA. 1954

### **Feuerbach, Ludwig** 1804–72

German philosopher

Nature returns no answer to the questions and lamentations of man; inexorably it refers him to himself.

In Ludwig Buchner

*Force and Matter*

Chapter VI (p. 35)

Trubner & Company. London, England. 1864

### **Fevre, R. W.**

No biographical data available

The real truth is that, not only has man failed to overcome nature in any sphere whatsoever but that at best he has merely succeeded in getting hold of and lifting a tiny corner of the enormous veil which she has spread over her eternal mysteries and secret. He never creates anything. All he can do is discover something. He does not master nature but has only come to be the master of those living things who have not gained the knowledge he has arrived at by penetrating into some of nature's laws and mysteries. Apart from all this, an idea can never subject to its own sway those conditions which are necessary for the existence and development of mankind; for the idea itself has come only from man. Without man there would be no human idea in this world. The idea as such is therefore always dependent on the existence of man and consequently is dependent on those laws which furnish the conditions of his existence.

*The Demoralization of Western Culture: Social Theory and the Dilemmas of Modern Living* (p. 28)

Continuum. London, England. 2000

### **Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Trying to understand the way nature works involves a most terrible test of human reasoning ability. It involves

subtle trickery, beautiful tightropes of logic on which one has to walk in order not to make a mistake in predicting what will happen.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 15)  
Perseus Books. Reading, Massachusetts, USA. 1998

Everywhere science is enriched by unscientific methods and unscientific results...the separation of science and non-science is not only artificial but also detrimental to the advancement of knowledge. If we want to understand nature, if we want to master our physical surroundings, then we must use all ideas, all methods, and not just a small selection of them.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 18 (pp. 305, 306)  
Verso. London, England. 1978

**Feynman, Richard P.** 1918–88  
American theoretical physicist

There was a moment when I knew how nature worked. It had elegance and beauty. The goddamn thing was gleaming.

In Lee Edson  
Two Men in Search of a Quark  
*New York Times Magazine*, October 8, 1967

Nature uses only the longest threads to weave her patterns, so each small piece of her fabric reveals the organization of the entire tapestry.

*The Character of Physical Law*  
Chapter 1 (p. 34)  
The M.I.T. Press. Cambridge, Massachusetts, USA. 1967

People may come along and argue philosophically that they like one better than another; but we have learned from much experience that all philosophical intuitions about what nature is going to do fail.

*The Character of Physical Law*  
Chapter 2 (p. 53)  
BBC. London, England. 1965

**Fielding, Henry** 1707–54  
English novelist, playwright, and barrister

Nature seems to wear one universal grin.  
*The Tragedy of Tragedies, or, The Life and Death of Tom Thumb the Great*  
Act I, Scene 1  
Printed by S. Powell. Dublin, Ireland. 1730

**Fitz-Gerald, Charles Egerton**  
English physician

[Nature] swarms and palpitates with life under a myriad of unseen and unsuspected forms ...

*Semi-scientific Lectures*  
First Annual Address (p. 21)  
J. English. Folkstone, England. 1880

**Flammarion, Camille** 1842–1925  
French astronomer and writer

Nature, O immense, fascinating, infinite Nature! Who can divine, who can hear, the sounds of thy celestial harmony! What can we include in these childish formulae of our young science? We lisped an alphabet while the eternal Bible is still closed to us. But it is thus when all reading begins, and these first words are surer than all the antique affirmations of ignorance and human vanity.

*Popular Astronomy: A General Description of the Heavens*  
Book II, Chapter III (p. 112)  
Chatto & Windus. London, England. 1894

The dial of the heavens is eternal, and the inexorable hand which slowly marks their destinies shall turn forever. It is we who say *yesterday* or *to-morrow*. For nature it is always *today*.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book II, Chapter IX (p. 163)  
Chatto & Windus. London, England. 1894

...it has been said that nature has implanted in our bosoms a craving after the discovery of truth, and assuredly that glorious instinct is never more irresistibly awakened than when our notice is directed to what is going on in the heavens.

*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter VII (p. 328)  
Chatto & Windus. London, England. 1894

**Fraenkel, Aviezri S.**  
Applied mathematician

Nature might be somehow more powerful than a digital computer.

*New York Times*, March 25, 1997 (p. C5, col. 6)

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

...it is astonishing and incredible to us, but not to Nature; for she performs with utmost ease and simplicity things which are even infinitely puzzling to our minds, and what is very difficult for us to comprehend is quite easy for her to perform.

Translated by Stillman Drake  
*Dialogue Concerning Two Chief World Systems*  
Fourth Day (p. 448)  
University of California Press. Berkeley, California, USA, 1967

**Garth, Sir Samuel** 1661–1719  
English physician and poet

As distant prospects please us, but when near  
We find but desert rocks and fleeting air.

*The Dispensary*  
Canto III, l. 27  
Printed by J. Lister, at St. John's Gate. London, England. 1768

**Gay, John** 1685–1732  
English poet and dramatist

But he who studies nature's laws  
From certain truth his maxims draws.

*The Poetical Works of John Gay* (Volume 3)  
Introduction to the Fables, l. 76–77  
Lawrence & Bullen. London, England. 1893

**Gillispie, Charles Coulston** 1918–  
French writer and editor of philosophy and history of science

[T]he renewals of the subjective approach to nature make a pathetic theme. Its ruins lie strewn like good intentions all along the ground traversed by science, until it survives only in strange corners like Lysenkoism [doctrine centered on belief in acquired characteristics] and anthroposophy, where nature is socialized or moralized.

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*  
Chapter V (pp. 199–200)  
Princeton University Press. Princeton, New Jersey, USA. 1960

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

I do not believe that nature frustrates us by design, but I rejoice in her intransigence nonetheless.

*Hen's Teeth and Horses Toes*  
What, if Anything, Is a Zebra? (p. 365)  
W.W. Norton & Company, Inc. New York, New York, USA. 1983

The need to distinguish sturdy facts (pervasive pattern) from shaky factual claim (single cases with dubious documentation) has never been more evident to me than in the current debate between evolutionists and so-called “scientific creationists.” The fact of evolution is as sturdy as any claim in science. Its sturdiness resides in a pervasive pattern detected by several disciplines – for examples, the age of the earth and life as affirmed by astronomy and geology, and the pattern of imperfections in organisms that record a history of physical descent.

*Hen's Teeth and Horses Toes*  
Quaggas, Coiled Oysters, and Flimsy Facts (p. 384)  
W.W. Norton & Company, Inc. New York, New York, USA. 1983

Nature, to cite a modern cliché, always bats last. She will not succumb to the simplicities of our hopes or mental foibles, but she remains eminently comprehensible. Evolution follows the syncopated drumbeats of complex and contingent histories, shaped by the vagaries and uniquenesses of time, place, and environment. Simple laws with predictable outcomes cannot fully describe the pageant and pathways of life. A linear march of progress must fail as a model for evolution, but a luxuriantly branching tree does capture the basic geometry of history.

*Branching Through A Wormhole*  
*Natural History*, Volume 108, March, 1999

**Gray, George W.**  
Freelance science writer

Nature seems to be held in a mathematical web of relationship; and as we penetrate deeper into its infinite world of secrecy the relationships become more purely mathematical, and less obviously material or physically perceptual.

*New World Picture*  
Chapter II (p. 44)  
Little, Brown & Co. Boston, Massachusetts, USA. 1935

**Gray, Thomas** 1716–71  
English poet

E'en from the tomb the voice of nature cries,  
E'en in our ashes live their wonted fires.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*  
Elegy in a Country Churchyard  
Stanza 23  
J. Blackwood. London, England. 1800

**Greene, Brian** 1963–  
American physicist

You must allow Nature to dictate what is, and what is not, sensible.

*The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory*  
Part II, Chapter 5 (p. 111)  
W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Gregory, Dick** 1932  
American comedian and social activist

Nature is not affected by finance. If someone offered you ten thousand dollars to let them touch you on your eyeball without your blinking, you would never collect the money. At the very last moment, Nature would force you to blink your eye. Nature will protect her own.

*The Shadow that Scares Me*  
Chapter VIII (p. 175)  
Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

...direct contact with Nature and inquiry into her laws produce a habit of mind which cannot be acquired in literary fields, and they are associated with a wide outlook on life more often than is usually supposed.

*Discovery; Or: The Spirit and Service of Science*  
Preface (p. vi)  
Macmillan & Co Ltd. London, England. 1918

Nature, like the rich man of the parable, requires importunate pleading before she will bestow any of her riches upon a suppliant at her temple.

*Discovery; or: The Spirit and Service of Science*  
Chapter I (p. 12)  
Macmillan & Company Ltd. London, England. 1918



Nature must be loved for herself and not for her dowry.  
*Discovery; or, The Spirit and Service of Science*  
 Chapter III (p. 54)  
 Macmillan & Company Ltd. London, England. 1918

Nature must be loved for herself and not for her dowry.  
 The rewards which the world can give may come; but the  
 discoveries which may bring them can only be secured in  
 the pure quest for the advancement of knowledge.  
*Discovery, Or, The Spirit and Service of Science*  
 Chapter III (p. 54)  
 Macmillan & Co Ltd. London, England. 1916

**Gull, Sir William Withey** 1816–90  
 English physician

Do not explain Nature, but by patient attention to the  
 facts let her explain herself.  
*A Collection of the Published Writings of William Withey Gull* (Volume 2)  
 Notes and Aphorisms (p. lvi)  
 The New Sydenham Society. London, England. 1896

**Harkness, William** 1837–1903  
 Scottish-American astronomer and surgeon

All nature is one, but for convenience of classification  
 we have divided our knowledge into a number of sci-  
 ences which we usually regard as quite distinct from each  
 other.  
*Annual Report of the Board of Regents of the Smithsonian Institution,*  
 1896  
 On the Magnitude of the Solar System (p. 93)  
 Government Printing Office. Washington, D.C. 1896

**Hartwell, Leland H.** 1939–  
 American genome scientist

Sometimes nature rewards foolish optimism.  
*Lex Prix Nobel. The Nobel Prizes in 2001*  
 Nobel banquet speech for award received in 2001  
 Nobel Foundation. Stockholm, Sweden. 2002

**Harvey, Moses** 1820–1901  
 Irish clergyman, essayist, and naturalist

Like the fabled Sphinx of old she [Nature] propounds  
 her riddles; and man, the intellectual monad, is the inter-  
 preter whose powers are at once taxed and developed by  
 the demands she makes. Onward the beautiful Sphinx  
 leads him [the man of science], showing him, as he pen-  
 etrates one secret after another, that deeper ones remain  
 undisclosed, that mightier mazes of mystery open -as  
 he advances, that law within law rules the play of her  
 mighty forces, in their marches and combinations; thus  
 directing his steps along.  
 Science and Religion  
*The Maritime Monthly*, Volume 2, Number 5, November, 1873 (p. 478)

Not at once, or even readily, does nature disclose the  
 secret laws and processes by which she works. Like the  
 fabled Sphinx of old she propounds her riddles; and man,  
 the intellectual monad, is the interpreter whose powers

are at once taxed and developed by the demands she  
 makes.  
 Science and Religion  
*The Maritime Monthly*, Volume II, November, 1873 (p. 478)

**Heaviside, Oliver** 1850–1925  
 English electrical engineer, mathematician, and physicist

...there is no absolute scale of size in nature, and the  
 small may be as important, or more so, than the great.  
*Electromagnetic Theory: Including an Account of Heaviside's Unpub-  
 lished Notes* (Volume 2)  
*Trojan Horse Cloud*  
 Scientific Limitations on Human Knowledge (p. 519)  
 "The Electrician" Publishing & Printing Co. London, England.  
 1894–1912

**Heine, Heinrich** 1797–1856  
 German poet

Nature, like a true poet, abhors abrupt transitions.  
*The German Classics of the Nineteenth and Twentieth Centuries*  
 (Volume 6)  
 Translated by Charles Godfrey Leland  
 The Journey to the Harz (p. 73)  
 The German Publication Society. New York, New York, USA. 1913–1914

Nature knows how to produce the greatest effects with  
 the most limited means.  
*The German Classics of the Nineteenth and Twentieth Centuries*  
 (Volume 6)  
 Translated by Charles Godfrey Leland  
 The Journey to the Harz (p. 73)  
 The German Publication Society. New York, New York, USA.  
 1913–1914

Like a great poet, Nature produces the greatest results  
 with the simplest means. These are simply a sun, trees,  
 flowers, water and love. Of course, if the spectator be  
 without the last, the whole will present but a pitiful  
 appearance, and, in that case, the sun is merely so many  
 miles in diameter, the trees are good for fuel, the flowers  
 are classified by stamens, and the water is simply wet.  
 Translated by Simon Alder Stern  
*Scintillations from the Prose Works of Heinrich Heine*  
 Miscellaneous (p. 169)  
 Henry Holt & Co. New York, New York, USA. 1873

**Heinlein, Robert A.** 1907–88  
 American science fiction writer

He shut up, realizing that grim old Mother Nature, red of  
 tooth and claw, invariably punished damn fools who tried  
 to ignore Her or repeal Her ordinances.  
*Time Enough for Love*  
 Chapter VI (p. 205)  
 G.P. Putnam's Sons. New York, New York, USA. 1973

**Henley, William Ernest** 1849–1903  
 English poet

What Nature has writ with her lusty wit  
 Is worded so wisely and kindly



That whoever has dipped in her manuscript  
Must up and follow her blindly.

*Echoes of Life and Death*

Number XXXIII

T.B. Mosher. Portland, Maine, USA. 1908

**Heraclitus** 540 BCE–480 BCE

Greek philosopher

The real constitution of things is accustomed to hide  
itself.

In G.S. Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of  
Texts*

Fragment 211 (p. 193)

At The University Press. Cambridge, England. 1963

Nature loves to hide.

*Fragments*

Fragment x (p. 4)

Publisher undetermined

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

From the least of nature's work he may learn the greatest  
lesson.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 10 (p. 14)

Printed for Longman, Rees, Orme, Brown & Green. London, England.  
1831

...Nature builds up by her refined and invisible archi-  
tecture, with a delicacy eluding our conception, yet with  
a symmetry and beauty which we are never weary of  
admiring.

*The Cabinet of Natural Philosophy*

Part III, Chapter II, Section 292 (p. 263)

Longman, Rees, Orme, Brown & Green. London, England. 1831

Instances...where great, and indeed immeasurable, steps  
in our knowledge of nature are made at once, and almost  
without intellectual effort, are well calculated to raise our  
hopes of the future progress of science, and by pointing  
out the simplest and most obvious combinations – as  
those which are actually found to be most agreeable to  
the harmony of creation – to hold out the cheering pros-  
pect of difficulties diminishing as we advance, instead of  
thickening around us in increasing complexity.

In Henry Enfield Roscoe

*John Dalton and the Rise of Modern Chemistry*

Chapter VII (p. 160)

Macmillan & Co. New York, New York, USA. 1895

**Hibbard, Shirley**

No biographical data available

When man looks upon Nature, he sees everywhere the  
records of death's work among the representatives of cre-  
ative energy. The stratified rocks are but the tombstones  
in the great graveyard of the world; they cover the bones

of a million generations, and their inscription is, "The  
dust we tread upon was once alive."

The Balance of Life in the Aquarium

*The Popular Science Monthly*, August, 1872 (p. 434)

**Hickok, Laurens Perseus** 1798–1888

No biographical data available

Nothing in nature, and equally so not nature itself, can be  
made intelligible except as it has been subjected to ratio-  
nal principle, and such principle must both have been, and  
been made controlling, in the very origination of nature,  
or nature must forever be without meaning or end.

*Rational Cosmology: Or, The Eternal Principles and the Necessary*

*Laws of the Universe*

Preface (p. 3)

D. Appleton & Co. New York, New York, USA. 1858

**Hinman, Russell**

No biographical data available

Nothing in nature is permanent; everything is constantly  
changing. Day changes into night, fair weather into foul,  
plants and animals die and decay, and even the solid rocks  
gradually wear away into soil or sand. These changes do  
not occur by chance, but each is the result of some defi-  
nite cause, and, under similar circumstances, precisely  
the same effects are produced by the same causes. The  
invariable relations between causes and resulting effects  
constitute the *laws of nature*.

*Eclectic Physical Geography*

Introduction (p. 7)

American Book Co. New York, New York, USA. 1916

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

Nature (the Art whereby God hath made and governs the  
World) is by the *Art* of man, as in many other things, so in  
this also imitated, that it can make an Artificial Animal.  
For seeing life is but a motion of Limbs, the beginning  
whereof is in some principal part within; why may we  
not say, that all *Automata* (Engines that move themselves  
by springs and wheels as doth a watch) have an artificial  
life? For what is the *Heart*, but a *Spring*; and the *Nerves*,  
but so many *Strings*; and the *Joynts*, but so many *Wheels*,  
giving motion to the whole *Body*, such as was intended  
by the Artificer?

In A.R. Waller (ed.)

*Leviathan*

The Introduction (p. xviii)

At the University Press. Cambridge, England. 1904

**Holbach, Paul Henri Thiry** 1723–89

French philosopher

Let us, then, be content with an honest avowal, that  
Nature contains resources of which we are ignorant; but  
never let us substitute phantoms, fictions, or imaginary

causes, senseless terms, for those causes which! escape our research; because, by such means, we only confirm ourselves in ignorance, impede our inquiries, and obstinately remain in error.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World* (Volume 1)

Chapter 4 (p. 28)

J.P. Mendum. Boston, Massachusetts, USA. 1889

**Holland, Elihu Goodwin** 1817–78

No biographical data available

Nature is a harp, not of a thousand, but of ten times ten thousand strings, not one of which can be struck, without yielding harmony.

*Reviews and Essays*

The Infinite Harmony (p. 281)

Wm. Crosby & H.P. Nichols. Boston, Massachusetts, USA. 1849

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Our old mother Nature has pleasant and cheery tones enough for us when she comes in her dress of blue and gold over the eastern hill-tops; but when she follows us up-stairs to our beds in her suit of black velvet and diamonds, every creak of her sandals and every whisper of her lips is full of mystery and fear.

*The Professor at the Breakfast Table*

Chapter VII (p. 237)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE

Roman philosopher and dramatic critic

You may turn nature out of doors with violence, but she will still return.

*Satires, Epistles, and Ars Poetica*

Epistles, Book I, Epistle 10, l. 24

W. Heinemann. London, England. 1929

**Housman, Alfred Edward** 1859–1936

English poet, scholar, and satirist

For nature, heartless, witless nature,

Will neither care nor know

What stranger's feet may find the meadow

And trespass there and go.

*Last Poems*

Number XL (p. 76)

Henry Holt & Company. New York, New York, USA. 1922

**Hovenden, Frederick**

No biographical data available

Every deep thinker and observer of the Natural Laws is convinced that Nature is an orderly arrangement of matter and forces; that, in a word, Nature is not chaos, but cosmos.

*What is Life?, Or, Where are We? What are We? Whence Did We Come? And Whither Do We Go?* (2nd edition)

Preface (p. vii)

Chapman & Hall, Ltd. London, England. 1899

**Hudson, William Henry** 1841–1922

Argentinean/English ornithologist, naturalist, and author

Here Nature is unapproachable with her green, airy canopy, a sun-impregnated cloud – cloud above cloud – and though the highest may be reached by the eye, the beams yet filter through, illuming the wide spaces beneath – chambers succeeded by chamber, each with its own special lights and shadows.

*Green Mansions*

Chapter 2 (p. 28)

Grosset & Dunlap. New York, New York, USA. 1931

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Nature has no candor. She shows herself to man with her face turned away.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 415)

The Heritage Press. New York, New York, USA. 1961

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Where so many living creatures are to ply their respective powers, in pursuing the end for which they were intended, we are not to look for nature in a quiescent state; matter itself must be in motion, and the scenes of life a continued or repeated series of agitations and events.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section I (p. 4)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

It is of importance to the happiness of man, to find consummate wisdom in the constitution of this earth, by which things are so contrived that nothing is wanting, in the bountiful provision of nature, for the pleasure and propagation of created beings; more particularly of those who live in order to know their happiness, and who know their happiness on purpose to see the bountiful source from whence it flows.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter VI (p. 183)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95

English biologist

There is not throughout Nature a law of wider application than this, that a body impelled by two forces takes the direction of their resultant.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 32)

Macmillan & Company Ltd. London, England. 1904

Harmonious order governing eternally continuous progress – the web and woof of matter and force interweaving by slow degrees, without a broken thread, that veil which lies between us and the Infinite – that universe which

alone we know or can know; such is the picture which science draws of the world, and in proportion as any part of that picture is in unison with the rest, so may we feel sure that it is rightly painted.

*Collected Essays* (Volume 2)

*Darwintiana*

The Origin of Species (p. 59)

Macmillan & Company Ltd. London, England. 1904

To everyone of us the world was once as fresh and new as to Adam. And then, long before we were susceptible of any other mode of instruction, Nature took us in hand, and every minute of waking life brought its educational influence, shaping our actions into rough accordance with Nature's laws, so that we might not be ended untimely by too gross disobedience. Nor should I speak of this process of education as past for anyone, be he as old as he may. For every man the world is as fresh as it was at the first day, and as full of untold novelties for him who has the eyes to see them. And Nature is still continuing her patient education of us in that great university, the universe, of which we are all members – Nature having no Test-Acts.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 84)

Macmillan & Company Ltd. London, England. 1904

Those who take honours in Nature's university, who learn the laws which govern men and things and obey them, are the really great and successful men in this world. The great mass of mankind are the "Poll," who pick up just enough to get through without much discredit. Those who won't learn at all are plucked; and then you can't come up again. Nature's pluck means extermination.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 85)

Macmillan & Company Ltd. London, England. 1904

My business with my scientific friends is something like yours with the Puritans, nature being our Paul.

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XXIV (p. 353)

D. Appleton & Co. New York, New York, USA. 1916

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

...we may mount from this dull Earth, and viewing it from on high, consider whether Nature has laid out all her cost and finery upon this small speck of Dirt. So, like Travelers into other distant Countries, we shall be better able to judge of what's done at home, know how to make a true estimate of, and set its own value upon everything.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, their Inhabitants and Productions*

Book the First, These Studies useful to Religion (p. 10)

Printed for T. Childe. London, England. 1698

Nature seems to court variety in her Works, and may have made them widely different from ours either in their matter or manner of Growth, in their outward Shape, or their inward Contexture; she may have made them such as neither our Understanding nor Imagination can conceive.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, their Inhabitants and Productions*

Book the First, Not to be imagin'd too unlike ours (p. 22)

Printed for T. Childe. London, England. 1698

**Irwin, Keith Gordon**

No biographical data available

It is nature, of course, that is the great chemist. Every growing plant is a marvelous chemical factory, every living thing a brilliant shifter of atoms from one bewildering compound to another. And down in the depths of the earth enormous forces operate to create the minerals that someday may be close to the earth's surface.

*The Romance of Chemistry*

Forward (p. xi)

The Viking Press. New York, New York, USA. 1959

**Jefferies, Richard** 1848–87

English naturalist and author

*Stoop and touch the earth*, and receive its influence; touch the flower, and feel its life; face the wind, and have its meaning; let the sunlight fall on the open hand as if you could hold it. Something may be grasped from them all, invisible yet strong. It is the sense of a wider existence – wider and higher.

*The Hills and the Vale*

The Idle Earth (p. 273)

Duckworth & Co. London, England. 1909

**Jevons, William Stanley** 1835–82

English economist and logician

It must be the ground of all reasoning and inference that *what is true of one thing will be true of its equivalent*, and that under carefully ascertained conditions *Nature repeats herself*.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Introduction (p. 2)

Macmillan & Co Ltd. London, England. 1887

...that what is true of one thing will be true of its equivalent, and that under carefully ascertained conditions *Nature repeats herself*.

*The Principles of Science: A Treatise on Logic and Scientific Method*

(2nd edition)

Introduction (p. 2)

Macmillan & Co Ltd. London, England. 1877

**Juvenal (Decimus Junius Juvenal)**

Roman poet

*Nunquam aliud Natura aliud Sapientia dicit.*

Nature never says one thing, Wisdom another.

*Satires*

Chapter XIV, 321

Indiana University Press. Bloomington, Indiana, USA. 1958

Nature and Wisdom always speak alike.

*Decii Junii Juvenalis et A. Persii Flacci Satirae*

Satire XIV (p. 308)

Whittaker & Co. London, England. 1857

**Kearton, Richard** 1862–1928

English naturalist

Nature appeals to us in a thousand tongues everyone of which may be known and loved.

*Wild Nature's Ways*

Introduction (p. ix)

Cassell & Co., Ltd. London, England. 1903

**Kepler, Johannes** 1571–1630

German astronomer

...the closer I approach her [Nature], the more petulant her games become, and the more she again and again sneaks out of the seeker's grasp just when he is about to seize her through some circuitous route. Nevertheless, she never ceases to invite me to seize her, as though delighting in my mistakes.

Translated by William H. Donahue

*New Astronomy*

Part IV, 58 (p. 573)

At the University Press. Cambridge, England. 1992

**Kett, Henry** 1761–1825

English college teacher and writer

At the same time that she [nature] solicits him [man] to follow her not only into her open walks, but likewise to explore her secret recesses, she – fails not to reward him with the purest gratifications of the mind, because at every step he takes, new instances of beauty, variety, and perfection are unfolded to his view.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 89)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

Nature speaks by her works an universal language, the rudiments of which are peculiarly adapted to the inclination and capacity of the young, whose curiosity may be gratified and excited by turns: but more profound and extensive inquiries are suitable to the contemplation of persons of every age; and no subject can be more worthy of their attentive observation.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 90)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Keyser, Cassius Jackson** 1862–1947

American mathematician

To assume that nature is thinkable, an incarnate rational logos, and to seek the thought supposed incarnate there – these are at once the principle and the hope of the nature student.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

The Universe and Beyond (p. 136)

Columbia University Press. New York, New York, USA. 1916

**Kingsley, Charles** 1819–75

English clergyman and writer

Ay! there is no lie in Nature, no discord in the revelations of science, in the laws of the universe.

*Alton Locke*

Chapter XVIII (p. 143)

Macmillan & Co Ltd. London, England. 1862

Nature's deepest laws, her own true laws, are her invisible ones.

*Alton Locke, Taylor and Poet*

Chapter XXXVIII (p. 289)

Macmillan & Company Ltd. London, England. 1911

Madame Nature allows no dangerous classes, in the modern sense. She has, doubtless for some wise reason, no mercy for the weak. She rewards each organism according to its works; and if anything grows too weak or stupid to take care of itself, she gives it its due deserts by letting it die and disappear.

*Scientific Essays and Lectures*

On Bio-Geology (p. 3)

Publisher undetermined

...see how nature is not only "maxima in minimis – greatest in her least, but often" pulcherrima in abditis – fairest in her most hidden...works.

*Glaucus; Or, The Wonders of the Shore* (p. 88)

Macmillan & Co Ltd. London, England. 1890

...there is no lie in Nature, no discord in the revelations of science, in the laws of the universe. Infinite, pure, unfallen, earth-supporting Titans, fresh as on the morning of creation, those great laws endure; your only true democrats, too – for nothing is too great or too small for them to take note of. No tiniest gnat, or speck of dust, but they feed it, guide it, and preserve it.

*Novels, Poems and Letters of Charles Kingsley* (Volume 2)

*Alton Locke*

My Fall (p. 37)

The Co-Operative Publication Society. New York, New York, USA. 1898

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

To those who study her, Nature reveals herself as extraordinarily fertile and ingenious in devising means, but she has no ends which the human mind has been able to discover or comprehend.

*The Modern Temper*

Chapter Two, Section iii (p. 27)

Harcourt, Brace & Company. New York, New York, USA. 1929

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

Do we not therefore perceive that by the action of the laws of organization...nature has in favorable times, places, and climates multiplied her first germs of animality, given place to developments of their organizations...

and increased and diversified their organs? Then...aided by much time and by a slow but constant diversity of circumstances, she has gradually brought about in this respect the state of things which we now observe. How grand is this consideration, and especially how remote is it from all that is generally thought on this subject!

In *Alpheus Spring Packard*

*Lamarck, the Founder of Evolution: His Life and Work*

Chapter 16 (p. 259)

Longmans, Green & Company. London, England. 1901

Nature has produced all the species of animals in succession, beginning with the most imperfect or simplest, and ending her work with the most perfect, so as to create a gradually increasing complexity in their organisation; these animals have spread at large throughout all the habitable regions of the globe, and every species has derived from its environment the habits that we find in it and the structural modifications which observation shows us.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VII (p. 126)

The University of Chicago Press. Chicago, Illinois, USA. 1984

### **Lankester, Edwin Ray** 1847–1929

English zoologist

Nature, it has been said, gives no reply to a general inquiry – she must be interrogated by questions which already contain the answer she is to give; in other words, the observer can only observe that which he is led by hypothesis to look for: the experimenter can only obtain the result which his experiment is designed to obtain.

*The Advancement of Science*

Chapter I (p. 9)

Macmillan & Company Ltd. London, England. 1890

### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

...[if] the result of a long series of precise observations approximates a simple relation so closely that the remaining difference is undetectable by observation and may be attributed to the errors to which they are liable, then this relation is probably that of nature.

*Pierre Simon Laplace 1749–1827: A Life in Exact Science*

Chapter 16 (p. 130)

Princeton University Press. Princeton, New Jersey, USA. 1997

### **Lardner, Dionysius** 1793–1859

British physicist and astronomer

Nature has raised the curtain of futurity, and displayed before him [Man] the succession of her decrees, so far as they effect the physical universe, for countless ages to come; and the revelations of which she has made him the instrument, are supported and verified by a never-ceasing train of predictions fulfilled.

*Popular Lectures on Science and Art* (Volume 1)

Haley's Comet (p. 171)

Henry W. Law. New York, New York, USA. 1856

### **Lavoisier, Antoine Laurent** 1743–94

French chemist

It is a maxim universally admitted in geometry, and indeed in every branch of knowledge, that, in the progress of investigation, we should proceed from known facts to what is unknown. In early infancy, our ideas spring from our wants; the sensation of want excites the idea of the object by which it is to be gratified. In this manner, from a series of sensations, observations, and analyses, a successive train of ideas arises, so linked together, that an attentive observer may trace back to a certain point the order and connection of the whole sum of human knowledge.

*Elements of Chemistry* (Volume 1) (5th edition)

Preface of the Author (p. xx)

Printed for W. Creech. Edinburgh, Scotland. 1802

### **Leclerc, Georges-Louis, Comte de Buffon** 1707–88

French naturalist

Nature turns upon two steady pivots, unlimited fecundity which she has given to all species; and those innumerable causes of destruction which reduce the product of this fecundity...

*Natural History, General and Particular* (Volume 5) (p. 88)

T. Caldwell and W. Davies. London, England. 1812

### **Lehmann, Karl Gotthelf**

No biological data available

Even if Nature really knows her own mind, there are certain things she has no intention of letting us know in advance.

*Physiological Chemistry*

Chapter IX (p. 129)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1855

### **Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

If ants had a language they would, no doubt, call their anthill an artifact and describe the brick wall in its neighborhood as a natural object. Nature in fact would be for them all that was not “ant-made.” Just so, for us, nature is all that is not man-made; the natural state of anything is its state when not modified by man.

*Studies In Words*

Nature (pp. 45–46)

The University Press. Cambridge, England. 1960

### **Lewes, George Henry** 1817–78

English philosopher

Come with me, and lovingly study Nature, as she breathes, palpitates, and works under myriad forms of Life forms unseen, unsuspected, or unheeded by the mass of ordinary men.

*Studies in Animal Life*

Chapter I (p. 1)

Smith, Elder & Co. London, England. 1862



Nature *lives*: every pore is bursting with Life; every death is only a new birth, every grave a cradle.

*Studies in Animal Life*

Chapter I (p. 3)

Smith, Elder & Co. London, England. 1862

### Lewis, Exum Percival

No biographical data available

Nature does not always afford us the best opportunities for observing her phenomena. They may occur so rarely or so fitfully, or on such a small scale, that we cannot study them; or they may be so complex as to make it very difficult to resolve them into their simplest elements.

*Notes on the Properties of Matter and Heat*

Introductory (pp. 2–3)

Percival Lewis. Berkeley, California, USA. 1903

### Lockley, Martin

American geologist

When we lose touch with nature, we lose touch with our own natures, and so begin to think of rocks, plants, animals, and even people as somehow less important than the stressful job of fitting into the artificial world we are so busy creating. We lose our sense of perspective on history, and time becomes something we save or make, despite our awareness that there are no time banks or time storage units. We are so befuddled that we have to make time for people, and even make time to eat! All the while the Bushman's dream is dreaming us, and the inconceivably vast space-time continuum rolls on as it has from time immemorial.

*The Eternal Trail: A Tracker Looks at Evolution*

Chapter One (p. 12)

Perseus Publishing. Cambridge, Massachusetts, USA. 2000

### Locy, William Albert

No biographical data available

The growth of the knowledge of organic nature is a long story, full of human interest. Nature has been always the same, but the capacity of man as its interpreter has varied.

*Biology and Its Makers: With Portraits and Other Illustrations* (3rd edition)

Part I, Chapter I (p. 7)

Henry Holt & Co. New York, New York, USA. 1908

### Longfellow, Henry Wadsworth 1807–82

American poet

Nature with folded hand seemed there,  
Kneeling at her evening prayer!

*The Poetical Works of Henry Wadsworth Longfellow*

Voices of The Night

Prelude, Stanza 11

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

No tears

Dim the sweet look that Nature wears.

*The Poetical Works of Henry Wadsworth Longfellow*

Sunrise on the Hills, l. 35

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

So Nature deals with us, and takes away  
Our playthings one by one, and by the hand  
Leads us to rest so gently, that we go,  
Scarce knowing if we wish to go or stay,  
Being too full of sleep to understand  
How far the unknown transcends the what we know.

*The Poetical Works of Henry Wadsworth Longfellow*

Nature, l. 9

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

And Nature, the old nurse, took  
The child upon her knee,  
Saying: "Here is a story-book  
Thy Father has written for thee."  
"Come, wander with me," she said,  
"Into regions yet untrod;  
And read what is still unread  
In the manuscripts of God."

*Fiftieth Birthday of Agassiz*

Sackett & Wilhelms Lithographing Corp. New York, New York, USA. 1935

### Lubbock, John, First Baron Avebury 1834–1919

English banker, politician, biologist and archaeologist

... we are not the only tenants of our farms – that the fields and hedges, woods and waters, all around us, teem with a complex, rich, and interesting life. ... [N]ature will speak only to those who listen with love and sympathy...

In Henry C. McCook

*Tenants of an Old Farm; Leaves from the Note-Book of a Naturalist*

Introduction (p. vi)

George W. Jacobs & Company. Philadelphia, Pennsylvania, USA. 1895

To most of us, surely, Nature when sombre, or even gloomy, is soothing and consoling; when bright and beautiful, not only raises the spirits, but inspires and elevates our whole being –

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter I (p. 5)

Macmillan & Company Ltd. London, England. 1904

### Luther Standing Bear 1868–1939

Oglala Lakota chief, 1905–1939

Only to the white man was nature a "wilderness" and only to him was the land "infested" with "wild" animals and "savage" people. To us it was tame. Earth was bountiful and we were surrounded with the blessings of the Great Mystery. Not until the hairy man from the east came and with brutal frenzy heaped injustices upon us and the families that we loved was it "wild" for us. When the very animals of the forest began fleeing from his approach, then it was that for us the "Wild West" began.

*Land of the Spotted Eagle*

Boyhood (p. 38)

University of Nebraska Press. Lincoln, Nebraska, USA. 1978

### Lyell, Sir Charles 1797–1875

English geologist

So in Geology, if we could assume that it is part of the plan of nature to preserve, in every region of the globe,



an unbroken series of monuments to commemorate the vicissitudes of the organic creation, we might infer the sudden extirpation of species, and the simultaneous introduction of others, as often as two formations in contact include dissimilar organic fossils. But we must shut our eyes to the whole economy of the existing causes, aqueous, igneous, and organic, if we fail to perceive that such is not the plan of Nature.

*Principles of Geology* (Volume 3)

Chapter III (p. 34)

John Murray. London, England. 1830

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

Nature never errs in the long-run. She made man from a shred of the Milky Way, and she may be trusted to look after the creature she has made.

*Science, Matter and Immortality*

Chapter XVIII (p. 224)

William & Norgate. London, England. 1909

**Maclaurin, Colin** 1698–1746

Scottish mathematician and natural philosopher

A strong curiosity has prompted men in all times to study nature; every useful art has some connexion with the science; and the unexhausted beauty and variety of things makes it ever agreeable, new and surprising.

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books*

Book I, Chapter I (p. 3)

Printed for the Author's Children. London, England. 1748

**Malan, Solomon Caesar** 1812–94

British divine and orientalist

In Nature everything has a meaning; that is, every object is exactly adapted to the place it occupies, and to the purpose for which it was made.

*Aphorisms on Drawing*

IV (p. 5)

Longman, Brown, Green, Longmans & Roberts. London, England. 1856

**Manning, Richard**

No biographical data available

Now I take this thought as necessary to humble our science, to understand that everything we know was taught us by nature, but nature gave us brains evolved to their niche, so they are limited in their understanding. All that we know we have learned from nature, but we do not know all that nature knows.

*Grassland*

Chapter 12 (p. 263)

The Viking Press. New York, New York, USA. 1995

**Marcet, Mrs. (Jane Haldimand)** 1769–1858

English expository author in chemistry, botany, religion, and economics

**Comstock, John Lee** 1789–1858

American physician and writer

**Blake, John Lauris**

No biographical data available

Nature...has her laboratory, which is the universe, and there she is incessantly employed in chemical operations.

*Conversations on Chemistry*

Conversation I (p. 9)

John Beach. Boston, Massachusetts, USA. 1836

**Marsh, George Perkins** 1801–82

American scholar, writer, and statesman

Nature, left undisturbed, so fashions her territory as to give it almost unchanging permanence of form, outline, and proportion, except when shattered by geologic convulsions; and in these comparatively rare cases of derangement, she sets herself at once to repair the superficial damage, and to restore, as nearly as practicable, the former aspect of her dominion.

*The Earth as Modified by Human Action: A New Edition of Man and Nature*

Chapter I (p. 26)

Scribner, Armstrong & Company. New York, New York, USA. 1874

**Mason, Frances**

No biographical data available

Nature shows nothing finished and perfect in the beginning; she shows orderly divergence and an advance from lower to higher levels of creation.

*Creation by Evolution*

Editors Preface (p. vii)

The Macmillan Company. New York, New York, USA. 1928

**McCarthy, James Remington**

No biographical data available

Now Time took into partnership Nature to help it carry out the remainder of the program. Time is ruthless but patient. Nature is beautiful but calculatingly cruel. She had on her agenda something more than a lifeless, cold ball whirling in space. She visualized vast and contrary things.

*Fire in the Earth: The Story of the Diamond*

Chapter I (p. 1)

Harper & Brothers Publishers. New York, New York, USA. 1942

**McKibben, Bill** 1960–

Freelance writer

The end of nature sours all my material pleasures. The prospect of living in a genetically engineered world sickens me. And yet it is toward such a world that our belief in endless material advancement hurries us. As long as that desire drives us, there is no way to set limits.

*The End of Nature*

A Path of More Resistance (p. 173)

Random House, Inc. New York, New York, USA. 1989

**McLennan, Evan**

No biographical data available

There is a charm for man in the study of Nature. It elevates his soul to real greatness. It frees his mind from stormy life, and thrills him with the purest joy.

*Cosmical Evolution: A New Theory of the Mechanism of Nature*

Introduction (p. 23)

Donohue, Henneberry &amp; Company. Chicago, Illinois, USA. 1890

**Meldola, R.**

No biographical data available

It is only the active worker – the original investigator – who, by personal appeal to Nature through artificially imposed considerations, *i.e.*, experiment, or through observation, *i.e.*, ready-made phenomena, has come to understand fully what a fact really means in the scientific sense; to realise how laborious is the process of wooing truth and ambiguous are the answers often given by Nature to his cross-examinations.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 40)

Macmillan &amp; Company Ltd. London, England. 1918

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Nature abhors a moron.

*A Mencken Chrestomathy*

Chapter XXX (p. 616)

Alfred A. Knopf. New York, New York, USA. 1949

**Mendelejev, Dmitry Ivanovich** 1834–1907

Russian chemist

Nature, inert to the eyes of the ancients, has been revealed to us as full of life and activity.

*The Principles of Chemistry* Part IV

Appendix I (p. 453)

P.F. Collier &amp; Son. New York, New York, USA. 1902

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

Nature alone is always grand, in her terrors as well as her charms.

*A Strange Story* (Volume 2)

J.B. Lippincott &amp; Co. Philadelphia, Pennsylvania, USA. 1870

Nature, my mother nature! as the infant in the harsh slavery of schools pines for home, I yearned within the dark walls of cities, and amidst the hum of unfamiliar men, for thy sweet embrace – and thy bosom whereon to lay my head, and weep wild tears at my will!

*Miscellaneous Prose Works* (Volume 2)*Conversations with an Ambitious Student in His Last Illness*

Conversation the Ninth (p. 301)

Harper &amp; Brothers Publishers. New York, New York, USA. 1868

**Mill, John Stuart** 1806–73

English political philosopher and economist

Nature means the sum of all phenomena, together with the causes which produce them; including not only all that happens, but all that is capable of happening...

*Three Essays on Religion*

Nature (p. 5)

Longmans, Green, Reader &amp; Dyer. London, England. 1875

**Milton, John** 1608–74

English poet

Wherefore did Nature power her bounties forth  
With such a full and unwithdrawing hand,  
Covering the earth with odours, fruits, flocks,  
Thronging the seas with spawn innumerable,  
But all to please and sate the curious taste?

In *Great Books of the Western World* (Volume 32)*Comus*, l. 710

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Accuse not Nature, she hath done her part;

Do thou but thine...

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book VIII, l. 561–562

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Montgomery, Robert**

No biographical data available

...not from Nature up to Nature's God,  
But down from Nature's God look Nature through.

*Luther: Or, the Spirit of the Reformation*

A Landscape of Domestic Life

Francis Baisler. London, England. 1843

**Morley, John First Viscount Morley of Blackburn** 1838–1923

English statesman and writer

Nature, in her most dazzling aspects or stupendous parts, is but the background and theatre of the tragedy of man.

*Critical Miscellanies*

Byron (p. 140)

Macmillan &amp; Company Ltd. London, England. 1886

**Morris, Robert Tuttle** 1857–1945

American surgeon

If we ask why nature has such definite plans, the answer lies with infinity – out of our reach.

*Microbes and Men*

Chapter I (p. 11)

Doubleday Page &amp; Co. Garden City, New York, USA. 1916

**Morrison, A. Cressy** 1884–1951

American scientist

Although nature, the great chemist, has provided man with the prototypes and methods by which he has attempted, with considerable success, to conquer his environment,

her motives and objectives have seldom been man's. The beautiful silks with which man bedecks himself and his womankind...were created for far different purposes than those to which man has put them.

*Man in a Chemical World*

Chapter 2 (p. 13)

Charles Scribner's Sons. New York, New York, USA. 1937

**Motherwell, William** 1797–1835

Scottish poet

And we, with Nature's heart in tune,  
Concerted harmonies.

In Frederick Saunders and Minnie K. Davis (eds.)

*Gems of Genius in Poetry and Art*

Jeannie Morrison

Thompson & Thompson. Chicago, Illinois, USA. 1899

**Muir, John** 1838–1914

American naturalist

Then to think of the infinite numbers of smaller fellow mortals, invisibly small, compared with which the smallest ants are as mastodons.

*My First Summer in the Sierra*

June 13 (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

None of Nature's landscapes are ugly so long as they are wild.

*Our National Parks*

Chapter I (p. 4)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Thus review the eventful past, we see Nature working with enthusiasm like a man, blowing her volcanic forges like a blacksmith blowing his smithy fires, shoving glaciers over the landscapes like a carpenter shoving his planes, clearing, ploughing, harrowing, irrigating, planting, and sowing broadcast like a farmer and gardener, doing rough work and fine work, planting sequoias and pines, rosebushes and daisies; working in gems, filling every crack and hollow with them; distilling fine essences; painting plants and shells, clouds, mountains, all the earth and heavens, like an artist, ever working toward beauty higher and higher.

*Our National Parks*

Chapter II (p. 73)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Nature...leading us with work...yet cheers us like a mother with tender prattle words of love...

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter II, Section 2, Undated (pp. 66–67)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

When we are with Nature we are awake, and we discover many interesting things and reach many a mark we are not aiming at.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter VII, Section I, June, 1890 (p. 300)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

None may wholly escape the Good of Nature, however imperfectly exposed to her blessings.

*Steep Trails*

Chapter III (p. 48)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

[I]n every walk with Nature one receives far more than he seeks.

*Steep Trails*

Chapter IX (p. 128)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Nature has always something rare to show us...and the danger to life and limb is hardly greater than one would experience crouching deprecatingly beneath a roof.

*Mountains of California*

Chapter X (p. 249)

The Century Company. New York, New York, USA. 1911

How fiercely, devoutly wild is Nature in the midst of her beauty loving tenderness.

*My First Summer in the Sierra*

July 29 (p. 177)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Munroe, J.**

No biographical data available

In the young prime of the world, before the era of positive Science, Nature could not but be viewed with unchecked feelings. She was looked at with the eye of the poet and the artist. Her beautiful forms and colours inspired delight and wonder: the play of her varied energies invoked sympathetic moods and feelings in the soul.

Science and the Sense of Beauty

*The Journal of Science*

Volume IV, Number c, April, 1882 (p. 201)

By occupying ourselves so much with the little we have learned to understand of her [nature] insensible to what is still beyond our knowledge. By classifying the shells in the bay we have lost some respect for the ocean still unexplored.

Science and the Sense of Beauty

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

Volume IV, (Third series), April, 1882 (p. 203)

**Myres, John Linton** 1869–1954

English archaeologist

...in separate favoured regions, various kinds of men set out to domesticate and master the gifts and forces around them: to "live well," in the old Greek phrase, under the given conditions of their home, or failing this, to seek and make a new one: in either event, to comply as well as to command; to conquer Nature by observance of her laws.

*The Dawn of History*

Chapter II (p. 44)

Henry Holt & Co. New York, New York, USA. 1911

## National Research Council (US)

Nature offers no greater splendor than the starry sky on a clear, dark night. Silent, timeless, jeweled with the constellations of ancient myth and legend, the night sky has inspired wonder throughout the ages. It is a wonder that leads our imagination far from the confines of Earth and the pace of present day, out into boundless space and cosmic time itself.

*Astronomy and Astrophysics for the 1980's* (Volume 1)  
Chapter 1 (p. 3)  
National Academy Press. Washington, D.C. 1982

**Newcomb, Simon** 1835–1909  
Canadian-American astronomer

In our time we think of the process of development in nature as one going continuously forward through the combination of the opposite processes of evolution and dissolution. The tendency of our thought has been in the direction of banishing cataclysms to the theological limbo, and viewing Nature as a sleepless plodder, endowed with infinite patience, waiting through long ages for results.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*  
Chapter XVI (p. 239)  
Harper & Brothers Publishers. New York, New York, USA. 1906

**Nichols, Ernest Fox** 1869–1924  
American physicist

It is doubtful if our understanding of the unity of external nature can ever be illuminated by the lamp of anyone of the natural sciences.

*Lectures on Science, Philosophy and Art, 1907–1908*  
Physics (p. 5)  
The Columbia University Press. New York, New York, USA. 1908

**Nicolson, Marjorie Hope** 1894–1981  
Professor of English

...we see in Nature what we have been taught to look for, we feel what we have been prepared to feel.

*Mountain Gloom and Mountain Glory*  
Introduction (p. 1)  
University of Washington Press. Seattle, Washington, USA. 1997

**Nietzsche, Friedrich Wilhelm** 1844–1900  
German philosopher

...while you rapturously pose as deriving the canon of your law from nature, you want something quite the reverse from that, you strange actors and self-deceivers! Your pride wants to prescribe your morality, your ideal, to nature, yes to nature itself, and incorporate them in it; you...would like to make all existence exist only after your own image.... All your love of truth notwithstanding, you have compelled yourselves for so long and with such persistence and hypnotic rigidity to view nature *falsely*...you are no longer capable of viewing it in any

other way – and some abysmal arrogance infects you at last with the Bedlamite hope that, *because* you know how to tyrannize over yourselves...nature too can be tyrannized over...

*Beyond Good and Evil*  
Part One (p. 39)  
Penguin Books. London, England. 2003

**Oliver, Mary** 1935–  
American poet

Nature, the total of all of us, is the wheel that drives our world; those who ride it willingly might yet catch a glimpse of a dazzling, even a spiritual restfulness, while those who are unwilling simply to hang on, who insist that the world must be piloted by man for his own benefit, will be dragged around and around all the same, gathering dust but no joy.

*Blue Pastures*  
A Few Words (p. 92)  
Harcourt Brace & Company. New York, New York, USA. 1995

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

Nature has been generous to astronomers, offering an abundance of different stars and galaxies at all stages in their lives to look at.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part One, Chapter 1 (p. 28)  
Simon & Schuster. New York, New York, USA. 1985

Nature avoids infinities.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Four, Chapter 1 (p. 354)  
Simon & Schuster. New York, New York, USA. 1985

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Nature has placed us so well in the middle that if we change one side of the balance, we change the other also.

In Roger Ariew  
*Pensees*  
Miscellaneous Thoughts 1 (p. 140)  
Hackett. Indianapolis, Indiana, USA. 2004

## Pater, Walter

...nature, with its unlimited space, its innumerable suns, and the earth but a mote in the beam; how different the strange new awe, or superstition, with which it fills our minds!

*The Renaissance*  
Pico Della Mirandola (p. 43)  
The Macmillan Company. New York, New York, USA. 1899

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist and author

It is Nature herself, as we grow in comprehension of her, who weans us from our early faith.

*An Almanac for Moderns*

March Thirtieth (p. 12)

G.P. Putnam's Sons. New York, New York, USA. 1935

### Peters, Ted

No biographical data available

Nature as we daily experience it is ambiguous, fraught with benefits and liabilities.

*Playing God?: Genetic Determinism and Human Freedom*

Playing God with DNA (p. 20)

Routledge. New York, New York, USA. 1997

### Planck, Max 1858–1947

German physicist

If one wishes to obtain a definite answer from Nature one must attack the question from a more general and less selfish point of view.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Unity of the Physical Universe (p. 15)

Methuen & Company Ltd. London, England. 1925

In all cases, the quantum hypothesis has given rise to the idea, that in Nature, changes occur which are not continuous, but of an explosive nature.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

New Paths of Physical Knowledge (p. 51)

Methuen & Company Ltd. London, England. 1925

...compared with immeasurable rich, ever young nature, advanced as man may be in scientific knowledge and insight, he must forever remain the wondering child and must constantly be prepared for new surprises.

Translated by F. Gaynor

*Scientific Autobiography and Other Papers* (p. 117)

Philosophical Library. New York, New York, USA. 1949

### Pliny (C. Plinius Secundus) 23–79

Roman savant and writer

Hail, Nature, mother of all creation, and mindful that I alone of the men of Rome have praised thee in all thy manifestations, be gracious to me.

*Natural History* (Volume 10)

Book XXXVII, sec 205

Harvard University Press. Cambridge, Massachusetts, USA. 1947

### Plutarch 46–119

Greek biographer and author

Nature without learning is like a blind man; learning without nature is like the maimed; practice without both these is incomplete. As in agriculture a good soil is first sought for, then a skilful husbandman, and then good seed: in the same way nature corresponds to the soil; the teacher to the husbandman; precepts and instruction to the seed.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 283)

Edward Howell. Liverpool, England. 1864

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living.

*The Foundations of Science*

*Science and Method*, Book I

Chapter I (p. 366)

The Science Press. New York, New York, USA. 1913

### Pope, Alexander 1688–1744

English poet

See plastic Nature working to this end,  
The single atoms each to other tend,  
Attract, attracted to, the next in place  
Form'd and impell'd its neighbor to embrace.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle III, l. 9

Houghton Mifflin Company. New York, New York, USA. 1903

Eye nature's walks, shoot folly as it flies,  
And catch the manners, living as they rise;  
Laugh where we must, be candid where we can,  
But vindicate the ways of God to man.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle I, l. 13

Houghton Mifflin Company. New York, New York, USA. 1903

All are but parts of one stupendous whole,  
Whose body Nature is, and God the soul;  
That chang'd thro' all, and yet in all same,  
Great in the earth as in th' ethereal frame;  
Warms in the sun, refreshes in the breeze,  
Glow in the stars, and blossoms in the trees;  
Lives thro' all life, extends thro' all extent,  
Spreads undivided, operates unspent;  
Breathes in our soul, informs our mortal part,  
As full, as perfect, in a hair as heart.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle I, l. 267

Houghton Mifflin Company. New York, New York, USA. 1903

All nature is but art, unknown to thee.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, l. 289

Houghton Mifflin Company. New York, New York, USA. 1903

### Pouchet, Félix Archimède 1800–72

French biologist

In her slightest sketches nature knows how to unite power to an exquisite fineness of mechanism; the first glance at insects proves this, and thus so soon as their interesting history is displayed before us, we feel no longer tempted



to treat them with the disdain that poets have shown. A simple butterfly, a single fly humbles the pride of man, and despite of him levels his forests, devours his crops, and reduces him to despair.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Book III, Chapter I (p. 100)  
Blackie & Son. London, England. 1870

The more we study nature the grander does she appear. Science, by penetrating her secrets, often shows us the hidden and imposing forces exist where we only see inertia.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
The Vegetable Kingdom, Chapter II (p. 414)  
Blackie & Son. London, England. 1870

**Quammen, David** 1948–  
American science writer and naturalist

Nature grants no monopolies in resourcefulness. She does not even seem to hold much with the notion of portioning it out hierarchically. Gold, she decrees, is where you find it.

*Natural Acts: A Sidelong View of Science and Nature*  
A Better Idea (p. 3)  
Shocken Books. New York, New York, USA. 1985

**Quintilian** ca. 35–ca. 100  
Roman rhetorician

Nature herself has never attempted to effect great changes rapidly.

*De Institutione Oratoria*  
X,3,4  
Publisher undetermined  
London, England. 1822

**Reichenbach, Hans** 1891–1953  
German philosopher of science

Perhaps there has been no greater revolution in the history of mankind than this gradual transition, from the nature, full of gods, of primitive peoples, through the metaphysical nature of the philosophers, to the dispassionate nature of the physics of today, in which there are only facts and conceptual relations between them.

*Atom and Cosmos: The World of Modern Physics*  
Chapter 19 (pp. 287–288)  
The Macmillan Co. New York, New York, USA. 1933

**Rey, Jean** 1583–1645  
French physician and chemist

Nature in her inscrutable wisdom has...set limits which she never oversteps.

*Essays of Jean Rey*  
Essay XXVI (p. 52)  
William F. Clay. Edinburgh, Scotland. 1895

**Rice, Harvey** 1800–91  
American lawyer and newspaper publisher

Nature declares herself in her works. What exists beyond her domain, if anything, becomes necessarily a matter of faith or imagination.

*Nature and Culture*  
Chapter 1 (p. 7)  
Lee & Shepard. Boston, Massachusetts, USA. 1875

Nature seems to delight in creating the wonderful, as well as the beautiful, and often combines both in the same exhibition. Hence she entertains us, occasionally, with a magnificent display of fireworks, known as northern lights; or with an apparent shower of falling stars; or with the sudden descent of an aerolite, all ablaze, as if dropped from the fiery forge of the sun; or with a brilliant comet, which, with its long and glittering trail, sweeps in lady-like style the star-dust from the pavement of the sky.

*Nature and Culture*  
Chapter 1 (p. 31)  
Lee & Shepard. Boston, Massachusetts, USA. 1875

**Richet, Charles** 1850–1935  
French physiologist

Nature guards her secrets jealously: it is necessary to lay violent siege to her for a long time to discover a single one of them, however small it be.

*The Natural History of a Savant*  
Chapter XIII (p. 149)  
J.M. Dent & Sons Ltd. London, England. 1927

**Roberts, Nora** 1950–  
American author

Nature will kill you without a minute's thought, and in nastier ways than a crazy guy with a gun. It doesn't make her any less beautiful.

*Northern Lights*  
Twenty-six (p. 534)  
Penguin Group (USA)  
New York, New York, USA. 2004

**Rolleston, George** 1916–2001  
English physician and physiologist

Let us hope that in the interludes of rhetoric the logic of facts may find a moment to make itself heard. It will teach men...to hold of Nature that her ways are not as our ways, nor her thoughts as our thoughts.

*Scientific Papers and Addresses* (Volume 1)  
Chapter IV (p. 61)  
At The Clarendon Press. Oxford, England. 1884

**Romanes, George John** 1848–94  
Canadian-born English evolutionary biologist and physiologist

...wherever we tap organic nature, it seems to flow with purpose ...

*Mind and Motion and Monism*  
Monism (p. 108)  
Longmans, Green & Co. London, England. 1896

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

A strange mystery it is that Nature, omnipotent but blind, in the revolutions of her secular hurrying through the



abysses of space, has brought forth at last a child [man], subject still to her power, but gifted with sight, with knowledge of good and evil, with the capacity of judging all the works of his unthinking Mother.

*Mysticism and Logic: And Other Essays*

Chapter III (p. 48)

Longmans, Green & Co. London, England. 1919

Literature embodies what is general in particular circumstances whose universal significance shines through their individual dress; but mathematics endeavors to present whatever is most general in its purity, without any irrelevant trappings.

*Mysticism and Logic: And Other Essays*

Chapter IV (p. 61)

Longmans, Green & Co. London, England. 1919

**Russell, Henry Norris** 1877–1957

American astronomer

In the grandeur of its sweep in space and time, and the beauty and simplicity of the relations which it discloses between the greatest and the smallest things of which we know, it reveals as perhaps nothing else does, the majesty of the order about us which we call nature, and, as I believe, of that Power behind the order, of which it is but a passing shadow.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1923*

Constitution of the Stars (p. 158)

Government Printing Office. Washington, D.C. 1925

**Sagan, Carl** 1934–96

American astronomer and author

Scientists do not seek to impose their needs and wants on Nature, but instead humbly interrogate Nature and take seriously what they find.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 32)

Random House, Inc. New York, New York, USA. 1995

**Sayers, Dorothy L.** 1893–1957

English novelist and essayist

**Eustace, R.**

No biographical data available

Nature never worked by rule and compass.

*The Documents in the Case*

Letter 16, Agatha Milsom to Olive Farebrother (p. 56)

Victor Gollancz. London, England. 1978

**Scheffer, Victor B.**

Zoologist

Nature having hit upon certain practical blueprints for building an animal, uses them over and over again. Nature is parsimonious.

*Spires of Form*

Problems and Solutions

University of Washington Press. Seattle, Washington, USA. 1983

**Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Just because thou reatest in Nature what thou hast written,  
Just because thine eye all her phenomena marks, Reck-  
oning on the bonds which man upon Nature imposes,  
Does thy mind presume infinite Nature to know?

*The Poems of Schiller*

Human Knowledge (p. 303)

H. Holt & Co. New York, New York, USA. 1902

**Schrieber, Hermann** 1920–

Austrian historian

If nature and earth, those kindest of mother-goddesses,  
were so aroused as to annihilate cities, men could only  
conclude that the fault was theirs.

Translated by Richard and Clara Winston

*Vanished Cities*

Part One (p. 4)

Alfred A. Knopf. New York, New York, USA. 1962

**Schreiner, Olive**

No biographical data available

Nature, ever, like the old Hebrew God, cries out, “Thou  
shalt have no other gods before me.”

*The Story of an African Farm*

Part II, Chapter XIV (p. 372)

Little Brown, & Co. Boston, Massachusetts, USA. 1924

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

As our mental eye penetrates into smaller and smaller  
distances and shorter and shorter times, we find nature  
behaving so entirely differently from what we observe in  
visible and palpable bodies of our surroundings that no  
model shaped after our large-scale experiences can ever  
be “true.” A complete satisfactory model of this type  
is not only practically inaccessible, but not even think-  
able. Or, to be precise, we can, of course, think of it, but  
however we think it, it is wrong; not perhaps quite as  
meaningless as a “triangular circle,” but more so than a  
“winged lion.”

*Science and Humanism*

The Nature of Our “Models” (p. 25)

At The University Press. Cambridge, England. 1952

**Seeley, John Robert** 1834–95

English essayist and historian

He who studies it [nature] has continually the exquisite  
pleasure of discerning or half discerning and divining  
laws; regularities glimmer through an appearance of con-  
fusion; analogies between phenomena of a different order  
suggest themselves and set the imagination in motion;  
the mind is haunted with the sense of a vast unity not yet  
discoverable or nameable. There is food for contempla-  
tion which never runs short; you gaze at an object which

is always growing clearer, and yet always, in the very act of growing clearer, presenting new mysteries. And this arresting and absorbing spectacle, so fascinating by its variety, is at the same time overwhelming by its greatness; so that those who have devoted their lives to the contemplation scarcely ever fail to testify to the endless delight it gives them, and also to the overpowering awe with which from time to time it surprises them.

*Natural Religion, by the Author of 'Ecce homo'*  
Chapter I (pp. 21–22)  
Macmillan & Co Ltd. London, England. 1882

Nature, even if we hesitate to call it good, is infinitely interesting, infinitely beautiful.

*Natural Religion, by the Author of 'Ecce homo'*  
Chapter I (p. 21)  
Macmillan & Co Ltd. London, England. 1882

### **Selye, Hans** 1907–82

Austrian-American endocrinologist

To me nature created man, and nature is superior.

In Denis Brian  
*Genius Talk: Conversations with Nobel Scientists and Other Luminaries*  
Chapter 13 (p. 267)  
Plenum Press. New York, New York, USA. 1995

### **Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Nature does not turn out her work according to a single pattern; she prides herself upon her power of variation...

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*  
Book VII, Chapter XXVII (p. 301)  
Macmillan & Company Ltd. London, England. 1910

Nature does not reveal all her secrets at once. We imagine we are initiated in her mysteries: we are, as yet, but hanging around her outer courts.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*  
Book VII, Chapter XXXI (p. 306)  
Macmillan & Company Ltd. London, England. 1910

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

Thou, nature, art my goddess; to thy laws  
My services are bound.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*King Lear*  
Act I, Scene ii, l. 1–2  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

One touch of nature makes the whole world kin,  
That all with one consent praise new-born gawds,  
Though they are made and moulded of things past,  
And give to dust that is a little gilt  
More laud than gilt o'er-dusted.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Troilus and Cressida*  
Act III, Scene iii, l. 175–179  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

How sometimes nature will betray its folly,  
Its tenderness, and make itself a pastime  
To harder bosoms!

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Winter's Tale*  
Act I, Scene ii, l. 151–153  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...nature is made better by no mean  
But nature makes that mean.

So, over that art  
Which you say adds to nature, is an art  
That nature makes.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Winter's Tale*  
Act IV, Scene iv, l. 88–90  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In Nature's infinite book of secrecy  
A little I can read.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Anthony and Cleopatra*  
Act I, Scene ii, l. 9–10  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

The notion that Nature does not proceed by jumps is only one of the budget of plausible lies that we call classical education. Nature always proceeds by jumps. She may spend twenty thousand years making up her mind to jump; but when she makes it up at last, the jump is big enough to take us into a new age.

*Back to Methuselah*  
Part II, XXXIII (p. 81)  
Constable & Company Ltd. London, England. 1921

### **Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

...the moon gazed on my midnight labours, while, with  
unrelaxed and breathless eagerness, I pursued nature to  
her hiding-places.

*Frankenstein: Or, The Modern Prometheus*  
Chapter IV (p. 74)  
George Routledge & Sons. London, England. 1891

### **Sherman, Mrs. John Dickinson**

No biographical data available

Give to the child of today an opportunity to acquire an  
intimate knowledge of Nature's products and Nature's

ways, and future generations will avoid many of the mistakes of those gone before.

The Study of Nature for Children

*Nature Magazine*, Volume 1, Number 1. 1923 (p. 45)

**Slossin, Edwin Emery** 1865–1919

Chemist and author

Imitate Nature? Yes, when we cannot improve upon her. Admire Nature? Possibly, but be not blinded to her defects. Learn from Nature? We should sit humbly at her feet until we can stand erect and go our own way. Love Nature? Never! She is our treacherous and unsleeping foe, ever to be feared and watched and circumvented, for at any moment and in spite of all our vigilance she may wipe out the human race by famine, pestilence or earthquake and within a few centuries obliterate every trace of its achievement.

*Creative Chemistry*

Chapter I (p. 10)

The Century Co. New York, New York, USA. 1919

**Smyth, Nathan A.**

No biographical data available

By the pull of pleasure and prod of pain nature keeps the individual in tune with her purposes.

*Through Science to God*

Chapter X (p. 146)

The Macmillan Company. New York, New York, USA. 1936

**Sonneberg, Walter**

No biographical data available

Men enter into competition with Nature without in the least understanding the rules of the game.

*Social Eccentricities*

Social Eccentricities (p. 3)

Broadway Publishing Co. New York, New York, USA. 1906

Nature must have many a laugh at her disciples' antics.

*Social Eccentricities*

Social Eccentricities (p. 14)

Broadway Publishing Co. New York, New York, USA. 1906

**Spencer, Herbert** 1820–1903

English social philosopher

Is it not, indeed, an absurd and almost sacrilegious belief that the more a man studies Nature the less he reveres it? Think you that a drop of water, which to the vulgar eye is but a drop of water, loses anything in the eye of the physicist who knows that its elements are held together by a force which, if suddenly liberated, would produce a flash of lightning?

*Education: Intellectual, Moral and Physical*

A.L. Fowle. New York, New York, USA. 1860

Sad, indeed, is it to see how men occupy themselves with trivialities, and are indifferent to the grandest phenomena – care not to understand the architecture of

the Heavens, but are deeply interested in some contemptible controversy about the intrigues of Mary Queen of Scots! – are learnedly critical over a Greek ode, and pass by without a glance that grand epic written by the finger of God upon the strata of the Earth!

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 83)

D. Appleton & Co. New York, New York, USA. 1891

Nature's rules...have no exceptions.

*Social Statics*

Introduction, Lemma II (p. 39)

John Chapman. London, England. 1851

With a perfect economy, Nature turns all forces to account.

*Social Statics*

National Education (p. 178)

D. Appleton & Co. New York, New York, USA. 1899

Pervading all nature we may see at work a stern discipline, which is a little cruel that it may be very kind.

*Social Statics*

Part III, Chapter XXV (p. 352)

Dover Publications. New York, New York, USA. 1890

We hear a great deal about “the vile body;” and many are encouraged by the phrase to transgress the laws of health. But Nature quietly suppresses those who treat thus disrespectfully one of her highest products, and leaves the world to be peopled by the descendants of those who are not so foolish.

*Essays, Scientific, Political, and Speculative*

The Americans (pp. 482–483)

D. Appleton & Co. New York, New York, USA. 1892

Either unknowingly or in spite of themselves, Nature leads men by purely personal motives to fulfil her ends: Nature being one of our expressions for the Ultimate Cause of things, and the end, remote when not proximate, being the highest form of human life.

*Essays, Scientific, Political, and Speculative* (Volume 2)

The Americans (p. 491)

D. Appleton & Co. New York, New York, USA. 1892

**Spenser, Edmund** 1552–99

English poet

Yet neither spinnes, nor cards, ne cares nor fretts,

But to her mother Nature all her care she lets.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book II, Canto VI

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Stanton, Elizabeth Cady** 1810–87

American social activist

Nature, like a loving mother, is ever trying to keep land and sea, mountain and valley, each in its place, to hush the angry winds and waves, balance the extremes of heat and cold, of rain and drought, that peace, harmony, and beauty may reign supreme.

*A Library of American Literature* (Volume 7)  
A Plea for Woman Suffrage (p. 321)  
Charles L. Webster & Co. New York, New York, USA. 1889

**Steele, Joel Dorman** 1836–86  
American educator and textbook writer

In Nature all is common, and no use is base. She keeps no selected elements done up in gilt papers for sensitive people.  
*A Fourteen Weeks Course in Chemistry*  
Conclusion (p. 223)  
A.S. Barnes & Company. New York, New York, USA. 1870

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

The seeming significance of nature's appearances, their unchanging strangeness to the senses, and the thrilling response which they awaken in the mind of man.... If we could only write near enough to the facts, and yet with no pedestrian calm, but ardently, we might transfer the glamour of reality direct upon our pages.  
*The Novels and Tales of Robert Louis Stevenson*  
*Character and Opinions* (p. 134)  
Charles Scribner's Sons. New York, New York, USA. 1902

...Nature, the great Moloch, which exacts a frightful tax of human blood, sparing neither young nor old; taking the child from the cradle, the mother from her babe, and the father from the family.  
*Underwoods* (7th edition)  
Doctor and Nurse (p. 18)  
Chatto & Windus. London, England. 1895

**Swammerdam, Jan**  
No biographical data available

...Nature far surpasses all the writings and treatises that can be compiled, and in this and all other cases will teach more in one instant of time than anyone can learn in a long series of years out of the best library.  
In Thomas Medwin  
*The Angler in Wales* (Volume 1)  
Treatise on the Ephemerus (p. 311)  
Richard Bentley. London, England. 1834

**Swann, William Francis Gray** 1884–1962  
Anglo-American physicist

There are times...in the growth of human thought when nature, having led man to the hope that he may understand her glories, turns for a time capricious and mockingly challenges his powers to harmonize her mysteries by revealing new treasures.  
In Bernard Jaffe  
*Crucibles: The Story of Chemistry*  
Chapter XVI (p. 322)  
Dover Publications. New York, New York, USA. 1976

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Who trusted  
God was love indeed

And love Creation's final law –  
Tho' Nature, red in tooth and claw  
With ravine, shriek'd against his creed.  
*Alfred Tennyson's Poetical Works*  
In Memoriam A.H.H., LVI, Stanza IV  
Oxford University Press, Inc. London, England. 1953

Nothing in Nature is unbeautiful.  
*Alfred Tennyson's Poetical Works*  
Lover's Tale, I. 348  
Oxford University Press, Inc. London, England. 1953

A void was made in Nature;  
all her bonds  
Crack'd; and I saw the flaring atom-streams  
And torrents of her myriad universe  
Ruining along the illimitable inane,  
Fly on to clash together again...  
*Alfred Tennyson's Poetical Works*  
Lucretius, I. 37–39  
Oxford University Press, Inc. London, England. 1953

**Thierry, Paul Henri, Baron d'Holbach** 1723–89  
German-born French man of leisure

Instead...of seeking out of the world he inhabits for beings who can procure him a happiness denied to him by Nature, let man study this Nature, let him learn her laws, contemplate her energies [and] observe the immutable rules by which she acts ...  
Translated by H.D. Robinson  
*The System of Nature, Or, Laws of the Moral and Physical World*  
(Volume 1)  
Chapter I (p. 2)  
J.P. Mendum. Boston, Massachusetts, USA. 1889

**Thompson, Vance** 1863–1925  
American literary critic, novelist, and poet

Nature never says anything to a child. To read its message one must look at it with eyes already old.  
*The Ego Book*  
Chapter II (p. 37)  
E.P. Dutton & Co. New York, New York, USA. 1919

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

In her manifold opportunities Nature has thus helped man to polish the mirror of [man's] mind, and the process continues. Nature still supplies us with abundance of brain-stretching theoretical puzzles and we eagerly tackle them; there are more worlds to conquer and we do not let the sword sleep in our hand; but how does it stand with feeling? Nature is beautiful, gladdening, awesome, mysterious, wonderful, as ever, but do we feel it as our forefathers did?  
*The System of Animate Nature* (Volume 1)  
Lecture I (p. 25)  
William & Norgate. London, England. 1920

When we are thrilled with the wonder of the world, the heights and depths of things; when our Nature-feeling is

informed with knowledge; when our science leaves us with a conviction of the mysteriousness of Nature – the unfathomed universe; when our philosophical outlook leads us towards a realisation of a meaning behind the process; then there may be a total reaction on our part worthy of the name of Natural Religion.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 42)

William & Norgate. London, England. 1920

All roads lead to Rome, and he must be a bold man who will declare any of Nature's beckonings to be unworthy of attention.

*Introduction to Science*

Chapter III (pp. 62–63)

Henry Holt & Co. New York, New York, USA. 1911

As we begin to feel at home in Nature, our wonder grows into delight and what may almost be called affection. This is true of those who have what Meredith called "love exceeding a simple love of the things that glide in grasses and rubble of woody wreck."

*Introduction to Science*

Chapter VI (p. 171)

Henry Holt & Co. New York, New York, USA. 1911

### Thomson, James 1700–48

Scottish poet

O nature!...

Enrich me with the knowledge of thy works;  
Snatch me to Heaven.

*Seasons*

Autumn, I. 1,352

Printed by John Mycall. Newburyport, Massachusetts, USA. 1790

I care not, Fortune, what you me deny;  
You cannot rob me of free Nature's grace,  
You cannot shut the windows of the sky,  
Through which Aurora shows her brightening face;  
You cannot bar my constant feet to trace  
The woods and lawns, by living stream, at eve.

*Castle of Indolence*

Canto II, Stanza 3

William Smith. London, England. 1842

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

I seek acquaintance with Nature to know her moods and manners.

In Harrison Gray Otis Blake (ed.)

*The Writings of Henry David Thoreau* Volume 5

*Early Spring in Massachusetts: From the Journals of Henry David Thoreau*

May 23, 1856 (p. 230)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

Nature will bear the closest inspection; she invites us to lay our eye level with the smallest leaf, and take an insect view of its plain. She has no interstices; every part is full of life.

*The Writings of Henry David Thoreau* (Volume 9)

*Natural History of Massachusetts* (p. 132)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Nature must be viewed humanly to be viewed at all; that is, her scenes must be associated with humane affections, such as are associated with one's native place. She is most significant to a lover. A lover of Nature is preeminently a lover of man. If I have no friend, what is Nature to me? She ceases to be morally significant...

*The Journal of Henry David Thoreau* (Volume 4)

June 30, 1852 (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

I love Nature partly *because* she is not man, but a retreat from him. None of his institutions control or pervade her. There a different kind of right prevails. In her midst I can be glad with an entire gladness. If this world were all man, I could not stretch myself, I should lose all hope. He is constraint, she is freedom to me. He makes me wish for another world. She makes me content with this.

*The Journal of Henry David Thoreau* (Volume 4)

January 3, 1853 (p. 440)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

I have a room all to myself; it is nature.

*The Journal of Henry David Thoreau* (Volume 4)

January 3, 1853 (p. 446)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

I sit in my boat on Walden, playing the flute this evening, and see the perch, which I seem to have charmed, hovering around me, and the moon traveling over the bottom, which is strewn with the wrecks of the forest, and feel that nothing but the wildest imagination can conceive of the manner of life we are living. Nature is a wizard. The Concord nights are stranger than the Arabian nights.... Heaven lies above, because the air is deep.

*Journal (Volume 1): 1837–1844*

May 27, 1841 (p. 311)

Princeton University Press. Princeton, New Jersey, USA. 1981

We can never have enough of nature.

*Walden*

Chapter XVII (p. 350)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1910

Let us not succumb to nature. We will marshal the clouds and restrain tempests; we will bottle up pestilent exhalations; we will probe for earthquakes, grub them up, and give vent to the dangerous gas; we will disembowel the volcano, and extract its poison, take its seed out. We will wash water, and warm fire, and cool ice, and underprop the earth. We will teach birds to fly, and fishes to swim, and ruminants to chew the cud. It is time we had looked into these things.

*The Writings of Henry David Thoreau*

*Paradise (to be) Regained* (p. 283)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906



Every child should be encouraged to study not man's system of nature but Nature's.

In Robert Sattelmeyer (ed.)  
*Journal 1842–1848* (Volume 2)  
Princeton University Press. Princeton, New Jersey, USA. 1984

**Tomonaga, Sin-Itiro** 1906–79  
Japanese physicist

We are too powerless to make assumptions based only on reasoning. We must beg instruction from Nature herself.

T. Miyazima (ed.)  
*Scientific Papers* (Volume 1) (p. 545)  
Misuzu-Shobo, Tokyo, Japan. 1971

**Trotter, Spencer**  
No biographical data available

Technical nomenclature is the embodiment of that orderly and definite arrangement of knowledge which constitutes a science. It serves to symbolize a conception of the relationships that exist between living beings, one with another, and is at once the expression of a logical system of classification; a working basis for the ideal scheme which the mind constructs from observed facts. It is eminently a rational process.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1909)  
An Inquiry into the History of the Current English Names of North American Land Birds (p. 505)  
Government Printing Office. Washington, D.C. 1910

**Turgenev, Ivan** 1818–83  
Russian novelist and dramatist

However much you knock at nature's door, she will never answer you in comprehensible words because she is dumb. She will utter a musical sound, or a moan like a harp string, but you don't expect a song from her.

*On the Eve*  
Chapter I (p. 10)  
Charles Scribner's Sons. New York, New York, USA. 1903–04

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Architects cannot teach nature anything.  
*The Complete Essays of Mark Twain*  
A Memorable Midnight Experience (p. 30)  
De Capo Press. New York, New York, USA. 2000

...Nature's attitude toward all life is profoundly vicious, treacherous and malignant.

*Mark Twain's Notebook*  
Chapter XXIII (pp. 255–256)  
Harper & Brothers. New York, New York, USA. 1935

**Tyndall, John** 1820–93  
Irish-born English physicist

Would it not seem that Nature harboured the intention of educating us for other enjoyments than those derivable

from meat and drink? At all events, whatever Nature meant – and it would be mere presumption to dogmatize as to what she meant – we find ourselves here, as the upshot of her operations, endowed with capacities to enjoy not only the materially useful, but endowed with others of indefinite scope and application, which deal alone with the beautiful and the true.

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)  
Lecture I (p. 41)  
D. Appleton & Co. New York, New York, USA. 1901

We have no reason to believe that the sheep or the dog, or indeed any of the lower animals, feel an interest in the laws by which natural phenomena are regulated. A herd may be terrified by a thunder-storm; birds may go to roost, and cattle return to their stalls during a solar eclipse; but neither birds nor cattle, so far as we know, ever think of inquiring into the causes of these things. It is otherwise with man. The presence of natural objects, the occurrence of natural events, the varied appearances of the universe in which he dwells, penetrate beyond his organs of sense, and appeal to an inner power of which the senses are the mere instruments and excitants. No fact is to him either final or original. He cannot limit himself to the contemplation of it alone, but endeavors to ascertain its position in a series to which the constitution of his mind assures him it must belong. He regards all that he witnesses in the present as the afflux and sequence of something that has gone before, and as the source of a system of events which is to follow. The notion of spontaneity, by which in his ruder state he accounted for natural events, is abandoned; the idea that nature is an aggregate of independent parts also disappears, as the connection and mutual dependence of physical powers become more and more manifest; until he is finally led to regard Nature as an organic whole, as a body each of whose members sympathizes with the rest, changing, it is true, from age to age, but without any real break of continuity, or interruption of the fixed relations of cause and effect.

*Fragments of Science* (Volume 1)  
Chapter XV (pp. 343–344)  
D. Appleton & Co. New York, New York, USA. 1915

**van Dyke, John Charles** 1856–1932  
American art historian and critic

Nature seems a benevolent or a malevolent goddess just as our own inadequate vision happens to see her. If we have eyes only for her creative beauties we think her all goodness; if we see only her power of destruction we incline to think she is all evil.

*The Desert*  
Chapter VIII (p. 128)  
Charles Scribner's Sons. New York, New York, USA. 1930

Nature's work is all of it good, all of it purposeful, all of it wonderful, all of it beautiful. We like or dislike certain things which may be a way of expressing our prejudice



or our limitation ; but the work is always perfect of its kind irrespective of human appreciation. We may prefer the sunlight to the starlight, the evening primrose to the bisnaga, the antelope to the mountain lion, the mockingbird to the lizard ; but to say that one is good and the other bad, that one is beautiful and the other ugly, is to accuse Nature herself of preference – something which she never knew.

*The Desert*

Chapter X (p. 192)

Charles Scribner's Sons. New York, New York, USA. 1930

### **Vaughan, Thomas** 1857–1942

Writer

Nature moves not by the theorie of men, but by their practice, and surely wit and reason can perform no miracles, unlesse the hands supplie them.

Translated by Arthur Edward Waite

*The Magical Writings of Thomas Vaughan (Eugenius Philatethes)*

A Perfect and Full Discovere of the True Coleum Terrae (p. 144)

George Redway. London, England. 1888

### **Voltaire (François-Marie Arouet)** 1694–1778

French writer

What are you, Nature? Live in you? But I have been searching for you for fifty years, and have never been able to find you.

*The Works of Voltaire* (Volume 12)

*Philosophical Dictionary* (Volume 8)

Nature (p. 48)

The St. Hubert Guild. Akron, Ohio, USA. 1901

### **von Baeyer, Adolf** 1835–1917

German research chemist

What makes a great scientist? He must not command but listen; he must adapt himself to what he hears and reshape himself accordingly.... The ancient empiricists already did this. They put their ear to Nature. The modern scientist does the same.... Coming nearer to Nature has a very special effect on people. They develop very differently from someone who confronts Nature with preconceived ideas. Someone who approaches Nature with set ideas will, so to speak, stand before it like a general. He will want to issue orders to Nature.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 140)

W.A. Benjamin. New York, New York, USA. 1965

### **von Baeyer, Hans Christian** 1938–

German-born physicist and author

Not the scientist, but nature has the last word.

*Rainbows, Snowflakes, and Quarks: Physics and the World Around Us*

The Measure of Things (p. 189)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1984

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

When a man of lively intellect first responds to Nature's challenge to be understood, he feels irresistibly tempted to impose his will upon the natural objects he is studying. Before long, however, they close in upon him with such force as to make him realize that he in turn must now acknowledge their might and hold in respect the authority they exert over him.

*Goethe's Botanical Writings*

Formation and Transformation (p. 21)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

We live in her midst and know her not. She is incessantly speaking to us, but betrays not her secret. We constantly act upon her, and yet have no power over her.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

That which is most unnatural is still Nature; the stupidest philistinism has a touch of her genius. Whoso cannot see her everywhere, sees her nowhere rightly.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She tosses her creatures out of nothingness, and tells them not whence they came, nor whither they go. It is their business to run, she knows the road.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She loves herself, and her innumerable eyes and affections are fixed upon herself. She has divided herself that she may be her own delight. She causes an endless succession of new capacities for enjoyment to spring up, that her insatiable sympathy may be assuaged.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She rejoices in illusion. Whoso destroys it in himself and others, him she punishes with the sternest tyranny. Whoso follows her in faith, him she takes as a child to her bosom.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She has always thought and always thinks; though not as a man, but as Nature. She broods over an all-comprehending idea, which no searching can find out.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

Each of her works has an essence of its own; each of her phenomena a special characterisation: and yet their diversity is in unity.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

The one thing she seems to aim at is Individuality; yet she cares nothing for individuals. She is always building up and destroying; but her workshop is inaccessible.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

Her mechanism has few springs – but they never wear out, are always active and manifold.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

Every instant she commences an immense journey, and every instant she has reached her goal.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 10)

She creates needs because she loves action. Wondrous! that she produces all this action so easily. Every need is a benefit, swiftly satisfied, swiftly renewed. Every fresh want is a new source of pleasure, but she soon reaches an equilibrium.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 10)

Her crown is love. Through love alone dare we come near her. She separates all existences, and all tend to intermingle. She has isolated all things in order that all may approach one another. She holds a couple of draughts from the cup of love to be fair payment for the pains of a lifetime.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 10)

Whoever wishes to deny nature as an organ of the divine must begin by denying all revelation.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter VIII (p. 303)

Suhrkamp. New York, New York, USA. 1988

It is not easy for us to grasp the vast, the super colossal, in nature; we have lenses to magnify tiny objects but none to make things smaller. And even for the magnifying glass we need eyes like Carus and Nees to profit intellectually from its use. However, since nature is always the same, whether found in the vast or the small, and every piece of turbid glass produces the same blue as the whole of the atmosphere covering the globe, I think it right to seek out prototypal examples and assemble them before me. Here, then, the enormous is not reduced; it is present within the small, and remains as far beyond our grasp as it was when it dwelt in the infinite.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter VIII (p. 304)

Suhrkamp. New York, New York, USA. 1988

Nature goes her own way, and all that to us seems an exception is really according to order.

In Johann Peter Eckermann

*Conversations with Goethe*

Thursday, December 9, 1824 (p. 75)

J.M. Dent & Sons Ltd. London, England. 1970

Mere communion with nature, mere contact with the free air, exercise a soothing yet strengthening influence on the wearied spirit, calm the storm of passion, and soften the heart when shaken by sorrow to its inmost depths.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 25)

Harper & Brothers. New York, New York, USA. 1869

In order to depict nature in its exalted sublimity, we must not dwell exclusively on its external manifestations, but we must trace its image, reflected in the mind of man, at one time filling the dreamy land of physical myths with forms of grace and beauty, and at another developing the noble germ of artistic creations.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)

Description of Nature by the Ancients (p. 20)

Harper & Brothers. New York, New York, USA. 1869

**von Schelling, Friedrich Wilhelm Joseph** 1775–1854  
German philosopher

What then is that secret bond which couples our mind to Nature, or that hidden organ through which Nature speaks to our mind or our mind to Nature? For what we want is not that Nature should coincide with the laws of our mind by chance (as if through some third intermediary), but that she herself, necessarily and originally, should not only express, but even realize, the laws of our mind, and that she is, and is called, Nature only insofar as she does so.

Nature should be Mind made visible, Mind the invisible Nature. Here then, in the absolute identity of Mind in us and Nature outside us, the problem of the possibility of a Nature external to us must be resolved.

Translated by Errol E. Harris and Peter Heath

*Ideas for a Philosophy of Nature as Introduction to the Study of this Science*

Introduction (pp. 41–42)

Cambridge University Press. Cambridge, England. 1988

The purest exercise of man's rightful dominion over dead matter, which was bestowed upon him together with reason and freedom, is that he spontaneously operates upon Nature, determines her according to purpose and intention, lets her act before his eyes, and as it were spies on her at work. But that the exercise of this dominion is possible, he owes yet again to Nature, whom he would strive in vain to dominate, if he would not put her in conflict with herself and set her own forces in motion against her.

Translated by Errol E. Harris and Peter Heath

*Ideas for a Philosophy of Nature as Introduction to the Study of this Science*

Book I (p. 57)

Cambridge University Press. Cambridge, England. 1988

Nature! We are surrounded by her and locked in her clasp: powerless to leave her, and powerless to come closer to her. Unasked and unwarned she takes us up into the whirl of her dance, and hurries on with us till we are weary and fall from her arms.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

Nature: Aphorisms (p. 207)

The Macmillan Co. New York, New York, USA. 1906

We live in the midst of her [Nature] and are strangers. She speaks to us unceasingly and betrays not her secret. We are always influencing her and yet can do her no violence.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

Nature: Aphorisms (p. 207)

The Macmillan Co. New York, New York, USA. 1906

Nature knows no trifling; she is always sincere, always serious, always stern; she is always in the right, and the errors and mistakes are invariably ours.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter II (p. 26)

Macmillan & Co Ltd. London, England. 1916

You are engrossed in botany? in optic? What are you doing? Is it not much nicer to move a tender heart? Ah well, those tender hearts! A bungler can easily move them; Let my only happiness be to stay in touch with you, Oh Nature!

Translated by Aterman K. Frankfurt

In R. Otto (ed.)

*Romische Elegien und Venezianische Epigramme* (p. 53)

### **von Helmholtz, Hermann** 1821–94

German scientist and philosopher

We have taught the forces of inanimate nature to minister to the wants of human life and the designs of the human intellect.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

First Series

On the Relation of Natural Science to General Science (pp. 26–27)

D. Appleton & Co. New York, New York, USA. 1897

The artist cannot transcribe Nature; he must translate her

...

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

Second Series

On the Relation of Optics to Painting (pp. 135–136)

Longmans, Green & Co. London, England. 1903

### **von Humboldt, Alexander** 1769–1859

German naturalist and explorer

He, therefore, who amid the discordant strife of nations would seek intellectual repose, turns with delight to contemplate the silent life of plants, and to study the hidden

forces of Nature in her sacred sanctuaries; or, yielding to that inherent impulse which for thousands of years has glowed in the breast of man, directs his mind, by a mysterious presentiment of his destiny, towards the celestial orbs, which, in undisturbed harmony, pursue their ancient and eternal course.

Translated by E.C. Otte

*Views of Nature, Or, Contemplations on the Sublime Phenomena of Creation*

Steppes and Deserts (p. 21)

Henry G. Bohn. London, England. 1850

In the uniform plain bounded only by a distant horizon, where the lowly heather, the cistus, or waving grasses, deck the soil; on the ocean shore, where the waves, softly rippling over the beach, leave a track, green with the weeds of the sea; everywhere, the mind is penetrated by the same sense of the grandeur and vast expanse of nature, revealing to the soul, by a mysterious inspiration, the existence of laws that regulate the forces of the universe.

*Cosmos* (Volume 1)

Introduction (p. 3)

Henry G. Bohn. London, England. 1849

...nature may by degrees lose a portion of the charm and magic of her power, as we learn more and more how to unveil her secrets, comprehend the mechanism of the movements of the heavenly bodies, and estimate numerically the intensity of natural forces. It is true that, properly speaking, the forces of nature can only exercise a magical power over us, as long as their action is shrouded in mystery and darkness, and does not admit of being classed among the conditions with which experience has made us acquainted.

*Cosmos* (Volume 1)

Introduction (p. 18)

Henry G. Bohn. London, England. 1849

Nature considered *rationaly*, that is to say, submitted to the process of thought, is a unity in diversity of phenomena; a harmony, blending together all created things, however dissimilar in form and attributes; one great whole animated by the breath of life.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 24)

Harper & Brothers Publishers. New York, New York, USA. 1858

When man began to interrogate nature, and, not content with observing, learned to evoke phenomena under definite conditions; when once he sought to collect and record facts, in order that the fruit of his labors might aid investigation after his own brief existence had passed away, the 'philosophy of Nature' cast aside the vague and poetic garb in which she had been enveloped from her origin, and, having assumed a severer aspect, she now weighs the value of observations, and substitutes induction and reasoning for conjecture and assumption.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 24)  
Harper & Brothers Publishers. New York, New York, USA. 1858

Mere communion with Nature, mere contact with the free air, exercise a soothing yet strengthening influence on the wearied spirit, calm the storm of passion, and soften the heart when shaken by sorrow to its inmost depths. Everywhere, in every region of the globe, in every stage of intellectual culture, the same sources of enjoyment are alike vouchsafed to man.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 25)  
D. Appleton & Co. New York, New York, USA. 1850

Communion with nature awakens within us perceptive faculties that had long lain dormant; and we thus comprehend at a single glance the influence exercised by physical discoveries on the enlargement of the sphere of intellect, and perceive how a judicious application of mechanics, chemistry, and other sciences may be made conducive to national prosperity.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 32)  
Henry G. Bohn. London, England. 1849

It is almost with reluctance that I am about to speak of a sentiment, which appears to arise from narrow-minded views, or from a certain weak and morbid sentimentality – I allude to the fear entertained by some persons, that nature may by degrees lose a portion of the charm and magic of her power, as we learn more and more how to unveil her secrets, comprehend the mechanism of the movements of the heavenly bodies, and estimate numerically the intensity of natural forces.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 38)  
Harper & Brothers Publishers. New York, New York, USA. 1858

...nature can only exercise a magical power over us as long as their action is shrouded in mystery and darkness, and does not admit of being classed among the conditions with which experience has made us acquainted.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 38)  
Harper & Brothers Publishers. New York, New York, USA. 1858

Discord of the Elements Lost in Higher Unity. The knowledge of the laws of Nature, whether we can trace them in the alternate ebb and flow of the ocean, in the measured path of comets, or in the mutual attractions of multiple stars, alike increases our sense of the calm of Nature, while the chimera so long cherished by the human mind in its early and intuitive contemplations, the belief in a “discord of the elements,” seems gradually to vanish in proportion as science extends her empire.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 42)  
Harper & Brothers Publishers. New York, New York, USA. 1850

An equal appreciation of all branches of the mathematical, physical, and natural sciences is a special requirement of the present age, in which the material wealth and the growing prosperity of nations are principally based upon a more enlightened employment of the products and forces of Nature.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 53)  
D. Appleton & Co. New York, New York, USA. 1850

Man cannot act upon Nature, or appropriate her forces to his own use, without comprehending their full extent and having an intimate acquaintance with the laws of the physical world.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 53)  
D. Appleton & Co. New York, New York, USA. 1850

Nature, in the manifold signification of the word – whether considered as the universality of all that is and ever will be – as the inner moving force of all phenomena, or as their mysterious prototype – reveals itself to the simple mind and feelings of man as something earthly, and closely allied to himself.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
General Review of Natural Phenomena (p. 82)  
Harper & Brothers Publishers. New York, New York, USA. 1858

In the simple consideration of the incitements to a scientific study of Nature, I would not omit calling attention to the fact that impressions arising from apparently accidental circumstances often as is repeatedly confirmed by experience exercise so powerful an effect on the youthful mind as to determine the whole direction of a man’s career through life.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)  
Part I (p. 20)  
D. Appleton & Co. New York, New York, USA. 1850

If the starry heavens, by incalculable numbers, magnitude, space, duration, and length of periods, impress man with the conviction of his own insignificance, his physical weakness, and the ephemeral nature of his existence; he is, on the other hand, cheered and invigorated by the consciousness of having been enabled, by the application and development of intellect, to investigate very many important points in reference to the laws of Nature and the sidereal arrangement of the universe.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 3)  
Special Results of OBSERVATION IN THE DOMAIN OF COSMICAL PHENOMENA (pp. 30–31)  
Harper & Brothers Publishers. New York, New York, USA. 1851

**von Liebig, Justus** 1803–73

German organic chemist

The literary man and the statesman have not been impressed, in the course of their early studies, with the principles indispensable to the successful study of nature.

In John Gardner

*Familiar Letters on Chemistry*

Second Series

Letter I (pp. 3–4)

Taylor &amp; Walton. London, England. 1844

**von Schelling, Friedrich Wilhelm Joseph** 1775–1854

German philosopher

Nature is not an inert mass; and to him who can comprehend her vast sublimity, she reveals herself as the creative force of the universe – before all time, eternal, ever active, she calls to life all things, whether perishable or imperishable.

In Alexander von Humboldt

*Cosmos* (Volume 1)

Introduction (p. 36)

Henry G. Bohn. London, England. 1849

**von Siemens, Werner** 1816–1892

German inventor and entrepreneur

The deeper the insight we obtain into the mysterious workings of nature's forces...the more we are convinced that we are still standing in the vestibule of science; that an unexplored world still lies before us; and however much we may discover, we know not whether mankind will ever arrive at a full knowledge of nature.

In Gardner G. Hubbard

*Annual Report of the Board of Regents of the Smithsonian Institution, 1891*

The Evolution of Commerce (p. 660)

Government Printing Office. Washington, D.C. 1893

**Walcott, Charles D.** 1850–1927

Geologist

Nature has a habit of placing some of her most attractive treasures in places where it is difficult to locate and obtain them.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1915*

Evidences of Primitive Life (p. 246)

Government Printing Office. Washington, D.C. 1916

**Walker, John** 1731–1803

English minister and educator

Nature consults no philosophers.

*Lectures on Geology: Including Hydrography, Mineralogy, and Meteorology with an Introduction to Biology*

Biographical Introduction (p. xxxi)

The University of Chicago Press. Chicago, Illinois, USA. 1966

**Ward, Lester Frank** 1898–1970

American sociologist

An entirely new dispensation has been given to the world. All the materials and forces of nature have been

thus placed completely under the control of one of the otherwise least powerful of the creatures inhabiting the earth.... Nature has thus been made the servant of man.

*Glimpses of the Cosmos* (Volume 3)

Mind as a Social Factor (p. 370)

G.P. Putnam's Sons. New York, New York, USA. 1913

**Watts, Alan Wilson** 1915–73

American philosopher

For the point is not, in our accustomed ego-centric mode of thinking, that it would be good to return to our original integrity with nature. The point is that it is simply impossible to get away from it, however vividly we may imagine that we have done so. Similarly, it is impossible to experience the future and not to experience the present. But trying to realize this is another attempt to experience the future. Some logician may object that this is a merely tautological statement which has no consequence, and he will be right. But we are not looking for a consequence. We are no longer saying "So what?" to everything, as if the only importance of our present experience were in what it is leading to, as if we should constantly interrupt a dancer, saying, "Now just where are you going, and what, exactly, is the meaning of all these movements?"

*Nature, Man, and Woman* (p. 21)

Pantheon. New York, New York, USA. 1958

In [some people's] world flowers have scent and color in order to attract bees, and chameleons change their skin-tone with the intent of concealing themselves. Or, if what they are projecting upon nature is not mind but machinery, bees are attracted to flowers because they have scent and color, and chameleons survive because they have skin which changes its tone. They do not see the world of color and scented bee-visited flowers growing – without the abstract and divisive "because." Instead of interrelated patterns wherein all the parts grow simultaneously together, they see conglomerations of "billiard ball" things, strung together by the temporal sequence of cause and effect. In such a world things are what they are only in relation to what was and what will be, but in the goalless world of the Tao, things are what they are in relation to each other's presence.

*Nature, Man, and Woman* (p. 122)

Pantheon. New York, New York, USA. 1958

The rush of waterfalls and the babbling of streams are not loved for their resemblance to speech; the irregularly scattered stars do not excite us because of the formal constellations which have been traced out between them; and it is for no symmetry or suggestion of pictures that we delight in the patterns of foam, of the veins in rock, or of the black branches of trees in wintertime.

*Nature, Man, and Woman*

Part I, Chapter 5 (p. 124)

Vintage Books. New York, New York, USA. 1970



**Webber, Charles Wilkins** 1819–56  
American explorer and journalist

God's own presence is felt lingering yet, as if, in love with his own work, he stayed to touch it again – creating new charms in multiplied duration.

*Old Hicks, the Guide: Or, Adventures in the Comanche Country in Search of a Gold Mine*

VIII

Harper & Brothers. New York, New York, USA. 1848

**Webster, Daniel** 1782–1852  
American statesman

The cause of science and literature also imposes upon us an important and delicate trust. The wealth and population of the country are now so far advanced, as to authorize the expectation of a correct literature and a well formed taste, as well as respectable progress in the abstruse sciences.

*The Great Speeches and Orations of Daniel Webster*

First Settlement of New England (p. 51)

Little, Brown & Co. Boston, Massachusetts, USA. 1914

**Weyl, Hermann** 1885–1955  
German mathematician

Once and for all I wish to record my unbounded admiration for the work of the experimenter in his struggle to wrest interpretable facts from an unyielding Nature who knows so well how to meet our theories with a decisive No – or with an inaudible Yes.

Translated by H.P. Robertson

*The Theory of Groups and Quantum Mechanics*

Introduction (p. xx)

Methuen & Company Ltd. London, England. 1931

**Wheeler, John Archibald** 1911–  
American physicist and educator

... nature at the quantum level is not a machine that goes its inexorable way. Instead what answer we get depends on the question we put, the experiment we arrange, the registering device we choose. We are inescapably involved in bringing about that which appears to be happening.

In John Archibald Wheeler and Wojciech Hubert Zurek (eds.)

*Quantum Theory and Measurement* (p. 185)

Princeton University Press. Princeton, New Jersey, USA. 1982

**Whipple, Edwin Percy** 1819–86  
American essayist

Nature does not capriciously scatter her secrets as golden gifts to lazy pets and luxurious darlings, but imposes tasks when she presents opportunities, and uplifts him whom she would inform. The apple that she drops at the feet of Newton is but a coy invitation to follow her to the stars.

*Character and Characteristic Men*

Chapter III (p. 78)

James R. Osgood & Co. Boston, Massachusetts, USA. 1877

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

... nature can be thought of as a closed system whose mutual relations do not require the expression of the fact that they are thought about.

*The Concept of Nature*

Chapter I (p. 3)

The University Press. Cambridge, England. 1920

The primary task of a philosophy of natural science is to elucidate the concept of nature, considered as one complex fact for knowledge, to exhibit the fundamental entities and the fundamental relations between entities in terms of which all laws of nature have to be stated, and to secure that the entities and relations thus exhibited are adequate for the expression of all the relations between entities which occur in nature.

*The Concept of Nature*

Chapter II (p. 46)

At The University Press. Cambridge, England. 1920

... nature gets credit which in truth should be reserved for ourselves: the rose for its scent: the nightingale for his song: and the sun for his radiance. The poets are entirely mistaken. They should address their lyrics to themselves, and should turn them into odes of self-congratulation on the excellence of the human mind. Nature is a dull affair, soundless, scentless, colorless; merely the hurrying of material, endlessly, meaninglessly.

*Science and the Modern World*

Chapter III (p. 80)

The Macmillan Company. New York, New York, USA. 1929

Thus we gain from the poets the doctrine that a philosophy of nature must concern itself with at least these five notions: change, value, eternal objects, endurance, organism, interfusion.

*Science and the Modern World*

Chapter V (p. 127)

The Macmillan Company. New York, New York, USA. 1929

You cannot talk vaguely about Nature in general.

*Nature and Life*

Part I (p. 1)

At the University Press. Cambridge, England. 1934

We have to remember that while nature is complex with timeless subtlety, human thought issues from the simple-mindedness of beings whose active life is less than half a century.

*An Enquiry Concerning the Principles of Natural Knowledge*

Part I (p. 15)

At the University Press. Cambridge, England. 1919

Nature, even in the act of satisfying anticipation, often provides a surprise.

*Adventures of Ideas*

Chapter VIII (p. 161)

The Macmillan Company. New York, New York, USA. 1956



**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

The fields of Nature long prepared and fallow,  
the silent, cyclic chemistry,  
The slow and steady ages plodding, the unoccupied  
surface ripening, the rich ores forming beneath.

*Complete Poetry and Collected Prose*

Song of the Redwood Tree

The Library of America. New York, New York, USA. 1982

I believe a leaf of grass is no less than the journey-work  
of the stars,

And the pismire is equally perfect, and a grain of sand,  
and the egg of the wren,

And the tree-toad is a chef-d'oeuvre for the highest,

And the running blackberry would adorn the parlors of  
heaven,

And the narrowest hinge in my hand puts to scorn all  
machinery,

And the cow crunching with depress'd head surpasses  
any statue,

And a mouse is miracle enough to stagger sextillions of  
infidels.

*Leaves of Grass*

Song of Myself

Doubleday, Page & Co. Garden City, New York, USA. 1919

The Earth never tires,

The Earth is rude, silent, incomprehensible at first,

Nature is rude, silent, incomprehensible at first;

Be not discouraged, keep on, there are divine things well  
envelop'd,

I swear to you there are divine things more beautiful than  
words can tell.

*Leaves of Grass*

Song of the Open Road

Doubleday, Page & Co. Garden City, New York, USA. 1919

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

It seems to me that we all look at nature too much, and  
live with her too little.

*The Complete Writings of Oscar Wilde*

*De Profundis* (p. 158)

Nottingham Society. New York, New York, USA. 1907

**Willstätter, Richard** 1872–1942

German chemist

It is the scientist's lot, as it is the artist's, to be less impor-  
tant than his work. He who is chosen to lift the veil from  
Nature's secrets will be easily overshadowed by the crea-  
tion he has revealed and which will make him immortal.

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 141)

W.A. Benjamin. New York, New York, USA. 1965

**Wilson, Andrew** 1852–1912

No biographical data available

Before our eyes, for instance, we see *Madre Natura*  
spending her wherewithal in apparent thriftlessness

and woeful waste. The proverb, "Waste not, want  
not," so thoroughly and repeatedly dinned into youth-  
ful ears, would seem to have no application to the  
works and ways of the prodigal All-mother that sur-  
rounds and encompasses us. The flower that "blooms  
unseen and wastes its sweetness on the desert air,"  
is a very mild illustration of a nature-spirit which  
appeals in more forcible ways to the mind as an example  
of needless contrivance, wasted effort, and useless  
prodigality.

*Leisure-time Studies, Chiefly Biological: A Series of Essays and  
Lectures*

Chapter II (p. 22)

Chatto & Windus. London, England. 1898

**Wilson, Edward O.** 1929–

American biologist and author

Nature first, then theory. Or, better, Nature and theory  
closely intertwined while you throw all your intel-  
lectual capital at the subject. Love the organisms for  
themselves first, then strain for general explanations,  
and, with good fortune, discoveries will follow. If  
they don't, the love and the pleasure will have been  
enough.

*Naturalist*

Part 2, Chapter Ten (p. 191)

Island Press. Washington, D.C. 1994

When you have seen one ant, one bird, one tree, you have  
not seen them all.

*Time*, Volume 128, October 13, 1986 (p. 12)

**Winchell, Alexander** 1824–91

American geologist

We have learned to look upon Nature with a profounder  
respect; and, though the alphabet of our philosophy be  
trees, and birds, and rocks, and fossils, and other mate-  
rial things which metaphysics affects to despise, we have  
found that they combine themselves into a language  
freighted with grand conceptions ...

*Sketches of Creation*

Chapter I (p. 15)

Harper & Brothers Publishers. New York, New York, USA. 1870

**Wöhler, Friedrich** 1800–82

German chemist

**von Liebig, Justus** 1803–73

German organic chemist

When in the dark province of organic nature, we succeed  
in finding a light point, appearing to be one of those inlets  
whereby we may attain to the examination and investiga-  
tion of this province, then we have reason to congratulate  
ourselves, although conscious that the object before us is  
unexhausted.

Translated by James C. Booth

Researches Respecting the Radical of Benzoic Acid

*American Journal of Science and Arts*, Volume 26, Number 2, July 1834  
(p. 261)

**Wood, Theodore**

No biographical data available

Man increases the supply of food prodigiously; Nature increases the number of devourers prodigiously.

*Our Insect Enemies*

Introductory (p. 9)

Society for Promoting Christian Knowledge. London, England. 1884

**Wood, William Hamilton**

No biographical data available

Men, knowledge, religion will vanish but nature exists forever.

*The Religion of Science*

Chapter V (p. 71)

The Macmillan Co. New York, New York, USA. 1922

**Woodbridge, Frederick James Eugene** 1867–1940

American philosopher

The incorporation of man into nature may well do something to man, but it must also do something to nature. It is impossible that the word “nature” can mean the same after this incorporation that it meant before.

*Nature and Mind: Selected Essays of Frederick J.E. Woodbridge* (p. 7)

Columbia University Press. New York, New York, USA. 1937

**Woodhead, German Sims** 1855–1921

English pathologist

Those who have once attempted to catch a glimpse of the wonderful secrets that Nature will unveil to the earnest and discreet searcher can never again look upon things as common or of little importance because they do not display to the eye of the superficial observer the beauties that lie hidden under an unattractive appearance or are shrouded in size so minute that the ordinary eye is incapable of discerning their exquisite plan and detail.

In Richard Kerr

*Nature Through Microscope & Camera*

Introduction (p. 5)

The Religious Tract Society. London, England. 1909

**Wordsworth, William** 1770–1850

English poet

To the solid ground  
Of Nature trusts the Mind that builds for aye.

*The Complete Poetical Works of William Wordsworth*

A Violent Tribe of Bards on Earth

Crowell. New York, New York, USA. 1888

Come forth into the light of things;  
Let Nature be your teacher.

*The Complete Poetical Works of William Wordsworth*

The Tables Turned, l. 15–16

Crowell. New York, New York, USA. 1888

Nature never did betray  
The heart that loved her.

*The Complete Poetical Works of William Wordsworth*

Lines Composed a Few Miles Above Tintern Abbey

Crowell. New York, New York, USA. 1888

As in the eye of Nature he has lived,  
So in the eye of Nature let him die!

*The Old Cumberland Beggar* (last lines)

Crowell. New York, New York, USA. 1888

I have learned

To look on nature, not as in the hour  
Of thoughtless youth; but hearing oftentimes  
The still, sad music of humanity.

*The Complete Poetical Works of William Wordsworth*

Lines Composed a Few Miles above Tintern Abbey, l. 88–91

Crowell. New York, New York, USA. 1888

**Wright, Thomas** 1711–86

English cosmologist

...three of the finest Sights in Nature, are a rising Sun  
at Sea, a verdant Landskip with a Rainbow, and a clear  
Star-light Evening...

*An Original Theory or New Hypothesis of the Universe*

Letter the Fifth (p. 37)

Printed for the Author. London, England. 1750

**Yogananda, Paramahansa** 1893–1952

Indian yogi

Because modern science tells us how to utilize the powers of Nature, we fail to comprehend the Great Life in back of all names and forms. Familiarity with Nature has bred a contempt for her ultimate secrets; our relation with her is one of practical business. We tease her, so to speak, to discover the ways in which she may be forced to serve our purposes; we make use of her energies, whose Source yet remains unknown. In science our relation with Nature is like that between an arrogant man and his servant; or, in a philosophical sense, Nature is like a captive in the witness box. We cross-examine her, challenge her, and minutely weigh her evidence in human scales that cannot measure her hidden values.

*Autobiography of a Yogi*

Chapter 35 (pp. 337–338)

Self-Realization Fellowship. Los Angeles, California, USA. 1971

**Young, Edward** 1683–1765

English poet and dramatist

The course of nature governs all!  
The course of nature is the heart of God.  
The miracles thou call'st for, this attest;  
For say, could nature nature's course control?  
But miracles apart, who sees Him not?

*Night Thoughts*

Night IX, l. 1,280

Printed by R. Nobels for R. Edwards. London, England. 1797

Read Nature, Nature is a friend of truth...

*Night Thoughts*

Printed by R. Nobels for R. Edwards. London, England. 1797

**NATURE, ANIMATED**

**Parkinson, James** 1755–1824  
English physician and paleontologist

The study of animated nature affords more amusement, and excites more general attention, than, perhaps, any other department of natural history. It yields to the mind the amplest, gratification, by the positive and indubitable information it conveys, respecting the varying economy, and the curious instinctive habitudes, which distinguish the numerous species of animals; and by displaying the almost insensible shades of difference, by which the varieties of each species are distinguished; and the more marked and striking contrast, by which each species is separated from the other.

*Organic Remains of a Former World* Volume 1

Letter II (p. 9)

Sherwood, Neely, & Jones. London, England. 1811

**NATURE, ADAPTION OF**

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

There is no chasm in the operations of nature; the mineral world joins the vegetable, the vegetable the animal, and the animal the intellectual, by mutual but almost imperceptible gradations. The adaptations that each system makes to its neighbour are reciprocal; the highest parts of the lower ascending a little out of their order, to fill the receding parts of that which is higher; until the whole universe, like the maps that are made of it for the amusement of children, becomes one well arranged and connected whole, dovetailed, as it were, and compacted together, by the advancement of some parts and the retrocession of others.

*Lacon: or, Many Things in Few Words*

Adaptations of Nature (p. 3)

William Tegg. London, England. 1866

**NATURE, APPRECIATION OF**

**Evans, Howard Ensign** 1919–2002  
Entomologist

One's appreciation of nature is never more acute than when a bit of nature is injected into one's flesh.

*The Pleasures of Entomology: Portraits of Insects and the People Who Study them*

Chapter 18 (p. 221)

Smithsonian Institution Press. Washington, D.C. 1985

**NATURE, ARRANGEMENT OF****Author undetermined**

If the arrangements of nature were left undisturbed, the result would be a wholesome equilibrium of destruction.

In David A. Wells

*Annual of Scientific Discovery*

Insect and Grain Eating Birds (p. 321)

Gould & Lincoln. Boston, Massachusetts, USA. 1862

**NATURE, AUTHOR OF**

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

...in the planetary motions, where geometry has carried the eye so far both into the future and the past, we discover no mark either of the commencement or termination of the present order. It is unreasonable, indeed, to suppose that such marks should any where exist. The Author of nature has not given laws to the universe, which, like the institutions of men, carry in themselves the elements of their own destruction; he has not permitted in his works any symptom of infancy or of old age, or any sign by which we may estimate either their future or their past duration. He may put an end, as he no doubt gave a beginning, to the present system, at some determinate period of time; but we may rest assured, that this great catastrophe will not be brought about by the laws now existing, and that it is not indicated by anything which we perceive.

*The Works of John Playfair* (Volume 4)

*Biographical Account of the Late James Hutton* (pp. 56–57)

Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**NATURE, BALANCE OF**

**Egerton, E. N.**

No biographical data available

The balance of nature has been a background assumption in natural history since antiquity.

Changing Concepts of the Balance of Nature

*Quarterly Review of Biology*, No. 48, Number 2, 1973 (p. 322)

**NATURE, BEAUTY OF**

**Cooke, Josiah Parsons** 1827–94  
American chemist

The beauty of Nature is infinite, and the more we study her works the more her loveliness unfolds.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 39)

D. Appleton & Co. New York, New York, USA. 1855

**Lorenz, Konrad** 1903–89  
Austrian zoologist

...he who has once seen the intimate beauty of nature cannot tear himself away from it again. He must become either a poet or a naturalist and, if his eyes are keen and his powers of observation sharp enough, he may well become both.

*King Solomon's Ring: New Light on Animal Ways*  
The Aquarium (p. 10)  
Routledge. London, England. 2002

Much of the beauty and wonder of nature is based on the fact that organic life is directed towards goals – towards survival, reproduction, and the attainment of higher perfection.

In Niko Tinbergen  
*The Herring Gull's World: A Study of the Social Behavior of Birds*  
Foreword (p. vi)  
Basic Books, Inc. Publishers. New York, New York, USA. 1960

### Munroe, J.

No biographical data available

Our free and healthy sense of the beauty of Nature is undoubtedly to some degree sapped by the close study of Science.

Science and the Sense of Beauty  
*The Journal of Science, and Annals of Astronomy, Biology, Geology,*  
Volume IV, (Third series), April, 1882 (p. 204)

## NATURE, BEG OF

### Poincaré, Jules Henri 1854–1912

French mathematician and theoretical astronomer

Today we no longer beg of nature; we command her, because we have discovered certain of her secrets and shall discover others each day. We command her in the name of laws she cannot challenge, because they are hers; these laws we do not madly ask her to change, we are the first to submit to them. Nature can only be governed by obeying her.

*The Foundations of Science*  
*The Value of Science*  
Part II, Chapter VI (p. 290)  
The Science Press. New York, New York, USA. 1921

## NATURE, BOARDING-HOUSE OF

### James, William 1842–1910

American philosopher and psychologist

It seems a priori improbable that the truth should be so nicely adjusted to our needs and powers.... In the great boarding-house of nature, the cakes and the butter and the syrup seldom come out so even and leave the plates so clean.

*The Will to Believe and Other Essays in Popular Philosophy*  
The Will to Believe  
Section VIII (p. 27)  
Dover Publications, Inc. New York, New York, USA. 1956

## NATURE, BOOK OF

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

Lay aside all conceit. Learn to read the book of nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search.

In David Starr Jordan  
*Popular Science Monthly*, Volume 40, 1891

The book of Nature is always open, and all that I can do or say shall be to lead young people to study that book, and not to pin their faith to any other.

Quoted in David Starr Jordan  
*Science Sketches*  
Agassiz at Penikese (p. 135)  
A.C. McClurg & Co. Chicago, Illinois, USA. 1896

### Ansted, David Thomas 1814–80

English geologist

All know what is meant by the Book of Nature. But Nature is rather a Library than a Book; for it is the general and well-stored receptacle of all that has ever been created – of all that we know and all we have not yet learned – of all that is animate and all that is inanimate – of all that is happening and all that has happened, not only on the earth, but above the earth and within it and around it.

*The Great Stone Book of Nature*  
The Book of Nature (p. 3)  
Macmillan & Co Ltd. London, England. 1864

### Cable, George W. 1844–1925

American writer and reformer

The book of nature is a catechism. But, after it answers the first question with “God,” nothing but questions follow.

*Madame Delphine*  
Chapter V  
Charles Scribner's Sons. New York, New York, USA. 1896

### Corbett, Jim 1875–1955

Indian-born hunter and naturalist

...for the book of nature has no beginning as it has no end. Open the book where you will at any point of your life, and if you have the desire to acquire knowledge, you will find it of intense interest, and no matter how long or how intently you study the pages, your interest will not flag for in nature there is no finality.

*Jungle Lore*  
Chapter IV (p. 33)  
Oxford University Press, Inc. New York, New York, USA. 1953

### Eckert, Allan W. 1931–

American historian, naturalist, and author

...in nature's book, everything has its place and its time; there exists a persistent interdependency of its creatures one upon another.

And there is never waste.

*Wild Season*  
Epilogue (p. 244)  
Little, Brown & Company. Boston, Massachusetts, USA. 1967

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The book of Nature is the book of Fate. She turns the gigantic pages – leaf after leaf – never re-turning one. One leaf she lays down, a floor of granite; then a thousand ages, and a bed of slate; a thousand ages, and a measure of coal; a thousand ages, and a layer of marl and mud: vegetable forms appear: her first misshapen animals, zoophyte, trilobium, fish; then, saurians – rude forms, in which she has only blocked her future statue, concealing under these unwieldy monsters the fine type of her coming king. The face of the planet cools and dries, the races meliorate, and man is born. But when a race has lived its term, it comes no more again.

*The Prose Works of Ralph Waldo Emerson* (Volume 2)

Fate (p. 323)

Fields, Osgood &amp; Co. Boston, Massachusetts, USA. 1870

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

It is the exclusive property of man, to contemplate and to reason on the great book of nature. She gradually unfolds herself to him, who with patience and perseverance, will search into her mysteries; and when the memory of the present and of past generations shall be obliterated, he shall enjoy the high privilege of living in the minds of his successors, as he has been advanced in the dignity of his nature, by the labours of those who went before him.

In Thomas Steele Hall

*A Source Book in Animal Biology* (p. 32)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Peirce, Benjamin** 1809–80

American mathematician

To translate a great poem demands months and years of earnest devotion, coupled with poetic inspiration. But to read the book of Nature is the province and privilege of consummate genius, submissive to unremitting discipline.

*Ideality in the Physical Sciences*

Lecture I (p. 15)

Little, Brown &amp; Co. Boston, Massachusetts, USA. 1881

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

It is from the great book of Nature, the same through a thousand editions, whether of black-letter, or wire-wove, and hot-pressed, that I have venturously essayed to read a chapter to the public.

*Waverley Novels* (Volume 1)

Chapter I (p. 64)

Adam &amp; Charles Black. Edinburgh, Scotland. 1852

**von Liebig, Justus** 1803–73

German organic chemist

...to enable us to read the book of nature, to understand its language, to perceive the truth of the theories of the philosopher, to subject to our will and examine at our pleasure the phenomena upon which a theory is based, and the powers producing them, we must necessarily learn the alphabet of the language, we must become familiar with the use of the signs or symbols employed, and by practice acquire skill in their management, and a knowledge of the laws which regulate their combinations.

*Familiar Letters on Chemistry*

Letter I (pp. 11–12)

Walton &amp; Maberly. London, England. 1859

**Whewell, William** 1794–1866

English philosopher and historian

The *Senses* place before us the *Characters* of the Book of Nature; but these convey no knowledge to us, till we have discovered the Alphabet by which they are to be read.

*Aphorisms Concerning Ideas, Science & the Language of Science*

Aphorisms Concerning Ideas (p. 1)

Harrison &amp; Co. London, England. 1840

**NATURE, COMPLEXITY OF****Dampier, Sir William Cecil** 1867–1952

English scientific writer

Whether we look inwards or outwards the complexity of Nature seems boundless: “Boundless inward in the atom; boundless outward in the whole.”

*The Recent Development of Physical Science*

Chapter I (p. 15)

P. Blakiston’s Son &amp; Co. Philadelphia, Pennsylvania, USA. 1904

**NATURE, CONQUEST OF****Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Man’s conquest of Nature turns out, in the moment of its consummation, to be Nature’s conquest of Man.

*The Abolition of Man*

Chapter 3 (p. 68)

HarperCollins. New York, New York, USA. 2001

**NATURE, CONTROL OF****Carson, Rachel** 1907–64

American marine biologist and writer

The “control of nature” is a phrase conceived in arrogance, born of the Neanderthal age of biology and philosophy, when it was supposed that nature exists for the convenience of man. The concepts and practices of applied entomology for the most part date from that Stone Age of science. It is our alarming misfortune that so primitive a science has armed itself with the most modern and terrible weapons,



and that in turning them against the insects it has also turned them against the earth.

*Silent Spring*

Chapter 17 (p. 297)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

## NATURE, COURSE OF

**Bailey, Philip James** 1816–1902

English poet

The course of Nature seems a course of Death,  
And nothingness the whole substantial thing.

*Festus: A Poem*

Scene III (p. 58)

George Routledge & Sons, Ltd. London, England. 1893

**Huxley, Thomas Henry** 1825–95

English biologist

The course of nature as it is, as it has been, and as it will be, is the object of scientific inquiry; whatever lies beyond, above, or below this, is outside science. But the philosopher need not despair at the limitation of his field of labour: in relation to the human mind Nature is boundless; and, though nowhere inaccessible, she is everywhere unfathomable.

*The Crayfish: An Introduction to the Study of Zoology* (p. 3)

C. Kegan Paul & Co. London, England. 1880

## NATURE, CONTEMPLATION OF

**Bates, Henry Walter** 1825–92

English naturalist and explorer

...the contemplation of Nature alone is not sufficient to fill the human heart and mind.

*The Naturalist on the River Amazons* (2nd edition)

Chapter X (p. 308)

John Murray. London, England. 1864

**Burnet, Thomas** 1635–1715

English cleric and scientist

SINCE I was first inclin'd to the Contemplation of Nature, and took pleasure to trace out the Causes of Effects, and the dependence of one thing upon another in the visible Creation, I had always, methought, a particular curiosity to look back into the first Sources and ORIGINAL of Things; and to view in my mind, so far as I was able, the Beginning and Progress of a RISING WORLD.

*The Sacred Theory of the Earth* (2nd edition)

Book I, Chapter I (p. 23)

Printed by R. Norton. London. 1691

## NATURE, DANCE OF

**Kaku, Michio** 1947–

Japanese-American theoretical physicist

For most of human history, we could only watch, like bystanders, the beautiful dance of Nature. But today,

we are on the cusp of an epoch-making transition, from being passive observers of Nature to being active choreographers of Nature. The Age of Discovery in science is coming to a close, opening up an Age of Mastery.

*Visions – How Science Will Revolutionize the 21st Century*

Chapter 1 (p. 12)

Anchor Books. New York, New York, USA. 1998

## NATURE, DEHUMANISATION OF

**Reichenbach, Hans** 1891–1953

German philosopher of science

We may regret this dehumanisation of nature, we may say that it takes the soul out of physical nature and thus makes it lifeless and uninteresting – these are all concepts to which the physicist pays no attention, because they judge physical research by criteria which are taken from the world of the poet and the painter, and which, therefore, have significance for another sphere only. Rather must it be regarded as a matter of intellectual integrity to avoid applying such criteria to scientific research; and the man with artistic sensibility should possess the power to effect such a purgation, since artistic creation is itself pervaded by such a power of moral purgation.

*Atom and Cosmos: The World of Modern Physics*

Chapter 19 (p. 286)

The Macmillan Co. New York, New York, USA. 1933

## NATURE, DESTRUCTION OF

**Marsh, George Perkins**

The ravages committed by man subvert the relations and destroy the balance which nature had established between her organized and her inorganic creations, and she avenges herself upon the intruder, by letting loose upon her defaced provinces destructive energies hitherto kept in check by organic forces destined to be his best auxiliaries, but which he has unwisely dispersed and driven from the field of action.

*The Earth As Modified by Human Action*

Chapter I (p. 42)

Charles Scribner's Sons. New York, New York, USA. 1885

## NATURE, EFFECT OF

**Pascal, Blaise** 1623–62

French mathematician and physicist

Let this effect of nature, which previously seemed to you impossible, make you know that there may be others of which you are still ignorant. Do not draw this conclusion from your experiment, that there remains nothing for you to know; but rather that there remains an infinity for you to know.

*Thoughts*

231 (p. 83)

P.F. Collier & Son. New York, New York, USA. 1910



## NATURE, END OF

**Burroughs, John** 1837–1921  
American naturalist and essayist

What is the end of Nature? Where is the end of a sphere? The sphere balances at any and every point. So everything in Nature is at the top, and yet no one thing is at the top.

*Birds and Poets With Other Papers*

Touches of Nature (p. 62)

David Douglas Edinburgh, Scotland. 1884

## NATURE, ENERGY OF

**Tyndall, John** 1820–93  
Irish-born English physicist

The energy of Nature is a constant quantity, and the utmost man can do in the pursuit of physical truth, or in the applications of physical knowledge, is to shift the constituents of the never-varying total, sacrificing one if he would produce another.

*Heat Considered as a Mode of Motion*

Chapter XIV (p. 467)

D. Appleton & Company. New York, New York, USA. 1875

## NATURE, ENJOYMENT OF

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

The fear of sacrificing the free enjoyment of nature, under the influence of scientific reasoning, is often associated with an apprehension that every mind may not be capable of grasping the truths of the philosophy of nature.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 40)

Harper & Brothers Publishers. New York, New York, USA. 1858

## NATURE, EXPLORING

**Carson, Rachel** 1907–64  
American marine biologist and writer

Exploring nature with your child is largely a matter of becoming receptive to what lies around you. It is learning again to use your eyes, ears, nostrils, and finger tips, opening up the disused channels of sensory impression.

*The Sense of Wonder* (p. 52)

Harper & Row, Publishers, New York 1984

## NATURE, FACE OF

**Harvey, Moses** 1820–1901  
Irish clergyman, essayist and naturalist

The face of nature is veiled, and it is for man, who had been so wondrously endowed for the task by his Creator,

reverently yet fearlessly to lift the veil, and gaze into that awful but lovely face which dimly yet truly mirrors the Omnipotent One.

Science and Religion

*The Maritime Monthly*, Volume II, November, 1873 (p. 478)

**Hazlitt, William Carew** 1834–1913  
English bibliographer

There are only three pleasures in life pure and lasting, and all are derived from inanimate things – books, pictures, and the face of nature.

*Criticisms on Art* (2nd edition)

The Marquis of Stanford's Gallery (p. 40)

C. Templeman. London, England. 1856

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

Every new improvement in science affords the means of delineating more accurately the face of nature as it *now* exists, and of transmitting, to future ages, an account, which may be compared with the face of nature as it shall *then* exist.

*The Works of John Playfair* (Volume 1)

*Illustrations of the Huttonian Theory*, Paragraph 134 (p. 150)

Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**Priestley, Joseph** 1733–1804  
English theologian and scientist

I view with rapture the glorious face of nature, and I admire its wonderful constitution, the laws of which are daily unfolding themselves to our view.

In F.W. Gobbs

*Joseph Priestley: Adventure in Science and Champion of Truth*

Chapter 10 (p. 168)

Thomas Nelson & Sons Ltd. London, England. 1965

**Raman, Chandrasekhar Venkata** 1888–1970  
Indian physicist

The face of Nature as presented to us is infinitely varied, but to those who love her it is ever beautiful and interesting.

*The New Physics: Talks on Aspects of Science*

Chapter V (p. 29)

Philosophical Library, New York. 1951

## NATURE, FACTS OF

**Tyndall, John** 1820–93  
Irish-born English physicist

Brightness and freshness take possession of the mind when it is crossed by the light of principles, shewing the facts of Nature to be organically connected.

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)

Lecture II (p. 42)

D. Appleton & Co. New York, New York, USA. 1901

**NATURE, FASCINATION OF**

**Beebe, William** 1877–1962  
American ornithologist

There was the ending still unfinished, the finale buried in the future – and in this we find the fascination of Nature and Science.

In William H. Carr  
*The Stir of Nature*

Chapter Thirteen (p. 167)

Oxford University Press, Inc. New York, New York, USA. 1930

**NATURE, FERTILITY OF**

**Muir, John** 1838–1914  
American naturalist

One is constantly reminded of the infinite lavishness and fertility of Nature – inexhaustible abundance amid what seems enormous waste. And yet when we look into any of her operations that lie within reach of our minds, we learn that no particle of her material is wasted or worn out. It is eternally flowing from use to use, beauty to yet higher beauty.

*Gentle Wilderness* (p. 139)

Ballantine Books. New York, New York, USA. 1968

**NATURE, FOOTSTEPS OF**

**Hooke, Robert** 1635–1703  
English physicist

... the footsteps of Nature are to be trac'd, not in her ordinary course, but when she seems to be put to her shifts, to make many doublings and turnings, and to use some kind of art in endeavoring to avoid our discovery.

*Micrographia*

Preface (third page)

Printed by Jo. Martyn and Ja. Allestry. London, England. 1665

**NATURE, FORCES OF**

**Čapek, Karel** 1890–1938  
Czechoslovakian author

We must be exact, mathematical and geometrical, in order to be equal to nature. Number and fantasy, law and abundance are the feverish forces of nature; not sitting down beneath a green tree, but creating crystals and ideas denotes becoming as nature; creating laws and forms; penetrating matter with glowing flashes of divine computation.

*Letters from England* (p. 44)

Doubleday, Page & Co. Garden City, New York, USA. 1924

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

How sweet the morning air is! See how that one little cloud floats like a pink feather from some giant flamingo.

Now the red rim of the sun pushes itself over the London cloud-bank. It shines on a good many folk, but on none, I dare bet, who are on a stranger errand than you or I. How small we feel with our petty ambitions and strivings in the presence of the great elemental forces of Nature.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Sign of the Four*, Chapter 7 (p. 648)

Wings Books. New York, New York, USA. 1967

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

Futile for science to try to discover what the forces of Nature are; it can only discover how they operate.

*An Almanac for Moderns*

March Twenty-Eighth (p. 10)

G.P. Putnam's Sons. New York, New York, USA. 1935

**NATURE, FORM OF**

**Watts, Alan Wilson** 1915–73  
American philosopher

The form of Christianity differs from the form of nature because in the Church and in its spiritual atmosphere we are in a universe that has been made. Outside the Church we are in a universe that has grown.

*Nature, Man, and Woman*

Part I, Chapter 1 (p. 40)

Vintage Books. New York, New York, USA. 1970

**NATURE, GOLD OF**

**Burroughs, John** 1837–1921  
American naturalist and writer

The gold of nature does not look like gold at the first glance. It must be smelted and refined in the mind of the observer. And one must crush mountains of quartz and wash hills of sand to get it.

*Signs and Seasons*

Chapter I (p. 35)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**NATURE, HARMONY OF**

**Tuttle, Hudson** 1836–1910  
American medium

We find in the constant harmony of nature a sufficient proof in favor of the immutability of its laws. Every miracle would involve their infraction; a process to which nature would submit as little as to any other intervention in its empire; in which everything, from the gnat which dances in the sunbeam up to the human mind which issues from the brain, is governed by fixed principles.

In Ludwig Buchner

*Force and Matter*

Chapter VI (p. 38)

Trubner & Company. London, England. 1864

## NATURE, HISTORY OF

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

The only condition on which there could be a history of nature is that the events of nature are actions on the part of some thinking being or beings, and that by studying these actions we could discover what were the thoughts which they expressed and think these thoughts for ourselves. This is a condition which probably no one will claim is fulfilled. Consequently the processes of nature are not historical processes and our knowledge of nature, though it may resemble history in certain superficial ways, e.g., by being chronological, is not historical knowledge.

*The Idea of History*

Part V, Section 5 (p. 302)

At The Clarendon Press. Oxford, England. 1967

## NATURE, IGNORANCE OF

**Holbach, Paul Henri Thiry** 1723–89  
French philosopher

If the ignorance of nature gave birth to the Gods, the knowledge of nature is calculated to destroy them.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World*  
(Volume 1)

Chapter XVIII (p. 174)

J.P. Mendum

Boston, Massachusetts, USA. 1889

**Thierry, Paul Henri, Baron d’Holbach** 1723–89  
German-born French man of leisure

Man is only unhappy because he is ignorant of nature.

Translated by M. Mirabaud

*System of Nature or, The Laws of the Moral and Physical World* (Volume 1)

Preface by the Author (p. vii)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

## NATURE, IMAGINATION OF

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

But see that the imagination of nature is far, far greater than the imagination of man. No one who did not have some inkling of this through observations could ever have imagined such a marvel as nature is.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 10)

Perseus Books. Reading, Massachusetts, USA. 1998

**Feynman, Richard P.** 1918–88  
American theoretical physicist

...see that the imagination of nature is far, far greater than the imagination of man. No one who did not have

some inkling of this through observations could ever have imagined such a marvel as nature is.

*The Meaning of It All*

Chapter I (p. 10)

Perseus Books. Reading, Massachusetts, USA. 1998

## NATURE, IMITATION OF

**Child, Lydia M.** 1802–80  
American writer and abolitionist

That man’s best works should be such bungling imitations of Nature’s infinite perfection, matters not much: but that he should make himself an imitation, this is the fact which Nature moans over, and deprecates beseechingly. Be spontaneous, be truthful, be free, and thus be individuals! is the song she sings through warbling birds, and whispering pines, and roaring waves, and screeching winds.

*Letters from New York*

Letter XXXVIII (p. 276)

C.S. Francis & Company. New York, New York, USA. 1945

## NATURE, IMMUTABILITY OF THE LAWS

### Author undetermined

We are about to venture a few suggestions...on one short phrase, which is insensibly stealing into general circulation, and which seems to require considerable watchfulness and caution. They are offered for the consideration of Physical Science and Inductive Logic – not in any spirit of antagonism to them, and still less dogmatically. But the phrase itself appears not only to involve a violation of the first laws of accurate inductive reasoning, but to be charged with most perilous conclusions to Christian faith, unless it be carefully modified. This phrase is “the Immutability of the Laws of Nature.”

Immutability of Nature

*The Living Age*, Number 913, November 30, 1861 (p. 387)

## NATURE, INTERPRETER OF

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Man, as the minister and interpreter of nature, dies and understands as much as his observations on the order of nature, either with regard to things or the mind permit him, and neither knows or is capable of more.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 1 (p. 107)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**NATURE, INTERRELATEDNESS OF**

**Watts, Alan Wilson** 1915–73  
American philosopher

For the notion that the interrelatedness of nature is complex and highly detailed is merely the result of translating it into the linear units of thought. Despite its rigor and despite its initial successes, this is an extremely clumsy mode of intelligence. Just as it is a highly complicated task to drink water with a fork instead of a glass, so the complexity of nature is not innate but a consequence of the instruments used to handle it. There is nothing complex about walking, breathing, and circulating one's blood. Living organisms have developed these functions without thinking about them at all.

*Nature, Man, and Woman*

Part I, Chapter 2 (p. 62)

Vintage Books. New York, New York, USA. 1970

**NATURE, INVESTIGATION OF**

**Huxley, Thomas Henry** 1825–95  
English biologist

The investigation of Nature is an infinite pasture-ground, where all may graze, and where the more bite, the longer the grass grows, the sweeter is its flavor, and the more it nourishes.

*Collected Essays* (Volume 1)

*Method and Result*

Administrative Nihilism (p. 282)

Macmillan & Company Ltd. London, England. 1904

**Poynting, John Henry** 1852–1914  
English physicist

While the investigation of Nature is ever increasing our knowledge, and while each new discovery is a positive addition never again to be lost, the range of the investigation and the nature of the knowledge gained from the theme of endless discussion.

*Collected Scientific Papers*

Presidential Address

The Mathematical and Physical Section

The British Association (Dover) 1899 (p. 599)

At The University Press. Cambridge. 1920

**NATURE, KINGDOM OF**

**Orton, James** 1830–77  
Explorer

The Kingdom of Nature is a literal Kingdom. Order and beauty, law and dependence, are seen everywhere. Amidst the great diversity of the forms of life, there is unity; and this suggests that there is one general plan, but carried out in a variety of ways.

*Comparative Zoology, Structural and Systematic*

Chapter XXI (p. 222)

Harper & Brothers. New York, New York, USA. 1877

**NATURE, KNOWLEDGE OF**

**Adams, George** 1750–  
English instrument maker

As you advance in the knowledge of nature's varieties, your mind will be opened, and you will find fresh ornament in truth, fresh dignity in devotion, and fresh reason in religion.

*Lectures on Natural and Experimental Philosophy* (Volume 2)

Lecture XII (p. 2)

Printed by R. Hindmarsh. London, England. 1794

**Gray, George W.**  
Freelance science writer

Our knowledge of nature is limited by our ability to apprehend the materials and the forces which meet us – both those of the Earth, which we encounter in their hurrying to and fro, and those of the Universe outside, which beat upon us from the stars and the darkness beyond the stars.

*The Advancing Front of Science*

Chapter I, Section 5 (pp. 20–21)

Whittlesey House. New York, New York, USA. 1937

**Kirchoff, Gustav Robert** 1824–87  
German physicist

...there are such limits to our knowledge of nature, must be borne with patience by every sound mind whether he be a scientist or a workman. I can only advise you to leave off all impossible aspirations and trying to conceive things that are beyond conception. This requires a struggle, but a struggle is the lot of many men of all professions.

In Robert von Helmholtz

*Annual Report of the Board of Regents of the Smithsonian Institution, 1889*

A Memoir of Gustav Robert Kirchhoff (p. 533)

Government Printing Office. Washington, D.C. 1889

**Soddy, Frederick** 1877–1956  
English chemist

...our knowledge of Nature is always of necessity partial, and is bounded in all directions by certain inevitable but too often forgotten limitations connected, for example, with the briefness of human life and the physical impossibility of pursuing investigations except under conditions where the life of the investigator can be maintained.

*The Interpretation of Radium and the Structure of the Atom*

Part I, Chapter I (p. 4)

G.P. Putnam's Sons. New York, New York, USA. 1920

**von Schelling, Friedrich Wilhelm Joseph** 1775–1854  
German philosopher

The knowledge of nature is a good thing; but it must be studied primarily in its natural and healthy connection with ourselves. I would not force young people to court a

curious intimacy with worms, and beetles, and monkeys, and other creatures removed from the natural range of human sympathy.

In John Stuart Blackie  
*The Wisdom of Goethe*

Nature – Natural History (p. 182)

William Blackwood & Sons. Edinburgh, Scotland. 1883

## NATURE, LANGUAGE OF

**Davy, Sir Humphry** 1778–1829

English chemist

The whole language of nature informs us, that in animated beings there is something above our powers of investigation ; something which employs, combines, and arranges the gross elements of matter – a spark of celestial fire, by which life is kindled and preserved, and which, if even the instruments it employs are indestructible in their essence, must itself, of necessity, be immortal.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 218)

Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

If I am overflowing with life, am rich in experience for which I lack expression, then nature will be my language full of poetry – all nature will fable, and every natural phenomenon be a myth.

*The Writings of Henry David Thoreau* (Volume 5)

Chapter III (p. 135)

Houghton Mifflin & Co. New York, New York, USA. 1906

## NATURE, LAW OF

**Barrow, Hohn D.** 1952–

English theoretical physicist

For millennia Nature has slowly been fashioning first our minds, and then, within them, an imitation of her workings that we have come to call the law of Nature. This imitation of Nature we have found effective from the microscopic inner world of matter to the farthest reaches of the Universe. We have built it up. Step by step, through observation, and trial and error, from the mundane everyday world around us to the extremities of inner=

*The World Within the World*

Prologue (p. 1)

Clarendon Press. Oxford, England. 1988

**Boole, George** 1815–64

English mathematician

The general laws of Nature are not, for the most part, immediate objects of perception.

*An Investigation of the Laws of Thought*

Chapter I (p. 4)

Walton & Maberly. London, England. 1854

**Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

The laws of nature may be operative up to a certain limit, beyond which they turn against themselves to give birth to the absurd.

Translated by Justin O'Brien

*The Myth of Sisyphus and Other Essays*

Philosophical Suicide (p. 37)

Alfred A. Knopf. New York, New York, USA. 1961

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Often the regularities in the “laws of nature” are only the reflection of the regularity of the method employed in their formulation!

*Heraclitean Fire: Sketches from a Life before Nature* (p. 57)

The Rockefeller University Press. New York, New York, USA. 1978

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

The separation of the laws of nature among the different sciences is a human conceit; nature itself is an integrated whole.

*Science and Survival*

Chapter 2 (p. 25)

The Viking Press. New York, New York, USA. 1966

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Nature is constrained by the cause of her laws which dwell inborn in her.

Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 168)

The Merrymount Press. Boston, Massachusetts, USA. 1906

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

It isn't true that the laws of Nature have been capriciously disturbed, that snakes have talked, that women have been turned to salt, that rods have brought water out of rocks.

*The Stark Munro Letters*

III (p. 47)

D. Appleton & Co. New York, New York, USA. 1895

**Duke of Argyll (George Douglas**

**Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

...the laws of Nature appear to be employed in the system of Nature in a manner precisely analogous to that in which we ourselves employ them. The difficulties and obstructions which are presented by one law in the way of accomplishing a given purpose are met and overcome exactly on the same principle on which they are met and overcome by man, viz., by knowledge of other laws and by resource in applying them that is, by ingenuity in



mechanical contrivance. It cannot be too much insisted on that this is a conclusion of pure science.

*The Reign of Law* (4th American edition)

Chapter 2 (p. 99)

George Routledge & Sons. New York, New York, USA. 1873

...laws of nature are seen to be nothing but combinations of force with a view to purpose: combinations which indicate complete knowledge, not only of what is, but of what is to be, and which foresees the end from the beginning.

*The Works of the Duke of Argyll*

Chapter IV (p. 123)

John B. Alden, Publisher. New York, New York, USA. 1884

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

Everything must give way to the laws of Nature, and he alone who has mastered those laws can control her processes. But the mastery cannot be obtained with a struggle. The fable of Proteus is a true picture of the combat between man, eager for knowledge, and the stubborn guardian, charged with the protection of the secrets of destiny. Proteus changed himself into a thousand shapes before speaking, and yielded only to the hero who, far from being moved by his transformations, bound him with bands of ever increasing strength. Such is Nature herself, her answers are always truthful, but like the ancient shepherd of Neptune's flocks, before allowing Truth to shine forth, she arrays herself in the garments of error, or hides herself behind the phantom of illusion, and will only assume her proper shape under the determined assaults of a resolute disciple of Science.

The Faraday Lecture

*Chemical News and Journal of Physical Science*, Volume V, No. 3, 1870 (p. 122)

**Faraday, Michael** 1791–1867

English physicist and chemist

It will be impossible for us to consider the Laws of Nature, and what they effect, unless we now and then give our sole attention, so as to obtain a clear idea upon the subject. Give me now that attention, and then I trust we shall not part without your knowing something about those Laws, and the manner in which they act.

In William Crookes

*A Course of Six Lectures on the Various Forces of Matter and Their Relations to Each Other*

Lecture II (p. 31)

Richard Griffin & Co. London, England. 1860

**Feuerbach, Ludwig** 1804–72

German philosopher

Who suspends one law of nature suspends them all.

In Ludwig Buchner

*Force and Matter*

Chapter VII (p. 44)

Trubner & Company. London, England. 1864

**Fielding, Henry** 1707–54

English novelist, playwright, and barrister

The law of nature is a jargon of words, which means nothing.

*The History of Tom Jones, A Foundling*

Book IV, Chapter IV (p. 134)

George Bell & Sons. London, England. 1876

**Fisher, H. A. L.** 1865–1940

English historian

The fact of progress is written plain and large on the page of history; but progress is not a law of nature.

*A History of Europe*

Preface (p. v)

Edward Arnold Publishers Ltd. London, England. 1936

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

Those who transgress the laws of man sometimes escape punishment; but the laws of Nature can never be broken without paying the penalty. The man who steps over the side of a cliff, consciously or unconsciously, meets the consequences of his action swiftly, whether he be sinner or saint ...

*Discovery, Or, The Spirit and Service of Science*

Chapter VIII (p. 201)

Macmillan & Co Ltd. London, England. 1916

**Haeckel, Ernst Heinrich Philipp August** 1834–1919

German biologist and philosopher

The anthropomorphic notion of a deliberate architect and ruler of the world has gone forever from this field; the “eternal iron laws of nature” have taken its place.

*The Riddle of the Universe*

Chapter XIV (p. 267)

Watts & Company. London, England. 1900

The highest triumph of the human mind, the true knowledge of the most general laws of nature, ought not to remain the private possession of a privileged class of learned men, but ought to become the common property of all mankind.

Translated by E. Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)

Chapter I (p. 4)

D. Appleton & Co. New York, New York, USA. 1892

**Hawking, Stephen William** 1942–

English theoretical physicist

...there are grounds for cautious optimism that we may now be near the end of the search for the ultimate laws of nature.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 10 (p. 156)

Bantam Books. Toronto, Ontario, Canada. 1988



**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The laws of nature [that] we formulate mathematically in quantum theory deal no longer with the particles themselves but with our knowledge of the elementary particles.

*Daedalus*, Volume 87, 1958 (p. 99)

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

But the laws of nature are not only permanent, but consistent, intelligible, and discoverable with such a moderate degree of research, as is calculated rather to stimulate than to weary curiosity.

*The Cabinet of Natural Philosophy*

Part I, Chapter III, Section 33 (pp. 42–43)

Longman, Rees, Orme, Brown & Green. London, England. 1831

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

This is no dream; it is the universal law of Nature. But how to extract from Nature the secret of this universal law?

Translated by Jessie Haynes

*Notre Dame de Paris*

Book VII, Chapter III (p. 266)

P.F. Collier & Son. New York, New York, USA. 1902

**Huxley, Thomas Henry** 1825–95

English biologist

This universe is, I conceive, like to a great game being played out, and we poor mortals are allowed to take a hand. By great good fortune the wiser among us have made out some few of the rules of the game, as at present played. We call them “Laws of Nature,” and honour them because we find that if we obey them we win something for our pains. The cards are our theories and hypotheses, the tricks our experimental verifications.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XVII (p. 262)

D. Appleton & Co. New York, New York, USA. 1901

The chess-board is the world; the pieces are the phenomena of the universe; the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just, and patient. But also we know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance.

*Lay Sermons, Addresses and Reviews*

A Liberal Education (pp. 31–32)

New York, New York, USA. 1872

...the “Law of Nature” is not a command to do, or to refrain from doing, anything. It contains, in reality, nothing but a statement of that which a given being tends to do under the circumstances of its existence; and which, in

the case of a living and sensitive being, it is necessitated to do, if it is to escape certain kinds of disability, pain, and ultimate dissolution.

*Collected Essays* (Volume 1)

*Method and Result*

Natural and Political Rights (p. 349)

Macmillan & Company Ltd. London, England. 1904

Education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 83)

Macmillan & Company Ltd. London, England. 1904

**Jordan, David Starr** 1851–1931

American scientist and university administrator

The laws of nature have in themselves no necessary principle of progress. Their functions, each and all, may be defined as cosmic order. The law of gravitation brings order in rest or motion. The laws of chemical affinity bring about molecular stability. Heredity repeats strength or weakness, good or ill, with like indifference. The past will not let go of us; we cannot let go of the past.

*Evolution and Animal Life*

Chapter I (p. 10)

D. Appleton & Co. New York, New York, USA. 1907

**Kingsley, Charles** 1819–75

English clergyman and author

Nature’s deepest laws, her own true laws, are her invisible ones.

*Alton Locke*

Chapter XXXVIII (p. 291)

Chapman & Hall. London, England. 1856

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

All events, even those which on account of their insignificance do not seem to follow the great laws of nature, are a result of it just as necessarily as the revolutions of the sun.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter II (p. 3)

John Wiley & Sons. London, England. 1902

**Lederman, Leon** 1922–

American high-energy physicist

The laws of nature must have existed before even time began in order for the beginning to happen. We say this, we believe it, but can we prove it?

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 9 (p. 401)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

This terror then and darkness of mind must be dispelled not by the rays of the sun and glittering shafts of day, but by the aspects and the law of nature; the warp of whose design we shall begin with this first principle, nothing is ever gotten out of nothing by divine power.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book One, l. 146 (pp. 2–3)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lyell, Sir Charles** 1797–1875  
English geologist

Our estimate, indeed, of the value of all geological evidence, and the interest derived from the investigation of the earth's history, must depend entirely on the degree of confidence which we feel in regard to the permanency of the laws of nature. Their immutable constancy alone can enable us to reason from analogy, by the strict rules of induction, respecting the events of former ages, or, by a comparison of the state of things at two distinct geological epochs, to arrive at the knowledge of general principles in the economy of our terrestrial system.

*Principles of Geology*

Chapter IX (p. 165)

John Murray. London, England. 1830

**Lynch, John Joseph**  
No biographical data available

The laws of nature are written deep in the folds and faults of the earth. By encouraging men to learn those laws one can lead them further to a knowledge of the Author of all laws.

*New York Times*, December 5, 1963

**Mather, Kirtley F.** 1888–1978  
American geologist

The laws of nature are not chains which shackle man, nor gods which drive him down any predetermined alley. They are tools which strengthen his hands and increase his efficiency; implements which have waited long for his master mind to make them useful.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (p. 17)

Thomas Y. Crowell Company. New York, New York, USA. 1931

**Moleschott, Jacob** 1822–93  
Dutch scientist, physiologist, and philosopher

The law of nature is a stringent expression of necessity.

In Ludwig Buchner

*Force and Matter*

Chapter VI (p. 33)

Trubner & Company. London, England. 1864

**Needham, Joseph** 1900–95  
English biochemist and sinologist

There was no confidence that the code of Nature's laws could be unveiled and read, because there was no assurance that a divine being, even more rational than ourselves, had ever formulated such a code capable of being read.

*The Grand Titration: Science and Society in East and West* (p. 350)

University of Toronto Press. Toronto, Ontario, Canada. 1969

**Pareto, Vilfredo Federico Damaso** 1848–1923  
Italian sociologist, economist, and philosopher

Above, far above the prejudices and passions of men soar the laws of nature. Eternal and immutable, they are the expression of the creative power they represent what is, what must be, what otherwise could not be. Man can come to understand the: he is incapable of changing them.

Translated by Samuel Edward Finer

*Sociological Writings* (p. 122)

Praeger. New York, New York, USA. 1966

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

Amid all the revolutions of the globe the economy of Nature has been uniform, and her laws are the only things that have ever resisted the general movement. The rivers and the rocks, the seas and the continents, have been changed in all their parts; but the laws which direct those changes, and the rules to which they are subject, have remained invariably the same.

*The Works of John Playfair* (Volume I)

Note XIX, section 117 (p. 415)

Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

**Richards, Theodore William** 1868–1928  
American chemist

The laws of nature cannot be intelligently applied until they are understood, and in order to understand them, many experiments bearing upon the ultimate nature of things must be made, in order that all may be combined in a far-reaching generalization impossible without the detailed knowledge upon which it rests.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1918)

The Problem of Radioactive Lead (p. 219)

Government Printing Office

Washington, D.C. 1919

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

The laws of physics are generally looked upon as a paradigm of exactitude. Therefore one would naturally take it for granted that probably no other science would be able to give such a clear and definite answer when asked what is meant when we speak of the law of nature.

*Science and the Human Temperament*

Chapter VI (p. 133)

W.W. Norton & Company, Inc. New York, New York, USA. 1935

### Scriven, Michael

No biographical data available

The most interesting fact about laws of nature is that they are virtually all known to be in error.

In H. Feigl and G. Maxwell (eds.)

*Current Issues in the Philosophy of Science – Proceedings of Section L of the American Association for the Advancement of Sciences*

The Key Property of Physical Laws – Inaccuracy (p. 91)

Holt, Rinehart & Winston. New York, New York, USA. 1961

### Sterne, Laurence 1713–68

English novelist and humorist

The laws of nature will defend themselves ...

*Tristram Shandy*

Chapter XIX (p. 127)

Derby & Jackson. New York, New York, USA. 1857

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

If we knew all the laws of Nature, we should need only one fact, or the description of one actual phenomenon, to infer all the particular results at that point. Now we know only a few laws, and our result is vitiated, not, of course, by any confusion or irregularity in Nature, but by our ignorance of essential elements in the calculation. Our notions of law and harmony are commonly confined to those instances which we detect; but the harmony which results from a far greater number of seemingly conflicting, but really concurring, laws, which we have not detected, is still more wonderful. The particular laws are as our points of view, as to the traveler, a mountain outline varies with every step, and it has an infinite number of profiles, though absolutely but one form. Even when cleft or bored through it is not comprehended in its entirety.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter XVI (p. 448)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Trefil, James

The laws of nature are the skeleton of the universe.

*The Nature of Science*

Introduction (p. vii)

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

How blind and unreasoning and arbitrary are some of the laws of nature – most of them, in fact!

*The Man That Corrupted Hadleyburg, and Other Stories and Essays*

A Double-Barreled Detective Story

Chapter III (p. 296)

Harper & Brothers. New York, New York, USA. 1917

### van Dyke, John Charles 1856–1932

American art historian and critic

There is no appeal from the law of nature. It was made for beast and bird and creeping things. Will the human never learn that in the eye of the law he is not different from the things that creep?

*The Desert*

Chapter VI (p. 108)

Charles Scribner's Sons. New York, New York, USA. 1930

### von Schelling, Friedrich Wilhelm Joseph 1775–1854

German philosopher

There is here little that is universal and subjective, for the isolated manifestations of the laws of nature lie without us – all sphynx-like, motionless, firm, and dumb.

*Conversations of Goethe With Eckermann and Soret*

Tues., Dec. 30 (p. 47)

George Bell & Sons. London, England. 1883

### Weyl, Hermann 1885–1955

German mathematician

The truth as we see it today is this: The laws of nature do not determine uniquely the one world that actually exists.

*Symmetry*

Bilateral Symmetry (p. 27)

Princeton University Press. Princeton, New Jersey, USA. 1960

### Whewell, William 1794–1866

English philosopher and historian

When we speak of material nature as being governed by laws, it is sufficiently evident that we use the term in a manner somewhat metaphorical.

*Astronomy and General Physics*

Chapter II (p. 17)

Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

### Wigner, Eugene Paul 1902–95

Hungarian-born American physicist

The regularities in the phenomena which physical science endeavors to uncover are called the laws of nature. The name is actually very appropriate. Just as legal laws regulate actions and behavior under certain conditions but do not try to regulate all action and behavior, the laws of physics also determine the behavior of its objects of interest only under certain well-defined conditions but leave much freedom otherwise.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1914

Events, Laws of Nature, and Invariance principles (p. 6)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

### Witten, Edward 1951–

American theoretical physicist

Understanding natural science has been, historically, an important source of mathematical inspiration. So it is

frustrating that, at the outset of the new century, the main framework used by physicists for describing the laws of nature is not accessible mathematically.

Physical Law and the Quest for Mathematical Understanding  
*Bulletin of the American Mathematical Society*, Volume 40, Number 1, October 2, 2002 (p 23).

## NATURE, LEARN OF

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

It is our business to learn of nature (that is by observation) the ways and means, which in her wisdom are adopted; and we are to imagine these only in order to find means for further information, and to increase our knowledge from the examination of things which actually have been. It is in this manner, that intention may be found in nature; but this intention is not to be supposed, or vainly imagined, from what we may conceive to be.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter I, Section IV (p. 197)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

## NATURE, LOOM OF

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Nothing is gained by saying that the loom of nature works like our muscles if we cannot explain how our muscles work.

*Physics and Philosophy*  
Chapter I (p. 15)  
Dover Publications. New York, New York, USA. 1981

**Poynting, John Henry** 1852–1914

English physicist

...the loom of Nature is weaving a pattern with no mere geometrical design. The threads of life, coming in we know not where, now twining together, now dividing, are weaving patterns of their own, ever increasing in intricacy, ever gaining in beauty.

*Report of the Sixty-ninth Meeting British Association for the Advancement of Science*  
The President's Address (p. 624)  
John Murray. London, England. 1900

## NATURE, LOVE OF

**Burroughs, John** 1837–1921

American naturalist and writer

The love of nature is different from the love of science, though the two may go together.

*The Breath of Life*  
Preface (p. vii)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**Davies, William H.** 1871–1940

English poet

It takes more than a short holiday to get a real love of Nature; such a love as makes trees like human companions, and green the colour we look for everywhere we go.

*Nature*  
Chapter I (p. 1)  
B.T. Batsford, Ltd. London, England. 1914

**Hamilton, Frank L.**

No biographical data available

Next to a knowledge of himself, man should have a love of nature deeply planted in his soul.

The Round Table  
*The Connecticut Magazine: An Illustrated Monthly*, Volume 1, Number 3, 1895 (p. 308)

**Kearton, Richard** 1862–1928

English naturalist

Men are coming to know that there are greater possessions than those which can be measured by the surveyor's chain or locked in iron safes. A love of Nature is one of them, and it has the unspeakably good quality of endurance.

*Wild Nature's Ways*  
Introduction (p. ix)  
Cassell & Co., Ltd. London, England. 1903

**Lubbock, John, First Baron Avebury** 1834–1919

English banker, politician, biologist, and archaeologist

The love of Nature is a great gift, and if it is frozen or crushed out, the character can hardly fail to suffer from the loss.

*The Pleasures of Life*  
Chapter VII (p. 147)  
The Macmillan Co. New York, New York, USA. 1891

**Roe, Edward Payson** 1837–88

American author, horticulturalist, and clergyman

The love of Nature is something that may be developed in every heart, and it is a love that rarely fails to purify and exalt. To many she is a cold, indifferent beauty. They see, but do not know and appreciate her, and she passes on her way as if they were nothing to her. But when wooed patiently and lovingly, she stops to smile, caress, and entertain with exhaustless diversion.

*Nature's Serial Story*  
Preface (p. viii)  
Harper & Brothers Publishers. New York, New York, USA. 1885

**Webb, Mary Gladys Meredith** 1881–1927

English romantic novelist

...the love of nature is a passion for those in whom it once lodges. It can never be quenched. It cannot change.

It is a furious, burning, physical greed, as well as a state of mystical exaltation. It will have its own.

*The House in Dormer Forest*

Chapter XXIV (p. 277)

George H. Doran Co. New York, New York, USA. 1921

## NATURE, LOVERS OF

### Saunders, W. E.

Naturalist

Lovers of nature feel so confidently that their hobby is an enormous asset in life that there is no feeling of hesitancy in advocating that every person should become acquainted with new species of birds, trees, insects, etc., just as often as opportunity offers. And the time to do so is always NOW!

In R.J. Rutter (ed.)

*W.E. Saunders, Naturalist: A Memorial Volume*

Saundersisms (p. 50)

Federation of Ontario Naturalists. Toronto, Ontario, Canada. 1949

## NATURE, MACHINES OF

### Leibniz, Gottfried Wilhelm 1646–1716

German philosopher and mathematician

...the machines of nature, namely, living bodies, are still machines in their smallest parts *ad infinitum*.

*The Monadology and Other Philosophical Writings*

Section 64 (p. 254)

At The Clarendon Press. Oxford, England. 1898

## NATURE, MECHANISMS OF

### Leopold, Aldo 1886–1948

American naturalist

In a surprising number of men there burns a curiosity about machines and a loving care in their construction, maintenance, and use. This bent for mechanisms, even though clothed in greasy overalls, is often the pure fire of intellect. It is the earmark of our times.

Everyone knows this, but what few realize is that an equal bent for the mechanisms of nature is a possible earmark of some future generation.

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

The Farmer as a Conservationist (p. 257)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

## NATURE, METHOD OF

### Morehouse, George Wilkinson 1840–?

American naturalist

We cannot become too familiar with the methods of Nature, whether on an extensive scale, or, as is often more instructive, on a minute or microscopic scale.

*The Wilderness of Worlds*

Chapter XIV (p. 189)

Peter Eckler, Publisher. New York, New York, USA. 1898

## NATURE, MONUMENTS OF

### Davy, Sir Humphry 1778–1829

English chemist

If we look with wonder upon the great remains of human works, such as the columns of Palmyra, broken in the midst of the desert, the temples of Paestum, beautiful in the decay of twenty centuries, or the mutilated fragments of Greek sculpture, in the Acropolis of Athens, or in our own Museum, as proofs of the genius of artists, and power and riches of nations now passed away; with how much deeper a feeling of admiration must we consider those grand monuments of nature, which mark the revolutions of the globe: continents broken into islands; one land produced, another destroyed; the bottom of the ocean become a fertile soil; whole races of animals extinct, and the bones and exuviae of one class covered with the remains of another; and upon these graves of past generations, the marble or rocky tombs, as it were, of a former animated world, new generations rising, and order and harmony established, and a system of life and beauty produced, as it were, out of chaos and death; proving the infinite power, wisdom, and goodness of the Great Cause of all being!

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* (Volume 7)

Award of the Copley Medal (pp. 43–44)

Smith, Elder & Co. London, England. 1840

### Younghusband, Sir Francis 1863–1942

English army officer, explorer, and spiritual writer

The Mystery of Nature only serves to draw us on. We cannot Resist. But then comes our reward. The deeper we penetrate the higher is our exaltation. Those who pierce farthest into the mystery of Nature enjoy the purst delight. So on and on we have to go – layman and scientist alike. And we shall never stop. The lure is too great.

In Francis Mason (ed.)

*The Great Design*

The Mystery of Nature (p. 255)

The Macmillan Co. New York, New York, USA. 1934

## NATURE, MYSTERIES OF

### Chambers, Robert 1802–71

Scottish journalist and geologist

It is most interesting to observe into how small a field the whole of the mysteries of nature thus ultimately resolve themselves. The inorganic has one final comprehensive law, GRAVITATION. The organic, the other great department of mundane things, rests in like manner on one law, and that is – DEVELOPMENT. Nor may even these be



after all twain, but only branches of one still more comprehensive law, the expression of that unity which man's wit can scarcely separate from Deity itself.

*Vestiges of the Natural History of Creation*  
Mental Constitution of Animals (pp. 263–264)  
George Routledge & Sons. London, England. 1887

## NATURE, NOTIONS OF

**von Liebig, Justus** 1803–73  
German organic chemist

Our children have more correct notions of nature and natural phenomena than had Plato! they may treat with ridicule the errors which Pliny has committed in his *Natural History*!

In John Blyth (ed.)  
*Familiar Letters on Chemistry*  
Letter I (p. 3)  
Walton & Maberly. London, England. 1859

## NATURE, OPERATION OF

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

I may say that here, as in most cases where the operations of nature interfere with the designs of man, it is not by a direct intervention on our part that we may remedy the difficulties, but rather by a precise knowledge of [nature's] causes, which may enable us, if not to check, at least to avoid the evil consequences.

*Annual Report of the Superintendent of the Coast Survey, Showing the Progress of that Work During the Year Ending November, 1851*  
Extracts from the report of Professor Agassiz to the Superintendent of the Coast Survey, on the examination of the Florida reefs, keys, and coast (p. 158)  
Printed by Robert Armstrong, Washington. 1852

**Hales, Stephen** 1677–1761  
English physiologist and clergyman

...our reasonings about the wonderful and intricate operations of Nature are so full of uncertainty, that, as the wise-man truly observes, hardly do we guess aright at the things that are upon earth, and with labour do we find the things that are before us.

*Vegetable Staticks*  
Chapter VII (p. 181)  
The Scientific Book Guild. London, England. 1961

**Morehouse, George Wilkinson** 1840–?  
American naturalist

The flood of light now thrown on the orderly evolution of worlds in the past, enables us to project the powerful search-light of the fundamental truth of the uniformity of the operations of Nature into the darkness of the future.

*The Wilderness of Worlds*  
Chapter XVII (p. 218)  
Peter Eckler, Publisher. New York, New York, USA. 1898

## NATURE, OBSERVERS OF

**Sturm, Christoph Christian** 1740–68  
Evangelical preacher

I am convinced there would be more attentive observers of nature, if, for example, the spider spun threads of gold, if the lobsters contained pearls, or if the flowers of the field could make old people young.

*Reflections on the Works of God and of His Providence Throughout All Nature* (Volume 2)  
On Our Indifference to the Works of Nature (p. 197)  
Printed for J. Walker. London, England. 1808

## NATURE, ORDER OF

**Brooks, William Keith** 1848–1908  
American zoologist

...the order of nature presents infinite diversity: the different ways in which events may be combined are innumerable; and no natural response can be judicious or beneficial under all circumstances.

*The Foundations of Zoology*  
Lecture I (p. 13)  
The Macmillan Co. New York, New York, USA. 1899

**Lankester, Edwin Ray** 1847–1929  
English zoologist

The whole order of nature, including living and lifeless matter – man, animal and gas – is a network of mechanism the main features and many details of which have been made more or less obvious to the wondering intelligence of mankind by the labor and ingenuity of scientific investigators. But no sane man has ever pretended, since science became a definite body of doctrine, that we know, or ever can hope to know or conceive of the possibility of knowing, whence this mechanism has come, why it is there, whither it is going, and what there may or may not be beyond and beside it which our senses are incapable of appreciating.

*The Limits of Science*  
*Science*, Volume 18, Number 448, July 31, 1903 (p. 144)

**Spencer, Herbert** 1820–1903  
English social philosopher

If we contemplate the order of nature, we see that everywhere vast results are brought about by accumulations of minute actions.

*The Study of Sociology*  
Conclusion (pp. 366–367)  
D. Appleton & Co. New York, New York, USA. 1873



**NATURE, PART OF****Rey, Hans Augusto** 1898–1977

Author and illustrator of children's books

No matter what part of nature one studies – microbes or Milky Ways – there is a point where one begins, but never an end.

*The Stars: A New Way to See Them*

Part 4 (p. 108)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**NATURE, PASSIONS OF****Bloom, James Harvey**

No biographical data available

What man who can witness unmoved the moods and passions of Nature, whether seen in some mighty cataclysm or in the pure calm of moonlit landscape, must be very strangely composed; but in Nature's many varied colourings and harmonies what more glorious than her lavish display of flower and fruit, some long stretch of hillside sheeted with golden gorse or dyed by the setting sun with a thousand purpling shades of ling and heather, where all things – rock, foliage, and sky – speak alike the glory of the Divine Father?

*Shakespeare's Garden*

Introduction (p. 1)

Methuen &amp; Co. London, England. 1903

**NATURE, PHENOMENA OF****Herschel, Friedrich Wilhelm****(Sir William)** 1738–1822

English astronomer

The phenomena of nature, especially those that fall under the inspection of the astronomer, are to be viewed, not only with the usual attention to facts as they occur, but with the eye of reason and experience.

An Account of Three Volcanoes in the Moon

*Philosophical Transactions of the Royal Society of London*,

Volume 67, 1787 (p. 229)

**Horne, George** 1730–92

English divine

I wish we could derive the rest of the phenomena of nature by the same kind of reasoning from mechanical principles; for I am induced by many reasons to suspect that they may all depend on certain forces by which the particles of bodies, by some causes hitherto unknown, are either mutually impelled towards each other, and cohere in regular figures, or are repelled and recede from each other; which forces being unknown, philosophers have hitherto attempted the search of nature in vain; but I hope the principles here laid down will

afford some light either to that or some truer method of philosophy.

*The Works of the Right Reverend George Horne* (Volume 1)*State of the Case Between Sir Isaac Newton and Mr. Hutchinson*

(pp. 465–466)

Printed for F.C. &amp; J. Rivington. London, England. 1818

**Huggins, Sir William** 1824–1910

English astronomer

Since the time of Newton our knowledge of the phenomena of nature has wonderfully increased, but man asks, perhaps more earnestly now than in his days, What is the ultimate reality behind the reality of the perceptions? Are they only the pebbles of the beach with which we have been playing? Does not the ocean of ultimate reality and truth lie beyond?

*Annual Report of the Board of Regents of the Smithsonian Institution, 1891*

Celestial Spectroscopy (p. 102)

Government Printing Office. Washington, D.C. 1893

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

I wish we could derive the rest of the phenomena of Nature by the same kind of reasoning from mechanical principles, for I am induced by many reasons to suspect that they may all depend upon certain forces by which the particles of bodies, by some causes hitherto unknown, are either mutually impelled toward one another, and cohere in regular rigors, or are repelled and recede from one another.

In *Great Books of the Western World* (Volume 34)*Mathematical Principles*

Preface to the First Edition (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Winchell, Alexander** 1824–91

American geologist

The phenomena of Nature are the premises of our reasoning instead of its conclusions. We have learned to look upon Nature with a profounder respect; and, though the alphabet of our philosophy be trees, and birds, and rocks, and fossils, and other material things which metaphysics affects to despise, we have found that they combine themselves into a language freighted with grand conceptions, and rich in utterances of the unseen, the high, and the holy.

*Sketches of Creation*

Chapter I (p. 15)

Harper &amp; Brothers Publishers. New York, New York, USA. 1870

**NATURE, PHILOSOPHY OF****Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

It is in the philosophy of nature that the natural history of this earth is to be studied; and we must not

allow ourselves ever to reason without proper data, or to fabricate a system of apparent wisdom in the folly of a hypothetical delusion.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter XIV (p. 564)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

## NATURE, PLAN OF

**Winchell, Alexander** 1824–91

American geologist

Anything which is a plan has been thought out. The plans of Nature are the expressions of the mind.

*Walks and Talks in the Geological Field*

Chapter XXXII (p. 190)

Chautauqua Press. New York, New York, USA. 1890

## NATURE, POWER OF

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

If we knew all the powers of nature, and all the different conditions in which those powers may have their action varied, that is to say, if we were acquainted with every physical cause, then every natural effect, or all appearances upon the surface of this earth, might be explained in a theory that were just.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter III (p. 298)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**White, George Starr**

No biographical data available

The secret powers of NATURE ar [sic] generally discovered unsolicited.

*Prostatic Disease [sic] and Impotency*

Introduction (p. vii)

Los Angeles, California, USA. 1919

## NATURE, PRESENCE OF

**Hamerton, Philip Gilbert** 1834–94

English artist and art critic

The whole subject of landscape is a world of illusions, the only thing about it that is certainly not an illusion belong the effect upon the mind of each particular human being who fancies that he sees something, and *knows* that he feels something, when he stands in the presence of Nature.

*Landscape*

Chapter II (p. 13)

Roberts Brothers. Boston, Massachusetts, USA. 1885

## NATURE, PROCESS OF

**Maclaurin, Colin** 1698–1746

Scottish mathematician and natural philosopher

The processes of nature lie so deep, that, after all the pains we can take, much, perhaps, will remain undiscovered beyond the reach of human art or skill. But this is no reason why we should give ourselves up to the belief of fictions, be they ever so ingenious, instead of hearkening to the unerring voice of nature...

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books*

Book I, Chapter I (p. 12)

Printed for the Author's Children. London, England. 1748

## NATURE, PROFUSENESS OF

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

there are certain patches of ground, which, having lain neglected for a time, Nature, who always has her pockets full of seeds, and holes in all her pockets, has covered with hungry plebeian growths, which fight for life with each other, until some of them get broadleaved and succulent, and you have a coarse vegetable tapestry which Raphael would not have disdained to spread over the foreground of his masterpiece.

*The Autocrat of the Breakfast-table*

Chapter XII (p. 278)

A.L. Burt Co. New York, New York, USA. 1900

## NATURE, PROGRESS OF

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

The progress of Nature is effected by steps that are often imperceptible and blend into one another with the utmost gentleness...

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 158)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Porter, Jermain Gildersleeve** 1852–1933

Astronomer

The progress of civilization tends to wean us away from nature. We do indeed make use of her forces and her laws, but the knowledge and skill which such use implies and necessitates are confined mostly to scientists and inventors; and the scientific spirit which insists on uncovering all the secret springs of the cosmos reacts also on the popular mind and leads to unromantic views of nature. The rising and setting of the sun, the waxing and waning

of the moon, the solemn march of the glittering star host across the firmament, are taken as matters of course and excite no wonder and inspire no awe.

*The Stars in Song and Legend*

Introduction (p. xi)

Ginn & Co. Boston, Massachusetts, USA. 1901

## NATURE, REALITY OF

**Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

...if the nature of reality is revealed to us, albeit fleetingly and uncertainly, in aesthetic and mystical experience, if we are entitled to conceive it as the artist conceives the beauty that excites, or the mystic the Deity that awes him, our conception of it must be governed by two conditions. We must not conceive it in the likeness of ourselves, and we must not conceive it as capable of oneness of being with ourselves.

*Philosophical Aspects of Modern Science*

Chapter XI (p. 339)

G. Allen & Unwin Ltd. London, England. 1932

## NATURE, REALM OF

**Müller, Johann Heinrich Jacob** 1809–75

Physicist

The grand spectacle that is ever present to our eyes in the vast realm of nature excites within us so ardent a thirst for knowledge, that we feel ourselves irresistibly impelled to the consideration of the combined causes that have produced these wondrous results.

*Principles of Physics and Meteorology*

Introduction (p. 1)

Hippolyte Bailliere. London, England. 1847

## NATURE, RICHES OF

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

We shall never succeed in exhausting the immeasurable riches of nature; and no generation of men will ever have cause to boast of having comprehended the total aggregation of phenomena.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 73)

Harper & Brothers. New York, New York, USA. 1869

## NATURE, RULES OF

**Ford, Kenneth William** 1926–

Physicist

One of the elementary rules of nature is that, in the absence of a law prohibiting an event or phenomenon,

it is bound to occur with some degree of probability. To put it simply and crudely: Anything that can happen does happen.

Magnetic Monopoles

*Scientific American*, Volume 209, Number 6, December, 1963 (p. 122)

**Musser, George**

No biographical data available

The basic rules of nature are simple, but their consummation may never lose its ability to surprise.

From the Editors

*Scientific American*, Volume 280, Number 1, January, 1999 (p. 6)

## NATURE, SAVAGE

**Goldsmith, Oliver** 1728–74

Anglo-Irish writer, poet, and physician

The first desires of savage nature are merely to gratify the importunities of sensual appetite, and to neglect the contemplation of things, barely satisfied with their enjoyment: the beauties of nature, and all the wonders of creation, have but little charms for a being taken up in obviating the wants of the day, and anxious for precarious subsistence.

*A History of the Earth and Animated Nature* (Volume 1)

Chapter I (p. 9)

Claxton, Remson & Haffelfinger. Philadelphia, Pennsylvania, USA.

1875

## NATURE, SCIENCE OF

**Porter, Noah** 1811–92

American educator and philosopher

...an inductive science of nature presupposes a science of induction, and a science of induction presupposes a science of man.

*The Sciences of Nature Versus the Science of Man* (p. 29)

Dodd & Mead. New York, New York, USA. 1871

## NATURE, SECRET OF

**Bergman, Torbern Olaf** 1735–84

Swedish chemist and naturalist

The philosophical method, by pretending to unlock the secrets of nature with ease and expedition, soothes a natural impulse to explain all things; and by assuming everything to be accessible to the human intelligence, administers pleasing flattery to vanity and arrogance.

Quoted in Joseph William Mellor

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry* (Volume I)

Chapter I (p. 4)

Longman, Green & Co. London, England. 1922

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

The secrets of Nature are...reserved for those who seek them purely for the love of truth and desire for understanding. The “just and faithful knight” can see Nature unveiled and pass into the spiritual city of science, where purer joys than all earthly fame can give will be his prize.

*Discovery, Or, The Spirit and Service of Science*  
Chapter III (p. 55)  
Macmillan & Co Ltd. London, England. 1916

**Petrarch (Francesco Petrarca)** 1304–74  
Italian poet and humanist

There are fools who seek to understand the secrets of nature.

In Richard Olson  
*Science Deified and Science Defied: The Historical Significance of Science in Western Culture* (Volume 1)  
Chapter 7 (p. 210)  
University of California Press. Berkeley, California, USA. 1982

## NATURE, SIGHTS OF

**Curie, Marie Skłodowska** 1867–1934  
Polish-born French physical chemist

All my life through, the new sights of Nature made me rejoice like a child.

*Pierre Curie*  
Autobiographical Notes  
Chapter I (p. 162)  
The Macmillan Company. New York, New York, USA. 1926

## NATURE, SIMPLICITY OF

**Spottiswoode, William** 1825–83  
English mathematician and physicist

...the simplicity of nature which we at present grasp is really the result of infinite complexity; and that below the uniformity there underlies a diversity whose depths we have not yet probed, and whose secret places are still beyond our reach.

*Report of the Forty-eighth Meeting of the British Association for the Advancement of Science*  
Address of William Spottiswoode (p. 16)  
John Murray. London, England. 1879

## NATURE, SPIRIT OF

**Jefferies, Richard** 1848–87  
English naturalist and author

The forest is gone; but the spirit of nature stays...and will always be ...

*The Open Air*  
Outside London (p. 218)  
Chatto & Windus. London, England. 1908

## NATURE, STUDENT OF

**Huxley, Thomas Henry** 1825–95  
English biologist

The student of Nature wonders the more and is astonished the less, the more conversant he becomes with her operations; but of all the perennial miracles she offers to his inspection, perhaps the most worthy of admiration is the development of a plant or of an animal from its embryo.

*Darwiniana*  
The Origin of Species (p. 29)  
D. Appleton & Co. New York, New York, USA. 1896

## NATURE, STUDY OF

**Adams, George** 1750–95  
English instrument maker

The study of nature is as much distinguished from other subjects by the importance of its matter, as by the variety of its topics.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XII (p. 1)  
Printed by R. Hindmarsh. London, England. 1794

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The study of nature is an intercourse with the highest mind. You should never trifle with nature. At the lowest her works are the works of the highest powers – the highest something, in whatever way we may look at it.

In David Stair Jordan  
*Popular Science Monthly*, Volume 40, 1891

...in the study of Nature, we may be astonished at the infinite variety of her products; we may even study some portion of her works with enthusiasm, and nevertheless remain strangers to the spirit of the whole, ignorant of the plan on which it is based, and fail to acquire a proper conception of the varied affinities which combine beings together, so as to make of them that vast picture in which each animal, each plant, each group, each class, has its place, and from which nothing could be removed without destroying the proper meaning of the whole.

*Principles of Zoology*  
Chapter First (p. 26)  
Gould & Lincoln. Boston, Massachusetts, USA. 1867

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

**Gould, Augustus Addison** 1805–66  
American conchologist

So, in the study of Nature, we may be astonished at the infinite variety of her products; we may even study some portion of her works with enthusiasm, and nevertheless

remain strangers to the spirit of the whole, ignorant of the plan on which it is based, and fail to acquire a proper conception of the varied affinities which combine beings together, so as to make of them that vast picture in which each animal, each plant, each group, each class, has its place, and from which nothing could be removed without destroying the proper meaning of the whole.

*Principles of Zoology*

Chapter First (p. 26)

Gould & Lincoln. Boston, Massachusetts, USA. 1870

**Bucke, Charles** 1781–1846

English writer

I have ever had an inclination towards the study of Nature, and found inexhaustible delight in the contemplation of her varied phenomena. Never do I behold a beautiful landscape, but it is fixed so firmly in my mind that I could write a description of it at any distance of time. The features of men I frequently forget; those of the natural world, never.

*On the Beauties, Harmonies, and Sublimities of Nature*

Preface (p. v)

Harper & Brothers Publishers. New York, New York, USA. 1841

No pleasures are so pure – and none so worthy the capacities of the human mind, as those derived from the study of Nature. And though nothing is entirely within our limited comprehension, yet, as things seen afford presumptive evidence in regard to things unseen, what more noble employment than to trace in the beauties, harmonies, and sublimities of the material universe those proofs of power, wisdom, and goodness which lead to the acknowledgment and adoration of the Supreme Architect!

*On the Beauties, Harmonies, and Sublimities of Nature*

Preface (p. ix)

Harper & Brothers Publishers. New York, New York, USA. 1841

**Chargaff, Erwin** 1905–2002

Austrian biochemist

What makes the study of nature so magnificent is its very givenness; it is because it is; it is as it is; and tolle, lege! (pick up and read!) remains its eternal admonition.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 3 (pp. 18–19)

The Seabury Press. New York, New York, USA. 1977

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

In the study of Nature conjecture must be entirely put aside, and vague hypothesis carefully guarded against. The study of Nature begins with facts, ascends to laws, and raises itself, as far as the limits of man's intellect will permit, to the knowledge of causes, by the threefold means of observation, experiment and logical deduction. In Faraday Lectures

*Lectures Delivered Before the Chemical Society*

The First Faraday Lecture (p. 2)

The Chemical Society. London, England. 1928

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The study of Nature is elevating, and its material value is of the highest, yet it is deplorably neglected with the result that only very rarely is the simplest scientific subject referred to accurately in the works of literary men.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 13)

Macmillan & Company Ltd. London, England. 1918

**Holton, Gerald** 1922–

Research professor of physics and science history

The study of nature is a study of the artifacts that appear during an engagement between the scientist and the world in which he finds himself.

*The Roots of the Complementarity*

*Daedalus*, Number 4, Fall 1970 (p. 1019)

**Huggins, Sir William** 1824–1910

English astronomer

One of the great charms of the study of Nature lies in the circumstance that no new advance, however small, is ever final. There are no blind alleys in scientific investigation. Every new fact is the opening of a new path.

*Photographic Spectra of Stars* (p. 12)

Oxford, England. February 6, 1880

**Kant, Immanuel** 1724–1804

German philosopher

...in every study of nature there can be only so much genuine science as there is a priori knowledge, by the same token, natural philosophy will contain genuine science only to the extent in which mathematics can be applied to it.

Translated by James Ellington

*Metaphysical Foundations of Natural Science*

Preface (p. 7)

The Bobbs–Merrill Company, Inc. Indianapolis, Indiana, USA. 1970

**Thierry, Paul Henri, Baron d'Holbach** 1723–89

German-born French man of leisure

...man disdains the study of nature, to pursue phantoms, which resemble the Will with the Wisp, which at once terrifies and dazzles the benighted traveler, and which make him quit the simple road to truth, without pursuing which, he can never arrive at happiness.

Translated by M. Mirabaud

*System of Nature or, The Laws of the Moral and Physical World* (Volume 1)

Preface by the Author (p. vii)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

The higher enjoyments yielded by the study of nature depend upon the correctness and the depth of our views,



and upon the extent of the subjects that may be comprehended in a single glance.

*Cosmos* (Volume I)

Introduction (p. 18)

Henry G. Bohn. London, England. 1849

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The study of Nature makes a man at last as remorseless as Nature.

*Seven Science Fiction Novels of H. G. Wells*

*The Island of Dr. Moreau*

Chapter the Fourteenth (p. 134)

Dover Publications, Inc. New York, New York, USA. 1934

## NATURE, SYSTEM OF

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Surely, if there is in the system of nature wisdom, we may look for compensation between the destroying and repairing operations of the globe.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter VII (p. 221)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Swift, Jonathan** 1667–1745

Irish-born English writer

He said that new systems of nature were but new fashions, which would vary in every age; and even those who pretend to demonstrate them from mathematical principles, would flourish but a short period of time, and be out of vogue when that [system of nature] was determined.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter VIII (pp. 118–119)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Winchell, Alexander** 1824–91

American geologist

It has been revealed to us that the vast system of Nature is the expression of a divine thought – that the wide, blue, restless ocean is the symbol of a divine idea – the swelling prairie, the rocky cordillera, the teeming populations of land, and sea, and air, are the utterances of divine conceptions – the stirring leaf, the basking butterfly, the glistening pebble on the strand, are thoughts of the Infinite, crystallized in visible things, thrown down before us to arrest our attention – strewn over our pathway to provoke our curiosity and arouse the powers of the soul.

*Sketches of Creation*

Chapter I (pp. 15–16)

Harper & Brothers Publishers. New York, New York, USA. 1870

## NATURE, TEMPLE OF

**Jaeger, Benedict** 1789–1869

Austrian-born American entomologist

As no human eye can ever penetrate the spangled heavens that roll over us, covered with ruby and sapphire, and the thousand changing tints that dye the firmament – as no created being can ever bring into his scope of vision that illimitable space, where the glittering stars unceasingly twinkle and glow, and where, o'reaching all, the Milky Way presents the blended light of billions of shining worlds – so no human mind can ever attain perfection in the knowledge of those countless animated beings which surround man in the vast green temple of Nature.

*The Life of North American Insects*

ORDER II (p. 62)

Harper & Brothers Publishers. New York, New York, USA. 1859

## NATURE, THINK OF

**Ovrut, Burt**

Physicist

You can think of it [matter] as a violin string or a guitar string. If you pluck it in a certain way you get a certain frequency, but if you pluck it a different way you can get more frequencies on this string and in fact you have different notes. Nature is made of all the little notes, the musical notes, that are played on these super-strings.

Parallel Universes

BBC broadcast February 14, 2002

## NATURE, TREASURES OF

**Jefferies, Richard** 1848–87

English naturalist and author

...Nature flings treasures abroad, puffs them with open lips along on every breeze, piles up lavish layers of them in the free open air, packs countless numbers together in the needles of a fir-tree. Prodigality and superfluity are stamped on everything she does. The ear of wheat returns a hundredfold the grain from which it grew. The surface of the earth offers to us far more than we can consume – the grains, the seeds, the fruits, the animals, the abounding products are beyond the power of all the human race to devour. They can, too, be multiplied a thousandfold. There is no natural lack. Whenever there is lack among us it is from artificial causes, which intelligence should remove. From the littleness, and meanness, and niggardliness forced upon us by circumstances, what a relief to turn aside to the exceeding plenty of Nature! There are no bounds to it, there is no comparison to parallel it, so great is this generosity.

*The Life of the Fields*

Meadow Thoughts (p. 62)

Chatto & Windus. London, England. 1902



**Kett, Henry** 1761–1825  
English college teacher and writer

...the treasures of nature...are so rich and inexhaustible, that they may furnish employment for his greatest diligence, stimulated by the most ardent curiosity, and assisted by the most favourable opportunities.

*Elements of General Knowledge* (Volume 2)

Chapter IV (p. 89)

Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

## NATURE, UNDERSTANDING OF

### Ferguson, Marilyn

Real progress in understanding nature is rarely incremental. All important advances are sudden intuitions, new principles, new ways of seeing. We have not fully recognized this process of leaping ahead, however, in part because textbooks tend to tame revolutions, whether cultural or scientific. They describe the advances as if they had been logical in their day, not at all shocking.

*The Aquarian Conspiracy*

## NATURE, VARIETY OF

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

In the infinite variety of nature many ordinary events occur; while others appear uncommon, perplexing, astonishing, or even contradictory to the ordinary run of things. As long as this is the case we do not possess a well-settled and unitary conception of nature.

*The Science of Mechanics* (5th edition)

Introduction (p. 6)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

## NATURE, VIEW OF

**Adams, George** 1750–  
English instrument maker

...our views of nature are like the map of an inland country, where you see rivers without any sources continually discharging their waters without a sea to receive them; roads that you know not whence they come, nor whither they go; mountains, forests, and plains, cut off in the middle by the marginal lines of the paper: but even of those things which we know well, there is much that surpasses the extent of our faculties.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXXV (pp. 510–511)

Printed by R. Hindmarsh. London, England. 1794

**Maclaurin, Colin** 1838–1916  
Scottish mathematician

Our views of nature, however imperfect, serve to represent to us, in a most sensible manner, that mighty power which prevails throughout, acting with a force and efficacy that suffers no diminution from the greatest distances of space, or intervals of time; and to prove that all things are ordered by infinite wisdom and perfect goodness; scenes which should excite and animate us to correspond with the general harmony of nature.

*An Account of Sir Isaac Newton's Philosophical Discoveries*

Chapter I Section 5

London, England. 1748

## NATURE, VISIBLE

**James, William** 1842–1910  
American philosopher and psychologist

Visible nature is all plasticity and indifference – a moral multiverse...and not a moral universe. To such a harlot we owe no allegiance; with her as a whole we can establish no moral communion; and we are free in our dealing with her several parts to obey or to destroy, and to follow no law but that of prudence in coming to terms with such of her particular features as will help us to our private ends.

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living? (p. 43)

Dover Publications, Inc. New York, New York, USA. 1956

## NATURE, VOICE OF

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

These are the three voices of Nature. She joins hands with us; and says Struggle, Endeavor. She comes close to us, we hear her heart beating; she says Wonder, Enjoy, Revere. She whispers secrets to us, we cannot always catch her words; she says Search, Enquire. These three voices appeal to Hand and Heart and Head, to the trinity of our being.

*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* (Volume 2)

Lecture XX (p. 648)

Henry Holt & Co. New York, New York, USA. 1920

**Tyndall, John** 1820–93  
Irish-born English physicist

No human authority, however high, can maintain itself against the voice of Nature speaking through experiment. But the voice of Nature may be an uncertain voice, through the scantiness of data.

*Six Lectures on Light Delivered in America in 1872–1873*

Lecture II (p. 49)

D. Appleton & Co. New York, New York, USA. 1901

**NATURE, VOLUME OF****Hutton, W.**

No biographical data available

Every page of the volume of Nature is fraught with instruction.

*The Book of Nature Laid Open*

Chapter I (p. 1)

Joseph Milligan. Georgetown, Virginia, USA. 1822

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

Whatever we may think or believe, the volume of Nature contains nothing but truth. It is, in fact, God's manuscript, which awaits interpreters, and which, if read aright, leaves nothing to conjecture.

*Nature and Culture*

Chapter 1 (p. 8)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**NATURE, WAYS OF****Mann, Charles Riborg** 1869–1942

Physicist

**Twiss, George Ransom**

No biographical data available

He who knows the ways of Nature and is able to reason most clearly about them is the one who can best control her forces.

*Physics*

Part I, Chapter I (p. 17)

Scott Foresman & Co. New York, New York, USA. 1910

**NATURE, WILD THINGS OF****Cott, Hugh Bamford** 1900–87

British zoologist

...fortunate are those who have learned to see, in the wild things of nature, something to be loved, something to be wondered at, something to be revered, for they will have found the key to a never-failing source of recreation and refreshment.

*Adaptive Colouration in Animals*

Preface (p. xvi)

Methuen. London, England. 1957

**NATURE, WISDOM OF****Copernicus, Nicolaus** 1473–1543

Polish astronomer

But we should rather follow the wisdom of nature, which, as it takes very great care not to have produced anything

superfluous or useless, often prefers to endow one thing with many effects.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Chapter 10 (p. 526)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**NATURE, WONDERS OF****Darwin, Charles Robert** 1809–82

English naturalist

Truly the schemes and wonders of Nature are illimitable.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to C. Lyell, September 14, 1849 (p. 345)

D. Appleton & Company. New York, New York, USA. 1896

**Duke of Argyll (George Douglas****Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

Among the many wonders of Nature there is nothing more wonderful than this the adaptability of the one Vertebrate Type to the infinite variety of Life to which it serves as an organ and a home.

*The Reign of Law* (4th American edition)

Chapter IV (p. 206)

George Routledge & Sons. New York, New York, USA. 1873

**Kingsley, Charles** 1819–75

English clergyman and writer

I have so long enjoyed the wonders of nature; never, I can honestly say, alone; because when man was not with me, I had companions in every bee, and flower, and pebble; and never idle, because I could not pass a swamp, or a tuft of heather, without finding in it a fairy tale of which I could but decipher here and there a line or two, and yet found them more interesting than all the books, save one, which were ever written upon earth.

*Scientific Lectures and Essays*

How to Study Natural History (p. 310)

Macmillan & Company Ltd. London, England. 1893

**Wallace, Alfred Russel** 1820–1913

English humanist, naturalist, and geographer

The wonders of Nature have been the delight and solace of my life. From the day when I first saw a bee-orchis in ignorant astonishment, to my first view of the grand forests of the Amazon; thence to the Malay Archipelago, where every fresh island with its marvellous novelties and beauties was an additional delight – Nature has afforded me an ever-increasing rapture, and the attempt to solve some of her myriad problems an ever-growing sense of mystery and awe.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter I (p. 18)

Macmillan & Co Ltd. London, England. 1916

**NATURE, WORKS OF**

**Atterbury, Francis** 1662–1732  
English prelate

...the works of nature will bear a thousand views and reviews: the more frequently and narrowly we look into them, the more occasion we shall have to admire their beauty.

*Sermons and Discourses on Several Subjects and Occasions* (Volume 2)  
Sermon II (p. 25)  
Printed for John Cuthell. London, England. 1820

**Darwin, Charles Robert** 1809–82  
English naturalist

What a book a devil's chaplain might write on the clumsy, wasteful, blundering, low, and horribly cruel works of nature.

*More Letters of Charles Darwin*  
Letter To J.D. Hooker, 13 July, 1856 (p. 94)  
D. Appleton and Company. New York, New York, USA. 1903

**Kett, Henry** 1761–1825  
English college teacher and writer

The study of the works of nature is in itself capable of affording the most refined pleasure, and the most edifying instruction. All the objects with which we are surrounded, the smallest as well as the greatest, teach us some useful lesson. All of them speak a language directed to man, and to man alone.

*Elements of General Knowledge* (Volume 2)  
Chapter IV (p. 89)  
Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**NATURE, WORLD OF**

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Despite all the richness of what men have learned about the world of nature, of matter and of space, of change and of life, we carry with us today an image of the giant machine as a sign of what the objective world is really like.

*Science and the Common Understanding*  
Chapter I (pp. 14–15)  
Simon & Schuster. New York, New York, USA. 1954

**NATURE, WORSHIP OF**

**O'Rourke, P. J.** 1947–  
Political satirist

Worship of nature may be ancient, but seeing nature as cuddlesome, hug-a-bear and too cute for words is strictly a modern fashion.

*Parliament of Whores: A Lone Humorist Attempts to Explain the Entire U.S. Government*  
Dirt of the Earth (p. 196)  
Vintage Books. New York, New York, USA. 1992

**NATURE AND ART**

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

It is the end of art to inoculate men with the love of nature. But those who have a passion for nature in the natural way, need no pictures nor galleries. Spring is their designer, and the whole year their artist.

*Star Papers*  
Experiences of Nature, I (p. 94)  
J.B. Ford & Co. New York, New York, USA. 1873

**Malan, Solomon Caesar** 1812–94  
British divine and orientalist

Nature is Truth; and Art is but a poor attempt at an imitation of it.

*Aphorisms on Drawing*  
X (p. 17)  
Longman, Brown, Green, Longmans & Roberts. London, England. 1856

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Nature has made all her truths independent of one another. Our art makes one dependent on the other. But this is hot natural. Each keeps its own place.

Translated by William Finlayson Trotter  
*Thoughts*  
Number 21 (p. 14)  
P.F. Collier & Son. New York, New York, USA. 1910

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Nature is always mysterious and secret in her use of means; and art is always likest her when it is most inexplicable.

*Modern Painters* (Volume 1)  
Section II, Chapter II (p. 36)  
Smith, Elder & Co. London, England. 1873

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Nature is no great mother who has borne us. She is our creation. It is our brain that she quickens to life. Things are because we see them, and what we see, and how we see it, depends on the Arts that have influenced us.

*Intentions*  
The Decay of Lying (p. 41)  
Brentano's. New York, New York, USA. 1905

## NATURE AND POETRY

### Apollinaire, Guillaume (Wilhelm Apollinaris de Kostrowitzki) 1880–1918

Polish-Italian avant-garde poet

Without poets, without artists, men would soon weary of nature's monotony.

Translated by Lionel Abel

*The Cubist Painters*

On Painting (p. 13)

Wittenborn and Co. New York, New York, USA. 1944

### Munroe, J.

No biographical data available

We cannot enjoy to the full the beauty of the rose for thinking of its cellular tissue, and the tender hues of sunset lose their poetic spell because they remind us of the refraction of light. And yet, as we have said, the scientific and the poetical views of Nature ought not, in a well-regulated mind, to war with each other.

Science and the Sense of Beauty

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

Volume IV, (Third series), April, 1882 (pp. 204–205)

## NATURE AND RELIGION

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

Assuredly there is no more lovely worship of God than that for which no image is required, but which springs up in our breast spontaneously, when nature speaks to the soul, and the soul speaks to nature face to face.

In John Stuart Blackie

*The Wisdom of Goethe*

Nature – Natural History (p. 187)

William Blackwood & Sons. Edinburgh, Scotland. 1883

## NATURE IS

### Abbey, Edward 1927–89

American environmentalist and nature writer

Nature is indifferent to our love, but never unfaithful.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 86)

St. Martin's Press. New York, New York, USA. 1989

Nature, like Maimonides said, is mainly a good place to throw beer cans on Sunday afternoons.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 83)

St. Martin's Press. New York, New York, USA. 1989

### Adams, Abby 1939–

American astronaut and solar physicist

Nature is what wins in the end.

*The Gardener's Gripe Book*

What Is a Garden Anyway? (p. 10)

Workman Publishing. New York, New York, USA. 1995

### Alcott, Amos Bronson 1799–1888

American educational and social reformer

Nature is the armory of genius. Cities serve it poorly, books and colleges at second hand; the eye craves the spectacle of the horizon; of mountain, ocean, river and plain, the clouds and star; actual contact with the elements, sympathy with the seasons as they rise and roll.

*The Journals of Bronson Alcott*

January (Undated.) (p. 187)

Little, Brown & Co. Boston, Massachusetts, USA. 1938

Nature is thought immersed in matter ...

Pantheon

*The Journal of Speculative Philosophy*, Volume II, Number 1, 1868 (p. 47)

### Armstrong, L. O.

No biographical data available

Nature is a good mother, but she sternly resists any interference with her prerogatives.

*Report of the Fifth Annual Meeting of the Canadian Forestry Association*

The Lovers of Out-Of-Doors Life and the Forests (p. 113)

Government Printing Office. Ottawa, Canada. 1904

### Atherton, Gertrude 1857–1948

American novelist

Nature is a wicked old matchmaker.

*Senator North*

Book II, VII (p. 174)

John Lane: The Bodley Head. New York, New York, USA. 1900

### Besant, Anne 1847–1933

English social reformer

Nature is always lavish of her gifts even to the most insignificant forms. The butterflies and moths are richly dowered in this respect.

The Clothes' Moth

*Our Corner*, Volume 4, Number 1, July, 1884 (p. 40)

### Beston, Henry 1888–1968

American writer

Nature is a part of our humanity, and without some awareness and experience of that divine mystery, man ceases to be man.

*The Outermost House*

Forward (p. ix)

Rinehart & Company. New York, New York, USA. 1928

### Borland, Hal 1900–78

American writer

There are some things, but not too many, toward which the countryman knows he must be properly respectful if he would avoid pain, sickness, and injury. Nature is neither punitive nor solicitous, but she has thorns and fangs as well as bowers and grassy banks.

*Beyond Your Doorstep: A Handbook to the Country*

Chapter 13 (p. 303)

Alfred A. Knopf. New York, New York, USA. 1962

Nature is an infinitely complex series of facts; it is not an object lesson, and it is not a ready-made sermon on conduct or morality.

*The Enduring Pattern*

A Place to Live: Time (p. 20)

Simon & Schuster. New York, New York, USA. 1959

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Nature is a network of happenings that do not unroll like a red carpet into time, but are intertwined between every part of the world; and we are among those parts. In this nexus, we cannot reach certainty because it is not there to be reached; it goes with the wrong model, and the certain answers ironically are the wrong answers. Certainty is a demand that is made by philosophers who contemplate the world from outside; and scientific knowledge is knowledge for action, not contemplation. There is no God's eye view of nature, in relativity, or in any science: only a man's eye view.

*The Identity of Man*

The Machinery of Nature, Section 6 (p. 38)

Doubleday & Company, Inc. Garden City, New York, USA. 1972

**Bryan, J. Ingram**

No biographical data available

Nature is not static but dynamic; she is not now what she will be, for she moves toward a goal.

*The Interpretation of Nature in English Poetry*

Chapter I (p. 7)

Kaitakusha. Tokyo, Japan. 1932

**Burroughs, John** 1837–1921

American naturalist and writer

Nature is not benevolent; Nature is just, gives pound for pound, measure for measure, makes no exceptions, never tempers her decrees with mercy, or winks at any infringement of her laws.

*Harvest of a Quiet Eye: The Natural World of John Burroughs*

The Gospel of Nature, 5 (p. 149)

Tamarack Press. Madison, Wisconsin, USA. 1976

**Carlyle, Thomas** 1795–1881

English historian and essayist

Nature, like the Sphinx, is of womanly celestial loveliness and tenderness; the face and bosom of a goddess, but ending in claws and the body of a lioness.... Nature, Universe, Destiny, Existence, howsoever we name this grand unnamable Fact in the midst of which we live and struggle, is as a heavenly bride and conquest to the wise and brave, to them who can discern her behests and do them; a destroying fiend to them who cannot.

*Past and Present*

Chapter II (p. 7)

Chapman & Hall. London, England. 1843

**Carus, Carl Gustav** 1789–1869

German physiologist and painter

[Nature is] that which is ever growing and ever unfolding itself in new forms.

Quoted in Alexander von Humboldt

*Cosmos* (Volume I)

Introduction (p. 21)

Henry G. Bohn. London, England. 1849

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

Unfortunately, nature is very much a now-you-see-it, now-you-don't affair. A fish flashes, then dissolves in the water before my eyes like so much salt. Deer apparently ascend bodily into heaven; the brightest oriole fades into leaves.

*Pilgrim at Tinker Creek*

Chapter 2 (p. 16)

Harper's Magazine Press. New York, New York, USA. 1974

**Douglas, Andrew Ellicott** 1867–1962

American astronomer

Nature is a book of many pages and each page tells a fascinating story to him who learns her language. Our fertile valleys and craggy mountains recite an epic poem of geologic conflicts. The starry sky reveals gigantic suns and space and time without end.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1922*

Some Aspects of the Use of the Annual Rings of Trees in Climatic Study (p. 223)

Government Printing Office. Washington, D.C. 1924

Nature is, above all, profligate. Don't believe them when they tell you how economical and thrifty nature is, whose leaves return to the soil. Wouldn't it be cheaper to leave them on the tree in the first place?

*Pilgrim at Tinker Creek*

Chapter 4, II (p. 65)

Harper's Magazine Press. New York, New York, USA. 1974

The general rule in nature is that live things are soft within and rigid without. We vertebrates are living dangerously...like so many peeled trees.

*Pilgrim at Tinker Creek*

Chapter 6, II (p. 91)

Harper's Magazine Press. New York, New York, USA. 1974

**Draper, John William** 1811–82

American scientist, philosopher, and historian

As a cataract shows from year to year an invariable shape, though the water composing it is perpetually changing, so the aspect of Nature is nothing more than a flow of matter presenting an impermanent form. The universe considered as a whole is unchangeable. Nothing is eternal but space, atoms, force. The forms of

Nature that we see are essentially transitory, they must all pass away.

*History of the Conflict between Religion and Science*

Chapter I (p. 24)

D. Appleton & Company. New York, New York, USA. 1898

**Durell, Clement V.** 1882–1968

English mathematician

Nature is a conjurer for supermen. Generations of scientists have attempted to penetrate her secrets. Bit by bit the disguise is being torn away, but each new discovery seems only to open out fresh avenues demanding further exploration. Nature is a true woman, who will have the last word.

*Readable Relativity*

Chapter I (p. 9)

Harper & Brothers. New York, New York, USA. 1960

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Nature is a rag-merchant, who works up every shred and ort and end into new creations; like a good chemist, whom I found, the other day, in his laboratory, converting his old shirts into pure white sugar.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Considerations by the Way (p. 1088)

The Library of America. New York, New York, USA. 1983

Nature is an endless combination and repetition of a very few laws. She hums the old well-known air through innumerable variations.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

History (p. 243)

The Library of America. New York, New York, USA. 1983

Nature is no spendthrift, but takes the shortest way to her ends.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Fate (p. 961)

The Library of America. New York, New York, USA. 1983

Nature is a mutable cloud which is always and never the same.

*Essays*

History (p. 18)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1888

Nothing bizarre, nothing whimsical will endure. Nature is ever interfering with Art. You cannot build your house or pagoda as you will but as you must. Gravity, Wind, sun, rain, the size of men & animals, & such other aliens have more to say than the architect. Beneath the almighty necessity therefore I regard what is artificial in man's life & works as petty & insignificant by the side of what is natural. Every violation, every suicide, every miracle, every willfulness however large it may show near us,

melts quickly into the All, & at a distance is not seen. The outline is as smooth as the curve of the moon.... A writer must have l'abandon, he must be content to stand aside & let truth & beauty speak for him, or he cannot expect to be heard far.

*Journals of Ralph Waldo Emerson*

May 28, 1836 (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1910

Nature is full of a sublime family likeness throughout her works, and delights in startling us with resemblances in the most unexpected quarters.

*Essays: First Series*

Essay I (p. 20)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1884

Nature is a frugal mother, and never gives without measure.

In James Elliot Cabot

*A Memoir of Ralph Waldo Emerson (Volume 2)*

Appendix F (p. 779)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1887

To the dull mind all nature is leaden. To the illuminated mind the whole world burns and sparkles with light.

*Journals of Ralph Waldo Emerson: 1824–32*

May 20, 1831 (p. 381)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1909

**Flammarion, Camille** 1842–1925

French astronomer and writer

Nature is so varied in its modes of action, so multiple in the manifestations of its power, that we have no right to set any limits to its capabilities.

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter V (p. 134)

Chatto & Windus. London, England. 1894

Nature is immense in the little as in the great, or, to speak more correctly, for here there is neither little nor great.

*Popular Astronomy: A General Description of the Heavens*

Book III, Chapter II (p. 239)

Chatto & Windus. London, England. 1894

**Florio, John** 1553?–1625

English teacher, writer, and translator

Nature is the right law.

*Florio's Firste Fruites* (p. 88)

Taihoku Imperial University. Formosa, Japan. 1936

**Foster, Sir Michael** 1836–1907

English physiologist and educator

Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint, however small, to listen to her whisper, however low.

In J.A. Thomson

*Introduction to Science*

Chapter I (p. 16)

Williams & Norgate Ltd. London, England. 1916



**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

Nature is trying very hard to make us succeed, but nature does not depend on us. We are not the only experiment.  
*Minneapolis Tribune*, 30 April, 1978

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

[Nature] is a Katharine to be tamed by the Petruchil of Science rather than a Juliet to be worshiped by a love-sick Romeo.

*Discovery, Or, The Spirit and Service of Science*  
Chapter I (p. 5)  
Macmillan & Co Ltd. London, England. 1918

**Harvey, William** 1578–1657  
English physician

Nature...is the best and most faithful interpreter of her own secrets; and what she presents either more briefly or obscurely in one department, that she explains more fully and clearly in another.

In *Great Books of the Western World* (Volume 28)  
*Anatomical Exercises on the Generation of Animals*  
Dedication (p. 329)  
Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

Nature is herself to be addressed; the paths she shows us are to be boldly trodden; for thus, and whilst we consult our proper senses, from inferior advancing to superior levels, shall we penetrate at length into the heart of her mystery.

*The Works of William Harvey*  
Introduction (p. 153)  
Printed for the Sydenham Society. London, England. 1847

**Hastings, Horace Lorenzo** 1831–99  
No biographical data available

Nature is but the garment of Deity. Reason untwists a fringe, puzzles over a pattern, and investigates the frayed border of this royal robe, and slowly discovers some marks of wisdom and design in its wondrous texture; but faith looks up and adores the God who wove the whole magnificent fabric, spangled with the starry splendors of the skies, embroidered with auroras and rainbows and emeralds, and adorned with gems that gleam in the silent depths, unseen by human eyes.

*Atheism & Arithmetic: Or, Mathematical Law in Nature*  
Chapter I (p. 17)  
H.L. Hastings. Boston, Massachusetts, USA. 1889

**Hawkins, Michael** 1942–  
English astronomer

Nature is mindless, and is in itself essentially incoherent and chaotic.

*Hunting Down the Universe*  
Chapter I (p. 5)  
Addison – Wesley. Reading, Massachusetts, USA. 1997

**Hazlitt, William Carew** 1834–1913  
English bibliographer

Nature is stronger than reason: for nature is, after all, the text, reason but the comment.

In W. Carew Hazlitt (ed.)  
*The Round Table; Northcotes Conversations; Characteristics*  
Characteristics, CXXXV (p. 476)  
George Bell & Sons. London, England. 1884

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Nature eludes calculation. Number is a grim pullulation. Nature is the thing that cannot be numbered.

Because of nature's unity it has been concluded that she is simple. An error.

Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Third, Chapter III (p. 405)  
The Heritage Press. New York, New York, USA. 1961

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

Nature is considered as absolutely true; no error or contradiction can be found in nature. For, if such contradiction were truly found, if the stone, for example, which fell today were to rise again tomorrow, there would be an end of natural philosophy, our principles would fail, and we would no longer investigate the rules of nature from our observations.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter III (p. 297)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95  
English biologist

Nature is never in a hurry, and seems to have had always before her eyes the adage, "keep a thing long enough and you will find a use for it.

*Collected Essays* (Volume 8)  
*Discourses, Biological and Geological*  
On the Formation of Coal (p. 159)  
Macmillan & Company Ltd. London, England. 1904

**Jevons, William Stanley** 1835–82  
English economist and logician

Nature is a spectacle continually exhibited to our senses, in which phenomena are mingled in combinations of endless variety and novelty.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book I, Chapter I (p. 1)  
Macmillan & Company Ltd. London, England. 1892

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

Nature, as read by patient observation and experiment, is the ultimate philosopher.

*Blind Watchers of the Sky*

Chapter Three (p. 59)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Nature is so various in her productions and phenomena, that it is extremely difficult to ascertain their causes, hence it is requisite for a great number of men to unite their intellect and exertions in order to comprehend and develop her laws.

*System of the World* (Volume 2)

Book V, Chapter IV (p. 286)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

**Lawrence, Louise de Kiriline** 1894–1992

Canadian naturalist, author, and nurse

Nature is a deep reality and whether we understand it or not it is true and elemental.

*The Lovely and the Wild*

Chapter Three (p. 33)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Leclerc, Georges-Louis, Comte de Buffon** 1707–88

French naturalist

Nature is that system of laws established by the Creator for regulating the existence of bodies, and the succession of beings. Nature is not a body; for this body would comprehend everything. Either is it a being; for this being would necessarily be God. But nature may be considered as an immense living power, which animates the universe, and which, in subordination to the first and supreme Being, began to act by his command, and its action is still continued by his concurrence or consent.

*Natural History, General and Particular* (Volume 6)

Of Nature, First View (p. 249)

T. Caldwell and W. Davies. London, England. 1812

**Lewes, George Henry** 1817–78

English philosopher

Nature is economic as well as prodigal of space. She fills the illimitable heavens with planetary and starry grandeurs, and the tiny atoms moving over the crust of earth she makes the homes of the infinitely little. Far as the mightiest telescope can reach, it detects worlds in clusters, like pebbles on the shore of infinitude; deep as the microscope can penetrate, it detects life within life, generation within generation, as if the very universe itself were not vast enough for the energies of life.

*Studies in Animal Life*

Chapter I (pp. 26–27)

Smith, Elder & Co. London, England. 1862

**Long, J. M.**

No biographical data available

To the savage, nature is a Sibyl whose scattered leaves have no meaning; to the philosopher who carefully collects her leaves and places them in their true connection, she reveals the mysteries of ancient time.

*The Synthetic Philosophy an Organon of the Sciences*

*The Kansas City Review of Science and Industry*, Volume 4, Number 11, March, 1881 (p. 653)

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

Scientifically, Nature is a riddle without a definite solution to satisfy man's curiosity.

Translated by Maurice Maeterlinck

In Jean-Henri Fabre

*The Life of the Spider*

Preface (p. 34)

Dodd, Mead & Co. New York, New York, USA. 1913

**Melville, Herman** 1819–91

American novelist

...nature is an immaculate virgin, forever standing unrobed before us.

*Typee, Omoo, Mardi*

Mardi

Chapter 137 (p. 1094)

The Library of America. New York, New York, USA. 1982

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

Nature is the great agent of the external universe...

*The Last Days of Pompeii*

Book One, VIII

George Routledge & Sons, Ltd. London, England. 1900

**Merezhkovsky, Dmitry Sergeyeveich** 1865–1941

Russian novelist and critic

The Laws of nature, which are outside man's will, outside good and evil, are the laws which guide the life of every society.

*The Romance of Leonardo da Vinci: The Forerunner*

Chapter XII (p. 328)

G.P. Putnam's Sons. New York, New York, USA. 1903

**Mill, John Stuart** 1806–73

English political philosopher and economist

To account for a law of nature means, and can mean, no more than to assign other laws more general, together with collocations, which laws and collocations being supposed, the partial law follows without any additional supposition.

*A System of Logic, Ratiocinative and Inductive*

Chapter XII (p. 277)

Harper & Brothers Publishers. New York, New York, USA. 1867

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

It cannot be too extensively known, that nature is vast and knowledge limited; and that no individual, however humble in place or acquirement, need despair of adding to the general fund.

*The Old Red Sandstone*

Chapter I (p. 14)

John B. Alden, Publisher. New York, New York, USA. 1892

Nature is a vast tablet, inscribed with signs, each of which has its own significancy, and becomes poetry in the mind when read; and geology is simply the key by which myriads of these signs, hitherto undecipherable, can be unlocked and perused, and thus a new province added to the poetical domain.

*Popular Geology*

Lecture Third (p. 131)

Gould & Lincoln. Boston, Massachusetts, USA. 1860

**Muir, John** 1838–1914  
American naturalist

Nature is a good mother, and sees well to the clothing of her many bairns – birds with smoothly imbricated feathers, beetles with shining jackets, and bears with shaggy furs.

*Steep Trails*

Chapter I (p. 5)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1918

**Newcomb, Simon** 1835–1909  
Canadian-American astronomer

We cannot set any limit either to the discovery of new laws of nature or to the ingenious combination of devices to attain results which now look impossible.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter XII (p. 182)

Harper & Brothers Publishers. New York, New York, USA. 1906

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

For Nature is very consonant and conformable to herself.

In Eugene Hecht

*Optics*

Book III, Part 1, Question 31 (p. 531)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Robinson, Henry Peach** 1830–1901  
English pictorialist photographer

Nature is always wise, but has no mercy.

*The Elements of a Pictorial Photograph*

Chapter XX (p. 155)

Memorial Hall. London, England. 1896

**Roe, Edward Payson** 1837–88  
American author, horticulturalist, and clergyman

Nature is a good mother, after all, in our latitude. She does not coddle and over-indulge her children, but rewards their love abundantly, invigorates them if they dwell in her presence, and develops mind and muscle, heart and soul, if they obey her laws and seek to know her well.

*Nature's Serial Story*

Preface (p. viii)

Harper & Brothers Publishers. New York, New York, USA. 1885

**Root-Bernstein, Robert Scott**

Nature is always right, scientists rarely are.

*Discovering*

Day Six (p. 341)

Harvard University Press. Cambridge, Massachusetts, USA. 1989

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Though nature is constantly beautiful, she does not exhibit her highest powers of beauty constantly, for then they would satiate us and pall upon our senses. It is necessary to their appreciation that they should be rarely shown. Her finest touches are things which must be watched for; her most perfect passages of beauty are the most evanescent.

*Modern Painters* (Volume 1)

Part II, Section I, Chapter IV (p. 65)

John Wiley & Sons. New York, New York, USA. 1888

...nature is never distinct and never vacant, she is always mysterious, but always abundant; you always see something, but you never see all.

*Modern Painters* (Volume 1)

Section II, Chapter V (p. 193)

John Wiley & Sons. New York, New York, USA. 1888

**Sears, Paul Bigelow** 1891–1990  
American plant ecologist and conservationist

Nature is not to be conquered save on her own terms. She is not conciliated by cleverness or industry in devising means to defeat the operation of one of her laws through the workings of another.

*Deserts on the March*

Chapter I (p. 3)

University of Oklahoma Press. Norman, Oklahoma, USA. 1935

**Stedman, Edmund Clarence** 1833–1908  
American poet, critic, and essayist

Nature is strong and rank, but not externally so. She, too, has her sweet and sacred sophistries, and the delight of Art is to heighten her beguilement, and, far from making her ranker than she is, to portray what she might be in ideal combinations. Nature, I say, covers her slime, her

muck, her ruins, with garments that to us are beautiful.  
She conceals the skeleton, the frame-work, the intestinal  
thick of life, and makes fair the outside of things.

*Poets of America*

Chapter X (p. 368)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1885

**Sterne, Laurence** 1713–68

English novelist and humorist

Nature is shy, and hates to act before spectators.

*A Sentimental Journey through France and Italy* (Volume 1)

The Act of Charity, Paris (p. 128)

London, England. 1780

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

Nature is neutral. Man has wrested from nature the power  
to make the world a desert or to make the deserts bloom.

*High Fidelity Record Annual* 1955

Speech (p. 338)

30 April, 1946, House of Commons

J. B. Lippincott & Company. Philadelphia, Pennsylvania, USA. 1956

Nature is indifferent to the survival of the human species,  
including Americans.

*Adlai's Almanac: The Wit and Wisdom of Stevenson of Illinois* (p. 27)

H. Schuman. New York, New York, USA. 1952

**Stewart, John**

No biographical data available

Nature is the great integer of being, or matter and motion,  
without beginning and without end.

*The Moral State of Nations*

The Religion of Nature (p. 75)

Granville. Middletown, New Jersey, USA. 1837

**Teale, Edwin Way** 1899–1980

American naturalist

Nature is shy and noncommittal in a crowd. To learn her  
secrets, visit her alone or with a single friend, at most.

*Circle of the Seasons*

May 4 (p. 85)

Dodd, Mead & Company. New York, New York, USA. 1953

**Thomson, Sir Joseph John** 1856–1949

English physicist

Nature is far more wonderful and unconventional than  
anything we can evolve from our inner consciousness.  
The most far-reaching generalizations which may influ-  
ence philosophy as well as revolutionize physics, may be  
suggested, nay, forced on the mind by the discovery of  
some trivial phenomenon.

*The Atomic Theory* (p. 4)

Clarendon Press. 1914

**Thurlow, Lord Edward, First Baron**

**Thurlow** 1731–1806

English jurist and statesman

Nature is always wise in every part.

*Select Poems*

The Harvest Moon

Chadwyck-Healey. Cambridge, England. 1992

**Turgenev, Ivan** 1818–83

Russian novelist and dramatist

Nature is no temple, but a workshop, and man is the  
worker therein.

Translated by Bernard Guilbert Guerney

*Fathers and Sons*

Chapter 9 (p. 58)

The Modern Library. New York, New York, USA. 1961

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Nature is a free domain ; and the profound conceptions  
and enjoyments she awakens within us can only be viv-  
idly delineated by thought clothed in exalted forms of  
speech, worthy of bearing witness to the majesty and  
greatness of the creation.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume I)

Introduction (p. 1)

George Bell & Sons. London, England. 1901

**von Schelling, Friedrich Wilhelm Joseph** 1775–1854

German philosopher

...nature is always lavish, even prodigal ...

Translated by John Oxenford

*Conversations of Goethe With Eckermann and Soret*

Tues., Oct 7 (p. 331)

George Bell & Sons. London, England. 1883

**Warner, Charles Dudley** 1829–1900

American editor and author

Nature is, in fact, a suggester of uneasiness, a promoter of  
pilgrimages and of excursions of the fancy which never  
come to any satisfactory haven.

*Backlog Studies*

Ninth Study, Section II (p. 203)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

And then Nature is so indifferent, so unappreciative.  
Whenever I am walking in the park here, I always feel  
that I am no more to her than the cattle that browse on the  
slope, or the burdock that blooms in the ditch.

*The Works of Oscar Wilde* (Volume 10)

*Intentions*

The Decay of Lying

AMS Press. New York, New York, USA. 1909

Nature is so uncomfortable. Grass is hard and lumpy and damp, and full of dreadful insects.

*The Works of Oscar Wilde* (Volume 10)

*Intentions*

The Decay of Lying

AMS Press. New York, New York, USA. 1909

### Wilson, David Scofield

No biographical data available

Nature is present to naturalists the way God is to saints or the past is to humanists – not simply as a matter of fact but as an insistent and live reality.

*In the Presence of Nature*

Chapter I (p. 1)

University of Massachusetts Press. Amherst. 1978

## NATURE STUDY

### Bailey, Liberty Hyde 1858–1954

American horticulturist and botanist

Nature-study, as a process, is seeing the things that one looks at, and the drawing of proper conclusions from what one sees. Its purpose is to educate the child in terms of his environment, to the end that his life may be fuller and richer. Nature-study is not the study of a science, as of botany, entomology, geology, and the like. That is, it takes the things at hand and endeavors to understand them, without reference primarily to the systematic order or relationships of the objects.

*Cornell Nature-study Leaflets*

Leaflet I (p. 11)

J.B. Lyon Co. Albany, New York, USA. 1904

Real nature-study cannot pass away. We are children of nature, and we have never appreciated the fact so much as we do now. But the more closely we come into touch with nature, the less do we proclaim the fact abroad. We may hear less about it, but that will be because we are living nearer to it and have ceased to feel the necessity of advertising it.

*Cornell Nature-study Leaflets*

Leaflet I (p. 13)

J.B. Lyon Co. Albany, New York, USA. 1904

### Hodge, Clifton Fremont

American biologist

Nature study is learning those things in nature that are best worth knowing, to the end of doing those things that make life most worth the living.

*Nature Study and Life* (p. xvi)

Ginn & Co. Boston, Massachusetts, USA. 1902

### Scott, Geoffrey 1884–1929

Architect, biographer, and architectural historian

Nature is strange, fantastic, unexpected, terrible. Like the past, Nature is remote. Indifferent to human preoccupa-

tions and disowning human agency, Nature possesses all the more forcibly and imaginative appeal.

*The Architecture of Humanism: A Study in the History of Taste*

Chapter III (p. 66)

Constable & Co. London, England. 1924

### von Humboldt, Alexander 1769–1859

German naturalist and explorer

...nature is the domain of liberty; and to give a lively picture of those ideas and those delights which a true and profound feeling in her contemplation inspires, it is needful that thought should clothe itself freely and without constraint in such forms and with such elevation of language, as may be least unworthy of the grandeur and majesty of creation.

*Cosmos: A Sketch of a Physical Description of the Universe*

Introduction (pp. 3–4)

Longman, Brown, Green & Longmans. London, England. 1849

Nature is a free domain, and the profound conceptions and enjoyments she awakens within us can only be vividly delineated by thought clothed in exalted forms of speech, worthy of bearing witness to the majesty and greatness of the creation.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 23)

Harper & Brothers Publishers. New York, New York, USA. 1858

## NAVIGATION

### London, Jack 1876–1916

American author

...with the sextant he made obeisance to the sun-god, he consulted ancient tomes and tables of magic characters, muttered prayers in a strange tongue that sounded like Indexerrorparallaxrefraction, made cabalistic signs on paper, added and carried one, and then, on a piece of holy script called the Grail – I mean, the Chart – he placed his finger on a certain space conspicuous for its blankness and said, “Here we are.” When we looked at the blank space and asked, “And where is that?” he answered in the cipher-code of the higher priesthood, “31 -15 - 47 north, 133-5 - 30 west.” And we said, “Oh,” and felt mighty small.

*The Cruise of the Snark*

Chapter IV (p. 51)

The Macmillan Co. New York, New York, USA. 1919

The Snark sailed *Snark* sailed from Fiji on Saturday, June 6, and the next day, Sunday, on the wide ocean, out of sight of land, I proceeded to endeavor to find out my position by a chronometer sight for longitude and by a meridian sight for latitude. The chronometer sight was taken in the morning, when the sun was some 21 degrees above the horizon. I looked in the Nautical Almanac and

found that on that very day, June 7, the sun was behind time 1 minute and 26 seconds, and that it was catching up at a rate of 14/67 seconds per hour. The chronometer said that at the precise moment of taking the sun's altitude it was 25 minutes after 8:00 in Greenwich. From this date it would seem a schoolboy's task to correct the Equation of Time. Unfortunately I was not a schoolboy.

*The Cruise of the Snark*

Chapter XIV (p. 245)

The Macmillan Co. New York, New York, USA. 1919

**Markham, Beryl** 1902–86

British-born Kenyan horse trainer and adventurer

One day the stars will be as familiar to each man as the landmarks, the curves, and the hills on the road that leads to his door, and one day this will be an airborne life. But by then men will have forgotten how to fly; they will be passengers on machines whose conductors are carefully promoted to a familiarity with labeled buttons, and in whose minds the knowledge the sky and the wind and the way of the weather will be as extraneous as passing fiction.

*West with the Night*

Chapter XV (p. 186)

North Point Press. San Francisco, California, USA. 1983

**Melville, Herman** 1819–91

American novelist

Foolish toy! babies' plaything of haughty Admirals, and Commodores, and Captains; the world brags of thee, of thy cunning and might; but what after all canst thou do, but tell the poor, pitiful point, where thou thyself happenest to be on this wide planet and the hand that holds thee: no! not one jot more! Thou canst not tell where one drop of water or one grain of sand will be to-morrow noon; and yet with thy impotence thou insultest the sun! Science!

*Moby Dick*

Chapter CXVII (pp. 466–467)

L.C. Page & Co. Boston, Massachusetts, USA. 1892

**Mitchel, Ormsby MacKnight** 1805–62

American astronomer

Like the ocean islands which guided the early mariners, so God has given to us the stars of heaven as the fixed points to which we can ever refer, in all parts of their revolution, the places of the wandering planets, and the swiftly revolving moon.

*The Orbs of Heaven*

Introductory (p. 8)

Office of the National Illustrated Library. London, England. 1851

**Slocum, Joshua** 1844–1909

Canadian-American seaman and adventurer

I sailed with a free wind day after day, marking the position of my ship on the chart with considerable preci-

sion; but this was done by intuition, I think, more than by slavish calculations. For one whole month my vessel held her course true; I had not, the while, so much as a light in the binnacle. The Southern Cross I saw every night abeam; the sun every morning came up astern; every evening it went down ahead. I wished for no other compass to guide me, for these were true. If I doubted my reckoning after a long time at sea I verified it by reading the clock aloft made by the Great Architect, and it was

*Sailing Alone Round the World*

Chapter XI (p. 145)

The Century Co. New York, New York, USA. 1919

**NEANDERTHAL**

**Constable, George** 1941–

No biographical data available

Place him in a landscape of tall, waving grass, with the sun shining down and the bubbling music of summer in the air. Who is this man? He is an evolutionary bridge, just shy of fully modern status. He is a true human – our ancestor. We should regard him with honour, because almost everything that we are springs directly from him.

*The Neanderthals*

Chapter Five (p. 134)

Time-Life Books. New York, New York, USA. 1973

**Margulis, Lynn** 1938–

American cell biologist and evolutionist

**Sagan, Dorion** 1959–

American science writer

Neanderthalers, whatever else they were, were people. They were artists and poets and buriers of the dead.

*Microcosmos*

Chapter 12 (p. 225)

Summit Books. New York, New York, USA. 1986

**Osborn, Henry Fairfield**

We have only indirect means of knowing the courage and activity of the Neanderthals in the chase, through the bones of animals hunted for food which are found intermingled with the flints around their ancient hearths.

*Men of the Old Stone Age* (2nd edition)

Cave Life (p. 211)

Charles Scribner's Sons. New York, New York, USA. 1916

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Hairy or grisly, with a big face like a mask, great brow ridges and no forehead, clutching an enormous flint, and running like a baboon with his head forward, and not, like a man, with his head up, he must have been a fearsome creature for our forefathers to come upon.

*The Grisly Man*

*Storyteller Magazine*, April, 1921



## NEBULA

**de Quincey, Thomas** 1785–1859  
English author

...the famous *nebula* in the constellation of Orion; famous for the unexampled defiance with which it resisted all approaches from the most potent of former telescopes; famous for its frightful magnitude, and for the frightful depth to which it is sunk in the abysses of the heavenly wilderness; famous just now for the submission with which it has begun to render up its secrets to the all-conquering telescope; and famous in all time coming for the horror of the regal phantasma which it has perfected to eyes of flesh.

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 179)  
Adam & Charles Black. Edinburgh, Scotland. 1871

**Flammarion, Camille** 1842–1925  
French astronomer and writer

It seems that the hand of ages has outlined this universe, that the numberless suns collected there are lengthened out into a line and directed towards the central focus, that a second focus is condensed near the confines of this universe, and that the whole is displaced in space, leaving a luminous train behind it. The imagination is confounded in the presence of such a grand spectacle. On the hypothesis of a complete resolvability into stars, the mind is lost in numbering the myriads of suns, the agglomerated individual lights of which produce these nebulous fringes of such different intensities.

Translated by John Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book VI, Chapter X (p. 662)

Chatto & Windus. London, England. 1907

These are lights which glimmer on the frontiers of creation; they are the beginnings which show us the birth of other universes; they are the voices of the past which speak to us from the depths of the vanished ages.

*Popular Astronomy: A General Description of the Heavens*

Book VI, Chapter X (p. 668)

Chatto & Windus. London, England. 1894

**Herschel, Friedrich Wilhelm (Sir William)** 1738–1822  
English astronomer

On the 15th of February, 1786, I discovered that one of my planetary nebula, had a spot in the center, which was more luminous than the rest, and with long attention, a very bright, round, well defined center became visible. I remained not a single moment in doubt, but that the bright center was connected with the rest of the apparent disk.

On Nebulous Stars, Properly So Called

*Philosophical Transactions of the Royal Society of London,*

Volume 81, 1791

...nebulae were generally detected in certain directions rather than in others, that the spaces preceding them were generally quite deprived of stars, that the nebulae appeared some time after among stars of a certain considerable size and but seldom among very small stars, that when I came to one nebula I found several more in the same neighbourhood, and afterwards a considerable time passed before I came to another parcel.

*Philosophical Transactions*, 1784 (p. 448)

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

I know not how to describe it [the great nebula in the constellation of Orion] better than by comparing it with a curdling liquid, or a surface strewn over with flocks of wool, or to the breaking up of a mackerel sky, when the clouds of which it consists begin to assume a cirrus appearance.

Quoted in Dionysius Lardner

*Popular Lectures on Science and Art* (Volume 2)

The Stellar Universe (Second Lecture) (p. 388)

Greeley & McElrath

New York, New York, USA. 1846

They [nebula] have, as their name imports, exactly the appearance 'of planets; round or slightly oval disks, in some instances quite sharply terminated, in others a little hazy at the borders, and of a light exactly equable or only a very little mottled, which, in some of them, approaches in vividness to that of actual planets. Whatever their nature, they must be of enormous magnitude.

Quoted in Dionysius Lardner

*Popular Lectures on Science and Art* (Volume 2)

The Stellar Universe (Second Lecture) (p. 391)

Greeley & McElrath

New York, New York, USA. 1846

**Hubble, Edwin Powell** 1889–1953  
American astronomer

The term nebulae offers the values of tradition...the term galaxies, the glamour of romance.

In Timothy Ferris

*The Red Limit: The Search for the Edge of the Universe*

Chapter 1 (p. 41)

William Morrow & Company, Inc. New York, New York, USA. 1977

**Huggins, Sir William** 1824–1910  
English astronomer

On the evening of August 29, 1864, I directed the spectroscope for the first time to a planetary nebula in Draco. I looked into the spectroscope. No spectrum such as I had expected. A single bright line only!...The riddle of the nebulae was solved. The answer, which had come to us in the light itself, read: Not an aggregation of stars, but a luminous gas.

In George E. Hale  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*  
 Stellar Evolution in the Light of Recent Research (p. 155)  
 Government Printing Office. Washington, D.C. 1903

**Hugo, Victor** 1802–85  
 French author, lyric poet, and dramatist

A nebula is, as it were, a universe in the cocoon.  
 Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
 Part II, Book Third, Chapter III (p. 413)  
 The Heritage Press. New York, New York, USA. 1961

**Jeans, Sir James Hopwood** 1877–1946  
 English physicist and mathematician

...nebulae are the birthplaces of the stars, so that each  
 nebula consists of stars born and stars not yet born.  
*The Universe Around Us*  
 Chapter I (p. 67)  
 The Macmillan Company. New York, New York, USA. 1929

**Tennyson, Alfred (Lord)** 1809–92  
 English poet

Regions of lucid matter taking forms,  
 Brushes of fire, hazy gleams.  
 Clusters and beds of worlds, and bee-like swarms Of  
 suns, and starry streams.  
*The Works of Tennyson*  
 Notes (p. 697)  
 The Macmillan Co. New York, New York, USA. 1913

## NECESSITY

**Brooks, William Keith** 1848–1908  
 American zoologist

Science has nothing to do with the notion of “necessity,”  
 and is quite content to leave it in the hands of its originators,  
 the metaphysicians and theologians and “philosophers,”  
 who alone are responsible for all the mental confusion  
 it has brought about.  
*The Foundations of Zoology*  
 Lecture VI (p. 133)  
 The Macmillan Co. New York, New York, USA. 1899

**da Vinci, Leonardo** 1452–1519  
 Italian High Renaissance painter and inventor

Necessity is the mistress and guide of nature. Necessity  
 is the theme and artificer of nature, the bridle and the  
 eternal law.  
 In Edward McCurdy  
*Leonardo da Vinci's Note-books*  
 Book I: Life (p. 55)  
 Duckworth & Co. London, England. 1906

**Huxley, Thomas Henry** 1825–95  
 English biologist

Fact I know; and Law I know; but what is this Necessity,  
 save an empty shadow of my own mind's throwing?  
*Collected Essays (Volume 1)*  
*Method and Result*  
 On the Physical Basis of Life (p. 161)  
 Macmillan & Company Ltd. London, England. 1904

## NEURON

**Crick, Francis Harry Compton** 1916–2004  
 English molecular biologist, physicist, and neuroscientist

A single neuron may be rather dumb, but it is dumb in  
 many subtle ways.  
*The Astonishing Hypothesis: The Scientific Search for the Soul*  
 Chapter 8 (p. 104)  
 Touchstone. New York, New York, USA. 1995

**Sherrington, Sir Charles** 1857–1952  
 English physiologist

More than one way for doing the same thing is provided  
 by the natural constitution of the nervous system. This  
 luxury of means of compassing a given combination  
 seems to offer the means of restitution of an act after its  
 impairment or loss in one of its several forms.  
*Nobel Lectures, Physiology or Medicine 1922–1941*  
 Nobel lecture for award received in 1932  
 Inhibition as a Coordinative Factor (p. 289)  
 Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## NEMATODE

**Cobb, Nathan Augustus** 1859–1932  
 American plant pathologist

In short, if all the matter in the universe except the nema-  
 todes were swept away, our world would still be dimly  
 recognizable, and if, as disembodied spirits, we could  
 then investigate it, we should find its mountains, hills,  
 vales, rivers, lakes, and oceans represented by a film of  
 nematodes. The location of towns would be decipherable,  
 since for every massing of human beings there  
 would be a corresponding massing of certain nematodes.  
 Trees would still stand in ghostly rows representing our  
 streets and highways.  
*Yearbook, Department of Agriculture, 1914*  
 Department of Agriculture. Washington, D.C. 1914

## NEUROPHYSIOLOGY

**Hodgkin, Alan L.** 1914–98  
 English physiologist and biophysicist

Research in neurophysiology is much more like paddling  
 a small canoe on a mountain river. The river which is  
 fed by many distant springs carries you along all right,  
 though often in a peculiar direction. You have to paddle

quite hard to keep afloat. And sooner or later some of your ideas are upset and are carried downstream like an upturned canoe.

*Lex Prix Nobel. The Nobel Prizes in 1963*  
Nobel banquet speech for award received in 1963  
Nobel Foundation. Stockholm, Sweden. 1964

## NEUROSCIENCE

**Young, John Zachary** 1907–97  
English zoologist

What would be the use of a neuroscience that cannot tell us anything about love?

*Programs of the Brain*  
Chapter 14 (p. 143)  
Oxford University Press. Oxford, England. 1978

## NEUTRINO

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

The chances of a neutrino actually hitting something as it travels through all this howling emptiness are roughly comparable to that of dropping a ball bearing at random from a cruising 747 and hitting, say, an egg sandwich.

*The Ultimate Hitchhiker's Guide to the Galaxy*  
*Mostly Harmless*  
Chapter 3 (p. 656)  
The Ballantine Book Company. New York, New York, USA. 2002

### Author undetermined

The neutrino is about as close to intangibility as we can get in this world – the human soul, perhaps is the next stage.

*Engineering and Science*, February, 1973 (p. 15)

Mister Jordan  
Takes neutrinos  
And from those he  
Builds the light.  
And in pairs they  
Always travel  
One neutrino's  
Out of sight.

In Abraham Pais  
*Inward Bound*  
To the tune "Mac the Knife" (p. 419)  
Clarendon Press. Oxford, England. 1986

**Crane, H. Richard** 1907–2997  
Experimental physicist

Not everyone would be willing to say that he believes in the existence of the neutrino, but it is safe to say there is

hardly one of us who is not served by the neutrino hypothesis as an aid in thinking about beta-decay process.

The Energy and Momentum Relations in the Beta-Decay and the Search for the Neutrino  
*Review of Modern Physics*, Volume 20, Number 2, March, 1948 (p. 278)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The neutrino is just barely a fact.

The Two-Neutrino Experiment  
*Scientific American*, Volume 208, Number 3, March, 1963 (p. 60)

In an ordinary way I might say that I do not believe in neutrinos. But I have to reflect that a physicist may be an artist, and you never know where you are with artists. My old-fashioned kind of disbelief in neutrinos is scarcely enough. Dare I say that experimental physicists will not have sufficient ingenuity to make neutrinos? Whatever I may think, I am not going to be lured into a wager against the skill of the experimenters under the impression that it is a wager against the truth of a theory. If they succeed in making neutrinos, perhaps even in developing industrial application of them, I suppose I shall have to believe – though I may feel they have not been playing quite fair.

*The Philosophy of Physical Science*  
Chapter VII, Section II (p. 112)  
The Macmillan Company. New York, New York, USA. 1939

**Gamow, George** 1904–68  
Russian-born American physicist

My mass is zero,  
My Charge is the same.  
You are my hero,  
Neutrino's my name.

*Thirty Years That Shook Physics*  
First Part (p. 188)  
Doubleday & Company, Inc. Garden City, New York, USA. 1966

...one of the students asked whether the "Chadwick neutron" was the same "neutron" proposed by Pauli for the phenomena of beta transformation. "No," answered Fermi, "*il neutrone di Pauli è mol to più piccolo, cio è un neutrino.*" The name stuck.

The Reality of Neutrinos  
*Physics Today*, Volume 1, Number 3, July, 1948 (p. 5)

**Haag, Joel**  
No biographical data available

The Poet, J. Alfred Neutrino  
Who subsisted sublimely on vino,  
With a spin of one-half  
Wrote his own epitaph:  
"No rest-ness, no charge, no bambino."

In R.L. Weber  
*A Random Walk in Science* (p. 138)  
Institute of Physics Publishing. Bristol, England. 1973

**Harari, Haim**

Theoretical physicist

Neutrino physics is largely an art of learning a great deal by observing nothing.

*Proceedings 13th International Conference on Neutrino Physics and Astrophysics*

Boston, June 5–11, 1999 (p. 574)

**Lederman, Leon** 1922–

American high-energy physicist

Neutrinos have yet to play the role which Rutherford designed for his alpha particles, but...there is still hope that the analogous exploration may take place.

In Eric Henry Stoneley Burhop

*High Energy Physics* (Volume 2) (p. 361)

Academic Press, Inc. New York, New York, USA. 1967

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

I have committed the ultimate sin, I have predicted the existence of a particle that can never be observed.

In Frank Wilczek and Betsy Devine

*Longing For the Harmonies*

Ego and Survival (p. 65)

W. W. Norton & Company, Inc., Publishers. New York, New York, USA. 1988

**Perry, Georgette**

No biographical data available

To trap them is almost impossible.

You may wait for months in a deep mine

Inside an anti-coincidence shield.

No charge deflects them.

Desireless, they cruise through the world

As if it's nothing, not there.

*Twigs*

Neutrinos, 1977

**Pontecorvo, Bruno** 1913–93

Italian-born English physicist

It is difficult to find a case where the word "intuition" characterises a human achievement better than in the case of the neutrino invention by Pauli.

*Journal de Physique*, Supplement C8, Volume 48, 1982 (p. 221)

**Reines, Frederick** 1918–

American physicist

**Cowan, C.**

No biographical data available

We are happy to inform you that we have definitely detected neutrinos from fission fragments by observing beta-decay of protons.

Translated by R. Schlapp

In Wolfgang Pauli, Charles Paul Enz and Karl von Meyenn (eds.)

*Writings on Physics and Philosophy*

Telegram to W. Pauli

14 June, 1956

Springer-Verlag. Berlin, Germany. 1994

**Ruderman, M. A.**

No biographical data available

**Rosenfeld, A. H.**

No biographical data available

Every second, hundreds of billions of these neutrinos pass through each square inch of our bodies, coming from above during the day and from below at night, when the sun is shining on the other side of the earth!

An Elementary Statement on Elementary Particle Physics

*American Scientist*, Volume 48, Number 2, June, 1960 (p. 214)

**Stenger, Victor J.** 1935–

Physicist

Neutrinos are neither rare nor anomalous – just hard to detect.

*Physics and Psychics: The Search for a World Beyond the Senses*

Physics and Psychics, Chapter 1 (p. 20)

Prometheus Books. Buffalo, New York, USA. 1990

**Updike, John** 1932–

American novelist, short story writer, and poet

Neutrinos, they are very small.

They have no charge and have no mass

And do not interact at all.

*Telephone Poles and Other Poems*

Cosmic Gall (p. 4)

Alfred A. Knopf. New York, New York, USA. 1969

**NEUTRON****Chadwick, James** 1891–1974

English physicist

I think we shall have to make a real search for the neutron.

In Henry Abraham Boorse and Lloyd Motz

*The World of the Atom*

Letter to E. Rutherford (p. 1293)

Basic Books, Inc., Publishers. New York, New York, USA. 1966

It is to be expected that many of the effects of a neutron in passing through matter should resemble those of a quantum of high energy, and it is not easy to reach the final decision between the two hypotheses. Up to the present, all the evidence is in favor of the neutron, while the quantum hypothesis can only be upheld if the conservation of energy and momentum be relinquished at some point.

Possible Existence of a Neutron

*Nature*, Volume 129, Number 3252, February 27, 1932 (p. 312)

**Dr. Ruth Adams (Fictional character)**

It's only Neutron. We call him that because he's so positive.

*This Island Earth*

Film (1955)

**Gamow, George** 1904–68  
Russian-born American physicist

The Neutron has come to be.  
Loaded with Mass is he.  
Of Charge, forever free.  
Pauli, do you agree?

*Thirty Years That Shook Physics*

Finale (p. 213)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

The basic idea is: shove all fundamental difficulties on to the neutron and practice quantum mechanics inside the nucleus.

In Abraham Pais

*Inward Bound*

Letter to Niels Bohr, 20 June, 1932 (p. 413)

Clarendon Press. Oxford, England. 1986

**Pauli, Wolfgang** 1900–58  
Austrian-born physicist

Dear Radioactive Ladies and Gentlemen,  
As the bearer of these lines, for whom I pray the favor of a hearing will explain in more detail, I have...hit upon a desperate remedy for rescuing the "alternation law"... This is the possibility that there might exist in the nuclei electrically neutral particles, which I call neutrons...

In Charles P. Enz

*No Time to Be Brief*

Chapter 6 (p. 215)

Oxford University Press, Inc. Oxford, England. 2002

## NEW

**Mitchison, Naomi** 1897–1999  
Scottish novelist and poet

...nothing utterly new succeeds at once.

*Solution Three*

Chapter One (p. 8)

The Feminist Press at the City University of New York. New York, New York, USA. 1995

## NEWTON, ISAAC

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

Newton sat in an orchard, and an apple, plumping down on his head, started a train of thought which opened the heavens to us. Had it been in California, the size of the apples there would have saved him the trouble of much thinking thereafter, perhaps, opening the heavens to him, and not to us.

*Pleasant Talk About Fruits, Flowers and Farming*

Chapter I (p. 6)

J.B. Ford & Co. New York, New York, USA. 1874

**Einstein, Albert** 1879–1955  
German-born physicist

No one must think that Newton's great creation can be overthrown in any real sense by this or by any other theory. His clear and wide ideas will forever retain their significance as the foundation on which our modern conceptions of physics have been built.

Time, Space and Gravitation

*Science*, Volume LI, Number 1305, January 2, 1920 (p. 10)

**Sonneberg, Walter**  
No biographical data available

Newton stands responsible for much grave trespassing upon Nature.

*Social Eccentricities*

Social Eccentricities (p. 46)

Broadway Publishing Co. New York, New York, USA. 1906

## NEWTONIAN MECHANICS

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

However much we may feel free, everything that we do is, according to Laplace, completely determined. Indeed the entire cosmos is reduced to a gigantic clockwork mechanism, with each component slavishly and unfailingly executing its preprogrammed instructions to mathematical precision. Such is the sweeping implication of Newtonian mechanics.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 2 (p. 11)

Simon & Schuster. New York, New York, USA. 1988

## NIGHT

**Ackerman, Diane** 1948–  
American writer

It is nighttime on the planet Earth. But that is only a whim of nature, a result of our planet rolling in space at 1,000 miles per minute. What we call "night" is the time we spend facing the secret reaches of space, where other solar systems and, perhaps, other planetarians dwell. Don't think of night as the absence of day; think of it as a kind of freedom. Turned away from our sun, we see the dawning of far-flung galaxies. We are no longer sun-blind to the star-coated universe we inhabit.

*A Natural History of the Senses*

Vision, How to Watch the Sky (p. 245)

Random House, Inc. New York, New York, USA. 1990

**Amaldi, Ginestra Giovane**  
No biographical data available

The night sky looks like a giant fistful of glittering diamonds flung carelessly upon a black carpet.

*Our World and the Universe Around Us* (Volume 1)  
The Universe (p. 13)  
Abradale Press. New York, New York, USA. 1966

**Atwood, Margaret** 1939–  
Canadian poet, novelist, and critic

Night falls. Or has fallen. Why is it that night falls, instead of rising, like the dawn? Yet if you look east, at sunset, you can see night rising, not falling; darkness lifting into the sky, up from the horizon, like a black sun behind cloud cover. Like smoke from an unseen fire, a line of fire just below the horizon, brushfire or a burning city. Maybe night falls because it's heavy, a thick curtain pulled up over the eyes. Wool blanket. I wish I could see in the dark.

*The Handmaid's Tale*  
Chapter 30 (p. 201)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1986

**Beston, Henry** 1888–1968  
American writer

It is dark to-night, and over the plains of ocean the autumnal sky rolls up the winter stars.

*The Outermost House*  
Chapter I (p. 18)  
Rinehart & Company. New York, New York, USA. 1928

...today's civilization is full of people who have never even seen night. Yet to live thus, to know only artificial night, is as absurd and evil as to know only artificial day.

*The Outermost House*  
Chapter VIII (p. 169)  
Rinehart & Company. New York, New York, USA. 1928

With lights and ever more lights, we drive the holiness and beauty of night back to the forests and the sea; the villages, the crossroads even, will have none of it.

*The Outermost House*  
Chapter VIII (p. 168)  
Rinehart & Company. New York, New York, USA. 1928

For a moment of night we have a glimpse of ourselves and of our world islanded in its stream of stars – pilgrims of mortality, voyaging between horizons across the eternal seas of space and time.

*The Outermost House*  
Chapter VIII (p. 176)  
Rinehart & Company. New York, New York, USA. 1928

**Bürger, Bruno Hans** 1875–1948  
German astronomer

This is the hour when the stars awake. The ruddiness in the west has paled, the fiery lines that glowed across the horizon like streams of molten gold have vanished, and night approaches on its raven-hued wings.

Translated by Stella Bloch  
*Astronomy for All*  
Chapter I (p. 1)  
Cassell & Co., Ltd. London, England. 1911

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

Night, the beloved. Night, when words fade and things come alive. When the destructive analysis of day is done, and all that is truly important becomes whole and sound again. When man reassembles his fragmentary self and grows with the calm of a tree.

Translated by Bernard Lamotte  
*Flight to Arras*  
Chapter I (p. 23)  
Reynal & Hitchcock. New York, New York, USA. 1942

**Diamond, Neil** 1941–  
American pop/folk singer, composer, and musician

I thank the Lord for the night time  
To forget the day...

*Classics: The Early Years (1966–1967)*  
Thank the Lord for the Nighttime  
Columbia Records #38792. 1983

**Flammarion, Camille** 1842–1925  
French astronomer and writer

O Night, diapered with fires innumerable! hast thou not written in flaming letters on these Constellations the syllables of the great enigma of Eternity? The contemplation of thee is a wonder and a charm. How rapidly canst thou efface the regrets we suffered on the departure of our beloved Sun! What wealth, what beauty hast thou not reserved for our enraptured souls! Where is the man that can remain blind to such a pageant and deaf to its language!

Translated by Frances Alice Welby  
*Astronomy for Amateurs*  
Introduction (p. 11)  
D. Appleton & Co. New York, New York, USA. 1915

O Night, mysterious, sublime, and infinite! withdrawing from our eyes the veil spread above us by the light of day, giving back transparency to the Heavens, showing us the prodigious reality, the shining casket of the celestial diamonds, the innumerable stars that succeed each other interminably in immeasurable space!

Translated by Frances Alice Welby  
*Astronomy for Amateurs*  
Introduction (p. 26)  
D. Appleton & Co. New York, New York, USA. 1915

**Murdin, Paul**  
British astronomer

Astronomers, literally, and human beings in general, figuratively, need the interruption of the night.

In Derek McNally  
*The Vanishing Universe*  
The Aims of Astronomy in Science and the Humanities: Why Astronomy Must Be Protected (p. 19)  
Cambridge University Press. Cambridge, England. 1994



**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

Night is a dead monotonous period under a roof; but in the open world it passes lightly, with its stars and dews and perfumes, and the hours are marked by changes in the face of Nature.

*Travels with a Donkey in the Cevennes*

A Night Among the Pines (p. 79)

C. Kegan Paul & Company. London, England. 1879

**Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

The night is like a dark child just born of her mother day. Millions of stars crowding round its cradle watch it, standing still, afraid lest it should wake up.

*Personality*

The World of Personality (p. 57)

The Macmillan Company. New York, New York, USA. 1917

**Williams, Frederick Smeeton**

No biographical data available

It is night. Awhile ago the sun tinged the western hemisphere with his last golden beams, and sank to rest behind the distant hills. Earth has drawn around her the sable robe of darkness. The hum of the world's busy on-going is silenced – nature is hushed to repose – the birds have ceased their song, and the stillness is broken only by the bat's almost noiseless wing, the soft sighing of the evening breeze among the foliage, and the distant lowing of the cattle. These are voices of the night, calling us, with timid accents, to solitude and meditation.

*The Wonders of the Heavens*

Chapter I (p. 9)

John Cassell. London, England. 1852

Night is ever beautiful. Day has its peculiar charms, and night no less. Day shows us earth; night reveals to us the heavens. Day declares the greatness of our world; night the majesty and immensity of God's universe. Day awakens the harmonies of earth; night the music of the spheres.

*The Wonders of the Heavens*

Chapter I (p. 10)

John Cassell. London, England. 1852

...its [night sky] its solemnity awes and its beauty fascinates: and we cannot look upon the glittering bosom of the heavens without being beguiled into meditation on its wonders.

*The Wonders of the Heavens*

Chapter I (p. 10)

John Cassell. London, England. 1852

**NOBEL PRIZE****Wilson, Edward O.** 1929–

American biologist and author

Humanists are the shamans of the intellectual tribe, wise men who interpret knowledge and transmits the folklore, rituals, and sacred texts. Scientists are the scouts and hunters. No one rewards a scientist for what he knows. Nobel Prizes and other trophies are bestowed for the new facts and theories he brings home to the tribe.

*Biophilia*

The Poetic Species (p. 58)

Harvard University Press. Cambridge, Massachusetts, USA. 1984

**NOCTURNAL****Holland, W. J.**

No biographical data available

There are whole armies of living things, which when we go to sleep, begin to awaken; and when we awaken, go to sleep.

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*

The World of the Dark (p. 77)

Doubleday, Page & Company. New York, New York, USA. 1904

There are two worlds; the world of sunshine, and the world of the dark. Most of us are more or less familiarly acquainted with the first; very few of us are well acquainted with the latter. Our eyes are well adapted to serve us in the daylight, but they do not serve us as well in the dark, and we therefore fail to know, unless we patiently study them, what wonders this world of the dark holds within itself.

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*

The World of the Dark (p. 77)

Doubleday, Page & Company. New York, New York, USA. 1904

**NOMENCLATURE****Lavoisier, Antoine Laurent** 1743–94

French chemist

The impossibility of separating the nomenclature of a science from the science itself, is owing to this, that every branch of physical science must consist of three things; the series of facts which are the objects of the science, the ideas which represent these facts, and the words by which these ideas are expressed. Like three impressions of the same seal, the word ought to produce the idea, and the idea to be a picture of the fact. And, as ideas are preserved and communicated by means of words, it necessarily follows that we cannot improve the language of any science without at the same time improving the science itself; neither can we, on the other hand, improve a science, without improving the language or nomenclature which belongs to it. However certain the facts of any science may be, and, however just the ideas we may have formed of these facts, we can only communicate false

impressions to others, while we want words by which these may be properly expressed.

Translated by Robert Kerr

*Elements of Chemistry* (Volume 1) (5th edition)

Preface (pp. xviii–xix)

Printed for W. Creech. Edinburgh, Scotland. 1802

...while I thought myself employed only in forming a Nomenclature, and while I proposed to myself nothing more than to improve the chemical language, my work transformed itself by degrees, without my being able to prevent it, into a treatise upon the Elements of Chemistry.

*Elements of Chemistry*

Preface (p. xiii)

Publisher undetermined

Edinburgh, Scotland 1799

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

...we have lost the faculty of giving lovely names to things. Names are everything.

*The Picture of Dorian Gray*

Chapter XVII (p. 313)

Charles Carrington. Paris, France. 1908

**Dunglison, Robley** 1798–1869

English physician

In all sciences, Nomenclature is an object of importance; and each term should convey to the student a definite meaning.

*Medical Lexicon*

12th (p. 25)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1855

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

To enter on eternity under the safe-conduct of a diminutive animal which saves us from speedy oblivion under the mal-lows and rockets is no contemptible advantage. Most men disappear without leaving an echo to repeat their name; they lie buried in forgetfulness, the worst of graves.

Others, among the naturalists, benefit by the designation given to this or that object in life's treasure-house: it is the skiff wherein they keep afloat for a brief while. A patch of lichen on the bark of an old tree, a blade of grass, a puny beastie: anyone of these hands down a man's name to posterity as effectively as a new comet. For all its abuses, this manner of honouring the departed is eminently respectable. If we would carve an epitaph of some duration, what could we find better than a Beetle's wing-case, a Snail shell or a Spider's web? Granite is worth none of them. Entrusted to the hard stone, an inscription becomes obliterated; entrusted to a Butterfly's wing, it is indestructible.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Chapter XVI (pp. 360–361)

Dodd, Mead & Co. New York, New York, USA. 1917

**Melville, Herman** 1819–91

American novelist

...to know a great many names seems to look like knowing a good many things; though I should not be surprised, if there were a great many more names than things in the world.

*Redburn*

Chapter XIII (p. 89)

Harper & Brothers. New York, New York, USA. 1850

**Robinson, Phil** 1847–1902

English journalist and writer on natural history

Adam – it is evident – from his faculty in nomenclature – was a naturalist of the highest order.

*Noah's Ark; or, 'Mornings in the Zoo'*

Chapter II (p. 25)

Sampson Low, Marston, Searle & Rivington. London, England. 1882

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Perhaps nothing is more curious in the history of the human mind than the way in which the science of botany has become oppressed by nomenclature.

*Modern Painters* (Volume 5)

Part VI, Chapter 7 (p. 50)

John Wiley & Sons. New York, New York, USA. 1879

## NONSENSE

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

That which in the physical world shadows the nonsense in the mind affords no ground for its condemnation. In a world of aether and electrons we might perhaps encounter nonsense; we could not encounter damned nonsense.

*The Nature of the Physical World*

Conclusion (p. 345)

The Macmillan Company. New York, New York, USA. 1930

## NOTATION

**Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

As arithmetic and algebra are sciences of great clearness, certainty, and extent, which are immediately conversant about signs, upon the skilful use and management whereof they entirely depend, so a little attention to them may possibly help us to judge of the progress of the mind in other sciences; which, though differing in nature, design, and object, may yet agree in the general methods of proof and inquiry.

*The Works of George Berkeley* (Volume 2) (p. 342)

At The Clarendon Press. Oxford, England. 1901

**Brough, J. C.**

No biographical data available

Though Frankland's notation commands admiration,  
As something exceedingly clever,  
And Mr. Kay Shuttleworth praises its subtle worth,  
I give it up sadly forever:  
Its brackets and braces, and dashes and spaces,  
And letters decreased and augmented  
Are grimly suggestive of Lunes to make restive  
A chemical printer demented.  
I've tried hard, but vainly, to realize plainly  
Those bonds of atomic connexion  
Which Crum Brown's clear vision discerns with precision  
Projecting in every direction.

In C.A. Russell

*The History of Valencey*

Chapter V (p. 106)

Humanities Press. New York, New York, USA. 1971

**Cajori, Florian** 1859–1930

Swiss-born American educator and mathematician

The miraculous powers of modern calculation are due to three inventions: the Arabic Notation, Decimal Fractions, and Logarithms.

*A History of Mathematics*

Europe During the Sixteenth, Seventeenth and Eighteenth Centuries (p. 149)

The Macmillan Company. London, England. 1919

**Defoe, Daniel** 1660–1731

English pamphleteer, journalist, and novelist

I cut every day a notch with my knife, and every seventh notch was as long again as the rest, and every first day of the month, as long again as that long one; and thus I kept my calendar, or weekly, monthly, and yearly reckoning of time.

*Robinson Crusoe* (p. 46)

Dodd, Mead & Company. New York, New York, USA. 1946

**Dieudonné, Jean** 1906–92

French mathematician and educator

This difficulty lead very gradually to the recognition of the need for a shorthand to make the sequence of operations easily comprehensible: here we have the problem of notation, which crops up again after every introduction of new objects, and which will probably never cease to torment mathematicians.

*Mathematics – The Music of Reason*

Chapter III, Section 7 (p. 49)

Springer-Verlag. Berlin, Germany. 1992

**Frayn, Michael** 1933–

English dramatist

We look at the taciturn, inscrutable universe, and cry,  
“Speak to me!”

*Constructions*

Number 7

Wildwood House. London, England. 1974

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

I have great faith in the power of well-chosen notation to simplify complicated theories and to bring remote ones near and I think it is safe to predict that the increased knowledge of principles and the resulting improvements in the symbolic language of mathematics will always enable us to grapple satisfactorily with the difficulties arising from the mere extent of the subject.

Presidential Address, British Association for the Advancement of Science

*Nature*, Section A, Volume 42, Number 1089, September 11, 1890 (p. 466)

**Holland, John** 1929–

American computer scientist

Mathematical notation is for the scientist what musical notation is for the composer.

*Emergence: From Chaos to Order*

Chapter 1 (p. 15)

Addison-Wesley Publishing, Inc. Reading, Massachusetts, USA. 1998

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...for a good notation has a subtlety and suggestiveness which make it seem, at times, like a live teacher. Notational irregularities are often the first sign of philosophical errors, and a perfect notation would be a substitute for thought.

In Ludwig Wittgenstein

*Tractatus Logico-Philosophicus*

Introduction (pp. 17–18)

Routledge & Kegan Paul Ltd. London, England. 1922

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Before the introduction of the Arabic notation, multiplication was difficult, and the division even of integers called into play the highest mathematical faculties. Probably nothing in the modern world could have more astonished a Greek mathematician than to learn that, under the influence of compulsory education, the whole population of Western Europe, from the highest to the lowest, could perform the operation of division for the largest numbers. This fact would have seemed to him a sheer impossibility.... Our modern power of easy reckoning with decimal fractions is the most miraculous result of a perfect notation.

*An Introduction to Mathematics*

Chapter 5 (p. 39)

Oxford University Press, Inc. New York, New York, USA. 1958

## NOTEBOOK

**Burroughs, John** 1837–1921  
American naturalist and essayist

A Notebook containing a few smooth pebbles which the waves of Thought leave, from time to time, upon my Shores.

*The Heart of Burroughs's Journals*  
1859–1860 (p. 14)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

## NOTES

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

...how useful it is to write;  
For what one has, in black and white,  
One carries home and then goes through it.

*Faust*

IV (p. 67)

The Modern Publisher. New York, New York, USA. 1912

## NOTHING

**Faraday, Michael** 1791–1867  
English physicist and chemist

Nothing is too wonderful to be true, if it be consistent with the laws of nature ...

In Bence Jones

*The Life and Letters of Faraday* (Volume 2) (p. 253)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

**Kepler, Johannes** 1571–1630  
German astronomer

I am well aware how fond you are of Nothing, not so much for low price as for the sport, as delightful as it is witty, that it affords your pert sparrow; and so I can really guess that the closer a gift comes to Nothing the more welcome and acceptable it will be to you.

*The Six-cornered Snowflake*

To the Illustrious Counsellor at the Court of His Sacred Imperial Majesty (p. 3)

Oxford University Press. Oxford, England. 1966

**Updike, John** 1932–

American novelist, short story writer, and poet

The chief characteristic of the universe is, I would say, emptiness. There is infinitely more nothing in the universe than anything else.

*The Poorhouse Fair* (p. 113)

Alfred A. Knopf. New York, New York, USA. 1977

## NOTION

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

*Non notaiones, sed notiones*

Not notation, but notions.

Apocryphal

**Hazen, Robert M.**

No biographical data available

If science has taught us anything, it's that cherished notions about our place in the natural world often turn out to be dead wrong.

*Gen e sis*

Chapter 7 (p. 95)

Joseph Henry Press. Washington, D.C. 2005

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Everyone who busies himself with science recognises how unsettled and indefinite the notions are which he has brought with him from common life, and how, on a minute examination of things, old differences are effaced and new ones introduced.

Translated by Thomas Joseph McCormack

*Popular Scientific Lectures* (3rd edition)

The Forms of Liquids (pp. 1–2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1898

**Reichenbach, Hans** 1891–1953

German philosopher of science

If our everyday notions of the world are filled with pictorial descriptions, in which nature is constructed after the fashion of man; if, for instance, we compare the force of a spring under tension to the effort of a man lifting a burden uphill; if we compare the obedience of a falling stone to Galileo's law with human obedience to police law; if we regard light as the fine, coloured substance which our eye takes it to be – all these ideas merely amount to filling natural laws with a graphic content, which is borrowed from another world and is here out of place.

*Atom and Cosmos: The World of Modern Physics*

Chapter 19 (p. 286)

The Macmillan Co. New York, New York, USA. 1933

## NOTORIETY

**Jordan, David Starr** 1851–1931

American scientist and university administrator

In science and literature as well as in other fields notoriety is due either to the personality of the man or to the

work which he has accomplished, while in certain cases both contribute to his fame.

*Leading American Men of Science*

John James Audubon (p. 71)

Henry Holt & Co. New York, New York, USA. 1910

## NOUNS OF MULTITUDE

### Author undetermined

A pile of nuclear physicists  
 A grid of electrical engineers  
 A set of pure mathematicians  
 A field of theoretical physicists  
 An amalgamation of metallurgists  
 A line of spectroscopists  
 A coagulation of colloid chemists  
 A galaxy of cosmologists  
 A cloud of theoretical meteorologists  
 A shower of applied meteorologists  
 A litter of geneticists  
 A knot of nautical engineers  
 A labyrinth of communication engineers  
 An exhibition of Nobel prize winners  
 An intrigue of council members  
 A dissonance of faculty members  
 A stack of librarians  
 A chain of security officers  
 A complex of psychologists  
 A wing of ornithologists  
 A batch of fermentation chemists  
 A colony of bacteriologists.  
*Collective Names in Basic Science*  
*Journal of Irreproducible Results*, Volume 14, Number 4, 1965

A hive of allergists.  
 A body of anatomists.  
 A wiff of anesthesiologists.  
 A he(a)rd of audiologists.  
 A manipulation of chiropractors.  
 A clique of clinicians.  
 A wince of dentists.  
 A rash of dermatologists.  
 A guess of diagnosticians.  
 A crop of gastrologists.  
 A jury of generalists.  
 A smear of gynecologists.  
 A clot of hematologists.  
 A galaxy of hepatologists.  
 An obedience of hypnotists.  
 A harem of hysterologists.  
 An infusion of interns.  
 A practice of interns.  
 A scrub of interns.  
 A gargle of laryngologists.  
 A handful of mammologists.

A cuddle of nurses.  
 A giggle of nurses.  
 A help of nurses.  
 An eyeful of ophthalmologists.  
 A cast of orthopedic rheumatologists.  
 A vision of orthopists.  
 A joint of osteopaths.  
 A body of pathologists.  
 A mixture of pharmacists.  
 A chest of phthisiologists.  
 An exercise of physical therapists.  
 A poll of pollenologists.  
 A pile of proctologists.  
 A couch of psychologists.  
 A train of pulmonologists.  
 A pew of rhinologists.  
 A column of spondylotherapists.  
 A cut of surgeons.  
 A flood of urologists.  
 Source undetermined

## NOVAE

**Gaposchkin, Sergei** 1898–1984

Russian-born astronomer

When the greatest, the cosmic,  
 And the most fascinating explosion  
 Has been probed by the fabulous light  
 Of the human (but god-like) mind,  
 It will be remembered  
 That you shouldered the task  
 Of exploring the Novae  
 With intrepid boldness  
 And richness of thought.  
 In Arthur Beer  
*Vistas in Astronomy* (Volume 2)  
*Novae Observed* (p. 1506)  
 Pergamon Press. New York, New York, USA. n.d.

## NUCLEUS

**Cudmore, Lorraine Lee**

American cell biologist

Despite its comparatively prosaic name, like the unassuming nanny who turns out to be the head of the espionage network, the nucleus is the structural and actual center of the cell.

*The Center of Life: A Natural History of the Cell*

Cellular Evolution (p. 50)

New York Times Book Company. New York, New York, USA. 1977

**Rutherford, Ernest** 1871–1937

English physicist

It is my personal conviction that if we knew more about the nucleus, we should find it much simpler than

we suppose. I am always a believer in simplicity, being a simple fellow.

Guttingen Lecture  
December 14, 1931

## NULL HYPOTHESIS

### Dunnette, Marvin D.

...most of us still remain content to build our theoretical castles on the quicksand of merely rejecting the null hypothesis.

Fads, Fashions, and Folderol in Psychology  
*American Psychologist*, Volume 21, 1966 (p. 345)

### Fisher, Sir Ronald Aylmer 1890–1962

English statistician and geneticist

In relation to any experiment we may speak of this hypothesis as the “null hypothesis,” and it should be noted that the null hypothesis is never proved or established, but is possibly disproved, in the course of experimentation. Every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis.

*The Design of Experiments*  
II, 8 (p. 16)

Hafner Publishing Company. New York, New York, USA. 1971

### Tukey, John W. 1915–2000

American statistician

The worst, i.e., most dangerous, feature of “accepting the null hypothesis” is the giving up of explicit uncertainty.... Mathematics can sometimes be put in such black-and-white terms, but our knowledge or belief about the external world never can.

The Philosophy of Multiple Comparisons  
*Statistical Science*, Volume 6, Number 1, February, 1991 (pp. 100–101)

## NUMBER

### Aeschylus 525 BCE–426 BCE

Greek playwright

...but utterly without knowledge  
Moiled, until I the rising of the stars  
Showed them, and when they set, Though much  
obscure.

Moreover, number, the most excellent  
Of all inventions, I for them devised,  
And gave them writing that retaineth all,  
The serviceable mother of the Muse.

In *Great Books of the Western World* (Volume 5)

*The Plays of Aeschylus*  
*Prometheus Bound*, 457

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Airy, Sir George Biddell 1801–92

English mathematician and astronomer, Astronomer Royal from 1835 to 1881

I have not the smallest confidence in any result which is essentially obtained by the use of imaginary symbols. I am very glad to use them as conveniently indicating a conclusion which it may afterwards be possible to obtain by strictly logical methods: but, until these logical methods shall have been discovered, I regard the result as requiring further demonstration.

Supplement to a Proof of the Theorem that Every Algebraic Equation has a Root

*Transactions of the Cambridge Philosophical Society*, Volume X, 1864 (p. 327)

### Archimedes of Syracuse 287 BCE–212 BCE

Sicilian mathematician

There are some, King Gelon, who think that the number of the sand is infinite in multitude; and I mean by the sand not only that which exists about Syracuse and the rest of Sicily but also that which is found in every region inhabited or uninhabited. Again there are some who, without regarding it as infinite, yet think that no number has been named which is great enough to exceed its multitude.... But I will try to show you by means of geometrical proofs, which you will be able to follow, that, of the numbers named by me, and given in the work which I sent to Zeuxippus, some exceed not only the number of the mass of sand equal in magnitude to the earth, but also that of a mass equal in magnitude to the universe.

*The Works of Archimedes*

*The Sand-Reckoner*

At The University Press. Cambridge, England. 1897

### Aristotle 384 BCE–322 BCE

Greek philosopher

...the attributes of numbers are present in a musical scale and in the heavens...

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book XIV, Chapter 3 (p. 622)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Asimov, Isaac 1920–92

American author and biochemist

Human beings are very conservative in some ways and virtually never change numerical conventions once they grow used to them. They even come to mistake them for laws of nature.

*Foundation and Earth* (p. 376)

Doubleday & Company, Inc. Garden City, New York, USA. 1986

### Auster, Paul 1947–

American writer

I’ve dealt with numbers all my life, of course, and after a while you begin to feel that each number has a personality



of its own. A twelve is very different from a thirteen, for example. Twelve is upright, conscientious, intelligent, whereas thirteen is a loner, a shady character who won't think twice about breaking the law to get what he wants. Eleven is tough, an outdoorsman who likes tramping through woods and scaling mountains; ten is rather simpleminded, a bland figure who always does what he's told; nine is deep and mystical, a Buddha of contemplation.... Numbers have souls, and you can't help but get involved with them in a personal way.

*The Music of Chance*

Chapter 4 (p. 73)

Viking Penguin. New York, New York, USA. 1990

### **Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...insomuch as we see in the schools both of Democritus and of Pythagoras, that the one did ascribe figure to the first seeds of things, and the other did suppose numbers to be the principles and originals of things.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VIII, Section 1 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Barrett-Browning, Elizabeth** 1806–61

English poet

How do I love thee?

Let me count the ways.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Sonnets from the Portuguese, XLIII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

### **Begley, Sharon** 1956–

Science editor

...number theory... is a field of almost pristine irrelevance to everything except the wondrous demonstration that pure numbers, no more substantial than Plato's shadows, conceal magical laws and orders that the human mind can discover after all.

New Answer for an Old Question

*Newsweek*, 5 July, 1993 (p. 53)

### **Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Roughly it amounts to this: mathematical analysis as it works today must make use of irrational numbers (such as the square root of two); the sense in which such numbers exist is hazy. Their reputed mathematical existence implies the disputed theories of the infinite. The paradoxes remain. Without a satisfactory theory of irrational numbers, among other things, Achilles does not catch up with the tortoise, and the earth cannot turn on its axis. But as Galileo remarked, it does. It would seem to follow that something is wrong with our attempts to compass the infinite.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

If "Number rules the universe" as Pythagoras asserted, Number is merely our delegate to the throne, for we rule Number.

*Men of Mathematics* (p. 16)

Simon & Schuster. New York, New York, USA. 1986

The algebraic numbers are spotted over the plane like stars against a black sky; the dense blackness is the firmament of the transcendentals.

*Men of Mathematics* (p. 569)

Simon & Schuster. New York, New York, USA. 1937

The next fundamental assumption of the Pythagoreans lies much deeper, so deep in fact that civilized man can scarcely hope to fetch it up to the full light of reason. Odd numbers are male; even numbers, female. We can only ask why, expecting no answer except possibly a hesitant allusion to a vestigial phallicism or a forgotten Orphism.

*The Magic of Numbers*

Chapter 14 (p. 155)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

The theory of numbers is the last great uncivilized continent of mathematics. It is split up into innumerable countries, fertile enough in themselves, but all the more or less indifferent to one another's welfare and without a vestige of a central, intelligent government. If any young Alexander is weeping for a new world to conquer, it lies before him.

*The Queen of the Sciences*

Chapter VII (p. 91)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

### **Berry, Daniel M.**

No biographical data available

### **Yavne, Moshe**

No biographical data available

In the beginning, everything was void, and J. H. W. H. Conway began to create numbers. Conway said, "Let there be two rules which bring forth all numbers large and small. This shall be the first rule: Every number corresponds to two sets of previously created numbers, such that no member of the left set is greater than or equal to any member of the right set.

And the second rule shall be this: One number is less than or equal to another number if and only if no member of the first number's left set is greater than or equal to the second number, and no member of the second number's right set is less than or equal to the first number." And Conway examined these two rules he had made, and behold! they were very good.

The Conway Stones: What the Original Hebrew May Have Been  
*Mathematics Magazine*, Volume 49, Number 4, September, 1976 (p. 208)

**Boethius, Anicius Manlius Severinus** ca. 475–524  
Roman philosopher and statesman

...in the science of numbers ought to be preferred as an acquisition before all others, because of its necessity and because of the great secrets and other mysteries which there are in the properties of numbers. All sciences partake of it, and it has need of none.

In J Fauvel and J Gray  
*The History of Mathematics: A Reader*  
Chapter 7  
Section 7.B2 (p. 247)  
Macmillan Press Ltd. Houndmills, England. 1987

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

One grain of wheat does not constitute a pile, nor do two grains, nor three and so on. On the other hand, everyone will agree that a hundred million grains of wheat do form a pile. What, then, is the threshold number? Can we say that 325,647 grains of wheat do not form a pile, but that 325,648 grains do? If it is impossible to fix a threshold number, it will also be impossible to know what is meant by a pile of wheat; the words can have no meaning, although, in certain extreme cases, everybody will agree about them.

Translated by Douglas Scott  
*Probability and Certainty*  
Chapter 8 (p. 98)  
Walker & Company. New York, New York, USA. 1963

All of mathematics can be deduced from the sole notion of an integer; here we have a fact universally acknowledged today.

*A l'analyse arithmétique du continu*  
Oeuvres 3, 1439–1485  
Publisher undetermined

Numbers are the landmarks which enable us to speak in a language common to all men, of successive moments of duration.

*Space and Time*  
Introduction (p. 16)  
Dover Publications. New York, New York, USA. 1960

Number knows no limitations, either from the side of the infinitely great or from the side of the infinitely small, and the facility it offers for generalization is too great for us not to be tempted by it.

*Space and Time*  
Chapter I (p. 46)  
Dover Publications. New York, New York, USA. 1960

**Borges, Jorge Luis** 1899–1986  
Argentine writer

The man who has learned that three plus one are four doesn't have to go through a proof of that assertion with coins, or dice, or chess pieces, or pencils. He knows it, and that's that. He cannot conceive a different sum.

There are mathematicians who say that three plus one is a tautology for four, a different way of saying "four"... if three plus one can be two, or fourteen, then reason is madness.

Translated by Andrew Hurley  
*Shakespeare's Memory*  
Blue Tigers  
Penguin. 1999

**Bowley, Arthur Lyon** 1869–1957  
English statistician and economist

Great numbers and the averages resulting from them, such as we always obtain in measuring social phenomena, have great inertia.

*Elements of Statistics*  
Chapter I (p. 8)  
P.S. King & Son. London, England. 1901

**Bridgman, Percy Williams** 1882–1961  
American physicist

Nature does not count nor do integers occur in nature. Man made them all, integers and all the rest, Kroneker to the contrary notwithstanding.

*The Way Things Are*  
Chapter IV (p. 100)  
Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Buchanan, Scott** 1895–1968  
American educator and philosopher

Numbers are not just counters; they are elements in a system.

*Poetry and Mathematics*  
Chapter III  
The University of Chicago Press. Chicago, Illinois, USA. 1975

The theory of number is the epipoem of mathematics.

*Poetry and Mathematics*  
Chapter III  
The University of Chicago Press. Chicago, Illinois, USA. 1975

There is no more impressive form of literature than the narrative epic poem. That combination of depth and breadth of conception which some have called sublimity has here [number theory] found a natural and adequate expression. The theory of numbers is the epic poem of mathematics.

In Robert M. Hutchins and Mortimer J. Adler  
*The Great Ideas Today* 1974  
*Poetry and Mathematics* (p. 429)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1975

**Burger, Edward B.**  
American mathematician

**Starbird, Michael**  
American mathematician

...numbers have individual personalities that we can embrace and secrets that we can attempt to lure out of the shadows.

*Coincidences, Chaos, and All That Math Jazz*

Part I, Chapter 3 (p. 61)

W.W. Norton & Co. New York, New York, USA. 2005

Being attuned to the numbers that arise around us is a powerful way of seeing our world with more nuance and detail. Numbers have a way of forcing us to see structure and meaning in our surroundings – structure that could remain hidden without the magnifying lens of quantitative focus.

*Coincidences, Chaos, and All That Math Jazz*

Chapter 3 (p. 64)

W.W. Norton & Co. New York, New York, USA. 2005

### **Burke, Edmund** 1729–97

English statesman and philosopher

The starry heaven, though it occurs so very frequently to our view, never fails to excite an idea of grandeur. This cannot be owing to the stars themselves, separately considered. The number is certainly the cause. The apparent disorder augments the grandeur.

*On the Sublime and the Beautiful*

Part II, Sec. XIII (p. 139)

Printed for F.C. and J. Rivington and others. London, England. 1812

### **Butterworth, Brian**

Neuroscientist

Although the idea that we have no bananas is unlikely to be a new one, or one that is hard to grasp, the idea that no bananas, no sheep, no children, no prospects are really all the same, in that they have the same numerosity, is a very abstract one.

*The Mathematical Brain*

Macmillan & Company Ltd. London, England. 1999

### **Clawson, Calvin C.**

No biographical data available

Numbers, in fact, are the atoms of the universe, combining with everything else.

*Mathematical Mysteries: The Beauty and Magic of Numbers*

Chapter One (p. 22)

Plenum Press. New York, New York, USA. 1996

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

Jesearc sat motionless within a whirlpool of numbers.... [H]e was fascinated by the way in which the numbers he was studying were scattered, apparently according to no laws, across the spectrum of integers.

*The City and the Stars and The Sands of Mars*

*The City and the Stars*

Chapter 6 (pp. 51, 52)

Warner Books, Inc. New York, New York, USA. 2001

### **Comte, Auguste** 1798–1857

French philosopher

There is no inquiry which is not finally reducible to a question of Numbers; for there is none which may not be

conceived of as consisting in the determination of quantities by each other, according to certain relations.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (pp. 42–43)

John Chapman. London, England. 1853

### **Coutts, John**

No biographical data available

Numbers are like time, they begin with 0, flash forth into a one thing, then advance into numbers that seem to get lost in eternity.

*The Divine Order of Development*

Chapter I (p. 44)

National Hygienic Co. London, England. 1908

### **Crosby, Alfred W.**

American historian and professor

What could be more general than 2, which can represent two galaxies or two pickles, or one galaxy plus one pickle (the mind doth boggle), or just 2 gently bobbing – where? It, like God, is an *I* am and many have thought that it must be a precipitate of ultimate reality.

*The Measure of Reality*

Part I, Chapter 6 (p. 122)

Cambridge University Press. Cambridge, England. 1997

### **Dantzig, Tobias** 1884–1956

Russian mathematician

To attempt to apply rational arithmetic to a problem in geometry resulted in the first crisis in the history of mathematics. The two relatively simple problems – the determination of the diagonal of a square and that of the circumference of a circle – revealed the existence of new mathematical beings for which no place could be found within the rational domain.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 44)

Birkhäuser. Boston, Massachusetts, USA. 1987

### **Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

At this stage it might well seem that the infinity of natural numbers really is so big that it cannot be made any bigger, but this is wrong. In a celebrated theorem, Georg Cantor proved the seemingly impossible – that there are infinite sets which are so big that their elements cannot be counted, even with the infinity of natural numbers at one's disposal.

*The Edge of Infinity: Where the Universe Came from and How It Will End*

Chapter 2 (p. 30)

Simon & Schuster. New York, New York, USA. 1981

### **Davis, Philip J.** 1923–

American applied mathematician

The numbers are a catalyst that can help turn raving madmen into polite humans.

*3, 1416 and All that* (p. 64)

1985

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

You can be moved to tears by numbers – provided they are encoded and decoded fast enough.

*River Out of Eden: A Darwinian View of Life*

Chapter 1 (p. 14)

Basic Books. New York, New York, USA. 1995

**Dedekind, Richard** 1831–1916

German mathematician

I regard the whole of arithmetic as a necessary, or at least natural, consequence of the simplest arithmetical act, that of counting, and counting itself as nothing else than the successive creation of the infinite series of positive integers in which each individual is defined by the one immediately preceding...

Translated by Wooster Woodruff Beman

*Essays on the Theory of Numbers*

Chapter I (p. 4)

The Open Court Publishing Company. Chicago, Illinois, USA. 1901

...numbers are free creations of the human mind; they serve as a means of apprehending more easily and more sharply the difference of things.

Translated by Wooster Woodruff Beman

*Essays on the Theory of Numbers*

The Nature and Meaning of Numbers

Preface to the First Edition (p. 31)

The Open Court Publishing Company. Chicago, Illinois, USA. 1901

**Eberstadt, Nicholas N.** 1955–

American political economist

Though he may not always recognize his bondage, modern man lives under a tyranny of numbers.

*The Tyranny of Numbers: Mismeasurement and Misrule*

Introduction (p. 1)

American Enterprise Institute. Washington, D.C. 1995

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

With numbers you can do anything you like. Suppose I have the sacred number 9 and I want to get a number 1314, date of the execution of Jacques de Molay – a date dear to anyone who, like me, professes devotion to the Templar tradition of knighthood. What do I do? I multiply nine by one hundred and forty-six, the fateful day of destruction of Carthage. How do I arrive at this? I divided thirteen hundred and fourteen by two, by three, *et cetera*, until I found a satisfying date. I could also have divided thirteen hundred and fourteen by 6.28, the double of 3.14, and I would have got two hundred and nine. That is the year Attalus I, king of Pergamon, ascended the throne. You see?

Translated by William Weaver

*Foucault's Pendulum*

Chapter 48 (pp. 288–289)

Harcourt Brace Jovanovich. San Diego, California, USA. 1988

**Enzensberger, Hans Magnus** 1929–

German writer, poet, translator, and editor

Still in a daze the next morning, Robert said to his mother, “Do you know the year I was born? It was  $6 \times 1$  and  $8 \times 10$  and  $9 \times 100$  and  $1 \times 1,000$ . I don't know what's got into the boy lately,” said Robert's mother, shaking her head. “Here,” she added, handing him a cup of hot chocolate, “maybe this will help. You say the oddest things.” Robert drank his hot chocolate in silence. There are some things you can't tell your mother, he thought.

*The Number Devil*

The Second Night (p. 46)

Henry Holt & Company. New York, New York, USA. 1998

**Euler, Leonhard** 1707–83

Swiss mathematician and physicist

...we should take great care not to accept as true such properties of the numbers which we have discovered by observation and which are supported by induction alone. Indeed, we should use such a discovery as an opportunity to investigate more exactly the properties discovered and to prove or disprove them; in both cases we may learn something useful.

In G. Polya

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Euripides** ca. 480 BCE–406 BCE

Greek playwright

Numbers are a fearful thing, and joined to craft a desperate foe.

In *Great Books of the Western World* (Volume 5)

*The Plays of Euripides*

*Hecuba*, l. 884

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Fabilli, Mary**

No biographical data available

What would I do without numbers?

A 7 there and a 3 here,

days in a month

months in a year

AD and BC

and all such symbols.

In Ernest Robson and Jet Wimp

*Against Infinity*

Numbers (p. 22)

Primary Press. Parker Ford, Pennsylvania, USA. 1979

**Ferguson, Kitty**

Science writer

Letting numbers take us where we can't go in person – whether that's to the top of a windmill or to the origin

and borders of the universe – has been and still is one of humankind’s favorite intellectual adventures.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*  
Prologue (p. 3)  
Walker & Company. New York, New York, USA. 1999

**Feynman, Richard P.** 1918–88

American theoretical physicist

You know...there are about a hundred billion stars in the galaxy – ten to the eleventh power. That used to be considered a huge number. Today it’s less than the national debt. We ought to call them “economical numbers.”

In David L. Goodstein and Judith R. Goodstein  
*Feynman’s Lost Lecture: The Motion of Planets Around the Sun*  
Chapter 2 (p. 62)  
W.W. Norton & Company, Inc. New York, New York, USA. 1996

**Gass, Fredrick**

No biographical data available

Adam, did you find a good system for naming ordinals?

A: Ordinals? I thought you said “animals.”

Constructive Ordinal Notation Systems  
*Mathematics Magazine*, Volume 57, Number 3, May, 1984 (p. 131)

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

And he who is versed in the science of numbers can tell of the regions of weight and measures, but he cannot conduct you thither.

For the vision of one man lends not its wings to another man.

*The Prophet*  
On Teaching (pp. 56–57)  
Alfred A. Knopf. New York, New York, USA. 1969

**Ginsey, Gurney**

No biographical data available

There are numbers I don’t trust...take  
One – too proud, too pointed, much too  
Sure that all begins with him – and  
Two, that sits cross-legged on the  
Path and sneers as though he knows all secrets...

Numbers  
*Mathematics Magazine*, Volume 38, Number 3, May, 1965 (p. 168)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Numbers have undoubted powers to beguile and benumb, but critics must probe behind numbers to the character of arguments and the biases that motivate them.

*An Urchin in the Storm: Essays About Books and Ideas*  
Chapter 8 (p. 144)  
W.W. Norton & Company, Inc. New York, New York, USA. 1987

**Hales, Stephen** 1677–1761

English physiologist and clergyman

...since we are assured that the all-wise Creator has observed the most exact proportions, of number, weight, and measure, in the make of all things; the most likely way therefore, to get any insight into the nature of these parts of the creation, which come within our observation, must in all reason be to number, weigh and measure.

*Vegetable Statics*  
The Introduction (p. xxxi)  
The Scientific Book Guild. London, England. 1961

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

The elementary theory of numbers should be one of the very best subjects for early mathematical instruction. It demands very little previous knowledge; its subject matter is tangible and familiar; the processes of reasoning which it employs are simple, general and few; and it is unique among the mathematical sciences in its appeal to natural human curiosity. A month’s intelligent instruction in the theory of numbers ought to be twice as instructive, twice as useful, and at least ten times as entertaining as the same amount of calculus for engineers.

An Introduction to the Theory of Numbers  
*Bulletin of the American Mathematical Society*, Volume 35, 1929 (p. 818)

**Henle, James M.**

American mathematician

Belief in a large number is no more daring, I should think, than belief in Tolstoy’s *War and Peace*.

The Happy Formalist  
*The Mathematical Intelligencer*, Volume 13, Number 1, Winter, 1991 (p. 14)

**Høeg, Peter** 1957–

Danish writer

Do you know what the foundation of mathematics is?... The foundation of mathematics is numbers. If anyone asks me what makes me truly happy, I would say: numbers. Snow and ice and numbers. And do you know why?...Because the number system is like human life. First you have the natural numbers. The ones that are whole and positive. The numbers of a small child. But human consciousness expands. The child discovers a sense of longing, and do you know what the mathematical expression is for longing.... The negative numbers. The formalization of the feeling that you are missing something. And human consciousness expands and grows even more, and the child discovers the in between spaces. Between stones, between pieces of moss on the stones, between people. And between numbers. And do



you know what that leads to? It leads to fractions. Whole numbers plus fractions produce rational numbers. And human consciousness doesn't stop there. It wants to go beyond reason. It adds an operation as absurd as the extraction of roots. And produces irrational numbers.... It's a form of madness.

*Smilla's Sense of Snow*

The City (pp. 114–115)

Dell Publishing. New York, New York, USA. 1993

**Hofstadter, Douglas R.** 1945–

American academic

People enjoy inventing slogans which violate basic arithmetic but which illustrate “deeper” truths, such as “1 and 1 make 1” (for lovers), or “1 plus 1 plus 1 equals 1” (the Trinity)... Two raindrops running down a window pane merge; does one plus one make one? A cloud breaks up into two clouds – more evidence for the same? ...Numbers as realities misbehave. However, there is an ancient and innate sense in people that numbers ought not to misbehave. There is something clean and pure in the abstract notion of number...and there ought to be a way of talking about numbers without always having the silliness of reality come in and intrude. The hard-edged rules that govern “ideal” numbers constitute arithmetic, and their more advanced consequences constitute number theory.

*Gödel, Escher, Bach: An Eternal Golden Braid*

Part I, Chapter II (p. 56)

Basic Books, Inc. New York, New York, USA. 1979

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Dr. Hooke, the famous English mathematician and philosopher, made a calculation of the number of separate ideas the mind is capable of entertaining, which he estimated as 3,155,760,000.

*Pages from an Old Volume of Life*

Chapter VIII (p. 274, fn a)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

The power of dealing with numbers is a kind of “detached lever” arrangement, which may be put into a mighty poor watch. I suppose it is about as common as the power of moving the ears voluntarily, which is a moderately rare endowment.

*The Autocrat of the Breakfast Table*

Breakfast I (p. 8)

Alexander Strahan & Co. Edinburgh, Scotland. 1859

**Hume, David** 1711–76

Scottish philosopher and historian

...I observe that when we mention any great number, such as a thousand, the mind has generally no adequate idea of it, but only a power of producing such an idea by its adequate idea of the decimals, under which the number is comprehended.

*A Treatise of Human Nature*

Book I, Part I, Section VII (p. 70)

Penguin Books. Baltimore, Maryland, USA. 1969

**Huxley, Aldous** 1894–1963

English writer and critic

A million million spermatozoa,  
All of them alive:  
Out of their cataclysm but one poor Noah  
Dare hope to survive.  
And among that billion minus one  
Might have chanced to be  
Shakespeare, another Newton, a new Donne –  
But the One was Me.

*Stories, Essays, and Poems*

Fifth Philosopher's Song (p. 410)

J.M. Dent & Sons Ltd. London, England. 1937

**Jacobi, Karl Gustav Jacob** 1804–51

German mathematician

The God that reigns in Olympus is Number Eternal.

In Tobias Dantzig

*Number: The Language of Science* (4th edition)

Chapter 10 (p. 179)

The Macmillan Company. New York, New York, USA. 1954

**Jephson, Philippa Prittie**

No biographical data available

Oh where is the spell that once hung on thy numbers?  
Arise in thry beauty ...

*An April Day* (Volume I)

Chapter I (p. 7)

F.V. White & Co. London, England. 1883

**Jevons, William Stanley** 1835–82

English economist and logician

Number is but another name for diversity.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter VIII (p. 156)

Macmillan & Company. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Round numbers, she said, are always false.

In Mrs. Piozzi, Richard Cumberland, Bishop Percy and other book

*Johnsoniana*

Apothegms, Sentiment, Opinions, &c

G. Bell. London, England. 1884

**Juster, Norton** 1929–

American architect and writer

“How terribly confusing,” he cried. “Everything here is called exactly what it is. The triangles are called triangles, the circles are called circles, and even the same numbers have the same name. Why, can you imagine what would happen if we named all the twos Henry or



George or Robert or John or lots of other things? You'd have to say Robert plus John equals four, and if the four's name were Albert, things would be hopeless."

*The Phantom Tollbooth*

Chapter 14 (pp. 173–174)

Alfred A. Knopf. New York, New York, USA. 1989

"I don't think numbers are very important," confessed Milo, too embarrassed to admit the truth.

"NOT IMPORTANT!" roared the Dodecahedron, turning red with fury. "Could you have tea for two without the two? Or three blind mice without the three? Would there be four corners of the earth if there weren't a four? And how could you sail the seven seas without a seven? If you had high hopes, how would you know how high they were? And did you know that narrow escapes come in different widths? How could you do anything at long last," waving his arms over his head, "without knowing how long the last was? Why, numbers are the most beautiful and valuable things in the world."

*The Phantom Tollbooth*

### **Kaminsky, Kenneth**

American mathematics professor, writer, and editor

How poor were we? Why, we were so poor we only had imaginary numbers to play with.

Professor Fogelfroie

*Mathematics Magazine*, Volume 69, Number 4, October, 1996 (p. 303)

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

When you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

*Popular Lectures and Addresses* (Volume 1)

Lecture, Institution of Civil Engineering

3 May, 1883 (p. 73)

Macmillan & Company Ltd. London, England. 1894

### **Klein, William**

No biographical data available

Numbers are friends, for me, more or less. It doesn't mean the same for you, does it – 3,844? For you it's just a three and an eight and a four and a four. But I say, "Hi! 62 squared."

In Oliver Sacks

*The Man Who Mistook His Wife for a Hat and Other Clinical Tales*

The Twins (pp. 198–199)

Summit Books. New York, New York, USA. 1985

### **Kline, Morris** 1908–92

American mathematics professor and writer

The theory of infinite numbers is only one of the creations of the nineteenth-century critical thinkers. Almost bizarre in its contents it is nevertheless both logical and useful.

*Mathematics in Western Culture*

Chapter XXV (p. 409)

Oxford University Press, Inc. New York, New York, USA. 1953

### **Kronecker, Leopold** 1823–91

German mathematician

Number theorists are like lotus-eaters – having once tasted of this food they can never give it up.

In Howard W. Eves

*Mathematical Circles* (Volume 2)

Mathematical Circles Squared

302 (p. 149)

The Mathematical Association of America, Inc. 2003

*Die Ganzen Zahlen hat Gott gemacht, andere ist Menschenwerk.*

God created the natural numbers; everything else is man's handiwork.

In Sir Arthur Stanley Eddington

*The Nature of the Physical World* (p. 246)

At The University Press. Cambridge, England. 1929

### **Le Corbusier (Charles-Edouard**

### **Jeanneret)** 1887–1965

Swiss architect and city planner

The mathematical phenomenon always develops out of simple arithmetic, so useful in everyday life, out of numbers, those weapons of the gods; the gods are there, behind the wall, at play with numbers.

*The Modulor*

Part III, Chapter 7 (p. 220)

Birkhäuser. Basel, Switzerland. 2000

### **Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

There is an old saying that God created everything according to weight, measure and number.

*Philosophical Papers and Letters* (Volume 1)

On the General Characteristic (pp. 339–340)

The University of Chicago Press. Chicago, Illinois, USA. 1956

Some things cannot be weighed, as having no force and power; some things cannot be measured, by reason of having no parts; but there is nothing which cannot be numbered.

In G. Frege

*The Foundations of Arithmetic* (p. 31e)

Northwestern University Press. Evanston, Illinois, USA. 1968

...a miracle of analysis, a monster of the ideal world, almost an amphibian between being and not being.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 7, Section 7. 1 (p. 168)

Macmillan & Company Ltd. New York, New York, USA. 1967

### **Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

People don't like to choose lot #1 in a lottery. "Choose it," Reason cries loudly. "It has as good a chance of winning the 12,000 thalers as any other." "In Heaven's name don't choose it," *a je ne sais quoi* whispers. "There's no example of such little numbers being listed before great winnings." And actually no one takes it.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 46)

Jonathan Cape. London, England. 1969

### **Locke, John** 1632–1704

English philosopher and political theorist

For number applies itself to men, angels, actions, thoughts; everything that either doth exist, or can be imagined.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter XVI, Section 1 (p. 165)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The simple modes of numbers are of all other the most; every the distinct, least variation, which is an unit, making each combination as clearly different from that which approacheth nearest to it, as the most remote: two being as distinct from one, as two hundred; and the idea of two as distinct from the idea of three, as the magnitude of the whole earth is from that of a mite.

*The Works of John Locke: In Nine Volumes* (Volume 1)

12th Chapter XVI (p. 189)

Printed for C. & J. Rivington. London, England. 1824

### **Longfellow, Henry Wadsworth** 1807–82

American poet

Tell me not, in mournful numbers,

Life is but an empty dream!

*The Poetical Works of Henry Wadsworth Longfellow*

A Psalm of Life, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

### **Mallon, Thomas** 1951–

American writer

Her columns grew longer, and if she squinted at them, the confetti of inklings began to resemble a skyful of stars. She had time to let her mind wander. The Magi's search for Bethlehem; the music of Milton's crystal spheres... they could all be reduced to these numbers. There was actually no need to squint and pretend that the digits

were the stars. They were, by themselves, wildly alive, fact and symbol of the vast, cool distances in which one located the light of different worlds.

*Two Moons: A Novel*

Chapter One (p. 11)

Harcourt, Orlando, Florida, USA. 2000

### **Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

...large numbers have an odd effect upon the mind of man. Briefly and bluntly, they make him wicked. They seduce his spirit into all manner of vainglory and irreverence and megalomania.

*Prefaces*

Preface to a Moral Book of Arithmetic (p. 196)

D. Appleton & Co. New York, New York, USA. 1919

Large numbers exert a malign influence upon the imagination; something unsocial and sinister and detached from reality and demoniac steals out of them like a vapor to corrode and corrupt the pink and innocent convolutions of the brain.

*Prefaces*

Preface to a Moral Book of Arithmetic (p. 197)

D. Appleton & Co. New York, New York, USA. 1919

### **Maxwell, James Clerk** 1831–79

Scottish physicist

Thus numbers may be said to rule the whole world of quantity, and the four rules of arithmetic may be regarded as the complete equipment of the mathematician.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

### **Mayer, Robert**

No biographical data available

In physics numbers are everything, in physiology they are a little, in metaphysics, they are nothing.

Translated by Henry Downton

In Jules Ernest Naville

*Modern Physics, Studies Historical and Philosophical*

First Essay (p. 54)

T.&T. Clark. Edinburgh, Scotland. 1884

One single number has more real and permanent value than an expensive library full of hypotheses.

*Gesammelten Schriften*

Letter to Greisinger, July 20, 1844 (p. 145)

Stuttgart, Germany. 1893

### **Mazur, Barry** 1937–

American mathematician

In the history of the concept of number, number has been adjective (three cows, three monads) and noun (three, pure and simple), and now..., number seems to be more like a verb (to triple).

*Imagining Numbers*

Part II, Chapter 8, Section 37 (p. 138)

Farrar, Straus & Giroux. New York, New York, USA. 2003

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

It is strange that we know so little about the properties of numbers. They are our handiwork, yet they baffle us; we can fathom only a few of their intricacies. Having defined their attributes and prescribed their behavior, we are hard pressed to perceive the implications of our formulas.

*The World of Mathematics* (Volume 1)

Commentary on The Mysteries of Arithmetic (p. 497)

Simon & Schuster. New York, New York, USA. 1956

**O'Brien, Flann** 1911–66

Irish novelist and satirist

The Pooka MacPhellimey, a member of the devil class, sat in his hut in the middle of the firewood meditating on the nature of numerals and segregating in his mind the odd ones from the even.

*At Swim-Two-Birds*

Chapter I (p. 1)

Longmans, Green & Co. London, England. 1939

**Parker, F. W.**

No biographical data available

Number was born in superstition and reared in mystery... numbers were once made the foundation of religion and philosophy, and the tricks of figures have had a marvelous effect on a credulous people.

*Talks on Pedagogics*

Chapter IV (p. 64)

A.S. Barnes & Company. New York, New York, USA. 1909

**Paulos, John Allen** 1945–

American mathematician

The mathematician G. H. Hardy was visiting his protégé, the Indian mathematician Ramanujan, in the hospital. To make small talk, he remarked that 1729, the number of the taxi which had brought him, was a rather dull number, to which Ramanujan replied immediately, “No, Hardy! It is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways.

*Innumeracy*

Examples and Principles (p. 6)

Hill & Wang. New York, New York, USA. 1988

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The rudest numerical scales, such as that by which the mineralogists distinguish different degrees of hardness, are found useful. The mere counting of pistils and stamens sufficed to bring botany out of total chaos into some kind of form. It is not, however, so much from counting as a measuring, not so much from the conception of number as from that of continuous quantity, that the advantage of mathematical treatment comes.

Number, after all, only serves to pin us down to a precision in our thoughts which, however beneficial, can seldom lead to lofty conceptions, and frequently descends to pettiness.

*Chance, Love and Logic: Philosophical Essays*

The Doctrine of Chances (pp. 61–62)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

**Philolaus** ca. 480 BCE

Greek philosopher

All things which can be known have number; for it is not possible that without number anything can be either conceived or known.

In Carl B. Boyer

*A History of Mathematics* (p. 60)

John Wiley & Sons, Inc. New York, New York, USA. 1968

**Plato** 428 BCE–347 BCE

Greek philosopher

SOC: And all arithmetic and calculations have to do with number?

GLAUCON: Yes.

SOC: And they appear to lead the mind towards truth?

GLAUCON: Yes, in a very remarkable manner.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 525 (p. 393)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and writer

Why do we believe that in all matters the odd numbers are more powerful.

*Natural History* (Volume 8)

Book XXVIII, sec 23

Harvard University Press. Cambridge, Massachusetts, USA. 1947

**Plotinus** ca. 205–70

Egyptian-Roman philosopher

Objects of sense are not unlimited and therefore the Number applying to them cannot be so. Nor is an enumerator able to number to infinity; though we double, multiply over and over again, we still end with a finite number...

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Sixth Ennead VI.2 (p. 311)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pope, Alexander** 1688–1744

English poet

As yet a child, nor yet a fool to fame,  
I lisp'd in numbers, for the numbers came.

*The Complete Poetical Works*

An Epistle to Dr. Arbuthnot, l. 127

Houghton Mifflin Company. New York, New York, USA. 1903

**Proclus** 411–485  
Greek philosopher

Wherever there is number, there is beauty.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 131)  
Oxford University Press, Inc. New York, New York, USA. 1972

**Recorde, Robert** 1510?-58  
English mathematician and writer

Master. – Wherefore in all great works are clerks so much desired? Wherefore are auditors so richly fed?

What causeth geometricians so highly to be enhaused?  
Why are astronomers so greatly advanced? Because that by number such things they find, Which else would far excel man's mind.

In R.H. Carothers  
A Chapter On Figures  
*The Lafayette Monthly*, Volume V, September, 1874 (p. 132)

### The Bible (King James Version)

Let him that hath understanding count the number of the beast: for it is the number of a man; and his number is Six hundred threescore and six.

*Revelation 13:18*

**Robinson, Julia** 1919–85  
American mathematician

I think that I have always had a basic liking for the natural numbers. To me they are the one real thing. We can conceive of a chemistry that is different from ours, or a biology, but we cannot conceive of a different mathematics of numbers. What is proved about numbers will be a fact in any universe.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 264)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

We are the finite numbers.  
We are the stuff of the world.  
Whatever confusion cumber  
The earth is by us unfurled.  
We revere our master Pythagoras  
And deeply despise every hag or ass.  
Not Endor's witch nor Balaam's mount  
We recognize as wisdom's fount.  
But round and round in endless baller  
We move like comets seen by Halley.  
And honored by the immortal Plato  
We think no later mortal great-o.  
We follow the laws

Without a pause,  
For we are the finite numbers.

*The Collected Stories of Bertrand Russell*  
*Nightmares of Eminent Persons, The Mathematician's Nightmare* (p. 43)  
George Allen & Unwin Ltd. London, England. 1972

**Sagan, Carl** 1934–96  
American astronomer and author

Hiding between all the ordinary numbers was an infinity of transcendental numbers whose presence you would never have guessed until you looked deeply into mathematics.

*Contact: A Novel*  
Chapter 1 (p. 21)  
Simon & Schuster. New York, New York, USA. 1985

**Sandburg, Carl** 1878–1967  
American poet and biographer

He was born to wonder about numbers.

*Complete Poems*  
Number Man  
Harcourt, Brace. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

This is the third time; I hope good luck lies in odd numbers.... There is a divinity in odd numbers, either in nativity, chance or death.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Merry Wives of Windsor*  
Act V, Scene i, l. 2–3  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...I am ill at these numbers.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Hamlet, Prince of Denmark*  
Act II, Scene ii, l. 120  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, James Byrnie**  
American mathematician

Numbers go farther than do mere words, for they enable us to refer to the distinction between objects, without the necessity of identifying the objects.

*Lectures on the Philosophy of Mathematics*  
Chapter II (p. 15)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1918

**Smith, Adam (George J. W. Goodman)** 1930–  
American economist

...those who live by numbers can also perish by them and it is a terrifying thing to have an adding machine write an epitaph, either way.

*The Money Game*  
Chapter 7 (p. 84)  
Random House, Inc. New York, New York, USA. 1968

**Stewart, Ian** 1945–  
English mathematician

Mathematics rests on numbers but is not limited to them.

*Why Beauty is Truth: A History of Symmetry*

Chapter 1 (p. 5)

Basic Books. New York, New York, USA. 2007

**Stoney, George Johnstone** 1826–1911  
Irish physicist

When interpreting nature's work, we are obliged frequently to speak of high numbers and small fractions.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

Survey of That Part of the Range of Nature's Operations Which Man Is Competent to Study (p. 207)

Government Printing Office. Washington, D.C. 1901

**Sukoff, Albert**  
No biographical data available

Huge numbers are commonplace in our culture, but oddly enough the larger the number the less meaningful it seems to be.... Anthropologists have reported on the primitive number systems of some aboriginal tribes. The Yancos in the Brazilian Amazon stop counting at three. Since their word for "three" is "*poettarrarorincoaroac*," this is understandable.

Lotsa Hamburgers

*Saturday Review of the Society*, March, 1973 (p. 6)

**Synge, John L.** 1897–1995  
Irish mathematician and physicist

The northern ocean is beautiful, said the Orc, and beautiful the delicate intricacy of the snowflake before it melts and perishes, but such beauties are as nothing to him who delights in numbers, spurning alike the wild irrationality of life and the baffling complexities of nature's laws.

*Kandelman's Krim*

Chapter Six (p. 101)

Jonathan Cape. London, England. 1957

### The Bible (King James Version)

... MENE, MENE, TEKEL, UPHARSIN.

[Numbered, Numbered, Weighed, Divided]

Daniel 5:25

**Virgil** 70 BCE–19 BCE  
Roman epic, didactic, and idyllic poet

Uneven numbers are the god's delight.

In *Great Books of the Western World* (Volume 13)

*The Eclogues*

VIII, l. 77

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

...the simultaneous diffusion of the knowledge of the science of numbers and of numerical symbols with value

by position have variously, but powerfully, favored the advance of the mathematical portion of natural science, and facilitated access to the more abstruse departments of astronomy, optics, physical geography, and the theories of heat and magnetism, which, without such aids, would have remained unopened.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)

Part II (p. 227)

D. Appleton & Co. New York, New York, USA. 1850

**Waismann, Friedrich** 1896–1959  
Austrian mathematician, physicist, and philosopher

Will anyone seriously assert that the existence of negative numbers is guaranteed by the fact that there exist in the world hot assets and cold, and debts? Shall we refer to these things in the structure of arithmetic? Who does not see that thereby an entirely foreign element enters into arithmetic, which endangers the pureness and clarity of its concepts?

*Introduction to Mathematical Thinking: The Formation of Concepts in Modern Mathematics*

Chapter 2 (p. 15)

Frederick Ungar Publishing, Company. New York, New York, USA. 1951

**Whewell, William** 1794–1866  
English philosopher and historian

The Ideas on which the Pure Sciences depend, are those of Space and Number; but Number is a modification of the conception of Repetition, which belongs to the Idea of Time.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2) (2nd edition)

Aphorisms Concerning Ideas (p. 446)

John W. Parker. London, England. 1847

**Williams, Charles**  
No biographical data available

"Nought usually comes at the beginning," Ralph said.

"Not necessarily," said Sibyl. "It might come anywhere. Nought isn't a number at all. It's the opposite of number."

Nancy looked up from the cards. "Got you, aunt," she said. "What about ten? Nought's a number there – it's part of ten."

"Well, if you say that any mathematical arrangement of one and nought really makes ten –" Sibyl smiled. "Can it possibly be more than a way of representing ten?"

*The Greater Trumps*

Chapter I (p. 15)

Pellegrini & Cudahy . New York, New York, USA. 1950

## BARYON

**Feinberg, Gerald** 1933–92  
American physicist and futurist

**Goldhaber, Maurice** 1911–2011  
American physicist

...in the absence of a firm theoretical basis for the law [conservation of baryon number], we can only conclude that it is known to be true with great accuracy.

The Conservation Laws of Physics  
*Scientific American*, Volume 209, Number 4, October, 1963 (p. 45)

## COMPLEX

**Needham, Tristram**  
No biographical data available

Often problems that do not appear to involve complex numbers are nevertheless solved most elegantly by viewing them through complex spectacles.

*Visual Complex Analysis*  
Chapter I (p. 14)  
Oxford University Press. Oxford, England. 1998

Even with the benefit of enormous hindsight, it is hard to introduce complex numbers in a compelling manner.

*Visual Complex Analysis*  
Chapter I (p. 30)  
Oxford University Press. Oxford, England. 1998

## FIBONACCI

**Baumel, Judith** 1956–  
American poet

Learn the particular strength  
of the Fibonacci series,  
a balanced spiraling  
outward of shapes,  
those golden numbers  
which describe dimensions  
of sea shells, rams' horns,  
collections of petals  
and generations of bees.

*The Weight of Numbers*  
Fibonacci (p. 21)  
Wesleyan University Press, Middletown, Connecticut, USA; 1988

**Lindon, J. A.**  
No biographical data available

Each wife of Fibonacci,  
Eating nothing that wasn't starchy  
Weighed as much as the two before her.  
His fifth was some signora!

In Martin Gardner  
*Mathematical Circus*  
Chapter 13 (p. 152)  
Alfred A. Knopf. New York, New York, USA. 1979

## IMAGINARY

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

The imaginary number is a fine and wonderful recourse of the divine spirit, almost an amphibian between being and not being.

*Werke* Bd. 5.2 (p. xxx)  
1997

## NEGATIVE

**Kline, Morris** 1908–92  
American mathematics professor and writer

Negative numbers were not accepted by all the Hindus. Even Bhaskara said, while giving 50 and  $-5$  as solutions of a problem, "The second value is in this case not to be taken, for it is inadequate; people do not approve of negative solutions."

*Mathematics: The Loss of Certainty*  
Chapter V (p. 110)  
Oxford University Press, Inc. New York, New York, USA. 1980

## RANDOM

**Coveyou, R. R.**  
No biographical data available

The generation of random numbers is too important to be left to chance.

Random Number Generation Is Too Important to Be Left to Chance  
*Studies in Applied Mathematics*, Volume 3, 1970

## WHOLE

**Schroeder, Manfred Robert** 1926–  
Physicist

What could be more beautiful than a deep, satisfying relation between whole numbers? (One is almost tempted to call them the wholesome numbers.) In fact, it is hard to come up with a more appropriate designation than their learned name: the integers – meaning "the untouched ones". How high they rank, in the realms of pure thought and aesthetics, above their lesser brethren: the real and complex numbers ...

*Number Theory in Science and Communication* (3rd edition)  
Foreword (p. vii)

**Berlinski, David** 1942–  
American mathematician

Like the human soul, an irrational number is only partly known, and however more is known of either there is always infinitely more to know.

*A Tour of the Calculus*  
Chapter 9 (p. 55)  
Pantheon Books. New York, New York, USA. 1995

## NUMBER THEORY

**Barnett, I. A.**  
No biographical data available



...to discover mathematical talent, there is no better course in elementary mathematics than number theory. Any student who can work the exercises in a modern text in number theory should be encouraged to pursue a mathematical career.

The Theory of Numbers as A Required Course in the College Curriculum for Majors

*American Mathematical Monthly*, Volume 73, November, 1966 (pp. 1002–1003)

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

The theory of numbers has always occupied a peculiar position among the purely mathematical sciences. It has the reputation of great difficulty and mystery among many who should be competent to judge; I suppose that there is no mathematical theory of which so many well qualified mathematicians are so much afraid.

The Sixth Josiah Willard Gibbs Lecture

*Bulletin of the American Mathematical Society*, Volume 35, 1929

**Hilbert, David** 1862–1943

German mathematician

A problem in number theory is as timeless as a true work of art.

In Legh Wilber Reid

*The Elements of the Theory of Algebraic Numbers*

Introduction

The Macmillan Company. New York, New York, USA. 1910

**Mazur, Barry** 1937–

American mathematician

[Number theory] produces, without effort, innumerable problems which have a sweet, innocent air about them, tempting flowers; and yet...number theory swarms with bugs, waiting to bite the tempted flower-lovers who, once bitten, are inspired to excesses of effort!

Number Theory as Gadfly

*The American Mathematical Monthly*, Volume 98, 1991

## NUMBER, UNKNOWN

**Smith, Elmer Boyd**

Kits, cats, sacks and wives,

How many were going to St. Ives?

*The Boyd Smith Mother Goose*

As I Was Going to Saint Ives

G.P. Putnam's Sons. New York, New York, USA. 1919

## NUMERICAL

**Jevons, William Stanley** 1835–82

English economist and logician

Numerical facts, like other facts, are but the raw materials of knowledge, upon which our reasoning faculties

must be exerted in order to draw forth the principles of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXII (p. 483)

Macmillan & Co Ltd. London, England. 1887

## NURSE

**Cooke, Genevieve** 1867–1928

American nurse

Inadequate as the numbers of nurses may be to succor more than an infinitesimal fraction of the precious lives now being sacrificed in battle, it is some small consolation to realize that even the simple title Nurse means one who protects, one who nourishes, never one who destroys.

Address of the President

*The American Journal of Nursing*, Volume 15 (p. 920)

**Fisher, Alice** 1839–1888

American nurse

My dear, erase the word discouragement from your dictionary and your mind; it isn't worthy of a woman who hopes to be a nurse; never let me hear you say it again ...

In Marion E. Smith

The Pioneer Work of Alice Fisher

*The American Journal of Nursing*, Volume IV (p. 806)

**Flikke, Julia Otteson** 1879–1965

American nurse

It is for the purpose of affording to each soldier the highest type of professional skill that nurses are asked to accept the responsibility of rendering professional care to the young defenders of their country, regardless of sacrifices which in many instances must be made.

*Nurses in Action*

Chapter 11 (p. 89)

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1943

**Gray, Carolyn**

American nurse

One is reluctantly forced to admit that many nurses are not in any true sense of the word educators. This is a lamentable fact, and the responsibility for it must be put on the schools that have attempted to train them, but have failed to make them realize how numerous and diversified their opportunities are.

*Report* Volume 23

The Relation of the Private Duty Nurse to the Public as an Educator (p. 268)

Williams & Wilkins Co. Baltimore, Baltimore, Maryland, USA. 1917

**Krausz, Sigmund**

No biographical data available

Nurses, like poets, are born and not made, and it is quite a difference to the sick whether a nurse takes care of

them whose heart is in her work or one who, like an automaton, simply takes the temperature and administers with clock-like regularity the prescribed doses of medicine.

*Street Types of Great American Cities*

Trained Nurses (p. 30)

The Werner Co. Chicago, Illinois, USA. 1896

**Lambertsen, Eleanor C.** 1916–1998

American nurse

As long as groups of nurses continue to curtail progresses in clearly defining nursing functions of a professional nature and impede progress through advances in education because their “status is showing,” the quality of nursing care will remain at an elementary and superficial level. Tradition rightfully belongs to history: complacency must be replaced by vigorous effort.

In Thelma M. Schorr and Anne Zimmerman

*Making Choices, Taking Chances: Nurse Leaders Tell Their Story*

Eleanor C. Lambertsen (p. 184)

Mosby. St. Louis, Missouri, USA. 1988

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

The trained nurse as a factor in life may be regarded from many points of view – philanthropic, social, personal, professional and domestic. To her virtues we have been exceeding kind – tongues have dropped manna in their description. To her faults – well let us be blind ...

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter IX (p. 155)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

Marriage is the natural end of the trained nurse. So truly as a young man married is a young man marred, is a woman unmarried, in a certain sense, a woman undone.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter IX (p. 162)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

The trained nurse is a modern representative, not of the Roman Vestal, but of the female guardian in Plato's republic – a choice selection from the very best women of the community who know the laws of health, and whose sympathies have been deepened by contact with the best and worst of men.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter IX (pp. 162–163)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

**Parsons, Sara Elisabeth** 1864–1949

American nurse

The nurse is the doctor's assistant, but her work is no less responsible than his. His success and the patient's recovery often depend upon her intelligent interpretation

of his orders. She must not allow her work to be underestimated.

*Nursing Problems and Obligations*

Chapter V (p. 58)

Whitcomb & Barrows. Boston, Massachusetts, USA. 1916

**Robinson, Victor** 1886–1947

Physician and medical journalist

Woman is an instinctive nurse, taught by Mother Nature. The nurse has always been a necessity, thus lacked social status. In primitive times she was a slave, and in the civilized era a domestic. Overlooked in the plans of legislators, and forgotten in the curricula of pedagogues, she was left without protection and remained without education. She was not an artisan who could obtain the help of a hereditary guild; there was no Hanseatic League for nurses. Drawn from the nameless and numberless army of poverty, the nurse worked as a menial and obeyed as a servant. Denied the dignity of a trade, a devoid of professional ethics, she could not rise above the degradation of her environment. It never occurred to the Aristotles of the past that it would be safer for the public welfare if nurses were educated instead of lawyers. The untrained nurse is as old as the human race; the trained nurse is a recent discovery. The distinction between the two is a sharp commentary on the follies and prejudices of mankind.

*White Caps: The Story of Nursing* (p. ix)

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1946

**Strong, Anne Hervey** 1876–1925

American nurse

Every thoughtful woman in public health work sees on the one hand enormous need of the work that nurses can do, not only to save life but to increase the physical efficiency of the nation; on the other hand, she sees the totally inadequate number of nurses already trained for public health, the prospect of greatly increased need in the future, and the possibility of greatly decreased numbers of women preparing to meet it.... Of all our national resources, human life is the most important. Public health nursing directly contributes toward the conservation of human life ...

In National League of Nursing Education

*Report* Volume 23

Teaching Problems of Public Health Instructors (p. 260)

*The American Journal of Nursing*

Williams & Wilkins Co. Baltimore, Baltimore, Maryland, USA. 1917

**Wheeler, Claribel Augusta** 1881–1963

American nurse

...to be a nurse is to belong to a profession which has the highest ideals of service, and one in which the lives of its followers are dedicated to the service of humanity.

*The Profession of Nursing*

*The Public Health Nurse*, Volume 13, April, 1921 (p. 204)

**Wyche, Mary Lewis** 1858–1936

American nurse

A nurse needs an occasional snapshot of herself, for her own scrutiny, to see her manners or lack of manners, and phonographic record of her tone, which might force her to exclaim:

“Wad some power the giftie gie us  
To see oursels as ithers see us.”

In some pictures one cries, “A saint I see with voice and touch that soothes and inspires with hope.” We need more of a professional character, “That ingrained regard for standards and ideas, for special knowledge and special skill, which marks the professional man and his readiness to put the claims of public service and of intrinsic excellence of performers above considerations of private or personal gain.”

Nursing Conditions in the South

*The American Journal of Nursing* Volume 7. 1907 (p. 868)**NURSE, PUBLIC HEALTH****Brink, Frances V.** 1889–1978

American nurse

First. Do not diagnose, do not use curative methods without a physician’s orders and a parent’s permission. Do not take children to clinics without parents’ permission. Second. Do not confide your difficulties and criticisms to the teachers and town people, take them to your nursing committee.

Third. Do not make of your office a reception room for teachers or friends, keep your office private for all patients, old and young.

Fourth. Attend as many nurses’ district, state and national meetings, conventions and institutes as possible.

Fifth. Do not fail to demonstrate public health nursing through necessary bedside nursing whenever possible.

Sixth. Gain your teacher’s confidence and give information as to how she may assist in bettering the physical condition of pupils.

Seventh. Remember that one hour home calling is worth more than four hours in the office.

Eighth. Do have a plan of work most definitely mapped out – *system accomplishes much*.

Ninth. Do not give up your work in the community in a short time after entering because it seems discouraging – this is pioneer work.

Tenth. In case of a reported epidemic of contagious diseases in any part of your county be ready and willing to offer assistance to the Health Officer of the district where the epidemic exists. If the Health Officer makes a request for your assistance, drop the routine work and answer this request.

Suggestions for the County Nurse

*The Public Health Nurse*, Volume 13, Number 4, April, 1921 (p. 173)**NURSE, SPIRIT OF****Roberts, Mary May** 1877–1959

American nurse

...the spirit of the true nurse is one of the most beautiful gifts of a beautiful Creator.

The Spirit of Nursing

*The American Journal of Nursing* Volume 25, Number 9, September, 1925 (p. 734)

The spirit of nursing is one of the most indestructible elements of the lives of those who possess it. Like fine steel, it gives form and substance but yet it is flexible, it is shining but durable.

The Spirit of Nursing

*The American Journal of Nursing* Volume 25, Number 9, September, 1925 (p. 734)

It [the spirit of nursing] is made up of such qualities as *courage...love of truth*, with the accompanying characteristics of frankness, fidelity and sincerity; *kindness, tolerance, courtesy, generosity, compassion, sympathy and benevolence...* It is one on the things of which nurses rarely speak and of which the possessor is probably unaware ...

The Spirit of Nursing

*The American Journal of Nursing*, Volume 25, Number 9, September, 1925 (p. 734)**NURSING****Anderson, Peggy**

No biographical data available

The nurse’s job is to help the patients get well, or help them to die.

*Nurse*

Chapter 1 (p. 20)

Berkeley. New York, New York, USA. 1979

... nurse’s play the same role on a regular floor that the electrocardiograph plays in the intensive care unit. They’re the monitor.

*Nurse*

Chapter 1 (pp. 20–21)

Berkeley. New York, New York, USA. 1979

Nurses do whatever doctors and janitors won’t do.

*Nurse*

Chapter 2 (p. 31)

Berkeley. New York, New York, USA. 1979

**Barnes, Djuna** 1892–1982

American writer

The only people who really know anything about medical science are the nurses, and they never tell; they’d get slapped if they did.

*Nightwood*

La Somnambule (p. 40)

Harcourt, Brace &amp; Company. New York, New York, USA. 1937

**Beckett, Samuel** 1906–89  
Irish playwright

The patients seeing so much of the nurses and so little of the doctor, it was natural that they should regard the former as their persecutors and the latter as their savior.

*The Collected Works of Samuel Beckett*  
*Murphy*

Chapter 9 (p. 158)  
Grover Press, Inc., New York, New York, USA. 1970

**Burns, Olive Ann** 1924–90  
Professional writer, journalist, and columnist

They ain't no feelin' in the world like takin' on somebody wilted and near bout gone, and you do what you can, and then all a-sudden the pore thang starts to put out new growth and git well.

*Cold Sassy Tree*

Chapter 3 (p. 12)  
Ticknor & Fields. New York, New York, USA. 1984

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

A doctor is called in, but a nurse sent for.

*Note-Book of Anton Chekhov* (p. 122)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Cowper, William** 1731–1800  
English poet

The nurse sleeps sweetly, hir'd to watch the sick,  
Whom snoring she disturbs.

*The Poetical Works of William Cowper*

The Task

Book I, The Sofa, l. 89–90

John W. Lovell Company. New York, New York, USA. No date

**Curtin, Leah** 1942–  
American nurse

We in nursing share a common cause and a common tradition. We...have a tradition with a future. The tender loving care of human beings...will never become obsolete. In today's strained world among tomorrow's strange machines, people *more than ever* need to be touched to be restored, renewed, revived and redeemed.

*Nursing into the 21st Century* (pp. 28, 29)

Springhouse. Springhouse, Pennsylvania, USA. 1996

**Dauser, Sue Sophia** 1888–1972  
American nurse

...modern professional nursing was born in War.

*Navy Nurse, Part 807*

Preface (p. 1x)

McGraw-Hill Book Co, Inc. New York, New York, USA. 1946

**Delano, Jane Arminda** 1858–1919  
American nurse

Nursing is not alone caring for the sick, the *prevention of infection* often constitutes as important a duty as the actual care of the patient. A woman who is without

knowledge of the principles which should guide the performance of her work holds in her hands a capacity for doing infinite harm; she cannot avoid dangers which she does not recognize.

*American Red Cross Text-book on Home Hygiene and Care of the Sick*  
Introduction (p. xiii)

**Di Bacco, Babs Z.**  
No biographical data available

Why modern doctors  
Have more leisure time  
For golf and cards

And things maritime  
Than ever before

In history  
While nurses don't,

Is a mystery.

Leisure Gap

*American Journal of Nursing*, January, 1969 (p. 212)

**Donahue, Mary Patricia** 1939–  
American nurse

Nursing has long been defined as both an art and a science. The primary emphasis, however, has been on the scientific aspects of nursing with little consideration given to its state as an art. Nursing is a fine art. According to Florence Nightingale, it is "the finest of the fine arts." Nursing is not merely a technique but a process that incorporates the elements of soul, mind, and imagination. Its very essence lies in the creative imagination, the sensitive spirit, and the intelligent understanding that provide the very foundation for effective nursing care. These have been captured consistently in a wide range of illustrative material that can greatly enhance the study of nursing history through visual representation. Every art gallery has its nursing saints, nurturing mothers, healing miracles, sick beds, and lying-in chambers. Many of the finest paintings and sculptures dealing with nursing subjects have been done by the "great masters" and contemporary artists. All of these serve to capture the art of nursing.

*Nursing, the Finest Art: An Illustrated History*

Preface to the First Edition (p. ix)

Mosby. St. Louis, Missouri, USA. 1996

**Euripides** ca. 480 BCE–406 BCE  
Greek playwright

Better be sick than tend the sick; the first is but a single ill, the last unites mental grief with manual toil.

In *Great Books of the Western World* (Volume 5)

*The Plays of Euripides*

Hippolytus, l. 186

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hanson, Elayne Clipper**  
No biographical data available

It seems to be a well known fact  
That nurses fairly ooze with tact.

Their smiles so warm,  
 And full of charm,  
 Match voices, low  
 And movements slow.  
 Then why, if I may venture bold  
 Are nurses' hands so icy cold?

Paradox

*American Journal of Nursing*, March, 1969 (p. 672)

**Jewett, Sarah Orne** 1849–1909

American novelist and short story writer

She had no equal in sickness, and knew how to brew every old-fashioned dose and to make every variety of herb-tea, and when her nursing was put to an end by her patient's death, she was commander-in-chief at the funeral.

*Deephaven*

My Lady Brandon and the Widow Jim (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Kipling, Rudyard** 1865–1936

British writer and poet

Let us now remember many honourable women,  
 Such as bade us turn again when we were like to die.

*Collected Verse of Rudyard Kipling*

Dirge of Dead Sisters

Doubleday, Page. Garden City, New York, USA. 1915

**Lang, Norma M.**

American nurse

As the profession of nursing moves into the rapidly changing health care arena of the twenty-first century, it is imperative that we have a firm sense of the art and science of our history.

In M. Patricia Donahue

*Nursing, the Finest Art: An Illustrated History* (2nd edition)

Foreword (p. vii)

Mosby. St. Louis, Missouri, USA. 1996

**Leone, Lucile Petry** 1902–1999

American nurse

The horizon for nursing expands exhilaratingly.. The depth has not been sounded. So we explore depths and distances. The nugget of truth lies in the nurse-patient relation. The distant star is the health of the people.

In Gwendolyn Safier (ed.)

*Contemporary American Leaders in Nursing: An Oral History* (p. 179)

McGraw-Hill Book Co, Inc. New York, New York, USA. 1997

**Lewis, Lucille**

No biographical data available

The central focus of nursing is to help the person cope with his physiological, psychological, and spiritual reactions to health problems and maintain his integrity in these experiences. To be therapeutic, the nurse must con-

tribute to the wholeness of man, to the interrelationships of the parts to the whole, to the person's here-and-now as well as to his future, to the health of all the parts so that the person may attain and maintain his highest potential. All of these are essential.

This I Believe

*Nursing Outlook*, Volume 15, Number 5, May, 1968 (p. 27)

**Lindeman, Carol A.** 1935–

American nurse

Knowledge...has value if it serves as a guide to effective action in day-to-day reality. Contemporary nursing requires the use of all sources of knowledge in the moment-to-moment reality of a patient care situation.

*Fundamentals of Contemporary Nursing Practice*

Chapter 2 (p. 35)

W.B. Saunders Philadelphia, Pennsylvania, USA. 199p

**Lydston, George Frank** 1858–1923

American urologist

How absurd the situation! It is demanded that a woman should slave for three years and go through what would be a fair medical course, were it conscientiously given, for the privilege of finally earning a salary which, were she constantly employed – which, by the way, she never is – would just equal that of a good stenographer.

The Training School Fake and Its Victims

*New York Medical Journal*, Volume 79, 1904

**Manfreda, Margurite Lucy**

No biographical data available

People turn to God in times of crisis, and illness is among those times when people feel the need for spiritual guidance. Nurses, therefore, are in a unique position to bring spiritual aid to their patients and to the patients' families.

In Sharon Fish and Judith Allen Shelly

*Spiritual Care: The Nurse's Role*

Chapter I (p. 17)

InterVarsity Press. Dover Grove, Illinois, USA. 1978

**Matthews, Marian**

No biographical data available

Where are the interns I recall?  
 Fountains of wisdom, one and all.  
 Men in white, mature and strong –  
 They were the Doctors, never wrong.  
 Something happened to them, or me;  
 They're not the giants they used to be.  
 With stethoscopes like shiny toys  
 They seem to me like little boys.  
 Excuse me for crying on your shoulder –  
 They're not younger – I am older.

Interns

*American Journal of Nursing*, November, 1968 (p. 2492)



**Mayo, Charles Horace** 1865–1939  
American physician

The trained nurse has given nursing the human, or shall we say, the divine touch, and made the hospital desirable for patients with serious ailments regardless of their home advantages.

The Trained Nurse  
*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 13, 1921

**Nightingale, Florence** 1820–1910  
English nursing pioneer and statistician

For us who Nurse, our Nursing is a thing, which, unless in it we are making progress every year, every month, every week – take my word for it we are going back.

Address  
“Nightingale Fund” School  
St Thomas Hospital, 1872

Conceit and Nursing cannot exist in the same person any more than new patches on an old garment.

Address  
“Nightingale Fund” School  
St. Thomas Hospital, 1872

In watching disease, both in private houses and in public hospitals, the thing which strikes the experienced observer most forcibly is this, that the symptoms or the sufferings generally considered to be inevitable and incident to the disease are very often not symptoms of the disease at all, but of something quite different – of the want of fresh air, or of light, or of warmth, or of quiet, or of cleanliness, or of punctuality and care in the administration of diet, of each or of all of these. And this quite as much in private as in hospital nursing.

*Notes on Nursing: What It Is and What It Is Not*  
*Notes on Nursing: What It Is and What It Is Not* (p. 5)  
Harrison. London, England. 1859

I use the word nursing for want of a better. It has been limited to signify little more than the administration of medicines and the application of poultices. It ought to signify the proper use of fresh air, light, warmth, cleanliness, quiet, and the proper selection and administration of diet – all at the least expense of vital power to the patient. It has been said and written scores of times, that every woman makes a good nurse. I believe, on the contrary, that the very elements of nursing are all but unknown.

*Notes on Nursing: What It Is and What It Is Not*  
*Notes on Nursing: What It Is and What It Is Not* (p. 6)  
Harrison. London, England. 1859

Never to allow a patient to be wakened, intentionally or accidentally, is a sine qua non of all good nursing.

*Notes on Nursing: What It Is and What It Is Not*  
Noise (p. 25)  
Harrison. London, England. 1859

A nurse who rustles (I am speaking of nurses professional and unprofessional) is the horror of a patient, though perhaps he does not know why.

*Notes on Nursing: What It Is and What It Is Not*  
Noise (p. 27)  
Harrison. London, England. 1859

The most important practical lesson that can be given to nurses is to teach them what to observe – how to observe – what symptoms indicate improvement – what the reverse – which are of importance – which are of none – which are the evidence of neglect – and of what kind of neglect.

*Notes on Nursing: What It Is and What It Is Not*  
Chapter XIII (p. 59)  
Harrison. London, England. 1859

It seems a commonly received idea among men and even among women themselves that it requires nothing but a disappointment in love, the want of an object, a general disgust, or incapacity for other things to turn a woman into a good nurse.

*Notes on Nursing: What It Is and What It Is Not*  
Conclusion (p. 75)  
Harrison. London, England. 1859

**Nutting, Mary Adelaide**  
American nurse

**Dock, Lavinia L.**  
American nurse

Nursing is an art, and an art requiring an organised practical and scientific training. For nursing is the skilled servant of medicine, surgery, and hygiene.

*A History of Nursing* Volume 2  
Chapter III (p. 171)  
G.P. Putnam’s Sons. New York, New York, USA. 1907

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

...the trained nurse has become one of the great blessings of humanity, taking a place beside the physician and the priest, and not inferior to either in her mission.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
Nurse and Patient (p. 156)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Parsons, Sara Elisabeth** 1864–1949  
American nurse

If ever there was a profession that was a natural expression of a tendency born with most women to give love and service to the weak and suffering, it is nursing. If ever there was a profession that is acknowledged to be eminently suitable for women it is nursing. If ever there was a profession called into existence by the real needs of humanity, it is nursing. If ever there was a profession exalted by noble leadership, personifying spirituality, intellect and culture, all exemplified in a superlative degree by Florence Nightingale, it is nursing.

*Report*  
Address (p. 56)  
Williams & Wilkins Co. Baltimore, Baltimore, Maryland, USA. 1917



**Ray, John** 1627–1705  
English naturalist

A nurse's tongue is privileged to talk.  
*A Complete Collection of English Proverbs* (p. 17)  
Printed for G. Cowie. London, England. 1813

**Richardson, Samuel** 1689–1761  
English novelist

Male nurses are unnatural creatures!  
*Sir Charles Grandison*  
Part 2, Volume 3, Letter XI (p. 58)  
G. Allen. London, England. 1895

**Roosevelt, Franklin Delano** 1882–1945  
32nd president of the USA

...I urge that the Selective Service Act be amended to provide for the induction of nurses into the armed forces...  
Annual Message to Congress  
January 6, 1945

**Ruth Watson Lubic** 1927  
American nurse

Nursing prepares you for excellence. Be proud you are a nurse.  
*Making Choices, Taking Chances: Nurse Leaders Tell Their Stories*  
Ruth Watson Lubic (p. 235)  
Mosby. St. Louis, Missouri, USA. 1988

**Schmitz, Jacqueline T.**  
No biographical data available

Compressing an hour into a half,  
Busy, yet heedful  
Rushes the nurse  
Bringing earnest solace to the  
Sick and the needful.  
Who must come first? How can she know?  
Inverted scope, focused by Death,  
Grants new perspective as He robs breath.  
Point of View  
*Journal of Nursing*, November, 1968 (p. 2492)

**Styles, Margaretta M.**  
No biographical data available

In the beginning, God created nursing.  
He (or She) said, I will take a solid, simple,  
significant system of *education* and an adequate,  
applicable base of clinical, and  
On these rocks, will I build My greatest gift  
to Mankind – nursing practice.  
On the seventh day, He – threw up His hands. And has  
left it up to us.  
*On Nursing: Toward a New Endowment* (p. 154)  
Mosby. St. Louis, Missouri, USA. 1982

## NURSING EDUCATION

**Tracy, Margaret Anthony** 1893–1959  
American Nurse

Ours is the fault if the student sees her patient as an “acute appendix” or a “fractured skull,” not as an individual with family and community relationships. As we help them acquire the very necessary skills which they need, to care for surgical patients, we must do so in a way which will also enable them to see those skills as a tool to help them in the role of teacher and promoter of the public health.

Supervision and Teaching of Surgical Nursing  
*The American Journal of Nursing* Volume 26, October, 1926 (p. 797)

## NURSING PLEDGE

**Gretter, Lystra Eggert** 1858–1951  
American nurse

I solemnly pledge myself before God, and in the presence of this assembly, to pass my life in purity and to practise my profession faithfully. I will abstain from whatever is deleterious and mischievous, and will not take or knowingly administer any harmful drug. I will do all in my power to maintain and elevate the standard of my profession and will hold in confidence all personal matters committed to my keeping and all family affairs coming to my knowledge in the practice of my calling. With loyalty will I endeavor to aid the physician in his work and devote myself to the welfare of those committed to my care.

In Lavinia L. Dock  
*A Short History of Nursing from the Earliest Times to the Present Day*  
Appendix II (p. 381)  
G.P. Putnam's Sons. New York, New York, USA. 1920

**Jones, Caldwell**  
No biographical data available

You do solemnly swear, each by whatever she holds most sacred:

That you will be loyal to the physicians under whom you serve, as a good soldier is loyal to his officers.

That you will be just and generous to all worthy members of your profession, hiding them when it will be in your power to do so.

That you will live your lives and lead your profession in uprightness and honour.

That into whatsoever house you shall enter, it shall be for the good of the sick to the utmost of your power, and that you will hold yourselves aloof from all temptation.

That whatsoever you shall see or hear of the lives of men and women, whether they be your patients or members

of their households, you will keep inviolably secret, whether you are in other households, or among your own friends.

In Lavinia L. Dock

*A Short History of Nursing from the Earliest Times to the Present Day*

Appendix II (pp. 381–382)

G.P. Putnam's Sons. New York, New York, USA. 1920

## NURSING PRAYER

**Clark, Mildred Irene** 1915–1994

American nurse

Hear my prayer in silence before Thee

As I ask for courage each day.

Grant that I may be worthy of the sacred pledge of my profession,

And the lives of those entrusted to my care.

Help me to offer hope and cheer in the hearts of men and my country.

For their faith inspires me to give the world and nursing my best.

Instill in me the understanding and compassion of those who led the way,

For I am thankful to You for giving me this life to live.

In Mary May Roberts

*The Army Nurse Corps: Yesterday and Today*

Army Nurse (p. 49)

US Army Nursing Corps. 1958

## NURSING STANDARDS

**Nutting, Mary Adelaide**

American nurse

I am not a worshipper at the shrine of uniformity, nor a believer in any system which is directed solely towards averaging up the capacities and powers of human beings, but in our education of nurses we have gone so far in the other direction, have had and still have so many and such wide diversities of opinion and method, that it has been difficult to say what our common standards really are.

*A Sound Economic Basis for Schools of Nursing and Other Addresses* (Volume 1)

Some Results of Preparatory Courses for Nurses (p. 91)

G.P. Putnam's Sons. New York, New York, USA. 1926

## NURSING, DEVELOPMENT OF

**Bullough, Bonnie** 1927–1996

American nurse

**Bullough, Vern** 1928–2006

American historian and sexologist

To explain the development of nursing it is necessary to consider a society's attitude toward its sick, its wounded, its mentally ill, toward its paupers and lepers, toward

the crippled and malformed, toward the infant and the infirm.

*The Emergence of Modern Nursing*

Preface (p. v)

The Macmillan Co. New York, New York, USA. 1964

It has often been said that modern nursing could not have developed independently of modern medicine, but... modern medicine could not have developed without the emergence of modern nursing.

*The Emergence of Modern Nursing*

Preface (p. v)

The Macmillan Co. New York, New York, USA. 1964

## NURSING, IMAGE OF

**McBride, Angela Barron** 1941–

American nurse

The best way to improve the image of nursing is for all nurses to become image makers.

In Thelma M. Schorr and Anne Zimmerman

*Making Choices, Taking Chances: Nurse Leaders Tell Their Stories*

Angela Barron McBride (p. 265)

Mosby. St. Louis, Missouri, USA. 1988

## NURTURE

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Our inheritances are diverse and unequal, and they limit us; yet much can be gained by “nurture” and much lost for the lack of it.

*Introduction to Science*

Chapter I (p. 32)

Henry Holt & Co. New York, New York, USA. 1911

## NUTRITION

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

...nutrition by digestion is certainly necessary to life, only under certain circumstances, but that life is previously necessary to digestion is absolutely certain under all circumstances.

*Hints Towards the Formation of a More Comprehensive Theory of Life*

The Nature of Life (p. 26)

John Churchill. London, England. 1847

**Davis, Adelle** 1904–74

Nutritionist

Nutrition is a young subject; it has long been kicked around like a puppy that cannot take care of itself. Food faddists and crackpots have kicked it pretty cruelly.... They seem to believe that unless food tastes like Socratic hemlock, it cannot build health. Frankly, I often wonder

what such persons plan to do with good health in case they acquire it.

*Let's Eat Right to Keep Fit*

Chapter 1 (p. 3)

New American Library. New York, New York, USA. 1970

...eat breakfast like a king, lunch like a prince, and dinner like a pauper.

*Let's Eat Right to Keep Fit*

Chapter 2 (p. 19)

New American Library. New York, New York, USA. 1970

## O

### OBJECT

#### **Tillman, Samuel D.**

No biographical data available

...above and below the narrow zone of the visible are objects too far off and too fine for human scrutiny. Although the SEEMING ALL is rounded by intimations of other and brighter regions, Science can never compass them by any extension of her domain! In those unsounded depths which form the boundary and background of the known, thought grown dizzy finds no support...

Atoms and Molecules

*The American Chemist*, Volume 2, Number 10, April, 1872 (p. 362)

### OBJECTION

#### **Spencer, Herbert** 1829–1903

English social philosopher

When made by a competent reader, an objection usually implies one of two things. Either the statement to which he demurs is wholly or partially untrue; or, if true, it is presented in such a way as to permit misapprehensions.

Replies to Criticism

*The Popular Science Monthly*, Volume IV December, 1873 (p. 295)

### OBJECTIVENESS

#### **Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Do not allow haughtiness to take you in possession. Due to that you will refuse useful advice and friendly help, you will lose the standard of objectiveness.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

### OBJECTIVITY

#### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Objectivity is not an unobtainable emptying of mind, but a willingness to abandon a set of preferences – for or against some view, as Darwin said – when the world seems to work in a contrary way.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 11 (p. 136)

Random House, Inc. New York, New York, USA. 1995

Objectivity cannot be equated with mental blankness; rather, objectivity resides in recognizing your prefer-

ences and then subjecting them to especially harsh scrutiny – and also in a willingness to revise or abandon your theories when the tests fail (as they usually do).

*The Lying Stones of Marrakech: Penultimate Reflections in Natural History*

The Proof of Lavoisier's Plates (pp. 104–105)

Harmony Books. New York, New York, USA. 2000

#### **Schiebinger, Londa** 1952–

American professor and writer of science history

Objectivity in science cannot be proclaimed, it must be built.

*Nature's Body: Gender in the Making of Modern Science*

Chapter 3 (p. 114)

Beacon Press. Boston, Massachusetts, USA. 1993

### OBSCURATIONISM

#### **Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

Dawkin's Law of the Conservation of Difficulty states that obscuratationism in an academic subject expands to fill the vacuum of its intrinsic simplicity.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 8)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

### OBSCURITY

#### **Pearson, Karl** 1857–1936

English mathematician

The obscurity which envelops the *principia* of science is not only due to an historical evolution influenced by the authority which attaches even to the phraseology used by great discoverers, but to the fact that science, as long as it had to carry on a difficult warfare with metaphysics and dogma, like a skilful general conceived it best to hide its own deficient organisation.

*The Grammar of Science* (2nd edition)

Preface to the First Edition (p. x)

Adam & Charles Black. London, England. 1900

### OBSERVATION

#### **Abbott, Donald Putnam** 1920–86

American marine biologist and professor

Get the experience of looking at fresh things. If you watch live animals, you gain clearer insights in shorter time than you would watching dead animals for much longer.

In Galen Howard Hilgard (ed.)

*Observing Marine Invertebrates: Drawings from the Laboratory*

Author's Preface (p. xvi)

Stanford University Press. Stanford, California, USA. 1987

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

...a scientist must also be absolutely like a child. If he sees a thing, he must say that he sees it, whether it was what he thought he was going to see or not. See first, think later, then test. But always see first. Otherwise you will only see what you were expecting.

*The Ultimate Hitchhiker's Guide to The Galaxy*

*So Long and Thanks for All the Fish*

Chapter 31 (p. 587)

The Ballantine Book Company. New York, New York, USA. 2002

See first, think later, then test. But always see first. Otherwise you will only see what you were expecting. Most scientists forget that.

*So Long, and Thanks for All the Fish*

Chapter 31 (p. 161)

Harmony Books. New York, New York, USA. 1984

**Altmann, Jeanne**  
Biologist

The true situation may be the opposite of the apparent one.

*Baboon Mothers and Infants*

Introduction (p. 6)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Anscombe, Francis John** 1918–2001  
English-born American statistician

No observations are absolutely trustworthy.

Rejection of Outliers

*Technometrics*, Volume 2, Number 2, May, 1960 (p. 124)

**Ansted, David Thomas** 1814–80  
English geologist

There is much to be learned even from the very simplest things in nature, and when we begin to inquire about such of them as are seen and made use of every day, it is astonishing how little is really known, even by well-informed persons, and how large is the field of observation.

*Geological Gossip: Or, Stray Chapters on Earth and Ocean*

Chapter I (p. 1)

Routledge, Warne & Routledge. London, England.

**Argelander, Friedrich Wilhelm August** 1799–1875  
German astronomer

Observations buried in a desk are no observations.

In Harlow Shapley and Helen E. Howarth

*A Source Book in Astronomy*

Argelander (p. 237)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1929

**Arp, Halton Christian** 1927–  
American astronomer

Of course, if one ignores contradictory observations, one can claim to have an “elegant” or “robust” theory. But it isn't science.

Letters

*Science News*, Volume 140, Number 4, July 27, 1991 (p. 51)

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

Consider that everything which happens, happens justly, and if thou observest carefully, thou wilt find it to be so.

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, # 10 (p. 264)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Author Undetermined

I am an observation.

I was captured in the Field.

My conscience said ‘co-operate’

My instinct said ‘don't yield’.

But I yielded up my data

Now behold my sorry plight

I'm part of a statistic

Which is not a pretty sight.

The Bootstrap and the Jackknife

Oh, the tortures I've endured

They analyze my variance

Until my meaning is obscured.

But I've a plan to beat them

I'll climb up in the trees

Pretend I am a chi-square

And get freedom by degrees.

Source undetermined

**Ayres, Clarence Edwin** 1891–1972  
No biographical data available

When Moses emerged from the cloudy obscurity of Mount Sinai and stood before the people with the stone tablets in his hand, he announced that his laws were based on direct observation. It is not recorded that anyone doubted him.

*Science: The False Messiah*

Chapter III (p. 42)

The Bobbs-Merrill Company Publishers, Indianapolis, Indiana, USA.

1927

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Men mark when they hit, and never mark when they miss.

*Essays*

Essay XXXV (p. 381)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1875

**Baker, Henry** 1698–1774  
English naturalist

Beware of determining and declaring your Opinion suddenly on any Object; for Imagination often gets the Start of judgment, and makes People believe they see Things, which better Observations will convince them could not possibly be seen: Therefore assert nothing till after

repeated Experiments and Examinations in all Lights and in all Positions.

*The Microscope Made Easy*

Part I, Chapter XV, Cautions in Viewing Objects (p. 62)

Printed for R. Dodsley. London, England. 1743

### **Bauer, Georg (Agricola or Georgius**

**Agricola)** 1494–1555

German scholar and scientist

I have omitted all those things which I have not myself seen, or have not read or heard of from persons upon whom I can rely. That which I have neither seen, nor carefully considered after reading or hearing of, I have not written about. The same rule must be understood with regard to all my instruction, whether I enjoin things which ought to be done, or describe things which are usual, or condemn things which are done.

*De Re Metallica*

Preface (pp. xxx–xxxii)

Dover Publications, Inc. New York, New York, USA. 1950

### **Bergman, Torbern Olaf** 1735–84

Swedish chemist and naturalist

A vast number of observations without order or regularity is not unlike a confused heap of stones, lime, beams, and rafters requisite for constructing an edifice, but which being combined with no skill fail in producing the proposed effect.

Quoted in Joseph William Mellor

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry* (Volume 1)

Chapter I (p. 9)

Longman, Green, & Co. London, England. 1922

### **Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

...the largest views are not always the clearest, and that he who is short-sighted will be obliged to draw the object nearer, and may, perhaps, by a close and narrow survey, discern that which had escaped far better eyes.

*A Treatise Concerning the Principles of Human Knowledge*

Introduction (p. 7)

The Open Court Publishing Co. Chicago, Illinois, USA. 1904

... a mind at liberty to reflect on its own observations, if it produce nothing useful to the world, seldom fails of entertainment to itself.

*The Works of George Berkeley* (Volume 2)

First Dialogue (p. 32)

At The Clarendon Press. Oxford, England. 1901

### **Bernard, Claude** 1813–78

French physiologist

Only within very narrow boundaries can man observe the phenomena which surround him; most of them naturally escape his senses, and mere observation is not enough.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I (p. 5)

Henry Schuman, Inc. New York, New York, USA. 1927

Men sometimes seem to confuse experiment with observation.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I (p. 6)

Henry Schuman, Inc. New York, New York, USA. 1927

Observation, then, is what shows facts.; experiment is what teaches about facts and gives experience in relation to anything.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section ii (p. 11)

Henry Schuman, Inc. New York, New York, USA. 1927

Speaking concretely, when we say “making experiments or making observations,” we mean that we devote ourselves to investigation and to research, that we make attempts and trials in order to gain facts from which the mind, through reasoning, may draw knowledge or instruction.

Speaking in the abstract, when we say, “relying on observation and gaining experience,” we mean that observation is the mind’s support in reasoning, and experience the mind’s support in deciding, or still better, the fruit of exact reasoning applied to the interpretation of facts.

Observation, then, is what shows facts; experiment is what teaches about facts and gives experience in relation to anything.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section ii (p. 11)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Blake, William** 1757–1827

English poet, painter, and engraver

A fool sees not the same tree that a wise man sees.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, Proverbs of Hell, l. 8

University of California Press. Berkeley, California, USA. 1982

### **Bolles, Edmund Blair**

No biographical data available

...yet there is a difference between scientific and artistic observation. The scientist observes to turn away and generalize; the artist observes to seize and use reality in all its individuality and peculiarity.

*A Second Way of Knowing: The Riddle of Human Perception*

Chapter 11 (p. 150)

Press Hall Press. New York, New York, USA. 1991

### **Box, George E. P.** 1919–

English statistician

To find out what happens to a system when you interfere with it you have to interfere with it (not just passively observe it).

Use and Abuse of Regression

*Technometrics*, Volume 8, Number 4, November, 1966 (p. 629)



**Brownlee, Donald**

American astronomer

It is no secret that our lives are patterned by personal experience, and by our observations of the experience of others. So it is with the entire human family, staring outward from a place that we know to others that we do not. Our knowledge of home helps us to understand the ways of planets beyond our ken.

In Nigel S. Hey

*Solar System*

How Rare Is the Earth? (p. 156)

Weidenfield &amp; Nicolson. London, England. 2002

**Burroughs, John** 1837–1921

American naturalist and writer

Unadulterated, unsweetened observations are what the real nature-lover craves. No man can invent incidents and traits as interesting as the reality.

*Ways of Nature*

Chapter I (p. 15)

Book for Libraries Press. Freeport, New York, USA. 1971

**Carlyle, Thomas** 1795–1881

English historian and essayist

Shakespeare says, we are creatures that look before and after: the more surprising that we do not look round a little, and see what is passing under our very eyes.

*Sartor Resartus*

Book I, Chapter I (p. 3)

Ginn &amp; Company. Boston, Massachusetts, USA. 1897

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

No one who goes into the field with a mind merely receptive, or merely alert to see what presents itself, however nerved to a high effort, will return laden with all that might be seen. Only a part of the elements and aspects of complex phenomena present themselves at once to even the best observational minds. Some parts of the complex are necessarily obscure. Some of the most significant elements are liable to be unimpressive. These unobtrusive but yet vital elements will certainly escape observation unless the mind is forced to seek them out, and to seek them out diligently, acutely, and intensely.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

Volume 4

The Methods of the Earth-Sciences (pp. 479–80)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA. 1906

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

Observation...is the pitiless critic of theory; it detects weak points, and provokes reforms which may be the beginnings of discovery.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Introduction (p. 3)

Adam &amp; Charles Black. London, England. 1893

**Cohen, Morris Raphael** 1880–1947

American philosopher

Accidental discoveries of which popular histories of science make mention never happen except to those who have previously devoted a great deal of thought to the matter. Observation unilluminated by theoretic reason is sterile.... Wisdom does not come to those who gape at nature with an empty head. Fruitful observation depends not as Bacon thought upon the absence of bias or anticipatory ideas, but rather on a logical multiplication of them so that having many possibilities in mind we are better prepared to direct our attention to what others have never thought of as within the field of possibility.

*Reason and Nature*

Chapter One, Section III (p. 17)

The Free Press, Publishers, Glencoe, Illinois, USA. 1931

**Comstock, John Henry** 1849–1931

American entomologist

In making observations *be sure you are right and then look again.*

*Insect Life: An Introduction to Nature-study and a Guide for Teachers, Students, and Others*

Part II, Chapter III (p. 323)

D. Appleton &amp; Co. New York, New York, USA. 1898

**Cook, Alan H.**

No biographical data available

Physicists make observations upon the world, observations which of themselves might be no more than curiosities, but it is the aim of physics to put those observations into a rational scheme by which sense may be made of them and of the natural world behind them.

*The Observational Foundations of Physics*

Chapter 6 (pp. 96–97)

Cambridge University Press. Cambridge, England. 1994

The harder we question nature, the more fundamental the observations we make, the more dependent are the results on technique and theory.

*The Observational Foundations of Physics*

Chapter 8 (p. 141)

Cambridge University Press. Cambridge, England. 1994

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Science is the observation of things possible, whether present or past; prescience is the knowledge of things which may come to pass.

*The Literary Works of Leonardo da Vinci* (Volume 2)

1148 (p. 239)

University of California Press. Berkeley, California, USA. 1977

**Darwin, Charles Robert** 1809–82  
English naturalist

Some of my critics have said, “Oh, he is a good observer, but he has no power of reasoning!” I do not think that this can be true, for the “Origin of Species” is one long argument from the beginning to the end, and it has convinced not a few able men. No one could have written it without having some power of reasoning.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 82)  
D. Appleton & Company. New York, New York, USA. 1896

I have an old belief that a good observer really means a good theorist.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
Letter 118, Darwin to Bates, 22 November, 1860 (p. 195)  
D. Appleton & Company. New York, New York, USA. 1903

How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service!

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
Letter 133, Darwin to Henry Fawcett, Sept. 18, 1861 (p. 195)  
D. Appleton & Company. New York, New York, USA. 1903

I am a firm believer that without speculation there is no good and original observation.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
To Wallace, December 22, 1857 (p. 465)  
D. Appleton & Company. New York, New York, USA. 1896

**Davis, William Morris** 1850–1934  
American geographer, geologist, and teacher

...if earth-science were really limited to facts of direct observation, it would be at best a dreary subject.

How uninspiring would be such a knowledge of tides as could be gained only by actual observation along the seashore! A collection of such records would be like an orphanage, where the foundlings are doubtless well cared for and thoroughly drilled in their little duties, and yet left without the inspiriting, enlarging influence of parental care that they find on adoption into the family of earth, moon, and sun.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 4  
The Relations of the Earth-Sciences in View of Their Progress in the Nineteenth Century (p. 489)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**Davy, Sir Humphry** 1778–1829  
English chemist

The grandest as well as the most correct views are those that have been gained by minute observation, and by the application of all the more precise and accurate methods of science.

*The Collected Works of Sir Humphry Davy* (Volume 1)  
*Memories of the Life of Sir Humphry Davy*  
Chapter III (p. 153)  
Smith, Elder & Company. London, England. 1839–1849

**Dickens, Charles** 1812–70  
English novelist

The bearings of this observation lays in the application on it.

*The Works of Charles Dickens*  
*Dombey and Son* (part I)  
Chapter XXIII (p. 348)  
P.F. Collier & Son. New York, New York, USA. 1911

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

Great scientists are virtuosi of the art of discovering the meaning of what otherwise might seem barren observations.

In Robert M. Hutchins and Mortimer J. Adler  
*The Great Ideas of Today 1974*  
*Advancement and Obsolescence in Science* (p. 56)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

You see, but you do not observe. The distinction is clear.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Scandal in Bohemia* (p. 349)  
Wings Books. New York, New York, USA. 1967

The world is full of obvious things which nobody by any chance ever observes.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Hound of the Baskervilles*, Chapter 3 (p. 18)  
Wings Books. New York, New York, USA. 1967

...it is my business to know things. Perhaps I have trained myself to see what others overlook.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Case of Identity* (p. 406)  
Wings Books. New York, New York, USA. 1967

Never trust impressions, my boy, but concentrate yourself upon details.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Case of Identity* (p. 411)  
Wings Books. New York, New York, USA. 1967

**Drake, Daniel** 1785–1852  
American physician

If observation be the soil, reading is the manure of intellectual culture.

*Physician to the West: Selected Writings of Daniel Drake on Science and Society* (p. 307)  
University Press of Kentucky. Lexington, Kentucky, USA. 1970

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

...I said that an observed fact only becomes a scientific fact when all the observers are in unanimous agreement.

*The Road to Reason*

Chapter I (pp. 29–30)

Longmans, Green & Company. London, England. 1949

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

The art of observation and that of experimentation are very distinct. In the first case, the fact may either proceed from logical reasons or be mere good fortune; it is sufficient to have some penetration and a sense of truth in order to profit by it. But the art of experimentation leads from the first to the last link of the chain, without hesitation and without a blank, making successive use of Reason, which suggests an alternative, and of Experience, which decides on it, until, starting from a faint glimmer, the full blaze of light is reached.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 126)

Macmillan & Company Ltd. London, England. 1918

**Durkheim, Emile** 1858–1917  
French sociologist

Even one well-made observation will be enough in many cases, just as one well-constructed experiment often suffices for the establishment of a law.

Translated by Sarah A. Solovay and John H. Mueller

*The Rules of Sociological Method*

Chapter IV (p. 80)

The Free Press. Glencoe, Illinois, USA. 1938

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We should be unwise to trust scientific inference very far when it becomes divorced from opportunity for observational test.

*The Internal Constitution of the Stars*

Chapter I (p. 1)

At The University Press. Cambridge, England. 1930

For the truth of the conclusions of physical science, observation is the supreme Court of Appeal. It does not follow that every item which we confidently accept as physical knowledge has actually been certified by the Court; our confidence is that it would be certified by the Court if it were submitted. But it does follow that every item of physical knowledge is of a form which might be submitted to the Court. It must be such that we can specify (although it may be impracticable to carry out) an observational procedure which would decide whether it is true or not. Clearly a statement cannot be tested by observation unless it is an assertion about the results of observation.

Every item of physical knowledge must therefore be an assertion of what has been or would be the result of carrying out a specified observational procedure.

*The Philosophy of Physical Science*

Chapter I, Section IV (pp. 9–10)

The Macmillan Company. New York, New York, USA. 1939

Let us suppose that an ichthyologist is exploring the life of the ocean. He casts a net into the water and brings up a fishy assortment. Surveying his catch, he proceeds in the usual manner of a scientist to systematise what it reveals...In applying this analogy, the catch stands for the body of knowledge which constitutes physical science, and the net for the sensory and intellectual equipment which we use in obtaining it. The casting of the net corresponds to observation; for knowledge which has not been or could not be obtained by observation is not admitted into physical science.

*The Philosophy of Physical Science*

Chapter II, Section I (p. 16)

The Macmillan Company. New York, New York, USA. 1939

I hope I shall not shock the experimental physicists too much if I add that it is also a good rule not to put over-much confidence in the observational results that are put forward until they have been confirmed by theory...

*New Pathways In Science*

Chapter X, Section II (p. 211)

The Macmillan Company. New York, New York, USA. 1935

There are two parties to every observation – the observed and the observer.

*Space, Time and Gravitation*

Chapter II (p. 30)

At the University Press. Cambridge, England. 1921

**Einstein, Albert** 1879–1955  
German-born physicist

It is the theory which decides what we can observe.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 77)

Harper & Row, Publishers. New York, New York, USA. 1971

A man should look for what is, and not for what he thinks should be...

In Peter Michelmoro

*Einstein, Profile of the Man* (p. 20)

Dodd & Mead Publishers. New York, New York, USA. 1962

**Euler, Leonhard** 1707–83  
Swiss mathematician and physicist

It will seem not a little paradoxical to ascribe a great importance to observations even in that part of the mathematical sciences which is usually called Pure Mathematics, since the current opinion is that observations are restricted to physical objects that make impressions on the senses.

In G. Polya

*Induction and Analogy in Mathematics* (Volume 1)  
Chapter I (p. 3)  
Princeton University Press. Princeton, New Jersey, USA. 1954

...in the theory of numbers, which is still very imperfect, we can place our highest hopes in observations; they will lead us continually to new properties which we shall endeavor to prove afterwards.

In G. Polya  
*Induction and Analogy in Mathematics* (Volume 1)  
Chapter I (p. 3)  
Princeton University Press. Princeton, New Jersey, USA. 1954

**Faraday, Michael** 1791–1867  
English physicist and chemist

...the mind of man is not confined like the matter of his body, and thus he may and does travel outwards, for wherever his sight can pierce, there his observations can penetrate ...

In William Crookes  
*A Course of Six Lectures on the Various Forces of Matter and Their Relations to Each Other*  
Lecture 1 (p. 6)  
Richard Griffin & Co. London, England. 1860

**Fischer, Martin H.** 1879–1962  
German-American physician

You must acquire the ability to describe your observations and your experience in such language that whoever observes or experiences similarly will be forced to the same conclusion.

In Howard Fabing and Ray Marr  
*Fischerisms* (p. 8)  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Faraday, Michael** 1791–1867  
English physicist and chemist

If in such strivings, we...see but imperfectly, still we should endeavor to see, for even an obscure and distorted vision is better than none.

On the Conservation of Force  
*Philosophical Magazine*, Volume 13, Number 4, 1857 (p. 238)

**Feynman, Richard P.** 1918–88  
American theoretical physicist

The principle that the observation is the judge imposes a severe limitation to the kind of questions that can be answered. They are limited to questions that you can put this way: "if I do this, what will happen?" There are ways to try and see. Questions like, "should I do this?" and "what is the value of this?" are not of the same kind.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 16)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

It is not in ancient tomes, but in close observations and personal consecration that a grain of truth may be found.

It is so very easy to seek the significance of things in the papers of this or that man rather than in the works of nature which, ever alive and active, are constantly before our eyes.

In Helen Wright  
*Palomar: The World's Largest Telescope*  
Origin of the Telescope (p. 9)  
The Macmillan Company. New York, New York, USA. 1952

...to command the professors of astronomy to confute their own observations is to enjoin an impossibility, for it is to command them not to see what they do see ...

*The World's Greatest Books* (Volume 13) (p. 175)  
McKinley, Stoke & Mackekzu. 1910

**Gide, Andre** 1869–1951  
French author

On carelessly made or insufficient observations how many fine theories are built up which do not bear examination.

Translated by Justin O'Brien  
*Journals* (Volume 3)  
August 5, 1931 (p. 182)  
University of Illinois Press. Urbana, Illinois, USA. 2000

**Gore, George** 1826–1909  
English electrochemist

Observation differs from experiment. By experiment we evolve facts, by observation we find them.

*The Art of Scientific Discovery*  
Part III, Chapter XXXIIIIV (p. 316)  
Longmans, Green & Co. London, England. 1878

**Gregory, Sir Richard Arman** 1864–1952  
English scientific writer and journalist

It may be impossible for human intelligence to comprehend absolute truth, but it is possible to observe Nature with an unbiased mind and to bear truthful testimony of things seen.

*Discovery, Or, The Spirit and Service of Science*  
Chapter II (p. 26)  
Macmillan & Co Ltd. London, England. 1916

**Greer, Scott**  
No biographical data available

...the link between observation and formulation is one of the most difficult and crucial in the scientific enterprise. It is the process of interpreting our theory or, as some say, of "operationalizing our concepts." Our creations in the world of possibility must be fitted in the world of probability; in Kant's epigram, "Concepts without precepts are empty." It is also the process of relating our observations to theory; to finish the epigram, "Precepts without concepts are blind."

*The Logic of Social Inquiry*  
Part III, Chapter 14 (p. 160)  
Aldine Publishing Company. Chicago, Illinois, USA. 1969

**Gregg, Alan** 1890–1957

American medical educator and philosopher

...most of the knowledge and much of the genius of the research worker lie behind selection of what is worth observing. It is a crucial choice, often determining the success or failure of months of work, often differentiating the brilliant discoverer from the...plodder.

*The Furtherance of Medical Research*

Chapter I (p. 8)

Yale University Press. New Haven, Connecticut, USA. 1941

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

In the world of natural knowledge, no authority is great enough to support a theory when a crucial observation has shown it to be untenable.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 12)

Macmillan &amp; Company Ltd. London, England. 1918

An accurate observation remains unaltered throughout the ages. Its scientific value is determined by its truth to Nature; and the more complete the testimony, the less room is there for elaboration by investigators in succeeding generations.

*Discovery; or, The Spirit and Service of Science*

Chapter IV (p. 70)

Macmillan &amp; Company Ltd. London, England. 1918

**Grew, Nehemiah** 1641–1712

Scientific writer and journalist

If...an inquiry into the Nature of Vegetation may be of good Import; It will be requisite to see, first of all, What may offer itself to be enquired of; or to understand, what or Scope is: That so doing, we may take our aim the better in making, and having made, in applying our Observations thereunto.

*The Anatomy of Plants*

An Idea of a Philosophical History of Plants (p. 3)

Printed by W. Rawlins. London, England. 1682

**Hales, Stephen** 1677–1761

English physiologist and clergyman

...it is from long experience chiefly that we are to expect the most certain rules of practice, yet it is withal to be remembered, that observations, and to put us upon the most probable means of improving any art, is to get the best insight we can into the nature and properties of those things which we are desirous to cultivate and improve.

*Vegetable Statics*

The Conclusion (p. 214)

The Scientific Book Guild. London, England. 1961

**Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

...in every science which rests partly on the observation of nature, and not solely on the mind of man, a faith in

testimony is required, that the human race may not be stationary, and that the accumulated treasures of one man or of one generation of men may not be lost to another ...

*Report of the Fifth Meeting of the British Association for the Advancement of Science*

Address by Sir William Hamilton (p. xliii)

John Murray. London, England. 1836

**Hanson, Norwood Russell** 1924–67

American philosopher of science

...there is more to seeing than what meets the eyeball.

*Patterns of Discovery*

Chapter I (p. 7)

At The University Press. Cambridge, England. 1958

The observer may not know what he is seeing: he aims only to get his observations to cohere against the background of established knowledge. This seeing is the goal of observation.

*Patterns of Discovery*

Chapter I (p. 20)

At The University Press. Cambridge, England. 1958

**Harvey, William** 1578–1657

English physician

...the dull and unintellectual are indisposed to see what lies before their eyes...

*In Great Books of the Western World* (Volume 28)*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Dedication (p. 268)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

This assumption is not permissible in atomic physics; the interaction between observer and object causes uncontrollable and large changes in the system being observed, because of the discontinuous changes characteristic of atomic processes.

*The Physical Principles of the Quantum Theory*

Introductory (p. 3)

The University of Chicago Press. Chicago, Illinois, USA. 1930

This again emphasizes a subjective element in the description of atomic events, since the measuring device has been constructed by the observer, and we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter III (p. 58)

Harper &amp; Row, Publishers. New York, New York, USA. 1958

...what we observe is not nature itself, but nature exposed to our method of questioning.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter III (p. 58)

Harper &amp; Row, Publishers. New York, New York, USA. 1958

The idea that we do observe something already indicates something irreversible. If we draw a pencil line



on a paper, for instance, we have established something which cannot be undone, so to speak. Every observation is irreversible, because we have gained information that cannot be forgotten.

In Paul Buckley and F. David Peat

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 12)

University of Toronto Press, Toronto, Ontario, Canada. 1996

A real difficulty in the understanding of this interpretation arises, however, when one asks the famous question: But what happens “really” in an atomic event? It has been said before that the mechanism and the results of an observation can always be stated in terms of the classical concepts. But what one deduces from an observation is a probability function, a mathematical expression that combines statements about possibilities or tendencies with statements about our knowledge of facts. So we cannot completely objectify the result of an observation, we cannot describe what “happens” between this observation and the next.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*

The Copenhagen Interpretation of Quantum Mechanics (pp. 90–91)

Little, Brown & Company, Boston, Massachusetts, USA. 1991

### von Helmholtz, Robert

No biographical data available

To observe is to notice, and to collect what you have noticed. In proportion however as the collecting of things is done according to higher and higher standards, observation comes nearer to thinking, collecting approaches interpretation, and natural history verges into exact study of nature.

*Annual Report of the Board of Regents of the Smithsonian Institution,*

1889

A Memoir of Gustav Robert Kirchhoff (p. 528)

Government Printing Office, Washington, D.C. 1889

### Herschel, Friedrich Wilhelm

(Sir William) 1738–1822

English astronomer

If I should mention any observations that are difficult to be verified I beg the indulgence of observers. I hope it will be found that I have sufficiently guarded against optical illusions, and that I have all along had truth and reality in view as the sole object of my endeavors.

On the Parallax of the Fixed Stars

*Philosophical Transactions of the Royal Society of London,*

Volume 72, 1782 (p. 98)

A little practice in this business [looking through a telescope] soon makes it easy, especially to one who has already been used to look with both eyes open.

Description of a Lamp Micrometer, and the Method of Using It

*Philosophical Transactions of the Royal Society of London,*

Volume 72, 1782 (p. 170)

Familiar objects and events are far from presenting themselves to our senses in that aspect and with those connections under which science requires them to be viewed, and which constitute their rational explanation.

*Outlines of Astronomy: By Sir John F. W. Herschel*

Introduction (p. 21)

American Home Library Co. New York, New York, USA. 1902

### Herschel, Sir John Frederick William 1792–1871

English astronomer and chemist

There is scarcely any well-informed person, who, if he has but the will, has not also the power to add something essential to the general stock of knowledge, if he will only observe regularly and methodically some particular class of facts which may most excite his attention...

*A Preliminary Discourse on the Study of Natural Philosophy*

Part II, Chapter IV, Section 128 (p. 133)

Printed for Longman, Rees, Orme, Brown & Green, London, England. 1831

Seeing is in some respects an art which must be learnt. To make a person see with such a power is nearly the same as if I were asked to make him play one of Handel’s fugues upon the organ. Many a night I have been practicing to see, and it would be strange if one did not acquire a certain dexterity by such constant practice.

In William Hoyt

*Planets X and Pluto*

Chapter 1 (p. 12)

The University of Arizona Press, Tucson, Arizona, USA. 1981

### Hinshelwood, Sir Cyril 1897–1967

English chemist

Again and again, the key to a great discovery has been an unexpected observation.

Science and Scientists

*Nature*, Volume 207, Number 5001, September 4, 1965 (p. 1057)

### Hobbs, William Herbert 1864–1952

American geologist

It is a truism that the influence of things seen is more potent than that of things merely heard of or read about.

*Characteristics of Existing Glaciers*

Introduction (p. 2)

The Macmillan Co. New York, New York, USA. 1911

### Holton, Gerald 1922–

Research professor of physics and science history

### Roller, Duane H. D. ?–1994

Science historian

All intelligent endeavor stands with one foot on observation and the other on contemplation.

*Foundations of Modern Physical Science*

Chapter 13 (p. 218)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1950



**Hooke, Robert** 1635–1703  
English physicist

The truth is, the Science of Nature has been already too long made only a work of the Brain and the Fancy: It is now high time that it should return to the plainness and soundness of Observations on material and obvious things.

*Micrographia*

Preface (Fifth page)

Printed by Jo. Martyn and Ja. Allestry. London, England. 1665

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

You take a number of radioactive nuclei of a particular kind, the number being chosen so that there's an even chance of one of them going off in a certain period of time, say ten seconds. Then for ten seconds you surround them with counters, or any other detecting device you might like to use. At the end of the time the question is, has one of them decayed or not. To decide this you take a look at your counters. The conventional notion is that the state of the counters decides whether a nucleus has gone off or not...my problem now concerns an individual case.... It is perfectly possible to put your counters, or your bubble chamber, your camera, all your gobbledygook in fact, into your calculations – and we know quite definitely that any attempt to get a definite answer out of calculation will prove completely fruitless. The thing that gives the answer isn't the camera or the counter, it's the actual operation of looking yourself at your equipment. It seems that only when we ourselves take a subjective decision can we improve our description of the world, over and above the uncertainty of our theories. I'm talking about quantum theories now.

*October the First Is Too Late*

Chapter Five (pp. 52–53)

Harper & Row, Publishers. New York, New York, USA. 1966

**Hubble, Edwin Powell** 1889–1953  
American astronomer

...observation and theory are woven together, and it is futile to attempt their complete separation. Observation always involve theory. Pure theory may be found in mathematics, but seldom in science. Mathematics, it has been said, deals with possible worlds – logically consistent systems. Science attempts to discover the actual world we inhabit. So in cosmology, theory presents an infinite array of possible universes, and observation is eliminating them, class by class, until now the different types among which our particular universe must be included have become increasingly comprehensible.

*The Realm of the Nebulae*

Chapter I (p. 35)

Dover Publications, Inc. New York, New York, USA. 1958

**Huxley, Thomas Henry** 1825–95  
English biologist

There is no question in the mind of anyone acquainted with the facts that, so far as observation and experiment can take us, the structure and the functions of the nervous system are fundamentally the same in an ape, or in a dog, and in a man. And the suggestion that we must stop at the exact point at which direct proof fails us, and refuse to believe that the similarity which extends so far stretches yet further, is no better than a quibble. Robinson Crusoe did not feel bound to conclude, from the single human footprint which he saw in the sand that the maker of the impression had only one leg.

*Hume, with Helps to the Study of Berkeley* (p. 123)

D. Appleton & Company. New York, New York, USA. 1896

**James, William** 1842–1910  
American philosopher and psychologist

Roundabout the accredited and orderly facts of every science there ever floats a sort of dust-cloud of exceptional observations, of occurrences minute and irregular and seldom met with, which it always proves more easy to ignore than to attend to... Anyone will renovate his science who will steadily look after the irregular phenomena, and when science is renewed, its new formulas often have more of the voice of the exceptions in them than of what were supposed to be the rules.

*The Will to Believe and Other Essays in Popular Philosophy*

What Psychical Research Has Accomplished (pp. 299, 300)

Longmans, Green & Co. New York, New York, USA. 1919

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

Each observation destroys the bit of the universe observed, and so supplies knowledge only of a universe which has already become past history...

*The New Background of Science*

Chapter I (p. 2)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

We can only see nature blurred by the clouds of dust we ourselves make; we can still only see the rainbow, but a sun of some sort must exist to produce the light by which we see it.

*The New Background of Science*

Chapter I (p. 4)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

**Jeffreys, Sir Harold** 1891–1989  
English astronomer and geophysicist

An observation, strictly, is only a sensation. Nobody means that we should reject everything but sensations. But as soon as we go beyond sensations we are making inferences.

*Theory of Probability*

General Questions (p. 412)

Clarendon Press. Oxford, England. 1961

**Jevons, William Stanley** 1835–82  
English economist and logician

It is difficult to find persons who can with perfect fairness register facts for and against their own peculiar views. Among uncultivated observers the tendency to remark favourable and forget unfavourable events is so great, that no reliance can be placed upon their supposed observations.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
(2nd edition)  
Book IV, Chapter VIII (p. 402)  
Macmillan & Co Ltd. London, England. 1877

**Jones, Steve**  
No biographical data available

Observation and experiment are what count, not opinion and introspection. Few working scientists have much respect for those who try to interpret nature in metaphysical terms. For most wearers of white coats, philosophy is to science as pornography is to sex: it is cheaper, easier, and some people seem, bafflingly, to prefer it. Outside of psychology it plays almost no part in the functions of the research machine.

Review of *How the Mind Works* by Steve Pinker  
*The New York Review of Books*, November 6, 1997 (p. 13)

**Jonson, Ben** 1573–1637  
English dramatist and poet

...let me alone to observe, till I turned myself into nothing but observation.

*The Poetaster*  
Act II, Scene I, l. 193  
Henry Holt & Company. New York, New York, USA. 1905

**Kearton, Richard** 1862–1928  
English naturalist

Nature's children do not reveal their intimate ways to the bustling, human noise-maker, and he who would seek to know something of their interesting daily doings must first of all acquire the faculty to observe whilst remaining unobserved, and hear without being heard.

*Wild Nature's Ways*  
Chapter I (p. 1)  
Cassell & Co., Ltd. London, England. 1903

**Kett, Henry** 1761–1825  
English college teacher and writer

It is the glorious privilege of man, while other animals are confined within the limits which instinct has prescribed, to carry his observations beyond his own immediate wants, and to contemplate the universe at large.

*Elements of General Knowledge* (Volume 2)  
Chapter IV (p. 88)  
Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

Objects that are open to daily observation lose their effect upon our minds; but such as are rare and uncommon seldom fail to strike us with admiration.

*Elements of General Knowledge* (Volume 2)  
Chapter IV (p. 100)  
Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

The art of science is knowing which observations to ignore and which are the key to the puzzle.

*Blind Watchers of the Sky*  
Chapter Seven (p. 189)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kuhn, Thomas S.** 1922–96  
American historian of science

Observation and experience can and must drastically restrict the range of admissible scientific belief, else there would be no science. But they cannot alone determine a particular body of such belief. An apparently arbitrary element, compounded of personal and historical accident, is always a formative ingredient of the beliefs espoused by a given scientific community at a given time.

*The Structure of Scientific Revolutions*  
Chapter I (p. 4)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

**Langer, Susanne Katherina Knauth** 1895–1985  
American philosopher

The faith of scientists in the power of mathematics is so implicit that their work has gradually become less and less observation, and more and more calculation. The promiscuous collection and tabulation of data have given way to a process of assigning possible meanings, merely supposed real entities, to mathematical terms, working out the logical results, and then staging certain crucial experiments to check the hypothesis against the actual, empirical results. But the facts...accepted by virtue of these tests are not actually observed at all.

*Philosophy in a New Key*  
Chapter I (pp. 19–20)  
Harvard University Press. Cambridge, Massachusetts, USA. 1957

Observation has become almost entirely indirect; and readings take the place of genuine witness.

*Philosophy in a New Key*  
Chapter I (p. 20)  
Harvard University Press. Cambridge, Massachusetts, USA. 1957

The men in the laboratory...cannot be said to observe the actual objects of their curiosity at all.... They sense data on which the propositions of modern science rest are, for the most part, little photographic spots and blurs, or inky curved lines on paper.... What is directly observable is only a sign of the "physical fact"; it requires interpretation to yield scientific propositions.

*Philosophy in a New Key*  
Chapter I (p. 20)  
Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The more numerous the number of observations and the less they vary among themselves the more their results approach the truth. We fulfill this last condition by the choice of the methods of observations, by the precision of the instruments, and by the care which we take to observe closely; then we determine by the theory of probabilities the most advantageous mean results or those which give the least value of the error. But that is not sufficient; it is further necessary to appreciate the probability that the errors of these results are comprised in the given limits; and without this we have only an imperfect knowledge of the degree of exactitude obtained.

*A Philosophical Essay on Probabilities*

Chapter IX (p. 73)

John Wiley &amp; Sons. New York, New York, USA. 1902

... it may be laid down as a general rule that, if the result of a long series of precise observations approximates a simple relation so closely that the remaining difference is undetectable by observation and may be attributed to the errors to which they are liable, then this relation is probably that of nature.

In Charles Coulston Gillispie

*Pierre-Simon Laplace, 1749–1827: A Life in Exact Science*

Chapter XVI (p. 130)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Latham, Peter Mere** 1789–1875

English physician

...you cannot tax the faculty of observation beyond its common powers and capacities.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture I (p. 6)

Longman, Rees, Orme, Brown, Green &amp; Longman. London, England. 1836

...without observation of the living body, there can be no pathology. Observation needs certain helps to give it a pathological aim; but these are only subordinate; and it still belongs to observation to concentrate all that they are capable of teaching in the real knowledge of disease.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture IV (p. 89)

Longman, Rees, Orme, Brown, Green &amp; Longman. London, England. 1836

**Lee, Oliver Justin** 1881–1964

American astronomer

Every bit of knowledge we gain and every conclusion we draw about the universe or about any part or feature of it depends finally upon some observation or measurement. Mankind has had again and again the humiliating experience of trusting to intuitive, apparently logical conclusions without observations, and has seen Nature sail by in her radiant chariot of gold in an entirely different direction.

*Measuring Our Universe: From the Inner Atom to Outer Space*

Chapter 3 (p. 33)

Ronald Press Company. New York, New York, USA. 1950

**Leslie, Sir John** 1766–1832

Scottish physicist and mathematician

The range of Observation is limited by the position of the spectator, who can seldom expect to follow Nature through her winding and intricate paths.

*Elements of Natural Philosophy: Including Mechanics and Hydrostatics* (Volume 1)

Introduction (p. x)

Oliber &amp; Boyd. Edinburgh, Scotland. 1829

**Lewis, Gilbert Newton** 1875–1946

American chemist

I claim that my eye touches a star as truly as my finger touches this table.

In George W. Gray

*New Eyes on the Universe**The Atlantic Monthly*, Volume 155, Number 5, 1935 (p. 608)**Lewis, Sir Thomas** 1881–1945

No biographical data available

Observations undertaken by any method which is not generally approved and which has not passed a rigorous censorship, are observations which add little to the sum of general knowledge.

*The Mechanism and Graphic Registration of the Heart Beat*

Preface (p. vi)

Shaw &amp; Sons. London, England. 1920

**Lodge, Sir Oliver** 1851–1940

English physicist

His [Tycho Brahae] theories were poor, but his observations were admirable.

*Pioneers of Science*

Dates and Summary of Facts for Lecture II (p. 32)

Macmillan &amp; Co Ltd. London, England. 1905

**Longair, Malcolm** 1941–

Scottish physicist

Although by now a large amount of observational material is available, the implications of these observations are far from clear.

*Quasi-Stellar Radio Sources**Contemporary Physics*, Volume 8, Number 4, 1967 (p. 357)**Lonsdale, Dame Kathleen** 1903–71

Irish-born English crystallographer

...observation is not enough, and it seems to me that in science, as in the arts, there is very little worth having that does not require the exercise of intuition as well as of intelligence, the use of imagination as well as of information.

*Facts About Crystals**American Scientist*, Volume 39, Number 4, October, 1951 (p. 576)

**Louis, Pierre-Charles-Alexandre** 1787–1872  
French physician

It behooves those who devote themselves to observation to be impressed by this truth (*i.e.*, that many “facts” grow old) and to realize that the best work is only good in relation to its time and that it awaits another, more exact and more complete.

*Recherches Anatomiques, Pathologiques et Therapeutiques sur la Maladie Connue Sous les Noms de Gastro-Enterite* (p. vii)  
Publisher undetermined

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

What we do see depends mainly on what we look for. When we turn our eyes to the sky, it is in most cases merely to see whether it is likely to rain. In the same field the farmer will notice the crop, geologists the fossils, botanists the flowers, artists the coloring, sportsmen the cover for game. Though we may all look at the same things, it does not at all follow that we should see them.

*The Beauties of Nature and the Wonders of the World We Live In*  
Introduction (pp. 3–4)  
The Macmillan Company. New York, New York, USA. 1893

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Everything which we observe in nature imprints itself uncomprehended and unanalyzed in our percepts and ideas which then, in their turn, mimic the processes of nature in their most general and most striking features.

*The Science of Mechanics* (5th edition)  
Chapter I, Part II, Section 2 (p. 36)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Macy, Arthur**  
No biographical data available

But I keep no log of my daily grog,  
For what's the use o' being bothered? I drink a little more  
when the wind's offshore,  
And most when the wind's from the no'th'ard.

*Poems*  
The Indifferent Mariner  
W.B. Clarke Company. Boston, Massachusetts, USA. 1905

**Marschall, Laurence A.**  
American astronomer

A first-time deep-sky observer usually sees little more than a fuzzy glow against the blackness of the night. Thus, to the nonastronomer, once you've seen one celestial object, you've pretty much seen them all.

*The Supernova Story*  
Chapter 1 (p. 2)  
Plenum Press. New York, New York, USA. 1988

**Marsh, George Perkins** 1801–82  
American diplomat, scholar, and conservationist

Sight is a faculty; seeing, an art.  
*Man and Nature: Or, Physical Geography as Modified by Human Action*  
Chapter I (p. 10)  
Charles Scribner's Sons. New York, New York, USA. 1865

**Marsland, Douglas**  
American biologist

The primary basis of all scientific thinking is observation.  
*Principles of Modern Biology* (p. 12)  
Holt, Rinehart, Winston. New York, New York, USA. 1969

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

Innocent, unbiased observation is a myth.  
*Induction and Intuition in Scientific Thought*  
Chapter II, Section 2 (p. 28)  
American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

It is not methodologically an exaggeration to say that Fleming eventually found penicillin because he had been looking for it. A thousand people might have observed whatever it was that he did observe without making anything of it or building upon the observation in any way; but Fleming had the right slot in his mind, waiting for it. Good luck is almost always preceded by an expectation that it will gratify. Pasteur is well known to have said that fortune favors the prepared mind, and Fontenelle observed, “*Ces hasards ne sont que pour ceux qui jouent bien!*” (“These strokes of good fortune are only for those who play well!”).

*Advice to a Young Scientist*  
Chapter 11 (p. 90)  
Basic Books, Inc. New York, New York, USA. 1979

**Meredith, George** 1828–1909  
English novelist and poet

Observation is the most enduring of the pleasures of life...

*Diana of the Crossways*  
Chapter XI (p. 104)  
Charles Scribner's Sons. New York, New York, USA. 1924

**Mellor, Joseph William** 1863–1938  
Chemist

However successful a theory or law may have been in the past, directly it fails to interpret new discoveries its work is finished, and it must be discarded or modified. However plausible the hypothesis, it must be ever ready for sacrifice on the altar of observation.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
Chapter I (p. 17)  
Longman, Green & Co. London, England. 1922

**Mill, John Stuart** 1806–73  
English political philosopher and economist

...in almost every act of our perceiving faculties, observation and inference are intimately blended. What we are said to observe is usually a compound result, of which one-tenth may be observation and the remaining nine-tenths inference.

*A System of Logic, Ratiocinative and Inductive*  
Book IV, Chapter I (p. 384)  
Harper & Brothers Publishers. New York, New York, USA. 1867

**Minnaert, M.**  
No biographical data available

It is indeed wrong to think that the poetry of Nature's moods in all their infinite variety is lost on one who observes them scientifically, for the habit of observation refines our sense of beauty and adds a brighter hue to the richly coloured background against which each separate fact is outlined. The connection between events, the relation of cause and effect in different parts of a landscape, unite harmoniously what would otherwise be merely a series of detached sciences.

*The Nature of Light and Colour in the Open Air*  
Preface (p. v)  
Dover Publications. New York, New York, USA. 1954

**Minot, Charles Sedgwick** 1852–1914  
American anatomist

A generalization is a mountain of observations; from the summit the outlook is broad. The great observer climbs to the outlook, while the mere thinker struggles to imagine it.

Fifty-first meeting  
The Problem of Consciousness in Its Biological Aspects  
*Proceedings of the American Association for the Advancement of Science*, June–July 1902 (p. 269)

**Mitchell, Maria** 1818–89  
American astronomer and educator

Nothing comes out more clearly in astronomical observations than the immense activity of the universe.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter XI (p. 237)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

**Morris, Richard** 1939–2003  
American physicist and science writer

Simple observation generally gets us nowhere. It is the creative imagination that increases our understanding by finding connections between apparently unrelated phenomena, and forming logical, consistent theories to explain them. And if a theory turns out to be wrong, as many do, all is not lost. The struggle to create an imaginative, correct picture of reality frequently tells us where

to go next, even when science has temporarily followed the wrong path.

*The Universe, the Eleventh Dimension, and Everything: What We Know and How We Know It*  
Part 3, Chapter 2 (p. 190)  
Four Walls Eight Windows. New York, New York, USA. 1999

**Moulton, Lord** 1844–1921  
English mathematician

When we are reduced to observation Science crawls.

In Alan Gregg  
*The Furtherance of Medical Research*  
Chapter I (p. 7)  
Yale University Press. New Haven, Connecticut, USA. 1941

**Müller, Johannes** 1801–58  
German physiologist

Observation is simple, indefatigable, industrious, upright, without any preconceived opinion. Experiment is artificial, impatient, busy, digressive, passionate, unreliable.

In V.J.E. Kruta  
*Purkyne Physiologist: A Short Account of His Contributions to the Progress of Physiology* (p. 20)  
Publisher undetermined

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

As in mathematics, so in natural philosophy the investigation of difficult things by the method of analysis ought ever to precede the method of composition. This analysis consists of making experiments and observations, and in drawing general conclusions from them by induction.... By this way of analysis we may proceed from compounds to ingredients, and from motions to the forces producing them; and in general from effects to their causes, and from particular causes to more general ones till the argument end in the most general. This is the method of analysis: and the synthesis consists in assuming the causes discovered and established as principles, and by them explaining the phenomena preceding from them, and proving the explanations.

In *Great Books of the Western World* (Volume 34)  
*Optics*  
Book III: Part I, Query 31  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**O'Neil, William Matthew**  
No biographical data available

It urges the scientist, in effect, not to take risks incurred in moving far from the facts. However, it may properly be asked whether science can be undertaken without taking the risk of skating on the possibly thin ice of supposition. The important thing to know is when one is on the more solid ground of observation and when one is on the ice.

*Fact and Theory: An Aspect of the Philosophy of Science*  
Chapter 8 (p. 154)  
Sydney University Press. Sydney, Australia. 1969



**Orwell, George (Eric Arthur Blair)** 1903–50  
English novelist and essayist

To see what is in front of one's nose requires a constant struggle.

In Sonia Orwell and Ian Angus (eds.)  
*The Collected Essays, Journalism and Letters of George Orwell: In Front of Your Nose, 1945–1950*  
1946, 36 (p. 125)  
Harcourt, Brace & World. New York, New York, USA. 1968

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Observation plus thinking has given us the bodies of living creatures in health and disease. There have been two inherent difficulties – to get men to see straight and to get men to think clearly; but in spite of the frailty of the instrument, the method has been one of the most powerful ever placed in the hands of man.

The Pathological Institute of a General Hospital  
*Glasgow Medical Journal*, Volume 76, 1911

Note with accuracy and care everything that comes within your professional ken.... Let nothing slip by you; the ordinary hum-drum cases of the morning routine may have been accurately described and pictured, but study each one separately as though it were new – so it is so far as your special experience goes; and if the spirit of the student is in you the lesson will be there.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
The Army Surgeon (p. 104)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The whole art of medicine is in observation, as the old motto goes, but to educate the eye to see, the ear to hear and the finger to feel takes time, and to make a beginning, to start a man on the right path, is all that we can do. We expect too much of the student and we try to teach him too much. Give him good methods and a proper point of view, and all other things will be added, as his experience grows.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
The Hospital as a College (pp. 315–316)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

Man can do a great deal by observation and thinking, but with them alone he cannot unravel the mysteries of Nature. Had it been possible the Greeks would have done it; and could Plato and Aristotle have grasped the value of experiment in the progress of human knowledge, the course of European history might have been very different.

*Man's Redemption of Man*  
Address, University of Edinburgh, July 1910 (p. 22)

See, and then reason and compare and control. But see first. No two eyes see the same thing. No two mirrors give forth the same reflection.

In W.S. Thayer

*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*  
Osler, The Teacher (p. 51)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

Viewed through the perspective of memory, an unrecorded observation, the vital details long since lost, easily changes its countenance and sinks obediently into the frame fashioned by the fancy of the moment.

In W.S. Thayer  
*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*  
Osler, The Teacher (p. 51)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

The collection and study of your own observations is much, but he who works in his own small compartment leads, after all, a restricted and circumscribed life. Go out among your fellows, and learn of them. The good observer is not limited to the large hospital. The modest country doctor may furnish you the vital link in your chain, and the simple rural practitioner is often a very wise man.

In W.S. Thayer  
*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*  
Osler, The Teacher (p. 52)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Owen, Ed** 1896–1981  
American geologist

I wandered far and saw many things over a long time. Most of the things which I saw I did not understand. I looked about me and did not see that any others understood the complex pattern either. But as I wandered I could not escape the feel of things and of places and of the people in them.

In Samuel P. Ellison, Jr., Joseph J. Jones, and Mirva Owen (eds.)  
*The Flavor of Ed Owen – A Geologist Looks Back*  
Introduction (p. 1)  
Geology Foundation, University of Texas at Austin. Austin, Texas, USA. 1987

**Paylov, Ivan Petrovich** 1849–1936  
Russian physiologist

Observation collects whatever nature offers, whereas experimentation takes from nature whatever it requires.

In Ivan Valiela  
*Doing Science: Design, Analysis, and Communication of Scientific Research*  
Chapter I (p. 11)  
Oxford University Press, Inc. Oxford, England. 2001

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

The things that any science discovers are beyond the reach of direct observation. We cannot see energy, not the attraction of gravitation, nor the flying molecules of gasses, nor the luminiferous ether, nor the forests of the carbonaceous era, nor the explosions in nerve cells. It is



only the premises of science, not its conclusions, which are directly observed.

In Justice Buchler (ed)

*Philosophical Writings of Peirce*

Chapter 22 (pp. 310–311)

Dover Publications. Mineola, New York, USA. 1955

**Planck, Max** 1858–1947

German physicist

As long as Natural Philosophy exists, its ultimate highest aim will always be the correlating of various physical observations into a unified system, and, where possible, into a single formula.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Unity of the Physical Universe (p. 1)

Methuen & Company Ltd. London, England. 1925

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

...to observe is not enough. We must use our observations, and to do that we must generalize.

*The Foundations of Science*

*Science and Hypothesis*, Part IV

Chapter IX (p. 127)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

To observations which ourselves we make,  
We grow more partial for th' observer's sake.

*The Complete Poetical Works*

Moral Essays, Epis. I, l. 11–12

Houghton Mifflin Company. New York, New York, USA. 1903

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Some scientists find, or so it seems, that they get their best ideas when smoking; others by drinking coffee or whiskey. Thus there is no reason why I should not admit that some may get their ideas by observing or by repeating observations.

*Realism and the Aim of Science*

Part I, Chapter I (p. 36)

Rowman & Littlefield. Totowa, New Jersey, USA. 1983

**Preston, Thomas** 1860–1900

Irish scientist

The inquiring mind cannot rest satisfied with the mere observation of the facts of nature, but is irresistibly led to investigate their origin and cause.

*The Theory of Heat* (2nd edition)

Introduction (p. 4)

Macmillan & Co Ltd. London, England. 1904

**Rowland, Henry Augustus** 1848–1901

American physicist

The power to produce is not the exclusive possession of any particular class; and in the realm of science it comes to all who will approach Nature with clear eyes, will observe accurately, weigh the observations with unprejudiced mind and weave them into a reasonable web of interpretation.

*Discovery, Or, The Spirit and Service of Science*

Chapter III (p. 43)

Macmillan & Co Ltd. London, England. 1916

**Rumford, Benjamin** 1743–1814

American-British scientist

I...am persuaded that a habit of keeping the eyes open to everything that is going on in the ordinary course of the business of life has oftener led, as it were by accident, or in the playful excursions of the imagination, put into action by contemplating the most common appearances, to useful doubts and sensible schemes for investigation and improvement, than all the more intense meditations of philosophers in the hours expressly set apart for expressly set apart for study.

*The Complete Works of Count Rumford*

An Inquiry Concerning the Source of the Heat Which is Excited by Friction (p. 471)

American Academy of Arts & Sciences. Boston, Massachusetts, USA. 1870

**Saxe, John Godfrey** 1816–87

American poet

It was six men of Indostan  
To learning much inclined,  
Who went to see the Elephant  
(Though all of them were blind),  
That each by observation  
Might satisfy his mind.

*The Poetical Works of John Godfrey Saxe*

The Parable of the Blind Men and the Elephant

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Selye, Hans** 1907–82

Austrian-American endocrinologist

If a scientist makes no important observation he deserves no credit. But if a significant fact comes his way and he still does not see its importance, he can only blame himself.

*From Dream to Discovery: On Being a Scientist*

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Serviss, Garrett Putman** 1851–1921

American science fiction writer

...with the aid of an opera-glass most interesting, gratifying, and, in some instances, scientifically valuable observations may be made in the heavens. I have more than once heard persons who knew nothing about the stars, and probably cared less, utter exclamations of surprise and delight when persuaded to look at certain parts of

the sky with a good glass, and thereafter manifest an interest in astronomy of which they would formerly have believed themselves incapable.

*Astronomy With an Opera-glass*

Introduction (pp. 3–4)

D. Appleton & Co. New York, New York, USA. 1888

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

ARMANDO: How hast thou purchased this experience?

MOTH: By my penny of observation.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Love's Labour's Lost*

Act III, Scene i, l. 23

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smyth, William Henry** 1788–1865

English admiral and scientific writer

Many things, deemed Invisible to secondary instruments, are plain enough to one who 'knows how to see them'.

Quoted in Thomas William Webb

*Celestial Objects for Common Telescopes* (Volume 2) (p. iv)

Longmans, Green & Co. London, England. 1907

**Steinbeck, John** 1902–68

American novelist

There are good things to see in the tide pools and there are exciting and interesting thoughts to be generated from the seeing. Every new eye applied to the peep hole which looks out at the world may fish in some new beauty and some new pattern, and the world of the human mind must be enriched by such fishing.

In Edward F. Ricketts, Jack Calvin, and Joel W. Hedgpeth

*Between Pacific Tides*

Prefaces (p. xi)

Stanford University Press. Stanford, California, USA. 1968

...one can live in a prefabricated world, smugly and without question, or one can indulge perhaps the greatest human excitement: that of observation to speculation to hypothesis. This is a creative process, probably the highest and most satisfactory we know.

In Edward F. Ricketts, Jack Calvin and Joel W. Hedgpeth

*Between Pacific Tides*

Prefaces (p. xi)

Stanford University Press. Stanford, California, USA. 1968

You are one of the rare people who can separate your observation from your preconception. You see what is, where most people see what they expect.

*East of Eden* (p. 130)

The Viking Press. New York, New York, USA. 1952

**Sterne, Laurence** 1713–68

English novelist and humorist

What a large volume of adventures may be grasped within this little span of life by him who interests his heart in everything and who, having eyes to see what

time and chance are perpetually holding out to him as he journeyeth on his way, misses nothing he can fairly lay his hands on.

*The Life and Opinions of Tristram Shandy, Gentleman and a Sentimental Journey Through France and Italy* (Volume 2)

In the Street (p. 251)

Macmillan & Company Ltd. London, England. 1900

**Stewart, Ian** 1945–

English mathematician and science writer

It's amazing how long it can take to see the obvious. But of course it's only obvious now.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*

Chapter 3 (pp. 32–33)

Basic Books, Inc. New York, New York, USA. 1995

**Swift, Jonathan** 1667–1745

Irish-born English writer

That was excellently observ'd, say I, when I read a Passage in an Author, where his Opinion agrees with mine. When we differ, there I pronounce him to be mistaken.

*Satires and Personal Writings*

Thoughts on Various Subjects (p. 416)

Oxford University Press, Inc. New York, New York, USA. 1965

Observation is an old man's memory.

In Henry Morley

*The Tale of a Tub and Other Works*

Thoughts on Various Subjects (p. 407)

George Routledge & Sons. London, England. 1889

**Sylvester, James Joseph** 1814–97

English mathematician

Most, if not all, of the great ideas of modern mathematics have had their origin in observation.

A Plea for the Mathematician

*Nature*, Volume 1, Thursday, December 30, 1869 (p. 238)

**Tait, Archibald Campbell** 1811–82

Lord Bishop of London

And while the student of nature goes on honestly, patiently, diffidently, observing and storing up his observations, and carrying his reasonings unflinchingly to their legitimate conclusions, convinced that it would be treason to the majesty at once of science and of religion if he sought help either by swerving ever so little from the straight rule of truth, yet he does all this under a reverent sense of responsibility, fostered and deepened by his religious convictions.

*Harmony of Revelations and the Sciences*

Address to the Edinburgh Philosophical Association (p. 17)

Edmonston & Douglas. Edinburgh, Scotland. 1864

**Teale, Edwin Way** 1899–1980

American naturalist

For observing nature, the best pace is a snail's pace.

*Circle of the Seasons*

July 14 (p. 150)

Dodd, Mead & Company. New York, New York, USA. 1953

## The Bible (King James Version)

Seeing many things, but thou observest not; ...  
Isaiah 42:20

**Thiele, T. N.** 1838–1910  
Danish astronomer

An isolated sensation teaches us nothing, for it does not amount to an observation. Observation is a putting together of several results of sensation which are or are supposed to be connected with each other according to the law of causality, so that some represent causes and others their effects.

*Theory of Observations* (p. 2)  
Cahales & Edwin Layton. London, England. 1903

**Thomas, Lewis** 1913–93  
American physician and biologist

The role played by the observer in biological research is complicated but not bizarre: he or she simply observes, describes, interprets, maybe once in a while emits a hoarse shout, but that is that; the act of observing does not alter fundamental aspects of the things observed, or anyway isn't supposed to.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
An Apology (p. 88)  
The Viking Press. New York, New York, USA. 1979

**Thompson, Silvanus P.** 1851–1916  
English physics professor and author

The seemingly useless or trivial observation made by one worker leads on to a useful observation by another; and so science advances, "creeping on from point to point."

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter XI (p. 292)  
Macmillan & Company Ltd. London, England. 1918

**Thompson, William Robin** 1887–1972  
Canadian entomologist

The mathematical machine works with unerring precision; but what we get out of it is nothing more than a rearrangement of what we put into it. In the last analysis observation – the actual contact with real events – is the only reliable way of securing the data of natural history.

*Science and Common Sense*  
Chapter Six (pp. 114–115)  
Yale University Press. New Haven, Connecticut, USA. 1951

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

...the raw material of observation is not rare like gold or diamonds, but near to us as sunshine and rain-drops.

*The Study of Animal Life* (2nd Edition)  
Part I, Chapter I (p. 1)  
John Murray. London, England. 1892

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The question is not what you look at – but how you look & whether you see.

*Journal* (Volume 3: 1848–1851)  
August 5, 1851 (pp. 354–355)  
Princeton University Press. Princeton, New Jersey, USA. 1981

...the naturalist's observations is not in new genera or species, but in new contemplations still, and science is only a more contemplative man's recreation.

*A Week on the Concord and Merrimack Rivers*  
Saturday (p. 16)  
Charles Scribner's Sons. New York, New York, USA. 1921

**Tyndall, John** 1820–93  
Irish-born English physicist

...observation tends to chasten the emotions and to check those structural efforts of the intellect which have emotion for their base.

*Fragments of Science for Unscientific People*  
Chapter II (p. 35)  
D. Appleton & Co. New York, New York, USA. 1875

**van Hise, Charles** 1857–1918  
American academic

The difference between bad observation and good observation is that the former is erroneous; the latter is incomplete.

*Proceedings of the American Association for the Advancement of Science*  
The Training and Work of a Geologist  
Fifty-first meeting, Pittsburgh, Pennsylvania June-July 1902

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

An extremely odd demand is often set forth but never met, even by those who make it; *i.e.*, that empirical data should be presented without any theoretical context, leaving the reader, the student, to his own devices in judging it. This demand seems odd because it is useless simply to look at something. Every act of looking turns into observation, every act of observation into reflection, every act of reflection into the making of associations; thus it is evident that we theorize every time we look carefully at the world.

In Douglas Miller  
*Scientific Studies* (Volume 12)  
Theory of Color  
Preface (p. 159)  
Suhrkamp. New York, New York, USA. 1988

Individual observations, drawn from the natural objects with which we are in contact, are often the more valuable, the less the observer professionally belongs to the particular department of science which he illustrates.

In John Stuart Blackie  
*The Wisdom of Goethe*  
Nature – Natural History (p. 187)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

The belief in the uncommon and the wonderful lends a definite outline to every manifestation of ideal creation; and the realm of fancy a fairy-land of cosmological, geognostical and magnetic visions becomes thus involuntarily blended with the domain of reality.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
General Review of Natural Phenomena (p. 81)  
D. Appleton & Co. New York, New York, USA. 1850

True cosmical views are the result of observation and ideal combination, and of a long-continued communion with the external world; nor are they a work of a single people, but the fruits yielded by reciprocal communication, and by a great, if not general, intercourse between different nations.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)  
Physical Contemplation of the Universe (p. 116)  
Harper & Brothers. New York, New York, USA. 1869

**von Liebig, Justus** 1803–73  
German organic chemist

However numerous our observations may be, yet, if they only bear on one side of a question, they will never enable us to penetrate the essence of a natural phenomenon in its full significance.

*Animal Chemistry*

Preface (p. xxxii)

Johnson Reprint Corporation. New York, New York, USA. 1964

When a power of nature, invisible and impalpable, is the subject of scientific inquiry, it is necessary, if we would comprehend its essence and properties, to study its manifestations and effects. For this purpose simple observation is insufficient, since error always lies on the surface, whilst truth must be sought in deeper regions.

*Familiar Letters on Chemistry*

Letter I (pp. 16–17)

Walton & Maberly. London, England. 1859

...a thousand unconnected observations have no more value, as a demonstrative proof, than a single one.

In John Gardner

*Familiar Letters on Chemistry*

Second Series

Letter I (pp. 26–27)

Taylor & Walton. London, England. 1844

The art of observing is like a piece of glass destined for a mirror, which requires to be polished with the utmost care, to produce the reflection of a clear and undistorted image.

*Familiar Letters on Chemistry*

Letter II (p. 28)

Walton & Maberly. London, England. 1859

There is no art so difficult as that of observation; it requires a cultivated, sober mind, and a well schooled

experience, which is only acquired by long practice. *The man who only seen with his eyes an object before him, has no claim to the title of an observer, which is reserved for him only who takes notice of the different parts of the object, and sees the connection between the parts and the whole.*

*Familiar Letters on Chemistry*

Letter II (p. 28)

Walton & Maberly. London, England. 1859

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...nothing destroys the powers of general observation quite so much as a life of experimental science.

*Seven Famous Novels by H.G. Wells*

*The Food of the Gods*

Chapter 2 (p. 540)

Alfred A. Knopf. New York, New York, USA. 1934

**Westaway, Frederic William**  
Science writer

It is the essence of good observation that the eye shall not only see a thing itself, but of what parts that thing is composed. And if an observer is to become a successful investigator in any department of Science, he must have an extreme acquaintance with what has already been done in that particular department. Only then will he be prepared to seize upon anyone of those minute indications which often connect phenomena apparently quite remote from each other. His eyes will thus be struck with any occurrence which, according to received theories, ought not to happen; for these are the facts which serve as clues to new discoveries.

*Scientific Method: Its Philosophy and Its Practice*

Chapter XVI, Section 3 (p. 196)

Blackie & Sons Ltd. London, England. 1919

**Whately, Richard** 1787–1863  
English theologian

Observation digs the materials; reasoning erects the building.

In Elizabeth Jane Whately

*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D.*

Apothegm 91 (p. 9)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Wheeler, John Archibald** 1911–  
American physicist and educator

Only by the analysis and interpretation of observations as they are made, and the examination of the larger implications of the results, is one in a satisfactory position to pose new experimental and theoretical questions of the greatest significance.

*Elementary Particle Physics*

*American Scientist*, Spring, April, 1947 (p. 189)

**Wheeler, John Archibald** 1911–  
American physicist and educator

**Thorne, Kip S.** 1940–  
American theoretical physicist

May the universe in some strange sense be “brought into being” by the participation of those who participate?... [T]he vital act is the act of participation. “Participant” is the incontrovertible new concept given by quantum mechanics. It strikes down the term “observer” of classical theory, the man who stands safely behind the thick glass wall and watches what goes on without taking part. It can’t be done, quantum mechanics says.

*Gravitation* (p. 1273)  
W.H. Freeman and Company. New York, New York, USA. 1973

**Whewell, William** 1794–1866  
English philosopher and historian

How impossible the formation of these sciences [mechanics, optics, physiology and chemistry], without a constant and careful reference to observation and experiment; – how rapid and prosperous their progress may be when they draw from such sources the materials on which the mind of the philosopher employs itself ...

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)  
Introduction (p. 7)  
John W. Parker & Son. London, England. 1857

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

We habitually observe by the method of difference. Sometimes we see an elephant, and sometimes we do not. The result is that an elephant, when present, is noticed.

*Process and Reality: An Essay in Cosmology*  
Part I, Chapter I, Section II (p. 6)  
The Macmillan Company. New York, New York, USA. 1929

Neither logic without observation, nor observation without logic, can move one step in the formation of science. The Organization of Thought  
*Science*, Volume 44, Number 1134, September 29, 1916 (p. 419)

**Wilson, Jr., E. Bright** 1908–92  
American physical chemist

Observations are useless until they have been interpreted.  
*An Introduction to Scientific Research*  
Chapter 8 (p. 169)  
McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**Willmott, Robert Eldridge Aris** 1809–63  
English writer and poet

...the rarest flowers bloom in vain, if the eye be not fixed upon the bed.

*Pleasures, Objects, and Advantages, of Literature* (4th edition)  
Chapter X (p. 37)  
G. Routledge & Co. London, England. 1855

**Wöhler, Friedrich** 1800–82  
German chemist

My imagination is pretty active, but in thinking I am very slow. No one is less made to be a critic than I. The organ for philosophical thought I lack completely, as you well know, as completely as that for mathematics. Only for observing, do I possess, or at least I believe I do, a passable arrangement in my brain. A kind of instinct that allows me to become aware of relations among data may well be connected with [this arrangement].

In O. Theodor Benfey  
*From Vital Force to Structural Formulas*  
Chapter 3 (p. 18)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1964

**Wright, R. D.**  
No biographical data available

Whatever happened to the terms probability and observation? Are statements of high probability now to be deified by calling them truths? Does a set of consistent observations become fact? When I teach biology to the college student, the nature of information mandates that the class and I preserve a healthy skepticism regarding both the broad generalizations and the specific statements of the discipline. Fact and truth are terms we almost never use. There is nothing shameful in describing what we know as having a certain probability, following from observations that have a degree of imprecision. That’s the nature of science, including the science of evolution.

Letters  
*BioScience*, Volume 31, Number 11, December, 1981 (p. 788)

**Zinsser, Hans** 1878–1940  
American bacteriologist

The scientist takes off from the manifold observations of predecessors, and shows his intelligence, if any, by his ability to discriminate between the important and the negligible, by selecting here and there the significant stepping-stones that will lead across the difficulties to new understanding. The one who places the last stone and steps across the terra firma of accomplished discovery gets all the credit. Only the initiated know and honor those whose patient integrity and devotion to exact observation have made the last step possible.

*As I Remember Him: The Biography of R.S.*  
Chapter XX (p. 332)  
Little, Brown & Company. Boston, Massachusetts, USA. 1940

## OBSERVATORY

**Bürgel, Bruno Hans** 1875–1948  
German astronomer

A singular charm rests on the home of the stellar workers. It is here that man, earth’s lord, communes with the



Infinite; it might almost be called the gate to eternity.

Translated by Stella Bloch

*Astronomy for All*

Chapter IV (p. 31)

Cassell & Co., Ltd. London, England. 1911

There is something very mysterious and attractive to the uninitiated about the silent building outside the city, whose high domed roofs rise up from the green foliage like the ancient temples of the East. Far away from the town, with its mists and noises, closed against every stranger, the astronomer's tranquil home calls forth a feeling of the unearthly within us.

Translated by Stella Bloch

*Astronomy for All*

Chapter IV (p. 31)

Cassell & Co., Ltd. London, England. 1911

**Cerf, Bennett** 1898–1971

American publisher and editor

Some weeks later the Einsteins were taken to the Mt. Wilson Observatory in California. Mrs. Einstein was particularly impressed by the giant telescope.

*Try and Stop Me: A Collection of Anecdotes and Stories, Mostly Humorous*

On the Telescope (p. 163)

Simon & Schuster. New York, New York, USA. 1944

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

What is so good in a college as an observatory? The sublime attaches to the door and to the first stair you ascend; – and this is the road to the stars...

*Journals of Ralph Waldo Emerson 1864–1876*

November 14, 1865 (p. 118)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Hale, George Ellery** 1868–1938

American astronomer

An observatory, like any other laboratory of research, may concentrate its attention upon either one of two widely different objects: the accumulation of great stores of data in existing departments of knowledge, or the opening up and exploration of new fields of investigation.

*Ten Years' Work of a Mountain Observatory*

Ten Years' Work of a Mountain Observatory (p. 4)

Carnegie Institution of Washington. Washington, D.C. 1915

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Go to yon tower, where busy science plies  
Her vast antennae, feeling thro' the skies;  
That little vernier, on whose slender lines  
The midnight taper trembles as it shines,  
A silent index, tracks the planets' march  
In all their wanderings thro' the ethereal arch,  
Tells through the mist where dazzled Mercury burns,

And marks the spot where Uranus returns.

*Urania: A Rhymed Lesson* (3rd edition)

Poem (pp. 9–10)

William D. Ticknor & Co. Boston, Massachusetts, USA. 1846

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

An astronomer is a sort of police constable of the heavens. The observatory is but a sentry box.

*Napoleon the Little*

Book Seventh (p. 193)

Vizetelly & Co. London, England. 1852

**Lowell, Percival** 1855–1916

American astronomer

A steady atmosphere is essential to the study of planetary detail; size of instrument being a very secondary matter.

A large instrument in poor air will not begin to show what a smaller one in good air will. When this is recognized, as it eventually will be, it will become the fashion to put up observatories where they can see rather than be seen.

*Mars*

Preface (p. v)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Mitchell, Maria** 1818–89

American astronomer and educator

There is no observatory in this land, nor in any land, probably, of which the question is not asked, "Are they doing anything? Why don't we hear from them? They should make discoveries, they should publish."

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter XI (p. 223)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Rosseland, Svein** 1894–1985

Norwegian astronomer

...an astronomical observatory of today looks more like a factory plant than an abode for philosophers. The poetry of constellations has given way to the lure of plate libraries, and the angel of cosmogenic speculation has been caught in a cobweb of facts insistently clamoring for explanations.

*Theoretical Astrophysics: Atomic Theory and the Analysis of Stellar Atmospheres and Envelopes*

Introduction (p. xi)

At The Clarendon Press. Oxford, England. 1936

**Russell, Henry Norris** 1877–1957

American astronomer

The good spectroscopist – to parody the old jest – might perhaps be permitted to go, when he died, instruments and all, and set up an observatory on the moon.

Where Astronomers Go When They Die

*Scientific American*, Volume 149, Number 3, September, 1933 (p. 112)



**OBSERVE**

**Aesop** ca. 620 BCE–560 BCE  
Greek fabulist and author

Of what avail to spy the heavens out, When you can't see what's here on earth about?

In William Ellery Leonard  
*Aesop and Hyssop*  
The Astronomer

**Bernard, Claude** 1813–78  
French physiologist

To experiment is to disturb certain natural phenomena in order to establish their nature or cause.

To observe is to examine things as they pass in natural sequence. Whatever means on may use, microscopes, telescopes, one only observes.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin  
*The Cahier Rouge of Claude Bernard* (p. 35)  
Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

**Kirby, William** 1759–1850  
English entomologist

**Spence, William** 1783–1860  
English entomologist

Things that are universally obvious and easy of examination, as they are the first that fall under our notice, so are they also most commonly those which we first feel an inclination to study; while, on the contrary, things that must be sought for in order to be seen, and which when sought for avoid the approach and inquiring eye of man, are often the last to which he directs his attention.

*An Introduction to Entomology; Or, Elements of the Natural History of Insects*

Introductory Letter (p. 2)  
Printed for Longman, Hurst, Rees, Orme & Brown. London, England. 1818

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

What we do see depends mainly on what we look for. When we turn our eyes to the sky, it is in most cases merely to see whether it is likely to rain. In the same field the farmer will notice the crop, geologists the fossils, botanists the flowers, artists the colouring, sportsmen the cover for game. Though we may all look at the same things, it does not at all follow that we should see them.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter I (p. 3)  
The Macmillan Company. New York, New York, USA. 1905

**Wilson, Andrew** 1852–1912  
No biographical data available

To observe rightly and truly, and as science teaches us to observe, is a habit which lies at the foundation of all order in mental things; and without this habit of looking

at things in their due sequence, thoughts and thinking can only appear as acts and processes which exist but to confuse and bewilder the thinker.

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

Science-Culture for the Masses (p. 31)  
Chatto & Windus. London, England. 1879

**OBSERVER**

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

He is lost, as an observer, who believes that he can, with impunity, affirm that for which he can adduce no evidence.

In Burt G. Wilder  
Louis Agassiz, Teacher  
*The Harvard Graduate's Magazine*, June, 1907

**Bergman, Torbern Olaf** 1735–84  
Swedish chemist and naturalist

One observer will relate an event with the most extravagant encomiums; another will detract from its real merit; a third, by some oblique insinuation, will cast suspicion on the motive; and a fourth will represent it as a crime of the blackest dye. These different descriptions represent the character of the respective observers.

Quoted in Joseph William Mellor  
*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
(Volume 1)  
Chapter I (p. 7)  
Longman, Green, & Co. London, England. 1922

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

The observer listens to nature; the experimenter questions and forces her to unveil herself.

In Claude Bernard  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I (p. 6)  
Henry Schuman, Inc. New York, New York, USA. 1927

**de Chambaud, J. J. Ménéuret**  
No biographical data available

The name of observer has been given to the physicist who is content to examine the phenomena just as nature presents them to him; he differs from the experimental physicist who combines...and who sees only the result of his own combinations. This latter one never sees nature as it is in fact; he pretends by his labor to render nature more accessible to the senses, to raise the mask which conceals it from our eyes, but often he disfigures it and renders it unintelligible. Nature is always unveiled and bare for him who has eyes – or it is covered only by a slight gauze which the eye and reflection easily pierce – and the pretended mask exists only in the imagination,

usually quite limited, of the manipulator of experiments.  
In D. Diderot and J.L. d'Alembert (eds.)  
Observateur  
*Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers*, Volume 23 (p. 287D)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Let the observer place himself so that he is, to the best of his knowledge, at rest. If he is a normal human being, he will seat himself in an arm-chair; if he is an astronomer, he will place himself on the sun or at the centre of the stellar universe.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*  
Chapter II (p. 38)  
At The University Press. Cambridge, England. 1921

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

The observer must neglect nothing: he never knows what the humblest fact may bring forth.

Translated by Alexander Teixeira de Mattos  
*The Life of the Weevil*  
Chapter v (p. 89)  
Hodder & Stoughton. London, England. nd

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

...separation of the observer from the phenomenon to be observed is no longer possible.

*Across the Frontiers* (p. 227)  
Harper & Row Publishers. New York, New York, USA. 1974

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Not less important are the observers of the birds than the birds themselves.

*The Writings of Henry David Thoreau* (Volume 10)  
Chapter VIII (p. 315)  
Houghton Mifflin & Co. New York, New York, USA. 1906

**von Liebig, Justus** 1803–73  
German organic chemist

The man who only sees with his eyes an object before him, has no claim to the title of an observer, which is reserved for him only who takes notice of the different parts of the object, and sees the connection between the parts and the whole.

In John Blyth (ed.)  
*Familiar Letters on Chemistry*  
Letter II (p. 28)  
Walton & Maberly. London, England. 1859

## OBSTACLE

**Enriques, Federigo** 1871–1946  
Italian mathematician

It sometimes happens in Alpine excursions that one who does not know just how far off is the goal, thinks he is about to reach it, while he is mounting the rocky summit of some height facing it. But once scaled, a new valley opens unexpectedly to view. One must descend with care. After a fatiguing walk of several hours he finds himself perhaps no higher than when he started. But the time and labor have not been wasted, since even if the summit seems now more distant, in the enlarged horizon, in reality we have come nearer to our goal by surmounting an obstacle which had concealed it. We must not then lose courage, nor give up in a moment of weakness.

*Problems of Science*  
Chapter I (p. 10)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1914

## OBSTETRICS

**Hosmer, William**  
No biographical data available

The present practice of medicine, especially obstetrics, must be set down not only as having an immoral tendency, but as, in itself, a gross, abusive, and shameless immorality.

*Young Lady's Book: Or, Principles of Female Education*  
Chapter V (p. 191)  
Miller, Orton & Mulligan. Buffalo, New York, USA. 1854

## OBSTRUENESS

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

...this young man expresses himself in terms too deep for *me*.

*Patience: Or, Bunthorne's Bride* (p. 25)  
Doubleday, Page & Co. New York, New York, USA. 1902

**Goldsmith, Oliver** 1728–74  
Anglo-Irish writer, poet, and physician

Who, too deep for his hearers, still went on refining, And thought of convincing while they thought of dining.

In Robert Chambers  
*Cyclopædia of English Literature* (Volume 2)  
Retaliation (p. 64)  
William & Robert Chambers. Edinburgh, Scotland. 1844

## OBVIOUS

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Before proceeding I must apologize for slaying the already slain and elaborating the obvious.

*The Handmaiden of the Sciences*  
Chapter 7 (p. 107)  
Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Lepper, George Henry**

No biographical data available

The reason the obvious in Nature goes unrecognized so long is because artful man misdoubts her plain message and in a spirit of subtlety reads in a farrago of irrelevancies between the lines.

*From Nebula to Nebula*

Introduction (p. 14)

Privately printed. Pittsburgh, Pennsylvania, USA. 1917

**Stewart, Ian** 1945–

English mathematician

It's amazing how long it takes to see the obvious.

*Nature's Numbers*

Chapter 3 (p. 32)

BasicBooks. New York, New York, USA. 1995

**OCCAM'S RAZOR****Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

It is unfortunate that we try to solve the simplest questions cleverly, and therefore make them unusually complicated. We should seek a simple solution.

*Note-Book of Anton Chekhov* (p. 20)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Crick, Francis Harry Compton** 1916–2004

English biochemist

While Occam's razor is a useful tool in the physical sciences, it can be a very dangerous implement in biology. It is thus very rash to use simplicity and elegance as a guide in biological research.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 13 (p. 138)

Basic Books, Inc. New York, New York, USA. 1988

**Dixon, Malcom**

No biographical data available

God doesn't always shave with Occam's razor.

In David Hall

Letters, God's Razor

*New Scientist*, Volume 142, Number 1922, April 23, 1994 (p. 51)**Gettings, Fred**

No biographical data available

*Simplex sigillum veri*

Cut causes, be merry

Slash 'em and dock 'em

Said William of Ockham

Wiping his razor

On the sleeve of his blazer.

In Renee Haynes

Signs of Secrecy

*Times Literary Supplement*, June 18, 1981 (p. 688)**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

When two hypotheses are possible, we provisionally choose that which our minds adjudge to be the simpler, on the supposition that this is more likely to lead in the direction of the truth. It includes as a special case the principle of Occam's razor – *Entia non multiplicanda praeter necessitatem*.

*Physics and Philosophy*

Chapter VII (p. 183)

Dover Publications, Inc. New York, New York, USA. 1981

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.

*The Mathematical Principles of Natural Philosophy*

Book Three, Rule 1 (p. 270)

Printed for H.D. Symonds. London, England. 1803

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

We cannot in any sense be both the observers and the actors in any specific instance, or we shall fail properly to be either one or the other; yet we know that our life is built of these two modes, is part free and part inevitable, is part creation and part discipline, is part acceptance and part effort.

*Science and the Common Understanding*

Chapter 6 (p. 88)

Simon &amp; Schuster. New York, New York, USA. 1954

**Stenger, Victor J.** 1935–

American physicist

The use of Occam's razor, along with the related critical, skeptical view toward any speculations about the unknown, is perhaps the most misunderstood aspect of the scientific method. People confuse doubt with denial. Science doesn't deny anything, but it doubts everything not required by the data. Note, however, that doubt does not necessarily mean rejection, just an attitude of disbelief that can be changed when the facts require it.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 1 (p. 26)

Prometheus Books. Buffalo, New York, USA. 1990

**OCEAN****Aeschylus** 525 BCE–426 BCE

Greek playwright

Ye waves

That o'er th' interminable ocean wreath

Your crisped smiles.

*Prometheus Bound*, l. 95

Heritage Press. New York, New York, USA. 1966

## Author Undetermined

The mighty voice of ocean is like the wallowing of a river and the windroar of a forest, sometimes low and sometimes loud, but ever fitful, restless, incessant, and eternal.

*The Visitor; Or, Monthly Instructor*

Boatswain Billings: Or Scenes on the Ocean (p. 167)  
The Religious Tract Society. London, England. 1847

## Ballantyne, Robert Michael 1825–94

Scottish juvenile writer

The Voice of Ocean is constantly discoursing of many interesting and stirring truths and events to those who are disposed to listen.

*The Ocean and Its Wonders*

Preface (p. 1)

T. Nelson & Sons. London, England. 1876

There is a voice in the waters of the great sea. It calls to man continually. Sometimes it thunders in the tempest, when the waves leap high and strong, and the wild winds shriek and roar, as if to force our attention. Sometimes it whispers in the calm, and comes rippling on the shingly beach in a still, small voice, as if to solicit our regard.

*The Ocean and Its Wonders*

Chapter I (p. 13)

T. Nelson & Sons. London, England. 1876

## Beebe, William 1877–1962

American ornithologist

once it has been seen, [the deep ocean] will remain forever the most vivid memory in life, solely because of its cosmic chill and isolation, the eternal and absolute darkness and the indescribable beauty of its inhabitants.

*Half a Mile Down*

Chapter 9 (p. 175)

Durell, Sloan & Pearce. New York, New York, USA. 1951

The eternal one, the one most worthy and which will not pass from mind, the only other place comparable to these marvelous regions, must surely be naked space itself, out far beyond atmosphere, between the stars, where sunlight has no grip upon the dust and rubbish of planetary air, where the blackness of space, the shining planets, comets, suns, and stars must really be closely akin to the world of life as it appears to the eyes of an awed human being, in the open ocean, one half mile down.

*Half Mile Down*

Chapter 11 (p. 225)

Harcourt, Brace & Company. New York, New York, USA. 1934

## Beston, Henry 1888–1968

American writer

The seas are the heart's blood of the earth.

*The Outermost House*

Chapter III (p. 47)

Rinehart & Company. New York, New York, USA. 1928

## Bierce, Ambrose 1842–1914

American newspaperman, wit, and satirist

OCEAN, n. A body of water occupying about two-thirds of a world made for man – who has no gills.

*The Enlarged Devil's Dictionary* (p. 207)

Doubleday. Garden City, New York, USA. 1967

## Bishop Joseph Hall 1574–1656

English bishop and satirist

There is many a rich stone laid up in the bowels of the earth, many a fair pearl in the bosom of the sea, that never was seen nor never shall be.

*The Works of the Right Reverend Father in God, Joseph Hall* (Volume 1)  
Contemplations (p. 115)

Printed by C. Whittingham. London, England. 1808

## Bradbury, Ray 1920–

American writer

“The mysteries of the sea,” said McDunn thoughtfully. “You know, the ocean’s the biggest damned snowflake ever? It rolls and swells a thousand shapes and colors, not two alike. Strange.”

*Dinosaur Tales*

The Foghorn (p. 98)

Bantam Books. Toronto, Ontario, Canada. 1983

## Browning, Robert 1812–89

English poet

The sea heaves up, hangs loaded o’er the land,  
Breaks there, and buries its tumultuous strength.

*The Poems and Plays of Robert Browning*

Luria

Act I

The Modern Library. New York, New York, USA. 1934

## Bryant, William Cullen 1794–1878

American poet

That make the meadows green; and, poured round all,  
Old Ocean’s gray and melancholy waste – Are but the  
solemn decorations all

Of the great tomb of man.

*Poems*

Thanatopsis

D. Appleton. New York, New York, USA. 1874

## Bucke, Charles 1781–1846

English writer

Of all the objects in Nature, none strikes the soul – with so much wonder, awe, delight, and solemnity, as the solemnity, as the OCEAN.

*On the Beauties, Harmonies, and Sublimities of Nature*

Chapter I (p. 13)

Harper & Brothers Publishers. New York, New York, USA. 1841

## Byron, George Gordon, 6th Baron Byron 1788–1824

English Romantic poet and satirist

Roll on, thou deep and dark blue Ocean – roll!  
 Ten thousand fleets sweep over thee in vain;  
 Man marks the earth with ruin – his control  
 Stops with the shore.

*The Complete Poetical Works of Byron*

Childe Harold

canto IV, Stanza 179

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

Time writes no wrinkle on thine azure brow,  
 Such as Creation's dawn beheld, thou rollest now.

*The Complete Poetical Works of Byron*

Childe Harold

Canto IV, Stanza 182

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

### **Cable, Richard**

No biographical data available

The sight of the ocean is like the sound of music calling  
 forth the soul from the thoughts of today, from its cage-  
 life to freedom, and an unutterable yearning after what is  
 not – the perfect.

The Lightshipman

*The Living Age*, Volume LXI, Number 2272, January 18, 1888 (p. 108)

### **Carson, Rachel** 1907–64

American marine biologist and author

The continents themselves dissolve and pass to the sea, in  
 grain after grain of eroded land...

*The Sea Around Us*

Part III, Chapter 14 (p. 212)

Oxford University Press, Inc. New York, New York, USA. 1989

Unmarked and trackless though it may seem to us, the  
 surface of the ocean is divided into definite zones, and  
 the pattern of the surface water controls the distribution  
 of its life.

*The Sea Around Us*

Part I, Chapter 2 (p. 20)

Oxford University Press, Inc. New York, New York, USA. 1989

The face of the sea is always changing. Crossed by col-  
 ors, lights, and moving shadows, sparkling in the sun,  
 mysterious in the twilight, its aspects and its moods vary  
 hour by hour.

*The Sea Around Us*

Part I, Chapter 3 (p. 29)

Oxford University Press, Inc. New York, New York, USA. 1989

There is no drop of water in the ocean, not even in  
 the deepest parts of the abyss, that does not know and  
 respond to the mysterious forces that create the tide. No  
 other force that affects the sea is so strong.

*The Sea Around Us*

Part II, Chapter 3 (p. 149)

Oxford University Press, Inc. New York, New York, USA. 1989

The ocean is the earth's greatest storehouse of minerals.

*The Sea Around Us*

Part III, Chapter 2 (p. 185)

Oxford University Press, Inc. New York, New York, USA. 1989

The edge of the sea is a strange and beautiful place. All  
 through the long history of Earth it has been an area of  
 unrest where waves have broken heavily against the land,  
 where the tides have pressed forward over the continents,  
 receded, and then returned. For no two successive days  
 is the shore line precisely the same. Not only do the tides  
 advance and retreat in their eternal rhythms, but the level  
 of the sea itself is never at rest. It rises or falls as the gla-  
 ciers melt or grow, as the floor of the deep ocean basins  
 shift under its increasing load of sediments, or as the  
 earth's crust along the continental margins warps up or  
 down in adjustment to strain and tension. Today a little  
 more land may belong to the sea, tomorrow a little less.  
 Always the edge of the sea remains an elusive and inde-  
 finable boundary.

*The Edge of the Sea*

Chapter I (p. 1)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

Every living thing of the ocean, plant and animal alike,  
 returns to the water at the end of its own life span the  
 materials that had been temporarily assembled to form  
 its body. So there descends into the depths a gentle never-  
 ending rain of the disintegrating particles of what once  
 were living creatures of the sunlit surface waters, or of  
 those twilight regions beneath.

Undersea

*Atlantic Monthly*, September, 1937

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

How inappropriate to call this planet Earth when it is  
 clearly Ocean.

In James E. Lovelock

Hands Up for the Gaia Hypothesis

*Nature*, Volume 344, Number 6262, 8 March, 1990 (p. 102)

### **Conrad, Joseph** 1857–1924

Polish-born English novelist

...some of us, regarding the ocean with understanding  
 and affection, have seen it looking old, as if the immemo-  
 rial ages had been stirred up from the undisturbed bottom  
 of ooze. For it is a gale of wind that makes the sea look  
 old.

*The Mirror of the Sea*

Chapter XXII (pp. 70–71)

Doubleday, Page & Co. Garden City, New York, USA. 1924

The ocean has the conscienceless temper of a savage  
 autocrat spoiled by much adulation. He cannot brook the  
 slightest appearance of defiance, and has remained the  
 irreconcilable enemy of ships and men ever since ships  
 and men had the unheard-of audacity to go afloat together  
 in the face of his frown.

*The Mirror of the Sea*

Chapter XXXVI (p. 137)

Doubleday, Page & Co. Garden City, New York, USA. 1924



**Cooper, James Fenimore** 1789–1851  
American writer

...on the whole, it [the ocean] is capricious, rather than malignant.

*Cooper's Novels: The Two Admirals*  
Chapter XVII (p. 304)  
W.A. Townsend & Co. New York, New York, USA. 1861

**Cornwall, Barry (Bryan Waller Procter)** 1787–1874  
English author

The sea! the sea! the open sea!  
The blue, the fresh, the ever free!  
Without a mark, without a bound,  
It runneth the earth's wide regions round;  
It plays with the clouds; it mocks the skies;  
Or like a cradled creature lies.

In Richard Green Parker and J. Madison Watson (eds.)  
*The National Fourth Reader*  
The Sailor's Song (p. 156)  
Barns & Burr. New York, New York, USA. 1864

**Damon, William E.**  
No biographical data available

The ocean! the vast, glorious, boundless blue! How the vision of sunny hours, inspiring breezes, the invigorating scent of the salt air, and the sparkling of bright sea-foam, rises at thought of the great deep that restless, deceptive, yet ever-enchanting siren, which lures us in every tone of the gamut to trust ourselves on its sparkling bosom!

*Ocean Wonders:*  
*Companion for the Seaside*  
Chapter I (p. 1)  
D. Appleton & Co. New York, New York, USA. 1879

**David Reed (Fictional character)**

We've only just begun to learn about the water and its secrets, just as we've only touched on outer space. We don't entirely rule out the possibility that there might be some form of life on another planet. Then why not some entirely different form of life in a world we already know is inhabited by millions of living creatures?

*Creature from the Black Lagoon*  
Film (1954)

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

The seas perhaps hold the highest hopes for continued life. Yet, what does man do to the seas? Not only does he grab with greed the creatures of the sea, he turns nature's cradle for life into a receptacle for garbage and filth. This is man whose life blood contains sodium, potassium, and calcium in almost the same proportions as they still exist in the environment of mother sea which encouraged his birth.

In Maurice F. Strong (ed.)  
*Who Speaks for Earth?*  
Unity Through Diversity (p. 44)  
W.W. Norton & Company, Inc. New York, New York, USA. 1973

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Behold the Sea,  
The opaline, the plentiful and strong,  
Yet beautiful as is the rose in June,  
Fresh as the trickling rainbow of July;  
Sea full of food, the nourisher of kinds,  
Purger of earth, and medicine of men;  
Creating a sweet climate by my breath,  
Washing out harms and griefs from memory,  
And, in my mathematic ebb and flow,  
Giving a hint of that which changes not.  
*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
Seashore (p. 242)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Forbes, Edward** 1815–54  
English naturalist

Moreover it is becoming the Britons, whether scientific or unscientific, who boast at all fitting occasions of their aptitude to rule the waves, should know something of the population of their saline empire, especially of those parts of it immediately in contact with their terrestrial domain, and the coasts of the Continent to which our UK appertains.

*The Natural History of the European Seas*  
Chapter I (p. 3)  
John van Voorst. London, England. 1859

...beneath the waves there are many dominions yet to be visited, and kingdoms to be discovered; and he who venturously brings up from the abyss enough of their inhabitants to display the physiognomy of the country, will taste that cup of delight, the sweetness of whose draught those only who have made a discovery know.

*The Natural History of the European Seas*  
Chapter I (p. 11)  
John van Voorst. London, England. 1859

**Gould, Hannah Flagg** 1789–1865  
American poet

Alone I walked on the ocean strand,  
A pearly shell was in my hand;  
I stooped, and wrote upon the sand  
My name, the year, the day.  
As onward from the sport I passed,  
One lingering look behind I cast,  
A wave came rolling high and fast,  
And washed my lines away.  
*Poems*  
A Name in the Sand  
Hilliard, Gray & Company. Boston, Massachusetts, USA. 1839

**Gray, Thomas** 1716–71  
English poet

Full many a gem of purest ray serene,  
The dark unfathomed caves of ocean bear.



*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*  
Elegy in a Country Churchyard  
Stanza 14  
J. Blackwood. London, England. 1800

### Half Hours

The Great Deep! What a world of sublimity, of countless wealth, of awful power! Let the great deep share man's thought, and it shall inspire his admiration, his wonder, his awe.

*Half Hours in the Deep*  
Chapter I (p. 3)  
Dalby, Isbister & Co. London, England. 1875

Whether seen in noon, lying beneath the summer's cloudless sun, like burnished steel; or seen at night, beneath the pale light of the full moon, like some vast desert crossed by a shining silvery path, along which angels have left footprints of light; seen smooth, or rippled, or, risen into stern, wild tempest, in restless fury it rolls, and leaps, dashes against cliffs and clouds in all its moods the great deep awakens great feelings, feelings which make their subject a humbler, yet wiser and nobler man..

*Half Hours in the Deep*  
Chapter I (p. 3)  
Dalby, Isbister & Co. London, England. 1875

**Henderson, Lawrence** 1878–1942  
American biochemist

The regulatory devices of our modern laboratories have not yet succeeded in rivaling the oceans. Singly, certain conditions, for example, temperature, alkalinity, and concentration, may be more accurately regulated by man, though on a small scale only; but the regulation of all such properties together is not yet possible. The only known improvement upon the ocean is the body of a higher warm-blooded animal. Here, however, the processes of organic evolution have begun with the ocean, and in several respects merely perfected existing arrangements.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*  
Chapter V, Section III (p. 186)  
The Macmillan Company. New York, New York, USA. 1913

No philosopher's or poet's fancy, no myth of a primitive people has ever exaggerated the importance, the usefulness, and above all the marvelous beneficence of the ocean for the community of living things.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*  
Chapter V, Section III (p. 190)  
The Macmillan Company. New York, New York, USA. 1913

**Hess, Harry**  
No biographical data available

The birth of the oceans is a matter of conjecture, the subsequent history is obscure, and the present structure is

just beginning to be understood. Fascinating speculation on these subjects has been plentiful, but not much of it predating the last decade holds water.

In A.E.J. Engel, Harold L. James, and B.F. Leonard (eds.)  
*Petrologic Studies – A Volume in Honor of A.F. Buddington*  
History of the Ocean Basins (p. 599)  
The Geological Society of America. 1962

**Heyerdahl, Thor** 1914–2002  
Norwegian ethnographer and adventurer

...if man is to survive, the ocean is not dispensable.

In Alon Tal  
*Speaking of Earth*  
If Man is to Survive (p. 33)  
Rutgers University Press. New Brunswick, Maine, USA. 2006

Man harvest the sea as he harvests the land; let us therefore not fool ourselves by relying on the depth of the ocean, anymore than we rely on the depth of the land.

In Alon Tal  
*Speaking of Earth*  
If Man is to Survive (p. 35)  
Rutgers University Press. New Brunswick, Maine, USA. 2006

...bear in mind that the ocean currents circulate with no regard for political borderlines, and that nations can divide the land, but the revolving ocean, indispensable and yet vulnerable, will forever remain a common human heritage.

In Maurice F. Strong (ed.)  
*Who Speaks for Earth?*  
How Vulnerable Is the Ocean? (p. 63)  
W.W. Norton & Company, Inc. New York, New York, USA. 1973

**Horsfield, Brenda**  
No biographical data available

**Stone, Peter Bennet**  
No biographical data available

...there is on the other hand some encouragement in the reflection that Oceanography has usually only ruined the reputations of people who dared to speculate too little and thought on too small a scale. She has smiled most benignly on those who backed the most daring and outrageous possibility...

*The Great Ocean Business*  
Chapter 7 (p. 150)  
Coward, McCann & Geoghegan. New York, New York, USA. 1972

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

Nothing is more disturbing to the mind than the contemplation of the diffusion of forces at work in the unfathomable and illimitable space of the ocean.

*The Toilers of the Sea* (Volume 2) (p. 49)  
George Routledge & Sons. London, England. 1896

There, at a depth to which divers would find it difficult to descend, are caverns and dusky mazes, where sea monsters multiply and destroy each other. Huge crabs devour

fish and are devoured in their turn. Hideous living things, not created to be seen by human eyes, wander about in this obscurity. Vague forms of gaping mouths, antennae, tentacles, fins, open jaws, scales, and claws float about there, quivering, growing larger, or decomposing and perishing in the ill-omened gloom, while horrible swarms of loathsome creatures prowl about seeking their prey. It is a hive of hydras.

*The Toilers of the Sea* (Volume 1)

Book VI, Chapter I (p. 190)

George Routledge & Sons. London, England. 1896

**Ingelow, Jean** 1820–97

English poet and novelist

Quoth the Ocean, “Dawn! O fairest, clearest,  
Touch me with thy golden fingers bland;  
For I have no smile till thou appearest  
For the lovely land.”

*The Poetical Works of Jean Ingelow*

Winstanley

The Apology

John B. Alden, Publisher. New York, New York, USA. 1883

**Kennedy, John F.** 1917–63

35th president of the USA

Knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge upon it.

*General Government Matters: Department of Commerce, and Related Agencies Appropriations for 1862*

Letter to the President of the Senate on Increasing the National Effort, in *Oceanography*, March 29, 1961 (p. 549)

US Government Printing Office. Washington, D.C. 1961

**Landor, Walter Savage** 1775–1864

English poet and essayist

Past are three summers since she first beheld  
The ocean; all around the child await  
Some exclamation of amazement here:  
She coldly said, her long-lasht eyes abased,  
Is this the mighty ocean? is this all?

*Gebir*

Book V, l. 133–137

Woodstock Books. Oxford, England. 1993

But I have sinuous shells of pearly hue;

....

Shake one, and it awakens; then apply  
Its polished lips to your attentive ear,  
And it remembers its august abodes,  
And murmurs as the ocean murmurs there.

*Gebir*

Book I, l. 169, 173–176

Woodstock Books. Oxford, England. 1993

**Larcom, Lucy** 1824–93

American writer

The land is dearer for the sea,  
The ocean for the shore.

*The Poetical Works of Lucy Larcom*

On the Beach

Stanza 11

Houghton Mifflin Company. Boston, Massachusetts, USA. 1884

**Lee-Hamilton, Eugene J.** 1845–1907

English poet

The hollow sea-shell, which for years hath stood  
On dusty shelves, when held against the ear  
Proclaims its stormy parent, and we hear  
The faint, far murmur of the breaking flood.  
We hear the sea. The Sea? It is the blood  
In our own veins, impetuous and near.

Sea-Shell Murmurs

*The Living Age*, Volume CLVI, January-February-March, 1883 (p. 322)

**Longfellow, Henry Wadsworth** 1807–82

American poet

Would'st thou – so the helmsman answered,  
Learn the secret of the sea?

Only those who brave its dangers

Comprehend its mystery!

*The Seaside and the Fireside*

The Secret of the Sea

Stanza 8

Ticknor, Reed & Fields. Boston, Massachusetts, USA. 1850

**Maury, Matthew Fontaine** 1806–73

American astronomer, astrophysicist, historian, and oceanographer

Our planet is invested with two great oceans; one visible,  
the other invisible; one underfoot, the other overhead;  
one entirely envelops it, the other covers about two thirds  
of its surface.

*The Physical Geography of the Sea*

Chapter 1 (p. 1)

Harper & Brothers Publishers. New York, New York, USA. 1871

**Melville, Herman** 1819–91

American novelist

...that same image [of Narcissus] we ourselves see in  
all rivers and oceans. It is the image of the ungraspable  
phantom of life: and this is the key to it all.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 1 (pp. 2–3)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Not only is the sea such a foe to man who is an alien to it,  
but it is also a fiend to its own offspring; worse than the  
Persian host who murdered his own guests; sparing not  
the creatures which itself hath spawned. Like a savage  
tigress that tossing in the jungle overlays her own cubs,  
so the sea dashes even the mightiest whales against the  
rocks, and leaves them there side by side with the split  
wrecks of ships. No mercy, no power but its own controls  
it. Panting and snorting like a mad battle steed that has  
lost its rider, the masterless ocean overruns the globe.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
 Chapter 58 (p. 204)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Milton, John** 1608–74  
 English poet

...a dark  
 Illimitable ocean without bound,  
 Without dimension, where length, breadth, and height

And time and place are lost...  
 In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
 Book II, l. 891–894  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mishima, Yukio** 1925–70  
 Japanese writer

Down beneath the spray, down beneath the whitecaps,  
 that beat themselves to pieces against the prow, there  
 were jet-black invisible waves, twisting and coiling their  
 bodies. They kept repeating their patternless movements,  
 concealing their incoherent and perilous whims.

*The Sound of Waves*  
 Chapter 14 (p. 125)  
 Berkeley Publishing Group. New York, New York, USA. 1961

**Montgomery, Robert**  
 No biographical data available

And Thou, vast Ocean! on whole awful face  
 Time's iron feet can print no ruin trace.

*Notes and Queries*  
 The Omnipresence of the Deity  
 Part I, Stanza 20  
 Oxford University Press. London, England. 1849

**Nietzsche, Friedrich Wilhelm** 1844–1900  
 German philosopher

Now, little ship, look out! Beside you is the ocean: to be  
 sure, it does not always roar, and at times it lies spread  
 out like silk and gold and reveries of graciousness. But  
 hours will come when you realize that it is infinite and  
 that there is nothing more awesome than infinity.

Translated by Josefine Nauckhoff  
 In Bernard Williams  
*Nietzsche: With a Prelude in German Rhymes and an Appendix of Songs*  
 Book Three, 124 (p. 119)  
 Cambridge University Press. Cambridge, England. 2001

**Payne, Roger** 1935–  
 American biologist and environmentalist

Many people view the ocean as a flat featureless plain.  
 But this is an erroneous perception. In truth it is a place  
 of great complexity and diversity, filled with excitement  
 and hidden drama.

*Among Whales*  
 Chapter 1 (p. 20)  
 Charles Scribner's Sons. New York, New York, USA. 1995

**Prager, Ellen J.**  
 American marine scientist

Simply, the ocean is big, wet, cold, dark, and inhospitable  
 to air-breathing terrestrial creatures like ourselves.

*The Oceans*  
 Foreword (p. xiii)  
 McGraw-Hill Book Co., Inc. New York, New York, USA. 2000

**Reclus, Elisee** 1830–1905  
 French geographer and anarchist

If the great geological labours of the oceans, such as the  
 erosion of cliffs, the demolition of promontories, and the  
 construction of new shores, astonish the mind of man by  
 their grandeur, on the other hand, the thousand details of  
 the stands and beaches charm by their infinite grace and  
 marvelous variety.

*The Ocean, Atmosphere, and Life*  
 Part I, Book IV, Chapter XXI (p. 175)  
 Harper & Brothers Publishers. New York, New York, USA. 1874

**Rossetti, Christina Georgina** 1830–94  
 English poet

Why does the sea moan evermore?  
 Shut out from heaven it makes its moan,  
 It frets against the boundary shore;  
 All earth's full rivers cannot fill  
 The sea, that drinking thirsteth still.

In William Michael Rossetti  
*The Poetical Works of Christina Georgina Rossetti*  
 By the Sea  
 Stanza 1  
 Macmillan & Company Ltd. London, England. 1911

**Scheffer, Victor B.**  
 Zoologist

The ocean and its contents do not yield to easy measure-  
 ment; the final data lie beyond our present grasp; an edu-  
 cated guess is now the best that men of science try to  
 make.

*The Year of the Whale*  
 January (p. 105)  
 Charles Scribner's Sons. New York, New York, USA. 1969

**Shelley, Percy Bysshe** 1792–1822  
 English poet

There the sea I found  
 Calm as a cradled child in dreamless slumber bound.

*The Poems of Percy Bysshe Shelley*  
 The Revolt of Islam, Canto I, Stanza 15  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Step, Edward** 1855–1931  
 No biographical data available

The sea. is the very fountain and reservoir of the life of  
 this globe. As the heart is to man and his fellow verte-  
 brates, so is the ocean to the world. It is the centre of the

circulatory system; and that system means the life, the health, the sustenance of the body through which it sends its fluids. With the destruction of the heart the human life must cease; and with the annihilation of the sea, could such a thing be possible, all life on the globe must come to an end.

*By the Deep Sea: A Popular Introduction to the Wild Life of the British Shores*  
Chapter I (p. 11)  
Jarrold & Sons. London, England. 1896

**Stoddard, Richard Henry** 1825–1903  
American critic and poet

Thou wert before the Continents, before  
The hollow heavens, which like another sea  
Encircles them and thee, but whence thou wert,  
And when thou wast created, is not known,  
Antiquity was young when thou wast old.

In Anna Ward (ed.)  
*Surf and Wave: The Sea as Sung by the Poets*  
Hymn to the Sea, l. 104  
Thomas Y. Crowell & Company. New York, New York, USA. 1883

**Taylor, Bayard** 1825–78  
American journalist and author

We follow and race  
In shifting chase,  
Over the boundless ocean-space!  
Who hath beheld when the race begun?  
Who shall behold it run?

In Anna Ward (ed.)  
*Surf and Wave: The Sea as Sung by the Poets*  
The Waves  
Thomas Y. Crowell & Company. New York, New York, USA. 1883

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Break, break, break,  
On thy cold gray stones, O sea!  
And I would that my tongue could utter  
The thoughts that arise in me.

*Alfred Tennyson's Poetical Works*  
"Break, Break, Break"  
Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The ocean is a wilderness reaching round the globe,  
wilder than a Bengal jungle, and fuller of monsters,  
washing the very wharves of our cities and the gardens  
of our seaside residences.

*Cape Cod*  
Chapter IX (p. 148)  
Princeton University Press. Princeton., New Jersey, USA. 2004

We do not associate the idea of antiquity with the ocean,  
nor wonder how it looked a thousand years ago, as we  
do of the land, for it was equally wild and unfathomable  
always.

*Cape Cod*  
Chapter IX (p. 219)  
Thomas Y. Crowell & Co. New York, New York, USA. 1908

**Verne, Jules** 1828–1905  
French novelist

The great depths of the ocean are entirely unknown to us. Soundings cannot reach them. What passes in those remote depths what beings live, or can live, twelve or fifteen miles beneath the surface of the waters what is the organization of these animals we can scarcely conjecture.

*20,000 Leagues Under the Sea*  
Part I, Chapter II (p. 10)  
G. Munro. New York, New York, USA. 1883

You are going to visit [talking of under the ocean] the  
fairyland of marvels.

Translated by Philip Schuyler Allen  
*20,000 Leagues Under the Sea*  
Chapter X (p. 80)  
Rand McNally & Co. Chicago, Illinois, USA. 1922

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

The sea is flowing ever,  
The land retains it never.  
The Works of Johann Wolfgang von Goethe

*Hikmet Nameh*  
Book of Proverbs (p. 395)  
J.H. Moore. Philadelphia, Pennsylvania, USA. 1901

**Webb, Charles Henry** 1834–1905  
American writer

I send thee a shell from the ocean-beach;  
But listen thou well, for my shell hath speech.  
Hold to thine ear  
And plain thou'lt hear  
Tales of ships.

*Vagrom Verse*  
With a Nantucket Shell  
Ticknor & Company. Boston, Massachusetts, USA. 1889

**Weisz, Paul B.** 1919–  
German-born American chemical engineer and biomedical researcher

The Pacific. You don't comprehend it by looking at a  
globe, but when you're traveling at four miles a second  
and it still takes you twenty-five minutes to cross it, you  
know it's big.

In Kevin W. Kelley  
*The Home Planet*  
With Plate 64  
Addison-Wesley. Reading, Massachusetts, USA. 1988

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

To me the sea is a continual miracle,  
The fishes that swim – the rocks – the motion of the

waves – the ships with men in them,  
What stranger miracles are there?

*Complete Poetry and Collected Prose*

Miracles

The Library of America. New York, New York, USA. 1982

**Wordsworth, William** 1770–1850  
English poet

I have seen

A curious child, who dwelt upon a tract  
Of inland ground, applying to his ear  
The convolutions of a smooth-lipped shell;  
To which, in silence hushed, his very soul  
Listened intensely; and his countenance soon  
Brightened with joy; for from within were heard  
Murmurings, whereby the monitor expressed  
Mysterious union with its native sea.

*Poems By William Wordsworth*

Excursions, Book IV

Ginn and Company. Boston, Massachusetts, USA. 1897

## OCEAN CURRENT

**Heyerdahl, Thor** 1914–2002  
Norwegian ethnographer and adventurer

...the ocean currents circulate with no regard for political borderlines, and that nations can divide the land, but the revolving ocean, indispensable and yet vulnerable, will forever remain a common human heritage.

In Alon Tal

*Speaking of Earth*

If Man is to Survive (p. 40)

Rutgers University Press. New Brunswick, Maine, USA. 2006

**Verne, Jules** 1828–1905  
French novelist

The sea has its large rivers like continents. They are special currents, known by their temperature and colour. The most remarkable is known under the name of the Gulf Stream. Science has found out the direction of five principal currents one in the North Atlantic, a second in the South Atlantic, a third in the North Pacific, a fourth in the South Pacific, and a fifth in the South Indian Ocean.

*Twenty Thousand Leagues Under The Sea*

Part I, Chapter XIV (p. 76)

Ward, Lock & Co., Ltd. London, England. n.d.

## OCEAN OF INEXPLICABILITY

**Huxley, Thomas Henry** 1825–95  
English biologist

The known is finite, the unknown infinite; intellectually we stand on an islet in the midst of an illimitable ocean

of inexplicability.

In Francis Darwin

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter XIV (p. 557)

D. Appleton & Co. New York, New York, USA. 1904

## OCEAN, PHOSPHORENCE OF

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

The phosphorescence of the ocean is one of those splendid phenomena of nature which excite our admiration, even when we behold its recurrence every night for months together.

Translated by E. C. Otte and Henry G. Bohn

*Views of Nature: or, Contemplations on the Sublime Phenomena of Creation*

Illustrations & Additions (p. 245)

Henry G. Bohn. London, England. 1850

## OCEANOGRAPHER

### Narrator

Since time began the ocean has withheld its secrets. Man has ventured merely to its threshold. Oceanographers have, with precise instruments, presented us with a framework of facts. Around these facts our imagination reconstructs the eerie, forbidden atmosphere of the deep.

*The Incredible Petrified Forest*

Film (1957)

## OCEANOGRAPHY

**Revelle, Richard**  
No biographical data available

Just as the United Nations is the meeting place for all the nations, the science of the sea is a meeting place for all the sciences.

In Mary Sears

*Oceanography; Invited Lectures Presented at the International Oceanographic Congress Held in New York, 31 August-12 September, 1959*

Preface (p. iii)

American Association for the Advancement of Science. Washington, D.C. 1961

**Spilhaus, Athelstan** 1911–78  
South-African born American geophysicist and oceanographer

The science of oceanography is not a discipline but an adventure wherein any discipline or combination of disciplines may be focused on understanding and using the sea and all that is in it.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1964*

The Future of Oceanography (p. 361)

Government Printing Office. Washington, D.C. 1965

**ODDS****Hans Solo (Fictional character)**

C3PO: Sir, the possibility of successfully navigating an asteroid field is approximately 3,720 to 1.

Hans Solo: Never tell me the odds.

*Star Wars: Episode V – The Empire Strikes Back*  
The film (1980)

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Choose a point in space at random and the odds against it being occupied by a star are enormous.

*The Universe Around Us*

Chapter I (p. 102)

The Macmillan Company. New York, New York, USA. 1929

**Stoppard, Tom** 1937–

Czech-born English playwright

Life is a gamble at terrible odds – if it was a bet you wouldn't take it.

*Rosencrantz and Guildenstern Are Dead*

Act Three (p. 115)

Grove Press, Inc. New York, New York, USA. 1967

**ODOR****Bell, Alexander Graham** 1847–1920

American scientist

Find out what an odor is – whether it is an emanation and therefore subject to being weighed, or a vibration and therefore capable of being reflected. Odors are becoming more and more important in the worlds of scientific experiments and in medicine – and the need of more knowledge will bring forth more knowledge, as sure as the sun shines.

In N.E. McIndoo

*Annual Report of the Board of Regents of the Smithsonian Institution*  
(1920)

The Senses of Insects (p. 464)

Government Printing Office. Washington, D.C. 1921

**OFFENSE****Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The most heinous offense a scientist as a scientist can commit is to declare to be true that which is not so; if a scientist cannot interpret the phenomenon he is studying, it is a binding obligation upon him to make it possible for another to do so.

*The Limits of Science* (p. 6)

Harper & Row Publishers. New York, New York, USA. 1984

**OLD AGE****Foster, Sir Michael** 1836–1907

English physiologist

The eyes of the young look ever forward; they take little heed of the short though ever-lengthening fragment of life which lies behind them; they are wholly bent on that which is to come. The eyes of the aged turn wistfully again and again to the past; as the old glide down the inevitable slope their present becomes a living over again the life which has gone before, and the future takes on the shape of a brief lengthening of the past.

Address by the President of the British Association for the Advancement of Science

*Science*, N.S. Volume 10, Number 249, October 6, 1899 (p. 466)

**OMEGA POINT****Barrow, John D.** 1952–

English theoretical physicist

**Tipler, Frank J.** 1947–

American physicist

If life evolves in all of the many universes in a quantum cosmology, and if life continue to exist in all of these universes, then all of these universes, which include all possible histories among them, will approach the Omega Point. At the instant the Omega Point is reached, life will have gained control of all matter and forces not only in a single universe, but in all universes whose existence is logically possible; life will have spread into all spatial regions in all universes which could locally exist, and will have stored an infinite amount of information, including all bits of knowledge which it is logically possible to know.

*The Anthropic Cosmological Principle*

Chapter 10 (p. 676)

Clarendon Press. Oxford, England. 1986

**OPINION****Adams, George** 1750–95

English instrument maker

Mankind are always ready to adopt or reject what accords with pre-conceived opinions, to make reason subservient to prejudice, and to reject without examination, whatever is discordant with a received system; thus closing the door of science, and excluding themselves from the benefit of light.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 27)

Printed by R. Hindmarsh. London, England. 1794



**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Everything is mere opinion.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 35)

Edward Howell. Liverpool, England. 1864

**Bergman, Torbern Olaf** 1735–84

Swedish chemist and naturalist

An observer swayed by preconceived opinions, may be considered as one who views objects through coloured glasses, so that each object assumes a tinge similar to that of the glasses employed. He who seeks the truth must learn to observe with equal candour those facts which controvert his opinions, and those which favour them.

Quoted in Joseph William Mellor

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 7)

Longman, Green, &amp; Co. London, England. 1922

**Bernard, Claude** 1813–78

French physiologist

...no man's opinion, formulated in a theory or otherwise, may be deemed to represent the whole truth in the sciences. It is a guide, a light, but not an absolute authority. The revolution which the experimental method has effected in the sciences is this: it has put a scientific criterion in the place of personal authority. The experimental method is characterized by being dependent only on itself, because it includes within itself its criterion – experience.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section IV (p. 40)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bourne, William** 1535–82

English mathematician

...for that my opinion doth differ from some of the ancient writers in natural Philosophy, it is possible that it may be utterly dislyked of and condemned to be of no truth.

*The Treasure for Travelers*

The Fyfh Booke, To The Reader (p. 3)

Publisher undetermined

**Browne, Sir Thomas** 1605–82

English author and physician

Where we desire to be informed, 'tis food to contest with men above ourselves; but, to confirm and establish our opinions, 'tis best to argue with judgments below our own, that the frequent spoils and victories over their reasons may settle in ourselves an esteem and confirmed opinion of our own.

In Charles Sayle (ed.)

*The Works of Sir Thomas Browne* (Volume 1)*Religio Medici*

The First Part, Section 6 (p. 12)

John Grant. Edinburgh, Scotland. 1912

**Carlyle, Thomas** 1795–1881

English historian and essayist

A man's honest, earnest opinion is the most precious of all he possesses: let him communicate this if he is to communicate anything.

*Critical and Miscellaneous Essays*

Taylor's Historic Survey of German Poetry (p. 450)

Brown &amp; Taggard. Boston, Massachusetts, USA. 1860

**Charlie Chan (Fictional character)**

Opinion like tea leaf in hot water— both need time for brewing.

*Charlie Chan in Honolulu*

Film (1938)

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

...it is only mental slothfulness and sluggishness that induce so many to adopt, and take for granted the opinions of others.

In John Payne Collier

*Seven Lectures on Shakespeare and Milton*

The First Lecture (p. 9)

Chapman &amp; Hall, Ltd. London, England. 1856

**Crum, H. A.**

No biographical data available

Let us also remember that plants vary and opinions vary. One man's fish is another man's poison. One man's moss is another man's mess.

Traditional Make-Do Taxonomy

*The Bryologist*, Volume 88, 1985 (p. 22)**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

All our knowledge originates in opinions.

In Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I: Life (p. 53)

Duckworth &amp; Co. London, England. 1906

**Davy, Sir Humphry** 1778–1829

English chemist

The opinions which result from passion are as the impressions made by the waves upon the sand; what one tide produces, the next modifies or destroys.

In John Davy

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 116)

John Churchill. London, England. 1858

**Faraday, Michael** 1791–1867  
English physicist and chemist

I can now only state facts, opinions you shall have next time.

In Bence Jones  
*The Life and Letters of Faraday* (Volume I)  
Chapter I (p. 26)  
J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1870

**Gjertsen, Derek**  
English scientist and author

Scientists solve problems; philosophers, along with historians and other humanists, it is argued, only have opinions.

*Science and Philosophy*  
Chapter 2 (p. 28)  
Penguin Group. London, England. 1989

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

It is never worth a first class man's time to express a majority opinion. By definition there are plenty of others to do that.

*A Mathematician's Apology*  
Foreword (p. 46)  
Cambridge University Press. Cambridge, England. 1967

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Oh, I have strong opinions, but a thousand reasoned opinions are never equal to one case of diving in and finding out.

*Time Enough for Love*  
Prelude, Chapter I (p. 31)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Hering, Constantine** 1800–80  
Father of American homeopathy

Among men of deliberate and acute reflection, no difference of opinion can exist relative to the truth of a discovery which rests upon the basis of actual experiment.

In S. Hahnemann  
*Organon of Homoeopathic Medicine*  
Preface (p. xii)  
W. Radde. New York, New York, USA. 1843

**Holbach, Paul Henri Thiry** 1723–89  
French philosopher

The pertinacity with which he [man] clings to blind opinions imbibed in his infancy, which interweave themselves with his existence, the consequent prejudice that warps his mind, that prevents its expansion, that renders him the slave of fiction, appears to doom him to continual error.

Translated by H.D. Robinson  
*The System of Nature, Or, Laws of the Moral and Physical World*  
Author's Preface (p. viii)  
J.P. Mendum. Boston, Massachusetts, USA. 1868

**Joubert, Joseph** 1754–1824  
French moralist

Our opinions are clouds between us and the clear skies of truth.

Translated by H.P. Collins  
*Pensées and Letters of Joseph Joubert*  
Chapter X (p. 83)  
Books for Libraries Press, Freeport, New York, USA. 1972

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

In things which are only probable the difference of the data, which each man has in regard to them, is one of the principal causes of the diversity of opinions which prevail in regard to the same objects.

*A Philosophical Essay on Probabilities*  
Chapter II (p. 8)  
John Wiley & Sons. New York, New York, USA. 1902

It is to the influence of the opinion of those whom the multitude judges best informed and to whom it has been accustomed to give its confidence in regard to the most important matters of life that the propagation of those errors [pertaining to errors of truth] is due which in times of ignorance have covered the face of the earth.

*A Philosophical Essay on Probabilities*  
Chapter II (p. 9)  
John Wiley & Sons. New York, New York, USA. 1902

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

There is an objection to the work which I am going to present to the public, which is perhaps better founded, that I have given no account of the opinion of those who have gone before me; that I have stated only my own opinion, without examining that of others. By this I have been prevented from doing that justice to my associates, and more especially to foreign chemists, which I wished to render them. But I beseech the reader to consider, that, if I had filled an elementary work with a multitude of quotations; if I had allowed myself to enter into long dissertations on the history of the science, and the works of those who have studied it, I must have lost sight of the true object I had in view, and produced a work, the reading of which must have been extremely tiresome to beginners. It is not to the history of the science, or of the human mind, that we are to attend in an elementary treatise: Our only aim ought to be ease and perspicuity, and with the utmost care to keep everything out of view which might draw aside the attention of the student; it is a road which we should be continually rendering more smooth, and from which we should endeavor to remove every obstacle which can occasion delay.

Translated by Robert Kerr  
*Elements of Chemistry* (Volume 1) (5th edition)  
Preface (pp. xxxvii–xxxviii)  
Printed for W. Creech. Edinburgh, Scotland. 1802

**Lippmann, Walter** 1889–1974

American journalist and author

True opinions can prevail only if the facts to which they refer are known; if they are not known, false ideas are just as effective as true ones, if not a little more effective.

*Liberty and the News*

Liberty and the News (pp. 64–65)

Transaction Publishers. New Brunswick, New Jersey, USA. 1995

**Locke, John** 1632–1704

English philosopher and political theorist

New opinions are always suspected, and usually opposed, without any other reason but because they are not already common.

In *Great Books of the Western World* (Volume 35)*An Essay Concerning Human Understanding*

Dedicatory Epistle (p. 85)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

...a scientist does not hold exactly the same opinions about his research from one day to the next, for reading, reflection, and discussions with colleagues cause a change of emphasis here or there and possibly even a radical reappraisal of his way of thinking.

*Advice to a Young Scientist*

Chapter 11 (pp. 92–93)

Basic Books, Inc. New York, New York, USA. 1979

**Mellor, Joseph William** 1863–1938

Chemist

The purity of truth is almost certain to be corrupted when the observer is ruled by preconceived opinions ...

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 7)

Longman, Green &amp; Co. London, England. 1922

**Milton, John** 1608–74

English poet

...opinion in good men is but knowledge in the making.

In *Great Books of the Western World* (Volume 32)*Areopagitica* (p. 406)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearson, Karl** 1857–1936

English mathematician

We never think of taking the opinion of the man in the street on the reasons why the moon does not keep her calculated times; we do not ask his opinion on the value of the opsonic index; we recognise that these are problems which require special training and analysis wholly beyond his grasp, but we still think he is quite capable of expressing an opinion on whether the employment of

women is good for her infants or not, although he may be in possession of no data, and although, if he were, he would be quite incapable of interpreting them.

*Eugenics Laboratory Lecture Series*

The Academic Aspect of the Science of National Eugenics, 7, 1911 (p. 20)

**Richardson, David Lester** 1801–65

Poet and writer

...nothing is easier than to collect the opinions of celebrated men for or against any branch of human learning.

*Literary Chit-Chat*

Chapter X (p. 76)

P.S. D'Rozario and Co. Calcutta, India. 1848

**Spencer, Herbert** 1829–1903

English social philosopher

The presumption that any current opinion is not wholly false, gains in strength according to the number of its adherents.

*First Principles of a New System of Philosophy*

Part I, Chapter I, section 1 (p. 4)

D. Appleton &amp; Co. New York, New York, USA. 1892

**Terence** 190 BCE–158 BCE

Roman comic dramatist

...as many men, so many opinions...

In T. A. Blythe

*A Literal Translation of the Phormio by Terence* (p. 22)

Simkin, Marshall &amp; Company. London, England. 1880

**Thiselton-Dyer, W. T.**

No biographical data available

When a man of known distinction gives public expression to an opinion it is, of course, received with attention. But its validity will depend, not upon his distinction, but upon the authority which he has achieved in the field to which his opinion relates.

The Limits of Science

*Science*, Volume 18, Number 448, July 31, 1903 (p. 138)**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

Our opinions do not really blossom into fruition until we have expressed them to someone else.

In Opie Read

*Mark Twain and I*

Five Quarts of Moonlight Juice (p. 38)

Reilly &amp; Lee. Chicago, Illinois, USA. 1940

Opinions based upon theory, superstition, and ignorance are not very precious.

In Albert Bigelow Paine

*Mark Twain's Letters* (Volume 2)

Letter to J. H. Twitchell, 1/27/1900 (p. 695)

Harper &amp; Brothers. New York, New York, USA. 1917

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Since nothing is so important to people as their opinions, everyone who propounds an opinion looks about him right and left for props with which to support it.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 158)

William Blackwood & Sons. Edinburgh, Scotland. 1883

**Waugh, John Hugh W.**

No biographical data available

In entering upon the delicate, and always ungracious, task of discussing opinions in connection with names of universal sanction and authority, it is certainly not without a deep sense of the weighty responsibilities involved in such an undertaking. At the same time, it is not too much to presume, that even the greatest men may possibly entertain, occasionally, opinions or views which may not altogether harmonise with the admitted soundness of their general reasonings, and which yet may fall within the reach of ordinary attention to the subject to correct or discover.

*Mathematical Essays*

Essay II (pp. 22–23)

Johnstone & Hunter. Edinburgh, Scotland. 1854

**Windle, Sir Bertram C. A.**

No biographical data available

The ordinary nonscientific person cannot be expected to embrace, and ought not to be expected to embrace, any scientific opinion until it may be asserted of that opinion that the genuine scientific world is fairly unanimous in giving its adherence to it.

*Darwin and Darwinism* (p. 7)

Paulist Press. New York, New York, USA. 1912

**Young, Thomas** 1773–1829

English polymath

The object of the present dissertation is not so much to propose any opinions which are absolutely new, as to refer some theories, which have been already advanced, to their original inventors, to support them by additional evidence, and to apply them to a great number of diversified facts, which have hitherto been buried in obscurity. Nor is it absolutely necessary in this instance to produce a single new experiment; for of experiments there is already an ample store.

On the Theory of Light and Colours

*Philosophical Transactions of the Royal Society of London*, Volume 92, 1802 (p. 12)

**OPTICS****Day, Roger E.**

No biographical data available

I wish I were a crystal lens,  
With aplanatic face,  
And lived at Number Seven Ten,  
Illumination Place,  
City of Glass.

Fantasy of Glass

*The Physics Teacher*, Volume 3, Number 6, September, 1965 (p. 288)

**Digges, Leonard** ca. 1520–59

English mathematician

But marvelous are the conclusions that may be performed by glasses concave and convex of Circulare and parabolical formes, using for multiplication of beames sometime the aide of Glasses transparent, which by fraction should unite or dissipate the images or figures presented by the reflection of other. By these kinde of Glasses or rather frames of them, placed in due Angles, yee may not only set out of the proportion of an whole region, ye may represent before your eye the lively image of every Towne, Village, &c and that in as little or great space or place as ye will prescribe, but also augment and dilate any parcell thereof.

*A Geometrical Practial Treatise Named Pantometria, Divided into Three Bookes, Longimetra, Planimetra, and Stereometria*

Chapter 21

Publisher undetermined

**Grosseteste, Robert** 1175–1253

English statesman

This part of *Perspectiva*, when well understood, shows us how we may make things a very long distance off appear as if placed very close, and larger near things appear very small, and how we may make small things placed at a distance appear any size we want, so that it may be possible for us to read the smallest letters at incredible distances, or to count sand, or grains, or seeds, or any sort of minute objects...

In A. C. Crombie

*Science, Optics, and Music in Medieval and Early Modern Thought*

Chapter 9, Section II (p. 198)

The Hambledon Press. London, England. 1990

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

As happens in all the sciences in which Geometry is applied to matter, the demonstrations concerning Optics are founded on truths drawn from experiences.

*A Treatise on Light*

Chapter I (p. 1)

Macmillan & Company Ltd. London, England. 1912

**Joyce, James** 1882–1941

Irish-born author

He faced about and, standing between the awnings, held out his right arm at arm's length toward the sun. Wanted to try that often. Yes; completely. The tip of his little

finger blotted out the sun's disc. Must be the focus where the rays cross.

*Ulysses* (p. 164)

Random House, Inc. New York, New York, USA. 1946

### **Marton, Ladislaus**

No biographical data available

“Electron optics I believe,”

He often gravely said,

“Concern a branch of knowledge

That is way above my head.”

Alice in Electronland

*American Scientist*, Volume 31, Number 3, July 1943 (p. 251)

### **Molyneux, William** 1656–98

Irish astronomer

Were there no other use of Optics, than the invention of “Spectacles” for the help of defective Eyes, I should think the advantage which mankind receives, thereby, inferior to no other benefit, whatever, not absolutely requisite to support Life.

In William Kitchiner

*The Economy of the Eyes: Precepts for the Improvement and Preservation of the Sight* (p. 2)

Printed for Jurst, Robinson & Co. London, England. 1824

## **ORBIT**

### **Kepler, Johannes** 1571–1630

German astronomer

The testimony of the ages confirm that the motions of the planets are orbicular.

*New Astronomy*

Part I, 1 (p. 115)

At the University Press. Cambridge, England. 1992

### **Gregory, Sir Richard Arman** 1864–1952

English scientific writer and journalist

Out of these eight minutes [referring to the Copernican theory of the orbits of planets] we will construct a new theory that will explain the motions of all the planets.

*Discovery, Or, The Spirit and Service of Science*

Chapter VII (pp. 167–168)

Macmillan & Co Ltd. London, England. 1916

## **ORCHARD**

### **Burroughs, John** 1837–1921

American naturalist and essayist

There are few places on the farm where there is so much live natural history to be gathered as in the orchard. All the wild creatures seem to feel the friendly and congenial atmosphere of the orchard.

*The Writings of John Burroughs* (Volume 19)

Chapter I (p. 1)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

## **ORDER**

### **Anaxagoras** ca. 500 BCE–428 BCE

Greek philosopher of nature

Mind orders all things.

In Fabre

*The Glow-Worm* (p. 234)

Hodder & Stoughton Ltd. London, England. 1919

### **Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

The human understanding is of its own nature prone to abstractions, and gives a substance and reality to things which are fleeting.

In John M. Robinson (ed.)

*The Philosophical Woks of Francis Bacon*

*Novum Organon*

LI (p. 267)

George Routledge & Sons, Ltd. London, England. 1905

### **Birkhoff, Garrett** 1911–96

American mathematician

...there is hidden order in Nature, to be found only by patient search.

*Hydrodynamics: A Study in Logic, Fact, and Simulation*

Conclusion (p. 179)

Princeton University Press. Princeton, New Jersey, USA. 1950

### **Boole, George** 1815–64

English mathematician

It is the ability inherent in our nature to appreciate Order, and the concurrent presumption, however founded, that the phenomena of Nature are connected by a principle of Order. Without these, the general truths of physical science could never have been ascertained.

*An Investigation of the Laws of Thought*

Chapter XXII (p. 403)

Walton & Maberly. London, England. 1854

### **Brooks, William Keith** 1848–1908

American zoologist

Order is not an explanation of anything; but something that itself calls for explanation.

*The Foundations of Zoology*

Lecture XII (p. 287)

The Macmillan Co. New York, New York, USA. 1899

### **Brown, Thomas**

No biographical data available

Even the rudest wanderer in the fields...finds that the profusion of blossoms around him – in the greater number of which he is able himself to discover many striking resemblances – may be reduced to some order of arrangement.

Quoted in Hugh Miller

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture First (p. 37)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Browne, Sir Thomas** 1605–82  
English author and physician

All things begin in order, so shall they end, and so shall they begin again; according to the ordainer of order, and the mysticall mathematicks of the City of Heaven.

In John Carter (ed.)  
*Urne Buriall and The Garden of Cyrus*  
The Garden of Cyrus, Chapter V (p. 114)  
Cassell. London, England. 1932

**Buchner, Ludwig** 1824–99  
German physician and philosopher

How is it possible that the unalterable order in which things move should ever be disturbed without producing an irremediable gap in the world, without delivering us and everything up to arbitrary power, without reducing all science, every earthly endeavor, to a vain and childish effort.

*Force and Matter*  
Chapter VI (p. 36)  
Trübner & Co. London, England. 1864

**Darwin, Charles Robert** 1809–82  
English naturalist

An organic being is a microcosm – a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars of heaven.

*The Variation of Animals and Plants Under Domestication* (Volume 2)  
Chapter XXVII (p. 399)  
D. Appleton & Company. New York, New York, USA

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

The universe contains vastly more order than Earth-life could ever demand. All those distant galaxies, irrelevant for our existence, seem as equally well ordered as our own.

In Eugene F. Mallove  
*The Quickening Universe: Cosmic Evolution and Human Destiny* (p. 61)  
St. Martin's Press. New York, New York, USA. 1987

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

If you take a pack of cards as it comes from the maker and shuffle it for a few minutes, all trace of the original systematic order disappears. The order will never come back however long you shuffle. Something has been done which cannot be undone, namely, the introduction of a random element in place of the arrangement.

*The Nature of the Physical World*  
Chapter IV (p. 63)  
The Macmillan Company. New York, New York, USA. 1930

**Frankel, Felice** 1945–  
Science photographer

**Whitesides, George M.**  
American chemist

Order is repetition, regularity, symmetry, simplicity. It forms the spine of our efforts to measure, control, and understand.

*On the Surface of Things: Images of the Extraordinary in Science*  
Order (p. 63)  
Chronicle Books. San Francisco, California, USA. 1997

**Huntington, Edward V.** 1874–1952  
Mathematician

The fundamental importance of the subject of order may be inferred from the fact that all the concepts required in geometry can be expressed in terms of the concept of order alone.

*The Continuum, and Other Types of Serial Order*  
Introduction (p. 2)  
Harvard University Press. Cambridge, Massachusetts, USA. 1917

**Huxley, Thomas Henry** 1825–95  
English biologist

...the man of science knows that here, as everywhere, perfect order is manifested; that there is not a curve of the waves, not a note in the howling chorus, not a rainbow glint on a bubble which is other than a necessary consequence of the ascertained laws of nature; and that with sufficient knowledge of the conditions competent physico-mathematical skill could account for, and indeed predict, everyone of those 'chance' events.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter XIV (p. 554)  
D. Appleton & Company. New York, New York, USA. 1896

Harmonious order governing eternally continuous progress – the web and woof of matter and force interweaving by slow degrees, without a broken thread, that veil which lies between us and the Infinite – that universe which alone we know or can know; such is the picture which science draws of the world ...

*Darwiniana*  
The Origin of Species (p. 59)  
D. Appleton & Co. New York, New York, USA. 1894

The object [of the method of investigation] is the discovery of the rational order which pervades the universe; the method consists of observation and experiment (which is observation under artificial conditions) for the determination of the facts of Nature; of inductive and deductive reasoning for the discovery of their mutual relations and connection.

*Method and Results: Essays*  
The Progress of Science (p. 60)  
D. Appleton & Co. New York, New York, USA. 1898



**Kline, Morris** 1908–92

American mathematics professor and writer

Is there a law and order in this universe or is its behavior merely the working of chance and caprice? Will the Earth and other planets continue their motions around the sun or will some unknown body, coming from great distances, rush through our planetary system and alter the course of every planet? Cannot the sun someday explode, as other suns are doing daily, and burn us all to a crisp? Was man deliberately planted on a planet especially prepared for his existence or is he merely an insignificant concomitant of accidental cosmic circumstances?

*Mathematics in Western Culture*

Chapter XXIV (p. 374)

Oxford University Press, Inc. New York, New York, USA. 1953

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

To the modern man it seems simply natural that an ordered cosmos should emerge from chaos, that life should come out of the inanimate, reason out of instinct, civilization out of savagery, virtue out of animalism. This idea is supported in his mind by a number of false analogies: the oak coming from the acorn, the man from the spermatozoon, the modern steamship from the primitive coracle. The supplementary truth that every acorn was dropped by an oak, every spermatozoon derived from a man, and the first boat by something so much more complex than itself as a man of genius, is simply ignored. The modern mind accepts as a formula for the universe in general the principle “almost nothing may be expected to turn into almost everything” without noticing that the parts of the universe under our direct observation tell a quite different story.

*Present Concerns: Essays by C.S. Lewis*

Modern Man and His Categories of Thought (p. 63)

Harcourt Brace Jovanovich. New York, New York, USA. 1986

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

For verily not by design did the first-beginnings of things station themselves each in its right place guided by keen intelligence, nor did they bargain sooth to say what motions each should assume, but because many in number and shifting about in many ways throughout the universe they are driven and tormented by blows during infinite time past, after trying motions and unions of every kind at length they fall into arrangements such as those out of which our sum of things has been formed...

In *Great Books of the Western World* (Volume 12)

*Lucretius: On the Nature of Things*

Book One, l. 1020 (p. 13)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mann, Thomas** 1875–1955

German-born American novelist

...order and simplification are the first steps toward the mastery of a subject – the actual enemy is the unknown.

*The Magic Mountain*

Chapter V

Encyclopaedic (pp. 245–246)

Alfred A. Knopf. New York, New York, USA. 1966

**Miller, Jr., G. Tyler**

No biographical data available

Man continually engages in attempts to create order, but only at the expense of greater disorder in the surroundings.

*Energetics, Kinetics, and Life: An Ecological Approach* (p. 200)

Wadsworth Publishing Company. Belmont, California, USA. 1971

**Moulton, Forest Ray** 1872–1952

American astronomer

To an astronomer the most remarkable and interesting thing about that part of the physical universe with which he has become acquainted is not its vast extent in space, nor the number and great masses of its stars, nor the violent forces that operate in the stars, nor in the long periods of astronomical time, but that which holds him awestruck is the perfect orderliness of the universe and the majestic succession of the celestial phenomena.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 30)

The University of Chicago Press. Chicago, Illinois, USA. 1927

The orderliness of the universe is the supreme discovery in science; it is that which gives us hope that we shall be able to understand not only the exterior world but also our own bodies and our own mind.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 30)

The University of Chicago Press. Chicago, Illinois, USA. 1927

Now we find ourselves a part of a Universal Order of which we did not dream and whose alphabet we are just beginning to learn. Instead of shrinking it to our measure, we contemplate its infinite orderliness and set no limits to the goal our race may hope to attain.

*Astronomy*

Chapter XVI (p. 533)

The Macmillan Company. New York, New York, USA. 1931

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

We cannot make much progress without a faith that in this bewildering field of human experience, which is so new and so much more complicated than we thought even five years ago, there is a unique and necessary order: not an order that we can tell a priori, not an order that we can see without experience, but an order which means that the parts fit into a whole and that the whole requires the parts.

*The Constitution of Matter* (p. 37)

Oregon State System of Higher Education. Eugene, Oregon, USA. 1956

One may only hope that what is at the moment just a picture of chaos will ultimately reveal again that deep harmony and order which one has always found in the physical world when one has pushed hard, and which is very beautiful indeed.

In Lincoln Barnett

*Writing on Life: Sixteen Close-Ups*

Physicist Oppenheimer (p. 358)

William Sloane Associates, Publishers. New York, New York, USA. 1951

The knowledge which comes to us at such a terrifyingly, inhumanly rapid rate has some order in it. We are allowed to forget a great deal, as well as to learn. The order is never adequate. The mass of understanding things, which cannot be summarized, or wholly ordered, always grows greater; but a great deal does get understood.

The Growth of Science and the Structure of Society

*Daedalus*, Winter, 1958

**Picard, Charles Emile** 1856–1941

French mathematician

We no longer pretend to be able to grasp reality in a physical theory; we see in it rather an analytic or geometric mold useful and fertile for a tentative representation of phenomena, no longer believing that the agreement of a theory with experience demonstrates that the theory expresses the reality of things. Such statements have sometimes seemed discouraging; we ought rather to marvel that, with representations of things more or less distant and discolored, the human spirit has been able to find its way through the chaos of so many phenomena and to derive from scientific knowledge the ideas of beauty and harmony. It is no paradox to say that science puts order, at least tentative order, into nature.

In Lucienne Felix

*The Modern Aspect of Mathematics* (p. 31)

Basic Books, Inc. New York, New York, USA. 1960

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

To obtain a result of real value, it is not enough to grind out calculations or to have a machine to put things in order; it is not order alone, it is unexpected order, which is worthwhile. The machine may gnaw on the crude fact; the soul of the fact will always escape it.

*The Foundations of Science*

*Science and Method*, Book I

Chapter II (pp. 373–374)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

Where order in variety we see,  
And where, though all things differ, all agree.

*The Complete Poetical Works*

Windsor Forest, l. 15–16

Houghton Mifflin Company. New York, New York, USA. 1903

**Reichenbach, Hans** 1891–1953

German philosopher of science

...whereas inorganic nature was seen to be controlled by the laws of cause and effect, organic nature appeared to be governed by the law of purpose and means.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 192)

University of California Press. Berkeley, California, USA. 1951

**Ritchie, Arthur David** 1891–1967

Scottish philosopher and science history writer

But it seems to me equally obvious that the orderliness is not all-pervasive. There are streaks of order to be found among the chaos, and the nature of scientific method is to seek these out and to stick to them when found and to reject or neglect the chaos. It is obvious that we have succeeded in finding some order in nature, but this fact in itself does not prove anything farther.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter VII (p. 200)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Dimensions, in geometry, are a development of order. The conception of a limit, which underlies all higher mathematics, is a serial conception. There are parts of mathematics which do not depend upon the notion of order, but they are very few in comparison with the parts in which this notion is involved.

*Introduction to Mathematical Philosophy*

Chapter IV (p. 29)

Dover Publications, Inc. New York, New York, USA. 1993

The notion of continuity depends upon that of order, since continuity is merely a particular type of order.

*Mysticism and Logic and Other Essays*

Chapter V (p. 91)

Longmans, Green & Company. London, England. 1925

**Sarton, May** 1912–95

American poet and novelist

I see a certain order in the universe and math is one way of making it visible.

*As We Are Now* (p. 38)

W.W. Norton & Company, Inc. New York, New York, USA. 1973

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The heavens themselves, the planets, and this centre,  
Observe degree, priority, and place,  
Insisture, course, proportion, season, form,  
Office, and custom, in all line of order.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Troilus and Cressida*

Act I, Scene iii, l. 85–88

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sharp, W. H.**

If Nature had told Newton as much as she has since told those who regard him as her infallible interpreter, he would, I believe, have declared even more forcibly than he did that her first law is order.

*Universal Attraction*

Preface (p. 3)

E.&S. Livingstone, Edinburgh, Scotland. 1884

**Shepherd, William**

No biographical data available

**Joyce, J.**

No biographical data available

**Carpenter, Lant**

No biographical data available

Order is delightful; there is nothing in nature but what is stamped with it, and without it there could be no harmony.

*Systematic Education* (Volume 1)

Chapter XXXI (p. 498)

Longman, Hurst, Rees, Orme, & Brown. London, England. 1822

**Whewell, William** 1794–1866

English philosopher and historian

To trace order and law in that which has been observed, may be considered as interpreting what nature has written down for us, and will commonly prove that we understand her alphabet.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (2nd edition)

Book XI, Chapter V (p. 64)

John W. Parker. London, England. 1867

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

In the first place, there can be no living science unless there is a widespread instinctive conviction in the existence of an Order of Things, and, in particular, of an Order of Nature.

*Science and the Modern World*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1929

**Wöhler, Friedrich** 1800–82

German chemist

**von Liebig, Justus** 1803–73

German organic chemist

When in the dark province of organic nature, we succeed in finding a light point, appearing to be one of those inlets whereby we may attain to the examination and investigation of this province, then we have reason to congratulate ourselves, although conscious that the object before us is unexhausted.

*American Journal of Science and Arts*, Volume 26, 1834 (p. 261)

**Yang, Chen Ning** 1922–

Chinese-born American theoretical physicist

Nature possesses an order that one may aspire to comprehend.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1957

The Law of Parity Conservation and Other Symmetry Laws of Physics (p. 394)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**ORDERLY****National Research Council (US)**

As man gains more knowledge, what would have appeared complicated or capricious can be seen as essentially simple and, in a deep sense, orderly.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 14)

National Academy of Sciences

Washington, D.C. 1972

**ORE****Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

There are rivers of rocks on the surface and rivers of ore in the bowels of the earth.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2) (p. 33)

Princeton University Press. Princeton, New Jersey, USA. 1984

**ORGAN****Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The more you examine the structure of the organs and the laws of life, the more you will find how resolutely each of the cell-republics which make up the *E pluribus unum* of the body maintains its independence.

*The Writings of Oliver Wendell Holmes* (Volume 9)

*Medical Essays: 1842–1882*

Chapter IV (p. 252)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

**ORGAN, LOCATION OF****Wilder, Burt Green** 1841–1925

American zoologist, neurologist, and composer

To designate the locations of organs by the relation of animals to the surface of the earth is as far from philosophical as it would be to define the position of a house or of a tree by reference to the planet Jupiter.

A Partial Revision of Anatomical Nomenclature

*Science*, March 29, 1881 (p. 122)

## ORGAN TRANSPLANT

**Carrel, Alexis** 1873–1944

French surgeon and biologist

Thus, while the problem of the transplantation of organs has been solved from a surgical point of view, we see that this by no means suffices to render such operations of definite surgical practicability, and it will only be through a more fundamental study of the biological relationships existing between living tissues that the problems involved will come to be solved and thereby render possible the benefits to humanity which we hope to see accomplished in the future.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1912

Suture of Blood-Vessels and Transplantation of Organs (p. 464)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## ORGANIC

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

He who would study organic existence,  
First drives out the soul with rigid persistence;  
Then the parts in his hand he may hold and class,  
But the spiritual link is lost,

Translated by Bayard Taylor

*Faust*

IV (p. 66)

The Modern Publisher. New York, New York, USA. 1912

## ORGANIC CHEMISTRY

**Berzelius, Jöns Jacob** 1779–1848

Swedish chemist

We have reached a point where we are beginning to see a theory of organic compounds; but if, instead of letting this develop as our experience grows, we want to base it on isolated facts, considered without regard for their relations with the general system of our knowledge, and by giving explanations which do not harmonise with the principles of the science, and if, moreover, we want to conclude that this lack of agreement must lead us to reject as erroneous principles which are already well established on other grounds, then we shall never succeed in finding the truth.

*Annals de chimie et de physique*, Volume 71, 1839**Collie, John Norman** 1859–1942

English chemist

...Organic Chemistry has become a vast rubbish heap of puzzling and bewildering compounds.

In W.A. Stewart

*Recent Advances in Organic Chemistry*

Preface (p. xiii)

Longman, Green, &amp; Co. New York, New York, USA. 1909

**Cram, Donald J.** 1919–2001

American chemist

**Cram, Jane M.**

No biographical data available

No other profession is endowed with such a rich landscape, draws inspiration from so many fields of science, exercises the hand and mind in so many different ways, offers such opportunities to employ creative instincts, and mixes ideas, theory, and experiment on a daily basis. Hurrah for the science of organic chemistry, and for the joy it brings those who play the research game.

*Container Molecules and Their Guests*

Preface (p. vi)

Royal Society of Chemistry. Cambridge, England. 1994

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Drops of deliquescence glistened on his forehead,  
Whitened round his feet the dust of efflorescence,  
‘Till one Monday morning when the flow suspended,  
There was no de Sauty.

Nothing but a cloud of elements organic

C.O.H.N. Ferrum, Chlor. Flu. Sil. Potassa,

Calc. Sod. Phosph. Mag. Sulphur, Mang.? Alumin.?

Caprum?

Such as man is made of.

*The Professor at the Breakfast Table*

Chapter I

De Sauty (p. 33)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Hopkins, Frederick Gowland** 1844–89

English biochemist

A very distinguished organic chemist long since dead, said to me in the late eighties: “The chemistry of the living? That is the chemistry of protoplasm; that is superchemistry; seek, my young friend, for other ambitions.”

In Joseph Needham and Ernest Baldwin (eds.)

*Hopkins & Biochemistry*

Report of the British Association

Some Chemical Aspects of Life

1933 (p. 245)

**Kekulé, Friedrich August** 1829–96

German chemist

We define organic chemistry as the chemistry of carbon compounds. In doing this, we see no opposition between organic and inorganic compounds. What has been known for a long time as organic chemistry and which more usefully may be called the chemistry of carbon compounds, is rather only a special section of pure chemistry which is dealt with separately because the large number and special importance of carbon compounds seems to make a special field of study necessary.... It must be emphasized that organic chemistry

does not deal with the study of the chemical processes in the organs of plants and animals.

*Lehrbuch der Organischen Chemie* (Volume 1) (p. 10)  
Publisher undetermined

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

The mysteries of organic chemistry are great, and the differences between its processes or reactions as they are carried out in the organism and in the laboratory are many; the actions, catalytic and other, which go on in the living cell, are of extraordinary complexity. But the contention that they are different in kind from ordinary chemical operations...would seem to be no longer tenable.

*On Growth and Form* (Volume 2)  
Chapter IX (p. 652)  
At The University Press. Cambridge, England. 1951

**Thudichum, J. L. W.** 1829–1901  
Chemist

Organic chemistry is the child of medicine, and however far it may go on its way, with its most important achievements, it always returns to its parent.

On the Discoveries and Philosophy of Liebig  
*Journal of the Royal Society of Arts*, Volume 24, 1876 (p. 141)

**Ure, Andrew** 1778–1857  
Scottish physician

All of the elementary principles of organic nature may be considered as deriving the peculiar delicacy of their chemical equilibrium, and the consequent facility with which it may be subverted and new modeled, to the multitude of atoms grouped together in a compound. On this view, none of them should be expected to consist of a single atom of each component.

On the Ultimate Analysis of Vegetable and Animal Substances  
*Philosophical Transactions of the Royal Society of London*, Volume 112, 1822 (pp. 468–469)

**Wöhler, Friedrich** 1800–82  
German chemist

Organic chemistry just now is enough to drive one mad. It gives one the impression of a primeval, tropical forest full of the most remarkable things, a monstrous and boundless thicket, with no way of escape, into which one may well dread to enter.

In Edward Franklin Degering  
*An Outline of Organic Nitrogen Compounds*  
Letter to Berzelius, 28 January, 1835 (p. 5)  
University Lithoprinters. Ypsilanti, Michigan, USA. 1945

## ORGANIC FORM

**Harrison, Ross G.** 1870–1959  
American biologist and anatomist

...it is the mystery and beauty of organic form that sets the problem for us.

*The Anatomical Record* (Volume 7)  
Anatomy: Its Scope, Methods and Relations to Other Biological Sciences (p. 405)  
The Wistar Institute of Anatomy and Biology  
Philadelphia, Pennsylvania, USA. 1913

## ORGANIC LIFE

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

...the destinies of organic life may be determined by what are at first sight irrelevant accidents.

*The Nature of the Physical World*  
Chapter VIII (p. 171)  
The University Press. New York, New York, USA. 1929

## ORGANIC STRUCTURE

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

Thus, commencing our investigation by a careful survey of anyone bone by itself, a person who is sufficiently master of the laws of organic structure, may, as it were, reconstruct the whole animal to which that bone had belonged.

*Essay on the Theory of the Earth*  
Section 28 (p. 95)  
Printed by James Ballantyne & Co. Edinburgh, Scotland. 1817

## ORGANISM

### Author Undetermined

Under the most rigorously controlled conditions of pressure, temperature, volume, humidity, and other variables the organism will do as it pleases.

Source undetermined

**Bernard, Claude** 1813–78  
French physiologist

We may, of course strike a balance between what a living organism takes in as nourishment and what it gives out in excretions.... This would be like trying to tell what happens inside a house by watching what goes in by the door and what comes out by the chimney.

*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section IX  
The Macmillan Company. New York, New York, USA. 1927

**Evans, Howard Ensign** 1919–2002  
Entomologist

It has been said that for every problem concerning living things there is an organism ideal for its solution. It is probable that there are still undiscovered species living



that hold the answers to problems that face us now or will in the future.

*Pioneer Naturalist: The Discovery and Naming of North American Plants and Animals*

Naturalists, Then and Now (p. 267)

Henry Holt & Company. New York, New York, USA. 1993

**Hess, Walter** 1881–1973

Swiss physiologist

A recognized fact which goes back to the earliest times is that every living organism is not the sum of a multitude of unitary processes, but is, by virtue of interrelationships and of higher and lower levels of control, an unbroken unity.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1949

The Central Control of the Activity of Internal Organs (p. 247)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Jacob, François** 1920–

French biologist

And one of the deepest, one of the most general functions of living organisms is to look ahead, to produce future as Paul Valéry put it.

*The Possible and the Actual*

Time and the Invention of the Future (p. 66)

Pantheon Books. New York, New York, USA. 1982

**Jones, J. S.**

No biographical data available

**Ebert, D.**

No biographical data available

No organism can do everything. Every creature is restricted by constraints of various kinds. Many of these arise from the facts of history and the nature of evolution, both of which can proceed only from where they left off.

In R.J. Berry, T.J. Crawford, and G.M. Hewitt (eds.)

*Genes in Ecology*

Life History and Mechanical Constraints on Reproduction in Genes, Cells and Waterfleas (p. 393)

Blackwell Scientific Publications. Oxford, England. 1992

**Jordan, David Starr** 1851–1931

American scientist and university administrator

We see many kinds of birds and trees and insects and fishes and flowers and blades of grass, and yet when we look closely we find not one blade of grass in the meadow quite like another blade. The green cloak which covers the brown earth is the shield under which millions of organisms, brown or green, carry on their life work; yet not one organism in the world in body or mind is the exact measure of its neighbour. But with all this the real variety in life is far greater than that which appears.

In David Starr Jordan

*Foot-notes to Evolution, a Series of Popular Addresses on the Evolution of Life*

Chapter I (p. 1)

D. Appleton & Co. New York, New York, USA. 1907

The spontaneous generation of organisms has never been seen, nor with our dull senses and clumsy instruments could it ever be seen; for an organism without a history, untouched by heredity, un-selected by struggle, unaffected by environment, a coin fresh from the mint of creation, would be a fragment of pristine simplicity as far beyond our grasp as the molecules of the chemist.

*Foot-notes to Evolution, a Series of Popular Addresses on the Evolution of Life*

Chapter I (p. 5)

D. Appleton & Co. New York, New York, USA. 1907

The simplest organism we know is far more complex than the constitution of the USA.

*Footnotes to Evolution: A Series of Popular Addresses on the Evolution of Life*

Chapter X (pp. 258–259)

D. Appleton & Co. New York, New York, USA. 1898

**Price, P. W.**

No biographical data available

Visually stimulating organisms, the large, the colorful, the active, the aggressive, command our attention, while the secretive and insidious remain largely ignored.

*Evolutionary Biology of Parasites*

Chapter Eight (p. 171)

Princeton University Press. Princeton, New Jersey, USA. 1980

**Savage-Rumbaugh, Sue**

American psychologist

**Lewin, Roger Amos**

Anthropologist

All organisms with complex nervous systems are faced with the moment-by-moment question that is posed by life: What shall I do next?

*Kanzi: The Ape at the Brink of the Human Mind*

Chapter 10 (p. 255)

John Wiley & Sons, Inc. New York, New York, USA. 1994

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The hosts of living organisms are not random creatures, they can be classified in battalions and regiments. Neither are they isolated creatures, for every thread of life is inter-twined with others in a complex web.

*The System of Animate Nature* (Volume 1)

Lecture II (p. 58)

William & Norgate. London, England. 1920

From the physicist's point of view, the living organism resembles, as we have already said, some wonderful kind of engine.

*The Bible of Nature*

Lecture III (p. 100)

Charles Scribner's Sons. New York, New York, USA. 1908

The vital striving and struggling characteristic of the realm of organisms is something apart from and finer than even the music of the spheres.



*The System of Animate Nature: The Gifford Lectures Delivered in the University of St. Andrews in the Years 1915 and 1916* Volume 2  
Lecture XI (p. 358)  
Henry Holt & Co. New York, New York, USA. 1920

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Basic characteristics of an individual organism: to divide, to unite, to merge into the universal, to abide in the particular, to transform itself, to define itself, and as living things tend to appear under a thousand conditions, to arise and vanish, to solidify and melt, to freeze and flow, to expand and contract. Since these effects occur together, any or all may occur at the same moment.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 303–304)

Suhrkamp. New York, New York, USA. 1988

## ORGANIZATION

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

There is no doubt that the scheme of physics as it has stood for the last three-quarters of a century postulates a data at which either the entities of the universe were created in a state of high organization, or pre-existing entities were endowed with that organization, which they have been squandering ever since. Moreover, this organization is admittedly the antithesis of chance. It is something which could not occur fortuitously.

*The Nature of the Physical World*

Chapter IV (pp. 84–85)

The Macmillan Company. New York, New York, USA. 1930

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Men talk much of matter and energy, of the struggle for existence that molds the shape of life. These things exist, it is true; but more delicate, elusive, quicker than fins in water, is that mysterious principle known as “organization,” which leaves all other mysteries concerned with life stale and insignificant by comparison. For that without organization life does not persist is obvious. Yet this organization itself is not strictly the product of life, nor of selection. Like some dark and passing shadow within matter, it cups out the eyes’ small windows or spaces the notes of a meadow lark’s song in the interior of a mottled egg.

*The Immense Journey*

The Flow of the River (p. 26)

Vintage Books. New York, New York, USA. 1957

**Huxley, Thomas Henry** 1825–95  
English biologist

Not only are all animals existing in the present creation organized to one of these five plans; but paleontology

tends to show that in the myriad of past ages of which the earth’s crust contains the records, no other plan of animal life made its appearance on our planet. A marvelous fact and one which seems to present no small obstacle in the way of the notion of the possibility of fortuitous development of animal life.

In Michael Foster and E. Ray Lankester (eds.)

*Scientific Memoirs of Thomas Huxley* (Volume 1)

On Natural History as Knowledge, Discipline and Power (p. 306)

Publisher undetermined. 1901

**Needham, Joseph** 1900–95

English biochemist and sinologist

Organization and Energy are the two fundamental problems which all science has to solve.

*Time: The Refreshing River*

The Naturalness of the Spiritual World (p. 33)

The Macmillan Company. New York, New York, USA. 1943

...organization is not something fundamentally mystical and unamenable to scientific attack, but rather the basic problem confronting the biologist.... It is for us to investigate the nature of this biological organization, not to abandon it to the metaphysicians because the rules of physics do not seem to apply to it.

*Order and Life*

Chapter I (pp. 7, 17–18)

Yale University Press. New Haven, Connecticut, USA. 1936

**Simpson, George Gaylord** 1902–84

American paleontologist

The point about explanation in biology that I would particularly like to stress is this: to understand organisms one must explain their organization. It is elementary that one must know what is organized and how it is organized, but that does not explain the fact or the nature of the organization itself. Such explanation requires knowledge of how an organism came to be organized and what function the organization serves. Ultimate explanation in biology is therefore necessarily evolutionary.

*This View of Life: The World of an Evolutionist*

Chapter Six (p. 113)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

One of the most basic principles of biology is organization, which means that two things put together in a specific way form a new unit, a system, the properties of which are not additive and cannot be described in terms of the properties of the constituents. As points may be connected to letters, letters to words, words to sentences, etc., so atoms can join to molecules, molecules to organelles, organelles to cells, etc., every level of organization having a new meaning of its own and offering exciting vistas and possibilities.

*Bioenergetics*

Chapter 6 (p. 39)

Academic Press. New York, New York, USA. 1957

**Woodger, Joseph Henry** 1894–1981

English biologist

The failure to take organization seriously is perhaps but another consequence of the rapid development of physics and chemistry as compared to other sciences, and the consequent dazzling effect this had on biological vision.

*Biological Principles: A Critical Study*

Part II, Chapter VI, B, 5 (p. 291)

Kegan Paul, Trench, Trubner &amp; Company Ltd. London, England. 1929

If the concept of organization is of such importance as it appears to be it is something of a scandal that we have no adequate conception of it. The first duty of the biologist would seem to be to try and make clear this important concept. Some biochemists and physiologists...express themselves as though they really believed that if they concocted a mixture with the same chemical composition as what they call "protoplasm" it would proceed to "come to life." This is the kind of nonsense which results from forgetting or being ignorant of organization.

*Biological Principles: A Critical Study*

Part II, Chapter VI, B, 5 (p. 291)

Kegan Paul, Trench, Trubner &amp; Company Ltd. London, England. 1929

**ORGANS****Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

...We have also here an acting cause to account for that balance so often observed in nature – a deficiency in one set of organs always being compensated by an increased development of some others – powerful wings accompanying weak feet, or great velocity making up for the absence of defensive weapons; for it has been shown that all varieties in which an unbalanced deficiency occurred could not long continue their existence. The action of this principle is exactly like that of the centrifugal governor of the steam engine, which checks and corrects any irregularities almost before they become evident; and in like manner no unbalanced deficiency in the animal kingdom can ever reach any conspicuous magnitude, because it would make itself felt at the very first step, by rendering existence difficult and extinction almost sure soon to follow.

*Journal of the Proceedings of the Linnean Society, Zoology*, Volume 3, 1858 (pp. 61–62)**ORGASM****Burroughs, William S.** 1914–97

American writer

There is the pleasurable orgasm, like a rising sales graph, and there is the unpleasurable orgasm, slumping ominously like the Dow Jones in 1929. ...

*The Adding Machine*

My Experiences with Wilhelm Reich's Orgone Box (p. 165)

Arcade Publishing. New York, New York, USA. 1991

**ORIGIN****Berlinski, David** 1942–

American mathematician

...the origin is a mathematical point, something that has sucked from the concept of a place its essential property, that of being *here* rather than there, the infinitely extended line itself balanced perfectly on that slim, solitary, and singular spike.

*A Tour of the Calculus*

Chapter 3 (p. 17)

Pantheon Books. New York, New York, USA. 1995

**Dewar, Redcote**

No biographical data available

The preliminary problem in all human speculation has ever been, the origin of existence, and it still frets the natural philosopher; but the solution is partly determined by the definition of the problem, and its accuracy for today depends almost wholly upon the meaning which present intelligence attaches to the term *origin*.

*From Matter to Man: A New Theory of the Universe*

Chapter I (p. 1)

Chapman &amp; Hall, Ltd. London, England. 1898

...as nothing begets nothing, so something must be begotten of something.

*From Matter to Man: A New Theory of the Universe*

Chapter I (p. 1)

Chapman &amp; Hall, Ltd. London, England. 1898

**ORIGIN OF LIFE****Goldanskii, Vitalii** 1923–2001

Soviet physicist and chemist

Two properties of living systems that are unique from the standpoint of physics, namely, self-replication and homochirality, may serve as Ariadne's thread in the labyrinth of hypotheses concerning this [origin-of-life] problem.

In J. and K. Thon van Tran, J. C. Mounolou, J. Schneider, and C. Mckay (eds.)

*Frontiers of Life*

Chirality, Origin of Life, and Evolution

Publisher undetermined

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

...when I began to be interested in the problem of the origin of life, in the early 1920s, the whole topic was in a state of crisis. It appeared as if it was a forbidden subject in the world of science. The problem was generally felt to be insoluble in principle using objective scientific

research methods. It was felt that it belonged more to the sphere of faith than knowledge, and that, for this reason, serious scientists should not waste their time and effort on hopeless attempts to solve the problem.

Jubilee for Heterogenesis Research  
*New Scientist*, Volume 142, 1974

**Sagan, Carl** 1934–96

American astronomer and author

Every human community has somehow or other tried to understand...deep questions of origins. Origin of our group, whatever it is, origin of our species, origin of life, origin of Earth, origin of the universe. I think you have to be made out of wood not to be interested in these questions. And there's no way to understand even the questions, much less the answers, without understanding science.

Speech

National meeting of the American Astronomical Society (January 5, 1993)

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

To push anything back into the past is equivalent to reducing it to its simplest element. Traced as far as possible in the direction of their origins, the last fibers of the human aggregate are lost to view and are merged in our eyes with the very stuff of the universe.

*The Phenomenon of Man*

Book One, Chapter I (p. 39)

Harper & Brothers. New York, New York, USA. 1959

**Wächtershäuser, Günter**

International patent lawyer

The chemist strives to explain the inanimate world by reference to mechanistic laws. The historian strives to understand the world of human culture by reference to a fabric of plans and purposes.... Nowhere is this encounter in sharper focus than in the problem of the origin of life.

The Origin of Life and Its Methodological Challenge

*Journal of Theoretical Biology*, Volume 187, 1997

**ORIGIN OF SPECIES**

**Gulick, John T.** 1832–1923

American missionary and evolutionist

When a number of closely related varieties and species, occupying adjoining districts of very limited extent, come under observation, the problems connected with the origin of species are liable to be forced upon us.

*Evolution, Racial and Habitudinal: Racial & Habitudinal*

Chapter I (p. 1)

Carnegie Institution of Washington. Washington, D.C. 1905

**ORIGINAL**

**Lee, Gerald Stanley** 1862–1944

Writer

To be original is to discover the commonplace of a thousand years – to face at first the sneer that no one would have thought of it, and at last the indifference because anyone would.

*The Shadow Christ*

Chapter XIX (p. 118)

The Century Co. New York, New York, USA. 1905

**ORIGINALITY**

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Those theories to which we ascribe originality are not so easily grasped, not so quickly epitomized and systematized. An author tends toward this or that way of thinking; but it is modified by his individuality, indeed, often simply by his presentation, by the peculiarity of the idiom in which he speaks and writes, by the change in times, by various considerations.

In Karl J. Fink

*Goethe's History of Science*

Chapter 9 (p. 115)

Cambridge University Press. Cambridge, England. 1991

Originality provokes originality.

Translated by Otto Wenckstern

*Goethe's Opinions on the World, Mankind, Literature, Science, and Art* (p. 41)

John W. Parker & Son. London, England. 1853

**ORNAMENT**

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Ornament cannot be overcharged if it be good, and is always overcharged when it is bad.

*The Seven Lamps of Architecture*

Chapter I (p. 23)

John Wiley & Son. New York, New York, USA. 1865

...as a woman of feeling would not wear false jewels, so would a builder of honor disdain false ornaments.

*The Seven Lamps of Architecture*

Chapter 2 (p. 44)

John Wiley & Son. New York, New York, USA. 1865

No ornaments... are so cold, clumsy, and vulgar, so essentially incapable of a fine line, or shadow, as those of cast iron...

*The Seven Lamps of Architecture*

Chapter 2 (p. 46)

John Wiley & Son. New York, New York, USA. 1865

## ORNITHOLOGIST

### Broderip, William John 1789–1859

English naturalist

The melody of birds finds its way to the heart of everyone; but the cause that prompts the outpourings that make copse, rock, and river, ring again on a fine spring morning is more a matter of doubt with ornithologists than the uninitiated in zoological mysteries might suppose.

*Zoological Recreations*

Part First: Birds (p. 13)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1849

### Elliot, Daniel G.

No biographical data available

The ornithologist is not made, but born to fill his role in life as is the poet; and as you cannot construct a naturalist, neither can you destroy that irresistible impulse which compels him to follow his allotted part, and which was implanted into his very nature by the Great Ruler of Events with the first breath he drew.

The Life and Services of John James Aud

*Transactions of the New York Academy of Sciences*, Volume XIII,

November 5, 1893 (p. 54)

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

We should go to the ornithologist with a new feeling if he could teach us what the social birds say when they sit in the autumn council, talking together in the trees. The want of sympathy makes his record a dull dictionary. His result is a dead bird. The bird is not in its ounces and inches, but in its relations to nature; and the skin or skeleton you show me is no more a heron than a heap of ashes or a bottle of gases into which his body has been reduced, is Dante or Washington.

*The Conduct of Life* (pp. 281–282)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

### John Lambert (Fictional character)

No ornithologist should ever marry. After all you can't watch birds and chase women at the same time.

*The Flying Serpent*

Film (1946)

### Kutchin, Victor 1851–1939

No biographical data available

The difference between a “Bird Lover” and an “Ornithologist” is much the same as between a “Demonstrator of Anatomy” and a “Family Physician,” one gains his facts from death, the dissection of a dead body, the other from life, the study of a living creature.

*What Birds Have Done With Me*

Chapter X (p. 109)

Richard G. Badger. Boston, Massachusetts, USA. 1922

### Lumaden, James

No biographical data available

The name ornithologist is a most comprehensive one. According to the popular use of the word it is applied alike to the scientist who spends his time in studying the anatomical structure of the various orders of birds, and to the old cobbler who prides himself on the colour of his pet canary, the shape of his pigeons, or the tail of his Spanish cock.

*Transactions of the Stirling*

Hints on the Study of Ornithology

1886–87 (p. 13)

### Macgillivray, William 1796–1852

Scottish naturalist and ornithologist

A pompous ornithologist is of all characters one of the most absurd; and the solemnity of scientific pride sits ill upon him who is alternately scaling precipices and wading bogs, chasing the ptarmigan on the weather-beaten summits of the Highland hills, and pursuing the flights of plovers along the sandy shores of our bays and estuaries.

*A History of British Birds, Indigenous and Migratory*

Preface (p. iii)

Printed for Scott, Webster & Geary. London, England. 1837

### Parkhurst, Howard Elmore 1842–1933

American clergyman and reformer

Any ornithologist is very narrow-minded, who, in all his wanderings, finds only birds.

*Song Birds and Water Fowl*

Water Fowl (p. 59)

Charles Scribner's Sons. New York, New York, USA. 1897

### Watkins, Morgan George

One of the most tantalising accidents which can happen to an ornithologist is when a rare bird is eaten by its captor through ignorance of its value.

*In the Country*

British Birds and Bird Lovers (p. 180)

W. Satchell & Co. London, England. 1883

## ORNITHOLOGY

### Audubon, John James 1785–1851

West Indian-born American ornithologist and artist

To render more pleasant the task you have imposed upon yourself, of following an author through the mazes of descriptive ornithology, permit me, kind reader, to relieve the tedium which may be apt now and then to come upon you, by presenting you with occasional descriptions of the scenery and manners of the land which has furnished the objects that engage your attention.

*Ornithological Biography* (Volume 1)

The Ohio (p. 29)

Adam Black. Edinburgh, Scotland. 1831

**Author Undetermined**

...the philosophy of science is just about as useful to scientists as ornithology is to birds.

In S. Weinberg

Newtonianism, Reductionism and the Art of Congressional Testimony  
*Nature*, Volume 330, Number 6147, 3–9 December, 1987 (p. 433)

**Darwin, Charles Robert** 1809–82

English naturalist

I took much pleasure in watching the habits of birds, and even made notes on the subject. In my simplicity I remember wondering why every gentleman did not become an ornithologist.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 32)

D. Appleton & Company. New York, New York, USA. 1896

**Vidal, Gore** 1925–

American essayist, novelist, and social/political commentator

To a man, ornithologists are tall, slender, and bearded so that they can stand motionless for hours, imitating kindly trees, as they watch for birds.

*Armageddon? Essays 1983–1987*

Mongolia (p. 131)

Vintage Books. New York, New York, USA. 1990

**White, Gilbert** 1720–93

English naturalist and cleric

A good ornithologist should be able to distinguish birds by their air [manner] as well as by their colours and shape; on the ground as well as on the wing, and in the bush as well as in the hand.

*The Natural History of Selborne*

Letter XLII

To Dianas Barrington

August 7, 1778

Robert M. McBride & Company. New York, New York, USA. 1925

**OSMOTIC PRESSURE****van't Hoff, Jacobus Henricus** 1852–1911

Dutch physical and organic chemist

In an investigation, whose essential aim was a knowledge of the laws of chemical equilibrium in solutions, it gradually became apparent that there is a deep-seated analogy – indeed, almost an identity – between solutions and gases, so far as their physical relations are concerned; provided that with solutions we deal with the so-called osmotic pressure, where with gases we are concerned with the ordinary elastic pressure.

The Role of Osmotic Pressure in the Analogy between Solutions and Gases

*Zeitschrift für physikalische Chemie*, Volume 1, 1887

**OSTEOPATH****Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Osteopath – One who argues that all human ills are caused by the pressure of hard bone on soft tissue. The proof of his theory is to be found in the heads of those who believe it.

*A Mencken Chrestomathy*

Chapter XXX (p. 625)

Alfred A. Knopf. New York, New York, USA. 1949

**OTHER WORLDS****Abbey, Henry** 1842–1911

Author

When from the vaulted wonder of the sky  
The curtain of the light is drawn aside,  
And I behold the stars in all their wide  
Significance and glorious mystery,  
Assured that those more distant orbs are suns  
Round which innumerable worlds revolve,  
My faith grows strong, my day-born doubts dissolve,  
And death, that dread annulment which life shuns,  
Or fain would shun, becomes to life the way,  
The thoroughfare to greater worlds on high,  
The bridge from star to star. Seek how we may,  
There is no other road across the sky;  
And, looking up, I hear star-voices say:  
“You could not reach us if you did not die.”

*The Poems of Henry Abbey*

Faith's Vista

Kingston. New York, New York, USA. 1895

**Asimov, Isaac** 1920–92

American author and biochemist

Of course there are worlds. Millions of them! Every star you see has worlds, and most of those you don't see.

*Pebbles in the Sky*

Chapter 11 (p. 119)

Doubleday & Co. Garden City, New York, USA. 1950

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

...you tell us that Democritus says that there are a countless number of worlds, and that there are some which are not only so like one another, but so completely and absolutely equal in every point, that there is no difference whatever between them, and that they are quite innumerable; and so also are men.

Translated by C.D. Yonger

*The Academic Questions, Treatise de Finibus and Tusculan Disputations of M. T. Cicero*

Academic Questions (p. 49)

Henry G. Bohn. London, England. 1853



**Derham, William** 1657–1735  
English clergyman and natural philosopher

...if the reader should have a mind to amuse himself with probable guesses about the furniture of the planets of our solar system, what countries 'tis probable are there, what vegetables are produced, what minerals and metals are afforded, what animals live there, what parts, faculties and endowments they have, with much more to the same purpose, he may find a pleasant entertainment in the great Mr. Christian Huygens' *Cosmotheoros*, and some other authors that have written on the subject.

*Astro-theology: Or, A Demonstration of the Being and Attributes of God* (pp. liv–lv)  
Printed for W. Innys. London, England. 1731

### **Halpern, Paul**

Professor of Mathematics and Physics

...there are four major ways in which researchers are hunting for planets. Technically, these are called astrometry, spectroscopy, interferometry, and photometry. For descriptive purposes, however, I refer to them respectively as the wobble method, the speed-trap technique, the zebra-stripe procedure, and the shadow approach.

*The Quest for Alien Planets: Exploring Worlds outside the Solar System* Chapter 1 (p. 16)  
Plenum Trade. New York, New York, USA. 1997

### **Howe, Herbert Alonzo** 1858–1926

American astronomer

When at the dead of night, while nature is hushed in repose, one looks out upon the over-arching sky, inlaid with "patines of bright gold," and, perchance, plying his telescope, is carried in imagination from cluster to cluster, from universe to universe, the thought that there is no intelligent being in those unfathomable depths of space, gives an oppressive sense of the loneliness of man.

*The Habitability of Other Worlds*  
*The Sidereal Messenger*, Volume 4, Number 10, December, 1885 (p. 294)

### **Jackson, Helen Hunt** 1830–85

American writer and poet

Who knows what myriad colonies there are  
Of fairest fields, and rich, undreamed-of gains  
Thick planted in the distant shining plains  
Which we call sky because they lie so far?  
Oh, write of me, not "Died in bitter pains,"  
But "Emigrated to another star!"

*Helen Jackson's Poems*

Emigravit  
Robert Brothers. Boston, Massachusetts, USA. 1888

### **Magnus, Albertus** 1206–1280

Scientist, philosopher, and theologian

Do there exist many worlds, or is there but a single world?  
This is one of the most noble and exalted questions in the study of Nature.

In G. McColley  
*The Seventeenth-Century Doctrine of a Plurality of Worlds*  
*Annals of Science*, Volume 1, Number 4, October 15, 1936 (p. 385)

### **Milne, Edward Arthur** 1896–1950

English astrophysicist and cosmologist

Is it irreverent to suggest that an infinite God could scarcely find the opportunities to enjoy Himself, to exercise His godhead, if a single planet were the sole seat of His activities?

*Modern Cosmology and the Christian Idea of God* (p. 152)  
Clarendon Press. Oxford, England. 1952

### **Oersted, Hans Christian** 1777–1851

Danish physicist and chemist

Dost thou perceive naught but machinery  
In laws which guide the course along heaven's paths?  
Look with a larger view around; behold  
The unity of living thoughts, displayed  
In countless varying forms. The mighty sun  
Is but a twinkling star amidst the space  
Infinite filled with worlds, whose suns, heaven's lamps,  
Shine in our night.... Look

Upon the spangled heav'ns, there to discover  
Thousands of blazing suns, encircled by  
Companions numerous.... A race of beings behold  
Struggling for mental power, knowledge divine.

*The Soul in Nature: With Supplementary Contributions*  
The Balloon  
H.G. Bohn. London, England. 1852

### **Tennyson, Alfred (Lord)** 1809–92

English poet

The Moon's white cities, and the opal width  
Of her small glowing lakes, her silver heights  
Unvisited with dew of vagrant cloud,  
And the unsounded, undescended depth  
Of her black hollows. The clear galaxy  
Shorn of its hoary lustre, wonderful,  
Distinct and vivid with sharp points of light,  
Blaze within blaze, an unimagined depth  
And harmony of planet-girded suns  
And moon-encircled planets, wheel in wheel,  
Arch'd the wan sapphire. Nay – the hum of men,  
Or other things talking in unknown tongues  
And notes of busy life in distant worlds  
Beat like a far wave on my anxious ear.

*Alfred Tennyson's Poetical Works*

Timbuctoo  
Oxford University Press, Inc. London, England. 1953

And the suns of the limitless universe sparkled and shone  
in the sky,  
Flashing with fires as of God, but we knew that their light  
was a lie –



Bright as with deathless hone – but, however they spar-  
kled and shone,  
The dark little worlds running round them were worlds  
of woe like our own.

*Alfred Tennyson's Poetical Works*

Despair, Stanza III

Oxford University Press, Inc. London, England. 1953

**Tyndall, John** 1820–93

Irish-born English physicist

Whether the other fixed stars have similar planetary com-  
panions or not is to us a matter of pure conjecture, which  
may or may not enter into our conception of the universe.  
But, probably, every thoughtful person believes, with  
regard to those distant suns, that there is in space some-  
thing besides our system on which they shine.

*Fragments of Science for Unscientific People: A Series of Detached  
Essays*

Chapter I (p. 11)

D. Appleton & Co. New York, New York, USA. 1871

...every thoughtful person believes, with regard to those  
distant suns, that there is in space something besides our  
system on which they shine.

*Fragments of Science for Unscientific People*

Chapter I (p. 11)

D. Appleton & Co. New York, New York, USA. 1875

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Let your soul stand cool and composed before a million  
universes.

*Complete Poems and Collected Prose*

Song of Myself

Section 48

The Library of America. New York, New York, USA. 1982

I was thinking this globe enough, till there sprang out so  
noiseless

around me myriads of other globes.

Now, while the great thoughts of space and eternity fill  
me, I will

measure myself by them;

And now, touch'd with the lives of other globes, arrived  
as far

along as those of the earth,

Or waiting to arrive, or pass'd on farther than those of  
the earth,

I henceforth no more ignore them, than I ignore my own  
life,

Or the lives of the earth arrived as far as mine, or waiting  
to arrive.

*Complete Poetry and Collected Prose*

Night on the Prairies

The Library of America. New York, New York, USA. 1982

## OUTER SPACE

**Ballard, Robert D.** 1942–

American oceanographer

At a time when most think of outer space as the final  
frontier, we must remember that a great deal of unfin-  
ished business remains here on earth.

*The Eternal Darkness*

Introduction (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 2002

**Hey, Nigel S.** 1936–

American science writer

Human minds are being pulled into outer space by a thin,  
strong filament of neural energy called wonder. And this,  
to me, is a very good thing. As more of us let our sense  
of wonder expand into the cosmos – so that we compre-  
hend the delicate smallness of our planet in the scheme  
of things – we are gaining a special kind of wisdom.  
My dream is that, with the blessing of good fortune, this  
wisdom will eventually enable us to transcend the dan-  
gerous confusion of civilizations that are maintained by  
coercion and misbelief. All sane persons will compre-  
hend their innate unity with the supernovas of which we  
are made. There will be no need for Utopia, for then we  
will have become meta-humans, siblings to all things that  
exist with and among the planets and the teeming stars.  
And then, perhaps, there will be peace at last.

Why People Need Space

Lecture, National Space Center, October, 2002

**MacLeod, Ken** 1954–

Scottish science fiction writer

Outer space is, fundamentally, familiar. It's only the night  
sky, without the earth beneath your feet.

*The Engines of Light*

Cosmonaut's Keep (p. 1)

Tom Doherty Associates, LLC. New York, New York, USA. 2002

## United Nations Treaty on the Exploration and Use of Space

The exploration and use of outer space, including the  
moon and other celestial bodies, shall be carried out for  
the benefit and in the interests of all countries, irrespec-  
tive of their degree of economic or scientific develop-  
ment, and shall be the province of all mankind.

January 27, 1967

**Webb, Jimmy** 1946–

American music composer

I'll fly a starship, across the universe divine,

And when I reach the other side

I'll find a place to rest my spirit if I can

Perhaps I may become a highwayman again  
 Or I may simply be a single drop of rain  
 But I will remain, and I'll be back again  
 And again, and again, and again.

*Ten Easy Pieces*  
 Highwayman  
 CM Angel. 1996

## OUTLIER

**Green, Celia** 1935–  
 English philosopher and psychologist

The fact that something is far-fetched is no reason why it

should not be true; it cannot be as far-fetched as the fact  
 that something exists.

*The Decline and Fall of Science*  
 Aphorisms (p. 1)  
 Hamilton. London, England. 1976

**Hoyle, Sir Fred** 1915–2001  
 English mathematician and astronomer

I don't see the logic of rejecting data just because they  
 seem incredible.

In D.O. Edge and M.J. Mulkay  
*Astronomy Transformed: The Emergence of Radio Astronomy in Britain*  
 Notes: Chapter 3 (p. 432, fn j)  
 John Wiley & Sons, Inc. New York, New York, USA. 1976

## P

### PAIN

**Bell, Sir Charles** 1774–1842  
Scottish anatomist and surgeon

Pain is the necessary contrast to pleasure; it ushers us into existence or consciousness: it alone is capable of exciting the organs into activity: it is the compassion and the guardian of human life.

*The Hand, Its Mechanism and Vital Endowments as Evincing Design*  
Chapter 7 (p. 211)  
John Murray. London, England. 1852

**Burney, Fanny** 1752–1840  
English novelist and diarist

When the dreadful steel was plunged into the breast – cutting through veins – arteries – flesh – nerves – I needed no more injunctions not to restrain my cries. I began a scream that lasted unintermittingly during the whole time of the incision – & I almost marvel that it rings not in my Ears still! so excruciating was the agony.

In A. Dally  
*Women Under the Knife: A History of Surgery*  
Letter to Esther Burney, 1811  
Hutchinson Radius. London, England. 1991

**Coates, Florence Earle** 1850–1927  
American poet

Ah, me! the Prison House of Pain! –  
what lessons there are bought! –  
Lessons of a sublimer strain  
Than any elsewhere taught.

*Poems* (Volume 2)  
The House of Pain  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Dickinson, Emily** 1830–86  
American lyric poet

Pain has an element of blank;  
It cannot recollect  
Where it began, or if there were  
A day when it was not.

*The Complete Poems of Emily Dickinson*  
No. 650 (p. 323)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

He has seen but half the universe who never has been  
shewn the House of Pain.

*The Complete Works of Ralph Waldo Emerson* (Volume 12)  
*Natural History of Intellect*  
The Tragic (p. 405)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Hilton, John** 1804–78  
English surgeon

Every pain has its distinct and pregnant signification, if we will but carefully search for it.

*Rest and Pain: A Course of Lectures on the Influence of Mechanical and Physiological Rest In the Treatment of Accidents and Surgical Diseases, and the Diagnostic Value of Pain* (p. 499)  
George Bell & Sons. London, England. 1892

Pain the monitor, and Rest the cure, are starting points for contemplation which should ever be present to the mind of the surgeon in reference to his treatment.

*Rest and Pain: A Course of Lectures on the Influence of Mechanical and Physiological Rest In the Treatment of Accidents and Surgical Diseases, and the Diagnostic Value of Pain* (p. 500)  
George Bell & Sons. London, England. 1892

**Hood, Thomas** 1582–98  
English poet and editor

Of all our pains, since man was curst,  
I mean of body, not the mental,  
To name the worst, among the worst,  
The dental sure is transcendental;  
Some bit of masticating bone,  
That ought to help to clear a shelf:  
But let its proper work alone,  
And only seems to gnaw itself.

*The Complete Poetical Works of Thomas Hood*  
A True Story  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

...those who do not feel Pain, seldom think that it is felt...  
*The Rambler* (Volume 1)  
No. 48, September 1, 1750 (p. 335)  
Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Latham, Peter Mere** 1789–1875  
English physician

It would be a great thing to understand Pain in all its meanings.

In William B. Bean  
*Aphorisms from Latham* (p. 71)  
Prairie Press. Iowa City, Iowa, USA. 1962

**Mather, Cotton** 1663–1728  
American minister and religious writer

WHAT is Pain? Tis a Sensation produced on the Tension of a Nerve.

*The Angel of Bethesda*  
Capsula IX (p. 54)  
American Antiquarian Society and Barre Publishers. Barre, Massachusetts, USA. 1972

**Robinson, Victor** 1886–1947  
Physician

The first cry of pain through the primitive jungle was the first call for a physician.

*The Story of Medicine*

Chapter I (p. 1)

The New York Home Library. New York, New York, USA. 1943

**Schweitzer, Albert** 1875–1965

Alsatian-German theologian and philosopher

Whosoever is spared personal pain must feel himself called to help in diminishing the pain of others.

Recalled on his death

September 4, 1965

Source undetermined

**Sonneberg, Walter**

No biographical data available

Pain is a blessing for which the dentist offers daily thanks.

*Social Eccentricities*

Social Eccentricities (p. 35)

Broadway Publishing Co. New York, New York, USA. 1906

**Thompson, Francis** 1859–1907

English writer

Nothing begins, and nothing ends,

That is not paid with a moan;

For we are born in other's pain,

And perish in our own.

*Complete Poetical Works of Francis Thompson*

Daisy, Stanza 15

Boni & Liveright, Inc., Publishers. New York, New York, USA. 1923

**Watson, Sir William** 1858–1935

English author of lyrical and political verse

Pain with the thousand teeth.

*The Poems of William Watson*

The Dream of Man (p. 127)

Macmillan & Company. New York, New York, USA. 1893

**Woolf, Virginia** 1882–1941

English novelist and essayist

English which can express the thoughts of Hamlet and the tragedy of Lear, has no words for the shiver and the headache.... The merest schoolgirl, when she falls in love, has Shakespeare, Donne, Keats to speak her mind for her; but let a sufferer try to describe a pain in his head to a doctor and language at once runs dry.

*The Moment: And Other Essays*

On Being Ill (p. 15)

The Hogarth Press. London, England. 1947

## PALAEONTOLOGY

**Andrews, Roy Chapman** 1884–1960

American explorer and dinosaur hunter

Palaeontology is the Aladdin's lamp of the most deserted and lifeless regions of the earth; it touches the

rocks and there spring forth in orderly succession the monarchs of the past and the ancient river streams and savannahs wherein they flourished. The rocks usually hide their story in the most difficult and inaccessible places.

*On The Trail Of Ancient Man: A Narrative Of The Field Work Of The Central Asiatic Expeditions*

Introduction (p. x)

G. P. Putnam's Sons. 1926

**Burroughs, Edgar Rice** 1875–1950

American writer

He was a pretty good scholar despite his love of fun, and his particular hobby was palaeontology.

*The People That Time Forgot*

Chapter 2 (p. 17)

**Gissing, George** 1857–1903

English novelist

Though a man be well versed in a science such as palaeontology it does not follow that he will view it in its philosophical relations.

*Born in Exile*

Part the Third, III (p. 228)

Adam & Charles Black. London, England. 1893

**Simpson, George Gaylord** 1902–84

American paleontologist

To those who follow that science, nothing is more lively than the study of the dead remains of ancient life. Fascinating in itself, paleontology also impinges on much else that is interesting, important, and useful.

*Life of the Past*

Preface (p. vii)

Yale University Press. New Haven, Connecticut, USA. 1953

**Owen, Richard** 1804–92

English biologist, comparative anatomist, and paleontologist

Paleontology further teaches, that not only the individual, but the species perishes; that as death is balanced by generation, so extinction has been concomitant with the creative power which has produced a succession of species; and furthermore, that, in this succession, there has been "an advance and progress in the main."

*Palaeontology* (2nd edition)

Introduction (p. 3)

Adam & Charles Black. Edinburgh, Scotland. 1861

**Weber, Richard John**

Biologist

**Taylor, William T.**

No biographical data available

*Paleontology* is a science which deals with the study of extinct plants and animals that survive today as fossils.

*General Biology* (p. 3)

van Nostrand. Princeton, New Jersey, USA. 1961

**PALEOBIOLOGY**

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

Three hundred and fifty million years ago is as far away as a star. To describe a plant that was growing then would seem the attempt of a madman or a magician, so lost in time is it now. In the eons since it was green, whole populations of plants have arisen and conquered the world and fallen again, leaving here and there a few survivors to persist, altering with the ages, vague reminders of what the world was like in their day.

*Flowering Earth*

Chapter 9 (p. 103)

G.P. Putnam's Sons. New York, New York, USA. 1939

**PALEOECOLOGY**

**Valentine, James**

No biographical data available

Our task, then, is to identify the remains that lived together, reconstruct the community structure and infer its ecological and evolutionary significance.

*Evolutionary Paleocology of the Marine Biosphere* (p. 308)

Prentice-Hall. Englewood, Cliffs, New Jersey, USA. 1973

**PALEONTOLOGIST**

**Bracker, Milton**

No biographical data available

Consider the sages who pulverize boulders,  
And burrow for elbows and shinbones and shoulders,  
And shovel the loot from a hill or a dale of it,  
And lovingly carry off pail after pail of it.

P Is for Paleontology

*Journal of Geological Education*, Volume 19, Number 4, September, 1971 (p. 192)

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

The paleontologist watching the rise and fall of races sees, with only actors and setting changed, one drama repeated. Thus like the jaded critic he knows the end before the final curtain. He sees that death is the penalty for life.

*Parade of the Living*

Part III, Chapter XVII (pp. 237–238)

Coward-McCann, Inc. New York, New York, USA. 1930

**Brett-Surman, Michael** 1950–

American paleontologist

Being a paleontologist is like being a coroner except all the witnesses are dead and all the evidence has been left out in the rain for 65 million years.

In Louie Psihoyos

*Hunting Dinosaurs* (p. vii)

Random House, Inc. New York, New York, USA. 1994

**Burroughs, Edgar Rice** 1875–1950

American writer

...about all that remained was an impression of horror that the illustrations of restored prehistoric monsters had made upon me, and a well-defined belief that any man with a pig's shank and a vivid imagination could "restore" most any sort of paleolithic monster he saw fit, and take rank as a first class paleontologist.

*At the Earth's Core*

Chapter IV (p. 67)

University of Nebraska Press. Lincoln, Nebraska, USA. 2000

**Colbert, Edwin H.** 1905–2001

American vertebrate paleontologist

Any paleontologist worth his or her salt takes a great deal of pleasure in thinking of the discoveries he has made in the field and laboratory, but true satisfaction is in the publications that describe and interpret the fossils.

*Digging into the Past: An Autobiography*

Chapter VII (p. 126)

Dembner Books. New York, New York, USA. 1989

**Cousteau, Jacques-Yves** 1910–77

French naval officer and ocean explorer

A paleontologist holds the thread of evolution in his hands by combining the biological and geological evidence in fossils.

*The Ocean World of Jacques Cousteau: The Adventure of Life*

Chapter I (p. 13)

The World Publishing Company. New York, New York, USA. 1973

**Gaudry, Jean-Albert** 1827–1908

French paleontologist

It is the proper function of paleontologists to supply some proofs to the doctrine of evolution; it does not fall to them to explain the process by which the author of the world has produced the modifications. That study of processes is what is called Darwinism.... Assuredly it is a subject quite worthy of the attention of those naturalists that study the causes of the modifications of beings; but it is up to the physiologists, who experiment on living creatures, to teach us how the changes are produced today, and must have been produced formerly.... On this subject a paleontologist can avow his ignorance. All that he can say is that the discovery of vestiges buried in the bowels of the earth teach us that a constant harmony has presided at the transformation of the organic world.

Les Enchaenements

*Revue des Deux Mondes*, 9th Series, Volume 23, 1877 (p. 183)

**Matthew, William Diller** 1871–1930

Canadian-American paleontologist

...evolution is only one aspect of the order of nature, of the relations of cause and effect, of continuity of space and time, which pervade the universe and enable us to comprehend its simplicity of plan, its complexity of detail. The paleontologist, engaged in adding year by

year to the mass of documents which record the history of life, in deciphering their meaning and interpreting their significance, has no more occasion to doubt its continuity and orderly development than the historian has to doubt the continuity and consecutive evolution of human history, or the student of current affairs to doubt that the events of tomorrow.

*Natural History*, Volume 25, Number 2, 1925

**Morris, Simon Conway** 1951–  
English paleontologist

As well as being lumps of patterned stone, fossils are also historical documents. History per se has had a bit of bad press recently.... There is a tension between the documentation of history (famously referred to as “one bloody thing after another”), and the search for universal principles that are ahistoric and possibly timeless. After a period in the doldrums, the bearers of the historical tidings, the paleontologists, are making tentative movements toward the legendary High Table where, just visible through the clouds of incense (and rhetoric), the high priests of evolutionary theory smile benignly.

*The Phylogeny of Life and the Accomplishments of Phylogenetic Biology*

Symposium at the University of Arizona. Tucson, Arizona, USA  
October 11–13, 1996

Early Metazoan Radiations: What the Fossil Record Can and Cannot Tell Us

**Simpson, George Gaylord** 1902–84  
American paleontologist

Not long ago paleontologists felt that a geneticist was a person who shut himself in a room, pulled down the shades, watched small flies disporting themselves in milk bottles, and thought that he was studying nature. A pursuit so removed from the realities of life, they said, had no significance for the true biologist. On the other hand, the geneticists said that paleontology had no further contributions to make to biology, that its only point has been the completed demonstration of the truth of evolution, and that it was a subject too purely descriptive to merit the name “science.” The paleontologist, they believed, is like a man who undertakes to study the principles of the internal combustion engine by standing on a street corner and watching the motor cars whizz by.

*Tempo and Mode in Evolution*

Introduction (p. xv)

Columbia University Press. New York, New York, USA. 1944

**Turney, John**  
No biographical data available

Take a complete, illustrated catalogue of London’s National Gallery. Shred it into tiny pieces and cast them into the wind from the gallery’s steps above Trafalgar Square. Wait a few weeks, then scour the square for

surviving scraps of paper. Now try to reconstruct the history of painting from your haul. If you manage to produce a coherent story – schools, styles, genres, named painters and all – you are probably a paleontologist.

Review of “In Search of Deep Time”

*New Scientist*, 25 March, 2000

## PALEONTOLOGY

**Grassé, Pierre P.** 1895–1985  
French zoologist

Naturalists must remember that the process of evolution is revealed only through fossil forms. A knowledge of paleontology is, therefore, a prerequisite; only paleontology can provide them with the evidence of evolution and reveal its course or mechanisms. Neither the examination of present beings, nor imagination, nor theories can serve as a substitute for paleontological documents. If they ignore them, biologists, the philosophers of nature, indulge in numerous commentaries and can only come up with hypotheses. That is why we constantly have recourse to paleontology, the only true science of evolution. From it we learn how to interpret present occurrences cautiously; it reveals that certain hypotheses considered certainties by their authors are in fact questionable or even illegitimate.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*

An Introduction to the Study of Evolution (p. 4)

Academic Press. New York, New York, USA. 1977

**Bakker, Robert T.** 1945–  
American paleontologist

Paleontology is a very visual inquiry.... All paleontologists scribble on napkins at coffee breaks, making sketches to explain their thinking.

Brushing Up On Dinosaurs

*Science News*, October 4, 1986

**Crawford, Osbert Guy Stanhope** 1886–1957  
English archaeologist

If archaeology is humanity revealed by its works, paleontology is life revealed by its own remains.

*Man and His Past*

Chapter VI (p. 70)

Oxford University Press, Inc. London, England. 1921

**Dunbar, Carl O.**  
No biographical data available

If they stink, the remains belong to zoology, but if not, to paleontology.

In Alan M. Cvanara

*Sleuthing Fossils: The Art of Investigating Past Life*

Chapter 1 (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1990



**Hillery, Herbert**

No biographical data available

There is no end to paleontology, there is no end to geology; and when the morning of the resurrection shall come, some paleontologist will be searching for some previously undiscovered species of extinct beings, and some geologist will be pecking away at the rocks to find some characteristics which have never been before ascertained. There is no end to it.

*Congressional Record*, Volume 23, 1892 (p. 4626)

**Herzen, Aleksandr** 1812–70

Russian political author

The small buds of organic chemistry, geology, paleontology, comparative anatomy have grown in our century into huge branches and borne fruit exceeding our wildest hopes. The world of the past, obedient to the mighty voice of science, has left the tomb to bear witness to the upheavals which accompany the evolution of the surface of the globe; the soil on which we live, this tombstone of the past life, is growing transparent, as it were; the stone vaults have opened, the interior of the rocks could not retain their secrets. Not only do the half-decayed, half-petrified vestiges again assume flesh, paleontology also strives to discover the law of the relation between geologic epochs and their complete flora and fauna. Then everything that ever lived will be resurrected in the human mind, will be saved from the sad fate of utter oblivion, and those whose bones have been completely decayed, whose phenomenal existence has been utterly obliterated, will be restored in the bright sanctuary of science where the temporal finds its repose and is perpetuated.

*Selected Philosophical Works*

Letters on the Study of Nature, Letter One (pp. 99–100)

Foreign Languages Publishing House. Moscow, Russia. 1956

**Howard, Robert West**

No biographical data available

The three volumes of [Lyell's] *Principles of Geology*, published between 1829 and 1833, became the essential textbook of the profession. In its discussion of fossils and the vital role they had played in the development of geology as an exact science, Lyell urged adoption of a Greek-rooted word, meaning "the science of early beings," as the professional name for research of the types of plant and animal fossils embedded in the Earth's layered crust. His suggestion was adopted throughout Europe and the Americas. Thus, three centuries after the curiosities of Leonardo da Vinci, the dawnseekers' science was given the name of paleontology.

*The Dawnseekers: The First History of American Paleontology*

Chapter 9 (p. 126)

Harcourt Brace Jovanovich. New York, New York, USA. 1975

**Huxley, Thomas Henry** 1825–95

English biologist

That application of the sciences of biology and geology, which is commonly known as palæontology, took its origin in the mind of the first person who, finding something like a shell, or a bone, naturally imbedded in gravel or rock, indulged in speculations upon the nature of this thing which he had dug out – this "fossil" – and upon the causes which had brought it into such a position.

*Collected Essays* (Volume 4)

The Rise and Progress of Palæontology (p. 24)

Macmillan & Company Ltd. London, England. 1904

**Kielan-Jaworowska, Zofia** 1925–

Polish paleontologist

No scientist familiar with the intellectual adventure of studying animals from times long past will have any hesitation in affirming that to travel millions of years into the past, which is what paleontological study amounts to, is much more fascinating than the most exotic geographical travel we are able to undertake today. The study of animals that lived on Earth millions of years ago is not merely a study of their anatomy, but first and foremost a study of the course of evolution on earth and of the laws that govern it.

Translated by the Israel Translation Society

*Hunting for Dinosaurs*

Chapter 15 (p. 176)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Kitts, David B.**

Evolutionist and paleontologist

Despite the bright promise that paleontology provides a means of "seeing" evolution, it has presented some nasty difficulties for evolutionists, the most notorious of which is the presence of "gaps" in the fossil record. Evolution requires intermediate forms between species and paleontology does not provide them...

*Evolution*, Volume 28, September, 1974 (p. 467)

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It may seem that palaeontology is a science of pure speculation or inquisitiveness, and the palaeontologist the most unreal and useless of researchers; a man dedicated to retrospection, plunged living into the past, where he spends his days collecting the debris of dead things.

*The Future of Man*

Chapter IV, Part I, Section 3 (p. 66)

Harper & Row, Publishers. New York, New York, USA. 1964

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Paleontology, or the science of ancient organisms, deals, as its subject, with all the plants and animals of all the

geologic periods. It bears nearly the same sort of relation to the physical history of the past that biography does to the civil and political history of the past.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture First (p. 33)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Osborn, Henry Fairfield** 1857–1935

American paleontologist and geologist

Paleontology is the zoology of the past.

*The Age of Mammals in Europe, Asia and North America*

Chapter I (p. 1)

The Macmillan Company. New York, New York, USA. 1910

The preservation of extinct animals and plants in the rocks is one of the fortunate accidents of time, but to mistake this position as indicative of affinity [with zoology and botany] is about as logical as it would be to bracket the Protozoa, which are principally aquatic organisms, under hydrology, or the Insecta, because of their aerial life, under meteorology. No, this is emphatically a misconception which is still working harm in some museums and institutions of learning. Paleontology is not geology, it is zoology; it succeeds only so far as it is pursued in the zoological and biological spirit.

The Present Problems of Paleontology

*Popular Science Monthly*, 1905 (p. 226)

**Rudwick, Martin J. S.**

Science historian

As paleontology now prepares for a great leap forward into a computerised age there is perhaps a danger that it may lose sight of its historic origins in the “steam age” of science and before.

*The Meaning of Fossils, Episodes in the History of Paleontology*

Chapter Five, Section XII (p. 266)

Macdonald. London, England. 1972

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

What a noble science is paleontology! And what really startling sagacity its votaries exhibit!

*Collected Tales, Sketches, Speeches & Essays 1852–1890* (Volume 1)

A Brace of Brief Lectures on Science (p. 528)

The Library of America. New York, New York, USA. 1992

**van der Gracht, W. A.** 1873–1943

Dutch petroleum geologist

There are few subjects where there exists greater diversity of opinions regarding practically everything than in paleontology.

In C.G. Simpson

Mammals and the Nature of Continents

*American Journal of Science*, Volume 241, 1943 (p. 1)

**von Buch, L.**

No biographical data available

...through knowledge of [paleontology] we obtain not only the history of the Earth but also the history of life.

In Rudolf Daber and Jochen Helms (eds.)

*Fossils: The Oldest Treasures that Ever Lived*

Only a Slab of Transitional Limestone (p. 40)

T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Palaeontological studies have brought charm and variety to the science of the rigid structures of this Earth. Petrified strata show us, preserved in their graves, the flora and fauna of past millennia. We climb upwards in time when, noting the spatial stratification conditions, we penetrate downwards from one stratum to the next. Long-vanished plant and animal life emerges before our eyes.

In Jochen Helms

*Fossils: The Oldest Treasures that Ever Lived*

Knowledge and Museums (p. 9)

T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

## PANSPERMIA

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Should the time come when this earth comes into collision with another body, comparable in dimensions to itself...many great and small fragments carrying seeds of living plants and animals would undoubtedly be scattered through space. Hence, and because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present instance no life existed upon this earth, one such stone falling upon it might, by what we blindly call natural causes, lead to its becoming covered with vegetation.

*Popular Lectures and Addresses* (Volume 2)

Presidential Address to the British Association, Edinburgh, 1871

British Association for the Advancement of Science, Volume 4, Number 262, 1871 (p. 201)

Macmillan & Company Ltd. London, England. 1894

Careful enough scrutiny has in every case up to the present day discovered life as antecedent to life. Dead matter cannot become living matter without coming under the influence of matter previously alive. This seems to be as sure a teaching of science as the law of gravitation.... I am ready to adopt, as an article of scientific faith, true through all space and through all time, that life proceeds from life, and from nothing but life. How, then, did life originate on the Earth?

Sir William Thomson on the Law of Biogenesis and the Law of Gravitation  
*Nature*, September 7, 1871 (p. 368)

### Richter, H. E.

German physician

The infinite space is filled with, or (more correctly) contains, growing, mature, and dying celestial bodies. By mature worlds we understand those which are capable of sustaining organic life. We regard the existence of organic life in the universe as eternal. Life has always been there; it has always propagated itself in the shape of living organisms, from cells and from individuals composed of cells.

Translated by D.H. Borns

Quoted in Svante Arrhenius

*Worlds in the Making*

Chapter VIII (p. 218)

Harper & Brothers Publishers. New York, New York, USA. 1908

### von Helmholtz, Hermann 1821–94

German scientist and philosopher

I cannot object if anyone considers this hypothesis to be in a high, or even in the highest, degree improbable. But to me it seems a perfectly correct scientific procedure, that when all our attempts fail in producing organisms from inanimate matter, we may inquire whether life has ever originated at all or not, and whether its germs have not been transported from one world to another, and have developed themselves wherever they found a favourable soil.

Translated by Edmund Atkinson

*Popular Lectures on Scientific Subjects*

2nd Series

Lecture IV (p. 196)

Longmans, Green & Co. London, England. 1903

## PARABOLA

### Allen, Woody 1935–

American film director and actor

She wore a short skirt and a tight sweater and her figure described a set of parabolas that could cause cardiac arrest in a yak.

*Getting Even*

Mr. Big (p. 139)

Random House, Inc. New York, New York, USA. 1971

### Bell, E. T. (Eric Temple) 1883–1960

Scottish-American mathematician and educator

A parabola is approximately the path of a ball, a bullet, or a shell in the air. If the air offered no resistance the path would be exactly a parabola. Thus if warfare were conducted in a vacuum, as it should be, the calculations of ballistics would be much simpler than they actually are, and it would cost considerably less than the \$25,000 or so of taxes which it is now necessary to shoot away in

order to slaughter one patriot.

*The Handmaiden of the Sciences*

Chapter 2 (p. 24)

Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

### Bodenheim, Maxwell 1891–1954

American poet and novelist

A waterfall hurdled its crazed parabola between gray rocks, flying into a stifled scream of motion far below.

*Introducing Irony*

Scientific Philosophy (p. 75)

Boni & Liveright. New York, New York, USA. 1922

### Frere, John Hookham 1769–1846

British diplomat and man of letters

And first, the fair PARABOLA behold,  
 Her timid arms, with virgin blush, unfold!

Though, on one focus fixed, her eyes betray

A heart that glows with love's resistless sway...

In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 107–108

Printed for J. Wright, by W. Bulmer & Company. London, England. 1801

### Galilei, Galileo 1564–1642

Italian physicist and astronomer

It has been observed that missiles and projectiles describe a curved path of some sort; however no one has pointed out the fact that this path is a parabola. But this and other facts, not few in number or less worth knowing, I have succeeded in proving; and what I consider more important, there have been opened up to this vast and most excellent science, of which my work is merely the beginning, ways and means by which other minds more acute than mine will explore its remote corners.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Third Day (p. 197)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Shaw, George Bernard 1856–1950

Irish comic dramatist and literary critic

KNELLER:...take a sugar loaf and cut it slantwise, and you will get hyperbolas and parabolas, ellipses and ovals...

*The Complete Plays of Bernard Shaw*

*In Good King Charles's Golden Days*, Act I (p. 1358)

Odham's Press. London, England. 1950

## PARACHUTE

### de Bergerac, Cyrano 1619–55

French dramatist

...he was high enough still to have been hurt by the fall, had it not been for – the large skirts of his Gown, which

being swelled by the Wind, gently upheld him till he set  
Foot on ground.

*A Voyage to the Moon*

Chapter VI (p. 56)

Doubleday & McClure Co. New York, New York, USA. 1849

## PARADIGM

### Barnes, Barry

Sociologist

...paradigms, the core of the culture of science, are transmitted and sustained just as is culture generally: scientists accept them and become committed to them as a result of training and socialization, and the commitment is maintained by a developed system of social control.

In Quentin Skinner (ed.)

*The Return of Grand Theory in the Human Sciences*

Thomas Kuhn (p. 89)

Cambridge University Press. Cambridge, England. 1985

### Kuhn, Thomas S. 1922–96

American historian of science

Normal science does not aim at novelties of fact or theory and, when successful, finds none. New and unsuspected phenomena are, however, repeatedly uncovered by scientific research, and radical new theories have again and again been invented by scientists. History even suggests that the scientific enterprise has developed a uniquely powerful technique for producing surprises of this sort. If this characteristic of science is to be reconciled with what has already been said, then research under a paradigm must be a particularly effective way of inducing a paradigm change. That is what fundamental novelties of fact and theory do. Produced inadvertently by a game played under one set of rules, their assimilation requires the elaboration of another set. After they have become parts of science, the enterprise, at least of those specialists in whose particular field the novelties lie, is never quite the same again.

*The Structure of Scientific Revolutions*

Chapter VI (p. 52)

The University of Chicago Press. Chicago, Illinois, USA. 1970

The operations and measurements that a scientist undertakes in the laboratory are not “the given” of experience but rather “the collected with difficulty.” They are not what the scientist sees – at least not before his research is well advanced and his attention focused.... Science does not deal in all possible laboratory manipulations. Instead, it selects those relevant to the juxtaposition of a paradigm with the immediate experience that that paradigm has partially determined.

*The Structure of Scientific Revolutions*

Chapter X (p. 126)

The University of Chicago Press. Chicago, Illinois, USA. 1970

A paradigm is what members of the scientific community share, and, conversely a scientific community consists of men who share a paradigm.

*The Structure of Scientific Revolutions*

Postscript (p. 176)

The University of Chicago Press. Chicago, Illinois, USA. 1970

## PARADISE

### Abbey, Edward 1927–89

American environmentalist and nature writer

When I write “paradise” I mean not only apple trees and golden women but also scorpions and tarantulas and flies, rattlesnakes and Gila monsters, sandstorms, volcanoes and earthquakes, bacteria and bear, cactus, yucca, bladderweed, ocotillo and mesquite, flash floods and quicksand, and yes – disease and death and the rotting of the flesh.

*Desert Solitaire*

Down the River (p. 190)

Ballantine Books. New York, New York, USA. 1968

### Hilbert, David 1862–1943

German mathematician

No one...will drive us out of this paradise that Cantor has created for us!

*Hilbert – Courant*

Hilbert

Chapter XX (p. 177)

Springer-Verlag. New York, New York, USA. 1986

## PARADOX

### Bohr, Niels Henrik David 1886–1962

Danish physicist

How wonderful that we have met with a paradox. Now we have some hope of making progress.

In L.I. Ponomarev

*The Quantum Dice* (p. 75)

Institute of Physics Publishing. Bristol, England. 1993

### Bourbaki, Nicholas

Mathematical discussion group

There is no sharply drawn line between those contradictions which occur in the daily work of every mathematician, beginner or master of his craft, as a result of more or less easily detected mistakes, and the major paradoxes which provide food for logical thought for decades and sometimes centuries.

In Bryan H. Bunch

*Mathematical Fallacies and Paradoxes*

Chapter 2 (p. 38)

van Nostrand Reinhold Company. New York, New York, USA. 1982

**Cudmore, Lorraine Lee**

American cell biologist

It is a bizarre paradox we are facing, for we find that experimental scientists (who are supposed to be fair) at times make the Spanish Inquisition a model of fair hearings and unbiased judgment.

*The Center of Life: A Natural History of the Cell*

Cellular Evolution (p. 55)

New York Times Book Company. New York, New York, USA. 1977

**de Morgan, Augustus** 1806–71

English mathematician and logician

If I had before me a fly and an elephant, having never seen more than one such magnitude of either kind; and if the fly were to endeavor to persuade me that he was larger than the elephant, I might possibly be placed in a difficulty. The apparently little creature might use such arguments about the effect of distance, and might appeal to such laws of sight and hearing as I, if unlearned in those things, might be unable wholly to reject. But there were a thousand flies, all buzzing, to appearance, about the great creature and, to a fly, declaring, each one for himself, that he was bigger than the quadruped; and all giving different and frequently contradictory reasons; and each one despising and opposing the reasons of the others – I should feel quite at my ease...[to] say, My little friends, the case of each one of you is destroyed by the rest.

*A Budget of Paradoxes*

Introduction

The Open Court Publishing Company. Chicago, Illinois, USA. 1915

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Play not with paradoxes. That caustic which you handle in order to scorch others may happen to sear your own fingers and make them dead to the quality of things.

*Felix Holt, the Radical*

Chapter XIII (p. 151)

Wm. L. Allison Company. New York, New York, USA. No date

**Falletta, Nicholas**

No biographical data available

A paradox is truth standing on its head to attract attention.

*The Paradoxicon* (p. xvii)

Doubleday & Company, Inc. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88

American theoretical physicist

...sometimes an idea which looks completely paradoxical at first, if analyzed to completion in all detail and in experimental situations, may, in fact, not be paradoxical.

*Nobel Lectures, Physics 1963–1970*

The Development of the Space-Time View of Quantum

Electrodynamics

Elsevier Publishing Co. Amsterdam, The Netherlands. 1972

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

RUTH: A paradox?

KING: A paradox!

A most ingenious paradox!

We've quips and quibbles heard in flocks,

But none to beat this paradox!

*The Complete Plays of Gilbert and Sullivan*

*Pirates of Penzance*

Act II (p. 142)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

How quaint the ways of paradox

At common sense she gaily mocks.

*The Complete Plays of Gilbert and Sullivan*

*Pirates of Penzance*

Act II (p. 168)

Random House, Inc. New York, New York, USA. 1936

**Humphries, W. J.** 1862–1949

American meteorologist and atmosphere scientist

The scientific paradox is only an exception to some familiar but too inclusive generalization. It, therefore, has both the appeal of the riddle and the charm of surprise – the surprise, the instant the truth is seen, of a sudden and unexpected discovery....

*Annual Report of the Board of Regents of the Smithsonian Institution, 1920*

A Bundle of Meteorological Paradoxes (p. 183)

Government Printing Office. Washington, D.C. 1922

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

Perhaps the greatest paradox of all is that there are paradoxes in mathematics...because mathematics builds on the old but does not discard it, because its theorems are deduced from postulates by the methods of logic, in spite of its having undergone revolutionary changes we do not suspect it of being a discipline capable of engendering paradoxes.

*Mathematics and the Imagination*

Paradox Lost and Paradox Regained (p. 193)

Simon & Schuster. New York, New York, USA. 1940

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Paradoxes have no place in science. Their removal is the substitution of true for false statements and thoughts.

*Popular Lectures and Addresses* (Volume 1)

On Sun's Heat

Lecture

Royal Institution of Great Britain

January 21, 1887 (pp. 372–373)

Macmillan & Company Ltd. London, England. 1894



**Knox, Ronald Arbuthnott** 1887–1957  
Catholic apologist and translator of the Bible

...after all, what was a paradox but a statement of the obvious so as to make it sound untrue?

*A Spiritual Aeneid*  
Chapter VIII (p. 120)  
Longmans, Green & Co. London, England. 1918

**Lewis, Gilbert Newton** 1875–1946  
American chemist

A paradox is never very terrifying to the scientist. Faraday wrote to Tyndall, “The more we can enlarge the number of anomalous facts and consequences the better it will be for the subject, for they can only remain anomalies to us while we continue in error.” The scientist recognizes that he is always in the midst of paradoxes and that it is his duty to resolve them. He knows that the science of the future will also have its paradoxes, but believes that every individual paradox can be resolved, that this process of resolution will lead not to greater complexity but to greater simplicity, and that out of discord a more perfect harmony will evolve. This I take to be the universal *credo* of science.

*The Anatomy of Science*  
Chapter I (pp. 8–9)  
Yale University Press. New Haven, Connecticut, USA. 1926

**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

What seasoning is to food, paradox is to problem.

Translated by F.V.M.T. & U.C.B.  
*The Disciples at Saïs and Other Fragments*  
Thoughts on Philosophy, Love and Religion (p. 68)  
Methuen & Co. London, England. 1903

**Rapoport, Anatol** 1911–2007  
Russian-born mathematician and biologist

Paradoxes have played a dramatic part in intellectual history, often foreshadowing revolutionary developments in science, mathematics, and logic. Whenever, in any discipline, we discover a problem that cannot be solved within the conceptual framework that supposedly should apply, we experience an intellectual shock. The shock may compel us to discard the old framework and adopt a new one. It is to this process of intellectual molting that we owe the birth of many of the major ideas in mathematics and science.

Escape from Paradox  
*Scientific American*, Volume 217, Number 1, July 1967 (p. 50)

**Rogers, Jr., Hartley**  
American mathematician

It is a paradox in mathematics and physics that we have no good model for the teaching of models.

In Lynn Arthur Steen  
*Mathematics Tomorrow*  
Physics and Mathematics (p. 232)  
Springer-Verlag. New York, New York, USA. 1981

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

Books on paradoxes in statistics are similar to mystery books. They have a faithful readership, and they follow a rigorous sequence in their presentation, like Greek tragedies.

*Indiscrete Thoughts*  
Chapter XX (p. 224)  
Birkhäuser. Boston, Massachusetts, USA. 1997

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Although this may seem a paradox; all exact science is dominated by the idea of approximation.

In Jefferson Hane Weaver  
*The World of Physics* (Volume 2)  
K.2 (p. 22)  
Simon & Schuster. New York, New York, USA. 1987

**Schild, Alfred** 1921–77  
Physicist

Consider a pair of twins. Immediately after birth they are separated. One of them, the first one, remains on earth, the second one is put in a rocket ship and flown to Alpha Centauri at a pretty high speed, 99% that of light. Alpha Centauri is the nearest star; it is about four light-years away from us. As soon as the second twin gets to Alpha Centauri, he turns around and flies back to earth at the same high speed. When the two twins meet again, the first one, the one who stayed behind on earth, will be eight years old...he will be able to talk quite well and read a little bit. He may have finished second grade and be about to enter third. The second twin, the one who took the journey, on his return will be approximately one year old.... He will still need diapers, he will be barely able to walk, and he won't be able to talk much.

The Clock Paradox in Relativity Theory  
*The American Mathematical Monthly*, Volume 66, Number 1, January, 1959 (p. 1)

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

Attention had recently (A. Einstein, B. Podolsky, and N. Rosen, *Phys. Rev.* 47 (1935) 777) been called to the obvious but very disentangling measurement to one system, the representative obtained for the other system is by no means independent of the particular choice of observations which we select for that purpose and which by the way are entirely arbitrary. It is rather discomfoting that the theory should allow a system to be steered or piloted



into one or the other type of state at the experimenter's mercy in spite of his having no access to it.

*Proceedings of the Cambridge Philosophical Society*, Volume 11, 1935 (p. 555)

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Paradoxes are the only truths.

*Misalliance* (p. 142)

Samuel French, Inc. London, England. 1957

**Shimony, Abner** 1928–

American physicist and philosopher of science

I hope that the rigor and beauty of the argument of EPR [Einstein–Podolsky–Rosen paradox] is apparent. If one does not recognize how good an argument it is – proceeding rigorously from premises which are thoroughly reasonable – then one does not experience an adequate intellectual shock when one finds out that the experimental evidence contradicts their conclusions. This shock should be as great as the one experienced by Frege when he read Russell's theoretical paradox and said, "Alas, arithmetic totters!"

Quoted by Franco Seller

*Quantum Mechanics Versus Local Realism: The Einstein–Podolsky–Rosen Paradox*

Chapter 1, Section 2 (p. 19)

Plenum Press. New York, New York, USA. 1988

**Smith, E. E.** 1890–1965

No biographical data available

With sufficient knowledge, any possible so-called paradox can be resolved.

*Masters of the Vortex*

Chapter 11 (p. 109)

Pyramid. New York, New York, USA. 1968

**Sylvester, James Joseph** 1814–97

English mathematician

As lightning clears the air of impalpable vapours, so an incisive paradox frees the human intelligence from the lethargic influence of latent and unsuspected assumptions. Paradox is the slayer of Prejudice.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

A Lady's Fan on Parallel Motion, and on an Orthogonal Web of Jointed Rods (p. 36)

University Press. Cambridge, England. 1904–1912

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

**Talley, Wilson**

No biographical data available

Two paradoxes are better than one; they may even suggest a solution.

*Conversations on the Dark Secrets of Physics*

Chapter 9 (p. 135 fn)

Plenum Press. New York, New York, USA. 1991

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

It is no paradox to say that in our most theoretical moods we may be nearest to our most practical applications.

*An Introduction to Mathematics*

Chapter VII (p. 100)

Henry Holt & Co. New York, New York, USA. 1911

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

The way of paradoxes is the way of truth. To test Reality we must see it on the tight-rope. When the Verities become acrobats we can judge them.

*The Picture of Dorian Gray*

Chapter 3 (p. 44)

The Modern Library. New York, New York, USA. 1992

## PARALLAX

**Huxley, Thomas Henry** 1825–95

English biologist

The parallax of time helps us to the true position of a conception, as the parallax of space helps us to that of a star.

*Method and Results: Essays*

Animal Automism (p. 202)

D. Appleton & Co. New York, New York, USA. 1898

## PARALLEL LINES

**Wharton, William** 1925–2008

American-born author

In Plane Geometry that afternoon, I got into an argument with Mr. Shull, the teacher, about parallel lines. I say they have to meet. I'm beginning to think everything comes together somewhere.

*Birdy* (p. 231)

1979

## PARAMECIUM

**Shipley, Arthur Everett** 1861–1927

Zoologist

It has a plump, pleasant appearance, like a well-fed puppy.

*Hunting Under the Microscope* (p. 51)

The Macmillan Company. New York, New York, USA. 1928

## PARASITE

### Bishop of Birmingham

...the loathsome parasite is a result of the integration of mutations: it is both an exquisite example of adaptation to environment and ethically revolting.

Heredity and Predestination

*Nature*, Volume 126, Number 3187, November 29, 1930 (p. 842)

### Brooks, Daniel R. 1951–

American evolutionary biologist

### McLennan, Deborah A. 1955–

Canadian evolutionary biologist

Parasites are an enigma. To some people they are an unpleasant but unavoidable fact of life. To others they are, like Victorian ankles, an embarrassing topic to be avoided in polite conversation.

*Parascript: Parasites and the Language of Evolution*

Chapter 1 (p. 1)

Smithsonian Institution Press. Washington, D.C. 1993

### Cobbold, Thomas Spencer 1828–86

English man of science

Whatever notions people may entertain respecting the dignity of the human race, there is no gainsaying the fact that we share with the lower animals the rather humiliating privilege and prerogative of entertaining a great variety of parasites.

*Parasites*

Book I (p. 13)

J.&A. Churchill. London, England. 1879

### Darwin, Charles Galton 1809–82

English naturalist

I cannot persuade myself that a beneficent and omnipotent God would have designedly created the Ichneumonidae with the express intention of their feeding within the living bodies of Caterpillars ...

In Francis Darwin

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Asa Gray, May 22, 1860 (p. 105)

D. Appleton & Co. New York, New York, USA. 1887

### Elton, Charles S. 1900–91

English biologist

The difference between the methods of a carnivore and a parasite is simply the difference between living upon capital and upon income; between the habits of the beaver, which cuts down a whole tree a hundred years old, and the bark-beetle, which levies a daily toll from the tissues of the tree; between the burglar and the blackmailer.

*Animal Ecology*

Chapter VI (pp. 72–73)

Sidgwick & Jackson, Ltd. London, England. 1927

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

...each man, like each plant, has his parasites.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

*The Conduct of Life*

Chapter I (p. 45)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

We nestle in nature, and draw our living as parasites from her roots and grains ...

*Nature* (p. 12)

Duffield & Co. New York, New York, USA. 1909

### Frost, Robert 1874–1963

American poet

Will the blight end the chestnut?

The farmers rather guess not.

It keeps smoldering at the roots

And sending up new shoots

Till another parasite

Shall come to end the blight.

*Complete Poems of Robert Frost*

Evil Tendencies Cancel

Henry Holt & Company. New York, New York, USA. 1949

### Haldane, John Burdon Sanderson 1892–1964

English biologist

But alas, insect societies are no more perfect than human, and parasites can as easily find a place in an economic system determined by instinct, as in the products of intelligence, enlightened self-interest, or whatever else is at the basis of human economies. Whether the correct form of demand for food in an ant's or termite's nest is a gentle stroking of the donor, an offer of a drop of some sweet secretion, or what not, some unprincipled insect will generally be found to make it. Students of human society will compare these parasites with brewers, burglars, bolsheviks, bankers, bishops or bookmakers according to their tastes.

*Possible Worlds*

Food Control in Insect Societies (p. 67)

Transaction Publishers

New Brunswick, New Jersey, USA. 2000

### Mayr, Ernst 1904–2005

German-born American biologist

Parasitologists have accumulated, during the past decades, an amount of information that is truly formidable. This information is not only valuable for the parasitologist, but is also a potential gold-mine for the evolutionist and general biologist. Yet, much of this information is hidden away in a widely scattered and highly technical literature.

In J. G. Baer (ed.)

*Premier Symposium sur la spécificité parasitaire des parasites des Vertébrés*

Evolutionary Aspects of Host Specificity Among Parasites of Vertebrates

Université de Neuchâtel. Neuchâtel, Switzerland, 1957

**Michelet, Jules** 1798–1874  
French historian

Now call to mind that every creature nourishes other creatures on its surfaces, in the thickness of its solids, in its fluids, and in its blood; that each insect is a little world inhabited by insects; and that these again have parasites of their own.

Translated by W.D.H. Adams

*The Insects*

Chapter I (p. 18)

T. Nelson & Sons. London, England. 1875

### Mr. Spock (Fictional character)

A truly successful parasite is commensal, living in amity with its host, or even giving it positive advantages.... A parasite that regularly and inevitably kills its host cannot survive long, in the evolutionary sense, unless it multiplies with tremendous rapidity.... It is not pro-survival.

*Star Trek II: The Wrath of Khan*

Film (1982)

**Noble, Elmer R.** 1909–2001  
American protozoologist and parasitologist

**Noble, Glenn A.** 1909–?  
American biologist

Parasites as a whole are worthy examples of the inexorable march of evolution into blind alleys.

*Parasitology: The Biology of Animal Parasites* (3rd edition)

Section X, Chapter 25 (p. 572)

Lea & Febiger. Philadelphia, Pennsylvania, USA. 1971

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Unbidden guests

Are often welcomest when they are gone.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The First Part of King Henry the Sixth*

Act II, Scene ii, l. 55–56

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**van Beneden, P. J.**  
No biographical data available

In the ancient as well as the new world, more than one animal resembles somewhat the sharper leading the life of a great nobleman; and it is not rare to find, by the side of the humble pickpocket, the audacious brigand of the high road, who lives solely on blood and carnage. A great proportion of these creatures always escape, either by cunning, by audacity, or by superior villainy, from social retribution.

*Animal Parasites and Messmates* (p. xvii)

Henry S. King. London, England. 1876

**Wilson, Andrew** 1852–1912  
No biographical data available

If man is to be regarded as the favoured child of Nature, and if it be held as true that life at large is subservient to his sway and rule, it is no less true that he is liable to suffer severely from the attack of certain of his lower neighbours, and that he is despoiled in various fashions by some of the most insignificant of living beings.

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

Some Animal Parasites and Their Development (p. 183)

Chatto & Windus. London, England. 1879

**Wilson, Edward O.** 1929–  
American biologist and author

Leishmaniasis, schistosomiasis, malignant tertian malaria, filariasis, echinococcosis, onchocerciasis, yellow fever, amoebic dysentery, bleeding bot-fly cysts... evolution has devised a hundred ways to macerate livers and turn blood into a parasite's broth.

*Biophilia*

Bernhardsdorp (pp. 12–13)

Harvard University Press. Cambridge, Massachusetts. 1984

**Zimmer, Carl** 1966–  
US science writer

Discovering parasites at work in ecosystems can feel a bit like watching in terror as a bank robbery unfolds and then looking across the street and seeing a movie crew with its cameras and boom mikes.

*Parasite Rex*

Chapter 4 (p. 110)

The Free Press. New York, New York, USA. 2000

## PARK

**Olmsted, Frederick Law, Jr.** 1870–1957  
American landscape architect

The National Parks are set apart primarily in order to preserve to the people for all time the opportunity of peculiar kinds of enjoyment and recreation, not measurable in economic terms and to be obtained only from the remarkable scenery which they contain – scenery of those primeval types which are in most parts of the world rapidly vanishing for all eternity before the increased thoroughness of the economic use of land.

National Parks and Forests: Inherent Values

*Landscape Architecture*, Volume 48 Number 3

## PARTIAL DIFFERENTIAL EQUATION

**Einstein, Albert** 1879–1955  
German-born physicist

...the partial differential equation entered theoretical physics as a handmaid, but has gradually become mistress.

*The World As I See It* (p. 63)

Philosophical Library. New York, New York, USA. 1949

## PARTIAL FRACTIONS

**Webster, Miriam**

No biographical data available

Partial fractions were terrifically unpopular among the calculus students. Problems involving partial fractions take a long time to solve. Most students hate such problems.

*After Math*

Chapter 7 (p. 78)

Zinka Press. Wayne, Pennsylvania, USA. 1997

## PARTICLE

**Davy, Sir Humphry** 1778–1829

English chemist

...the different bodies in nature are composed of particles or minute parts, individually imperceptible to the senses. When the particles are similar, the bodies they constitute are denominated simple, and when they are dissimilar, compound. The chemical phenomena result from the different arrangements of the particles of bodies; and the powers that produce these arrangements are repulsion, or the agency of heat, and attraction.

*Syllabus of a Course of Lectures at the Royal Institution* (p. 2)

Publisher undetermined. London, England. 1802

**Fermi, Enrico** 1901–54

Italian-born American physicist

If I could remember the names of all these particles, I'd be a botanist.

In A. Zee

*Fearful Symmetry*

Chapter 11 (p. 168)

Macmillan Publishing Company. New York, New York, USA. 1986

**Feynman, Richard P.** 1918–88

American theoretical physicist

One of the consequences is that things which we used to consider as waves also behave like particles, and particles behave like waves; in fact everything behaves the same way. There is no distinction between a wave and a particle. So quantum mechanics unifies the idea of the field and its waves, and the particles, all into one.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Basic Physics (p. 36)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

We seem gradually to be groping toward an understanding of the world of sub-atomic particles, but we really do not know how far we have yet to go in this task.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Basic Physics (p. 45)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

Quantum mechanics has many aspects. In the first place, the idea that a particle has a definite location and a definite speed is no longer allowed; that is wrong.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–3 (pp. 2–6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Glashow, Sheldon L.** 1932–

American physicist

Tapestries are made by many artisans working together. The contributions of separate workers cannot be discerned in the complete work, and the loose and false threads have been covered over. So it is in our picture of particle physics.

*Nobel Lectures, Physics 1971–1980*

Nobel lecture for award received in 1979

Towards a Unified Theory – Threads in a Tapestry (p. 494)

World Scientific Publishing Company. Singapore. 1992

**Gleick, James** 1954–

American author, journalist, and essayist

Quantum mechanics taught that a particle was not a particle but a smudge, a traveling cloud of possibilities...

*Genius: The Life and Science of Richard Feynman*

M. I. T. (p. 89)

Pantheon Books. New York, New York, USA. 1992

**Hein, Piet** 1905–96

Danish poet and scientist

Nature, it seems is the popular name for milliards and milliards and milliards of particles playing their infinite game of billiards and billiards and billiards.

*Grooks II*

Atomyriades

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1969

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

We cannot longer speak of the behavior of the particle independently of the process of observation. As a final consequence, the natural laws formulated mathematically in quantum theory no longer deal with the elementary particles themselves but with our knowledge of them. Nor is it any longer possible to ask whether or not these particles exist in space and time objectively...

*The Physicist's Conception of Nature*

Chapter I (p. 15)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

The mathematically formulated laws of quantum theory show clearly that our ordinary intuitive concepts cannot be unambiguously applied to the smallest particles. All the words or concepts we use to describe ordinary physical objects, such as position, velocity, color, size, and so on, become indefinite and problematic if we try to [apply them to] elementary particles.

*Across the Frontiers*

Chapter IX (p. 114)

Harper & Row, Publishers. New York, New York, USA. 1974

In the light of quantum theory these elementary particles are no longer real in the same sense as objects of daily life, trees or stones, but appear as abstractions derived from the real material of observation in the true sense.

*On Modern Physics*

Philosophical Problems (p. 13)

C.N. Potter. New York, New York, USA. 1961

The conception of the objective reality of the elementary particles has thus evaporated in a curious way, not into the fog of some new, obscure, or not yet understood reality concept, but into the transparent clarity of a mathematics that represents no longer the behavior or the elementary particles but rather our knowledge of this behavior.

The Representation of Nature in Contemporary Physics

*Daedalus*, Volume 87, Number 3, Summer 1958 (p. 100)

How can one divide an elementary particle? Certainly only by using extreme forces and very sharp tools. The only tools available are other elementary particles. Therefore, collisions between particles of extremely high energy would be the only processes by which the particles could be eventually divided.

*Physics and Philosophy: The Revolution in Modern Science* (p. 47)

HarperPerennial. New York, New York, USA. 2007

### **Johnson, George** 1952–

American science writer

In science's great chain of being, the particle physicists place themselves with the angels, looking down from the heavenly spheres on the chemists, biologists, geologists, meteorologists – those who are applying, not discovering, nature's most fundamental laws. Everything, after all, is made from subatomic particles. Once you have a concise theory explaining how they work, the rest should just be filigree.

New Contenders for a Theory of Everything

*The New York Times*, F1, Column 1, Tuesday, December 4, 2001

### **Regnault, Noël** 1702–62

Jesuit mathematician

The Imagination is lost here. Rather than the Minds; for if you divide a Particle into the most inconceivably minute Parts, the Mind will always find therein something that regards the West, and something that regards the East; and what regards the West, is not that which regards the East.

*Philosophical Conversations* (Volume 1)

Conversation I (p. 9)

Printed for W. Innys, C. Davis, and N. Prevost. London, England. 1731

### **Stewart, Ian** 1945–

English mathematician and science writer

### **Cohen, Jack**

Reproductive biologist

They ask wavy questions to decide whether it's a wave, and particle questions to decide whether it's a particle.

*The Collapse of Chaos: Discovering Simplicity in a Complex World*

Chapter 8 (p. 276)

The Viking Press. New York, New York, USA. 1994

### **Weinberg, Steven** 1933–

American nuclear physicist

As a scientist, you're probably not going to get rich. Your friends and relatives probably won't understand what you're doing. And if you work in a field like elementary particle physics, you won't even have the satisfaction of doing something that is immediately useful. But you can get great satisfaction by recognizing that your work in science is a part of history.

Scientist: Four Golden Lessons

*Nature*, Volume 426, 2003 (p. 389)

### **Whitman, Walt** 1819–92

American poet, journalist, and essayist

Oh amazement of things – even the least particle!

*Complete Poems and Collected Prose*

Song at Sunset

The Library of America. New York, New York, USA. 1982

## PARTICLE DUALITY

### **de Broglie, Louis** 1892–1987

French physicist

Thus to describe the properties of matter as well as those of light, waves and corpuscles have to be referred to at one and the same time. The electron can no longer be conceived as a single, small granule of electricity; it must be associated with a wave and this wave is no myth.... And it is on this concept of duality of waves and corpuscles in Nature, expressed in a more or less abstract form, that the whole recent development of theoretical physics has been founded and that all future development of this science will apparently have to be founded.

*Nobel Lectures, Physics 1922–1941*

The Wave Nature of the Electron (p. 13)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## PARTICLE PHYSICS

### **Glashow, Sheldon L.** 1932–

American physicist

Tapestries are made by many artisans working together. The contributions of separate workers cannot be discerned in the completed work, and the loose and false threads have been covered over. So it is in our picture of particle physics. Part of the picture is the unification of weak and electromagnetic interactions.... Another part concerns the reasoned evolution of the quark hypothesis from mere whimsy to established dogma. Yet another is the development of quantum chromodynamics into a plausible, powerful, and predictive theory of strong interactions. All is woven together in the tapestry; one part makes little sense without the other.

*Nobel Lectures, Physics 1971–1980*

Towards a Unified Theory – Threads in a Tapestry (p. 495)  
World Scientific Publishing Co. Singapore, Malaysia. 1992

The confusion of the past [in particle physics] is now replaced by a simple and elegant synthesis. [This] standard theory may survive as a part of the ultimate theory, or it may turn out to be fundamentally wrong. In either case, it will have been an important way-station, and the next theory will have to be better.

*Physics 1971–1980*

Towards a Unified Theory – Threads in a Tapestry  
World Scientific Publishing Co. Singapore, Malaysia. 1992

## PARTICLES

**Feynman, Richard P.** 1918–88

American theoretical physicist

Nature seems to keep piling on these particles [having the same properties but heavier masses] as if to drug us.

*QED: The Strange Theory of Light and Matter*

Chapter 4 (p. 146)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...both matter and radiation possess a remarkable duality of character, as they sometimes exhibit the properties of waves, at other times those of particles. Now it is obvious that a thing cannot be a form of wave motion and composed of particles at the same time – the two concepts are too different.

Translated by Carl Eckart and Frank C. Hoyt

*The Physical Principles of the Quantum Theory*

Introductory (p. 10)

Courier Dover Publications. New York, New York, USA. 1949

## PARTICLES, ELEMENTARY

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The conception of the objective reality of the elementary particles has thus evaporated in a curious way, not into the

fog of some new, obscure, or not yet understood reality concept, but into the transparent clarity of a mathematics that represents no longer the behavior of the elementary particles but rather our knowledge of this behavior.

*The Representation of Nature in Contemporary Physics*  
*Daedalus*, Summer, 1958 (p. 100)

## PARTS

**Pascal, Blaise** 1623–62

French mathematician and physicist

...it is as impossible to know the parts without knowing the whole as to know the whole without knowing the particular parts.

*Pensees*

Transition from the Knowledge of Man to That of God (p. 62)

Hackett. Indianapolis, Indiana, USA. 2004

## PAST

**Ansted, David Thomas** 1814–80

English geologist

The present is the key of the past.

*The Great Stone Book of Nature*

The Book of Nature (p. 9)

Macmillan & Co Ltd. London, England. 1864

## Author undetermined

“Hands off the Past!” he cried. “No man is fit

To see or touch it till I’ve sieved each bit.

The Past is mine!” Well, now he’s part of it.

Epitaph on an Archaeologist

*Punch*, February 12, 1986 (p. 63)

**Ayer, Alfred Jules** 1910–89

English philosopher

In practice, speculations about the past, if they are not to be entirely idle, must relate to the traces which the past has left.

*The Central Questions of Philosophy*

Chapter II (p. 25)

Weidenfeld & Nicolson. London, England. 1973

**Barrow, John D.** 1952–

English theoretical physicist

Things are as they are because they were as they were.

*The Origin of the Universe*

Chapter 1 (p. 17)

Basic Books. New York, New York, USA. 1994

**Belloc, Hilaire** 1870–1953

French-born poet and historian

To study something of great age until one grows familiar with it and almost to live in its time, is not merely to satisfy a curiosity or to establish aimless truths: it is rather



to fulfill a function whose appetite has always rendered History a necessity. By the recovery of the Past, stuff and being are added to us; our lives which, lived in the present only, are a film or surface, take on body are lifted into one dimension more.

*The Old Road*

On the Road and the Fascination of Antiquity (p. 9)  
Constable & Co. London, England. 1911

**Colbert, Edwin H.** 1905–2001  
American vertebrate paleontologist

The past is mysterious, ever so the farther we look back from our vantage point in the twentieth-century world. As we follow the procession of the year back through time the earth and its inhabitants seem to us less real and less substantial the more distantly they are removed from this age in which we live.

*The Age of Reptiles*

Chapter 1 Time, Tetrapods and Fossils (p. 1)  
W.W. Norton & Company, Inc. New York, New York, USA. 1965

**Crawford, Osbert Guy Stanhope** 1886–1957  
English archaeologist

The archaeologist who tries to re-create the past is like a craftsman at work upon a great building. At first he sees but dimly the plan of the whole, but as he warms to his work it gradually unfolds itself before him.

*Man and His Past*

Chapter XIX (p. 225)  
Oxford University Press, Inc. London, England. 1921

**Elton, G. R.**  
No biographical data available

The future is dark, the present burdensome; only the past, dead and finished, bears contemplation.

*The Beaver*, Volume 72, Number 4, Aug./Sept. 1992 (p. 4)

**Foster, Sir Michael** 1836–1907  
English physiologist

Our [men of science] feet are set, not on the shifting sands of the opinions and of the fancies of the day, but on a solid foundation of verified truth, which by the labors of each succeeding age is made broader and more firm. To us the past is a thing to look back upon, not with regret, not as something which has been lost never to be regained, but with content, as something whose influence is with us still, helping us on our further way.

*Educational Review*

A Century's Progress in Science  
Volume XVIII (p. 335)

**Gaddis, John Lewis** 1941–  
Historian

We bravely advance into the future with our eyes fixed firmly on the past...

*The Landscape of History*

Chapter One (p. 2)  
Oxford University Press. Oxford, England. 2004

...we're bound to learn from the past whether or not we make the effort, since it's the only data base we have ...

*The Landscape of History*

Chapter One (pp. 8–9)  
Oxford University Press. Oxford, England. 2004

**Gazin-Schwartz, Amy** 1952–  
American archaeologist

**Holtorf, Cornelius**  
Archaeologist

Everyone concerned with the past-archaeologist, historian, politician, storyteller, priest, parent-constructs ideas and images of the past from materials available in the present.

*Archaeology and Folklore*

Chapter One (p. 3)  
Routledge. London, England. 1999

**Gorky, Maxim** 1868–1938  
Soviet/Russian writer

You can't drive anywhere in a carriage of the past!

*The Lower Depths*

Act Four (p. 80)  
Brentano's Publishers. New York, New York, USA. 1923

**Hartley, L. P.** 1895–1972  
English writer

The past is a foreign country; they do things differently there.

*The Go-Between*

Prologue (p. 3)  
Alfred A. Knopf. New York, New York, USA. 1954

**Hawking, Stephen William** 1942–  
English theoretical physicist

...the light that we see from distant galaxies left them millions of years ago, and in the case of the most distant object we have seen, the light left some eight thousand million years ago. Thus, when we look at the universe, we are seeing it as it was in the past.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 2 (p. 28)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Horn, Alfred Aloysius** 1854–1927  
Traveler, trader, and adventurer

There's places in Africa where you get visions of primeval force...in Africa the Past has hardly stopped breathing.

*Trader Horn: Being the Life and Works of Alfred Aloysius Horn*

Chapter XXIII (pp. 257, 258)  
Simon & Schuster. New York, New York, USA. 1927

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

...we are to examine the construction of the present earth, in order to understand the natural operations of time past.

Theory of the Earth  
*Transactions of the Royal Society of Edinburgh*, Volume I, 1788 (p. 219)

## Inscription

What is past is prologue.

Entrance to National Archives, Washington, D.C.

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

...man cannot inherit the past; he has to recreate it.

*The Act of Creation*  
Book One, Part Two, Chapter XI (p. 266)  
The Macmillan Company. New York, New York, USA. 1964

**Kohl, Philip L.** 1946–  
American anthropologist

A real past, although blurred, can be glimpsed through archaeological materials.

Symbolic Cognitive Archaeology  
*Dialectical Anthropology*, Volume 9, 1985 (p. 115)

**Kubler, George** 1912–96  
American art historian

Knowing the past is as astonishing a performance as knowing the stars.

*The Shape of Time: Remarks on the History of Things*  
Chapter 1 (p. 19)  
Yale University Press. New Haven, Connecticut, USA. 1962

**Leakey, Mary** 1913–96  
English archaeologist

Man's early tools and any insights we can get into the lifestyles and activities in succeeding stages of human evolution have been the aspects of the past that I have found the most absorbing, more so than the anatomical features linking or separating one fossil hominoid from another...

*Disclosing the Past: An Autobiography*  
Chapter 16 (p. 211)  
Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Lipe, William D.**  
American archaeologist

...consideration of the past removes us from the immediate concerns of the here and now...[and] plunges us directly into the larger common world which exists in the stream of time and hence bridges the mortality of generations.

In H. Cleere (ed.)  
*Approaches to the Archaeological Heritage: A Comparative Study of World Cultural Resource*

Management Systems Value and Meaning in Cultural Resources (p. 10)  
Cambridge University Press. London, England. 1984

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Let me review the scene,  
And summon from the shadowy Past  
The forms that once have been.

*The Poetical Works of Henry Wadsworth Longfellow*  
A Glean of Sunshine  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

Others have taken a more hopeful view, but in attempting to reconstruct the story of the past, they have too often allowed imagination to usurp the place of research, and have written in the spirit of the novelist, rather than in that of the philosopher.

*Pre-historic Times: As Illustrated by Ancient Remains and the Manners and Customs of Modern Savages* (6th edition)  
Chapter I (p. 1)  
William & Norgate. London, England. 1900

**Mann, Thomas** 1875–1955  
German-born American novelist

Very deep is the well of the past. Should we not call it bottomless?

Translated by H. T. Lowe-Porter  
*Joseph and His Brothers*  
Prelude (p. 3)  
Alfred A. Knopf. New York, New York, USA. 1939

**Mill, John Stuart** 1806–73  
English political philosopher and economist

Our conception of the past is not drawn from its own records, but from books written about it, containing not the facts, but a view of the facts which has shaped itself in the mind of somebody of our own or a very recent time.

*Inaugural Address: Delivered to the University of St. Andrews* (p. 14)  
Longmans, Green, Reader & Dyer. London, England. 1867

**Newton, Sir Charles Thomas** 1816–94  
British archaeologist

The record of the Human Past is not all contained in printed books. Man's history has been graven on the rocks of Egypt, stamped on the bricks of Assyria, enshrined in the marble of the Parthenon – it rises before us a majestic Presence in the piled-up arches of the Coliseum – it lurks an unsuspected treasure amid the oblivious dust of archives and monasteries – it is embodied in all the heirlooms of religions, of races, of families; in the relics which affection and gratitude, personal or national, pride of country or pride of lineage, have preserved for us...

*Essays on Art and Archaeology*  
Chapter I (p. 1)  
Macmillan & Company Ltd. London, England. 1880

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

The past is in one respect a misleading guide to the future:  
It is far less perplexing.

*The Open Mind*  
The Open Mind (p. 47)  
Simon & Schuster. New York, New York, USA. 1955

**Orwell, George (Eric Arthur Blair)** 1903–50  
English novelist and essayist

Who controls the past controls the future: who controls  
the present controls the past.

*Nineteen Eighty-Four*  
Part Three, Chapter II (p. 251)  
Buccaneer Books. Cutchogue, New York, USA. 1949

**Sandburg, Carl** 1878–1967  
American poet and biographer

I tell you the past is a bucket of ashes.

*Complete Poems*  
Prairie  
Harcourt, Brace. New York, New York, USA. 1950

**Palgrave, Francis** 1788–1861  
English historian

We must give it up, that speechless past; whether fact or  
chronology, doctrine or mythology; whether in Europe,  
Asia, Africa, or America; at Thebes or Palenque, on Lycian  
shore or Salisbury Plain: lost is lost, gone is gone forever.

*The History of Normandy and of England* (Volume 1)  
Book I, Chapter III (p. 470)  
John W. Parker & Son. London, England. 1851

**Sir Joseph Whemple (Fictional character)**

We didn't come to Egypt to dig for medals! Much more  
is to be learned from studying bits of broken pottery than  
from all the sensational finds. Our job is to increase the  
sum of human knowledge of the past, not to satisfy our  
own curiosity.

*The Mummy*  
Film (1940)

**Toulmin, Stephen** 1922–  
Anglo-American philosopher

**Goodfield, June**  
Science writer and historian

...no transformation in men's attitude to Nature – in their  
"common sense" – has been more profound than the  
change in perspective brought about by the discovery of  
the past. Rather than take this discovery for granted, it is  
almost preferable to exaggerate its significance.

*The Discovery of Time*  
Introduction (pp. 17–18)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Weigall, Arthur Edward** 1880–1934  
English Egyptologist and author

Man is by nature a creature of the present. It is only by an  
effort that he can consider the future, and it is often quite  
impossible for him to give any heed at all to the past.

*The Glory of the Pharaohs*  
Chapter II (p. 35)  
G.P. Putnam's Sons. New York, New York, USA. 1923

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

[The] restoration of the past is one of the most astonishing  
adventures of the human mind.

The Grisly Folk  
*Storyteller Magazine*, April, 1921

Could anything be more dead, more mute and inexpressive  
to the inexperienced eye than the ochreous fragments of  
bone and the fractured lumps of flint that constitute the  
first traces of something human in the world?

The Grisly Folk  
*Storyteller Magazine*, April, 1921

It is our ignorance of the future and our persuasion that  
that ignorance is absolutely incurable that alone gives the  
past its enormous predominance in our thoughts.

*The Discovery of the Future*  
The Discovery of the Future (p. 22)  
B.W. Huebsch. New York, New York, USA. 1914

...the past is but the beginning of a beginning, and  
that all that is and has been is but the twilight of the  
dawn. It is possible to believe that all that the human  
mind has ever accomplished is but the dream before  
the awakening.

*The Discovery of the Future*  
The Discovery of the Future (p. 60)  
B.W. Huebsch. New York, New York, USA. 1914

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

To make the past live, we must perceive it in detail in  
addition to thinking of it in generalities.

*Essays in Science and Philosophy*  
The Education of an Englishman (p. 29)  
Philosophical Library. New York, New York, USA. 1947

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

The past, the infinite greatness of the past!

For what is the present, after all, but a growth out of the  
past.

*Complete Poetry and Collected Prose*  
Leaves of Grass  
Passage to India  
The Library of America. New York, New York, USA. 1982

**PATENT****O'Malley, John R.**

No biographical data available

Almost every engineer is affected by the patent system.  
Patents and the Engineer

*Engineering Facts from Gatorland*, Volume 4, Number 5,  
December, 1967

**Proverb**

A patent is merely a title to a lawsuit.

In Frank Lewis Dyer

*Edison. His Life and Inventions* (Volume 2)

Chapter XXVIII (p. 700)

Harper & Brothers. New York, New York, USA. 1929

**Roosevelt, Franklin Delano** 1882–1945

32nd president of the USA

Patents are the key to our technology; technology is the key to production.

In Robert A. Buckles

*Ideas, Inventions, and Patents: How to Develop and Protect Them*

Chapter 1 (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1957

**PATENT MEDICINE****Adams, Samuel Hopkins** 1871–1958

American author

With a few honorable exceptions the press of the USA is at the beck and call of the patent medicine. Not only do the newspapers modify news possibly affecting these interests, but they sometimes become their agents.

The Great American Fraud

*Collier's Weekly*, Volume 36, October 7, 1905 (p. 14)

**PATHOLOGIST****Lewis, Sir Thomas** 1881–1945

No biographical data available

If the basis of our working hypothesis is still speculative, if physiological imagination governs it, as pathologists we work upon a foundation guaranteeing no reasonable security.

*The Mechanism and Graphic Registration of the Heart Beat*

Preface (p. viii)

Shaw & Sons. London, England. 1920

**PATHOLOGY****Born-Volber, A. J.**

No biographical data available

The basis of pathology is physiology: that of therapeutics is hygiene.

In Albert Abrams

*Man and His Poisons*

Chapter X (p. 220)

E.B. Treat & Co. New York, New York, USA. 1906

**Latham, Peter Mere** 1789–1875

English physician

...you are never more engaged in studies strictly pathological than when you are busied about the sick in the wards of the hospital ...

*Lectures on Subjects Connected With Clinical Medicine*

Lecture IV (p. 90)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Pathology would remain a lovely science, even if there were no therapeutics, just as seismology is a lovely science, though no one knows how to stop earthquakes.

*A Mencken Chrestomathy*

Chapter XXX (pp. 625–626)

Alfred A. Knopf. New York, New York, USA. 1949

**Simpson, James Young** 1873–1934

No biographical data available

Few subjects in pathology are more curious, and at the same time more obscure, than the changes which, in the course of ages, have taken place in the diseases incident either to the human race at large, or to particular divisions and communities of it.

In John Stuart

*Archaeological Essays* (Volume 2)

On Leprosy and Leper Hospitals (p. 1)

Edmonston & Douglas. Edinburgh, Scotland 1872

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

Pathology has been released from the anomalous and isolated position which it has occupied for thousands of years. Through the application of its doctrines not only to diseases of man, but also to those of even the smallest and lowest of animals, and to those of plants, it helps to deepen biological knowledge, and to light up still further that region of the unknown which still envelops the intimate structure of living matter. It is no longer merely applied physiology – it has become physiology itself.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

The Place of Pathology Among the Biological Sciences (p. 169)

Stanford University Press. Stanford, California, USA. 1958

Pathology also has its place in the science of biology, certainly a very honorable one, for to pathology we owe the realization that the contrast between health and disease is not to be sought in a fundamental difference of two kinds of life, nor in an alteration of essence, but only in an alteration of conditions.

Translated by Lelland J. Rather  
*Disease, Life, and Man, Selected Essays*  
 The Place of Pathology Among the Biological Sciences (p. 169)  
 Stanford University Press. Stanford, California, USA. 1958

### Whittaker, James Thomas

No biographical data available

Pathology is only the physiology of disease.

*Physiology*  
 Lecture I (p. 15)  
 Chancy R. Murry. Cincinnati, Ohio, USA. 1879

## PATIENCE

### Bürgel, Bruno Hans 1875–1948

German astronomer

Patience is one of the chief virtues an astronomer must possess, and as women generally have more patience than men, they seem destined by Nature for some branches of astronomical science.

Translated by Stella Bloch  
*Astronomy for All*  
 Chapter 3 (p. 30)  
 Cassell & Co., Ltd. London, England. 1911

## PATIENT

### Abernethy, John 1680–1740

Irish Presbyterian minister, theologian, and dissenter

Private patients, if they do not like me, can go elsewhere, but the poor devils in the hospital I am bound to take care of.

*Memoirs of John Abernethy*  
 Chapter V (p. 37)  
 Harper & Brothers. New York, New York, USA. 1853

### Armour, Richard 1906–89

American poet

The perfect patient let us praise:  
 He's never sick on Saturdays,  
 In fact this wondrous, welcome sight  
 Is also never sick at night.  
 In waiting rooms he does not burn  
 But gladly sits and waits his turn,  
 And even, I have heard it said,  
 Beggars others, "Please go on ahead."  
 He takes advice, he does as told,  
 He has a heart of solid gold.  
 He pays his bills, without a fail,  
 In cash, or by the same day's mail.  
 He has but one small fault I'd list:  
 He doesn't (what a shame!) exist.

*The Medical Muse*  
 Ideal Patient  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1963

### Born-Volber, A. J.

No biographical data available

The patient wishes not only to be cured, but to be treated; his luxury is in the importance of the physician and his remedies.

In Albert Abrams  
*Man and His Poisons*  
 Chapter X (p. 222)  
 E.B. Treat & Co. New York, New York, USA. 1906

### Cushing, Harvey 1869–1939

American neurosurgeon

Every patient, he said, provided two questions – firstly what can be learnt from him and secondly what can be done for him.

In Robert Coope  
*The Quiet Art* (p. 103)  
 E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

### de Madariaga, Salvador 1886–1978

Spanish writer and statesman

There are no diseases, there are only patients.

*Essays with a Purpose*  
 On Medicine (p. 174)  
 Hollis & Carter. London, England. 1954

### Drake, Daniel 1785–1852

American physician

[There is no era in the life of a physician] in which his self-complacency is so exalted, as the time which passes between receiving his diploma with its blue ribbon, and receiving crepe and gloves, to wear at the funeral of his first patient.

*Western Journal of Medicine and Surgery*, New Series, II:355, October, 1844

### Eliot, T. S. (Thomas Stearns) 1888–1965

American-born British poet and playwright

REILLY: Most of my patients begin, Miss Coplestone, by telling me exactly what is the matter with them. And what I am to do about it.

*The Collected Poems and Plays 1909–1950*  
 The Cocktail Party, Act Two (p. 359)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1952

### Helmuth, William Tod 1833–1902

American physician

She sent for me in haste to come and see,  
 What her condition for a cure might be.  
 Dear me! a patient – what a happy tone,  
 To have a patient and one all my own –  
 To have a patient and myself be feed,  
 Raised expectations very high indeed –  
 I saw a practice growing from the seed.

*Scratches of a Surgeon*  
 My First Patient (p. 61)  
 W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Heschel, Abraham J.** 1907–72  
Jewish theologian

The patient must not be defined as a client who contracts a physician for service; he is a human being entrusted to the cure of a physician.

*The Insecurity of Freedom*

The Patient as a Person (p. 31)

Farrar, Straus & Giroux. New York, New York, USA. 1966

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Once in a while you will have a patient of sense, born with the gift of observation, from whom you may learn something.

*Medical Essays*

The Young Practitioner (pp. 382–383)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

What I call a good patient is one who, having found a good physician, sticks to him till he dies.

*Medical Essays*

The Young Practitioner (p. 390)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

If you are making choice of a physician, be sure to get one, if possible, with a cheerful and serene countenance.

*The Professor at the Breakfast Table*

Chapter VI (p. 180)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Hubbard, Kin** 1868–1930

American Democratic newspaper editor

Be kind t' th' henn egg. When sickness enters th' home an' th' patient comes thru th' crisis twenty pounds lighter than a straw hat, an' is propped up with pillows in th' bay window t' watch th' speedin', an' loved ones try t' tempt him with round steak, an' pickles an' near beer, he wearily waves 'em away. But with his first returnin' strength he squirms an' turns his listerless eyes toward th' kitchen an' says, in a voice weak an' scarcely audible, "Maw, I believe I could worry down an egg..."

*Abe Martin: Hoss Sense and Nonsense* (p. 53)

The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1926

**Lindeman, Carol A.** 1935–

American nurse

There are few, if any, "standard" patients.

*Fundamentals of Contemporary Nursing Practice*

Chapter 2 (p. 35)

W.B. Saunders Philadelphia, Pennsylvania, USA. 199p

**Mayo, William J.** 1861–1939

American physician

...the highly scientific development of this mechanistic age had led perhaps to some loss in appreciation of the individuality of the patient and to trusting largely to the laboratories and outside agencies which tended to make the patient not the hub of the wheel, but a spoke.

Edward Martin, M.D., 1859–1938

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 30, 1938

**Morris, Robert Tuttle** 1857–1945

Abdominal surgeon

It is the patient rather than the case which requires treatment.

*Doctors Versus Folks*

Chapter 2

Doubleday, Page & Company, Inc. Garden City, New York, USA. 1915

**Newman, Sir George** 1870–1948

English public health physician

There are four questions which in some form or other every patient asks his doctor: (a) What is the matter with me? This is diagnosis. (b) Can you put me right? This is treatment and prognosis. (c) How did I get it? This is causation. (d) How can I avoid it in future? This is prevention.

Preventive Medicine for the Medical Student

*The Lancet*, Volume 221, November 21, 1931 (p. 113)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

To study the phenomena of disease without books is to sail an uncharted sea, while to study books without patients is not to go to sea at all.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter IV (p. 67)

Clarendon Press. Oxford, England. 1925

**Parrot, Max**

No biographical data available

It is often been said that the technical aspects of medicine are easy. The difficult part is dealing with the personality of the patient, the so-called psychological or human factor. This takes up a great deal of the time of the practicing physician. It is harder on the doctor's constitution than all of the technical aspects of medicine. It may even cause his or her demise, in the case of a physician with an autonomic nervous system that can't take the heat.

In Irving Oyle

*The New American Medical Show: Discovering the Healing Connection* (p. 25)

Unity Press. Santa Cruz, California, USA. 1979

**Potter, Stephen** 1900–69

No biographical data available

If Patient turns out to be really ill, it is always possible to look grave at the same time and say "You realize, I suppose, that 25 years ago you'd have been dead?"

*One-Upmanship*

Chapter II (p. 28)

Henry Holt & Company. New York, New York, USA. 1952



**Rhazes** 865–925  
Persian physician

The patient who consults a great many physicians is likely to have a very confused state of mind.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 45)  
The S.E. Massengill Company, Bristol, Tennessee, USA. 1943

**Sacks, Oliver W.** 1933–  
American neurologist and author

There is only one cardinal rule: one must always listen to the patient.

Listening to the Lost

*Newsweek*, August 20, 1984 (p. 70)

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

“How does your patient,” doctor?

“Not so sick, my lord,

As she is troubled with thick-coming fancies.”

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Macbeth*

Act V, Scene iii, l. 37–39

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## PATTERN

### Burns, Marilyn

No biographical data available

Searching for patterns is a way of thinking that is essential for making generalizations, seeing relationships, and understanding the logic and order of mathematics. Functions evolve from the investigation of patterns and unify the various aspects of mathematics.

*About Teaching Mathematics: A K–8 Resource*

Patterns and Functions (p. 112)

Math Solutions Publications, USA. 1992

**Derry, Gregory N.** 1952–  
American professor of physics

In trying to understand nature, we rarely attempt to grasp completely every possible detail. If we did, we’d be overwhelmed by the mass of inconsequential information. As a result, we would miss the truly interesting patterns and relationships that give us scientific insight.

*What Science Is and How It Works*

Chapter 6 (p. 69)

Princeton University Press, Princeton, New Jersey, USA. 1999

**Feynman, Richard P.** 1918–88  
American theoretical physicist

Stuck on this carousel my little eye can catch one-million-year-old light. A vast pattern – of which I am a

part...What is the pattern or the meaning or the why? It does not do harm to the mystery to know a little more about it.

*The Feynman Lectures in Physics*

Chapter 3 (3–6)

**Gardner, Martin** 1914–

American writer and mathematics games editor

If the cosmos were suddenly frozen, and all movement ceased, a survey of its structure would not reveal a random distribution of parts. Simple geometrical patterns, for example, would be found in profusion – from the spirals of galaxies to the hexagonal shapes of snow crystals. Set the clockwork going, and its parts move rhythmically to laws that often can be expressed by equations of surprising simplicity. And there is no logical or a priori reason why these things should be so.

*Order and Surprise*

Chapter 4 (p. 57)

Prometheus Books, Buffalo, New York, USA. 1983

**Hofstadter, Douglas R.** 1945–

American academic

Yes, I am a relentless quester after the chief patterns of the universe – central organizing principles, clean and powerful ways to categorize what is “out there.”

*Metamagical Themas: Questing for the Essence of Mind and Pattern*

Introduction (p. xxv)

Basic Books, Inc. New York, New York, USA. 1985

**Huxley, Aldous** 1894–1963

English writer and critic

The difference between a piece of stone and an atom is that an atom is highly organised, whereas the stone is not. The atom is a pattern, and the molecule is a pattern, and the crystal is a pattern; but the stone, although it is made up of these patterns, is just a mere confusion. It’s only when life appears that you begin to get organisation on a larger scale. Life takes the atoms and molecules and crystals; but, instead of making a mess of them like the stone, it combines them into new and more elaborate patterns of its own.

*Time Must Have a Stop*

Chapter XIV (p. 145)

The Sun Dial Press, Garden City, New York, USA. 1944

**MacArthur, Robert H.** 1930–72

American ecologist

To do science is to search for repeated patterns, not simply to accumulate facts, and to do the science of geographical ecology is to search for patterns of plants and animal life that can be put on a map.

*Geographical Ecology*

Introduction (p. 1)

Harper & Row, Publishers, New York, New York, USA. 1972

**Maximillian Cohen (Fictional character)**

11:15, restate my assumptions: 1. Mathematics is the language of nature. 2. Everything around us can be represented and understood through numbers. 3. If you graph these numbers, patterns emerge. Therefore: There are patterns everywhere in nature.

*Pi*  
Film (1998)

**Peterson, Ivars**

Mathematics and computer writer and editor

In their search for patterns and logical connections, mathematicians face a vast, mysterious ocean of possibilities. Over the centuries, they have discovered an extensive archipelago of truth and beauty. Much of that accumulated knowledge is passed on to succeeding generations. Even more wonders await future explorers of deep, mathematical waters.

*Islands of Truth: A Mathematical Mystery Cruise*  
Chapter 8 (p. 292)  
W.H. Freeman & Company. New York, New York, USA. 1990

**Rucker, Rudy** 1946–

Science and science fiction author

The world is colors and motion, feelings and thought... and what does math have to do with it? No much, if “math” means being bored in high school, but in truth mathematics is the one universal science. Mathematics is the study of pure pattern, and everything in the cosmos is a kind of pattern.

*Mind Tools*  
Introduction (p. 3)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1987

**Stevens, Peter S.**

No biographical data available

It turns out that those patterns and forms are peculiarly restricted, that the immense variety that nature creates emerges from the working and reworking of only a few formal themes. These limitations on nature bring harmony and beauty to the natural world.

*Patterns in Nature*  
Chapter 1 (p. 3)  
Little, Brown & Company. Boston, Massachusetts, USA. 1974

**Stewart, Ian** 1945–

English mathematician

Each of nature’s patterns is a puzzle, nearly always a deep one.

*Nature’s Numbers*  
Chapter 2 (p. 14)  
BasicBooks. New York, New York, USA. 1995

...mathematics is the science of patterns, and nature exploits just about every pattern that there is.

*Nature’s Numbers*  
Chapter 2 (p. 18)  
BasicBooks. New York, New York, USA. 1995

**PAULI EFFECT****Gamow, George** 1904–68

Russian-born American physicist

The *Pauli Effect*, a mysterious phenomenon which is not and probably never will be understood on a purely materialistic basis.

*Thirty Years That Shook Physics* (p. 64)  
Courier Dover Publications. New York, New York, USA. 1985

**PAULI PRINCIPLE****Gamow, George** 1904–68

Russian-born American physicist

We do not know why they have the masses they do; we do not know why they transform into another the way they do; we do not know anything! The one concept that stands like the Rock of Gibraltar in our sea of confusion is the Pauli principle.

The Exclusion Principle  
*Scientific American*, Volume 201, Number 1, July 1959 (p. 86)

**PEACE****Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

There is, though I do not know how there is or why there is, a sense of infinite peace and protection in the glittering hosts of heaven. There it must be, I think, in the vast and eternal laws of matter, and not in the daily cares and sins and troubles of men, that whatever is more than animal within us must find its solace and its hope.

*Seven Science Fiction Novels of H. G. Wells*  
Chapter the Twenty-second (p. 182)  
Dover Publications, Inc. New York, New York, USA. 1934

**PEAK****Pouchet, Félix Archimède** 1800–72

French biologist

...every crumbling peak displays to our view the remains of generations buried by the revolutions of the globe. Their numbers, their size, their unknown forms astonish us; but we cannot doubt, for these inanimate remains, of which the earth has faithfully kept the impress, are so many medallions struck by the Creator and spared by the hand of time, to reveal to us the world’s eventful history

*The Universe*  
The Animal Kingdom, Book I (pp. 6–7)  
Blackie & Son. London, England. 1870

**PEDANTRY**

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Without a doubt, technical facility is a first requisite for valuable mental activity: we shall fail to appreciate the rhythm of Milton, or the passion of Shelley, so long as we find it necessary to spell the words and are not quite certain of the forms of the individual letters. In this sense there is no royal road to learning. But it is equally an error to confine attention to technical processes, excluding consideration of general ideas. Here lies the road to pedantry.

*An Introduction to Mathematics*

Chapter I (p. 8)

Henry Holt & Co. New York, New York, USA. 1911

**PENDULUM**

**Eco, Umberto** 1932–  
Italian novelist, essayist, and scholar

That was when I saw the Pendulum.

The sphere, hanging from a long wire set into the ceiling of the choir, swayed back and forth with isochronal majesty.

I knew – but anyone could have sensed it in the magic of that serene breathing – that the period was governed by the square root of the length of the wire and by pi, that number which, however irrational to sublunar minds, though a higher rationality binds the circumference and diameter of all possible circles. The time it took the sphere to swing from end to end was determined by an arcane conspiracy between the most timeless of measures: the singularity of the point of suspension, the duality of the plane's dimensions, the triadic beginning of  $\pi$ , the secret quadratic nature of the root, and the unnumbered perfection of the circle itself.

Translated by William Weaver

*Foucault's Pendulum*

Chapter 1 (p. 3)

Harcourt Brace Jovanovich, Publishers. San Diego, California, USA. 1988

**Graham, L. A.**

No biographical data available

Rock-a-bye baby in the tree top,  
As a compound pendulum, you are a flop.  
Your center of percussion is safe and low,  
As one may see when the wind doth blow.  
Your frequency of vibration is pretty small,  
Frankly, I don't think you'll fall at all.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 2

Dover Publications, Inc. New York, New York, USA. 1959

**Klee, Paul** 1879–1940  
Swiss painter

The purest mobile form, the cosmic one... is only created through the liquidation of gravity....

Translated by Sibyl Moholy-Nagy

*Pedagogical Sketchbook*

Introduction (p. 53)

Praeger Publishers. New York, New York, USA. 1953

**PENICILLIN**

**Fleming, Sir Alexander** 1881–1955  
Scottish bacteriologist

I have been frequently asked why I invented the name "Penicillin." I simply followed perfectly orthodox lines and coined a word which explained that the substance penicillin was derived from a plant of the genus *Penicillium* just as many years ago the word "Digitalin" was invented for a substance derived from the plant *Digitalis*.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1945

Penicillin (p. 83)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**PERCENTAGE**

**Barnes, Michael R.**

No biographical data available

There's a 50% chance of anything – either it happens or it doesn't.

In Paul Dickson

*The Official Explanations* (p. B-9)

Delacorte Press. New York, New York, USA. 1980

**Bloch, Arthur** 1948–

American humorist

90% of everything is crap.

*Murphy's Law*

Sturgeon's Law (p. 21)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Crichton, Michael** 1942–

American novelist

John. Trust us on this, we have the figures. We are telling you with ninety-five percent confidence intervals how the people feel.

*Rising Sun*

Second Day (p. 255)

Ballantine Books. New York, New York, USA. 1993

"I did," Gerhard said. "But I don't know anymore. We've passed the confidence limits already. They were about plus or minus two minutes for ninety-nine percent."

*The Terminal Man*

Chapter 6 (p. 157)

Alfred A. Knopf. New York, New York, USA. 1972

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

When half a million babies are born in England in a year, we may say that 20% of them are born in London, 2% in Manchester, 1% in Bristol, and so on. But when we think of one baby born in a single minute of time, we cannot say that 20% of it was born in London, 2% in Manchester, and so on. We can only say that there is a 20% probability of its being born in London, a 2% probability of its being born in Manchester, and so on.

*Physics and Philosophy*

Chapter V (p. 136)

Dover Publications, Inc. New York, New York, USA. 1981

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

...I do not remember just when, for I was not born then and cared nothing for such things. It was a long journey in those days and must have been a rough and tiresome one. The village contained a hundred people and I increased the population by 1%. It was more than many of the best men in history could have done for a town. It may not be modest in me to refer to this but it is true.

*Mark Twain's Autobiography* (Volume 1)

Chapter Begun in Vienna (pp. 94–95)

Harper & Brothers. New York, New York, USA. 1924

## PERCEPTION

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Everything you see or hear or experience in any way at all is specific to you. You create a universe by perceiving it.

*The Ultimate Hitchhiker's Guide to The Galaxy*

Mostly Harmless

Chapter 9 (p. 703)

The Ballantine Book Company. New York, New York, USA. 2002

**Blake, William** 1757–1827

English poet, painter, and engraver

As to that false appearance which appears to the reasoner As of a Globe rolling thro' Voidness, it is a delusion of Ulro.

The Microscope knows not of this nor the Telescope: they alter

The ratio of the Spectator's Organs, but leave Objects untouched.

*The Complete Poetry and Prose of William Blake*

The Building of Time

University of California Press. Berkeley, California, USA. 1982

**Cousins, Norman** 1912–90

American editor and author

As we enlarge our sense of the cosmos, we are enlarging our consciousness. As we extend the reach of the mind, we are learning more about our potentialities. As we move beyond the human habitat, we are gaining perspective on ourselves as custodians of the planet.

*Rendezvous with Infinity*

*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979

(pp. 30–31)

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

It has ever been my lot, though formally myself a teacher, to be taught surely by none. There are times when I have thought to read lessons in the sky, or in books, or from the behavior of my fellows, but in the end my perceptions have frequently been inadequate or betrayed.

*The Star Thrower*

The Star Thrower (p. 169)

Times Books. New York, New York, USA. 1978

**Murphy, Michael**

No biographical data available

To a frog with its simple eye, the world is a dim array of grays and blacks. Are we like frogs in our limited sensorium, apprehending just part of the universe we inhabit? Are we as a species now awakening to the reality of multidimensional worlds in which matter undergoes subtle reorganizations in some sort of hyperspace?

*The Future of the Body*

Part I, Chapter 8 (p. 216)

Penguin Putnam, Inc. New York, New York, USA. 1992

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Physics and perception are like two people on opposite sides of a brook which slowly widens as they walk; at first it is easy to jump across, but imperceptibly it grows more difficult, and at last a vast labor is required to get from one side to the other.

*Analysis of Matter*

Chapter XIV (p. 137)

Dover Publications, Inc., New York, New York, USA, 1954

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Our problem is, in fact, to fit the world to our perceptions, and not our perceptions to the world.

*The Organization of Thought*

Chapter VIII (p. 228)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## PERCUSSION

**Auenbrugger, Leopold** 1722–1809  
Viennese physician

I present the reader with a new sign, which I have discovered for detecting diseases of the chest, This consists in the percussion of the human thorax, whereby according to the character of the particular sounds thence elicited, an opinion is formed of the internal state of that cavity.

*New Invention by Means of Percussing the Human Thorax for Detecting Signs of Obscure Disease of the Interior of the Chest*  
December 31, 1761

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Even perfection will not bear the tedium of indefinite repetition.

*Atlantic*, September 29, 1979 (p. 244)

## PERIODIC TABLE

**Atkins, Peter William** 1940–  
English physical chemist and writer

The periodic table is arguably the most important concept in chemistry, both in principle and in practice. It is the everyday support for students, it suggests new avenues of research to professionals, and it provides a succinct organization of the whole of chemistry. It is a remarkable demonstration of the fact that the chemical elements are not a random clutter of entities but instead display trends and lie together in families. Anyone who seeks to be familiar with a scientist's-eye view of the world must be aware of the general form of the periodic table, for it is a part of scientific culture.

*The Periodic Kingdom: A Journey into the Land of the Chemical Elements*

Preface (pp. vii–viii)

Basic Books, Inc. New York, New York, USA. 1995

**Bolton, Henry Carrington** 1843–1903  
American chemist, bibliographer, and historian

The periodic law has given to chemistry that prophetic power long regarded as the peculiar dignity of its sister science, astronomy.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 9 (p. 122)

Longmans. London, England. 1967

**Mendeleyev, Dmitry Ivanovich** 1834–1907  
Russian chemist

I shall endeavor to show, as briefly as possible, ...how far the periodic law contributes to enlarge our range of vision. Before the promulgation of this law the chemical elements were mere fragmentary, incidental facts in Nature; there was no special reason to expect the discovery of

new elements, and the new ones which were discovered from time to time appeared to be possessed of quite novel properties. The law of periodicity first enabled us to perceive undiscovered elements at a distance which formerly was inaccessible to chemical vision...

The Periodic Law of the Chemical Elements

*Journal of the Chemical Society*, Volume 55, 1889 (p. 648)

There must be some bond of union between mass and the chemical elements; and as the mass of a substance is ultimately expressed...in the atom, a functional dependence should exist and be discoverable between the individual properties of the elements and their atomic weights. But nothing, from mushrooms to a scientific law, can be discovered without looking and trying. So I began to look about and write down the elements with their atomic weights and typical properties, analogous elements and like atomic weights on separate cards, and this soon convinced me that the properties of elements are in periodic dependence upon their atomic weights.

In Thomas H. Pope (ed.)

Translated by George Kamensky

*The Principles of Chemistry* (Volume 2)

Longmans, Green & Company. London, England. 1905

By ordering the elements according to increasing atomic weight in vertical rows so that the horizontal rows contain analogous elements, still ordered by increasing atomic weight, one obtains the following arrangement, from which a few general conclusions may be derived.

David M. Knight (ed.)

*Classical Scientific Papers – Chemistry, Second Series*

On the Relationship of the Properties of the Elements to Their Atomic Weights (1869)

American Elsevier Publishing Company. New York, New York, USA. 1968

An established system is limited by its order of known or discovered elements. With the periodic and atomic relations now shown to exist between all the atoms and the properties of their elements, we see the possibility not only of noting the absence of some of them but even of determining, and with great assurance and certainty, the properties of these as yet unknown elements; it is possible to predict their atomic weight, density in the free state or in the form of oxides, acidity or basicity, degree of oxidation, and ability to be reduced and to form double salts and to describe the properties of the metalloorganic compounds and chlorides of the given element; it is even possible...to describe the properties of some compounds of these unknown elements in still greater detail. ...[A]t the present time it is not possible to say when one of these bodies...will be discovered, yet the opportunity exists for finally convincing myself and other chemists of the truth of those hypotheses which lie at the base of the system I have drawn up.

A Natural System of the Elements and Its Use in Predicting the Properties of Undiscovered Elements

*Journal of the Russian Chemical Society*, Volume 3, 1871 (p. 25)



“I shall not form any hypothesis, either here nor further on to explain the nature of the periodic law. For first of all, the law itself is too simple; and secondly, this new subject has been too little studied yet, in its diverse parts for us to form any hypothesis.”

In B. Bensaude-Vincent

Mendeléev's Periodic System (part I)

*British Journal for the History of Science*, Volume 19, Number 61, March, 1986 (p. 7)

### **Roscoe, Henry E.** 1833–1915

English chemist

We must then find that these numbers regularly increase by a definite amount, *i.e.*, by the average age of a generation, which will be approximately the same in all the four families. Comparing the ages of the chemists themselves, we shall observe certain differences, but these are small in comparison with the period which has elapsed since the birth of their ancestors. Now each individual in this series of family trees represents a chemical element; and just as each family is distinguished by certain idiosyncrasies, so each group of the elementary bodies thus arranged shows distinct signs of consanguinity.

*Report of the British Association of the Advancement of Science* 1887 (p. 10)

Publisher undetermined

### **Sanderson, R. T.**

No biographical data available

Students may readily be bewildered by the apparently fundamental lack of agreement among various periodic tables, and some may even acquire reasonable doubt as to whether chemists actually know what they are doing.

One More Periodic Table

*Journal of Chemical Education*, Volume 31, 1954 (p. 481)

## PERFECT

### **Sylvester, James Joseph** 1814–97

English mathematician

It often happens that the pursuit of the beautiful and appropriate, or, as it may be otherwise expressed, the endeavor after the perfect, is rewarded with a new insight into the true.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Separation of the Roots of an Algebraical Equation (p. 544)

At the University Press. Cambridge, England. 1902

## PERFECT NUMBER

### **Woodman, William Robert**

No biographical data available

The perfect numbers are like the virtues, few in number.

In G.W. Speth

*Ars Quatuor Coronatorum* (Volume 3) Part I

Reviews (p. 197)

Publisher undetermined

## PERIODIC TABLE

### **Author undetermined**

I pledge allegiance to the chart of the Periodic Table of Elements, and to the Atomic Theory for which it stands. One concept, under Mendeléev, for observations and experimentation for all.

Source undetermined

### **Hayward, F. and Tucker, M.**

I love my baby, she makes me oh so blue

I love my baby, she makes me oh so blue

She keeps me oh so worried, that I call her U 92

*Atomic Baby*

Sung by Amos Milburn

Capitol CDP 7243, 1950

## PERISH

### **Duke of Argyll (George Douglas**

**Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

There is no existing order no present combination of matter or of force which we cannot conceive coming to an end. But when that end is come, we cannot conceive but that something must remain if it be nothing else than that by which the ending was brought about.

*The Unity of Nature*

Chapter 4 (p. 85)

G.P. Putnam's Sons. New York, New York, USA. 1885

## PERMANENCE

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Permanence is but a word of degrees.

*Essays*

Circles (p. 282)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1873

There are no fixtures in nature. The universe is fluid and volatile. Permanence is but a word of degrees.

*Essays, Lectures, and Orations*

Circles (p. 157)

William S. Orr & Co. London, England. 1848

### **Jeans, James W.**

... we now know that there is, in principle, no permanence in substance; it is mere bottled energy, and possesses no more inherent permanence than bottled beer ...



*Physics & Philosophy*

Chapter II (p. 41)

The University Press. Cambridge, England. 1943

## PERPETUAL MOTION

**Burroughs, John** 1837–1921

American naturalist and writer

Physics proves to us the impossibility of perpetual motion among visible, tangible bodies, at the same time that it reveals to us a world where perpetual motion is the rule – the world of molecules and atoms.

*The Breath of Life*

Chapter IX (p. 190)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Oh! Mediators of perpetual motion, how many vain projects of similar character you have devised! Go and join the seekers of gold.

Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 179)

The Merrymount Press. Boston, Massachusetts, USA. 1906

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Science seeks perpetual motion. She has found it: it is Science herself.

Translated by Melville Best Anderson

*William Shakespeare*

Part Second, Book I, Chapter IV (p. 105)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

## PERPETUAL MOTION MACHINE

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

Since a given system can never of its own accord go over into another equally probable state but into a more probable one, it is likewise impossible to construct a system of bodies that after traversing various states returns periodically to its original state, that is a perpetual motion machine.

In B.F. McGuinness

*Ludwig Boltzmann: Theoretical Physics and Philosophical Problems,*

*Selected Writings*

The Second Law of Thermodynamics (p. 30)

Springer-Verlag. New York, New York, USA. 1974

## PERSPECTIVE

**Chalmers, Thomas** 1780–1847

Scottish mathematician

...it was the telescope, that, by piercing the obscurity which lies between us and distant worlds, put Infidelity in possession of the argument against which we are now contending. But, about the time of its invention, another instrument was formed, which laid open a scene no less wonderful, and rewarded the inquisitive spirit of man with a discovery, which serves to neutralize the whole of argument. This was the microscope. The one led me to see a system in every star. The other leads me to see a world in every atom. The one taught me, that this mighty globe, with the whole burden of its people and of its countries, is but a grain of sand on the high field of immensity. The other teaches me, that every grain of sand may harbour within it the tribes and the families of a busy population. The one told me of the insignificance of the world I tread upon. The other redeems it from all its insignificance; for it tells me that in the leaves of every forest, and in the flowers of every garden, and in the waters of every rivulet, there are worlds teeming with life, and numberless as are the glories of the firmament.

*The Works of Thomas Chalmers* Volume 7

Discourse III (p. 80)

Robert Carter. New York, New York, USA. 1842

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Perspectives that are reversed or orthogonal to traditional modes form my stock in trade. (I have long argued that conceptual locks are far more powerful than factual lacks as barriers to scientific understanding.)

*Eight Little Piggies: Reflections in Natural History*

A Reflective Prologue (pp. 16–17)

W.W. Norton & Co. New York, New York, USA. 1993

**Low, George M.** 1926–84

NASA administrator

In the accelerating pace of scientific advance, perspective is often a casualty.

In Oran W. Nicks (ed.)

*This Island Earth*

Foreword (p. iv)

National Aeronautics and Space Administration. Washington, D.C.

1970

## PERSUADE

**Pascal, Blaise** 1623–62

French mathematician and physicist

People are generally better persuaded by the reasons which they have themselves discovered than by those which have come into the mind of Others.

Translated by William Finlayson Trotter

*Thoughts*

Number 10 (p. 11)

P.F. Colier & Son. New York, New York, USA. 1910

**PESSIMISM**

**Rashevsky, Nicolas** 1899–1972  
Mathematical biophysicist

Pessimism is not a healthy thing in science, but neither is unrealistic optimism.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)  
Chapter XXVIII (p. 307)  
Dover Publications, Inc. New York, New York, USA. 1960

**PESSIMIST**

**Stetson, Harlan True** 1885–1964  
American astronomer and physicist

Someone has said that a pessimist is a man who looks at the world with one eye closed, and that an optimist is a man who looks at the world with both eyes closed.

*Man and the Stars*  
Chapter I (p. 3)  
McGraw-Hill Book Co., Inc. New York, New York, USA. 1930

**PEST**

**Miller, George Abram** 1863–1951  
American mathematician

If a comparatively harmless pest destroys pests which are more harmful than itself, it is desirable to consider the injuries which it inflicts as well as the services which it renders.

The History of Science as an Error Breeder  
*The Scientific Monthly*, Volume XII, Number 5, May, 1921 (p. 439)

**PEST CONTROL**

**Müller, Paul** 1899–1965  
Swiss chemist

The field of pest control is immense, and many problems impatiently await a solution. A new territory has opened up for the synthetic chemist, a territory which is still unexplored and difficult, but which holds out the hope that in time further progress will be made.

*Nobel Lectures, Physiology or Medicine 1942–1962*  
Nobel lecture for award received in 1948  
Dichloro-Diphenyl-Trichloroethane and Newer Insecticides (p. 236)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**PESTICIDES**

**Carson, Rachel** 1907–64  
American marine biologist and author

If we are going to live so intimately with these chemicals [pesticides] – eating and drinking them, taking them into the very marrow of our bones – we had better know something about their nature and their power.

*Silent Spring*  
Chapter 3 (p. 25)  
Fawcett Publications. Greenwich, Connecticut, USA. 1962

**PESTILENCE**

**Camus, Albert** 1913–1960  
Algerian-French author and philosopher

A pestilence isn't a thing made to man's measure; therefore we tell ourselves that pestilence is a mere bogey of the mind, a bad dream that will pass away. But it doesn't pass away and, from one bad dream to another, it is men who pass away.

*The Plague*  
Part I, Chapter 5 (p. 37)  
Vintage Books. New York, New York, USA. 1991

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

...death has a way of its own of harassing victory, and it causes pestilence to follow glory. Typhus is an annex of triumph.

*Les Misérables*  
Volume 2, Book I, Chapter 2 (p. 7)  
The Heritage Press. New York, New York, USA. 1938

**PETRIFICATION**

**Leclerc, Georges-Louis, Comte de Buffon** 1707–88  
French naturalist

Petrification is the great means of nature to keep the transitory creatures of all epochs.

In Jochen Helms  
*Fossils: The Oldest Treasures that Ever Lived*  
The Berlin Specimen of the Primitive Bird Archaeopteryx (p. 94)  
T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

**PETROLOGY**

**Wyllie, Peter J.**  
Geologist

The results of experimental petrology...help to distinguish between possible and impossible processes.

In M.P. Atherton and C.D. Gribble (eds.)  
*Migmatites, Melting and Metamorphism*  
Experimental Studies on Biotite- and Muscovite-Granites and Some Crustal Magmatic Sources (p. 13)  
Shiva Geology Series. 1983

**PH.D.****Author undetermined**

Armed with the Open Sesame of the magic Ph.D., what could I not accomplish!

*American Review*, Volume 2, 1924 (p. 525)

A promising Ph.D. candidate was presenting his thesis at his final examination. He proceeded with a derivation and ended up with something like:  $F = -MA$ . He was embarrassed, his supervising professor was embarrassed, and the rest of the committee was embarrassed. The student coughed nervously and said 'I seem to have made a slight error back there somewhere.' One of the mathematicians on the committee replied dryly, 'Either that or an odd number of them!

Source undetermined

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The Ph.D. is essentially a license to start unlearning.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 2)

The Seabury Press. New York, New York, USA. 1977

**Dyson, Freeman J.** 1923–

American physicist and educator

The average student emerges at the end of the Ph.D. program, already middle-aged, overspecialized, poorly prepared for the world outside, and almost unemployable except in a narrow area of specialization. Large numbers of students for whom the program is inappropriate are trapped in it, because the Ph.D. has become a union card required for entry into the scientific job market.

*From Eros to Gaia*

Chapter 16 (p. 195)

Pantheon Books. New York, New York, USA. 1992

## PH.D. THESIS

**Dobie, Frank J.** 1888–1964

The average Ph.D. Thesis is nothing but a transference of bones from one graveyard to another.

*A Texan in England* (p. 26)

**MacLeish, Archibald** 1892–1982

American poet and Librarian of Congress

It is not for nothing that the scholar invented the Ph.D. thesis as his principal contribution to literary form. The Ph.D. thesis is the perfect image of his world. It is done for the sake of doing work – perfectly conscientious, perfectly laborious, perfectly irresponsible.

*The Irresponsibles: A Declaration* (p. 29)

Duell, Sloan and Pearce. New York, New York, USA. 1940

## PHAGOCYTE

**Shaw, George Bernard** 1856–1950

Irish playwright

There is at bottom only one genuinely scientific treatment for all diseases, and that is to stimulate the phagocytes. Stimulate the phagocytes. Drugs are a delusion.

*The Doctor's Dilemma*

Preface (p. 112)

Penguin Books. Baltimore, Maryland, USA. 1954

## PHAGOCYtic SYSTEM

**Mechnikov, Ilya** 1845–1916

Russian microbiologist

The sum of the very numerous facts established in the archives of science leaves no room to doubt the major part played by the phagocytic system, as the organism's main defence against the danger from infectious agents of all kinds, as well as their poisons.

*Nobel Lectures, Physiology or Medicine 1901–1921*

On the Present State of the Question of Immunity in Infectious Diseases

Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

## PHARMACIST

**Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

The surgeon who has performed scores of brilliant operations is less talked about than the one who has inadvertently killed a patient; the pharmacist who has carefully filled prescriptions for a lifetime remains obscure, but will gain publicity by a single oversight.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Seven (p. 87)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Flexner, Abraham** 1866–1959

American educator

The physician thinks, decides, and orders; the pharmacist obeys – obeys, of course, with discretion, intelligence, and skill – yet, in the end, obeys and does not originate. Pharmacy therefore is an arm added to the medical profession, a specially and distinctly higher form of handicraft, not a profession...

Is Social Work a Profession?

*School and Society*, Volume 1, 1915 (p. 905)

## PHARMACY

**Ghalioungui, Paul** 1908–87

Physician

The word pharmakon, whence pharmacy is derived, meant in Greek not only medicament, poison, or magical procedure, but also that which is slain to expiate the crimes of a city, like the scapegoat of Biblical times.... In other words, it meant "what carries off disease."

*Magic and Medical Science in Ancient Egypt*

Chapter II (p. 35)

Barnes and Nobles. New York, New York, USA. 1965

## PHENOMENA

### Campomanes, Pedro Rodriquez, Count de Campomanes 1723–1803

Spanish statesman

Nature, which you [Benjamin Franklin] have profoundly studied, is indebted to you for investigating and explaining phenomena, which wise men had not before been able to understand, and the great American philosopher, at the same time he discovers these phenomena, suggests useful methods for guarding men against their danger.

In Jared Sparks

*The Works of Benjamin Franklin* (Volume 10)

Letter from Count de Campomanes to B. Franklin, 26 July, 1784

Part III (p. 115)

Townsend Mac Coun. Chicago, Illinois, USA. 1882

### Cook, O. F.

No biographical data available

Science is by no means exempt from the very human tendency to place a fictitious value upon rare and exceptional phenomena, and to overlook the significance of familiar facts.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1904)

The Evolutionary Significance of Species (p. 397)

Government Printing Office. Washington, D.C. 1905

### Cornthwaite, Robert

American actor

There are no enemies in science, just phenomena to study.

*The Thing from Another World*

Film (1951)

### du Noüy, Pierre Lecomte 1883–1947

French scientist

When we speak of a phenomenon, we speak only of an event, or of a succession of events, arbitrarily isolated from the universe whose evolution they share. By isolating a fact in order to study it, we give it a beginning and an end, which are artificial and relative. In relation to the evolution of the universe, birth is not a beginning, and death is not an end. There are no more isolated phenomena in nature than there are isolated notes in a melody.

*The Road to Reason*

Chapter 2 (p. 53)

Longmans, Green & Company. London, England. 1949

### Gillette, George Francis

No biographical data available

In all the cosmos, there is naught but straight flying, lumping, caroming, and again straight flying. *Phenomena are but lumps, jumps, and bumps. A mass unit's career is but lumping, bumping, rejumping, rebumping, and finally unlumping.*

*The Rational Non-mystical Cosmos: The Mysticism of Science Exploded* (p. 33)

The Appeal Printing Co. New York, New York, USA. 1933

### Griffin Jay (Fictional character)

There are some things in science which should be brought to light. There are others, doctor, which should be left alone.

*The Mummy*

Film (1940)

### Grove, William Robert 1811–96

Judge and physical scientist

When natural phenomena are for the first time observed, a tendency immediately develops itself to refer them to something previously known – to bring them within the range of acknowledged sequences.

*The Correlation and Conservation of Forces*

Correlation of Physical Forces (p. 9)

D. Appleton & Co. New York, New York, USA. 1865

### Haas, W. H.

American microbiologist

As most of us are aware, the world is now divided into two sets of phenomena, scientific and non-scientific.

The Teaching of Geography as a Science

*Journal of Geography*, Volume 30, 1931 (p. 323)

### Heisenberg, Werner Karl 1901–76

German physicist and philosopher

We try to understand the phenomena and, in doing so, we realize that all understanding begins with recognising similarities or regularities in the phenomena.

*Natural Law and the Structure of Matter*

The Concept of Matter in Ancient Philosophy (p. 9)

The Rebel Press. London, England. 1970

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

Phenomena may well be suspected of anything, are capable of anything. Hypothesis proclaims the infinite; that is what gives hypothesis its greatness. Beneath the surface fact it seeks the real fact. It asks creation for her thoughts, and then for her second thoughts. The great scientific discoverers are those who hold nature suspect.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 415)

The Heritage Press. New York, New York, USA. 1961

### James, William 1842–1910

American philosopher and psychologist

Anyone will renovate his science who will steadily look after the irregular phenomena, and when science is renewed, its new formulas often have more of the voice of the exceptions in them than of what were supposed to be the rules.

*The Will to Believe and Other Essays in Popular Philosophy*  
What Psychical Research Has Accomplished (p. 300)  
Longmans, Green & Co. New York, New York, USA. 1899

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

It would be a dull mind that could see the rich variety of natural phenomena without wondering how they are inter-related.

*The New Background of Science*  
Chapter II (p. 59)  
The University of Michigan Press. 1959

**Jevons, William Stanley** 1835–82  
English economist and logician

...every strange phenomenon may be a secret spring which, if rightly touched, will open the door to new chambers in the palace of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book V, Chapter XXIX (p. 671)  
Macmillan & Company Ltd. London, England. 1887

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

The phenomena of nature are most often enveloped by so many strange circumstances, and so great a number of disturbing causes mix their influence, that it is very difficult to recognize them.

*A Philosophical Essay on Probabilities*  
Chapter IX (p. 73)  
Dover Publications, Inc. New York, New York, USA. 1951

There is no question here of vague causes, which cannot be submitted to analysis, and which the imagination modifies at pleasure to accommodate them to the phenomena.

Translated by J. Pond  
*The System of the World* (Volume 2)  
Book IV (p. 2)  
Printed for Richard Phillips. London, England. 1809

**Lederer, Charles** 1906–76  
American film writer and director

There are no enemies in science, professor. Only phenomena to study.

*The Thing From Another World*  
Film (1951)

**Liebig, Justus** 1803–73  
German organic chemist

Nature speaks to us in a peculiar language, in the language of phenomena; she answers at all times the questions which are put to her; and such questions are experiments.

*Chemistry In Its Application to Agriculture and Physiology*  
Part First, Chapter II (p. 21)  
T.B. Peterson. Philadelphia, Pennsylvania, USA. 1847

**Lodge, Sir Oliver** 1851–1940  
English physicist

The ordinary run of men live among phenomena, of which they know nothing and care less. They see bodies fall to the earth, they hear sounds, they kindle fires, they see the heavens roll above them, but of the causes and inner working of the whole they are ignorant, and with their ignorance they are content.

*Pioneers of Science*  
Lecture I (p. 5)  
Macmillan & Co Ltd. London, England. 1905

**Mellor, Joseph William** 1863–1938  
Chemist

If the evidence of an alleged phenomenon cannot be tested by verification, it is outside the range of science.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
Chapter I (p. 16)  
Longman, Green & Co. London, England. 1922

**Ramón y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

The intellect is presented with phenomena marching in review before the sensory organs. It can be truly useful and productive only when limiting itself to the modest tasks of observation, description, and comparison, and of classification that is based on analogies and differences.

*Advice for a Young Investigator*  
Chapter 1 (p. 2)  
The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rey, Jean** 1583–1645  
French physician and chemist

Some eminent personages having observed with astonishment that tin and lead increase in weight when they are calcined, have been seized with a praiseworthy desire to enquire into the cause of this phenomenon. It has proved a goodly subject, but the enquiry has been troublesome, and its fruits very small: in so far that after having directed their thoughts to all quarters, they have only been able to adduce reasons so feeble that no man of sound judgment dares trust them for support, or by their aid shelter his mind from all doubt.

*Essays of Jean Rey*  
On an Enquiry into the Cause Wherefore Tin and Lead Increase in Weight on Calcination (p. 5)  
William F. Glay. Edinburgh, Scotland 1895

**Royce, Josiah** 1855–1916  
American philosopher

The control of natural phenomena, which through the sciences, men have attained, grows daily vaster and more detailed, and in its details more assured.

Translated by George Bruce Halsted  
*Science and Hypothesis*  
Introduction (p. xvi)  
The Science Press. New York, New York, USA. 1905

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

To science, phenomena are of use only as they lead to facts; and to art facts are of use only as they lead to phenomena.

*The Stones of Venice* (Volume 3)  
Chapter II (p. 39)  
John R. Alden, Publisher. New York, New York, USA. 1885

**Spencer, Herbert** 1820–1903  
English social philosopher

Sad, indeed, is it to see how men occupy themselves with trivialities, and are indifferent to the grandest phenomena...

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 73)  
A.L. Fowle. New York, New York, USA. 1860

**Tait, Peter Guthrie** 1831–1901  
Scottish physicist and mathematician

From the earliest times man's apprehension of the causes and connections of natural phenomena has been rendered uncertain and imperfect by his wilfully ignoring the great fact that Natural Philosophy is an experimental, and not an intuitive, science.

*Sketch of Thermodynamics* (2nd edition)  
Chapter I (p. 1)  
David Douglas. Edinburgh, Scotland. 1877

**Trousseau, Armand** 1801–67  
French internist

A conception of the nature of tangible objects is acquired by a simple perception of all the phenomena by which objects manifest themselves. This perception demands no intellectual effort; it requires attention and memory, and – as memory may prove treacherous – registration of the observed phenomena.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)  
Introduction (p. 30)  
Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

In considering the study of physical phenomena, not merely in its bearings on the material wants of life, but in its general influence on the intellectual advancement of mankind, we find its noblest and most important result to be a knowledge of the chain of connection by which all natural forces are linked together and made mutually dependent upon each other; and it is the perception of these relations that exalts our views and ennobles our enjoyments. Such a result can, however, only be reaped as the fruit of observation and intellect, combined with the spirit of the age, in which are reflected all the varied phases of thought.

Translated by E.C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 23)  
D. Appleton & Co. New York, New York, USA. 1850

**von Liebig, Justus** 1803–73  
German organic chemist

When we obtain a correct knowledge of the link which connects certain associated phenomena, when we have made an acquisition of a new truth relative to causation, it becomes equivalent to a new and additional sense, enabling us to perceive innumerable phenomena which had previously escaped our notice, and which still remain mysterious or altogether invisible to others.

In John Gardner  
*Familiar Letters on Chemistry*  
Second Series  
Letter I (pp. 5–6)  
Taylor & Walton. London, England. 1844

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

There is no natural phenomenon that is comparable with the sudden and apparently accidentally timed development of science, except perhaps the condensation of a super-saturated gas or the explosion of some unpredictable explosives.

*Proceedings, American Philosophical Society*  
The Limits of Science  
Volume 94, Number 5, 1950 (p. 422)

**Wilson, Edward O.** 1929–  
American biologist and author

...all tangible phenomena, from the birth of stars to the workings of social institutions, are based on material processes that are ultimately reducible, however long and tortuous the sequences, to the laws of physics.

*Consilience: The Unity of Knowledge*  
Chapter 12 (p. 266)  
Alfred A. Knopf. New York, New York, USA. 1998

## PHEROMONE

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

Coming from every direction and appraised I know not how, here are forty lovers eager to pay their respects to the marriageable bride born that morning.

Translated by Alexander Teixeira de Mattos  
*The Life of the Caterpillar*  
The Great Peacock (p. 249)  
Dodd, Mead & Co. New York, New York, USA. 1918

**Sagan, Carl** 1934–96  
American astronomer and author

**Druryan, Ann** 1949–  
American author



When a honeybee dies it releases a death pheromone, a characteristic odor that signals the survivors to remove it from the hive.... The corpse is promptly pushed and tugged out of the hive. The death pheromone is oleic acid.... What happens if a live bee is dabbed with a drop of oleic acid? Then no matter how strapping and vigorous it might be, it is carried “kicking and screaming” out of the hive.

In Robert L. Solso

*Mind and Brain Sciences in the 21st Century*

What Thin Partitions... (p. 23)

MIT Press. 1999

## PHILOSOPHER

### Author undetermined

In this age the philosopher is no longer a member of some exclusive fraternity jealously guarding the mysteries of science, but the cultivator of his special branch of inductive philosophy for the general use of man, labouring in a spirit of profound humility, and knowing that though he should devote a life to his pursuit he must still be a learner.

Science and Royalty Under Highland Skies

*Bentley's Miscellany*, Volume 46 1859 (p. 609)

**Boutroux, Émile** 1845–1921

French philosopher

The philosopher asks himself whether natural law as assumed by science, wholly coincides with law as really existing in nature; whether science and reality are so alike that science may be regarded as exhausting everything intelligible and true that the real contains.

Translated by Fred Roth Well

*Natural law in Science and Philosophy*

Preface (p. 5)

The Macmillan Co. New York, New York, USA. 1914

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

Somehow or other no statement is too absurd for some philosophers to make.

Translated by William Armistead Falconer

*Cicero: De Senectute, De Amicitia, De Divinatione*

De Divinatione, II, LVIII (p. 505)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Darwin, Charles Robert** 1809–82

English naturalist

Why should the souls [of philosophers] be deeply vexed? The majesty of Fact is on their side, and the elemental forces of Nature are working for them. Not a star comes to the meridian at its calculated time but testifies to the justice of their methods – their beliefs are “one with the falling rain and with the growing corn.”

By doubt they are established, and open inquiry is their bosom friend.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 53)

Macmillan & Company Ltd. London, England. 1904

**Dickens, Charles** 1812–70

English novelist

... it has somehow or other happened, from time immemorial, that many of the best and ablest philosophers, who have been perfect lights of science in matters of theory, have been wholly unable to reduce them to practice.

*The Posthumous Papers of the Pickwick Papers*

Chapter XIX (p. 192)

J. van Amringe. New York, New York, USA. 1840

**Enriques, Federigo** 1871–1946

Italian mathematician

No greed for riches has driven philosophers to devote their whole energies to the problems of reality and of knowledge. If they had succeeded in their endeavors, one sole prize might seem to have awaited them; that is, the prize of reconquering, after having passed through philosophic skepticism, that solid and simple faith of men, which is beyond and above all criticism.

*Problems of Science*

Introduction (p. 9)

The Open Court Publishing Co. La Salle, Indiana, USA. 1914

**Faraday, Michael** 1791–1867

English physicist and chemist

The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favorite hypothesis; be of no school; and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities he added industry, he may indeed hope to walk within the veil of the temple of Nature.

*The Life and Letters of Faraday* (Volume 1) (p. 220)

Longmans, Green & Company. London, England. 1870

**Harvey, William** 1578–1657

English physician

True philosophers, who are only eager for truth and knowledge, never regard themselves as already so thoroughly informed, but that they welcome further information from whomsoever and from wheresoever it may come; nor are they so narrow-minded as to imagine any of the arts or sciences transmitted to us by the ancients, in such a state of forwardness or completeness, that nothing is left for the ingenuity and industry of others.

*On the Motion of the Heart and Blood in Animals*

Dedication (p. 6)

George Bell & Sons. London, England. 1889

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

...to the natural philosopher there is no natural object unimportant or trifling.

*A Preliminary Discourse on The Study of Natural Philosophy*  
Part I, Chapter I, Section 10 (p. 14)  
Printed for Longman, Rees, Orme, Brown, and Green. London, England. 1831

**Lindley, David** 1956–  
English astrophysicist and author

As philosophers have frequently found, the real world seems to messy, too stubbornly arbitrary, to be found out by the power of thought alone, no matter how fine the guiding sense of aesthetics.

*The End of Physics: The Myth of a Unified Theory*  
Part III, Chapter 8 (p. 231)  
Basic Books, Inc. New York, New York, USA. 1993

**Marryat, Frederick** 1792–1848  
English novelist

A modern philosopher, with his hypothesis, is like a man possessed with a devil in times of yore; and it is not to be cast out by any human means, that I know of.

*The King's Own*  
Chapter XXXV (p. 227)  
George Routledge & Sons. London, England. 1873

**Pouchet, Félix Archimède** 1800–72  
French biologist

Whoever aspires to the title of a philosopher has, in the present day, a double mission to perform – to discover and to popularize; he should labour on the one hand for the advancement, on the other for the diffusion, of science.

*The Universe: Or, The Infinitely Great and the Infinitely Little*  
Preface (p. vi)  
Blackie & Son. London, England. 1870

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Organic life, we are told, has developed gradually from the protozoon to the philosopher, and this development, we are assured, is indubitably an advance. Unfortunately it is the philosopher, not the protozoon, who gives us this assurance, and we can have no security that the impartial outsider would agree with the philosopher's self-complacent assumption.

*Mysticism and Logic: And Other Essays*  
Chapter VI (p. 106)  
Longmans, Green & Co. London, England. 1919

**Whewell, William** 1794–1866  
English philosopher and historian

The character of the true philosopher is, not that he never conjectures hazardously, but that his conjectures are

clearly conceived, and brought into rigid contact with facts. He sees and compares distinctly the Ideas and the Things; – the relations of his notions to each other and to phenomena.

*The Philosophy of the Inductive Sciences, Founded Upon Their History*  
(2nd edition)  
Book XI, Chapter V (p. 55)  
John W. Parker. London, England. 1867

## PHILOSOPHER'S STONE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The philosopher's stone is no more to be found in the organic than the inorganic world; and we shall seek as vainly to transform the lower animal types into the higher ones by any of our theories, as did the alchemists of old to change the baser metals into gold.

*Methods of Study in Natural History*  
Chapter XVI (p. 319)  
Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Smith, Horace** 1779–1849  
No biographical data available

The true possessor of the philosopher's stone is the miner, whose iron, copper, and tin are always convertible into the more precious metals.

*The Tin Trumpet; Or Heads and Tales, for the Wise and Waggish Alchymist* (p. 28)  
D. Appleton & Co. New York, New York, USA. 1859

## PHILOSOPHIC DOUBT

**Brooks, William Keith** 1848–1908  
American zoologist

The hardest of intellectual virtues is philosophic doubt, and the mental vice to which we are most prone is our tendency to believe that lack of evidence for an opinion is a reason for believing something else.

*The Foundations of Zoology*  
Lecture XI (p. 283)  
The Macmillan Co. New York, New York, USA. 1899

## PHILOSOPHICAL DOCTRINE

**Hollister, John Hamilcar** 1824–1911  
American physician

The popular conception of any philosophical doctrine is necessarily imperfect, and very generally unjust.

*Memories of Eighty Years; Autosketches, Random Notes and Reminiscences*  
Lucretius and the Atomic Theory (p. 177)  
Publisher undetermined  
Chicago, Illinois, USA. 1912

## PHILOSOPHICAL PAPERS

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

The snobbish symbol-dropping found nowadays in philosophical papers raises eyebrows among mathematicians, like someone paying his grocery bill with Monopoly money.

*Indiscrete Thoughts*

Chapter VII (p. 93)

Birkhäuser. Boston, Massachusetts, USA. 1997

## PHILOSOPHY

**Alexander, Samuel** 1859–1938

Australian-born British philosopher

The more comprehensive a science becomes the closer it comes to philosophy, so that it may become difficult to say where the science leaves off and philosophy begins.

*Space, Time, and Deity: The Gifford Lectures at Glasgow, 1916–1918*

(Volume 1)

Introduction (p. 2)

Macmillan &amp; Co. Ltd. London, England. 1920

**Astaire, Fred** 1899–1955

American dancer, actor, and singer

I wish I had your confidence...without your viewpoint.

*Holiday Inn*

Film (1942)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...natural philosophy, even among those who have attended to it, has scarcely ever possessed, especially in these later times, a disengaged and whole man...but... has been made merely a passage and bridge to something else. And so this great mother of the sciences has with strange indignity been degraded to the offices of a servant; having to attend on the business of medicine or mathematics, and likewise to wash and imbue youthful and unripe wits with a sort of first dye, in order that they may be the fitter to receive another afterwards. Meanwhile let no man look for much progress in the sciences – especially in the practical part of them – unless natural philosophy be carried on and applied to particular sciences, and particular sciences be carried back again to natural philosophy.

*The Works of Francis Bacon* (Volume 4)*The New Organon*, Aphorisms, Book I (pp. 78–79)

Longman &amp; Co. London, England. 1858

**Barthelme, Donald** 1931–89

American author

But I think everyone should have a little philosophy, Thomas said. It helps, a little. It helps. It is good. It is about half as good as music.

*The Dead Father* (p. 76)

Pocket Books. New York, New York, USA. 1975

**Bell, R. P.**

English chemist

The exact verbal definition of qualitative concepts is more often the province of philosophy than of physical science.

*The Proton in Chemistry*

Chapter II (p. 7)

Cornell University Press. Ithaca, New York, USA. 1959

**Bernard, Claude** 1813–78

French physiologist

I can no more accept a philosophy, then, which tries to assign boundaries to science, than a science which claims to suppress philosophic truths that are at present outside its own domain.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 223)

Henry Schuman, Inc. New York, New York, USA. 1927

**Born, Max** 1882–1970

German-born English physicist

A philosophy in which the notions of chance and freedom are fundamental seems to me preferable to the almost inhuman determinism of the previous epoch – but that is no scientific argument.

*Les Prix Nobel. The Nobel Prizes in 1954*

Nobel banquet speech for award received in 1954

Nobel Foundation. Stockholm, Sweden. 1955

**Buchner, Ludwig** 1824–99

German physician and philosopher

...empirical philosophy, wherever it may search for it, is nowhere able to find a trace of a supernatural influence either in time or space.

*Force and Matter*

Chapter VIII (p. 55)

Trübner &amp; Co. London, England. 1864

**Bulwer Lytton, Edward** 1831–91

English statesman and poet

Real philosophy seeks rather to solve than to deny. While we hear, every day, the small pretenders to science talk of the absurdities of Alchemy and the dream of the Philosopher's Stone, a more erudite knowledge is aware that by Alchemists the greatest discoveries in science have been made, and much which still seems abstruse, had we the key to the mystic phraseology they were compelled to adopt, might open the way to yet more noble acquisitions.

*Zanoni*

Book II, Chapter 6 (p. 61)

Chapman &amp; Hall. London, England. 1853

**Burnet, Thomas** 1635–1715

English cleric and scientist

Orators and Philosophers treat Nature after a very different manner...with all her graces and ornaments, and if there be anything which is not capable of that, they dissemble it, or pass it over slightly. But Philosophers view Nature with a more impartial eye, and without favor or prejudice give a just and free account [of] how they find all the parts of the Universe, some more, some less perfect.

*The Sacred Theory of the Earth* (2nd edition)

Book I, Chapter IX (p. 90)

Printed by R. Norton. London, England. 1691

**Carus, Paul** 1852–1919

American philosopher

Science is originally one and undivided and serves the practical purpose of guidance in life. When by a division of labor the several sciences originated, there remained a field which was common to all of them; and this field is the domain of the science of the sciences, i.e., of philosophy.

*Philosophy as a Science: A Synopsis of Writings of Dr. Paul Carus*

Introduction (p. 7)

The Open Court Publishing Co. Chicago, Illinois, USA. 1909

**Clarke, Samuel** 1675–1729

English philosopher

‘Tis of singular use, rightly to understand, and carefully to distinguish from hypotheses or mere suppositions, the true and certain consequences of experimental and mathematical philosophy; which do, with wonderful strength and advantage, to all such as are capable of apprehending them, confirm, establish, and vindicate against all objections, those great and fundamental truths of natural religion, which the wisdom of providence has at the same time universally implanted, in some degree, in the minds of persons even of the meanest capacities, not qualified to examine demonstrative proofs.

In H.G. Alexander

*The Leibniz–Clarke Correspondence*

Dedication (p. 6)

Philosophical Library Inc. New York, New York, USA. 1956

**Comte, Auguste** 1798–1857

French philosopher

The study of the external world and of Man is the eternal business of philosophy.

*The Positive Philosophy of Auguste Comte* (Volume 2)

Book V, Chapter I (p. 1)

George Bell & Sons. London, England. 1896

**Davy, Sir Humphry** 1778–1829

English chemist

Philosophy is simple and intelligible. We owe confused systems to men of vague and obscure ideas.

In John Davy

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter II (p. 122)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Dawson, Sir John William** 1820–99

Canadian geologist and educator

It is a wise and thoughtful philosophy which can distinguish what is fixed and unchangeable from that which is fluctuating and capable of development.

*Some Salient Points in the Science of the Earth*

Chapter XII (p. 342)

Hodder & Stoughton. London, England. 1893

**de Botton, Alain** 1969–

Swiss-born English writer and television producer

Seneca believed...arguments are like eels: however logical, they may slip from the mind’s weak grasp unless fixed there by imagery and style.

*The Consolations of Philosophy* (p. 92)

Vintage Books. New York, New York, USA. 2000

**Dewar, Redcote**

No biographical data available

Nothing in philosophy is truly more pitiable than to witness how great intellects, after breaking loose from their moorings of scientific reason and practical demonstration, plunge under the wing of some unintelligible hypothesis into a tempest of their own verbosity, where, borne aloft on an inflation solely of words, and floundering hopelessly in the bathos of a “peradventure,” they fondly imagine themselves cleaving the empyrean of “pure intelligence.”

*From Matter to Man: A New Theory of the Universe*

Chapter II (p. 14)

Chapman & Hall, Ltd. London, England. 1898

**Dewey, John** 1859–1952

American philosopher and educator

What would happen to philosophy...if it ceased to deal with the problem of reality and knowledge at large?... From this point of view, the problem of philosophy concerns the *interaction* of our judgments about ends to be sought with the knowledge of the means for achieving them.

*Quest for Certainty: A Study of the Relation of Knowledge and Action*

Chapter II (pp. 36–37)

Minton, Balch & Company. New York, New York, USA. 1929

[Philosophy] has tried to combine acceptance of the conclusions of scientific inquiry as to the natural world with the acceptance of doctrines about the nature of mind and knowledge which originated before there was such a thing as systematic experimental inquiry. Between the two there is an inherent incompatibility.

*Quest for Certainty: A Study of the Relation of Knowledge and Action*

Chapter III (p. 49)

Minton, Balch & Company. New York, New York, USA. 1929

**Dickens, Charles** 1812–70

English novelist

Measles, rheumatics, whooping-cough, fevers, agers, and lumbagers is all philosophy together; that’s what it

is. The heavenly bodies is philosophy; and if there's a screw loose in a earthly body, that's philosophy too; or it may be that sometimes there's a little metaphysics in it, but that's not often. Philosophy's the chap for me.

*Nicholas Nickleby*

Chapter LVII (p. 571)

John Serratt & Son. Altrincham, England. 1948

### **Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Philosophy becomes poetry, and science imagination, in the enthusiasm of genius.

*Miscellanies of Literature, by the Author of 'Curiosities of Literature'* (p. 426)

G. Routledge. London, England. 1886

### **Donne, John** 1572–1631

English poet and divine

And new Philosophy calls all in doubt,  
The Element of fire is quite put out;  
The sun is lost, and th' earth, and no man's wit  
Can well direct him where to look for it.  
And freely men confess that this world's spent,  
When in the Planets and the Firmament  
They seek so many new, they see that this  
Is crumbled out again to his Atomies.

*An Anatomy of the World*

The First Anniversary, II, 205–212

Presented for presentation to members of the Roxburghe Club. Cambridge, England. 1951

### **Durant, William James** 1885–1981

American historian and essayist

Science gives us knowledge, but only philosophy can give us wisdom.

*The Story of Philosophy*

Introduction (p. 3)

Simon & Schuster. New York, New York, USA. 1953

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The recent tendencies of science do...take us to an eminence from which we can look down into the deep waters of philosophy; and if I rashly plunge into them, it is not because I have confidence in my powers of swimming, but to try to show that the water is really deep.

*The Nature of the Physical World*

Chapter XIII (p. 276)

The Macmillan Company. New York, New York, USA. 1930

### **Einstein, Albert** 1879–1955

German-born physicist

The Heisenberg–Bohr tranquilizing philosophy – or religion? – is so delicately contrived that, for the time

being, it provides a gentle pillow for the true believer from which he cannot very easily be aroused. So let him lie there.

*Letters on Wave Mechanics*

Letter to Schrödinger, 31 May, 1928 (p. 31)

I have never belonged wholeheartedly to a country, a state, nor to a circle of friends, nor even to my own family. When I was still a rather precocious young man, I already realized most vividly the futility of the hopes and aspirations that most men pursue throughout their lives. Well-being and happiness never appeared to me as an absolute aim. I am even inclined to compare such moral aims to the ambitions of a pig.

In C.P. Snow

*Variety of Men* (p. 77)

Penguin Books, Harmondsworth, U.K. 1969

If philosophy is interpreted as a quest for the most general and comprehensive knowledge, it obviously becomes the mother of all scientific inquiry.

Physics, Philosophy, and Scientific Progress

*Physics Today*, Issue 6 June, 2005 (p. 46)

### **Epictetus** ca. 55–135

Greek philosopher

Behold, the beginning of philosophy is the observation of how men contradict each other, and the search whence cometh this contradiction, and the censure and mistrust of bare opinion. And it is an inquiry into that which seems, whether it rightly seems; and the discovery of a certain rule, even as we have found a balance for weights, and a plumb line for straight and crooked. This is the beginning of philosophy.

Translated by T.W. Rolleston

*The Teaching of Epictetus*

Book I, Chapter I (p. 5)

Walter Scott. London, England. 1888

### **Foster, Hannah W.** 1758–1840

English writer

You ask me, my friend, whether I am in pursuit of truth, or [of] a lady? I answer, both. I hope and trust they are united; and really expect to find truth and the virtues and graces besides in a fair form.

*The Coquette: The History of Eliza Norton (A Novel)* (p. 10)

Oxford University Press. 1986

### **Gundisalvo, Domingo** fl 1140

Spanish philosopher

...Since there is no science which is not some part of philosophy, we should first see, therefore, what philosophy is ...

Translated by Marshall Clagett and Edward Grant

*A Source Book in Medieval Science* (Volume 1)

Classification of the Sciences (pp. 59–60)

Harvard University Press. Cambridge, Massachusetts, USA. 1971



**Hickok, Laurens Perseus** 1798–1888

No biographical data available

Not facts alone, no matter how logically classified, but facts expounded by principles, constitute philosophy.

*Rational Cosmology: Or, The Eternal Principles and the Necessary Laws of the Universe* (p. 14)

D. Appleton & Co. New York, New York, USA. 1858

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

I realized that only in music could I find the answer I was seeking to the questions of the previous evening. Argument I could follow, it weighed with me, yet I could decide nothing from it.

*October the First Is Too Late*

Chapter Fourteen (p. 187)

Harper & Row, Publishers. New York, New York, USA. 1966

**Huxley, Aldous** 1894–1963

English writer and critic

Finding bad reasons for what one believes for other bad reasons – that’s philosophy.

*Brave New World*

Chapter 3 (p. 235)

HarperCollins Publisher. New York, New York, USA. 1998

**Huxley, Thomas Henry** 1825–95

English biologist

The genius which sighs for new worlds to conquer beyond that surprising region in which “geometry, algebra, and the theory of numbers melt into one another like sunset tints, or the colours of a dying dolphin,” may be of comparatively little service in the cold domain (mostly lighted by the moon, some say) of philosophy.

*Lay Sermons, Addresses and Reviews* (p. vi)

D. Appleton & Co. New York, New York, USA. 1903

...M. Comte’s philosophy, in practice, might be compendiously described as Catholicism minus Christianity.

*Method and Results: Essays*

On the Physical Basis of Life (p. 156)

D. Appleton & Co. New York, New York, USA. 1898

**Inge, William Ralph** 1860–1954

English religious leader and author

...science and philosophy cannot be kept in water-tight compartments.

*God and the Astronomers*

Preface (p. vii)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Jaeger, Benedict** 1789–?

Austrian born American entomologist

Philosophy has invested even the commonest objects of Nature with charms unknown to the uneducated.

*The Life of North American Insects*

Preface (p. xi)

Harper & Brothers Publishers. New York, New York, USA. 1859

**Lewis, Gilbert Newton** 1875–1946

American chemist

The average scientist, unequipped with the powerful lenses of philosophy, is a nearsighted creature, and cheerfully attacks each difficulty in the hope that it may prove to be the last.

*The Anatomy of Science*

Chapter I (p. 1)

Yale University Press. New Haven, Connecticut, USA. 1926

**Long, J. M.**

No biographical data available

Philosophy, from whatever point of view it may begin its investigations, attempts the solution of the most difficult problem which can possibly engage the thought of the human mind.

The Synthetic Philosophy an Organon of the Sciences

*The Kansas City Review of Science and Industry*, Volume 4, Number 11, March, 1881 (p. 649)

Philosophy justifies itself to science by showing that the methods and fundamental ideas of the latter are inadequate to their own explanation.

The Synthetic Philosophy an Organon of the Sciences

*The Kansas City Review of Science and Industry*, Volume 4, Number 11, March, 1881 (p. 649)

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

...every philosopher has his own private view of science, and every scientist his private philosophy.

*Knowledge and Error: Sketches on the Psychology of Enquiry*

Chapter I (p. 3)

D. Reidel Publishing Company. Dordrecht, Germany. 1976

**Maclaurin, Colin** 1698–1746

Scottish mathematician and natural philosopher

Is it not therefore the business of philosophy, in our present situation in the universe, to attempt to take in at once, in one view, the whole scheme of nature; but to extend, with great care and circumspection, our knowledge, by just steps, from sensible things as far as our observations or reasonings from them will carry us in our enquiries concerning either the greater motions and operations of nature, or her more subtle and hidden works.

*An Account of Sir Isaac Newton’s Philosophical Discoveries*

Book I, Chapter I (p. 19)

Printed for the Author’s Children. London, England. 1748

**Marett, Robert Randolph** 1866–1943

Social anthropologist

Knowing by parts is science, knowing the whole as a whole is philosophy.

*Anthropology*

Chapter I (p. 12)

Henry Holt & Co. New York, New York, USA. 1912



**Nielsen, Kai**

American-born Canadian philosopher

We must be on guard against the irrational heart of rationalism and not set out on the quest for certainty.

*Ethics Without God* (Revised edition) (p. 47)

Prometheus Books. Amherst, New York, USA. 1990

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

Now as all the sciences are connected with each other, Philosophy is never completed. In a complete system of all the sciences will philosophy for the first time be made manifest.

Quoted in Panthea

*The Reasoner*

Eclectic Gatherings

Volume 6 1849 (p. 373)

The idea of philosophy is a mysterious tradition. Philosophy is, in all, the problem of knowing. It is an undefined Science of the Sciences, a mysticism of the desire for knowledge; it is the very Spirit of the Sciences, and consequently unrepresentable, either in form or application, in the perfect representation of a special science.

Quoted in Panthea

*The Reasoner*

Eclectic Gatherings

Volume 6 1849 (p. 373)

**Paine, Thomas** 1737–1809

Anglo-American political theorist and writer

Natural philosophy, mathematics and astronomy, carry the mind from the country to the creation, and give it a fitness suited to the extent.

Address to the People of England

Philadelphia, March, 1780

**Raether, H.**

No biographical data available

There are more things between cathode and anode than are dreamt of in your philosophy.

*Electron Avalanches and Breakdown in Gases*

Introduction (p. 1)

Butterworths. London, England. 1964

**Rolleston, Thomas William** 1857–1920

Irish writer

Nature-study if it is to be possible must begin, and if it is to be fruitful must end, in something which is not strictly the study of nature, but which we call Philosophy.

*Parallel Paths: A Study in Biology, Ethics, and Art*

Part I, Chapter 1 (p. 17)

Duckworth & Co. London, England. 1908

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

To create a healthy philosophy you should renounce metaphysics but be a good mathematician.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

Philosophy, from the earliest times, has made greater claims, and achieved fewer results, than any other branch of learning.

*Our Knowledge of the External World*

Lecture I (p. 3)

The Open Court Publishing Company. Chicago, Illinois. 1914

...science is what you more or less know and philosophy is what you do not know.

*Logic and Knowledge*

The Philosophy of Logical Atomism (p. 281)

George Allen & Unwin Ltd. London, England. 1926

in spite of the splendidly imaginative systems to which, they have given rise, have been on the whole a hindrance to the progress of philosophy, and ought now to be: It is my belief that the ethical and religious motives, consciously thrust aside by those who wish to discover philosophical truth. Science, originally, was entangled in similar motives, and was thereby hindered in its advances. It is, I maintain, from science, rather than from ethics and religion, that philosophy should draw its inspiration.

*Mysticism and Logic: And Other Essays*

Chapter VI (pp. 97–98)

Longmans, Green & Co. London, England. 1919

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

A further bar to fruitful discussion in philosophy is the curious etiquette which apparently taboos the asking of questions about a philosopher's meaning while he is alive.

*Must Philosophers Disagree: and Other Essays in Popular Philosophy*

(p. 13)

The Macmillan Co. New York, New York, USA. 1934

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*

Act I, Scene v, l. 167–168

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shepherd, William**

No biographical data available

Philosophy without geometry, is like medicine without chemistry.

*Systematic Education* (Volume 1)

Chapter XXXI (p. 498)

Longman, Hurst, Rees, Orme, & Brown. London, England. 1822

**Updike, John** 1932–

American novelist, short story writer, and poet

The mad things dreamt up in the sky

Discomfort our philosophy.

*Collected Poems 1953–1993*

Skyey Developments (p. 334)

Alfred A. Knopf. New York, New York, USA. 1993

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Philosophy begins in wonder. And, at the end, when philosophical thought has done its best, the wonder remains. There have been added, however, some grasp of the immensity of things, some purification of emotion by understanding.

*Modes of Thought*

Chapter III, Lecture VIII (p. 232)

The Macmillan Company. New York, New York, USA. 1938

Philosophy asks the simple question, What is it all about?

Whitehead's Philosophy

*Philosophical Review*, Volume 46, Number 2, March, 1937 (p. 178)

It [philosophy] builds cathedrals before the workmen have moved a stone, and it destroys them before the elements have worn down their arches.

*Science and the Modern World*

Preface (p. x)

The Macmillan Co. New York, New York, USA. 1925

Philosophy works slowly. Thoughts lie dormant for ages; and then, almost suddenly as it were, mankind finds that they have embodied themselves in institutions.

*Science and the Modern World*

Preface (p. x)

The Macmillan Co. New York, New York, USA. 1925

**Wright, Frances** 1795–1853

Scottish-born American social reformer

...Philosophy cannot change the laws of nature; but she may teach us to accommodate to them.

*A Few Days in Athens*

Chapter X (p. 132)

Longman, Hurst, Reese, Orme & Brown. London, England. 1822

## PHILOSOPHY OF SCIENCE

### American Institute of Biological Science 1963

What is science? Is it a body of factual information? Is it a set of theories? Is it an activity or set of procedures for finding facts and developing theories? Science is really a combination of all three of these.

*Biological Science: Molecules to Man* (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1963

**Asimov, Isaac** 1920–92

American author and biochemist

Science is a process. It is a way of thinking, a manner of approaching and of possibly resolving problems, a route

by which one can produce order and sense out of disorganized and chaotic observations. Through it we achieve useful conclusions and results that are compelling and upon which there is a tendency to agree.

*"X" Stands for Unknown*

Introduction (p. 10)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Ayala, Francisco J.** 1934–

Spanish-born American biologist

Science is systematic organisation of knowledge about the universe on the basis of explanatory hypotheses which are genuinely testable. Science advances by developing gradually more comprehensive theories; that is, by formulating theories of greater generality which can account for observational statements and hypotheses which appear as *prima facie* unrelated.

*Studies in the Philosophy of Biology: Reduction and Related Problems*

Introduction (p. ix)

Macmillan & Company Ltd. London, England. 1974

**Barrow, John D.** 1952–

English theoretical physicist

The goal of science is to make sense of the diversity of Nature.

*Theories of Everything: The Quest for Ultimate Explanation*

Chapter One (p. 10)

The Clarendon Press. Oxford, England. 1991

**Bauer, Henry H.** 1931–

American chemist

Science is uniquely distinguished from other human practices: it is the only activity in which the constraints of reality have brought to the quest for deep answers an effective consensus across all the variations that in other respects divide the human species.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 143)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Bernard, Claude** 1813–78

French physiologist

True science teaches us to doubt and, in ignorance, to refrain.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section VIII (p. 55)

Henry Schuman, Inc. New York, New York, USA. 1927

True science suppresses nothing, but goes on searching and is undisturbed in looking straight at things that it does not yet understand.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 223)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bohm, David** 1917–92  
American physicist

**Peat, F. David** 1938–  
English holistic physicist and author

The essential activity of science consists of thought, which arises in creative perception and is expressed through play. This gives rise to a process in which thought unfolds into provisional knowledge which then moves outward into action and returns as fresh perception and knowledge. This process leads to a continuous adoption of knowledge which undergoes constant growth, transformation, and extension. Knowledge is therefore not something rigid and fixed that accumulates indefinitely in a steady way but is a continual process of change. Its growth is closer to that of an organism than a data bank. When serious contradictions in knowledge [are] encountered, it is necessary to return to creative perception and free play, which act to transform existing knowledge. Knowledge apart from this cycle of activity, has no meaning.

*Science, Order, and Creativity*  
Chapter One (p. 56)

Bantam Books. New York, New York, USA. 1987

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

Science is driven forward by unexpected and surprising results emerging from new experiments or by the appearance of contradictions between theories previously thought compatible. Solving such problems as they arise is of the essence of our work. Thus science is not something strange and odd but the most human of pursuits.

*The Philosopher of Science*

*Nature*, Volume 358, Number 6385, 30 July, 1992 (p. 363)

**Boulding, Kenneth E.** 1910–93  
English economist and social scientist

Science might also be defined as the process of substituting unimportant questions which can be answered for important questions which cannot.

*Image: Knowledge in Life and Society*  
Chapter XI (p. 154)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1956

**Bushnell, Horace** 1802–76  
American Congregational minister

What is science, anyhow, but the knowledge of species? And if species do not keep their places, but go a masking or really becoming one another, in strange transmutations, what is there to know, and where is the possibility of science? If there is no stability or fixity in species, then, for aught that appears, even science itself may be transmuted into successions of music, and moonshine, and auroral fires. If a single kind is all kinds, then all are one, and since that is the same as none, there is knowledge

no longer. The theory may be true, but it never can be proved, for that reason if no other. And when it is proved, if that must be the fact, we may well enough agree to live without religion.

*Science and Religion*

*Putnam's Magazine*, Volume 1, 1868 (p. 271)

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Science is the creation of concepts and their exploration in the facts. It has no other test of the concept than its empirical truth to fact.

*Science and Human Values*

*The Sense of Human Dignity* (p. 60)

Harper & Row, Publishers. New York, New York, USA. 1965

Science is not a mechanism but a human progress, and not a set of findings but the search for them.

*Science and Human Values*

*The Sense of Human Dignity* (p. 63)

Harper & Row, Publishers. New York, New York, USA. 1965

Science is a great many things...but in the end they all return to this: science is the acceptance of what works and the rejection of what does not. That needs more courage than we might think. It need more courage than we have ever found when we have faced our worldly problems.

*The Common Sense of Science*

Chapter IX, Section 6 (p. 148)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Carnap, Rudolf** 1891–1970  
American philosopher

Science is a system of statements based on direct experience, and controlled by experimental verification. Verification in science is not, however, of single statements but of the entire system or a sub-system of such statements.

*The Unity of Science*

*Physics as a Universal Science*, Section 3 (p. 42)

Thommes Press. Bristol, England. 1995

**Burhoe, R. W.**  
Founding editor of *Zygon*

...in the usual sense a science is a discipline possessed of an empirically validated theoretical structure, which can indeed explain or account for and not simply describe, categorize, and correlate, patterns of human experience/behavior.

*The Source of Civilization in the Natural Selection of Coadapted Information in Genes and Culture*

*Zygon*, Volume 11, Number 3, September, 1976 (p. 264)

**Campbell, Norman R.** 1880–1949  
English physicist and philosopher

There are two aspects of science. First, science is a body of useful and practical knowledge and a method of obtaining it. It is science of this form which played so large a part in the destruction of war, and, it is claimed,

should play an equally large part in the beneficent restoration of peace.... In its second form or aspect, science has nothing to do with practical life, and cannot affect it, except in the most indirect manner, for good or for ill. Science of this form is a pure intellectual study.... [I]ts aim is to satisfy the needs of the mind and not those of the body; it appeals to nothing but the disinterested curiosity of mankind.

*What Is Science?*

Chapter I (p. 1)

Dover Publications, New York, New York, USA. 1952

**Cassirer, Ernst** 1874–1945

German philosopher

Are we to be disgusted with science because it has not fulfilled our hopes or redeemed its promises? And are we, for this reason, to announce the “bankruptcy” of science, as is so often and so flippantly done? But this is rash and foolish: for we can hardly blame science just because we have not asked the right questions.

In David Hackett Fischer

*Historian's Fallacies: Toward a Logic of Historical Thought*

Chapter I (p. 3)

Harper & Row, Publishers, New York, New York, USA. 1970

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The sciences have started to swell. Their philosophical basis has never been very strong. Starting as modest probing operations to unravel the works of God in the world, to follow its traces in nature, they were driven gradually to ever more gigantic generalizations. Since the pieces of the giant puzzle never seemed to fit together perfectly, subsets of smaller, more homogeneous puzzles had to be constructed, in each of which the fit was better.

Voices in the Labyrinth

*Perspectives in Biology and Medicine*, VII, Volume 18, Spring, 1975 (p. 323)

In science, there is always one more Gordian knot than there are Alexanders. One could almost say that science, as it is practiced today, is an arrangement through which each Gordian knot, once cut, gives rise to two new knots, and so on. Out of one problem considered as solved, a hundred new ones arise; and this has created the myth of the limitlessness of the natural sciences. Actually, many sciences now look as feeble and emaciated as do mothers who have undergone too many deliveries.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part II

More Foolish and More Wise (p. 116)

Rockefeller University Press, New York, New York, USA. 1978

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Science finds facts in Nature, but Science is not Nature; because Science has co-ordinated ideas, interpretations

and analyses; and can say of Nature what Nature cannot say for itself.

*The Resurrection of Rome*

Chapter IV (p. 126)

Dodd, Mead & Company, New York, New York, USA. 1930

**Clark, Gordon H.** 1902–85

American philosopher

The theologians who reply to...attacks [on religious faith] are under a disadvantage. When a scientist or a philosopher argues against religion, he does not need to know much about religion; but when a theologian discusses science, he must know quite a lot. The scientist can get by if he understands no more than that Christians believe God to be an incorporeal spirit; but the theologian is called upon to discuss space, time, motion, energy, electrodynamics, the solar system, quantum theory, relativity, and other assorted items. There is something else the theologian must know, and something more important. In addition to a selection of particular pieces of information, such as the details just mentioned, the theologian must have an overall view of science as a whole. He must have a philosophy of science; that is, he must know what science is. Obviously he cannot compare, contrast, or relate religion and science unless he knows them both.... The scientific method is said to be the best, indeed, the only method for solving any problem, so that in every debate it is science, not theology, that has the last word. Since every curious and intelligent person naturally wishes to understand his own times, he must be prepared to give science sustained attention.

*The Philosophy of Science* (pp. 8–9)

Craig Press, Nutley, New Jersey, USA. 1964

**Cohen, Morris Raphael** 1880–1947

American philosopher

The certainty which science aims to bring about is not a psychologic feeling about a given proposition but a logical ground on which its claim to truth can be founded.

*Reason and Nature*

Chapter Three, Section II (A) (p. 84)

The Free Press, Publishers, Glencoe, Illinois, USA. 1931

**Collingwood, Robin George** 1889–1943

English historian and philosopher

The aim of science is to apprehend this purely intelligible world as a thing in itself, an object which is what it is independently of all thinking, and thus antithetical to the sensible world.... The world of thought is the universal, the timeless and spaceless, the absolutely necessary, whereas the world of sense is the contingent, the changing and moving appearance which somehow indicates or symbolizes it.

*Essays in the Philosophy of Art*

Outlines of a Philosophy of Art

Chapter 6, Section 27 (p. 142)

Indiana University Press, Bloomington, Indiana, USA. 1964

Science in general...does not consist in collecting what we already know and arranging it in this or that kind of pattern. It consists in fastening upon something we do not know, and trying to discover it.

*The Idea of History*

Introduction, Section 2 (p. 9)

At The Clarendon Press. Oxford, England. 1967

**Courant, Richard** 1888–1972

German-born American mathematician

**Robbins, Herbert** 1915–2001

American mathematician

A serious threat to the very life of science is implied in the assertion that mathematics is nothing but a system of conclusions drawn from definitions and postulates that must be consistent but otherwise may be created by the free will of the mathematician. If this description were accurate, mathematics could not attract any intelligent person. It would be a game with definitions, rules and syllogisms, without motivation or goal.

*What Is Mathematics?* (p. xvii)

Oxford University Press, Inc. London, England. 1941

The notion that the intellect can create meaningful postulational systems at its whim is a deceptive half-truth. Only under the discipline of responsibility to the organic whole, only guided by intrinsic necessity, can the free mind achieve results of scientific value.

*What Is Mathematics?* (p. xvii)

Oxford University Press, Inc. London, England. 1941

**Davy, Sir Humphry** 1778–1829

English chemist

Natural science is founded on minute critical views of the general order of events taking place upon our globe, corrected, enlarged, or exalted by experiments, in which the agents concerned are placed under new circumstances, and their diversified properties separately examined. The body of natural science, then, consists of facts; is analogy – the relation of resemblance of facts by which its different parts are connected, arranged, and employed, either for popular use, or for new speculative improvements.

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* (Volume 8)

Introductory Lecture to the Chemistry of Nature (pp. 167–168)

Smith, Elder & Company. London, England. 1839–1840

**Dawson, Sir John William** 1820–99

Canadian geologist and educator

It is of the nature of true science to take nothing on trust or on authority. Every fact must be established by accurate observation, experiment, or calculation. Every law and principle must rest on inductive argument. The apostolic motto, “Prove all things, hold fast that which is good,” is thoroughly scientific. It is true that the mere reader

of popular science must often be content to take that on testimony which he cannot personally verify; but it is desirable that even the most cursory reader should fully comprehend the modes in which facts are ascertained and the reasons on which the conclusions are based.

*The Chain of Life in Geological Time*

Chapter I (p. 1)

Religious Tract Society. London, England. 1888

**de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

Wisdom is to science what death is to life, or, if you prefer it, wisdom is to death what science is to life.

*Essays and Soliloquies*

Some Arbitrary Reflections Upon Europeanization (p. 55)

Alfred A. Knopf. New York, New York, USA. 1925

**Dennett, Daniel Clement** 1942–

American philosopher

Science does not answer all good questions. Neither does philosophy. But for that very reason the phenomena of consciousness...do not need to be protected from science – or from the sort of demystifying philosophical investigation we are embarking on.... Looking on the bright side, let us remind ourselves of what has happened in the wake of earlier demystifications. We find no diminution of wonder; on the contrary, we find deeper beauties and more dazzling visions of the complexity of the universe than the protectors of mystery ever conceived. The “magic” of earlier visions was, for the most part, a cover-up for frank failures of imagination, a boring dodge enshrined in the concept of a *deus ex machina*.

*Consciousness Explained* (pp. 22, 25)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

...there is no such thing as philosophy-free science; there is only science whose philosophical baggage is taken on board without examination.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 21)

Simon & Schuster. New York, New York, USA. 1995

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Science in its entirety is true and evident cognition. He is no more learned who has doubts on many matters than the man who has never thought of them; may he appear to be less learned if he has formed wrong opinions on any particulars. Hence it were better not to study at all than to occupy one's self with objects of such difficulty, that, owing to our inability to distinguish true from false, we are forced to regard the doubtful as certain; for in those matters any hope of augmenting our knowledge is exceeded by the risk of diminishing it. Thus in accordance with the above maxim we reject all such merely probable knowledge and make it a rule to trust only what is completely known and incapable of being doubted.



In *Great Books of the Western World* (Volume 31)  
*Rules for the Direction of the Mind*  
 Rule II (p. 2)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Einstein, Albert** 1879–1955  
 German-born physicist

The aim of science is...a comprehension, as complete as possible, of the connection between the sense experience in [its] totality, and...the accomplishment of this aim by the use of a minimum of primary concepts and relations.

*Out of My Later Years*  
 Physics and Reality, I (p. 63)  
 Thames & Hudson. London, England. 1950

Science is the attempt to make the chaotic diversity of our sense experience correspond to a logically uniform system of thought.

Considerations Concerning the Fundaments of Theoretical Physics  
*Science*, Volume 91, Number 2369, May 24, 1940 (p. 487)

Although it is true that it is the goal of science to discover rules which permit the association and foretelling of facts, this is not its only aim. It also seeks to reduce the connections discovered to the smallest possible number of mutually independent conceptual elements. It is in this striving after the rational unification of the manifold that it encounters its greatest successes, even though it is precisely this attempt which causes it to run the greatest risk of falling a prey to illusion. But whoever has undergone the intense experience of successful advances made in this domain, is moved by profound reverence for the rationality made manifest in existence.

*Ideas and Opinions*  
 Science and Religion (p. 49)  
 Crown Publishers, Inc. New York, New York, USA. 1954

The belief in the external world independent of the perceiving subject is the basis of all natural science.

Translated by Alan Harris  
*Essays in Science*  
 Clerk Maxwell's Influence on the Evolution of the Idea of Physical Reality (p. 40)  
 Philosophical Library. New York, New York, USA. 1934

The grand aim of all science...is to cover the greatest number of empirical facts by logical deductions from the smallest number of hypotheses or axioms.

In Lincoln Barnett  
 The Meaning of Einstein's New Theory  
*Life*, January 9, 1950 (p. 22)

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

What is the fundamental hypothesis of science, the fundamental philosophy? ...[It is that] the sole test of the validity of any idea is experiment.... We will invent some way to summarize the results of the experiment, and we do not have to be told ahead of time what this way

will look like. If we are told that the same experiment will always produce the same result, that is all very well, but if when we try it, it does not, then it does not. We just have to take what we see, and then formulate all the rest of our ideas in terms of our actual experience.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*  
 Basic Physics (p. 32)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Jeans, Sir James Hopwood** 1877–1946  
 English physicist and mathematician

Science came to recognize that its only proper objects of study were the sensations that the objects of the external universe produced on our senses. The dictum *esse est percipi* was adopted whole-heartedly from philosophy – not because scientists had any predilection for an idealist philosophy, but because the assumption that things existed which could not be perceived had led them into a whole morass of inconsistencies and impossibilities. Those who did not adopt it were simply left behind, and the torch of those who did.

The Mathematical Aspect of the Universe  
*Philosophy*, Volume VII, Number 25, January, 1932 (p. 11)

**Joad, Cyril Edwin Mitchinson** 1891–1953  
 English philosopher and broadcasting personality

...the philosophising of the physicists is noticeably inferior to their physics, and eminent men are at the moment engaged in making all the mistakes which the philosophers made for themselves some three hundred years ago and have been engaged in detecting and correcting ever since. In particular it is thought that modern physics lends support to Idealism, and suggests, if it does not actually require, a religious interpretation of the universe.

*Guide to Modern Thought*  
 Chapter I (pp. 15–16)  
 Faber & Faber Ltd. London, England. 1936

**Meredith, Patrick**  
 No biographical data available

Hence a true philosophy of science must be a philosophy of scientists and laboratories as well as one of waves, particles and symbols.

*Instruments of Communication*  
 Chapter 2, Section 5 (p. 40)  
 Pergamon Press. Oxford, England. 1966

**Moreland, J. P.** 1936–  
 American philosopher

For the question What is the proper definition of science? is itself a philosophical question about science that assumes a vantage point above science; it is not a question of science. One may need to reflect on specific episodes in the history of science to answer the question.



But the question and the reflection required to answer it are philosophical in nature, a point not diminished merely because a scientist may try to define science. When she does so, she is doing philosophy.

*Christianity and the Nature of Science: A Philosophical Investigation* (pp. 20–21)  
Baker Book House. Grand Rapids, Michigan, USA. 1989

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...I shall certainly admit a system as empirical or scientific only if it is capable of being tested by experience. These considerations suggest that not the verifiability but the falsifiability of a system is to be taken as a criterion of demarcation. In other words: I shall not require of a scientific system that it shall be capable of being singled out, once and for all, in a positive sense: but I shall require that its logical form shall be such that it can be singled out, by means of empirical tests, in a negative sense: it must be possible for an empirical scientific system to be refuted by experience.

*The Logic of Scientific Discovery*  
Part I, Chapter I, Section 6 (p. 40)  
Basic Books, Inc. New York, New York, USA. 1959

We do not know: we can only guess.

*The Logic of Scientific Discovery*  
Part II, Chapter X, Section 85 (p. 278)  
Basic Books, Inc. New York, New York, USA. 1959

**Shapere, Dudley**

No biographical data available

...philosophy of science is immune to the vicissitudes of science – the coming and going of particular theories; for those changes have to do with content of science, whereas the philosopher is concerned with its structure – not with specific theories, but with the meaning of “theory” itself.

*Philosophical Problems of Natural Science*  
Introduction, Section IV (p. 9)  
The Macmillan Company. New York, New York, USA. 1965

**Simpson, George Gaylord** 1902–84

American paleontologist

It is inherent in any acceptable definition of science that statements that cannot be checked by observation are not really about anything...or at the very least, they are not science.

The Nonprevalence of Humanoids  
*Science*, Volume 143, Number 3608, February 21, 1964 (p. 770)

**Spencer, Herbert** 1820–1903

English social philosopher

Every science begins by accumulating observations, and presently generalizes these empirically; but only when it reaches the stage at which its empirical generalizations are included in a rational generalization does it become developed science.

*The Data of Ethics*

Chapter IV, Section 22a (p. 51)  
William & Norgate. London, England. 1907

**Torrance, Thomas F.**

No biographical data available

In natural science we are concerned ultimately, not with convenient arrangements of observational data which can be generalized into universal explanatory form, but with movements of thought, at once theoretical and empirical, which penetrate into the intrinsic structure of the universe in such a way that there becomes disclosed to us its basic design and we find ourselves at grips with reality.... We cannot pursue natural science scientifically without engaging at the same time in meta-scientific operations.

*Divine and Contingent Order* (p. 3)  
Oxford University Press, Inc. Oxford. 1981

**Toulmin, Stephen** 1922–

Anglo-American philosopher

Certainly, every statement in a science should conceivably be capable of being called in question, and of being shown empirically to be unjustified; for only so can the science be saved from dogmatism.

*The Philosophy of Science*  
Harper & Row, Publishers. New York, New York, USA. 1960

**Toynbee, Arnold J.** 1852–83

English historian

[T]here will be differences in the degree of approximation to scientific study, ...determined by the nature of the part or aspect of the Universe under consideration. Study will be most scientific when its object is the physical structure of the Universe.... The object of study that will be the least amenable to scientific treatment is the non-physical facet of human nature. Students in this field had better avoid letting themselves be tempted by the present-day prestige of the word “science” into applying that label to their own work.

*Occasional Paper; The Institute for the Study of Science in Human Affairs*

Science in Human Affairs: An Historian’s View

**van Fraassen, Bas C.** 1941–

Dutch-born philosopher

...certain issues in philosophy of science (having to do with observation and the definition of a theory’s empirical import) had been misconstrued as issues in philosophy of logic and of language. With respect to modality, I hold the exact opposite: important philosophical problems concerning language have been misconstrued as relating to the content of science and the nature of the world. This is not at all new, but is the traditional nominalist line.

*The Scientific Image*  
Chapter 6 (p. 196)  
Clarendon Press. Oxford, England. 1980

To develop an empiricist account of science is to depict it as involving a search for truth only about the empirical world, about what is actual and observable.... It must involve throughout a resolute rejection of the demand for an explanation of the regularities in the observable course of nature, by means of truths concerning a reality beyond what is actual and observable, as a demand which plays no role in the scientific enterprise.

*The Scientific Image*

Chapter 6 (p. 203)

Clarendon Press. Oxford, England. 1990

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

Science developed only when men refrained from asking general questions such as: What is matter made of? How was the universe created? What is the essence of life? Instead they asked limited questions such as: How does an object fall? How does water flow in a tube? Thus, in place of asking general questions and receiving limited answers, they asked limited questions and found general answers. It remains a great miracle, that this process succeeded, and that the answerable questions became gradually more and more universal.

*The Significance of Science*

*Science*, Volume 176, Number 4031, April 14, 1972 (p. 143)

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Science is simply setting out on a fishing expedition to see whether it cannot find some procedure which it can call measurement of space and some procedure which it can call the measurement of time, and something which it can call a system of forces, and something which it can call masses....

*The Concept of Nature*

Chapter VI (p. 139)

At The University Press. Cambridge, England. 1920

The aim of science is to seek the simplest explanation of complex facts.... Seek simplicity and distrust it.

*The Concept of Nature*

Chapter VII (p. 163)

At The University Press. Cambridge, England. 1920

**Wright, Chauncey** 1830–75

American philosopher of science

Science asks no questions about the ontological pedigree or a priori character of a theory, but is content to judge it by its performance; and it is thus that a knowledge of nature, having all the certainty which the senses are competent to inspire, has been attained – a knowledge which maintains a strict neutrality toward all philosophical systems and concerns itself not with the genesis or a priori grounds of ideas.

*The Philosophical Writings of Chauncey Wright*

The Philosophy of Herbert Spencer (p. 8)

The Liberal Arts Press. New York, New York, USA. 1958

## PHOTOELECTRIC

**Glashow, Sheldon L.** 1932–

American physicist

Einstein examined the photoelectric effect, which is now so well understood that it is used to open the doors of supermarkets and elevators when you step through a beam of light. In 1905 it was still a mystery.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 3 (p. 52)

Warner Books. New York, New York, USA. 1988

## PHOTOGRAPHY

**Adams, Robert** 1937–

American photographer

No place is boring, if you've had a good night's sleep and have a pocket full of unexposed film.

*Darkroom and Creative Camera Techniques*, May, 1995

**Bernard, E. E.**

No biographical data available

It would be difficult just here to predict the future of astronomical photography, though one can foresee something of the great results it must accomplish. It will displace some of the visual work, but it is more likely to move along new lines, opening up new fields of research. The older astronomy, so nobly represented by Simon Newcomb and a few others, will be strengthened at every point, and will stand all the more sublime for the help it shall receive from photography.

*The Development of Photography in Astronomy (II)*

*Science*, N.S. Volume VIII, Number 195, September 23, 1898 (p. 395)

## PHOTON

**Brennan, Kevin F.** 1956–2003

American engineer

...photons are like words. One creates as many as are necessary to fulfill a task but one can never use them up ...

*The Physics of Semiconductors: With Applications to Optoelectronic Devices*

Chapter 5 (p. 305)

Cambridge University Press. Cambridge, England. 1999

**Einstein, Albert** 1879–1955

German-born physicist

Every physicist thinks that he knows what a photon is.... I spent my life to find out what a photon is and I still don't know it.

In Eugene Hecht

*Optics*

Chapter 1 (p. 9)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hobbs, Philip C. D.**

No biographical data available

Photons are like money: A certain number are needed for the job at hand, and they're easier to lose than to gain back.

*Building Electro-Optical Systems: Making It All Work*  
Chapter 1 (p. 34)  
Wiley. New York, New York, USA. 2000

**Jespersen, James**

No biographical data available

**Fitz-Randolph, Jane**

No biographical data available

We can think of the photons as being like a shower of snowballs flying back and forth between the two electrons. And like the opponents in a snowball fight, the electrons retreat from each other under the assault of the photons.

*From Quarks to Quasars: A Tour of the Universe*  
Chapter 11 (p. 125)  
Athenaeum. New York, New York, USA. 1987

**Roberts, Michael**

No biographical data available

While I, maybe, precisely seize  
The elusive photon's properties  
In a's and b's, set in bronze-  
bright vectors, grim quaternions.

Notes on q, f, and y  
*The New Statesman*, March 23, 1935

**Rucker, Rudy** 1946–

Science and science fiction author

A photon is a wavy yet solid little package that can zip through empty space without the benefit of any invisible jelly vibrating underfoot.

*The Fourth Dimension: Toward a Geometry of Higher Reality*  
Chapter 6 (p. 73)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1984

**PHOTOSYNTHESIS****Baum, Harold**

No biographical data available

When sunlight bathes the chloroplast, and photons are absorbed

The energy's transduced so fast that food is quickly stored,

Photosynthetic greenery traps light the spectrum through  
Then dark pathway machinery fixes the CO<sub>2</sub>.

*The Biochemists' Handbook*  
Photosynthesis (Tune: Auld Lang Syne)  
van Nostrand. Princeton, New Jersey, USA. 1961

**Pallister, William Hales** 1877–1946

Canadian physician

The sunlight gives the stimulus  
Which makes a plant of you;  
Your chemic process puzzles us,  
We look and see you do  
Your photo-synthesis, and thus  
Grow and divide in two.

*Poems of Science*  
The Nature of Things, *Euglena viridis* (p. 5)  
Playford Press. New York, New York, USA. 1931

**Rabinowitch, Eugene** 1901–73

Russian-born American biophysicist

In photosynthesis we are like travelers in an unknown country around whom the early morning fog slowly begins to rise, vaguely revealing the outlines of the landscape. It will be thrilling to see it in bright daylight!

In A Scientific American Book  
*The Physics and Chemistry of Life*  
Photosynthesis (p. 47)  
Simon & Schuster. New York, New York, USA. 1955

**Rabinowitch, Eugene** 1901–73

Russian-born American biophysicist

Photosynthesis by plants is the process by which matter is brought up from the simplicity and inertness of the inorganic world to the complexity and reactivity that are the essence of life. The process is not only a marvel of synthetic chemical skill, but also a TOUR DE FORCE of power engineering. When plant physiologists and organic chemists study photosynthesis, they are struck most of all by the feat of manufacturing sugar from carbon dioxide and water. When physicists or photochemists contemplate the same phenomenon, they are awed and intrigued by the conversion of stable, chemically inert matter into unstable, energy-rich forms by means of visible light.

Photosynthesis  
*Scientific USA*, August, 1948

**PHYLOGENESIS****Haeckel, Ernst Heinrich Philipp****August** 1834–1919

German biologist and philosopher

Phylogenesis is the mechanical cause of ontogenesis. The connection between them is not of an external or superficial, but of a profound, intrinsic, and causal nature.

*Anthropogenie, oder; Entwicklungsgeschichte des Menschen gemeinverstandliche wissenschaftliche Vortrage uber die Grundzuge der mensch*

W. Engleman, Leipzig, Germany. 1874

**PHYLOGENY**

**Abbott, Donald Putnam** 1920–86  
American marine biologist and professor

Cultivate a suspicious attitude toward people who do phylogeny.

In Galen Howard Hilgard (ed.)  
*Observing Marine Invertebrates: Drawings from the Laboratory*  
Author's Preface (p. xvi)  
Stanford University Press. Stanford, California, USA. 1987

**PHYSIC**

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

Physic, for the most part, is nothing else but the substitute of exercise and temperance.

*The Spectator*, Number 195, October 13, 1911 (p. 287)

**Boorde, Andrew** 1490–1549  
English traveler, physician, and writer

A good cook is half a physician. For the chief physic (the counsel of a physician excepted) doth come from the kitchen; wherefore the physician and the cook for sick men must consult together for the preparation of meat for sick men. For if the physician, without the cook, prepared any meat, except he be very expert, he will make a wearish dish of meat, the which the sick cannot take.

*The Wisdom of Andrew Boorde* (p. 49)  
Edgar Backus. Leicester, England. 1936

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

No men despise physic so much as physicians, because no men so thoroughly understand how little it can perform.

*Lacon; or Many Things in a Few Words*  
1:179  
William Gowans. New York, New York, USA. 1849

**Heurnius**  
No biographical data available

Many of them to get a fee, will give physic to everyone that comes, when there is no cause.

In William Tod Helmuth  
*Scratches of a Surgeon*  
Medical Pomposity (p. 9)  
W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Not to take authority when I can have facts; not to guess when I can know; not to think a man must take physic because he is sick.

In Robert Coope  
*The Quiet Art* (p. 101)  
E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Lettsom, J. C.**  
No biographical data available

When people is ill, they comes to I,  
I physics, bleed, and sweats 'em;  
Sometimes they live, sometimes they die.  
What's that to I? I lets 'em.

In William Davenport Adams  
*English Epigrams*  
On Dr. Lettsom, by Himself (p. cclxxii)  
G. Routledge. London, England. 1878

**Luther, Martin** 1483–1546  
Leader of the Protestant Reformation

'Tis wonderful how God has put such excellent physic in mere muck; we know by experience that swine's dung stints the blood; horse's serves for the pleurisy; man's heals wounds and black blotches; asses' is used for the bloody flux, and cow's, with preserved roses, serves for epilepsy, or for convulsions of children.

Translated by William Hazlitt  
*The Table Talk or Familiar Discourse of Martin Luther*  
XCII (p. 41)  
David Bogue. London, England. 1848

**Milton, John** 1608–74  
English poet

...in Physic, things of melancholic hue and quality are us'd against melancholy, sour against sour, salt to remove salt humours.

*Samson Agonistes*  
On that Sort of Dramatic Poem Which Is Call'd Tragedy (p. 79)  
The Doves Press. London, England. 1905

**Pope, Alexander** 1688–1744  
English poet

Learn from the beasts the physic of the field.

*The Complete Poetical Works* (Volume 3)  
Essay on Man, Epis. Iii, l. 174  
Houghton Mifflin Company. New York, New York, USA. 1903

**Poynting, John Henry** 1852–1914  
English physicist

...we must confess, [that physical laws have] greatly fallen off in dignity. No long time ago they were quite commonly described us the Fixed Laws of Nature, and were supposed sufficient in themselves to govern the universe. Now we can only assign to them the humble rank of mere descriptions, often tentative, often erroneous, of similarities which we believe we have observed.

*Report of the Sixty-ninth Meeting British Association for the Advancement of Science*  
The President's Address (p. 616)  
John Murray. London, England. 1900

**Proverb**

Warre and Physicke are governed by the eye.

In George Herbert  
*Outlandish Proverbs*  
#906

Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ray, John** 1627–1705  
English naturalist

If physic do not work, prepare for the kirk.  
*A Complete Collection of English Proverbs* (p. 149)  
Printed for G. Cowie. London, England. 1813

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Throw physic to the dogs; I'll none of it.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Macbeth*  
Act V, Scene iii, l. 47  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

'Tis time to give 'em physic, their diseases  
Are grown so catching.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Famous History of the Life of King Henry the Eighth*  
Act I, Scene iii, l. 36–37  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Take physic, pomp;  
Expose thyself to feel what wretches feel.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*King Lear*  
Act III, Scene ii, l. 33–34  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In this point  
All his tricks founder, and he brings his physic  
After his patient's death.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Famous History of the Life of King Henry the Eighth*  
Act III, Scene ii, l. 39–41  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## PHYSICAL LAW

**Feynman, Richard P.** 1918–88  
American theoretical physicist

...there is...a rhythm and pattern between the phenomena of nature which is not apparent to the eye, but only to the eye of analysis; and it is these rhythms and patterns which we call Physical Laws.  
*The Character of Physical Law*  
Chapter 1 (p. 13)  
BBC. London, England. 1965

## PHYSICAL SCIENCE

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

The importance of physical science for the development of general philosophical thinking rests not only on its contributions to our steadily increasing knowledge of that nature of which we ourselves are part, but also on the opportunities which time and again it has offered for examination and refinement of our conceptual tools.  
*Atomic Physics and Human Knowledge*  
Introduction (p. 1)  
John Wiley & Sons. New York, New York, USA. 1958

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Physical science is like simple addition: it is either infallible or it is false. To mix science up with philosophy is only to produce a philosophy that has lost all its ideal value and a science that has lost all its practical value.  
*All Things Considered*  
Science and Religion (p. 187)  
John Lane Co. New York, New York, USA. 1910

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Broadly speaking the task of physical science is to infer knowledge of external objects from a set of signals passing along our nerves. But that rather underrates the difficulty of the problem. The material from which we have to make our inferences is not the signals themselves, but a fanciful story which has been in some way based on them. It is as though we were asked to decode a cipher message and were given, not the cipher itself, but a mis-translation of it made by a clumsy amateur.  
*New Pathways in Science*  
Chapter I (pp. 6–7)  
At the University Press. Cambridge, England. 1935

**Huxley, Thomas Henry** 1825–95  
English biologist

When simple curiosity passes into the love of knowledge as such, and the gratification of the aesthetic sense of the beauty of completeness and accuracy seems more desirable than the easy indolence of ignorance; when the finding out of the causes of things becomes a source of joy, and he is counted happy who is successful in the search, common knowledge of Nature passes into what our forefathers called Natural History, from whence there is but a step to that which used to be termed Natural Philosophy, and now passes by the name of Physical Science.



*The Crayfish*

Chapter I (p. 3)

D. Appleton & Company, New York, New York, USA. 1880

**Jukes, Joseph Beete** 1811–69

English geologist

We might, perhaps, without impropriety, say that all the physical sciences are included under two great heads – namely, Astronomy and Geology; the one comprehending all those sciences which teach us the constitution, the motions, the relative places, and the mutual action of the Astra, or heavenly bodies; while the other singles out for study the one Astrum on which we live – namely, the Earth.

*The Student's Manual of Geology* (3rd edition)

Chapter I (p. 1)

Adam & Charles Black, Edinburgh, Scotland. 1872

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Physical science began in the witch's kitchen. It now embraces the organic and inorganic worlds, and with the physiology of articulation and the theory of the senses, has even pushed its researches, at times impertinently, into the province of mental phenomena.

*Popular Scientific Lectures*

Why Has Man Two Eyes? (p. 87)

The Open Court Publishing Company, Chicago, Illinois, USA. 1898

**Poincaré, Lucien Antoine** 1862–1920

French physicist

If we now disentangle ourselves from contingencies, it will be understood that in reality physical science progresses by evolution rather than by revolution. Its march is continuous. The facts which our theories enable us to discover, subsist and are linked together long after these theories have disappeared. Out of the materials of former edifices overthrown, new dwellings are constantly being reconstructed.

*The New Physics and Its Evolution*

Chapter I (p. 6)

Kegan Paul, Trench, Triibner, & Co., Ltd. London, England. 1907

**Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

How far...then mathematics will suffice to describe, and physics to explain, the fabric of the body, no man can foresee. It may be that all the laws of energy, and all the properties of matter, and all the chemistry of all the colloids are as powerless to explain the body as they are impotent to comprehend the soul. For my part, I think it is not so. Of how it is that the soul informs the body, physical science teaches me nothing; and that living matter influences and is influenced by mind is a mystery without

a clue. Consciousness is not explained to my comprehension by all the nerve-paths and neurons of the physiologist; nor do I [explain by] physics how goodness shines in one man's face, and evil betrays itself in another. But of the construction and growth and workings of the body, as of all else that is of the earth earthy, physical science is, in my opinion, our only teacher and guide.

*On Growth and Form* (Volume 1)

Chapter I (p. 13)

At The University Press, Cambridge, England. 1951

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There can be no true physical science which looks first to mathematics for the provision of a conceptual model. Such a procedure is to repeat the errors of the logicians of the middle ages.

*Principles of Relativity* (p. 39)

Cambridge University Press, Cambridge, England. 1922

## PHYSICAL SCIENCE, STUDY OF

**Huxley, Thomas Henry** 1825–95

English biologist

How often have we not been told that the study of physical science is incompetent to confer culture; that it touches none of the higher problems of life; and, what is worse, that the continual devotion to scientific studies tends to generate a narrow and bigoted belief in the applicability of scientific methods to the search after truth of all kinds. How frequently one has reason to observe that no reply to a troublesome argument tells so well as calling its author a "mere scientific specialist."

*Science and Culture, and Other Essays*

Chapter I (pp. 6–7)

Macmillan & Company Ltd. London, England. 1881

## PHYSICAL UNIVERSE

**Carpenter, William Benjamin** 1813–85

English physiologist and naturalist

In regard to the Physical Universe, then, it might be better to substitute for the phrase "Government by laws," "Government according to laws;" – meaning thereby, the direct exertion of the Divine Will, or operation of the First Cause, in the Forces of Nature, according to certain constant Uniformities, which are simply unchangeable, because – having been originally the expressions of Infinite Wisdom – any change would be for the worse.

*Principles of Mental Physiology*

Book II, Chapter XX (p. 706)

D. Appleton & Co. New York, New York, USA. 1894



**PHYSICIAN**

**Abrams, Albert** 1863–1924  
American physician

Science and heart must be so nicely blended in the truly great physician that neither is operative separately.

*Man and His Poisons*

Chapter X (p. 222)

E.B. Treat & Co. New York, New York, USA. 1906

**Alexander the Great** 356 BCE–323 BCE  
Macedonian emperor

I am dying with the help of too many physicians.  
Attributed

**Allman, David**  
American physician

The dedicated physician is constantly striving for a balance between personal, human values, scientific realities and the inevitabilities of God's will.

Address to National Conference of Christian and Jews

The Brotherhood of Healing, 1 February, 1958

**Arnaldus de Villa Nova** 1235–1313  
Alchemist, astrologer, and physician

...the physician must be learned in diagnosing, careful and accurate in prescribing, circumspect and cautious in answering questions, ambiguous in making prognosis, just in making promises; and he should not promise health because in doing so he would assume a divine function and insult God.

In Henry E. Sigerist (trans.)

Bedside Manners in the Middle Ages: The Treatise De Cautelis Medicorum Attributed to Arnald of Villanova

*Quarterly Bulletin of Northwestern University Medical School*, Volume 20, 1946

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

Think continually how many physicians are dead after often contracting their eyebrows over the sick...

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, # 48 (p. 267)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Author undetermined**

...a new physician must have a new church-yard...

In Robert Burton

*The Anatomy of Melancholy* (Volume 2)

Part 2, Sect. IV, Memb. I, subsect. 1 (p. 230)

AMS Press, Inc. New York, New York, USA. 1973

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Physicians are some of them so pleasing and conformable to the humor of the patient, as they press not the true cure

of the disease; and some other are so regular in proceeding according to art for the disease, as they respect not sufficiently the condition of the patient. Take one of a middle temper; or if it may not be found in one man, combine two of either sort; and forget not to call as well the best acquainted with your body, as the best reputed of for his faculty.

*Essays, Advancement of Learning, New Atlantis, and Other Pieces*

The Essays or Counsels, Civil and Moral: I. Of Regiment of Health (p. 94)

Odyssey Press. New York, New York, USA. 1937

The weakness of patients, and sweetness of life, and nature of hope, maketh men depend upon physicians with all their defects.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 2 (p. 51)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...it is the office of a physician not only to restore health, but to mitigate pain and dolors; and not only when such mitigation may conduce to recovery, but when it may serve to make a fair and easy passage.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 7 (p. 52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bailey, Percival**

No biographical data available

The function of the physician is to cure a few, help many, and comfort all.

*Perspectives in Biology and Medicine*, Volume 4, Number 254, 1961

**Baldwin, Joseph G.** 1815–64  
American writer

Nobody knew who or what they were, except as they claimed, or as a surface view of their characters indicated. Instead of taking to the highway and magnanimously calling upon the wayfarer to stand and deliver, or to the fashionable larceny of credit without prospect or design of paying, some unscrupulous horse doctor would set up his sign as "Physician and Surgeon" and draw his lancet on you, or fire at random a box of pills into your bowels, with a vague chance of hitting some disease unknown to him, but with a better prospect of killing the patient, whom or whose administrator he charged some ten dollars a trial for his marksmanship.

*The Flush Times of Alabama and Mississippi: A Series of Sketches*

How the Times Served the Virginians (p. 89)

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1987

**Bartlett, Elisha** 1804–55  
American physician

The great purpose of this study [medicine] is to make the physician; and the physician is he who, within the limits and conditions of his science and art, prevents, mitigates, and cures disease.

In William E. Stempsey  
*Elisha Bartlett's Philosophy of Medicine* (p. 212)  
 Springer-Verlag, Dordrecht, The Netherlands. 2005

### **Bass, Murray H.**

No biographical data available

The ideal physician should be a combination of three persons – a clergyman, a fireman and a scientist. He must know how to handle and console the patient and his family...he must be ready to answer an “alarm” day and night; he must know the science of medicine...using its present potentialities to the utmost of his ability.

*Clinical Pediatrics*, Volume 3, Number 50, 1964

### **Belleville, Nicholas** 1753–1831

French-born American physician

If you get one good doctor, you get one good thing, but if you get one bad doctor, you get one bad thing. If you have a lawsuit, you get a bad lawyer, you lose your suit – you can appeal; but if you have one bad doctor, and he kills you, then there can be no appeal.

In Stephen Wickes

*History of Medicine in New Jersey*

Part 2 (p. 143)

Martin R. Dennis & Company, Newark, New Jersey, USA. 1879

### **Bernard, Claude** 1813–78

French physiologist

Medical personality is placed above science by physicians themselves; they seek their authority in tradition, in doctrines or in medical tact. This state of affairs is the clearest of proofs that the experimental method has by no means come into its own in medicine.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter Two, Section IV (p. 43)

Henry Schuman, Inc. New York, New York, USA. 1927

...physicians, in their treatment, often have to take account of the so-called influence of the moral over the physical, and also of any number of family and social considerations which have nothing to do with science. Therefore, an accomplished practising physician should be not only learned in his science, but also upright and endowed with keenness, tact and good sense.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter IC, Section III (p. 206)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Blackwell, Elizabeth** 1821–1910

First woman to practice medicine in the USA

The true physician must possess the essential qualities of maternity. The sick are as helpless in his hands as the infant. They depend absolutely upon the insight and judgment, the honesty and hopefulness, of the doctor.

*The Influence of Women in the Profession of Medicine* (p. 11)

G. Bell, Baltimore, Maryland, USA. 1890

### **Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

In my opinion physicians kill as many people as we generals.

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (p. 137)

Columbia University Press, New York, New York, USA. 1955

You are a physician, doctor. You would promise life to a corpse if he could swallow pills...

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (pp. 137–138)

Columbia University Press, New York, New York, USA. 1955

### **Brackenridge, Hugh Henry** 1748–1816

American author and jurist

Gravity is the most practical qualification of the physician.

*Modern Chivalry*

Part II, Volume 1, Chapter X (p. 378)

American Book Company, New York, New York, USA. 1937

### **Brown, Michael S.** 1941–

American physician

To apply tools of science, physicians must learn to think like scientists. They must acquire technical ability, taste in evaluating experiments, and a sense of creative adventure.

*Les Prix Nobel. The Nobel Prizes in 1985*

Nobel banquet speech for award received in 1985

Nobel Foundation, Stockholm, Sweden. 1986

### **Buchan, William** 1729–1805

Physician

No two characters can be more different than that of the honest physician and the quack; yet they have generally been much confounded.

*Domestic Medicine*

Introduction (p. xvi)

Publisher undetermined, New York, New York, USA. 1816

Physicians, like other people, must live by their employment.

*Domestic Medicine*

Introduction (p. xviii)

Publisher undetermined, New York, New York, USA. 1816

### **Burgess, Anthony** 1917–93

English novelist

Keep away from physicians. It is all probing and guessing and pretending with them. They leave it to Nature to cure in her own time, but they take the credit. As well as very fat fees.

*Nothing Like the Sun: A Story of Shakespeare's Love-Life*

Chapter VIII (p. 180)

W.W. Norton & Company, Inc. New York, New York, USA. 1964

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

This is the way physicians mend or end us,  
*Secundum aartem*: but although we sneer  
In health – when ill, we call them to attend us,  
Without the least propensity to jeer.

*The Complete Poetical Works of Byron*

Don Juan

Canto X, Stanza 42

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Camden, William** 1551–1623

English historian

Few physicians live well.

*Remains Concerning Britain*

Proverbs (p. 322)

J.R. Smith. London, England. 1870

**Carlyle, Thomas** 1795–1881

English historian and essayist

The healthy know not of their health, but only the sick:  
this is the physician's aphorism.

*Characteristics*, by Thomas Carlyle; *Favorite Poems*, by Percy Bysshe Shelley; *The Eve of St. Agnes*; and *Other Poems*, by John Keats

Paragraph 1 (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1882

**Cassell, Eric J.**

No biographical data available

Physicians should define their diagnostic and therapeutic goals in terms of the everyday life and function of individual patients.... Unfortunately, that ideal is seldom met.... In part the problem arises because physicians are trained from the first days of medical school to disregard the knowledge they bring with them of everyday life and human function as irrelevant to medicine.... Doctors are not trained to include in their decision making the kind of "soft" and often subjective information that is relevant to the everyday life and function of sick persons.

*The Place of the Humanities in Medicine* (p. 16)

The Hastings Center. New York, New York, USA. 1984

**Clark, A. Arnold**

No biographical data available

The scientific physician without statistics is like an astronomer without a catalogue of stars.

*Proceedings and Addresses at a Sanitary Convention*

Discussion of Meteorology and Disease (p. 88)

Thorp & Godfrey. Lansing, Michigan, USA. 1888

**Clowes, William** 1540–1604

English physician

When a physician or a surgeon comes to a man that lies sick and is in danger of death, yet by his judgment and skill, promises with God's help to cure him of his griefs and maladies, then the sick patient greatly rejoices and

presently compares him to a god. But afterwards, being somewhat recovered, and perceiving good amendment, he says he is but an angel and not a god. Again, after he begins to walk abroad and to fall to his meat, truly he is then accounted no better than a man. In the end, when he happily comes for his money for the curing of his grievous sickness, he now reports him to be a devil and shuts the door.

*Selected Writings*

A Tragical History (p. 63)

Harvey & Blythe. London, England. 1948

**Collins, Joseph**

No biographical data available

The longer I practice medicine, the more I am convinced every physician should cultivate lying as a fine art. There are lies which contribute enormously to the success of the physician's mission of mercy and salvation.

*Reader's Digest*, May, 1933 (p. 16)

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

Physicians must discover the weaknesses of the human mind, and even condescend to humor them, or they will never be called in to cure the infirmities of the body.

*Lacon; or Many Things in a Few Words*

1.482

William Gowans. New York, New York, USA. 1849

**Croll, Oswald** 1560–1609

German chemist and physician

A Physitian should be born out of the Light or Grace and Nature of the inward and invisible Man...

*Philosophy Reformed and Improved in Four Profound Tractates* (p. 22)

Printed by M.S. for Lodowick Lloyd. London, England. 1657

...a Physitian therefore should have both the Theory and Practice, he must both know and prepare his medicines...

*Philosophy Reformed and Improved in Four Profound Tractates* (p. 152)

Printed by M.S. for Lodowick Lloyd. London, England. 1657

**Cushing, Harvey** 1869–1939

American neurosurgeon

A physician is obligated to consider more than a diseased organ, more even than the whole man – he must view the man in his world.

In René J. Dubos

*Man Adapting*

Chapter XII (p. 342)

Yale University Press. New Haven, Connecticut, USA. 1965

**Davies, Robertson** 1913–95

Canadian novelist

I delivered my body into the hands of Learned Physicians this morning confiding that they may discover why

I have hay fever. As soon as they got me out of my clothes I ceased to be a man to them, and they began to talk about me as though I did not understand English.

*The Table Talk of Samuel Marchbanks* (p. 194)  
Clarke, Irwin. Toronto, Ontario, Canada. 1949

### DeBakey, Lois

Professor of Scientific Communication

An inquiring, analytical mind; an unquenchable thirst for new knowledge; and a heartfelt compassion for the ailing – these are prominent traits among the committed clinicians who have preserved the passion for medicine.

In Lois Debakery and Phil R. Manning  
*Medicine: Preserving the Passion in the 21st Century*  
Springer-Verlag. Berlin, Germany. 2004

### de Montaigne, Michel Eyquem 1533–92

French Renaissance writer

If your physician does not think it good for you to sleep, to drink wine, or to eat such and such meats, never trouble yourself; I will find you another that shall not be of that opinion...

In *Great Books of the Western World* (Volume 25)  
*The Essays*  
Book III, 13 (p. 528)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Dekker, Thomas 1570–1632

English dramatist

A good physician comes to thee in the shape of an angel, and therefore let him boldly take thee by the hand, for he has been in God's garden, gathering herbs and sovereign roots to cure thee. The good physician deals in simples and will be simply honest with thee in thy preservation.

In Robert Coope  
*The Quiet Art* (p. 192)  
E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

### Donne, John 1572–1631

English poet and divine

Whilst my Physitians by their love are growne  
Cosmographers, and I their Mapp, who lie  
Flat on this bed, that by them may be showne  
That this is my South-west discoverie  
per-fretum febris, by these streights to die.

In A.J. Smith (ed.)  
*The Complete English Poems*  
Hymne to God My God, in My Sicknesse, l. 6–10  
St. Martin's Press. New York, New York, USA. 1971

I observe the Physician with the same diligence as hee the disease.

*Devotions Upon Emergent Occasions*  
Meditation, VI (p. 29)  
McGill-Queen's University Press. Montreal, Canada. 1975

### Doyle, Sir Arthur Conan 1859–1930

Scottish writer

...if a gentleman walks into my room smelling of iodoform, with a black mark of nitrate of silver upon his right forefinger, and a bulge on the right side of his top-hat to show where he has secreted his stethoscope, I must be dull, indeed, if I do not pronounce him to be an active member of the medical profession.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Scandal in Bohemia* (p. 349)  
Wings Books. New York, New York, USA. 1967

### Drake, Daniel 1785–1852

American physician

The young physician is not aware how soon his elementary knowledge – much of which is historical and descriptive, rather than philosophical – will fade from his mind, when he ceases to study. That which he possesses can only be retained by new additions.

*Practical Essays on Medical Education, and the Medical Profession*  
Essay IV (p. 61)  
Roff & Young. Cincinnati, Ohio. 1832

Professional fame, is the capital of a physician, and he must not suffer it to be purloined, even should its defence involve him in quarrels.

*Practical Essays on Medical Education, and the Medical Profession*  
Essay VII (p. 99)  
Roff & Young. Cincinnati, Ohio. 1832

### Dryden, John 1631–1700

English poet, dramatist, and literary critic

The first Physicians by Debauch were made:

Excess began, and Sloth sustains the Trade.

*The Poems of John Dryden* (Volume 4)  
To John Dryden, of Chesterton, l. 73 (p. 1530)  
Longman. London, England. 1995

### Duffy, John C.

No biographical data available

### Litin, Edward M.

No biographical data available

These are the duties of a physician: First...to heal his mind and to give help to himself before giving it to anyone else.

Psychiatric Morbidity of Physicians  
*Journal of the American Medical Association*, Volume 189, 1964 (p. 989)

### Dumas, Alexandre 1824–95

French dramatist and novelist

The physician has a sacred mission on earth; and to fulfill it he begins at the source of life, and goes down to the mysterious darkness of the tomb.

*The Count of Monte Cristo*  
Chapter 80 (p. 1000)  
Grosset & Dunlap Publishers. New York, New York, USA. 1946

**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

The wise physician...knows when not to prescribe...  
*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Six (p. 71)  
Duell, Sloan & Pearce. New York, New York, USA. 1947

The wise physician avoids the knife; if he prescribes a bitter draft, he prescribes it in small doses or sweetens it to disguise its taste.  
*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Seven (p. 87)  
Duell, Sloan & Pearce. New York, New York, USA. 1947

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The physician prescribes hesitatingly out of his few resources.... If the patient mends, he is glad and surprised.  
*Ralph Waldo Emerson: Essays and Lectures*  
*The Conduct of Life*  
Considerations by the Way (p. 1079)  
The Library of America. New York, New York, USA. 1983

**Field, Eugene** 1850–95  
American poet and journalist

When one's all right, he's prone to spite  
The doctor's peaceful mission;  
But when he's sick, it's loud and quick  
He bawls for a physician.  
*The Poems of Eugene Field*  
Doctors  
Charles Scribner's Sons. New York, New York, USA. 1910

No matter what conditions  
Dyspeptic come to feaze,  
The best of all physicians  
Is apple pie and cheese!  
*The Poems of Eugene Field*  
Apple-Pie and Cheese, Stanza 5  
Charles Scribner's Sons. New York, New York, USA. 1910

**Fielding, Henry** 1707–54  
English novelist, playwright, and barrister

...every physician almost hath his favorite disease...  
*The History of Tom Jones: A Foundling* (Volume 1)  
Book II, Chapter 9 (p. 85)  
P.F. Collier & Son. New York, New York, USA. 1917

...the gentleman of the Aesculapian art are in the right in advising, that the moment the disease has entered at one door, the physician should be introduced at the other.  
*The History of Tom Jones: A Foundling* (Volume 1)  
Book V, Chapter VII (p. 219)  
P.F. Collier & Son. New York, New York, USA. 1917

...as a wise general never despises his enemy, however inferior that enemy's force may be, so neither doth a

wise physician ever despise a distemper, however inconsiderable.

*The History of Tom Jones: A Foundling* (Volume 1)  
Book V, Chapter VIII (p. 229)  
P.F. Collier & Son. New York, New York, USA. 1917

**Flexner, Abraham** 1866–1959  
American educator

...the physician's function is fast becoming social and preventive, rather than individual and curative.  
*Medical Education in the United States and Canada*  
Chapter 2 (p. 26)  
The Carnegie Foundation. New York, New York, USA. 1910

**Florio, John** 1553?–1625  
English teacher, writer, and translator

Unto a deadly disease, neyther  
Phisition nor phisick wil serve.  
*Firste Fruites*  
Proverbs, Chapter 19  
Da Capo Press. New York, New York, USA. 1969

From the phisito & Attorney,  
keepe not the truth hidden.  
*Firste Fruites*  
Proverbs, Chapter 19  
Da Capo Press. New York, New York, USA. 1969

**Ford, John** 1586–?1640  
English dramatist

Physicians are the bodies' cobblers, rather than the Botchers, of men's bodies; as the one patches our tattered clothes, so the other solders our diseased flesh.  
*The Lovers Melancholy*  
Act I, Scene I (p. 13)  
Da Capo Press. New York, New York, USA. 1970

**Freeman, R. Austin** 1862–1943  
British physician and mystery novelist

Take the case of an aurist. You think that he lives by dealing with obscure and difficult middle and internal ear cases. Nothing of the kind. He lives on wax. Wax is the foundation of his practice. Patient comes to him deaf as a post. He does all the proper jugglery – tuning fork, otoscope, speculum, and so on, for the moral effect. Then he hikes out a good old plug of cerumen, and the patient hears perfectly. Of course he is delighted. Thinks a miracle has been performed.  
*The D'Arblay Mystery* (p. 61)  
Dodd, Mead & Company New York, New York, USA. 1926

**Fox, Sir Theodore**  
No biographical data available

The patient may well be safer with a physician who is naturally wise than with one who is artificially learned.  
Purposes of Medicine  
*The Lancet*, Volume 2, October 23, 1965 (p. 801)



**Fuller, Thomas** 1608–61  
English clergyman and author

Every man is a fool or a physician at forty.  
*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*  
No. 1428  
Printed for Thomas and Joseph Allman. London, England. 1816

Commonly Physicians like beer are best when they are old; & Lawyers like bread when they are young and new.  
*The Holy and Profane State*  
Book II, Chapter I, Maxim VI (p. 50)  
Printed for Thomas Tegg. London, England. 1841

**Gisbourne, Thomas** 1758–1846  
English Anglican priest

It is frequently of much importance, not to the comfort only, but to the recovery of the patient, that he should be enabled to look upon his Physician as his friend.  
*An Enquiry into the Duties of Men*  
The Duties of Physicians (p. 398)  
Printed by J. Davis. London, England. 1794

**Gomperz, Theodor**  
Austrian philosopher and classical scholar

The best physicians must be the best observers, but the man who sees keenly, who hears clearly, and whose senses, powerful at the start, are sharpened and refined by constant exercise, will only in exceptional instances be a visionary or a dreamer.  
*Greek Thinkers: A History of Ancient Philosophy*  
Book III, Chapter I (p. 296)  
J. Murray. London, England. 1901–12

**Gracian, Baltasar** 1601–58  
Spanish philosopher

The wise physician, if he has failed to cure, looks out for someone who, under the name of consultation, may help him carry out the corpse.  
In Herbert V. Prochnow and Herbert V. Prochnow, Jr.  
*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*  
#4587 (p. 257)  
Harper & Row, Publishers. New York, New York, USA. 1969

**Gregg, Alan** 1890–1957  
American medical educator and philosopher

The true physician cannot remain outside the manifold of the events he observes.  
Humanism and Science  
*Bulletin of the New York Academy of Sciences*, Volume 17, 1941

**Gregory, John** 1724–73  
Scottish physician and philosopher

I come now to mention the moral qualities peculiarly required in the character of a physician. The chief of these is humanity; that sensibility of heart which makes us feel

for the distresses of our fellow creatures, and which of consequence incites in us the most powerful manner to help them.  
*Lectures on the Duties and Qualifications of a Physician* (p. 19)  
W. Strahan. London, England. 1772

**Gull, Sir William Withey** 1816–90  
English physician

There are many good general practitioners, there is only one good universal practitioner – “a warm bed.”  
*A Collection of The Published Writings* (Volume 2) (p. viii)  
New Sydenham Society. London, England. 1894

**Harrison, Tinsley R.** 1900–78  
American physician

No greater opportunity, responsibility, or obligation can fall to the lot of a human being than to become a physician. In the care of the suffering he needs technical skill, scientific knowledge, and human understanding. He who uses these with courage, with humility, and with wisdom will provide a unique service for his fellow man and will build an enduring edifice of character within himself. The physician should ask of his destiny no more than this; he should be content with no less.  
*Principles of Internal Medicine* (p. 1)  
Blakiston. Philadelphia, Pennsylvania, USA. 1950

The true physician has a Shakespearean breadth of interest in the wise and the foolish, the proud and the humble, the stoic hero and the whining rogue. He cares for people.  
*Principles of Internal Medicine* (4th edition) (p. 7)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1962

**Hazlitt, William Carew** 1834–1913  
English bibliographer

One said a Physitian was naturall brother to the wormes, because he was ingendered out of man’s corruption.  
*Shakespeare Jest Books* (Volume 3)  
Conceit, Clichés, Flashes and Whimzies, Number 42  
Willis & Sotheran. London, England. 1864

One said Physitians had the best of it; for, if they did well, the world did proclaime it; if ill, the earth did cover it.  
*Shakespeare Jest Books* (Volume 3)  
Conceit, Cliches, Flashes and Whimzies, Number 127  
Willis & Sotheran. London, England. 1864

**Heberden, William** 1710–1801  
Physician

Plutarch says that the life of a Vestal virgin was divided into three portions; in the first of which she learned the duties of her profession, in the second she practiced them, and in the third she taught them to others. This is no bad model for the life of a physician.  
*Commentaries on the History and Cure of Diseases*  
Preface (p. vii)  
T. Payne, Mews-Gate. London, England. 1802



**Herophilus** 325 BCE–255 BCE  
Greek physician

He is the best physician who knows how to distinguish the possible from the impossible.

In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 28)  
The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Heschel, Abraham J.** 1907–72  
Jewish theologian

What manner of man is the doctor? Life abounds in works of achievement, in areas of excellence and beauty, but the physician is a person who has chosen to go to the areas of distress, to pay attention to sickness and affliction, to injury and anguish.

*The Insecurity of Freedom*  
The Patient as a Person (p. 28)  
Farrar, Straus & Giroux. New York, New York, USA. 1966

**Hippocrates** 460 BCE–377 BCE  
Greek physician

It appears to me a most excellent thing for the physician to cultivate Prognosis; for by foreseeing and foretelling, in the presence of the sick, the present, the past, and the future, and explaining the omissions which patients have been guilty of, he will be the more readily believed to be acquainted with the circumstances of the sick; so that men will have confidence to entrust themselves to such a physician.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
The Book of Prognostics, 1 (p. 19)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...physicians are many in title but very few in reality.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
The Law, 1 (p. 144)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hoffmann, Friedrich** 1660–1742  
German physician

The physician is the servant of nature, not her master; the principles of nature and of art are the same and hence the physician must work and act with nature.

*Fundamenta Medicinæ*  
Physiology (p. 5)  
American Elsevier. New York, New York, USA. 1971

The perfect physician must have not only the knowledge of medical art but also prudence and wisdom.

*Fundamenta Medicinæ*  
Physiology, Chapter I, 10 (p. 6)  
American Elsevier. New York, New York, USA. 1971

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

A physician who talks about ceremony and gratitude, and services rendered, and the treatment he got, surely forgets himself...

*Medical Essays*  
The Contagious of Puerperal Fever (p. 115)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

But the practising physician's office is to draw the healing waters, and while he gives his time to this labor he can hardly be expected to explore all the sources that spread themselves over the wide domain of science. The traveler who would not drink of the Nile until he had tracked it to its parent lakes would be like to die of thirst; and the medical practitioner who would not use the results of many laborers in other departments without sharing their special toils, would find life far too short and art immeasurably too long.

*Medical Essays*  
Scholastic and Bedside Teaching (p. 274)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

...a physician's business is to avert disease, to heal the sick, to prolong life, and to diminish suffering...

*Medical Essays*  
Scholastic and Bedside Teaching (p. 274)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

A man of very moderate ability may be a good physician if he devotes himself faithfully to the work.

*Medical Essays*  
Scholastic and Bedside Teaching (p. 300)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The old age of a physician is one of the happiest periods of his life. He is loved and cherished for what he has been, and even in the decline of his faculties there are occasions when his experience is still appealed to, and his trembling hands are looked to with renewing hope and trust... The young man feels uneasy if he is not continually doing something to stir up his patient's internal arrangements. The old man takes things more quietly, and is much more willing to let well enough alone.

*Medical Essays by Oliver Wendell Holmes*  
Address  
Graduating Class of the Bellevue Hospital College, March 2, 1871 (pp. 377, 395)  
Classics of Medicine Library. Birmingham, Alabama, USA. 1987

The face of a physician, like that of a diplomat, should be impenetrable.

*Medical Essays*  
The Young Practitioner (p. 388)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The life of a physician becomes ignoble when he suffers himself to feed on petty jealousies and sours his temper in perpetual quarrels.

*Medical Essays*  
The Young Practitioner (p. 392)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The specialist is much like other people engaged in lucrative business. He is apt to magnify his calling, to make much of any symptom which will bring a patient within range of his battery of remedies.

*Over the Teacups*

Chapter VI (p. 129)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

### Howells, William Dean 1837–1920

American realist novelist

I do not know how it is that clergymen and physicians keep from telling their wives the secrets confided to them; perhaps they can trust their wives to find them out for themselves whenever they wish.

*The Rise of Silas Lapham*

Chapter XXVII (p. 511)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

### Hufeland, Christoph Wilhelm 1762–1836

German physician

The physician must generalize the disease, and individualize the patient.

In Oliver Wendell Holmes

*Medical Essays*

Scholastic and Bedside Teaching (p. 275)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### Hutchison, Sir Robert Grieve 1871–1960

English radiologist

From inability to let well alone; from too much zeal for the new and contempt for what is old; from putting knowledge before wisdom, science before art, and cleverness before common sense, from treating patients as cases, and from making the cure of the disease more grievous than the endurance of the same, Good Lord, deliver us.

*British Medical Journal*, Volume 1, 1953 (p. 671)

### Jackson, James

No biographical data available

I have often remarked that, though a physician is sometimes blamed very unjustly, it is quite as common for him to get more credit than he is fairly entitled to; so that he has not, on the whole, any right to complain.

*Letters to a Young Physician Just Entering Upon Practice*

Letter II (p. 41)

Phillips, Sampson & Company. Boston, Massachusetts, USA. 1855

### Jekyll, Joseph

No biographical data available

See, one physician, like a sculler, plies,  
The patient lingers and by inches dies.  
But two physicians, like a pair of oars,  
Waft him more swiftly to the Stygian shores.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#1661 (p. 94)

Harper & Row, Publishers. New York, New York, USA. 1969

### John of Salisbury ca. 1115–80

English author and diplomatist

The common people say, that physicians are the class of people who kill other men in the most polite and courteous manner.

*Polieraticus*

Book II, Chapter 29

Cambridge University Press. Cambridge, England. 1990

### Johnson, Samuel 1696–1772

English critic, biographer, and essayist

A physician in a great city seems to be the mere plaything of fortune; his degree of reputation is for the most part totally casual; they that employ him know not his excellence; they that reject him know not his deficiency.

In William Osler

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Preceding Chapter VIII (p. 132)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

### Jonsen, Albert

No biographical data available

...the absolute asceticism of the residency recreates, for the young physician, the sacrificial ethic of monastic medicine. That ethic is service: immediate response to the emergency room, to the demands of reports, unmitigated responsibility for correct decisions made promptly and communicated clearly; flagellating denial of sleep, self-indulgence, and frivolity, even to the point of depression and deterioration of personal life, of friendship and love.

Watching the Doctor

*New England Journal of Medicine*, Volume 308, Number 25, June 23, 1983 (p. 1534)

### King, William H.

No biographical data available

The first requisite for a physician is spiritual character and the next requisites are sympathy and a sense of humor.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter V (p. 52)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

### La Bruyère, Jean 1645–96

French satiric moralist

As long as men are liable to die and desirous to live, a physician will be made fun of, but he will be well paid.

*The Characters of Jean La Bruyère*

Characters 14.65

George Routledge & Sons, Ltd. London, England. 1929

**Lamb, William** 1779–1848  
British prime minister

English physicians kill you, the French let you die.

In Elizabeth Longford

*Queen Victoria: Born to Succeed*

Chapter 5 (p. 69)

Harper & Row, Publishers. New York, New York, USA. 1964

**Latham, Peter Mere** 1789–1875  
English physician

I am persuaded that when the physician is called upon to perform great things, even to arrest destructive disease, and to save life, his skill in wielding the implements of his art rests mainly upon the right understanding of simple and single indications, and of the remedies which have power to fulfill them.

In William B. Bean

*Aphorisms from Latham* (p. 19)

Prairie Press. Iowa City, Iowa, USA. 1962

There are always two parties of the management of the disease – the physician and the patient.

In William B. Bean

*Aphorisms from Latham* (p. 21)

Prairie Press. Iowa City, Iowa, USA. 1962

But Nature, in all her powers and operations, allows herself to be led, directed, and controlled. And to lead, direct, or control for purposes of good, this is the business of the physician.

In William B. Bean

*Aphorisms from Latham* (p. 24)

Prairie Press. Iowa City, Iowa, USA. 1962

Physicians, who have worthily achieved great reputation, become the refuge of the hopeless, and earn for themselves the misfortune of being expected to cure incurable diseases.

In William B. Bean

*Aphorisms from Latham* (p. 25)

Prairie Press. Iowa City, Iowa, USA. 1962

The best physicians have begun by being the physician of the poor.

In William B. Bean

*Aphorisms from Latham* (p. 25)

Prairie Press. Iowa City, Iowa, USA. 1962

Physicians are in a manner often called upon to be wiser than they possibly can be. Disease or imperfection of a vital organ is a fearfully interesting thing to him who suffers it, and he presses to learn all that is known, and often much more than is known about it.

In William B. Bean

*Aphorisms from Latham* (p. 26)

Prairie Press. Iowa City, Iowa, USA. 1962

The end of all the thought and labour of physicians is to make experiments with men's lives.

In William B. Bean

*Aphorisms from Latham* (p. 91)

Prairie Press. Iowa City, Iowa, USA. 1962

We physicians had need be a self-confronting and a self-reproving race; for we must be ready, without fear or favor, to call in question our own Experience and to judge it justly; to confirm it, to repeal it, to reverse it, to set up the new against the old, and again to reinstate the old and give it preponderance over the new.

In William B. Bean

*Aphorisms from Latham* (pp. 93–94)

Prairie Press. Iowa City, Iowa, USA. 1962

**Longfellow, Henry Wadsworth** 1807–82

American poet

You behold in me

Only a traveling Physician;

One of the few who have a mission

To cure incurable diseases,

Or those that are called so.

*The Works of Henry Wadsworth Longfellow* (Volume 5)

Christus, The Golden Legend, Part I (p. 144)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Ludmerer, Kenneth M.**

Physician

The thinking physician...is the one who in the practice of medicine asks not "What is there to do?" but "should it be done?"

*Learning to Heal: The Development of American Medical Education*

(p. 280)

Basic Books, Inc., Publishers. New York, New York, USA. 1985

**Luther, Martin** 1483–1546

Leader of the Protestant Reformation

Able, cautious, and experienced physicians, are gifts of God. They are the ministers of nature, to whom human life is confided; but a moment's negligence may ruin everything. No physician should take a single step, but in humility and the fear of God; they who are without the fear of God are mere homicides.

Translated by William Hazlitt

*The Table-Talk of Martin Luther*

DCCLXXXIII (p. 317)

H.G. Bohn. London, England. 1857

**MacPhail, Sir Andrew** 1864–1938

Canadian physician

I am well aware that in these days, when a student must be converted into a physiologist, a physicist, a chemist, a biologist, a pharmacologist, and an electrician, there is no time to make a physician of him.

*British Medical Journal*, Volume 1, 1933

**Manning, Phil R.**

American physician

The outstanding advances in information technology are simplifying and encouraging independent, practice-related study, making it easier for physicians to enhance learning in the practice environment.

In Lois Debakery and Phil R. Manning  
*Medicine: Preserving the Passion in the 21st Century* (p. vii)  
Springer-Verlag, Berlin, Germany, 2004

**Massinger, Philip** 1583–1640  
English dramatic poet

I October What art can do, we promise; physic's hand  
As apt is to destroy as to preserve,  
If Heaven make not the med'cine: all this while,  
Our skill hath combat hell with his disease;  
But 'tis so arm'd, and a deep melancholy,  
To be such in part with death, we are in fear  
The grave must mock our labours.

*The Plays of Philip Massinger* (Volume 1)  
*The Virgin-Martyr*, Act IV, Scene I (p. 76)  
G. & W. Nicol. London, England, 1805

**Mather, Cotton** 1663–1728  
American minister and religious writer

Of a Distemper we commonly say, To know the Cause,  
is Half the Cure. But, alas, how little Progress is there  
yet made in that Knowledge! Physicians talk about the  
Causes of Diseases. But their Talk is very Conjectural,  
very Uncertain, very Ambiguous; and often times a mere  
Jargon; and in it, they are full of Contradiction to One  
another.

*The Angel of Bethesda*  
Capsula VII (p. 43)  
American Antiquarian Society and Barre Publishers, Barre, Massachusetts, USA, 1972

**Mayo, Charles Horace** 1865–1939  
American physician

The definition of a specialist as one who “knows more  
and more about less and less” is good and true. Its truth  
makes essential that the specialist, to do efficient work,  
must have some association with others who, taken alto-  
gether, represent the whole of which the specialty is only  
a part.

Surgery's Problems as They Affect the Hospital  
*Modern Hospital*, Volume 51, September, 1938

The true physician will never be satisfied just to pass his  
therapeutic wares over a counter.

Problems in Medical Education  
*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 18,  
1926

As a profession [physician] we are probably less acute in  
our general observation than was the practitioner of the  
old school.

In M.H. Mellish  
*Collected Papers of the Mayo Clinic* (Volume 7)  
The Examination, Preparation, and Care of Surgical Patients (p. 859)  
W.B. Saunders Co. Philadelphia, Pennsylvania, USA, 1916

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

The true physician does not preach repentance; he offers  
absolution.

*Prejudices: Third Series*  
Chapter XIV, Section 5 (p. 269)  
Alfred A. Knopf, New York, New York, USA, 1922

**Meyer, Adolf** 1866–1950  
American neurologist and psychiatrist

I wonder how soon we shall be far enough along to have  
the physician ask: How much and what, if anything, is  
structural? how much Functional, somatic or metabolic?  
How much constitutional, psychogenic and social?

The “Complaint” as the Center of Genetic-Dynamic and Nosological  
Teaching in Psychiatry  
*New England Journal of Medicine*, August 23, 1928

**Miller, H.**  
No biographical data available

The worst mistakes...must be laid at the door of the  
specialist rather than the general practitioner, who, from  
his intimate contact with sick people in their natural sur-  
roundings, often has a lively understanding of the nerv-  
ous patient, and is able to see him and his problems as  
a whole.

The Recognition of Neurotic Illness  
*Practitioner*, Volume 159, 1947

**Molière (Jean-Baptiste Poquelin)** 1622–1673  
French playwright and actor

What will you do, sir, with four physicians? Is not one  
enough to kill anyone body?

In Logan Clendening  
*Sourcebook of Medical History*  
Love's the Best Doctor  
Act II, Scene I (p. 222)  
General Publishing Company Ltd. Toronto, Ontario, Canada, 1942

**Moore, Merrill**  
No biographical data available

If the average man is a harp on whom Nature occasion-  
ally plays, the physician is an instrument on whom the  
emotions are played continuously during his waking  
hours and that is not too good for any man.

In Mary Lou McDonough  
*Poet Physician: An Anthology of Medical Poetry Written by Physicians*  
Afterthought (p. 198)  
C.C. Thomas, Springfield, Illinois, USA, 1945

**More, Hannah** 1745–1833  
English religious writer

I used to wonder why people should be so fond of the  
company of their physician, till I recollected that he is the  
only person with whom one dares to talk continually of  
oneself, without interruption, contradiction or censure; I  
suppose that delightful immunity doubles their fees.

In William Roberts

*Memoirs of the Life and Correspondence of Mrs. Hannah Moore*  
(Volume 1)

Letter to Horace Walpole, 27 July, 1789 (p. 317)

Harper & Brothers. New York, New York, USA. 1837

**Nuland, Sherwin B.** 1930–

American surgeon and teacher of bioethics and medicine

The very success of his esoteric therapeutics too often leads the physician to believe he can do what is beyond his doing and save those who, left to their own unhindered judgment, would choose not to be subjected to his saving.

*How We Die: Reflections on Life's Final Chapter* (p. 221)

Alfred A. Knopf. New York, New York, USA. 1994

Just as physicians must constantly admonish one another to seek the most subtle beginnings of disease, they must also forgive themselves when timing or circumstances frustrate their best intentions.

The Uncertain Art: The Whole Law of Medicine

*The American Scholar*, Summer, Volume 67, Number 3, 1998

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

It may be well for a physician to have pursuits outside his profession, but it is dangerous to let them become too absorbing.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter III (p. 67)

Clarendon Press. Oxford, England. 1925

To investigate the causes of death, to examine carefully the condition of organs, after such changes have gone on in them as to render existence impossible and to apply such Knowledge to the prevention and treatment of disease, is one of the highest objects of the Physician...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter IV (p. 85)

Clarendon Press. Oxford, England. 1925

'Tis no idle challenge which we physicians throw out to the world when we claim that our mission is of the highest and of the noblest kind, not alone in curing disease but in educating the people in the laws of health, and in preventing the spread of plagues and pestilences...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XVI (p. 408)

Clarendon Press. Oxford, England. 1925

No class of men needs friction so much as physicians; no class gets less. The daily round of busy practitioners tends to develop an egoism of a most intense kind, to which there is no antidote. The few setbacks are forgotten, the mistakes are often buried, and ten years of successful work tend to make a man touchy, dogmatic, intolerant of correction, and abominably self-centered.

To this mental attitude the medical society is the best corrective, and a man misses a good part of his education who does not get knocked about a bit by his colleagues in discussions and criticisms...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter VXII (p. 447)

Clarendon Press. Oxford, England. 1925

Few men live lives of more devoted self-sacrifice than the family physician but he may become so completely absorbed in work that leisure is unknown.... There is danger in this treadmill life lest he lose more than health and time and rest – his intellectual independence. More than most men he feels the tragedy of isolation – that inner isolation so well expressed in Matthew Arnold's line – "We mortal millions live alone." Even in populous districts the practice of medicine is a lonely road which winds uphill all the way and a man may easily go astray and never reach the Delectable Mountains unless he early finds those shepherd guides of which Bunyan tells, Knowledge, Experience, Watchful and Sincere. The circumstances of life mould him into a masterful, self-confident, self-centered man, whose worst faults often partake of his best qualities.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XXI (p. 588)

Clarendon Press. Oxford, England. 1925

Permanence of residence, good undoubtedly for the pocket, is not always best for wide mental vision in the physician.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Army Surgeon (p. 101)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

Tis no idle challenge which we physicians throw out to the world when we claim that our mission is of the highest and of the noblest kind, not alone in curing disease but in educating the people in the laws of health, and in preventing the spread of plagues and pestilences...

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter VII (p. 125)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

The physician needs a clear head and a kind heart; his work is arduous and complex, requiring the exercise of the very highest faculties of the mind, while constantly appealing to the emotions and finer feelings.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter VII (pp. 132–133)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

To wrest from nature the secrets which have perplexed philosophers of all ages, to track to their sources the causes of disease, to correlate the vast stores of knowledge, that they may be quickly available for the prevention and cure of disease – these are our ambitions.



*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 267)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

To prevent disease, to relieve suffering and to heal the sick – this is our work.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 267)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The physician who shows in his face the slightest alteration, expressive of anxiety or fear, has not his medullary centres under the highest control, and is liable to disaster at any moment. I have spoken this to you on many occasions, and have urged you to educate your nerve centres so that not the slightest dilator or contractor influence shall pass to the vessels of your face under any professional trial.

In Christopher Lawrence and Steven Shapin

*Science Incarnate: Historical Embodiments on Natural Knowledge* (p. 171)

The University of Chicago Press. Chicago, Illinois, USA. 1998

A physician

who does not use books and journals, who does not need a library, who does not read one or two of the best weeklies and monthlies, soon sinks to the level of the cross-counter prescriber, and not alone in practice, but in those mercenary feelings and habits which characterize a trade...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XVII (p. 448)

Clarendon Press. Oxford, England. 1925

Often the best part of your work will have nothing to do with potions and powders, but with the exercise of an influence of the strong upon the weak, of the righteous upon the wicked, of the wise upon the foolish. To you, as the trusted family counselor, the father will come with his anxiety the mother with her hidden grief, the daughter with her trials, and the son with his follies. Fully one-third of the work you do will be entered in other books than yours. Courage and cheerfulness will not only carry you over the rough places of life, but will enable you to bring comfort and help to the weak-hearted and will console you in the sad hours when, like Uncle Toby, you have "to whistle that you may not weep."

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter XVIII (p. 386)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

**Ovid** 43 BCE–17 AD

Roman poet

'Tis not always in a physician's power to cure the sick...

In Arthur Leslie Wheeler

*Ovid with an English Translation*

Ex Ponto, Book I, iii (p. 281)

Harvard University Press. Cambridge, Massachusetts, USA. 1924

**Owen, John** 1616–83

English Puritan divine and theologian

Physicians take Gold, but seldom give:

They Physick give, take none; yet healthy live.

A Diet They prescribe; the Sick must for't

Give Gold; Each other Thus supply-support.

*Latine Epigrams*

Book I, Number 53

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1997

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541

Swiss alchemist and mystic

The book of Nature is that which the physician must read; and to do so he must walk over the leaves.

*Encyclopaedia Britannica* (9th edition) (Volume 18) (p. 234)

**Parkinson, John**

No biographical data available

The common duty required of a physician lies in the recognition and treatment of disease. If he enlarges his study to cover life as affected by disease, and masters the psychology of the individual sick in body, he will widen his usefulness and reach a fuller life himself as a physician.

*Annals of Internal Medicine*

The Patient and the Physician

Address

32nd Annual Session of the American College of Physicians, St Louis, Missouri, April 11, 1951

**Percival, Thomas** 1740–1804

English physician, philosopher, and writer

The relations in which a physician stands to his patients, to his brethren, and to the public, are complicated, and multifarious; involving much knowledge of human nature, and extensive moral duties.

*Medical Ethics*

To E.C. Percival (p. viii)

Printed by S. Russell. Manchester, England. 1803

Hospital physicians and surgeons should minister to the sick, with due impressions of the importance of their office; reflecting that the ease, the health, and the lives of those committed to their charge depend on their skill, attention, and fidelity.

*Medical Ethics*

Chapter I (p. 9)

Printed by S. Russell. Manchester, England. 1803



**Piozzi, Hester Lynch** 1741–1821  
English writer

A physician can sometimes parry the scythe of death, but has no power over the sand in the hourglass.

Letter to Fanny Burney, 12 November, 1781

**Plato** 428 BCE–347 BCE  
Greek philosopher

...no physician, in so far as he is a physician, considers his own good in what he prescribes, but the good of his patient; for the true physician is also a ruler having the human body as a subject, and is not a mere money-maker.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book I, Section 342 (p. 303)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the most skillful physicians are those who, from their youth upwards, have combined with the knowledge of their art the greatest experience of disease; they had better not be robust in health, and should have had all manner of diseases in their own persons.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book 3, Section 408 (p. 337)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...so to in the body the good and healthy elements are to be indulged and the elements of disease are not to be indulged, but discouraged. And this is what the physician has to do, and in this the art of medicine consists: for medicine may be regarded generally as the knowledge of the loves and desires of the body, and how to satisfy them or not; and the best physician is he who is able to separate fair love from foul, or to convert one into the other; and he who knows how to eradicate and how to implant love, whichever is required, and can reconcile the most hostile elements in the constitution and make them loving friends, is a skillful practitioner.

In *Great Books of the Western World* (Volume 7)

*Symposium*

Section 186 (p. 156)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Plutarch** 46–119  
Greek biographer and author

...a skillful physician, who, in a complicated and chronic disease, as he sees occasion, at one while allows his patient the moderate use of such things as please him, at another while gives him keen pains and drugs to work the cure.

In *Great Books of the Western World* (Volume 7)

*Pericles* (p. 129)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49  
American short story writer

Is there – is there balm in Gilead? – tell me – tell me, I implore!

*The Raven and Other Poems*

The Raven, Stanza 15

Columbia University Press. New York, New York, USA. 1942

**Prior, Matthew** 1664–1721  
English poet and diplomat

I sent for Ratcliffe; was so ill

That other doctors gave me over:

He felt my pulse – prescrib'd his pill,

And I was likely to recover.

But when the wit began to wheeze,

And wine had warm'd the politician

Cur'd yesterday of my disease,

I died last night of my physician.

In Helen & Lewis Melville

*An Anthology of Humorous Verse*

The Remedy Worse than the Disease

Dodd, Mead & Company. New York, New York, USA. 1924

## Proverb

Where there are three physicians, there are two atheists.

In Oliver Wendell Holmes

*Medical Essays*

The Medical Profession in Massachusetts (p. 364)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Deceive not thy Physitian, Confessor, nor Lawyer.

In George Herbert

*Outlandish Proverbs*

#105

Printed by T. Maxey for T. Garthwait. London, England. 1651

God heales, and the Physitian hath the thanks.

In George Herbert

*Outlandish Proverbs*

#169

Printed by T. Maxey for T. Garthwait. London, England. 1651

Go not for every grief to the Physitian, nor for every quarrel to the Lawyer, nor for every thirst to the pot.

In George Herbert

*Outlandish Proverbs*

#290

Printed by T. Maxey for T. Garthwait. London, England. 1651

There are more Physitians in health than drunkards.

In George Herbert

*Outlandish Proverbs*

#903

Printed by T. Maxey for T. Garthwait. London, England. 1651

The Physitian owes all to the patient, but the patient owes nothing to him but a little money.

In George Herbert

*Outlandish Proverbs*

#921

Printed by T. Maxey for T. Garthwait. London, England. 1651

A disobedient patient makes an unfeeling physician.

In Robert Christy  
*Proverbs, Maxims and Phrases of All Ages* (p. 255)  
 G.P. Putnam's Sons. New York, New York, USA. 1888

### Proverb, Chinese

The physician can cure the sick, but he cannot cure the dead.

In Robert Christy  
*Proverbs, Maxims and Phrases of All Ages* (p. 259)  
 G.P. Putnam's Sons. New York, New York, USA. 1888

### Proverb, German

When you call a physician call the judge to make your will.

In Robert Christy  
*Proverbs, Maxims and Phrases of All Ages* (p. 259)  
 G.P. Putnam's Sons. New York, New York, USA. 1888

### Proverb, Italian

From your confessor, lawyer and physician,  
 Hide not your case on no condition.

In Sir John Harrington  
*Metamorphosis of Ajax*  
 The Second Section (p. 154)  
 Columbia University Press. New York, New York, USA. 1962

### Proverb, Italian

*Dove non va il sole, va il medico*: Where the sunlight enters not, there goes the physician.

In Robert Means Lawrence  
*Primitive Psycho-Therapy and Quackery*  
 The Blue-Glass Mania (p. 95)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1910

**Quarles, Francis** 1592–1644  
 English poet

Physicians of all men are most happy; what good success soever they have, the world proclaimeth, and what faults they commit, the earth coverth.

*Hieroglyphikes of the Life of Man*  
 Part iv, Nicocles (p. 17)  
 Printed for M. Fleshor. London, England. 1638

**Rabelais, François** ca. 1490–1553  
 French writer and physician

Happy is the physician, whose coming is desired at the declension of a disease.

In *Great Books of the Western World* (Volume 24)  
*Gargantua and Pantagruel*  
*Pantagruel*  
 Book 3, Chapter 41 (p. 209)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ray, John** 1627–1705  
 English naturalist

The best physicians are Dr. Diet, Dr. Quiet, and Dr. Merryman.

*A Complete Collection of English Proverbs* (p. 34)  
 Printed for G. Cowie. London, England. 1813

Piss clear, and defy the physician.

*A Complete Collection of English Proverbs* (p. 35)  
 Printed for G. Cowie. London, England. 1813

**Saint Augustine of Hippo** 354–430  
 Theologian and doctor of the Church

...as it happens usually to him that having had experience of a bad physician, is fearful afterwards to trust himself with a good [physician]...

*St. Augustine's Confessions* (Volume 1)  
 Book VI, IV (p. 281)  
 William Heinemann. London, England. 1912

**Scott, Sir Walter** 1771–1832  
 Scottish novelist and poet

...the sick chamber of the patient is the kingdom of the physician.

*The Talisman*  
 Chapter VII (p. 99)  
 Grosset & Dunlap. New York, New York, USA. 1929

The praise of the physician... is the recovery of the patient.

*The Talisman*  
 Chapter VIII (p. 112)  
 Grosset & Dunlap. New York, New York, USA. 1929

...a slight touch of the cynic in manner and habits, gives the physician, to the common eye, an air of authority which greatly tends to enlarge his reputation.

*The Complete Works of Sir Walter Scott* (Volume 5)  
*The Surgeon's Daughter*  
 Chapter I (p. 23)  
 Conner & Cooke. New York, New York, USA. 1833

**Seegal, David**  
 No biographical data available

The young physician today is so generously provided with a kit of diagnostic and therapeutic tools, his attention might be wisely directed to the question of "what not to do" as well as "what to do."

*Journal of Chronic Diseases*, Volume 17, 299, 1964

**Selden, John** 1584–1654  
 English jurist

Preachers say, do as I say, not as I do. But if the physician had the same disease upon him that I have, and he should bid me to do one thing, and he do quite another, could I believe him?

*Table Talk of John Selden*  
 Preaching #13 (p. 145)  
 J.M. Dent. London, England. 1899

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

The physician cannot prescribe by letter...he must feel the pulse.

Translated by Richard M. Gummere  
*Ad Lucilium Epistulae Morales* (Volume 1)  
Epistle xxii, Section 1 (p. 149)  
Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Trust not the physician;  
His antidotes are poison, and he slays  
More than you rob.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Timon of Athens*  
Act IV, Scene iii, l. 434–436  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Kill thy physician, and the fee bestow  
Upon thy foul disease.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*King Lear*  
Act I, Scene i, l. 164–165  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sheridan, Richard Brinsley** 1751–1816  
English dramatist and politician

The art of the physician consists, in a great measure, in exciting hope, and other friendly passions and feelings.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 330)  
Robert Dick. Toronto, Ontario, Canada. 1853

...I had rather follow you to your grave, than see you owe your life to any but a regular bred physician.

*St. Patrick's Day*  
Act II, Scene Justice Hoofe (p. 24)  
Publisher undetermined

**Sissman, Louis Edward** 1928–76  
Poet

The doctors – eleven of them, all told – marshaled their forces for a truly impressive attack on the disease. Everything, I felt was meticulously planned in some War Room in the depths of the hospital: the battery of tests in just such a sequence; the alternative battle plans contingent on the outcome of the tests; the choice of weapons – radiation or chemotherapy – for the mopping-up afterward.

*A Little Night Music: A Tangential Line*  
*The Atlantic*, February, 1972

**Smollett, Tobias George** 1721–71  
Scottish novelist

The character of a physician, therefore, not only presupposes natural sagacity, and acquired erudition, but it also

implies every delicacy of sentiment, every tenderness of nature, and every virtue of humanity.

*The Life and Adventures of Sir Launcelot Greaves*  
Chapter XXIV (p. 192)  
Oxford University Press, Inc. London, England. 1973

**Stanton, Elizabeth Cady** 1815–1902  
American reformer

Besides the obstinacy of the nurse, I had the ignorance of the physicians to contend with.

*Eighty Years and More (1815–1897) Reminiscences of Elizabeth Cady Stanton*  
Motherhood (pp. 118–119)  
T. Fisher Unwin. London, England. 1898

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

There are men and classes of men that stand above the common herd; the soldier, the sailor, and the shepherd not unfrequently; the artist rarely; rarer still, the clergyman; the physician almost as a rule. He is the flower (such as it is) of our civilization; and when that stage of man is done with, and only remembered to be marveled at in history, he will be thought to have shared as little as any in the defects of the period, and most notably exhibited the virtue of the race. Generosity he has, such as is possible to those who practice an art, never to those who drive a trade; discretion, tested by a hundred secrets; tact, tried in a thousand embarrassments; and, what are more important, Herculean cheerfulness and courage. So it is that he brings air and cheer into the sick-room, and often enough, though not so often as he wishes, brings healing.

*Underwoods*  
Preface  
Charles Scribner's Sons. New York, New York, USA. 1887

**Swift, Jonathan** 1667–1745  
Irish-born English writer

Physicians ought not to give their Judgment of Religion, for the same Reason that Butchers are not admitted to be Jurors upon Life and Death.

*Satires and Personal Writings*  
Thoughts on Various Subjects (p. 410)  
Oxford University Press, Inc. New York, New York, USA. 1965

**Taylor, Jeremy** 1613–67  
English clergyman

...to preserve a man alive in the midst of so many chances, and hostilities, is as great a miracle as to create him...

*Holy Living and Holy Dying* (Volume 2)  
Chapter I, Section 1, l. 7–9  
At The Clarendon Press. Oxford, England. 1989

**The Bible (King James Version)**

And Asa in the thirty and ninth year of his reign was diseased in his feet, until his disease was exceeding

great: yet in his disease he sought not to the LORD, but to the physicians.

II Chronicles 16:12–13

Is there no balm in Gilead, is there no physician there?

Jeremiah 8:22

...They that be whole need not a physician, but they that are sick.

Matthew 9:12

Physician, heal thyself...

Luke 4:23

### **Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Priests and physicians should never look one another in the face. They have no common ground, nor is there any to mediate between them. When the one comes, the other goes. They could not come together without laughter, or a significant silence, for the one's profession is a satire on the other's, and either's success would be the other's failure.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimac Rivers*

Wednesday (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

It is wonderful that the physician should ever die, and that the priest should ever live. Why is it that the priest is never called to consult with the Physician? It is because men believe practically that matter is independent of spirit. But what quackery? It is commonly an attempt to cure the disease of a man by addressing his body alone. There is a need of a physician who shall minister to both soul and body at once, that is to man. Now he falls between two stools.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimac Rivers*

Wednesday (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Trousseau, Armand** 1801–67

French internist

...the physician, worthy of the priesthood to which he has devoted himself, has no right to place on one side his beliefs, even though they be false, that he may experiment upon his patients, and wait with curiosity to see what "expectation" can do for them.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)

Introduction (p. 16)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

...physics, chemistry, or natural history, which are unquestionably useful in medicine, but no more make the physician than the science of perspective makes the landscape-painter.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)

Introduction (p. 30)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

Take care not to fancy that you are physicians as soon as you have mastered scientific facts; they only afford to your understanding an opportunity of bringing forth fruit, and of elevating you to the high position as a man of art.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)

Introduction (p. 41)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

### **Tupper, Kerr Boyce**

No biographical data available

Let a physician believe with all his heart that God meant him to be a physician, only a physician, wholly a physician, always a physician, then will he be a physician indeed, uncorrupted by the love of money, untainted by infection for fame, untimidated by danger.... Have appetite for your life calling, and you will have aptitude for all its duties.

*The Ideal Physician* (p. 37)

Lea Brothers/Philadelphia, Pennsylvania, USA. 1899

### **Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

Only those who regard healing as the ultimate goal of their efforts can, therefore, be designated as physicians.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

Standpoints in Scientific Medicine (1847) (p. 26)

Stanford University Press. Stanford, California, USA. 1958

...there are circumstances in which the split between scientific and practical medicine is so great that the learned physician can do nothing, while the practical physician knows nothing. Lord Bacon has said, *scientia est potentia*. Knowledge which is unable to support action is not genuine, and how unsure is activity without understanding! This split between science and practice is rather new; our century and our country have brought it into being.

Translated by Lelland J. Rather

*Disease, Life, and Man*

Standpoints in Scientific Medicine (1847) (p. 27)

Stanford University Press. Stanford, California, USA. 1958

### **Voltaire (François-Marie Arouet)** 1694–1778

French writer

The Devil should not try his tricks on a clever physician. Those familiar with nature are dangerous for the wonder-workers. I advise the Devil always to apply to the faculty of theology – not to the medical faculty.

In Pearch Bailey

Voltaire's Relation to Medicine

*Annals of Medical History*, Volume 1, 1917 (p. 58)

Let nature be your first physician. It is she who made all.

*The Works of Voltaire* (Volume 11)

*Philosophical Dictionary* (Volume 7)

Medicine (p. 169)

The St. Hubert Guild. Akron, Ohio, USA. 1901

But nothing is more estimable than a physician who, having studied nature from his youth, knows the properties of the human body, the diseases which assail it, the remedies which will benefit it, exercises his art with caution, and pays equal attention to the rich and the poor.

*The Works of Voltaire* (Volume 12)

*Philosophical Dictionary* (Volume 8)

Physicians (pp. 199–200)

The St. Hubert Guild. Akron, Ohio, USA. 1901

**von Ebner-Eschenbach, Marie** 1830–1916

Austrian writer

Physicians are hated either on principle or for financial reasons.

Translated by David Scrase and Wolfgang Mieder

*Aphorisms* (p. 50)

Aridne Press. Riverside, California, USA. 1994

**Webster, John** 1580?–1625?

English playwright

Physicians are like kings –  
they brook no contradiction.

*The Duchess of Malfi*

Act V, Scene II, l. 69–70

Chatto & Windus. London, England. 1958

**Wordsworth, William** 1770–1850

English poet

Physician art thou? one, all eyes,  
Philosopher! a fingering slave,  
One that would peep and botanize  
Upon his mother's grave.

*The Complete Poetical Works of William Wordsworth*

A Poet's Epitaph

Crowell. New York, New York, USA. 1888

**Young, Arthur** 1741–1820

English traveler

...there is a great difference between a good physician and a bad one; yet very little between a good one and [no physician] at all.

*Travels in France*

9 September, 1787 (p. 66)

G. Bell. London, England. 19112

## PHYSIC

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

No men despise physic so much as physicians, because no men so thoroughly understand how little it can perform.

*Lacon: Or, Many Things in Few Words*

CCCXXXVIII (p. 160)

Longman, Rees, Orme, Brown & Green. London, England. 1826

**Young, Thomas** 1773–1829

English polymath

In physic, the wisest can do but little, and the ignorant can only do worse than nothing ...

*A Course of Lectures on Natural Philosophy and the Mechanical Arts*

Lecture I (p. 4)

Taylor & Walton. London, England. 1845

## PHYSICIST

Up to the time of the foundation of the Institute of Physics, the physicists had hardly been recognized as a member of one of the professions.

*The Institute of Physics: Objects of the Institute* (p. 5)

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Very strange people, physicists...in my experience the ones who aren't actually dead are in some way very ill.

*The Long Dark Tea-Time of the Soul*

Chapter II (p. 140)

Simon & Schuster. New York, New York, USA. 1990

It startled him even more when just after he was awarded the Galactic Institute's Prize for Extreme Cleverness he got lynched by a rampaging mob of respectable physicists who had finally realized that the one thing they really couldn't stand was a smart-ass.

*The Ultimate Hitchhiker's Guide to the Galaxy*

*The Hitchhiker's Guide to the Galaxy*

Chapter 10 (p. 60)

The Ballantine Book Company. New York, New York, USA. 2002

**Adams, Henry Brooks** 1838–1918

American man of letters

Thus results the plain assurance that the future of Thought, and therefore of History, lies in the hands of the physicists, and that the future historian must seek his education in the world of mathematical physics. Nothing can be expected from further study on the old lines.

*The Degradation of the Democratic Dogma*

The Rule of Phase Applied to History (p. 283)

The Macmillan Co. New York, New York, USA. 1919

...the future of Thought and therefore of History lies in the hands of physicists, and therefore the future historian must seek his education in the world of mathematical physics.

*The Degradation of the Democratic Dogma*

The Rule of Phase Applied to History (p. 283)

Peter Smith. New York, New York, USA. 1949

He had the physicist's heinous fault of professing to know nothing between flashes of intense perception.

*The Education of Henry Adams: An Autobiography*

Chapter XXIV (p. 377)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1918



**Alvarez, Luis W.** 1911–88  
American physicist

Most of us who become experimental physicists do so for two reasons; we love the tools of physics because to us they have intrinsic beauty, and we dream of finding new secrets of nature as important and as exciting as those uncovered by our scientific heroes. But we walk a narrow path with pitfalls on either side. If we spend all our time developing equipment, we risk the appellation of “plumber”, and if we merely use the tools developed by others, we risk the censure of our peers for being parasitic.

*Nobel Lectures, Physics 1963–1970*

Recent Developments in Particle Physics (p. 241)  
Elsevier Publishing Co. 1972

**Atiyah, Sir Michael** 1922–  
English mathematician

Physicists are much less worried than mathematicians about lack of rigor. One might propose as an analogy that mathematicians resemble professional linguists who are very concerned with the formal structure of languages. Physicists are like people who are perfectly successful at using language without being unduly concerned about the theory of grammatical structure.

In Jørgen Ellegaard Andersen, Henrik Pedersen and Andrew Swann  
*Geometry and Physics*

Geometry And Physics: Where are We Going? (p. 3)  
Marcel Dekker, Inc. New York, New York, USA. 1997

### Author undetermined

We seek, we study, and we stare  
At particles that weren't quite there.

In H. Arthur Klein

*The World of Measurements*

Song for A High-Energy Physicist (p. 180)  
Simon & Schuster. New York, New York, USA. 1974

Mathematicians are happy in their logic; chemists are happy in their common sense; but physicists are happy because they have neither logic nor common sense.

Quoted in Harold T. Davis

*Philosophy and Modern Science*

Chapter II (p. 26)

Principia Press. Bloomington, Indiana, USA. 1931

### Baker, Adolph

No biographical data available

Physics is engaged neither in the development of time machines nor in the fabrication of bombs. But it is the business of physicists to take flights of fancy which carry them far beyond the boundaries imposed by current technology.

*Modern Physics and Antiphysics*

Chapter 3 (p. 27)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1970

**Balfour, Arthur James** 1848–1930  
English prime minister

The physicist looks for something more than what by any stretch of language can be described as ‘coexistences’ and ‘sequences’ between so-called ‘phenomena.’ He seeks for something deeper than the laws connecting possible objects of experience. His object is physical reality; a reality which may or may not be capable of direct perception; a reality which is in any case independent of it; a reality which constitutes the permanent mechanism

Reflections Suggested by the New Theory of Matter

*Popular Science Monthly*, Volume 65, Number 6 October, 1904 (p. 496)

**Ball, Sir Robert Stawell** 1840–1913  
Irish astronomer

Just as the astronomer staggers our powers of conception by the description of appalling distances and stupendous periods of time, and relies with confidence on the evidence which convinces him of the reality of his statements, so the physicist avails himself of a like potent method of research to study distances so minute and times so brief that the imagination utterly fails to realize them.

*Essays in Astronomy*

Atoms and Sunbeams (p. 12)

D. Appleton & Co. New York, New York, USA. 1900

**Barnett, Lincoln Kinnear** 1909–79  
American science writer

The young physicists are beyond all doubt the noisiest, rowdiest, most active and most intellectually alert group we have here. For them the world changes every week and they are simply delighted by it. A few days ago I asked one of them as they came bursting out of a seminar, “How did it go?” “Wonderful” he said. “Everything we knew about physics last week isn't true!”

*Writing on Life: Sixteen Close-Ups*

Physicist Oppenheimer (p. 378)

William Sloane Associates, Publishers. New York, New York, USA. 1951

### Bergmann, P.

No biographical data available

In many aspects, the theoretical physicist is merely a philosopher in a working suit.

In Jean-Pierre Luminet

*Black Holes* (p. 51)

Cambridge University Press. New York, New York, USA. 1992

**Birkhoff, George David** 1884–1944  
American mathematician

It is to be hoped that in the future more and more theoretical physicists will command a deep knowledge of mathematical principles; and also that mathematicians will no longer limit themselves so exclusively to the aesthetic development of mathematical abstractions.

Mathematical Nature of Physical Theories

*American Scientist*, Volume 31, Number 4, October, 1943 (p. 286)



**Boltzmann, Ludwig Edward** 1844–1906  
Austrian Physicist

$S = k \log w$   
*Carved on Boltzmann's gravestone*

**Bradley, Francis Herbert** 1846–1924  
English philosopher

For Nature to the common man is not the Nature of the physicist; and the physicist himself, outside his science, still habitually views the world as what he must believe it cannot be.

*Appearance and Reality: A Metaphysical Essay*  
Book II, Chapter XXII (p. 262)  
Swan Sonnenschein & Co. New York, New York, USA. 1893

**Brecht, Bertolt** 1898–1956  
German writer

VIRGINIA: Father says theologians have their bells to ring; physicists have their laughter.

Translated by John Willett  
*Life of Galileo*  
Scene 9 (p. 74)  
Arcade Publishing. New York, New York, USA. 1994

**Bridgman, Percy Williams** 1882–1961  
American physicist

[Because of the principle of indeterminacy] the physicist thus finds himself in a world from which the bottom has dropped clean out; as he penetrates deeper and deeper it eludes him and fades away by the highly unsportsmanlike device of just becoming meaningless. No refinement of measurement will avail to carry him beyond the portals of this shadowy domain which he cannot even mention without logical inconsistency. A bound is thus forever set to the curiosity of the physicist. What is more, the mere existence of this bound means that he must give up his most cherished convictions and faith. The world is not a world of reason, understandable by the intellect of man, but as we penetrate ever deeper, the very law of cause and effect, which we had thought to be a formula to which we could force God Himself to subscribe, ceases to have meaning. The world is not intrinsically reasonable or understandable; it acquires these properties in ever-increasing degree as we ascend from the realm of the very little to the realm of everyday things; here we may eventually hope for an understanding sufficiently good for all practical purposes, but no more.

*The New Vision of Science*  
*Harper's Magazine*, Volume 158 (p. 450)

**Brillouin, Léon** 1889–1969  
French physicist

It is impossible to study the properties of a single mathematical trajectory. The physicist knows only bundles of trajectories, corresponding to slightly different initial conditions.

In John D. Barrow  
*The World Within the World* (p. 277)  
Clarendon Press. Oxford, England. 1988

**Burroughs, William S.** 1914–97  
American writer

No atomic physicist has to worry, people will always want to kill other people on a mass scale.

*The Adding Machine: Selected Essays*  
*A Word to the Wise Guy* (p. 29)  
Seaver Books. New York, New York, USA. 1986

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

Physicists are all too apt to look for the wrong sorts of generalizations, to concoct theoretical models that are too neat, too powerful, and too clean. Not surprisingly, these seldom fit well with data. To produce a really good biological theory, one must try to see through the clutter produced by evolution to the basic mechanisms. What seems to physicists to be a hopelessly complicated process may have been what nature found simplest, because nature could build on what was already there.

*What Mad Pursuit?: A Personal View of Scientific Discovery* (p. 139)  
Basic Books, Inc. New York, New York, USA. 1988

**Cvitanovic, Predrag**  
Physicist

Indicative of the depth of mathematics lurking behind physicists' conjectures is that fact that the properties that one would like to establish about the renormalization theory of critical circle maps might turn out to be related to number-theoretic abysses such as the Riemann conjecture....

In C. Itzykson, et al. (eds.)  
*From Number Theory and Physics*  
*Circle Maps: Irrationally Winding*  
Springer-Verlag New York, Inc. New York, New York, USA. 1992

**Darrow, Karl Kelchner** 1891–1982  
American physicist

It [physics] is less known, I suppose, than that of any other major science; and we who practice it scarcely dare avow ourselves as physicists in any group of laymen, for we know too well that if we do we shall be asked first to spell the word and then to define it!

*The Renaissance of Physics*  
Chapter I (p. 2)  
The Macmillan Co. New York, New York, USA. 1936

A century and more ago the older name was universal in English-speaking countries, and men who occupied themselves with mechanics and sound and heat and light were known as "natural philosophers." Would that we still were! it is a long and cumbersome title, but less cacophonous than our present name of *physicists*, with its three or four sibilants in three successive syllables, surely one of the ugliest words in any language.

*The Renaissance of Physics*

Chapter I (p. 3)

The Macmillan Co. New York, New York, USA. 1936

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

**Brown, Julian R.**

No biographical data available

Physicists, like theologians, are wont to deny that any system is in principle beyond the scope of their subject.

*Superstrings: A Theory of Everything*

Introduction (p. 1)

Cambridge University Press. Cambridge, England. 1988

**Dicke, R. H.**

No biographical data available

It is well known that carbon is required to make physicists.

Dirac's Cosmology and Mach's Principle

*Nature*, Volume 192, Number 4801, November 4, 1961 (p. 440)

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

Some physicists may be happy to have a set of working rules leading to results in agreement with observation. They may think that this is the goal of physics. But it is not enough. One wants to understand how Nature works.

*Proceedings of the Conference Perturbative Quantum Chromodynamics*, Volume 74, 1981 (pp. 129–130)

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

The watchmaker to whom one gives a watch that does not run will take it all apart and will examine each of the pieces until he finds out which one is damaged. The physician to whom one presents a patient cannot dissect him to establish the diagnosis. He has to guess the seat of the illness by examining the effect on the whole body. The physicist resembles a doctor, not a watchmaker.

Quelques reflexions au sujet de la physique experimentale

*Revue des questions scientifiques.*, Volume 36, 1897 (p. 55)

...if the aim of physical theories is to explain experimental laws, theoretical physics is not an autonomous science; it is subordinate to metaphysics.

*The Aim and Structure of Physical Theory*

Part I, Chapter I (p. 10)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Dürrenmatt, Friedrich** 1921–90

Swiss playwright and novelist

Dear Mobius. You have visitors. Now leave your physicist's lair for a moment and come in here.

Translated by James Kirkup

*The Physicists*

Act One (p. 37)

Grove Press, Inc. New York, New York, USA. 1964

It's ludicrous. Here we have hordes of highly paid physicists in gigantic state-supported laboratories working for years and years and years vainly trying to make some progress in the realm of physics, while you do it quite casually at your desk in this madhouse.

Translated by James Kirkup

*The Physicists*

Act Two (p. 75)

Grove Press, Inc. New York, New York, USA. 1964

**Dyson, Freeman J.** 1923–

American physicist and educator

Theoretical physicists are accustomed to living in a world which is removed from tangible objects by two levels of abstraction. From tangible atoms we move by one level of abstraction to invisible fields and particles. A second level of abstraction takes us from fields and particles to the symmetry-groups by which fields and particles are related. The superstring theory takes us beyond symmetry-groups to two further levels of abstraction. The third level of abstraction is the interpretation of symmetry-groups in terms of states in ten-dimensional space-time. The fourth level is the world of the superstrings by whose dynamical behavior the states are defined.

*Infinite in All Directions*

Part One, Chapter Two (p. 18)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

To the pure geometer the radius of curvature is an incidental characteristic – like the grin of the Cheshire cat. To the physicist it is an indispensable characteristic. It would be going too far to say that to the physicist the cat is merely incidental to the grin. Physics is concerned with interrelatedness such as the interrelatedness of cats and grins. In this case the “cat without a grin” and the “grin without a cat” are equally set aside as purely mathematical phantasies.

*The Expanding Universe*

Chapter IV, Section III (pp. 103–104)

The University Press. Cambridge. 1933

Wheresoever the carcass is, there will the eagles be gathered together, and where the symbols of the mathematical physicists flock, there presumably is some prey for them to settle on, which the plain man at least will prefer to call by a name suggestive of something more than passive emptiness.

*New Pathways in Science*

Chapter II, Section IV (p. 39)

The Macmillan Company. New York, New York, USA. 1935

Life would be stunted and narrow if we could feel no significance in the world around us beyond that which can be weighed and measured with the tools of the physicist or described by the metrical symbols of the mathematician.

In Arthur Beiser

*The World of Physics*

Introduction

Simon & Schuster. New York, New York, USA. 1987

### **Einstein, Albert** 1879–1955

German-born physicist

The supreme task of the physicist is to arrive at those universal elementary laws from which the cosmos can be built up by pure deduction.

*The World As I See It* (p. 22)

Philosophical Library. New York, New York, USA. 1949

Dear Schrödinger: You are the only contemporary physicist, besides Laue, who sees that one cannot get around the assumption of reality – if only one is honest. Most of them simply do not see what sort of risky game they are playing with reality – reality as something independent of what is experimentally established.

In A.P. French and P.J. Kennedy (eds.)

*Niels Bohr: A Centenary Volume*

Letter, Albert Einstein to Erwin Schrödinger, December 22, 1950

(p. 143)

Harvard University Press. Cambridge, Massachusetts, USA. 1985

How wretchedly inadequate is the theoretical physicist as he stands before Nature – and before his students!

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 15 March, 1922 (p. 24)

Princeton University Press. Princeton, New Jersey, USA. 1979

If you want to find out anything from the theoretical physicists about the methods they use, I advise you to stick closely to one principle: Don't listen to their words, fix your attention on their deeds.

*Ideas and Opinions*

On the Method of Theoretical Physics (p. 270)

Crown Publishers, Inc. New York, New York, USA. 1954

...the supreme task of the physicist is the discovery of the most general elementary laws from which the world-picture can be deduced logically.

In Max Planck

*Where Is Science Going?*

Prologue (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

### **Feynman, Richard P.** 1918–88

American theoretical physicist

A professor of theoretical physics always has to be told what to look for. He just uses his knowledge to explain the observations of the experimenters!"

*What Do You Care What Other People Think?*

The Cold Facts (p. 140)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

The limited imagination of physicists: When we see a new phenomenon we try to fit it into the framework we already have.... It's not because Nature is really similar;

it's because the physicists have only been able to think of the same damn thing, over and over again.

*QED: The Strange Theory of Light and Matter*

Chapter 4 (p. 149)

Princeton University Press. Princeton, New Jersey, USA. 1985

Physicists sometimes feel so superior and smart that other people would like to catch them out once on something. I will give you something to get them on. They should be utterly ashamed of the way they take energy and measure it in a host of different ways, with different names. It is absurd that energy can be measured in calories, in ergs, in electron volts, in foot pound, in B.T.U.s, in horsepower hours, in kilowatt hours – all measuring exactly the same thing.... For those who want some proof that physicists are human, the proof is in the idiocy of all the different units which they use for measuring energy.

*The Character of Physical Law*

Chapter 3 (p. 74)

BBC. London, England. 1965

### **Foster, G. Cary**

No biographical data available

...from the very outset of his investigations the physicist has to rely constantly on the aid of the mathematician, for even in the simplest cases, the direct results of his measuring operations are entirely without meaning until they have been submitted to more or less of mathematical discussion. And when in this way some interpretation of the experimental results has been arrived at, and it has been proved that two or more physical quantities stand in a definite relation to each other, the mathematician is very often able to infer, from the existence of this relation, that the quantities in question also fulfill some other relation, that was previously unsuspected. Thus when Coulomb, combining the functions of...from the very outset of his investigations the physicist has to rely constantly on the aid of the mathematician, for even in the simplest cases, the direct results of his measuring operations are entirely without meaning until they have been submitted to more or less of mathematical experimentalist and mathematician, had discovered the law of the force exerted between two particles of electricity, it became a purely mathematical problem, not requiring any further experiment, to ascertain how electricity is distributed upon a charged conductor, and this problem has been solved by mathematicians in several cases.

Presidential Address British Association for the Advancement of Science, Section A

*Nature*, Volume 16, May to October, 1877 (pp. 312–313)

### **Franklin, W. S.**

No biographical data available

Conversation with a physicist is, however, very like looking into the mechanism of a Mergenthaler type-casting machine, with the machine out of sight; a thing

which is feasible enough among designers and builders, but scarcely a satisfactory basis for the flow of thought when one party in the conversation happens to be unfamiliar with and perhaps not interested in the mechanism in question.

*Proceedings of the American Association for the Advancement of Science (Fifty-second meeting)*  
Address by W. S. Franklin (p. 366)  
Published by the permanent secretary  
1903

**Gamow, George** 1904–68  
Russian-born American physicist

Now, Physicists, take warning,  
Observe this sober test...  
When new fleas are a-borning  
Make sure they're fully dressed!

*Thirty Years That Shook Physics*  
First Part (p. 193)  
Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Gassendi, Pierre** 1592–1655  
French logician and philosopher

A physicist is like a hunter of nature, who just as a hunter does not pursue a wild animal sluggishly like an onlooker, but hunts with keen senses and tracks it down zealously...; likewise a physicist obtains the idea of the nature of things, or truth, not by considering it superficially and lazily, but by investigating it with many different kinds of experiments and observations.... Even though its nature keeps slipping away in many ways, he perseveres and seeks it in his search.

Quoted in Lisa T. Sarasohn  
*Gassendi's Ethics: Freedom in a Mechanistic Universe*  
Chapter 2 (p. 38)  
Cornell University Press. Ithaca, New York, USA. 1996

**Gibbs, J. Willard** 1839–1903  
American mathematician

A mathematician may say anything he pleases, but a physicist must be at least partially sane.

In R.B. Lindsay  
On the Relation of Mathematics and Physics  
*The Scientific Monthly*, December, 1944 (p. 456)

**Glaser, Donald A.** 1926–  
American physicist

In their exploration of the submicroscopic world of atomic nuclei, physicists are like men groping in a dark cave with a flashlight that goes on for only an instant and each time lights only a tiny corner of the cave.

The Bubble Chamber  
*Scientific American*, Volume 192, Number 2, February, 1955 (p. 46)

**Green, Celia** 1935–  
English philosopher and psychologist

If you say to a theoretical physicist that something is inconceivable, he will reply: "It only appears

inconceivable because you are naively trying to conceive it. Stop thinking and all will be well."

*The Decline and Fall of Science*  
Aphorisms (pp. 2–3)  
Hamilton. London, England. 1976

**Greene, Brian** 1963–  
American physicist

Physicists are more like avant-garde composers, willing to bend traditional rules.... Mathematicians are more like classical composers..."

*The Elegant Universe*  
Chapter 11 (p. 271)  
W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Gribbin, John**  
English science writer and astronomer

**Rees, Martin John** 1942–  
15th Astronomer Royal of England

...the fate of the Universe, like its present appearance, was imprinted right at the beginning, in the hot, dense fireball era. And to understand that era, and the nature of the relics it could have left behind, we enter the realm of the particle physicist.

*Cosmic Coincidences: Dark Matter, Mankind, and Anthropic Cosmology*  
Part One, Chapter Three (p. 99)  
Bantam Books. New York, New York, USA. 1989

**Hanson, Norwood Russell** 1924–67  
American philosopher of science

Physicists do not start from hypotheses; they start from data. By the time a law has been fixed into an H-D [hypothetico-deductive] system, really original physical thinking is over.

*Patterns of Discovery*  
Chapter IV (p. 70)  
At The University Press. Cambridge, England. 1958

**Hartshorne, Charles** 1897–2000  
American philosopher

More and more, physicists dare to say that all nature is in some sense life-like, that there is no absolutely new principle of life that comes in at some point in cosmic evolution.

*Omnipotence and Other Theological Mistakes*  
Chapter 2 (p. 62)  
State University of New York Press. Albany, New York, USA. 1984

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Some physicists would prefer to come back to the idea of an objective real world whose smallest parts exist objectively in the same sense as stones or trees exist independently of whether we observe them. That, however, is impossible.

*Physics and Philosophy: The Revolution in Modern Science*  
July, 1992  
Harper & Row, Publishers. New York, New York, USA. 1958

The physicist may be satisfied when he has the mathematical scheme and knows how to use it for the interpretation of the experiments. But he has to speak about his results also to non-physicists who will not be satisfied unless some explanation is given in plain language. Even for the physicist the description in plain language will be the criterion of the degree of understanding that has been reached.

*Physics and Philosophy: The Revolution in Modern Science*  
Chapter X (p. 168)  
Harper & Row, Publishers. New York, New York, USA. 1958

**Hoffmann, Banesh** 1906–86  
Mathematician and educator

They could but make the best of it, and went around with woebegone faces sadly complaining that on Mondays, Wednesdays and Fridays they must look on light as a wave; on Tuesdays, Thursdays and Saturdays, as a particle. On Sundays they simply prayed.

*The Strange Story of the Quantum*  
Chapter IV (p. 42)  
Dover Publications, Inc. New York, New York, USA. 1959

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

The physicist is mainly interested in the detailed structure of the threads in our tapestry. He is less interested in the broad pattern on the tapestry itself. The broadest pattern of all, on the scale of stars and galaxies, is the business of the astronomer.

*Ten Faces of the Universe*  
The Astrophysicist's Universe (p. 55)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

**James, Henry** 1843–1916  
American-born English author and literary critic

You know we great physicists never make an experiment without an 'assistant' – a humble individual who burns his fingers and stains his clothes in the cause of science, but whose interest in the problem is only indirect.

*Confidence*  
Chapter II (p. 22)  
Houghton, Osgood & Co. Boston, Massachusetts, USA. 1880

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The physicist who can discard his human spectacles, and can see clearly in the strange new light which then assails his eyes, finds himself living in an unfamiliar world, which even his immediate predecessors would probably fail to recognize.

*The New Background of Science*  
Chapter I (pp. 5–6)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

Physicists who are trying to understand nature may work in many different fields and by many different methods; one may dig, one may sow, one may reap.

But the final harvest will always be a sheaf of mathematical formulae. These will never describe nature itself, but only our observations on nature. Our studies can never put us into contact with reality; we can never penetrate beyond the impressions that reality implants in our minds.

*Physics and Philosophy*  
Chapter I (p. 15)  
Dover Publications. New York, New York, USA. 1981

**Johnson, George** 1952–  
American science writer

Trying to capture the physicists' precise mathematical description of the quantum world with our crude words and mental images is like playing Chopin with a boxing glove on one hand and a catcher's mitt on the other.

On Skinning Schrödinger's Cat  
*The New York Times*, Section 4, Sunday, 2 June, 1996 (p. 16)

**Joyce, James** 1882–1941  
Irish-born author

As a physicist he had learned that of the 70 years of complete human life at least 2/7, viz. 20 years are passed in sleep.

*Ulysses* (p. 704)  
Random House, Inc. New York, New York, USA. 1946

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

For the most part, physicists follow the same guidelines that have helped keep Hollywood movie producers rich: If it works, exploit it. If it still works, copy it.

*Fear of Physics: A Guide for the Perplexed*  
Chapter 1 (p. 4)  
Basic Books, Inc. New York, New York, USA. 1993

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

Electronic calculators can solve problems which the man who made them cannot solve; but no government-subsidized commission of engineers and physicists could create a worm...

*The Twelve Seasons*  
March (p. 184)  
W. Sloane Associates. New York, New York, USA. 1949

**Kuhn, Thomas S.** 1922–96  
American historian of science

Looking at a contour map, the student sees lines on paper, the cartographer a picture of a terrain. Looking at a bubble-chamber photograph, the student sees confused and broken lines, the physicist a record of familiar sub-nuclear events. Only after a number of such transformations of vision does the student become an inhabitant of the scientist's world.

*The Structure of Scientific Revolutions*  
Chapter X (p. 111)  
The University of Chicago Press. Chicago, Illinois, USA. 1970



**Kusch, Polykarp** 1911–93  
German-American physicist

Our early predecessors observed Nature as she displayed herself to them. As knowledge of the world increased, however, it was not sufficient to observe only the most apparent aspects of Nature to discover her more subtle properties; rather, it was necessary to interrogate Nature and often to compel Nature, by various devices, to yield an answer as to her functioning. It is precisely the role of the experimental physicist to arrange devices and procedures that will compel Nature to make a quantitative statement of her properties and behavior.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1955

The Magnetic Moment of the Electron (p. 298)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Ladenburg, Rudolf** 1882–1952  
German physicist

There are two kinds of physicists in Berlin: on the one hand was Einstein, and on the other all the rest.

In A.P. French

*Einstein: A Centenary Volume*

Chapter 4 (p. 125)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Lederman, Leon** 1922–  
American high-energy physicist

Today we have two groups of physicists both with the common aim of understanding the universe but with a large difference in cultural outlook, skills, and work habits. Theorists tend to come in late to work, attend grueling symposiums on Greek islands or Swiss mountaintops, take real vacations, and are at home to take out the garbage much more frequently. They tend to worry about insomnia.... Experimenters don't come in late – they never went home. During an intense period of lab work, the outside world vanishes and the obsession is total. Sleep is when you can curl up on the accelerator floor for an hour.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 14)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

The myths of the physicists.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 57)

Jonathan Cape. London, England. 1969

**Lindley, David** 1956–  
English astrophysicist and author

Physicists, however, are scavengers of mathematics; they take what they need, adapt it to their purposes, and discard the rest.

*The End of Physics: The Myth of a Unified Theory*

Prologue (p. 5)

Basic Books. New York, New York, USA. 1993

Theoretical physicists of today are in the grip of a collective mathematical zaniness, inventing twenty-six-

dimensional spaces and filling them with strings out of obfuscatory glee. Their use of language is as esoteric and baffling as that of the literary deconstructionist: each speaks in a private gobbledygook understandable only to those similarly initiated. It is easy to imagine that both are lost in a world of pointless tabulation.

*The End of Physics: The Myth of a Unified Theory*

Prologue: The Lure of Numbers (p. 19)

Basic Books, Inc. New York, New York, USA. 1993

But by tradition the physicist, having found one level of order in nature, invariably wants to know, like the archaeologist digging down into the remains of Troy, whether there is another, more primitive layer underneath.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 3 (p. 98)

Basic Books, Inc. New York, New York, USA. 1993

**Lodge, Sir Oliver** 1851–1940  
English physicist

But, notwithstanding any temptation to idolatry, a physicist is bound in the long run to return to his right mind; he must cease to be influenced unduly by superficial appearances, impracticable measurements, geometrical devices, and weirdly ingenious modes of expression; and remember that his real aim and object is absolute truth, however difficult of attainment that may be, that his function is to discover rather than to create, and that beneath and above and around all Appearances there exists a universe of full-bodied, concrete, absolute, reality.

Geometrisation of Physics, and Its Supposed Bias on the Michelson–Morley Experiment

*Nature*, Volume 106, Number 2677, February 17, 1921 (p. 800)

**Lützen, Jesper**

No biographical data available

The philosopher is like an engraver who enjoys a beautifully printed bill, the physicist is like the merchant who does not care about the quality of the bill.

*Mechanistic Images in Geometric Form*

Chapter 8 (p. 100)

Oxford University Press. New York, New York, USA. 2005

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Not every physicist is an epistemologist, and not everyone must or can be one. Special investigation claims a whole man, so also does the theory of knowledge.

Translated by Phillip E.B. Jourdain

*History and Root of the Principle of the Conservation of Energy*

Author's Preface (p. 12)

The Open Court Publishing Co. Chicago, Illinois, USA. 1911



We can see that the physicists are on the surest road to becoming a church, and are already appropriating all the customary means to this end. To this I simply answer: If belief in the reality of atoms is so essential to you [Max Planck] I hereby abandon the physicist manner of thought, I will be no regular physicist. I will renounce all scientific recognition; in short the communion of the faithful I will decline with best thanks. For dearer to me is freedom of thought.

Mach and his Work

*Monist*, Volume 21 1911 (p. 33)

### Malin, Shimon

Theoretical physicist

...physicists are like ordinary people. If they can't resolve a contradiction, and the contradiction is not pressing, they just disregard it and give their attention to those aspects of the theory (or theories) that are pleasantly consistent.

*Nature Loves to Hide: Quantum Physics and Reality, a Western Perspective*

Chapter 8 (p. 90)

Oxford University Press. New York, New York, USA. 2001

### Malpass, Brian

No biographical data available

... while one physicist in isolation can talk to a lay person, admittedly with difficulty, two physicists can only converse with each other in close proximity to a blackboard, on which they feverishly scrawl cabalistic symbols.

*The Bluffer's Guide to Science*

What is Science (p. 9)

Oval Books. London, England. 1993

### Marcus, Adrienne

No biographical data available

Let others lie about the universe,  
make visible worlds. I am the keeper  
of particles, custodian of stray  
atoms.

In Steve Rasnic Tem (ed.)

*The Umbral Anthology of Science Fiction Poetry*

The Physicist's Purpose, 1978

Umbral Press. Denver, Colorado, USA. 1982

### Mermin, Norman David

1935–  
Mathematician

...contemporary physicists come in two varieties. Type 1 physicists are bothered by EPR [electronparamagnetic resonance] and Bell's theorem. Type 2 (the majority) are not, but one has to distinguish two subvarieties. Type 2a physicists explain why they are not bothered. Their explanations tend either to miss the point entirely (like Born's to Einstein) or to contain physical assertions that can be shown to be false. Type 2b are not bothered and refuse to explain why.

Is the Moon There When Nobody Looks? Reality and the Quantum Theory

*Physics Today*, Volume 38, Number 4, April, 1985 (p. 41)

### Michelson, Albert Abraham

1852–1931

German-American physicist

If a poet could at the same time be a physicist, he might convey to others the pleasure, the satisfaction, almost the reverence, which the subject inspires. The aesthetic side of the subject is, I confess, by no means the least attractive to me. Especially is its fascination felt in the branch which deals with light...

*Light Waves and Their Uses*

Lecture I (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1903

### Milne, Edward Arthur

1896–1950

English astrophysicist and cosmologist

The mathematical physicist does not dictate to the world what it must be like. But he is guided by mathematical form to make suggestions to the experimenter. His peculiar role then ends. The experimenter decides.

*The Aims of Mathematical Physics* (p. 9)

Clarendon Press. London, England. 1929

### National Research Council (US)

All physicists, whatever the nature of their professional activity, should encourage those members of the physics profession with talent for such activity to devote a significant fraction of the time and resources available to them to introduce as many of their fellow citizens as possible – children and adults alike – to the pleasures and satisfaction that come from greater understanding of natural phenomena through application of the concepts and laws, as well as the style and approaches, of physics.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 25)

National Academy of Sciences

Washington, D.C. 1972

### Nietzsche, Friedrich Wilhelm

1844–1900

German philosopher

We must be physicists in order...to be creative since so far codes of values and ideals have been constructed in ignorance of physics or even in contradiction to physics.

*The Gay Science*

Aphorism 335

Cambridge University Press. Cambridge, England. 2001

### Oppenheimer, James Robert

1904–67

American theoretical physicist

In some sort of crude sense which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known sin, and this is a knowledge which they cannot lose.

Expiation

*Time*, Volume 51, Number 8, 23 February, 1948 (p. 94)

**Pagels, Heinz R.** 1939–88

American physicist and science writer

I once heard a story that physicists when they die go to a heavenly academy where their purpose is to lay down the laws of nature. But there is a rule they must obey: Any new law they make cannot contradict ones already discovered and verified by their colleagues back on earth. The legend says that Pauli, one of the sharpest critics of physics, is there now setting intellectual traps and doing physics tricks to foul our best efforts.

*The Cosmic Code: Quantum Physics as the Language of Nature*  
Part III, Chapter 1 (p. 339)  
Simon & Schuster. New York, New York, USA. 1982

**Petroski, Henry** 1942–

Civil engineer

Embedded in a matrix of mistakes  
And slips of sighs, his next equation lies  
About its symmetry. Among the lines  
Of exercise and bold heuristic thrusts  
Of algebra and calculus, it takes  
His magic mirror mind to recognize  
A juxtaposition that unifies  
His theory of another universe.  
Extracting the law from the accidents,  
He calls it Theorem and proceeds to prove  
It logically follows from stronger laws.  
He makes some definitions and extends  
The theorem more and more and marvels at the rules  
His universe follows, effect from cause.

The Mathematical Physicist  
*Southern Humanities Review*, Volume 8, Number 2, 1972 (p. 184)

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Nothing but facts are of importance. John Lackland passed by here. Here is something that is admirable. Here is a reality for which I would give all the theories in the world.” That is the language of the historian. The physicist would say rather: “John Lackland passed by here; that makes no difference to me, for he never will pass this way again.”

*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
Chapter IX (p. 128)  
The Science Press. New York, New York, USA. 1913

The physicist cannot demand of the analyst a revelation of new truth; the analyst can at best aid the physicist in the presentation of truth.

The Relations of Analysis and Mathematical Physics  
*Bulletin of the American Mathematical Society*, Volume IV, Number 6,  
March, 1898 (p. 248)

**Poynting, John Henry** 1852–1914

English physicist

The range of the physicist’s study consists in the visible motions and other sensible changes of matter. The experiences with which he deals are the impressions on his senses, and his aim is to describe in the shortest possible way how his various senses have been, will be, or would be affected.

*Report of the Sixty-ninth Meeting British Association for the Advancement of Science*  
The President’s Address (p. 615)  
John Murray. London, England. 1900

To take an old but never worn-out metaphor, the physicist is examining the garment of Nature, learning of how many, or rather of how few, different kinds of thread it is woven, finding how each separate thread enters into the pattern, and seeking from the pattern woven in the past to know the pattern yet to come.

Address to the British Association  
*Chemical News and Journal of Industrial Science*, Volume 80, Number 2079, September 29, 1899 (p. 155)

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

I think physicists are the Peter Pans of the human race. They never grow up, and they keep their curiosity.

In Jeremy Bernstein  
*Experiencing Science*  
Part 1. Two Faces of Physics. Chapter 2. Rabi: The Modern Age (p. 102)  
Basic Books, Inc. New York, New York, USA. 1978

**Rees, Martin John** 1942–

15th Astronomer Royal of England

The physicist is like someone who’s watching people playing chess and, after watching a few games, he may have worked out what the moves in the game are. But understanding the rules is just a trivial preliminary on the long route from being a novice to being a grand master. So even if we understand all the laws of physics, then exploring their consequences in the everyday world where complex structures can exist is a far more daunting task, and that’s an inexhaustible one I’m sure.

In Lewis Wolpert and Alison Richards  
*A Passion for Science*  
Chapter 3 (p. 37)  
Oxford University Press, Inc. Oxford, England. 1988

**Robinson, Howard A.**

No biographical data available

Because physicists are a small group, they often suffer in many ways from psychoses similar to those found in political minorities. In an effort to keep their own individuality they feel it necessary to resist pressure from the outside and the result is...that a group of physicists tend to behave like an amoebae.

The Challenge of Industrial Physics  
*Physics Today*, June, 1948 (p. 7)

**Rogers, Eric**

No biographical data available

The physicist who does not enjoy watching a dime and a quarter drop together has no heart.

*Astronomy for the Inquiring Mind*

Preliminary Introduction (p. 4)

Princeton University Press. Princeton, New Jersey, USA. 1982

**Rorty, Richard** 1931–

American philosopher

Here is one way to look at physics: the physicists are men looking for new interpretations of the Book of Nature. After each pedestrian period of normal science, they dream up a new model, a new picture, a new vocabulary, and then they announce that the true meaning of the Book has been discovered. But, of course, it never is, anymore than the true meaning of Coriolanus or the Dunciad or the Phenomenology of the Spirit or the Philosophical Investigations. What makes them physicists is that their writings are commentaries on the writings of earlier interpreters of Nature, not that they all are somehow “talking about the same thing”...

Philosophy as a Kind of Writing

*New Literary History*, Volume 10, Number 1, Autumn, 1978 (p. 141)

**Rowland, Henry Augustus** 1848–1901

American physicist

In a country where the doctrine of the equal rights of man has been distorted to mean the equality of man in other respects, we form a small and unique body of men, a new variety of the human race, as one of our greatest scientists calls it, whose views of what constitutes the greatest achievement in life are very different from those around us. In this respect we form an aristocracy, not of wealth, not of pedigree, but of intellect and of ideals, holding him in the highest respect who adds the – most to our knowledge or who strives after it as the highest good.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aims of the Physicist (p. 668)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

The aims of the physicist...are in part purely intellectual: he strives to understand the universe on account of the intellectual pleasure derived from the pursuit, but he is upheld in it by the knowledge that the study of nature's secrets is the ordained method by which the greatest good and happiness shall finally come to the human race.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aims of the Physicist (p. 678)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Ruelle, David** 1935–

Belgian-French mathematical physicist

What is the origin of the urge, the fascination that drives physicists, mathematicians, and presumably other scientists as well? Psychoanalysis suggests that it is sexual curiosity. You start by asking where little babies come

from, one thing leads to another, and you find yourself preparing nitroglycerine or solving differential equations. This explanation is somewhat irritating, and therefore probably basically correct.

*Chance and Chaos*

Chapter 26 (p. 164)

Princeton University Press. Princeton, New Jersey, USA. 1991

**Russell, Henry Norris** 1877–1957

American astronomer

If a first-rate physicist, well versed in all the knowledge acquired in the laboratory during the last quarter century on the structure and properties of the atom, should have lived his life on a planet so enshrouded by clouds that neither he nor others had ever glimpsed the starry heavens, yet if he had the imagination to conceive that immense quantities of matter might lie beyond the clouds, he would be able to picture the heavens much as they are, tell the probable maximum masses of the stars, their minimum distances, the range of their diameters and temperatures, the differences of their spectra, and in short to duplicate by prediction, not only in general features but in many of the finest details the actual appearance of the universe forever hidden from him.

Quoted in C.G. Abbot

*Annual Report of the Board of Regents of the Smithsonian Institution, 1922*

The Architecture of Atoms and a Universe Built of Atoms (p. 157)

Government Printing Office. Washington, D.C. 1924

**Sagan, Carl** 1934–96

American astronomer and author

Physicists had to invent words and phrases for concepts far removed from everyday experience. It was their fashion to avoid pure neologisms and instead to evoke, even if feebly, some analogous commonplace. The alternative was to name discoveries and equations after one another. This they did also. But if you didn't know it was physics they were talking, you might very well worry about them.

*Contact: A Novel*

Chapter 19 (p. 331)

Simon & Schuster. New York, New York, USA. 1985

**Singer, Kurt** 1886–1962

German philosopher

...the true mathematician and physicist know very well that the realms of the small and the great often obey quite different rules.

*Mirror, Sword and Jewel: A Study of Japanese Characteristics*

Chapter 5 (p. 75)

Croom Helm. London, England. 1973

**Standen, Anthony**

Anglo-American science writer

Physicists, being in no way different from the rest of the population, have short memories for what is inconvenient.

*Science Is a Sacred Cow*

Chapter III (p. 68)

E.P. Dutton. New York, New York, USA. 1950

... although in theory physicists realize that their conclusions are...not certainly true, this...does not really sink into their consciousness. Nearly all the time...they...act as if Science were indisputably True, and what's more, as if only science were true.... Any information obtained otherwise than by the scientific method, although it may be true, the scientists will call "unscientific," using this word as a smear word, by bringing in the connotation from its original [Greek] meaning, to imply that the information is false, or at any rate slightly phony.

*Science Is a Sacred Cow*

Chapter VII (pp. 176–177)

E.P. Dutton. New York, New York, USA. 1950

**Strutt, John William (Lord Rayleigh)** 1842–1919  
English physicist

The different habits of mind of the two schools of physicists sometimes lead them to the adoption of antagonistic views on doubtful and difficult questions. The tendency of the purely experimental school is to rely almost exclusively upon direct evidence, even when it is obviously imperfect, and to disregard arguments which they stigmatize as theoretical. The tendency of the mathematician is to over-rate the solidity of his theoretical structures, and to forget the narrowness of the experimental foundation upon which many of them rest.

*Life of John William Strutt: Third Baron Rayleigh* (p. 132)

University of Wisconsin Press. Madison, Wisconsin, USA. 1968

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

To seek not for end but for antecedents is the way of the physicist, who finds "causes" in what he has learned to recognise as fundamental properties, or inseparable concomitants, or unchanging laws, of matter and of energy.

*On Growth and Form*

Introductory (p. 6)

At the University Press. Cambridge, England. 1945

**Thomson, Sir Joseph John** 1856–1940  
English physicist

There is a school of mathematical physicists which objects to the introduction of ideas which do not relate to things which can actually be observed and measured.... I hold that if the introduction of a quantity promotes clearness of thought, then even if at the moment we have no means of determining it with precision, its introduction is not only legitimate but desirable. The immeasurable of today may be the measurable of tomorrow.

In John D. Barrow

*The World Within the World* (p. 97)

Clarendon Press. Oxford, England. 1988

**Tyndall, John** 1820–93

Irish-born English physicist

I have...tried to show [how physicists] pass from the world of the senses to a world where vision becomes spiritual, where principles are [formed], and from which the explorer emerges with [concepts] to be approved or rejected as they coincide] with sensible things.

*Heat A Mode of Motion* (6th edition)

Preface (p. viii)

D. Appleton & Co. New York, New York, USA. 1915

**Toulmin, Stephen** 1922–

Anglo-American philosopher

Natural historians...look for regularities of given forms, but physicists seek the form of given regularities.

*The Philosophy of Science: An Introduction*

Chapter II, Section 2.8 (p. 53)

Harper & Row, Publishers. New York, New York, USA. 1960

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...cement, patch-up, and glue together, as witchdoctors do, the Newtonian doctrine, so that it could, as an embalmed corpse, preside in the style of ancient Egyptians, at the drinking bouts of physicists.

In S.L. Jaki

Goethe and the Physicists

*American Journal of Physics*, Volume 37 (p. 198)

**von Helmholtz, Robert**

No biographical data available

Speaking generally, the greatest physicist nowadays will be he who is endowed equally with the gifts of observation and with logical precision of thinking, and has mastered experiment as well as mathematics.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1889*

A Memoir of Gustav Robert Kirchhoff (p. 528)

Government Printing Office. Washington, D.C. 1889

**Wald, George** 1906–97

American biologist and biochemist

It would be a poor thing to be an atom in a universe without physicists, and physicists are made of atoms. A physicist is an atom's way of knowing about atoms.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*

Foreword

Beacon Press. Boston, Massachusetts, USA. 1958

**Watson, William Heriot**

Physicist

The physicist, how-ever, is not in the happy position of the bricklayer in that no one takes the trouble to assert the importance of bricklaying for philosophy or of philosophy for bricklaying, whereas at the present time the

interest of philosophers in physics and of physicists in philosophy is greater than at any time in the last two hundred years.

*On Understanding Physics*  
The University Press. 1938

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

There are three kinds of physicists, as we know, namely the machine builders, the experimental physicists, and the theoretical physicists. If we compare those three classes, we find that the machine builders are the most important ones, because if they were not there, we could not get to this small-scale region. If we compare this with the discovery of America, then, I would say, the machine builders correspond to the captains and ship builders who really developed the techniques at that time. The experimentalists were those fellows on the ships that sailed to the other side of the world and then jumped upon the new islands and just wrote down what they saw. The theoretical physicists are those fellows who stayed back in Madrid and told Columbus that he was going to land in India.

In Heinz R. Pagels  
*The Cosmic Code: Quantum Physics as the Language of Nature*  
Part II, Chapter 1 (p. 198)  
Simon & Schuster. New York, New York, USA. 1982

Self-confidence is an important ingredient that makes for a successful physicist.

In L.M. Brown and L. Hoddeson  
*The Birth of Particle Physics*  
Growing Up with Field Theory: The Development of Quantum Electrodynamics (p. 75)  
Cambridge University Press. Cambridge, England. 1983

**Wheeler, John Archibald** 1911–  
American physicist and educator

The physicist does not have the habit of giving up something unless he gets something better in return.

In Cecil M. DeWitt and John A. Wheeler  
*Battelle Recontres: 1967 Lectures in Mathematics and Physics* (p. 261)  
W.A. Benjamin, Inc. New York, New York, USA. 1968

**White, Stephen**  
No biographical data available

[Physicists] are, as a general rule, highbrows. They think and talk in long, Latin words, and when they write anything down they usually include at least one partial differential and three Greek letters.

A Newsman Looks at Physicists  
*Physics Today*, Volume 1, Number 1, May, 1948 (p. 15)

**Wiener, Norbert** 1894–1964  
American mathematician

Experience has pretty well convinced the working physicist that any idea of nature which is not only difficult to

interpret but which actively resists interpretation has not been justified as far as his past work is concerned, and therefore, to be an effective scientist, he must be naive, and even deliberately naive, in making the assumption that he is dealing with an honest God, and must ask his questions of the world as an honest man.

*The Human Use of Human Beings*  
Chapter XI (p. 189)  
Da Capo Press. New York, New York, USA. 1988

**Ziman, John M.** 1925–2005  
English physicist

...theoretical physicists are like pure mathematicians, in that they are often interested in the hypothetical behaviour of entirely imaginary objects, such as parallel universes, or particles traveling faster than light, whose actual existence is not being seriously proposed at all.

*Real Science: What it Is, and what it Means*  
Chapter 10 (p. 315)  
Cambridge University Press. Cambridge, England. 2000

**Zolynas, Al** 1945–  
American poet

And so, the closer he looks at things, the farther away they seem. At dinner, after a hard day at the universe, he finds himself slipping through his food. His own hands wave at him from beyond a mountain of peas. Stars and planets dance with molecules on his fingertips. After a hard day with the universe, he tumbles through himself, flies through the dream galaxies of his own heart. In the very presence of his family he feels he is descending through an infinite series of Chinese boxes.

*The New Physics: Poems*  
The New Physics (p. 55)  
Wesleyan University Press. Middletown, Connecticut, USA. 1979

## PHYSICIST'S BILL OF RIGHTS

### Author undetermined

#### THE PHYSICIST'S BILL OF RIGHTS

We hold these postulates to be intuitively obvious, that all physicists are born equal, to a first approximation, and are endowed by their creator with certain discrete privileges, among them a mean rest life, n degrees of freedom, and the following rights which are invariant under all linear transformations:

1. To approximate all problems to ideal cases.
2. To use order of magnitude calculations whenever deemed necessary (i.e., whenever one can get away with it).
3. To use the rigorous method of 'squinting' for solving problems more complex than the addition of positive real integers.
4. To dismiss all functions which diverge as 'nasty' and 'unphysical.'



5. To invoke the uncertainty principle when confronted by confused mathematicians, chemists, engineers, psychologists, dramatists, and other lower scientists.
6. When pressed by non-physicists for an explanation of (4) to mumble in a sneering tone of voice something about physically naive mathematicians.
7. To equate two sides of an equation which are dimensionally inconsistent, with a suitable comment to the effect of, 'Well, we are interested in the order of magnitude anyway.'
8. To the extensive use of 'bastard notations' where conventional mathematics will not work.
9. To invent fictitious forces to delude the general public.
10. To justify shaky reasoning on the basis that it gives the right answer.
11. To cleverly choose convenient initial conditions, using the principle of general triviality.
12. To use plausible arguments in place of proofs, and thenceforth refer to these arguments as proofs.
13. To take on faith any principle which seems right but cannot be proved.

Source undetermined

## PHYSICS

### Achard, Franz Karl 1753–1821

German chemist and experimental physicist

Everyone now agrees that a physics lacking all connection with mathematics...would only be an historical amusement, fitter for entertaining the idle than for occupying the mind of a philosopher.

In J.L. Heilbron

*Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics* (p. 74)

University of California Press. Berkeley, California, USA. 1979

### Adair, Robert K.

American physicist

Physics is narrow, precise, and simple in a manner such that history, sociology, psychology, or the study of literature are broad, hazy, and difficult.

*The Great Design: Particles, Fields, and Creation*

Chapter I (p. 5)

Oxford University Press. Oxford, England. 1989

### Adams, Douglas 1952–2001

English author, comic radio dramatist, and musician

And as they drifted up their minds sang with the ecstatic knowledge that either what they were doing was completely and utterly and totally impossible or that physics had a lot of catching up to do.

*So Long, and Thanks for All the Fish*

Chapter 26 (p. 140)

Harmony Books. New York, New York, USA. 1984

### Alvarez, Luis Walter 1911–88

American experimental physicist

There is no democracy in physics. We can't say that some second rate guy has as much right to opinion as Fermi.

In Daniel S. Greenberg

*The Politics of Pure Science*

Book One, Chapter II (p. 42)

New American Library. New York, New York, USA. 1967

The world of mathematics and theoretical physics is hierarchical. That was my first exposure to it. There's a limit beyond which one cannot progress. The differences between the limiting abilities of those on successively higher steps of the pyramid are enormous. I have not seen described anywhere the shock a talented man experiences when he finds, late in his academic life, that there are others enormously more talented than he. I have personally seen more tears shed by grown men and women over this discovery than I would have believed possible. Most of those men and women shift to fields where they can compete on more equal terms.

*Alvarez: Adventures of a Physicist*

Chapter One (p. 20)

Basic Books, Inc. New York, New York, USA. 1987

### Author undetermined

Introductory physics courses are taught at three levels: physics with calculus, physics without calculus, and physics without physics.

Source undetermined

The Euclidean foundation of geometry is to the Gaussian foundation of geometry as the Newton particle concept of physics is to the Faraday–Maxwell concept of physics.

In Howard W. Eves

*Mathematical Circles* (Volume 2)

*Mathematical Circles Squared*

73 (p. 56)

The Mathematical Association of America, Inc. 2003

If you think, you experience time.

If you feel, you experience energy.

If you intuit, you experience wavelength

If you sense, you experience space.

In Fred Alan Wolf

*Star Wave: Mind Consciousness of Quantum Physics* (p. 16)

Macmillan Publishing Company. New York, New York, USA. 1984

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

We have no sound notions either in logic or physics; substance, quality, action, passion, and existence are not clear notions; much less weight, levity, density, tenuity, moisture, dryness, generation, corruption, attraction, repulsion, element, matter, form, and the like. They are all fantastical and ill-defined.

In *Great Books of the Western World* (Volume 30)



*Novum Organum*

First Book, Aphorism 15 (p. 108)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Physic...is situate in a middle term or distance between natural history and metaphysic. For natural history describeth the variety of things; physic the causes, but variable or respective causes; and metaphysic the fixed and constant causes.

In *Great Books of the Western World* (Volume 30)*Advancement of Learning*

Second Book, Chapter VII, Section 4 (p. 43)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...physics inquires into the efficient and the matter, and metaphysics into the form and the end. Physics, therefore, is vague and unstable as to causes, and treats movable bodies as its subjects, without discovering a constancy of causes in different subjects.

*Advancement of Learning: and Novum Organum**On the Dignity and Advancement of Learning*

Book I, Chapter IV (p. 84)

The Colonial Press. New York, New York, USA. 1900

**Ball, Walter William Rouse** 1850–1925

English mathematician

The advance in our knowledge of physics is largely due to the application to it of mathematics, and every year it becomes more difficult for an experimenter to make any mark in the subject unless he is also a mathematician.

*A Short Account of the History of Mathematics* (p. 503)

Macmillan &amp; Company Ltd. London, England. 1908

**Barker, George Frederick** 1835–1910

American scientist

...physics may be defined as that department of science whose province it is to investigate all those phenomena of nature which depend, either upon the transference of energy from one portion of matter to another, or upon its transformation into any of the forms which it is capable of assuming. In a word, physics may be regarded as the science of energy, precisely as chemistry may be regarded as the science of matter.

*Physics: Advanced Course* (4th edition)

Part First, Introduction (p. 6)

Henry Holt &amp; Co. New York, New York, USA. 1893

...physics regards matter solely as the vehicle of energy.... In a word, physics may be regarded as the science of energy, precisely as chemistry may be regarded as the science of matter.

*Physics: Advanced Course* (2nd edition)

Chapter I (p. 6)

Henry Holt &amp; Company. New York, New York, USA. 1892

**Bart Simpson (Fictional character)**

Lousy laws of physics!

*The Simpsons: Hit & Run*

Film (2003)

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Daniel Bernoulli has been called the father of mathematical physics.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 2)

Kinetic Theory of Gases (p. 774)

Simon &amp; Schuster. New York, New York, USA. 1956

**Bergson, Henri** 1859–1941

French philosopher

...physics is but logic spoiled.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter IV (p. 320)

The Modern Library. New York, New York, USA. 1944

**Berry, Sir Michael Victor** 1941–

English mathematical physicist

...in one of those unexpected connections that make theoretical physics so delightful, the quantum chorology of spectra turns out to be deeply connected to the arithmetic of prime numbers, through the celebrated zeros of the Riemann zeta function: the zeros mimic quantum energy levels of a classically chaotic system. The connection is not only deep but also tantalizing, since its basis is still obscure – though it has been fruitful for both mathematics and physics.

In R.J. Russell, P. Clayton, K. Wegter-McNelly, and J. Polkinghorne (eds.)

*Quantum Mechanics: Scientific Perspectives on Divine Action*

Chaos and the Semiclassical Limit of Quantum Mechanics (Is the Moon There When Somebody Looks?)

University of Notre Dame Press. Notre Dame, Indiana, USA. 2002

**Birkhoff, George David** 1884–1944

American mathematician

It will probably be the new mathematical discoveries suggested through physics that will always be the most important, for from the beginning Nature has led the way and established the pattern which mathematics, the language of Nature, must follow.

The Mathematical Nature of Physical Theories

*American Scientist*, Volume 31, Number 4, October, 1943 (p. 310)**Blackett, Lord Patrick Maynard****Stuart** 1897–1974

English physicist

Thus was born the vast modern subject of nuclear physics, which now gives such fertile research problems to so many of the world's physicists and, incidentally, such headaches to so many of the world's statesmen.

In J.B. Birks

*Rutherford at Manchester*

Memories of Rutherford (p. 104)

W.A. Benjamin. New York, New York, USA. 1962

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

My starting point was rather the stability of matter, a pure miracle when considered from the standpoint of classical physics. By “stability” I mean that the same substances always have the same properties...

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 3 (p. 39)

Harper &amp; Row, Publishers. New York, New York, USA. 1971

It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.

In N. Herbert

*Quantum Reality: Beyond the New Physics*

Chapter 3 (p. 45)

Anchor Press/Doubleday. Garden City, New York, USA. 1985

In physics...our problem consists in the co-ordination of our experience of the external world...

*Atomic Theory and the Description of Nature*

Introductory Survey (p. 1)

Cambridge University Press. Cambridge, England. 1934

...the new situation in physics is that we are both onlookers and actors in the great drama of existence.

*Atomic Theory and the Description of Nature*

Chapter IV (p. 119)

Cambridge University Press. Cambridge, England. 1934

**Born, Max** 1882–1970

German-born English physicist

It is natural that a man should consider the work of his hands or his brain to be useful and important. Therefore nobody will object to an ardent experimentalist boasting of his measurements and rather looking down on the “paper and ink” physics of his theoretical friend, who on his part is proud of his lofty ideas and despises the dirty fingers of the other.

*Experiment and Theory in Physics* (p. 1)

Cambridge University Press. Cambridge, England. 1944

The problem of physics is how the actual phenomena, as observed with the help of our sense organs aided by instruments, can be reduced to simple notions which are suited for precise measurement and used of the formulation of quantitative laws.

*Experiment and Theory in Physics* (pp. 8–9)

Cambridge University Press. Cambridge, England. 1944

Hope is a word one is unlikely to find in the literature of physics.

*My Life and My Views*

Chapter Six (p. 190)

Charles Scribner's Sons. New York, New York, USA. 1968

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

I confess, that after I began...to discern how useful mathematicks may be made to physicks, I have often wished that I had employed the speculative part of geometry, and the cultivation of the specious Algebra I had been taught very young, a good part of that time and industry, that I had spent about surveying and fortification (of which I remember I once wrote an entire treatise) and other parts of practick mathematicks.

*The Work of the Honourable Robert Boyles* (Volume 4)

The Usefulness of Mathematicks to Natural Philosophy, Volume 3 (p. 426)

Printed for A. Millar. London, England. 1744

**Bragg, Sir William Henry** 1862–1942

English physicist

On Mondays, Wednesdays, and Fridays we teach the wave theory and on Tuesdays, Thursdays, and Saturdays the corpuscular theory.

Electrons and Ether Waves, 23rd Robert Boyle Lecture

*Scientific Monthly*, Volume 4, Issue 2, 1922 (p. 11)**Brennan, Richard P.**

Science writer

Physics can be expected to continue because it is, by its nature, open-ended and exploratory and because, at its heart, science is simply people asking questions.

*Heisenberg Probably Slept Here*

Epilogue (p. 249)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1997

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Physics is not events but observations. Relativity is the understanding of the world not as events but as relations.

*The Ascent of Man*

The Majestic Clockwork (p. 254)

Little, Brown &amp; Co. Boston, Massachusetts, USA. 1973

Physics becomes in those years the greatest collective work of art of the twentieth century.

*The Ascent of Man*

Chapter 10 (p. 328)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1973

One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that that aim is unattainable.

*The Ascent of Man*

Chapter 11 (p. 353)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1973

**Burbridge, Geoffrey**

American astronomer

We live in an era when it seems legitimate to try everything conceivable within the known laws of physics, particularly in the absence of data.

Focal Point

*Sky and Telescope*, Volume 78, Number 6, June, 1990 (p. 580)

**Butterfield, Herbert** 1900–79

English historian and philosopher of history

...it [Aristotelian physics] outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to the rank of mere episodes, mere internal displacements, within the system of medieval Christendom...

*The Origins of Modern Science: 1300–1800*

Introduction (pp. vii–viii)

The Macmillan Co. New York, New York, USA. 1957

**Carmichael, Robert Daniel** 1879–1967

American mathematician

Those who look on physics from the outside not infrequently have the feeling that it has forgotten some of its philosophical foundations. Even among its own workers the condition of the science has not entirely escaped notice.

*The Theory of Relativity* (2nd edition)

Chapter I

John Wiley & Sons. New York, New York, USA. 1920

**Carnap, Rudolf** 1891–1970

American philosopher

Physics originally began as a descriptive macrophysics, containing an enormous number of empirical laws with no apparent connections. In the beginning of a science, scientists may be very proud to have discovered hundreds of laws. But, as the laws proliferate, they become unhappy with this state of affairs; they begin to search for underlying principles.

*An Introduction to the Philosophy of Science* (p. 244)

Clarendon Press. Oxford, England. 1988

...the facts and objects of the various branches of Science are fundamentally the same kind. For all branches are part of the unified Science, of Physics.

*The Unity of Science*

Unified Science in Physical Language, Section 7 (p. 101)

Thommes Press. Bristol, England. 1995

**Cartwright, Nancy** 1943–

Philosopher of physics

...the fundamental laws of physics do not describe true facts about reality. Rendered as descriptions of facts, they are false; amended to be true, they lose their explanatory force.

*How the Laws of Physics Lie*

Essay 3 (p. 54)

Clarendon Press. Oxford, England. 1983

Although philosophers generally believe in laws and deny causes, explanatory practice in physics is just the reverse.

*How the Laws of Physics Lie*

Essay 4 (p. 86)

Clarendon Press. Oxford, England. 1983

**CERN Courier**

The main goal of physics is to describe a maximum of phenomena with a minimum of variables.

In John N Shive and Robert L. Weber

In *Similarities in Physics*

Chapter 16 (p. 213)

John Wiley & Sons, Inc. New York, New York, USA. 1982

**Compton, Karl Taylor** 1887–1954

American educator and physicist

In the last fifty years physics has exerted a more powerful beneficial influence on the intellectual, economic and social life of the world than has been exerted in a comparable time by any other agency in history. Its influence has far exceeded that of wars, political alignment or social theories.

*Science (supplement)*, Volume 84, Number 10, 1936

**Comte, Auguste** 1798–1857

French philosopher

The domain of physics is no proper field for mathematical pastimes. The best security would be in giving a geometrical training to physicists, who need not then have recourse to mathematicians, whose tendency is to despise experimental science.

*The Positive Philosophy of Auguste Comte*

Book III, Chapter I (p. 220)

John Chapman. London, England. 1853

...the education of physicists must be more complicated than that of astronomers.

*The Positive Philosophy of Auguste Comte*

Book III, Chapter I (p. 222)

John Chapman. London, England. 1853

**Condon, Edward Uhler** 1902–74

American physicist

I take it to be the object of physics so to organize past experience and so to direct the acquisition of new experience that ultimately it will be possible to predict the outcome of any proposed experiment which is capable of being carried out – and to make the prediction in less time than it would have taken actually to carry out the proposed experiment. When this shall have been done I will say that man has a complete understanding of his physical environment. Others may ask more; with this I am satisfied.

The Philosophical Concepts of Modern Physics, Mathematical Models in Modern Physics

*Journal of the Franklin Institute*, Volume 225, Number 3, March, 1938 (p. 257)

“All is fair in love and war” and, I might add, in theoretical physics.

*Selected Popular Writings of E.U. Condon*

Mathematical Models in Modern Physics (p. 96)

Springer-Verlag. New York, New York, USA. 1991

If physics is too difficult for the physicists, the nonphysicist may wonder whether he should try at all to grasp its complexities and ambiguities.

In James R. Newmann  
*What is Science?*  
 Physics (p. 102)  
 Simon & Schuster. New York, New York, USA. 1955

### Crease, Robert P.

Science historian

### Mann, Charles C.

American journalist and science writer

On August 2, 1932, Anderson obtained a stunningly clear photograph that shocked both men. Despite Millikan's protestations, a particle had indeed shot up like a Roman candle from the floor of the chamber, slipped through the plate, and fallen off to the left. From the size of the track, the degree of the curvature, and the amount of momentum lost, the particle's mass was obviously near to that of an electron. But the track curved the wrong way. The particle was positive. Neither electron, proton, or neutron, the track came from something that had never been discovered before. It was, in fact, a "hole," although Anderson did not realize it for a while.... Anderson called the new particle a "positive electron"; positron was the name that stuck. Positrons were the new type of matter – antimatter – Dirac had been forced to predict by his theory. (The equation, he said later, had been smarter than he was.)

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*  
 Uncertainty and Complementarity (p. 78)  
 Little, Brown & Company. Boston, Massachusetts, USA. 1991

### Crew, Henry

Physicist

Physics is not a series of disconnected subjects, including Mechanics, Sound, Light, Heat, and Electricity. It is, on the contrary, a body of well-organized truth, forming one great whole; illustrating, as do few other subjects, what Dickens called "the universal dove-tailedness of things."

*Elements of Physics: For Use in High Schools*

From the Preface to the First Edition (p. v)

The Macmillan Co. New York, New York, USA. 1909

...physics, in too many of our schools, ranks as a most difficult subject. But dealing, as it does, with the familiar phenomena of daily life, and requiring, as it does, only a small fraction of the algebraic knowledge which the average student has already acquired, the author is inclined to believe that the difficulty lies chiefly in the presentation.

*Elements of Physics: For Use in High Schools*

From the Preface to the First Edition (p. v)

The Macmillan Co. New York, New York, USA. 1909

### Cropper, William N.

No biographical data available

Physics builds from observations. No physical theory can succeed if it is not confirmed by observations, and a theory strongly supported by observations cannot be denied.

*Great Physicists*  
 I, Mechanics (p. 3)  
 Oxford University Press, Inc. New York, New York, USA. 2001

### Darrow, Karl Kelchner 1891–1982

American physicist

...it does not take an idea so long to become "classical" in physics as it does in the arts.

Some Contemporary Advances in Physics V

*Bell System Technical Journal*, Electrical Solids, Volume 3, 1924  
 (p. 621)

### Davies, Paul Charles William 1946–

British-born physicist, writer, and broadcaster

Physics is the most pretentious of all the sciences, for it purports to address all of physical reality. The physicist may confess ignorance about a particular system – a snowflake, a living organism, a weather pattern – but he will never concede that it lies outside the domain of physics in principle. The physicist believes that the laws of physics, plus knowledge of the relevant boundary conditions, are sufficient to explain, in principle, every phenomenon in the universe. Thus the entire universe, from the smallest fragment of matter to the largest assemblage of galaxies, becomes the physicist's domain – vast natural laboratory for the interplay of lawful forces.

In P.C.W. Davies (ed.)

*The New Physics*

The New Physics: A Synthesis (p. 1)

Cambridge University Press. Cambridge, England. 1989

It is clear that for nature to produce a cosmos even remotely resembling our own, many apparently unconnected branches of physics have to cooperate to a remarkable degree.

*The Accidental Universe* (p. 111)

Cambridge University Press. Cambridge, England. 1984

It is no exaggeration to say that quantum mechanics had dominated twentieth-century physics and is far and away the most successful scientific theory in existence. It is indispensable for understanding subatomic particles, atoms and nuclei, molecules and chemical bonding, the structure of solids, superconductors and superfluids, the electrical and thermal conductivity of metals and semiconductors, the structure of stars, and much else. It has practical applications ranging from the laser to the microchip. All this from a theory that at first sight – and second sight – looks absolutely crazy! Neils Bohr, one of the founders of quantum mechanics, once remarked that anybody who is not shocked by the theory hasn't understood it.

In Richard P. Feynman

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Introduction (pp. xv, xvi)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

**Brown, Julian R.**

No biographical data available

No science is more pretentious than physics, for the physicist lays claim to the whole universe as his subject matter.

*Superstrings: A Theory of Everything*

Introduction (p. 1)

Cambridge University Press, Cambridge, England. 1988

**de Morgan, Augustus** 1806–71

English mathematician and logician

Among the mere talkers, so far as mathematics are concerned, are to be ranked three out of four of those who apply mathematics to physics, who, wanting a tool only, are very impatient of everything which is not of direct aid to the actual methods which are in their hands.

In Robert Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 348)

Hodges, Figgis & Company. Dublin, Ireland. 1882–89

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

I accept no principles of physics which are not also accepted in mathematics...

*Principles of Philosophy*

Part III, 4

Reidel. Dordrecht, Netherlands. 1983

I should consider that I know nothing about physics if I were able to explain only how things might be, and were unable to demonstrate that they could not be otherwise. For, having reduced physics to mathematics, the demonstration is now possible, and I think that I can do it within the small compass of my knowledge.

In A.C. Crombie

Descartes

*Scientific American*, Volume 201, Number 4, October, 1959 (p. 160)

**Deutsch, David** 1953

Physicist

Anything that seems incomprehensible is regarded by science merely as evidence that there is something we have not yet understood, be it a conjuring trick, advanced technology or a new law of physics.

*The Fabric of Reality*

Chapter 6 (p. 138)

Penguin Books Ltd. London, England. 1998

**Dilorenzo, Kirk**

No biographical data available

Physics is the interrelationship of everything.

*The Physics Teacher*, Volume 14, Number 5, May, 1976 (p. 315)

**Dingle, Herbert** 1890–1978

English astrophysicist

Modern physics is, indeed, not unlike a ship, drawing nearer to a goal not yet in sight, but so tossed about by the buffeting of experiment and working hypothesis that the passenger scarcely knows whether he is progressing or drifting.

*Through Science to Philosophy*

Prologue (p. 15)

The Clarendon Press, Oxford, England. 1937

**Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

Only questions about the results of experiments have a real significance and it is only such questions that theoretical physics has to consider.

*The Principles of Quantum Mechanics* (2nd edition)

Chapter I, Section 2 (p. 5)

At The Clarendon Press, Oxford, England. 1935

The present stage of physical theory is merely a steppingstone towards the better stages that we will have in the future. One can be quite sure that there will be better stages simply because of the difficulties that occur in the physics of today.

The Evolution of the Physicist's Picture of Nature

*Scientific American*, Volume 208, Number 5, May, 1963 (p. 48)

The new theories, if one looks apart from their mathematical setting, are built up from physical concepts which cannot be explained in terms of things previously known to the student, which cannot even be explained adequately in words at all. Like the fundamental concepts (e.g., proximity, identity) which everyone must learn on his arrival into the world, the newer concepts of physics can be mastered only by long familiarity with their properties and uses.

*The Principles of Quantum Mechanics* (2nd edition)

From the Preface to the First Edition (p. vi)

At The Clarendon Press, Oxford, England. 1935

A good deal of my research work in physics has consisted in not setting out to solve some particular problem but simply examining mathematical quantities of a kind that physicists use and trying to fit them together in an interesting way, regardless of any application that the work may have. It is simply a search for pretty mathematics. It may turn out later that the work does have an application. Then one has good luck.

*International Journal of Theoretical Physics*, Volume 21, 603 (1982)

**Duff, Michael**

English string theorist

Physics tend to be dictated by fad and fashion. There are the gurus who dictate the direction in which new ideas grow.



Parallel Universes  
BBC broadcast February 14, 2002

**Duhem, Pierre-Maurice-Marie** 1861–1916  
French physicist and mathematician

The development of physics incites a continual struggle between “nature that does not tire of providing” and reason that does not wish “to tire of conceiving.”

*The Aim and Structure of Physical Theory*  
Part I, Chapter II (p. 23)  
Princeton University Press. Princeton, New Jersey, USA. 1954

The laws of physics are therefore provisional in that the symbols they relate too simple to represent reality completely.

*The Aim and Structure of Physical Theory*  
Part II, Chapter V (p. 176)  
Princeton University Press. Princeton, New Jersey, USA. 1954

...physics makes progress because experiment constantly causes new disagreements to break out between laws and facts, and because physicists constantly touch up and modify laws in order that they may more faithfully represent the facts.

*The Aim and Structure of Physical Theory*  
Part II, Chapter V (p. 177)  
Princeton University Press. Princeton, New Jersey, USA. 1954

A “Crucial Experiment” is Impossible in Physics.

*The Aim and Structure of Physical Theory*  
Part II, Chapter VI (p. 188)  
Princeton University Press. Princeton, New Jersey, USA. 1954

Physics is not a machine one can take apart; one cannot try each piece in isolation and wait, to adjust it, until its solidity has been minutely checked. Physical science is a system that must be taken as a whole. It is an organism no part of which can be made to function without the remotest parts coming into play, some more, some less, but all in some degree.

*Essays in the History and Philosophy of Science* (p. 284)  
Hackett Publishing Company. Indianapolis, Indiana, USA. 1996

**Dyson, Freeman J.** 1923–  
American physicist and educator

Physics is littered with the corpses of dead unified field theories.

In John D. Barrow  
*The World Within the World* (p. 184)  
Clarendon Press. Oxford, England. 1988

I am acutely aware of the fact that the marriage between mathematics and physics, which was so enormously fruitful in past centuries, has recently ended in divorce.

Missed Opportunities  
*Bulletin of the American Mathematical Society*, Volume 78, 1972

...we have seen particle physics emerge as the playground of group theory.

In Joseph A. Gallian

*Contemporary Abstract Algebra*  
Chapter 3 (p. 55)  
D.C. Heath and Company. Lexington, Massachusetts, USA. 1994

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In the world of physics we watch a shadowgraph performance of familiar life. The shadow of my elbow rests on the shadow table as the shadow ink flows over the shadow paper.... The frank realisation that physical science is concerned with a world of shadows is one of the most significant of recent advances.

*The Nature of the Physical World*  
Introduction (p. xi)  
The Macmillan Company. New York, New York, USA. 1930

The external world of physics has become a world of shadows.

*The Nature of the Physical World*  
Introduction (p. xvi)  
The Macmillan Company. New York, New York, USA. 1930

Distance and duration are the most fundamental terms in physics; velocity, acceleration, force, energy, and so on, all depend on them; and we can scarcely make any statement in physics without direct or indirect reference to them.

In Ronald W. Clark  
*Einstein: The Life and Times*  
Part Two, Chapter 4 (p. 93)  
The World Publishing Company. New York, New York, USA. 1971

I have not suggested that religion and free will can be deduced from modern physics...

*New Pathways in Science*  
Chapter XIII, Section VI (p. 306)  
The Macmillan Company. New York, New York, USA. 1935

I am afraid the knockabout comedy of modern atomic physics is not very tender towards our aesthetic ideals. The stately drama of stellar evolution turns out to be more like the hair-breadth escapades in the films. The music of the spheres has a painful suggestion of – jazz.

*Stars and Atoms*  
Lecture I (p. 27)  
Yale University Press. London, England. 1927

It is impossible to trap modern physics into predicting anything with perfect determinism because it deals with probabilities from the outset.

In James R. Newman (ed.)  
*The World of Mathematics* (Volume 2)  
Causality and Wave Mechanics (p. 1056)  
Simon & Schuster. New York, New York, USA. 1956

**Edelstein, Ludwig** 1902–65  
German scholar and historian of medicine

Physics...in antiquity remained closely connected with philosophy, and was predominantly concerned with the philosophical category of the “why,” rather than the scientific category of the “how.”



In Philip P. Wiener and Aaron Noland  
*Roots of Scientific Thought*  
 Recent Trends in the Interpretation of Ancient Science (pp. 94–95)  
 Basic Books, Inc. New York, New York, USA. 1957

**Ehrenfest, Paul** 1880–1933  
 Austrian physicist

Physics is simple, but subtle.  
 In Victor F. Weisskopf  
*Physics in the Twentieth Century: Selected Essays*  
 My Life as a Physicist (p. 3)  
 The MIT Press. Cambridge, Massachusetts, USA. 1972

**Einstein, Albert** 1879–1955  
 German-born physicist

Reality is the real business of physics.  
 In Nick Herbert  
*Quantum Reality: Beyond the New Physics*  
 Chapter 1 (p. 4)  
 Anchor Press. Garden City, New York, USA. 1985

Today we know that no approach which is founded on classical mechanics and electrodynamics can yield a useful radiation formula.  
 In B.L. van der Waerden  
*Sources of Quantum Mechanics*  
 On the Quantum Theory of Radiation (p. 63)  
 Dover Publications. New York, New York, USA. 1968

What would physics look like without gravitation?  
 In Jean-Pierre Luminet  
*Black Holes* (p. 114)  
 Cambridge University Press. New York, New York, USA. 1992

In speaking here of “comprehensibility,” the expression is used in its most modest sense. It implies: the production of some sort of order among sense impressions, this order being produced by the creation of general concepts, relations between these concepts and sense experience. It is in this sense that the world of our sense experiences is comprehensible. The fact that it is comprehensible is a miracle.  
 In *Out of My Later Years*  
 Physics and Reality, Section 1  
 Thames & Hudson. London, England. 1950

Physics too deals with mathematical concepts; however, these concepts attain physical content only by the clear determination of their relation to the objects of experience.  
 In *Out of My Later Years*  
 The Theory of Relativity (p. 41)  
 Thames & Hudson. London, England. 1950

Physics constitutes a logical system of thought which is in a state of evolution, whose basis cannot be distilled, as it were, from experience by an inductive method, but can only be arrived at by free invention.  
 In *Out of My Later Years*  
 Physics and Reality, Summary  
 Thames & Hudson. London, England. 1950

Physics is the attempt at the conceptual construction of a model of the real world and its lawful structure.  
 In Gerald Holton  
*Thematic Origins of Scientific Thought: Kepler to Einstein*  
 Letter of November 28, 1930 to M. Schlick (p. 243)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1973

That this insecure and contradictory foundation was sufficient to enable a man of Bohr’s unique instinct and sensitivity to discover the principal laws of the spectral lines and of the electron shell of the atoms, together with their significance for chemistry appeared to me as a miracle – and appears to me a miracle even today.  
 Translated by Paul Arthur Schlipp  
*Albert Einstein: Autobiographical Notes* (p. 43)  
 Open Court. La Salle, Illinois, USA. 1979

Experience, of course, remains the sole criterion for the serviceability of mathematical constructions for physics, but the truly creative principle resides in mathematics.  
 In Philipp Frank  
*Modern Science and Its Philosophy*  
 Chapter 16 (p. 297)  
 Harvard University Press, Cambridge, England. 1952

But in physics I soon learned to scent out the paths that led to the depths, and to disregard everything else, all the many things that clutter up the mind, and divert it from the essential. The hitch in this was, of course, the fact that one had to cram all this stuff into one’s mind for the examination, whether one liked it or not.  
 In Robert H. March  
*Physics for Poets*  
 Chapter 9 (p. 101)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1996

I still lose my temper dutifully about physics. But I no longer flap my wings – I only ruffle my feathers. The majority of fools remain invincible.  
 In Sachi Sri Kantha  
*An Einstein Dictionary* (p. 96)  
 Greenwood Press, Publishers. Westport, Connecticut, USA. 1996

I have become an evil renegade who does not wish physics to be used on probabilities.  
 In Sachi Sri Kantha  
*An Einstein Dictionary* (p. 96)  
 Greenwood Press, Publishers. Westport, Connecticut, USA. 1996

In the matter of physics, the first lesson should contain nothing but what is experimental and interesting to see. A pretty experiment is in itself often more valuable than twenty formulae extracted from our minds; it is particularly important that a young mind that has yet to find its way about in the world of phenomena should be spared from formulae altogether. In [this mind] physics they play exactly the same weird and fearful part as the figures of dates in Universal History.  
 In A.P. French  
*Einstein: A Centenary Volume*  
 Chapter 11 (p. 220)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1979

If the basis of theoretical physics cannot be an inference from experience, but must be free invention, have we any right to hope that we shall find the correct way? Still more – does this correct approach exist at all, save in our imagination? To this I answer with complete assurance, that in my opinion there is the correct path; moreover, that it is in our power to find it.

In Philipp Frank

Einstein's Philosophy of Science

*Review of Modern Physics*, Volume 21, Number 3, July 1949 (p. 354)

...the development of physics has shown that at any given moment, out of all conceivable constructions, a single one has always proved itself decidedly superior to all the rest. Nobody who has really gone deeply into the matter will deny that in practice the world of phenomena uniquely determines the theoretical system, in spite of the fact that there is no logical bridge between phenomena and their theoretical principles; this is what Leibnitz described so happily as a "pre-established harmony."

*Ideas and Opinions*

Principles of Research (p. 224)

Crown Publishers, Inc. New York, New York, USA. 1954

There are so many unsolved problems in physics. There is so much that we do not know; our theories are from adequate.

In I. Bernard Cohen

An Interview with Einstein

*Scientific American*, Volume 193, Number 1, July, 1955 (p. 69)

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The axioms of physics translate the laws of ethics.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Language (p. 24)

The Library of America. New York, New York, USA. 1983

On the platform of physics we cannot resist the contracting influences of so-called science.

*The Complete Works of Ralph Waldo Emerson* (Volume 33)

*Essays: Second Series*

Chapter II (p. 52)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

How calmly and genially the mind apprehends one after another the laws of Physics!

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Discipline (p. 27)

The Library of America. New York, New York, USA. 1983

### **Faust (Fictional character)**

I have – alas – learned Valence Chemistry,  
Theory of Groups, of the Electric Field,  
And Transformation Theory as revealed  
By Sophus Lie in eighteen-ninety-three.  
Yet here I stand, for all my lore,

No wiser than I was before.

*BLEGDAMSVEJ FAUST*

Part First, Copenhagen Spring Conference, 1932

### **Ferguson, Arthlyn**

No biographical data available

Bouncing a ball, flying a kite, blowing up a balloon – to a child it's play; to a scientist it's physics.

What's Physics?

*The Physics Teacher*, Volume 14, Number 5, May, 1976 (p. 315)

### **Feynman, Richard P.** 1918–88

American theoretical physicist

In order for physics to be useful to other sciences in a theoretical way, other than in the invention of instruments, the science in question must supply to the physicist a description of the object in a physicist's language.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

The Relation of Physics to Other Sciences (p. 64)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

What do we mean by "understanding something?" We can imagine that this complicated array of moving things which constitutes "the world" is something like a great chess game being played by the gods, and we are observers of the game. We do not know what the rules of the game are: all we are allowed to do is to watch the playing. Of course, if we watch long enough we may eventually catch on to a few of the rules. The rules of the game are what we mean by fundamental physics. Even if we knew every rule, however, we might not be able to understand why a particular move is made in the game, merely because it is too complicated...

In P.C.W. Davies and J. Brown

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2-1 (p. 2-1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

The electron does anything it likes. It goes in any direction at any speed, forward or backward in time, however it likes...

In James Gleick

*Genius: The Life and Science of Richard Feynman*

Cornell (p. 250)

Pantheon Books. New York, New York, USA. 1992

The fact that I beat a drum has nothing to do with the fact that I do theoretical physics. Theoretical physics is a human endeavor, one of the higher developments of human beings – and this perpetual desire to prove that people who do it are human by showing that they do other things that a few other humans do (like playing bongo drums) is insulting to me. I'm human enough to tell you to go to hell.

In James Gleick

*Genius: The Life and Science of Richard Feynman*  
Caltec (p. 364)  
Pantheon Books. New York, New York, USA. 1992

Physics is to mathematics what sex is to masturbation.

In Lawrence M. Krauss  
*Fear of Physics: A Guide for the Perplexed*  
Chapter 2 (p. 27)  
Basic Books, Inc. New York, New York, USA. 1993

...the behavior of things on a small scale is so fantastic, so wonderfully and marvelously different than anything on a large scale! You can say, "Electrons behave like waves" – no, they don't, exactly; "they act like particles" – no, they don't exactly; "they act like a kind of fog around the nucleus" – no, they don't, exactly. Well, if you would like to get a clear, sharp picture of an atom, so that you can tell correctly how it's going to behave – have a good image of reality, in other words – I don't know how to do it, because that image has to be mathematical. Strange!

I don't know how it is that we can write mathematical expressions and calculate what the thing is going to do without actually being able to picture it. It would be something like having a computer where you put some numbers in, and the computer can do the arithmetic to figure out what time a car will arrive at different destinations but it cannot picture the car.

In Christopher Sykes (ed.)  
*No Ordinary Genius: The Illustrated Richard Feynman*  
Chapter Six (p. 149)  
W.W. Norton & Company, Inc. New York, New York, USA. 1994

Things happen faster in physics than in the book publishing business.

*QED: The Strange Theory of Light and Matter*  
Chapter 4 (p. 152)  
Princeton University Press. Princeton, New Jersey, USA. 1985

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

...the existence of the positive charge, in some sense, distorts, or creates a "condition" in space, so that when we put the negative charge in, it feels a force. This potentiality for producing a force is called an electric field.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 2-2 (p. 2-4)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

In its efforts to learn as much as possible about nature, modern physics has found that certain things can never be "known" with certainty. Much of our knowledge must always remain uncertain. The most we can know is in terms of probabilities.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 6-5 (p. 6-11)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Ford, Kenneth William** 1926–  
Physicist

Getting into a new field of physics is like reading a Russian novel. There are a lot of names to cope with, and at first you wonder who's who.

*The Quantum World: Quantum Physics for Everyone* (pp. 45–46)  
Harvard University Press. Cambridge, Massachusetts, USA. 2004

**Franklin, W. S.**  
No biographical data available

Physics is the science of the ways of taking hold of things and pushing them.

In R.B. Lindsay  
*The Broad Point of View in Physics*  
*The Scientific Monthly*, February, 1932 (p. 115)

**Fraser, Julius Thomas** 1923–  
No biographical data available

The task of asking nonliving matter to speak and the responsibility for interpreting its reply is that of physics.

*Time: The Familiar Stranger*  
From the Diaries of a Timesmith (p. 358)  
The University of Massachusetts Press. Amherst, Massachusetts, USA. 1987

**Gamow, George** 1904–68  
Russian-born American physicist

I remember that once, walking with him to the institute, I mentioned Pascal Jordan's idea of how a star can be created from nothing, since at the point zero its negative gravitational mass defect is numerically equal to its positive rest mass. Einstein stopped in his tracks, and, since we were crossing a street, several cars had to stop to avoid running us down.

*My World Line: An Informal Autobiography*  
Afterword (p. 150)  
The Viking Press. New York, New York, USA. 1979

**Gardner, Martin** 1914–  
American writer and mathematics games editor

In physics and chemistry, like all other branches of science, there is never a sharp line separating pseudo-scientific speculation from the theories of competent men.

*Fads and Fallacies in the Name of Science*  
Chapter 7 (p. 80)  
Dover Publications, Inc., New York, New York, USA; 1957

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

In the study of physics, we see what are called individual facts but which are by no means isolated and which are

not independent of each other; on the contrary they are related to each other by laws which the physicist devotes all his attention to discovering. It is this which is a measure of the true progress of the science.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1978

### Geordi (Fictional character)

Suddenly it's like the laws of physics went right out the window.

*Star Trek: The Next Generation*

True Q

Television program

Season 6, 1992

### Goepfert-Mayer, Maria 1906–72

German-American physicist

Mathematics began to seem too much like puzzle solving. Physics is puzzle solving, too, but of puzzles created by nature, not by the mind of man.

In J. Dash

*A Life of One's Own*

Maria Goepfert-Mayer (p. 252)

Harper & Row, Publishers. New York, New York, USA. 1973

### Greene, Brian 1963–

American physicist

...because observations are all we have, we take them seriously. We choose hard data and the framework of mathematics as our guides, not unrestrained imagination or unrelenting skepticism, and seek the simplest yet most wide-reaching theories capable of explaining and predicting the outcome of today's and future experiments.

*The Fabric of the Cosmos*

Preface (p. ix)

Alfred A. Knopf. New York, New York, USA. 2004

Space and time capture the imagination like no other scientific subject. For good reason. They form the arena of reality, the very fabric of the cosmos.

*The Fabric of the Cosmos*

Preface (p. ix)

Alfred A. Knopf. New York, New York, USA. 2004

To open our eyes to the true nature of the universe has always been one of physics' primary purposes.

*The Fabric of the Cosmos*

Chapter 1 (p. 12)

Alfred A. Knopf. New York, New York, USA. 2004

The arrow of time, through the defining role it plays in everyday life and its intimate link with the origin of the universe, lies at a singular threshold between the reality we experience and the more refined reality cutting-edge science seeks to uncover.

*The Fabric of the Cosmos*

Chapter 1 (p. 20)

Alfred A. Knopf. New York, New York, USA. 2004

Physicists generally do not spend their working days contemplating flowers in a state of cosmic awe and reverie. Instead, we devote much of our time to grappling with complex mathematical equations scrawled across well-scored chalkboards. Progress can be slow. Promising ideas, more often than not, lead nowhere. That's the nature of scientific research.

*The Fabric of the Cosmos*

Chapter 1 (p. 21)

Alfred A. Knopf. New York, New York, USA. 2004

It took the brashness of a Newton to plant the flag of modern scientific inquiry and never turn back.

*The Fabric of the Cosmos*

Chapter 1 (p. 22)

Alfred A. Knopf. New York, New York, USA. 2004

Nature does weird things. It lives on the edge. But it is careful to bob and weave from the fatal punch of logical paradox.

*The Fabric of the Cosmos*

Chapter 7 (p. 185)

Alfred A. Knopf. New York, New York, USA. 2004

Physicists spend a large part of their lives in a state of confusion. It's an occupational hazard. To excel in physics is to embrace doubt while walking the road to clarity.

*The Fabric of the Cosmos*

Chapter 16 (p. 470)

Alfred A. Knopf. New York, New York, USA. 2004

Black holes have the universe's most inscrutable poker faces.

*The Fabric of the Cosmos*

Chapter 16 (p. 477)

Alfred A. Knopf. New York, New York, USA. 2004

### Gross, David J. 1941–

American particle physicist

Progress in physics depends on the ability to separate the analysis of a physical phenomenon into two parts. First, there are the initial conditions that are arbitrary, complicated, and unpredictable. Then there are the laws of nature that summarize the regularities that are independent of the initial conditions.

*The Role of Symmetry in Fundamental Physics*

*Proceedings of the National Academy of Science USA*, Volume 93, Number 25, December 10, 1996

### Hanson, Norwood Russell 1924–67

American philosopher of science

Physics is not applied mathematics. It is a natural science in which mathematics can be applied.

*Patterns of Discovery*

Chapter IV (p. 72)

At The University Press. Cambridge, England. 1958

**Hasselberg, K. B.**

No biographical data available

...as for physics, it has developed remarkably as a precision science, in such a way that we can justifiably claim that the majority of all the greatest discoveries in physics are very largely based on the high degree of accuracy which can now be obtained in measurements made during the study of physical phenomena.... [Accuracy of measurement] is the very root, the essential condition, of our penetration deeper into the laws of physics – our only way to new discoveries.

*Nobel Lectures, Physics 1901–1921*

Presentation Speech to Michelson 1907 Nobel Award (p. 159)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Heidegger, Martin** 1889–1976

German philosopher

Modern physics is not experimental physics because it applies apparatus to the questioning of nature. Rather the reverse is true. Because physics, indeed already as pure theory, sets nature up to exhibit itself as a coherence of forces calculable in advance, it therefore orders its experiments precisely for the purpose of asking whether and how nature reports itself when set up in this way.

*The Question Concerning Technology and Other Essays*

Part I. The Question Concerning Technology (p. 21)  
Harper & Row, Publishers. New York, New York, USA. 1977

**Heinlein, Robert A.** 1907–88

American science fiction writer

Physics doesn't have to have any use. It just is.

*Time for the Stars* (p. 138)

Charles Scribner's Sons. New York, New York, USA. 1956

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

When I was a boy, my grandfather, who was a handi-craftsman and knew how to do practical things, once met me when I put a cover on a wooden box.... He saw that I took the cover and I took a nail and I tried to hammer this one nail down to the bottom. "Oh", he said, "that is quite wrong what you do there, nobody can do it that way and it is a scandal to look at." I did not know what the scandal was, but then he said, "I will show you how you could do it." He took the cover and he took one nail, put it just a little bit through the cover into the box, and then the next nail a little bit, the third nail a little bit, and so on until all the nails were there. Only when everything was clear, when one could see, that all the nails would fit, then he would start to put the nails really into the box. So, I think this is a good description of how one should proceed in theoretical physics.

In International Centre for Theoretical Physics

*From a Life of Physics. Evening Lectures at the International Centre For Theoretical Physics*

Theory, Criticism and a Philosophy, My General Philosophy (p. 46)

Questions and answers, observations and determinations, are no longer directed at a general, metaphysical and theological understanding, but are delimited with modesty.... This modesty was largely lost during the nineteenth century. Physical knowledge was considered to make assertions about nature as a whole. Physicists wished to turn philosophers.... Today physics is undergoing a basic change, the most characteristic trait of which is a return to its original self-limitation.

*The Physicist's Conception of Nature*

Chapter 4 (p. 105)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

Like all the other natural sciences, Physics advances by two distinct roads. On the one hand it operates empirically, and thus is enabled to discover and analyse a growing number of phenomena – in this instance, of physical facts; on the other hand it also operates by theory, which allows it to collect and assemble the known facts in one consistent system, and to predict new ones from the guidance of experimental research.

*The Physicist's Conception of Nature*

Chapter 6 (p. 158)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

I remember discussions with Bohr which went through many hours till very late at night and ended almost in despair, and when at the end of the discussion I went alone for a walk in the neighboring park I repeated to myself again and again the question: "Can nature possibly be as absurd as it seemed to us in these atomic experiments?"

*Physics and Philosophy: The Revolution in Modern Science*

Chapter II (p. 42)

Harper & Row, Publishers. New York, New York, USA. 1958

**Henderson, Charles Hanford** 1861–1941

American educator

**Woodhull, John Francis**

American physical science teacher

We live in a world bristling with physical phenomena that arouse our interest and compel our inquiry. The study of physics is merely a search for answers to our questions. We are limited on all sides by physical laws. We need to understand them so that we may not undertake physical impossibilities. If we are ignorant of physics we are liable to make unreasonable demands and make ourselves and others unhappy by not knowing when to yield to the inevitable. The reign of natural law is absolute, and when we learn obedience to it, much of the friction and distress of life disappears.

*Elements of Physics*

Chapter I (p. 5)

D. Appleton & Co. New York, New York, USA. 1909

**Heyl, Paul R.**

American Scientist

Physics is a state of mind.



In R.B. Lindsay  
The Broad Point of View in Physics  
*The Scientific Monthly*, February, 1932 (p. 115)

**Hilbert, David** 1862–1943  
German mathematician

Physics...is much too hard for physicists.  
In Constance Reid  
*Hilbert – Courant*  
Hilbert (p. 127)  
Springer-Verlag, New York, New York, USA. 1986

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

**Hoyle, Geoffrey** 1942–  
English science fiction writer

“In physics,” he said, “we plan. We plan months ahead, years ahead.... You astronomers don’t plan, you rush around like a chicken without a head. Observe and observe and observe and all shall be revealed unto you.”  
*The Inferno* (p. 87)  
Harper & Row, Publishers, New York, New York, USA. 1973

**Huebner, Jay S.**  
No biographical data available

Physics is what a group of people who call themselves physicists do.  
What’s Physics?  
*The Physics Teacher*, Volume 14, Number 5, May, 1976 (p. 315)

**Huxley, Thomas Henry** 1825–95  
English biologist

...nothing can be more incorrect than the assumption one sometimes meets with, that physics has one method, chemistry another, and biology a third.  
*Collected Essays* (Volume 1)  
*Method and Result*  
The Progress of Science (p. 60)  
Macmillan & Company Ltd. London, England. 1904

**Icke, Vincent** 1946–  
No biographical data available

Physics is not difficult; it’s just weird.... Physics is weird because intuition is false. To understand what an electron’s world is like, you’ve got to be an electron, or jolly nearly. Intuition is forged in the hellish fires of the everyday world, which makes it so eminently useful in our daily struggle for survival. For anything else, it is hopeless.  
*The Force of Symmetry*  
Preface (p. xiii)  
Cambridge University Press, Cambridge, England. 1995

Fiction writers worry about first as well as last sentences, but I don’t have to do that: in the book of physics, there never is a final sentence.

*The Force of Symmetry*  
Chapter 14 (p. 294)  
Cambridge University Press, Cambridge, England. 1995

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

Kronecker is quoted as saying that in arithmetic God made the integers and man made the rest; in the same spirit we may perhaps say that in physics God made the mathematics and man made the rest.  
*Physics and Philosophy*  
Chapter I (p. 16)  
Dover Publications, Inc. New York, New York, USA. 1981

...physics tries to discover the pattern of events which controls the phenomena we observe. But we can never know what this pattern means or how it originates; and even if some superior intelligence were to tell us, we should find the explanation unintelligible.  
*Physics and Philosophy*  
Chapter I (p. 16)  
Dover Publications, Inc. New York, New York, USA. 1981

The classical physics seemed to bolt and bar the door leading to any sort of freedom of the will; the new physics hardly does this; it almost seems to suggest that the door may be unlocked – if only we could find the handle. The old physics showed us a universe which looked more like a prison than a dwelling place. The new physics shows us a universe which looks as though it might conceivably form a suitable dwelling place for free men, and not a mere shelter for brutes – a home in which it may at least be possible for us to mould events to our desires and live lives of endeavor and achievement.  
*Physics and Philosophy*  
Chapter VII (p. 216)  
Dover Publications, Inc. New York, New York, USA. 1981

Yet we may reflect that physics and philosophy are at most a few thousand years old, but probably have lives of thousands of millions of years stretching away in front of them. They are only just beginning to get under way, and we are still, in Newton’s words, like children playing with pebbles on the sea-shore, while the great ocean of truth rolls, unexplored, beyond our reach. It can hardly be a matter for surprise that our race has not succeeded in solving any large part of its most difficult problems in the first millionth part of its existence. Perhaps life would be a duller affair if it had, for to many it is not knowledge but the quest for knowledge that gives the greater interest to thought – to travel hopefully is better than to arrive.  
*Physics and Philosophy*  
Chapter VII (p. 217)  
The University Press, Cambridge, England. 1943

...the tendency of modern physics is to resolve the whole material universe into waves, and nothing but waves. These waves are of two kinds: bottled-up waves, which



we call matter, and unbottled waves, which we call radiation or light.

*The Mysterious Universe*

Chapter III (p. 77)

The Macmillan Company. New York, New York, USA. 1932

### Joan (Fictional character)

“Physics is hard”? That’s like the intellectual version of “you’re not fat”.

*Joan of Arcadia*

Film (2003)

### Jones, John D. S.

Physics has always provided mathematicians with problems. Physicists are pragmatic people, whose primary interest is in the physical significance of theories rather than in their rigorous justification. This provides mathematicians with one of their additional sources of good problems. It also creates a little tension: the narrow-minded mathematician dismisses the physicist as sloppy, whereas the narrow-minded physicist complains of mathematicians quibbling over details with no physical significance. Others recognize that the disciplines have different, but compatible objectives and that each has much to learn from the other.

Topology, *Mysteries of Four Dimensions*

*Nature*, Volume 332, Number 6164, July 4, 1988 (p. 488)

### Karshenboim, Savely G.

No biographical data available

### Peik, Ekkehard

No biographical data available

The way physics explains Nature is to speak in terms of the consequences of a few very basic equations.

*Astrophysics, Clocks and Fundamental Constants*

An Introduction to Varying Fundamental Concepts (p. 1)

Springer-Verlag. Berlin, Germany. 2004

### Koyré, Alexandre 1892–1964

Russian-born French philosopher

Good physics is made a priori. Theory precedes fact. Experience is useless because, before any experience, we are already in possession of the knowledge we are seeking for. Fundamental laws of motion (and of rest), laws that determine the spatio-temporal behavior of material bodies, are laws of a mathematical nature. Of the same nature as those which govern relations and laws of figures and numbers. We find and discover them not in Nature, but in ourselves, in our mind, in our memory, as Plato long ago has taught us.

Galileo and the Scientific Revolution of the Seventeenth Century

*The Philosophical Review*, Volume 52, Number 3, July 1943 (p. 347)

### Larrabee, Eric 1922–90

Historian

Some people think that physics was invented by Sir Francis Bacon, who was hit by an apple when he was sitting under a tree one day writing Shakespeare.

*Humor from Harper’s*

Easy Road to Culture, Sort Of (p. 89)

Harper. New York, New York, USA. 1961

### Lerner, Eric J. 1947–

American popular science book

My conflict with conventional physics started when I was an undergraduate at Columbia in the mid-sixties. Physics itself interested me, learning why things happen as they do – mathematics was merely a tool to understand and test the underlying physical concepts. That was not the way physics was taught; instead, mathematical techniques were emphasized. This is almost exclusively what students are still tested on, and obviously study the most.

*The Big Bang Never Happened*

Part One, Chapter 6 (p. 242)

Time Books. New York, New York, USA. 1991

### Lewis, C. S. (Clive Staples) 1898–1963

British author, scholar, and popular theologian

Without a parable modern physics speaks not to the multitudes.

In John D. Barrow

*The World Within the World* (p. 238)

Clarendon Press. Oxford, England. 1988

### Lewis, Edwin Herbert 1866–1938

American rhetorician, novelist, and poet

To Marvin the advance of physics and chemistry was the most exciting thing on earth. The researchers were watching each other, checking each other, helping each other, bound to tell the exact truth no matter where it led. The two sciences were steadily becoming one science, and the great advance continued day by day as if one infinite reluctant mind were slowly revealing itself.

*White Lightning*

Chapter 56 (p. 242)

Covici-McGee. Chicago, Illinois, USA. 1933

### Lewis, Exum Percival

No biographical data available

All the natural phenomena which appeal to our senses are part of the subject-matter of Physics. This is true not only of the simpler processes of inorganic life, but, to a greater or less extent, of all the phenomena of organic life, such as the rise of sap, the circulation of the blood,

and muscular movements. Physics is, therefore, the foundation of all the sciences.

*Notes on the Properties of Matter and Heat*  
Introductory (p. 1)  
Percival Lewis. Berkeley, California, USA. 1903

### Liebson, Morris

No biographical data available

“What will I learn here?” you might query.  
You’ll learn some math and Einstein’s Theory.

Ask Teacher for an illustration.  
He’ll explain, “It’s time dilation.  
Length gets less. Mass gets more.  
Time decreases. That’s the law.  
When things go so very, very fast.  
Classical physics is of the past,  
And to find what’s really true,  
We must seek the physics new.  
Learning this is lots of fun  
In our course called Physics 1.

Physics Inspires the Muses  
*The Physics Teacher*, Volume 16, Number 9, December, 1978 (p. 636)

### Lindley, David 1956–

English astrophysicist and author

Physics may be complex, mathematical, and arcane, but it is not capricious. The inventors of strings and twenty-six dimensional spaces did not think up these things at random, simply to give themselves a new set of toys. There is a line of rational thinking that leads from the billiard-ball atoms of classical physics to the intangible mathematical entities of today. Physics is complicated because the world is complicated.

*The End of Physics: The Myth of a Unified Theory*  
Prologue (p. 19)  
Basic Books, Inc. New York, New York, USA. 1993

If particle physics is a mess, it is because that is the way the world appears to work.

*The End of Physics: The Myth of a Unified Theory*  
Part I, Chapter 4 (p. 124)  
Basic Books, Inc. New York, New York, USA. 1993

### Lodge, Sir Oliver 1851–1940

English physicist

When a thing behaves as if it were alive, physics loses interest in it and hands it over to another section; for it is incompetent to deal with motions attributable to spontaneity and free will.

Contributions to a British Association Discussion on the Evolution of the Universe  
*Nature*, Supplement, October, 24, 1931 (p. 722)

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

Physics is experience, arranged in economical order.  
In John N Shive and Robert L. Weber

*Similarities in Physics*

Preface (p. xi)  
John Wiley & Sons, Inc. New York, New York, USA. 1982

I only seek to adopt in physics a point of view that need not be changed the moment our glance is carried over into the domain of another science; for ultimately, all must form one whole.

Translated by C.M. Williams  
*Analysis of Sensations and the Relation of the Physical to the Psychical*  
Chapter 1 (p. 30, fn 1)  
Dover Publications, Inc. New York, New York, USA. 1959

Physics shares with mathematics the advantages of succinct description and of brief, compendious definition, which precludes confusion, even in ideas where, with no apparent burdening of the brain, hosts of others are contained.

Translated by Thomas J. McCormack  
*Popular Scientific Lectures* (2nd edition)  
The Economical Nature of Physical Inquiry (p. 197)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

### Maimonides, Moses 1135–1204

Spanish-born philosopher, jurist, and physician

...he who wishes to attain to human perfection, must therefore first study Logic, next the various branches of Mathematics in their proper order, then Physics, and lastly Metaphysics.

*The Guide for the Perplexed*  
Part I, Chapter XXXIV  
E.P. Dutton & Company. New York, New York, USA. 1904

### Maritain, Jacques 1882–1973

French philosopher

Few spectacles are as beautiful and moving for the mind as that of physics thus advancing toward its destiny like a huge throbbing ship.

Translated by Gerald B. Phelan  
*Distinguish to Unite or the Degrees of Knowledge*  
Chapter IV, section 12 (p. 165)  
University of Notre Dame Press. Notre Dame, Indiana, USA. 1995

### Mencken, H. L. (Henry Louis) 1880–1956

American journalist and literary critic

...it is now quite lawful for a Catholic woman to avoid pregnancy by a resort to mathematics, though she is still forbidden to resort to physics and chemistry.

*Minority Report: H.L. Mencken's Notebooks*  
No. 62 (p. 52)  
Alfred A. Knopf. New York, New York, USA. 1956

### Mephisto

Can no one laugh?  
Will no one drink?  
I'll teach you Physics in a wink....

*BLEGDAMSVEJ FAUST*  
Part First, Copenhagen Spring Conference, 1932

Beware alone of Reason and of Science,  
 Man's highest powers, unholy in alliance.  
 You let yourself, through dazzling witchcraft, yield  
 To all temptations of the Quantum field.  
 Listen! As now the obstacles abate,  
 You'll know the fair Neutrino for your fate!

*BLEDGAMSVEJ FAUST*

Part First, Copenhagen Spring Conference, 1932

**Millikan, Robert Andrews** 1868–1953

American physicist

Physics has opened the eyes of mankind so that it can now see in a very new truth new worlds – a marvelous world of electrons, already quite well explored, which underlies our former world of atoms and molecules, a world of quanta, not yet well understood, which lies perhaps behind the ether.

*Science and Life*

Chapter IV (p. 67)

The Pilgrim Press. Boston, Massachusetts, USA. 1924

**Milne, Edward Arthur** 1896–1950

English astrophysicist and cosmologist

Strictly speaking, physics has no philosophy. It has method.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1933)

Some Points in the Philosophy of Physics: Time: Evolution, and Creation (p. 219)

Government Printing Office. Washington, D.C. 1934

**Mohapatra, Rabindra**

Theoretical physicist

Most people who haven't been trained in physics probably think of what physicists do as a question of incredibly complicated calculations, but that's not really the essence of it. The essence of it is that physics is about concepts, wanting to understand the concepts, the principles by which the world works.

In Michio Kaku

*Hyperspace: A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension*

Chapter 7 (p. 152)

Oxford University Press, Inc. New York, New York, USA. 1995

If you want to do serious physics, sometime you just have to learn it.

As reported by Ernest Barreto, student

Quantum field theory class. 1994

**More, Louis Trenchard**

American educator

It is a more or less simple thing to discover and follow the main current of thought in a science like physics, which must develop logically or not at all, after the confusion of strife has passed away and only the permanent additions to our knowledge remain.

*The Limitations of Science*

Chapter II (p. 32)

Henry Holt & Co. New York, New York, USA. 1915

Physics, to be something more than an intellectual puzzle for the specialist, should enlarge our power over the external world and increase our use of natural resources.

*The Limitations of Science*

Chapter II (p. 36)

Henry Holt & Co. New York, New York, USA. 1915

**Morgan, Thomas Hunt** 1866–1945

American zoologist and geneticist

Physics has progressed because, in the first place, she accepted the uniformity of nature; because, in the next place, she early discovered the value of exact measurements; because, in the third place, she concentrated her attention on the regularities that underlie the complexities of phenomena as they appear to us; and lastly, and not the least significant, because she emphasized the importance of the experimental method of research. An ideal or crucial experiment is a study of an event, controlled so as to give a definite and measurable answer to a question – an answer in terms of specific theoretical ideas, or better still an answer in terms of better understood relations.

*The Relation of Biology to Physics*

*Science*, Volume 65, Number 1679, March 4, 1927 (p. 217)

**Morrow, James** 1947–

American author

Her eyes sprang fully opened, and she beheld Howard's rickety bookshelves. P-h-y-s-i-c-s. A coil of radiant energy shot from the word, flooding into her skull like a sunbeam passing through glass. She closed her eyes. Her dendrites danced. Her synapses sparkled.

*Only Begotten Daughter* (p. 90)

Harcourt Incorporated. Orlando, Florida, USA. 1990

**National Research Council (US)**

Science is knowing, and the most lasting and universal things that man knows about nature make up physics.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 14)

National Academy of Sciences. Washington, D.C. 1972

Let there be no misunderstanding. Even with the most judicious use of existing resources, this nation cannot continue as a leading contributor to world physics without support greater than is now available. This objective faces the hard facts of changing national goals.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 15)

National Academy of Sciences. Washington, D.C. 1972

Science is knowing. What man knows about inanimate nature is physics, or, rather, the most lasting and universal things that he knows make up physics.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 55)

National Academy of Sciences. Washington, D.C. 1972

What has been learned in physics stays learned.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 61)  
National Academy of Sciences. Washington, D.C. 1972

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

I do not define time, space, place, and motion, as being well known to all. Only I must observe, that the common people conceived those quantities under no other notions but from the relation they bear to sensible objects.... Absolute space, in its own nature, without relation to anything external remains always similar and immovable.

In *Great Books of the Western World* (Volume 34)  
*Mathematical Principles of Natural Philosophy*  
Definitions, Scholium (p. 8)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is indeed a matter of great difficulty to discover, and effectually to distinguish, the true motions of particular bodies from the apparent; because the parts of that immovable space, in which those motions are performed, do by no means come under the observation of our senses.

In *Great Books of the Western World* (Volume 34)  
*Mathematical Principles of Natural Philosophy*  
Definitions, Scholium (p. 12)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nietzsche, Friedrich Wilhelm** 1844–1900  
German philosopher

We...want to become...human beings who are new, unique, incomparable, who give themselves laws, who create themselves. To that end we must become the best learners and discoverers of everything that is lawful and necessary in the world: we must become physicists in order to be able to be creators in this sense – while hitherto all valuations and ideals have been based on ignorance of physics or were constructed so as to contradict it. Therefore: long live physics! And even more so that which compels us to turn to physics – our honesty!

*The Gay Science*  
Fourth Book, Aphorism 335  
Cambridge University Press. Cambridge, England. 2001

## Nimrod

Physics and Mathematics are now on the throne ...

*Heads of the People: Or, Portraits of the English* (Volume 2)  
The Coachman and the Guard (p. 240)  
George Routledge & Sons. London, England. 1878

**Noll, Ellis D.**  
No biographical data available

Physics is the science whose treehouse rests on the trunk of immutable physical law.

What's Physics?  
*The Physics Teacher*, Volume 14, Number 5, May, 1976 (p. 315)

**Oman, John** 1860–1939  
English Presbyterian theologian

Beauty...is the goal of physics as it seeks to construe the order of the universe...

*The Natural and the Supernatural*  
Value and Validity (p. 211)  
The Macmillan Company. New York, New York, USA. 1931

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Time and experience have clarified, refined and enriched our understanding of these notions. Physics has changed since then. It will change even more. But what we have learned so far, we have learned well. If it is radical and unfamiliar and a lesson that we are not likely to forget, we think that the future will be only more radical and not less, only more strange and not more familiar, and that it will have its own new insights for the inquiring human spirit.

In Lucienne Felix  
*The Modern Aspect of Mathematics* (p. 31)  
Basic Books, Inc. New York, New York, USA. 1960

The only thing that we can say about the properties of the ultimate particles is that we know nothing whatever about them.

In Cecilia Payne-Gaposchkin  
*Introduction to Astronomy*  
Chapter XIII, Section 5 (p. 339)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1954

As you undoubtedly know, theoretical physics – what with the haunting ghosts of neutrinos, the Copenhagen conviction, against all evidence, that cosmic rays are protons, Born's absolutely unquantizable field theory, the divergence difficulties with the positron, and the utter impossibility of making a rigorous calculation of anything at all – is in a hell of a way.

In Alice Smith and Charles Weiner  
*Robert Oppenheimer, Letters and Reflections*  
Letter to F. Oppenheimer, 4 June, 1934 (p. 181)  
Harvard University Press. Cambridge, Massachusetts, USA. 1980

**Padmanabhan, Thanu**  
Indian physicist

Attempts to understand extragalactic objects and the universe by using the laws of physics lead to difficulties that have no parallel in the application of the laws of physics to systems of a more moderate scale.

*Theoretical Astrophysics*  
Chapter I (p. 1)  
Cambridge University Press. Cambridge, England. 2002

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

Bohr wondered how we could even talk about the atomic world – it was so far removed from human experience. He struggled with this problem – how can we use ordinary language developed to cope with everyday events and objects to describe atomic events? Perhaps the logic inherent in our grammar was inadequate for the task.... The end of determinism meant not the end of physics but the beginning of a new vision of reality.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*  
 Uncertainty and Complementarity (pp. 103, 110)  
 Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Pais, Abraham** 1918–2000  
 Dutch-born physicist

It was a wonderful mess at that time. Wonderful! Just great! It was so confusing – physics at its best, when everything is confused and you know something important lies just around the corner.

In Robert Crease

*The Second Creation: Makers of the Revolution in 20th Century Physics*  
 Chapter 9 (p. 177)

The Macmillan Company. New York, New York, USA. 1986

...the state of particle physics...is...not unlike the one in a symphony hall before the start of a concert. On the podium one will see some but not all of the musicians. They are tuning up. Short brilliant passages are heard on some of the instruments; improvisations elsewhere; some wrong notes too. There is a sense of anticipation for the moment when the concert starts.

Particles

*Physics Today*, Volume 21, Number 2, May, 1968 (p. 28)

**Penman, Sheldon**

American biologist

The advance of physics can be compared to that of an army. Salients are thrust out where the opposition is lightest; troublesome areas are bypassed until the necessary forces are available.

The Muon

*Scientific American*, Volume 205, Number 1, July, 1961 (p. 46)

**Pines, David**

No biographical data available

The central task of theoretical physics in our time is no longer to write down the ultimate equations but rather to catalog and understand emergent behavior in its many guises...

In George Johnson

Challenging Particle Physics as Path to Truth

*The New York Times*, F5, Columns 2 and 3, Tuesday, December 4, 2001

**Planck, Max** 1858–1947

German physicist

In endeavoring to claim your attention for a short time, I would remark that our science, Physics, cannot attain its object by direct means, but only gradually along numerous and devious paths, and that therefore a wide scope is provided for the individuality of the worker. One works at one branch, another at another, so that the physical universe with which we are all concerned appears in different lights to different workers.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Unity of the Physical Universe (p. 1)

Methuen & Company Ltd. London, England. 1925

The chief law of physics, the pinnacle of the whole system is, in my opinion, the principle of least action.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Place of Modern Physics in the Mechanical View of Nature (p. 41)

Methuen & Company Ltd. London, England. 1925

Since Galileo's time, physics has achieved its greatest success by rejecting all teleological methods.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Principle of Least Action (p. 73)

Methuen & Company Ltd. London, England. 1925

...the second law of thermodynamics appears solely as a law of probability, entropy as a measure of the probability, and the increase of entropy is equivalent to a statement that more probable events follow less probable ones.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Relation Between Physical Theories (p. 86)

Methuen & Company Ltd. London, England. 1925

Physics is an exact Science and hence depends upon measurement, while all measurement itself requires sense-perception. Consequently all the ideas employed in Physics are derived from the world of sense-perception.

*The Universe in the Light of Modern Physics*

Section 1 (p. 7)

Unwin Brothers Ltd. London, England. 1937

Physics would occupy an exceptional position among all the other sciences if it did not recognize the rule that the most far-reaching and valuable results of investigation can only be obtained by following a road leading to a goal which is theoretically unobtainable. This goal is the apprehension of true reality.

*The Universe in the Light of Modern Physics*

Section 1 (p. 15)

Unwin Brothers Ltd. London, England. 1937

Modern Physics impresses us particularly with the truth of the old doctrine which teaches that there are realities existing apart from our sense-perceptions, and that there are problems and conflicts where these realities are of greater value for us than the richest treasures of the world of experience.

*The Universe in the Light of Modern Physics* (p. 107)

George Allen & Unwin Ltd. London, England. 1931

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The science of physics does not only give us [mathematicians] an opportunity to solve problems, but helps us to discover the means of solving them, and it does this in two ways: it leads us to anticipate the solution and suggests suitable lines of argument.

*The Foundations of Science*

*The Value of Science*

The Science Press. New York, New York, USA. 1913



**Quine, Willard van Orman** 1908–2000

American logician and philosopher

Physics investigates the essential nature of the world, and biology describes a local bump. Psychology, human psychology, describes a bump on the bump.

*Theories and Things*

Chapter 10 (p. 93)

Harvard University Press. Cambridge, Massachusetts, USA. 1981

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

I think physics is infinite. You don't have to try to exhaust it in your generation, or in your lifetime.

In Jeremy Bernstein

*Experiencing Science*

Part 1. Two Faces of Physics Chapter 2 Rabi: The Modern Age (p. 56)

Basic Books, Inc. New York, New York, USA. 1978

I think that physics should be the central study in all schools. I don't mean physics as it is usually taught – very badly, as a bunch of tricks – but, rather, an appreciation of what it means, and a feeling for it. I don't want to turn everybody into a scientist, but everybody has to be enough of a scientist to see the world in the light of science – to be able to see the world as something that is tremendously important beyond himself, to be able to appreciate the human spirit that could discover these things, that could make instruments to inquire and advance into its own nature. I rate this so highly [because] with this education people would find something above their religious affiliations, and find a basic unity in the spirit of man.

In Jeremy Bernstein

*Experiencing Science*

Part 1. Two Faces of Physics. Chapter 2. Rabi: The Modern Age (p. 126)

Basic Books, Inc. New York, New York, USA. 1978

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

The purpose of scientific study and research is to obtain an ever deeper understanding of the workings of nature. To the physicist falls the task of discovering the ultimate units or entities that constitute the material universe and of ascertaining the principles which govern their behavior.

*The New Physics: Talks on Aspects of Science*

Chapter II (p. 9)

Philosophical Library, New York. 1951

**Reichenbach, Hans** 1891–1953

German philosopher of science

If one knows physics for a distance only, if he hears merely strange names and mathematical formulae in it, he will, indeed, come to believe that it is an affair of the learned alone – ingeniously and wisely constructed, but without significance for men of other interests and problems.

*Atoms and Cosmos*

Chapter 19 (p. 293)

The Macmillan Company. New York, New York 1933

**Richardson, Owen Willans** 1879–1959

English physicist

The trouble with Physics at the present time is that there are so many workers making discoveries so fast, and important discoveries too, that it is difficult for anyone worker to keep a balanced view of the state of the subject.

*Lex Prix Nobel. The Nobel Prizes in 1928*

Nobel banquet speech for award received in 1928

Nobel Foundation. Stockholm, Sweden. 1929

**Roberts, Michael**

No biographical data available

**Thomas, E. R.**

No biographical data available

The most brilliant discoveries in theoretical physics are not discoveries of new laws, but of terms in which the law can be discovered.

*Newton and the Origin of Colours*

Chapter I (p. 6)

G. Bell &amp; Sons Ltd. London, England. 1934

**Röntgen, Wilhelm Conrad** 1845–1923

German physicist

To my view there are two methods of research, the apparatus and the calculation. Whoever prefers the first method is an experimenter; otherwise, he is a mathematical physicist. Both of them set up theories and hypotheses...

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter II (p. 24)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

Physics is a science which must be proved with honest effort. One can, perhaps, present a subject in such a manner that an audience of laymen may be convinced erroneously that it has understood the lecture. This, however, means a furthering a superficial knowledge, which is worse and more dangerous than none at all.

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter VIII (p. 119)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Physics must be interpreted in a way which tends toward idealism, and perception in a way which tends toward materialism.

*The Analysis of Matter*

Chapter I (p. 7)

Harcourt, Brace &amp; Company, Inc. New York, New York, USA. 1927

It is obvious that a man who can see, knows things that a blind man cannot know; but a blind man can know the whole of physics.

*The Analysis of Matter*

Chapter XXXVII (p. 389)

Harcourt, Brace &amp; Company, Inc. New York, New York, USA. 1927



The aim of physics, consciously or unconsciously, has always been to discover what we may call the causal skeleton of the world.

*The Analysis of Matter*

Chapter XXXVII (p. 391)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

Naive realism leads to physics, and physics, if true, shows that naive realism is false. Therefore naive realism, if true, is false; therefore it is false.

In John D. Barrow

*The World Within the World* (p. 144)

Clarendon Press. Oxford, England. 1988

Physics is mathematical not because we know so much about the physical world, but because we know so little: it is only its mathematical properties that we can discover.

In John D. Barrow

*The World Within the World* (p. 278)

Clarendon Press. Oxford, England. 1988

Broadly speaking, traditional physics has collapsed into two portions, truisms and geography.

*The ABC of Relativity*

Chapter XV

George Allen & Unwin Ltd. London, England. 1958

I come now to the statistical part of physics, which is concerned with the study of large aggregates. Large aggregates behave almost exactly as they were supposed to do before quantum theory was invented, so that in regard to them the older physics is very nearly right. There is, however, one supremely important law which is only statistical; this is the second law of thermodynamics. It states, roughly speaking, that the world is growing continuously more disorderly.

*Scientific Metaphysics*

The Scientific Outlook (p. 92)

George Allen & Unwin Ltd. London, England. 1931

Physics, it is plain, tells us something about some of the constituents of the actual world; what these constituents are may be doubtful, but it is they that are to be called physical, whatever their nature may prove to be.

*Mysticism and Logic: And Other Essays*

Chapter VIII (p. 150)

Longmans, Green & Co. London, England. 1919

**Sandage, Allan** 1926–

American astronomer

It is such a strange conclusion...it cannot really be true.

In Robert Jastrow

*God and the Astronomers*

Chapter 6 (p. 113)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Schlegel, Friedrich** 1772–1829

German poet

It is in fact wonderful how physics – as soon as it is concerned not with technical purposes but with general results – without knowing it gets into cosmogony,

astrology, theosophy, or whatever you wish to call it, in short, into a mystic discipline of the whole.

Translated by Ernst Behler and Roman Struc

*Dialogue on Poetry and Literary Aphorisms*

Talk on Mythology (p. 90)

The Pennsylvania State University Press. University Park, Pennsylvania, USA. 1968

**Schlick, Moritz** 1882–1936

German philosopher

Physics has ascended to summits hitherto visible only to philosophers, whose gaze has, however, not always been free from metaphysical haziness.

Translated by Henry L. Brose

*Space and Time in Contemporary Physics*

Chapter I (p. 1)

Oxford University Press. New York, New York, USA. 1920

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

Schrödinger: “Surely you realize the whole idea of quantum jumps is bound to end in nonsense...if the jump is sudden, Einstein’s idea of light quanta will admittedly lead us to the right wave number, but then we must ask ourselves how precisely the electron behaves during the jump. Why does it not emit a continuous spectrum, as electromagnetic theory demands? And what law governs its motion during the jump? In other words, the whole idea of quantum jumps is sheer fantasy.”

Niels Bohr: “What you say is absolutely correct. But it does not prove that there are no quantum jumps. It only proves that we cannot describe them, that the representational concepts with which we describe events in daily life and experiments in classical physics are inadequate when it comes to describing quantum jumps.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (pp. 73–74)

Harper & Row, Publishers. New York, New York, USA. 1971

Research in physics has shown beyond the shadow of a doubt that in the overwhelming majority of phenomena whose regularity and invariability have led to the formulation of the postulate of causality, the common element underlying the consistency observed is chance.

*What Is Natural Law*

Clarendon Press. Oxford, England. 1988

**Scotty (Fictional character)**

[To Captain Kirk on innumerable occasions] But I cannot change the laws of physics, Captain!

*Star Trek*

Television program

**Smith, Henry John Stephen** 1826–83

Irish mathematician

So intimate is the union between mathematics and physics that probably by far the larger part of the accessions

to our mathematical knowledge have been obtained by the efforts of mathematicians to solve the problems set to them by experiment, and to create “for each successive class of phenomena, a new calculus or a new geometry, as the case might be, which might prove not wholly inadequate to the subtlety of nature.” Sometimes, indeed, the mathematician has been before the physicists, and it has happened that when some great and new question has occurred to the experimentalist or the observer, he has found in the armory of the mathematician the weapons which he has needed ready made to his hand. But, much oftener, the questions proposed by the physicist have transcended the utmost powers of the mathematics of the time, and a fresh mathematical creation has been needed to supply the logical instrument requisite to interpret the new enigma.

Presidential Address British Association for the Advancement of Science *Nature*, Section A, Volume 8, Number 204, September 25, 1873 (p. 450)

### **Snow, Charles Percy** 1905–80

English novelist and scientist

He then gave me an explanation which I could not understand, although I had heard plenty of the jargon of nuclear physics from him and Luke. “Fission.” “Neutrons.” “Chain reaction.” I could not follow. But I could gather that at last the sources of nuclear energy were in principle open to be set loose; and that it might be possible to make an explosive such as no one had realistically imagined.

*The New Men* (p. 11)

Charles Scribner’s Sons. New York, New York, USA. 1955

I now believe that if I had asked an even simpler question – such as, What do you mean by mass, or acceleration, which is the scientific equivalent of saying, Can you read? – not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their neolithic ancestors would have had.

*The Two Cultures: And a Second Look*

Chapter I (p. 15)

At The University Press. Cambridge, England. 1964

### **Sobel, Michael I.**

No biographical data available

A friend of mine once said that the trouble with being an architect is that everyone is an architect; everyone knows what’s good and what’s bad. I seem to remember the same story told by an economist. In physics we don’t have that problem.

*Light*

Preface (p. ix)

The University of Chicago Press. Chicago, Illinois, USA. 1987

### **Stallo, John Bernhard** 1823–1900

German-American academic, jurist, philosopher, and ambassador

The science of physics, in addition to the general laws of dynamics and their application to the interaction of solid, liquid, and gaseous bodies, embraces the theory of those agents which were formerly designated as imponderables – light, heat, electricity, magnetism., etc.; and all these are now treated as forms of motion, as different manifestations of the same fundamental energy...

*The Concepts and Theories of Modern Physics*

Chapter II (p. 27)

D. Appleton & Company. New York, New York, USA. 1885

### **Standen, Anthony**

Anglo-American science writer

Physics is not about the real world, it is about “abstractions” from the real world, and this is what makes it so scientific.

*Science Is a Sacred Cow*

Chapter III (p. 61)

E.P. Dutton. New York, New York, USA. 1950

Physics is NOT a body of indisputable and immutable Truth; it is a body of well-supported probable opinion only....

*Science Is a Sacred Cow*

Chapter III (p. 68)

E.P. Dutton. New York, New York, USA. 1950

...the extraordinary degree of dullness that pervades the laboratory periods of physics courses...[is] so acute that for many people it is the bitterest experience of their education.

*Science Is a Sacred Cow*

Chapter III (p. 83)

E.P. Dutton. New York, New York, USA. 1950

...physics can never prove things the way things are proved in mathematics, by eliminating *all* of the alternative possibilities. It is not possible to say what the alternative possibilities are....

*Science Is a Sacred Cow*

Chapter III (p. 88)

E.P. Dutton. New York, New York, USA. 1950

It is *true* that physics gives a wonderful training in precise, logical thinking-about physics. It really does depend upon accurate reproducible experiments, and upon framing hypotheses with the greatest possible freedom from dogmatic prejudice. And if these were the really important things in life, physics would be an essential study for everybody.

*Science Is a Sacred Cow*

Chapter III (pp. 90–91)

E.P. Dutton. New York, New York, USA. 1950

### **Sullivan, John William Navin** 1886–1937

Irish mathematician

The present tendency of physics is toward describing the universe in terms of mathematical relations between unimaginable entities.

*The Bases of Modern Science* (p. 226)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1929

**Teilhard de Chardin, Pierre** 1881–1955  
French Jesuit, paleontologist, and biologist

The time has come to realise that an interpretation of the universe – even a positive one – remains unsatisfying unless it covers the interior as well as the exterior of things; mind as well as matter. The true physics is that which will, one day, achieve the inclusion of man in his wholeness in a coherent picture of the world.

*The Phenomenon of Man*

Forward (pp. 35–36)

Harper & Brothers. New York, New York, USA. 1959

## The X-Files

MULDER: [I]n most of my work, the laws of physics rarely seem to apply.

*Pilot*

Television program

Season 1, 1993

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

As soon as we adventure on the paths of the physicist, we learn to weigh and to measure, to deal with time and space and mass and their related concepts, and to find more and more our knowledge expressed and our needs satisfied through the concept of number, as in the dreams and visions of Plato and Pythagoras ...

*On Growth and Form*

Introductory (p. 2)

At the University Press. Cambridge, England. 1945

## Trowbridge, John

American physicist

Mathematical problems in physics have their place in teaching; but physics should not be made a means of teaching mathematics.

*The New Physics*

Preface (p. ix)

D. Appleton & Co. New York, New York, USA. 1884

**Truesdell, Clifford** 1919–2000

American mathematician, natural philosopher, and historian of mathematics

Pedantry and sectarianism aside, the aim of theoretical physics is to construct mathematical models such as to enable us, from the use of knowledge gathered in a few observations, to predict by logical processes the outcomes in many other circumstances. Any logically sound theory satisfying this condition is a good theory, whether or not it be derived from “ultimate” or “fundamental” truth. It is as ridiculous to deride continuum physics because it is not obtained from nuclear physics as it would be to reproach it with lack of foundation in the Bible.

In Clifford Truesdell and Walter Noll

*The Non-Linear Field Theories of Mechanics* (2nd edition) (pp. 2–3)

Springer-Verlag. Berlin, Germany. 1992

**Tyndall, John** 1820–93  
Irish-born English physicist

The ultimate problem of physics is to reduce matter by analysis to its lowest condition of divisibility, and force to its simplest manifestations, and then by synthesis to construct from these elements the world as it stands.

*Fragments of Science for Unscientific People*

Chapter V (p. 100)

D. Appleton & Co. New York, New York, USA. 1875

The term Physics, as made use of in the present Lecture, refers to that portion of natural science which lies midway between astronomy and chemistry. The former, indeed, is Physics applied to ‘masses of enormous weight,’ while the latter is Physics applied to atoms and molecules.

*Fragments of Science: A Series of Detached Essays, Addresses, and*

*Reviews* (Volume 1)

Chapter XI (p. 282)

D. Appleton & Co. New York, New York, USA. 1896

...I claim for the study of Physics the recognition that it answers to an impulse implanted by nature in the human constitution, and he who would oppose such study must be prepared to exhibit the credentials which authorize him to contravene Nature’s manifest designs.

In Royal Institute of Great Britain

*Lectures on Education: Delivered at the Royal Institute of Great Britain*

On the Importance of the Study of Physics (p. 179)

John W. Parker & Son. London, England. 1854

**Ulam, Stanislaw** 1909–84

Polish-born mathematician

I should add here for the benefit of the reader who is not a professional physicist that the last thirty years or so have been a period of kaleidoscopically changing explanations of the increasingly strange world of elementary particles and of fields of force. A number of extremely talented theorists vie with each other in learned and clever attempts to explain and order the constant flow of experimental results which, or so it seems to me, almost perversely cast doubts about the just completed theoretical formulations.

*Adventures of a Mathematician*

Chapter 13 (p. 261)

Charles Scribner’s Sons. New York, New York, USA. 1976

**van Sant, Gus** 1952–

American film editor

Like a disc jockey from Paradise, Howard flips Marie over and plays her B side. Every now and then she reaches for Sissy to include her, but the laws of physics insist on being obeyed.

*Even Cowgirls Get the Blues*

Screenplay (p. 34)

Faber & Faber Ltd. London, England. 1993

**von Baeyer, Hans Christian** 1938–

German-born physicist and author

When [an electron] is passing through the slits, it is a wave, when it is caught, it is a particle.... An atom, according to Bohr, represents a different reality from that of the ordinary world of our sense perceptions, and it is unreasonable to insist on forcing the language of our familiar macroscopic surroundings onto that alien mode of existence.

*Taming the Atom*

Chapter 13 (p. 197)

Random House, Inc. New York, New York, USA. 1992

**von Braun, Werner** 1912–77

German-American rocket scientist

Everything in space obeys the laws of physics. If you know these laws, and obey them, space will treat you kindly.

Reach for the Stars

*Time*, February 17, 1958

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Physics must be sharply distinguished from mathematics. The former must stand in clear independence, penetrating into the sacred life of nature in common with all the forces of love, veneration and devotion. The latter, on the other hand, must declare its independence of all externality, go its own grand spiritual way, and develop itself more purely than is possible so long as it tries to deal with actuality and seeks to adapt itself to things as they really are.

*Werke*

Schriften zur Naturwissenschaft, XXXIX (p. 92)

Temple-Verlag. Berlin, Germany. 1963

**von Weizsäcker, Carl Friedrich**

**(Baron)** 1912–2007

German theoretical physicist and philosopher

Physics begins by facing a mystery. It transforms the mystery into a puzzle. It solves the puzzle. And it finds itself facing a new mystery.

In Pekka Lahti and Peter Mittelstaedt

*Symposium on the Foundations of Modern Physics: 50 Years of the Einstein–Podolsky–Rosen Gedankenexperiment*

Quantum Theory and Space-Time (p. 237)

**Weinberg, Steven** 1933–

American nuclear physicist

Our job in physics is to see things simply, to understand a great many complicated phenomena, in terms of a few simple principles.

In Robert K. Adair

*The Great Design* (p. 325)

Oxford University Press, Inc. New York, New York, USA. 1987

I think that is one of the great things about physics, that it is sufficiently precise that it makes predictions which can

be disproved by observation, and which occasionally are. And, when you have that experience, you know that there is something out there that is not all just coming out of your closed society of fellow physicists. It's, I think, one of the things that I love so much about physics, the dialogue with nature; and this dialogue is not one in which nature always agrees with the physicists.

*Does Physics Describe Reality?*

The Challenge of the Universe

From *Hypermind* CD-ROM

Physics is not a finished logical system. Rather, at any moment it spans a great confusion of ideas, some that survive like folk epics from the heroic periods of the past, and others that arise like utopian novels from our dim premonitions of a future grand synthesis.

*Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity*

Part I, Chapter I (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1972

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

**Rosenbaum, E. P.**

No biographical data available

Modern physics is frequently accused of deserting the real world for abstract mathematics. Instead of attempting to explain nature in terms of what we can see and feel, the impeachment runs, theoretical physicists offer only an arid set of equations whose physical meaning they will not even think about, let alone interpret to the vulgar.

A Model of the Nucleus

*Scientific American*, Volume 193, Number 6, December, 1955 (p. 84)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The science of physics is even more tantalizing than it was half a century ago, and, above the level of an elementary introduction, optics, acoustics and the rest, even less teachable. The more brilliant investigators rocket off into mathematical pyrotechnics and return to common speech with statements that are, according to the legitimate meanings of words, nonsensical.

*Experiment in Autobiography*

Chapter 5, Section 2 (p. 176)

The Macmillan Company. New York, New York, USA. 1934

**Wheeler, John Archibald** 1911–

American physicist and educator

No point is more central than this, that empty space is not empty. It is the seat of the most violent physics.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 8 (p. 274)

Simon & Schuster. New York, New York, USA. 1982

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Physics refers to ether, electrons, molecules, intrinsically incapable of direct observation.

*The Principle of Relativity with Application to Physical Science* (p. 62)  
The University Press. Cambridge, England. 1922

...in the present-day reconstruction of physics, fragments of the Newtonian concepts are stubbornly retained. The result is to reduce modern physics to a sort of mystic chant over an unintelligible universe.

*Modes of Thought*

Chapter III, Lecture VII (p. 185)

The Macmillan Company. New York, New York, USA. 1938

**Whyte, A. Gowans**

Scottish writer

The progress of human thought is through metaphysics to physics.

The Triumph of Physics

*The Rationalist Annual*, 1931 (p. 28)

**Wiener, Norbert** 1894–1964

American mathematician

Physics – or so it is generally supposed – takes no account of purpose...

*God and Golem, Inc.: A Comment on Certain Points Where Cybernetics Impinges on Religion*

Chapter I (p. 5)

The MIT Press. Cambridge, Massachusetts, USA. 1964

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

Physics does not endeavor to explain nature. In fact, the great success of physics is due to the restriction of its objectives: it endeavors to explain the regularities in the behavior of objects. The renunciation of the broader aim, and the specification of the domain for which an explanation can be sought, now appears to us as an obvious necessity. In fact, the specification of the explainable may have been the greatest discovery of physics so far.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1963

Events, Laws of Nature, and Invariance Principles (p. 2)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

We have ceased to expect from physics an explanation of all events, even of the gross structure of the universe, and we aim only at the discovery of the laws of nature, that is the regularities, of the events.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1963

Events, Laws of Nature, and Invariance Principles (p. 9)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Wilczek, Frank** 1951–

American theoretical physicist

In physics, you don't have to go around making trouble for yourself – nature does it for you.

*Longing for the Harmonies*

How Asymptotic Freedom Discovered Me (p. 208)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

In physics, your solution should convince a reasonable person. In math, you have to convince a person who's trying to make trouble. Ultimately, in physics, you're hoping to convince Nature. And I've found Nature to be pretty reasonable.

*Fantastic Realities: 49 Mind Journeys and a Trip to Stockholm*

Nobel blog (p. 516)

World Scientific Publishing Co. Hackensack, New Jersey, USA. 2006

**Woodhull, John Francis**

American physical science teacher

The first purpose of a beginning course in physics, whether in grammar school, high school, or college, should be to make nature and her ways seem natural.

*The Teaching of Science*

Chapter VI (p. 83)

The Macmillan Co. New York, New York, USA. 1918

**Ziman, John M.** 1925–2005

English physicist

The most astonishing achievements of science, intellectually and practically, have been in physics, which many people take to be the ideal type of scientific knowledge. In fact, physics is a very special type of science, in which the subject matter is deliberately chosen so as to be amenable to quantitative analysis.

*Reliable Knowledge*

Chapter 1 (p. 9)

Cambridge University Press. Cambridge, England. 1978

Physics defines itself as the science devoted to discovering, developing and refining those aspects of reality that are amenable to mathematical analysis.

*Reliable Knowledge*

Chapter 2 (p. 28)

Cambridge University Press. Cambridge, England. 1978

In the education of a physicist, we recount the bold voyages of great explorers – Newton and Einstein, Faraday and Bohr – in search of new laws of nature. They found and charted the continents on which we have built our cities of the mind and of art. Does anyone really suppose that similar vast and fertile territories are still waiting to be discovered and colonized? The unaccustomed rules that govern black holes and quasars in the cosmic deeps affect our lives no more than the icy crags of the Himalayas or the conjunctions of the planets.

*Physics Bulletin*, Volume 25, 1974 (p. 280)

Think of physics simply as the “fundamental” science and it is oversubscribed almost to bankruptcy. But define it as the science whose aim is to describe natural phenomena in the most mathematical or numerical language, and you will understand its past and have confidence in its future. The task of the modern physicist is to determine the mathematically comprehensible characteristics



of the natural world and of human artifacts...  
*Physics Bulletin*, Volume 25, 1974 (p. 280)

### Zukav, Gary

American spiritual teacher

Unfortunately, when most people think of “physics”, they think of chalkboards covered with undecipherable symbols of an unknown mathematics. The fact is that physics is not mathematics. Physics, in essence, is simple wonder at the way things are and a divine (some call it compulsive) interest in how that is so. Mathematics is the tool of physics. Stripped of mathematics, physics becomes pure enchantment.

*The Dancing Wu Li Masters: An Overview of the New Physics*

Part One

Wu Li?

Chapter I (p. 31)

William Morrow. New York, New York, USA. 1979

## PHYSICS AND PHILOSOPHY

### Kosso, Peter

No biographical data available

Physics and philosophy sections are usually at opposite ends of the bookstore. While physics presides over the hard sciences, philosophy is somewhere beyond even the softer sciences, past psychology and to the left, against the wall with those tenuous, speculative topics like the occult and spiritualism. This is an unfortunate floor-plan because it gives a misleading impression of the relation between physics and philosophy.

*Appearance and Reality: An Introduction to the Philosophy of Physics*

Chapter 1 (p. 7)

Oxford University Press. Oxford, England. 1998

### Planck, Max 1858–1947

German physicist

Physic, it may be urged, is solely concerned with the objects and events of inanimate nature, while a general philosophy, if it is to be at all satisfactory, must embrace the whole of physical and intellectual life and must deal with questions of the soul, including the highest problems of ethics.

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter I (p. 9)

W.W. Norton & Co. New York, New York, USA. 1936

## PHYSICS, LAWS OF

### Harker, Alfred 1859–1939

English petrologist

...the laws of physics and chemistry must be the same in a crucible as in the larger laboratory of Nature ...

*The Natural History of Igneous Rocks*

Chapter XII (p. 282)

The Macmillan Co. New York, New York, USA. 1909

### London, Jack 1876–1916

American author

It obeyed no known laws of physics, and overthrew the hoary axiom that like things performed to like things produce like results.

*John Barleycorn*

Chapter XXIII (pp. 221–222)

The Century Co. New York, New York, USA. 1913

### Thompson, Sir D’Arcy Wentworth 1860–1948

Scottish zoologist and classical scholar

Cell and tissue, shell and bone, leaf and flower, are so many portions of matter, and it is in obedience to the laws of physics that their particles have been moved, molded and conformed.

*On Growth and Form*

Introductory (p. 10)

At the University Press. Cambridge, England. 1945

## PHYSICS, PROBLEMS OF

### Feynman, Richard P. 1918–88

American theoretical physicist

When the problems in physics become difficult we may often look to the mathematician who may already have studied such things and have prepared a line of reasoning for us to follow. On the other hand they may not have, in which case we have to invent our own line of reasoning, which we then pass back to the mathematician.

*The Character of Physical Law*

Chapter 1 (p. 39)

BBC. London, England. 1965

## PHYSICS, STUDENT OF

### Lewis, Exum Percival

No biographical data available

The student of Physics cannot...hope to find out why things happen; he can only expect to find out how they happen and to formulate this experience in general descriptions or laws.

*Notes on the Properties of Matter and Heat*

Introductory (p. 2)

Percival Lewis. Berkeley, California, USA. 1903

## PHYSICS, THEORETICAL

### Dirac, Paul Adrien Maurice 1902–84

English theoretical physicist

...mathematics is the tool specially suited for dealing with abstract concepts of any kind, and there is no limit to its power in this field [theoretical physics]. For this reason a book on the new physics, if not purely descriptive of experimental results, must be essentially mathematical.



In George D. Birkhoff  
*Science for a New World*  
 Mathematics, Quantity and Order (p. 296)  
 Harper & Brothers Publishers. New York, New York, USA. 1934

...the only object of theoretical physics is to calculate results that can be compared with experiment, and it is quite unnecessary that any satisfying description of the whole course of the phenomenon should be given.

In George D. Birkhoff  
*Science for a New World*  
 Mathematics, Quantity and Order (p. 296)  
 Harper & Brothers Publishers. New York, New York, USA. 1934

## PHYSIOGNOMY

**Miller, Hugh** 1802–56  
 Scottish geologist and theologian

Physiognomy is no idle or doubtful science in connection with geology. The physiognomy of a country indicates almost invariably its geological character.

*The Old Red Sandstone*  
 Chapter XI (p. 201)  
 J.M. Dent & Sons Ltd. London, England. 1922

## PHYSIOLOGIST

**Bernard, Claude** 1813–78  
 French physiologist

...physiologists should not be afraid to act somewhat at random, so as to try – permit me the common expression – fishing in troubled waters. This amounts to saying that, in the midst of the functional disturbances which they produce, they may hope to see some unexpected phenomena emerge which may give direction to their research.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine* (pp. 20–21)  
 Henry Schuman, Inc. New York, New York, USA. 1927

A physiologist is not a man of fashion, he is a man of science, absorbed by the scientific idea which he pursues: he no longer hears the cry of animals, he no longer sees the blood that flows, he sees only his idea and perceives only organisms concealing problems which he intends to solve.

*An Introduction to the Study of Experimental Medicine*  
 Part Two, Chapter II (p. 103)  
 Henry Schuman, Inc. New York, New York, USA. 1949

**Collingwood, Robin George** 1889–1943  
 English historian and philosopher

A physiologist...can certainly offer a definition of life; but this will only be an interim report on the progress of physiology to date. For him, as for the beginner, it is the nature of physiology that is relatively certain; it is the nature of life that is relatively vague.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*  
 Part I, Chapter I. Aphorism 1.47 (p. 3)  
 At The Clarendon Press. Oxford, England. 1942

**Mayo, Charles Horace** 1865–1939  
 American physician

Disease at times creates experiments that physiology completely fails to duplicate, and the wise physiologist can obtain clues to the resolution of many problems by studying the sick.

La funcion del higado en relacion con la cirugia  
*Annals de Circulation*, Volume 2, April, 1930

**Pirenne, M. H.**  
 No biographical data available

The soul, the mind, consciousness, thought, sensation, being nonmaterial, are not observable in physiological investigation like, say, nerve excitation or muscle contraction. Physiology gives no direct experimental evidence for them. Yet like all men, physiologists no doubt believe they have minds. Hence a dilemma.

*British Journal for the Philosophy of Science*, Volume 1, 1950/1951

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

The physiologist says it [ripening of fruit] is “due to an increased absorption of oxygen – That is the scientific account of the matter – only a reassertion of the fact. But I am more interested in the rosy cheek than I am to know what particular diet the maiden fed on.

*Excursions*  
 Autumnal Tints (p. 206)

## PHYSIOLOGY

**Bernard, Claude** 1813–78  
 French physiologist

General physiology is the basic biological science toward which all others converge.

Translated by Henry C. Greene  
*An Introduction to the Study of Experimental Medicine*  
 Chapter III  
 Henry Schuman, Inc. New York, New York, USA. 1927

**Cuvier, Georges** 1769–1832  
 French zoologist and statesman

All parts of a living body are interrelated; they can act only in so far as they act together; trying to separate one from the whole means transferring it to the realm of dead substances; it means entirely changing its essence.

Henry C. Greene  
 In Claude Bernard  
*An Introduction to the Study of Experimental Medicine*  
 III (p. 267)  
 Henry Schuman, Inc. New York, New York, USA. 1927

**Flexner, Abraham** 1866–1959  
American educator

Physiology is, in a sense, the central discipline of the medical school. It is the business of the physician to restore normal functioning: normal functioning is thus his starting-point in thought, his goal in action.

*Medical Education in the United States and Canada*

Chapter IV (p. 63)

The Carnegie Foundation. New York, New York, USA. 1910

**Gee, Samuel** 1839–1911  
Physician

Physiology owes more to medicine than medicine to physiology. Nature in disease performs vivisections for us. The greater and better part of what we know concerning the functions of the many organs of the body is derived from pathological observation and not from physiological experiment.

*Medical Lectures and Aphorisms* (p. 227)

Smith, Elder. London, England. 1902

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Anatomy studies the organism in space. Physiology studies it also in time.

*The Writings of Oliver Wendell Holmes* (Volume 9)

*Medical Essays: 1842–1882*

Chapter IV (p. 232)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

**Huxley, Thomas Henry** 1825–95  
English biologist

There is no side of the human mind which physiological study leaves uncultivated. Connected by innumerable ties with abstract science, Physiology is yet in the most intimate relation with humanity, and by teaching us that law and order, and a definite scheme of development, regulate even the strangest and wildest manifestations of individual life, she prepares the student to look for a goal even amidst the erratic wanderings of mankind, and to believe that history offers something more than an entertaining chaos – a journal of a toilsome, tragi-comic march nowhither.

*Collected Essays* (Volume 33)

*Science and Education*

On the Educational Value of the Natural History of Science (p. 59)

Macmillan & Company Ltd. London, England. 1904

A thorough study of Human Physiology is, in itself, an education broader and more comprehensive than much that passes under that name. There is no side of the intellect which it does not call into play, no region of human knowledge into which either its roots, or its branches, do not extend; like the Atlantic between the Old and the New Worlds, its waves wash the shores of the two worlds of matter and of mind; its tributary streams flow from both; through its waters, as yet unfurrowed by the keel

of any Columbus, lies the road, if such there be, from the one to the other; far away from that North-west Passage of mere speculation, in which so many brave souls have been hopelessly frozen up.

*Collected Essays* (Volume 33)

*Science and Education*

Universities: Actual and Ideal (p. 220)

Macmillan & Company Ltd. London, England. 1904

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

It is perfectly clear that the horizon of medical observation of life is immeasurably wider than the sphere of vital phenomena which the physiologists have before their eyes in their laboratories. Hence the permanent incongruity between that which medicine knows, sees and empirically applies, and that which physiology can reproduce and explain.

*Experimental Psychology and Other Essays*

Concerning Trophic Innervation (p. 74)

Philosophical Library. New York, New York, USA. 1957

The outer limit of physiological knowledge, its goal, is to express this infinitely complex interrelationship of the organism with the surrounding world in the form of an exact scientific formula.

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Chapter 5 (p. 153)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Starling, Ernest Henry** 1866–1927  
English physiologist

In physiology, as in all other sciences, no discovery is useless, no curiosity misplaced or too ambitious, and we may be certain that every advance achieved in the quest of pure knowledge will sooner or later play the part in the service of man.

*The Linacre Lecture on the Law of the Heart* (p. 147)

Publisher undetermined

**Richards, Herbert Maul** 1871–1928  
No biographical data available

It is in the field of physiology more than anywhere else, perhaps, that the worker must humble himself before the immensity of the problems before him; that he must realize how fragmentary is the most advanced knowledge of this subject.

*Lectures on Science, Philosophy and Art, 1907–1908*

Botany (pp. 15–16)

The Columbia University Press. New York, New York, USA. 1908

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

Of physiology from top to toe I sing ...

*Leaves of Grass*

One's-Self I Sing

Doubleday, Page & Co. Garden City, New York, USA. 1919

**Whittaker, James Thomas**

No biographical data available

It is physiology which distinguished regular medicine from charlatanry.

*Physiology*

Lecture I (p. 15)

Chancy R. Murry. Cincinnati, Ohio, USA. 1879

**PI****Beckmann, Petr** 1924–93

Physicist

The digits beyond the first few decimal places are of no practical or scientific value. Four decimal places are sufficient for the design of the finest engines; ten decimals are sufficient to obtain the circumference of the earth to within a fraction of an inch if the earth were a smooth sphere...

*A History of Pi*

Chapter 10 (p. 100)

St. Martin's Press. New York, New York, USA. 1974

**Chudnovsky, David**

Mathematician

Maybe in the eyes of God pi looks perfect.

In Richard Preston

*The Mountains of Pi*

*The New Yorker* March 2, 1992

**de Morgan, Augustus** 1806–71

English mathematician and logician

...mysterious 3.14159...comes in at every door and window, and down every chimney.

*A Budget of Paradoxes*

Cyclometry (p. 393)

Longmans, Green. London, England. 1872

**Duffin, R. J.**

No biographical data available

God created the world and the integers, all in seven days. He then ordered two of his biotechnicians, James and Francis, to construct a genetic code for the fractional numbers. Moreover, they were to give special prominence to His favorite number, pi.

The Patron Saint of Mathematics

*The Mathematical Intelligencer*, Volume 15, Number 1, 1993 (p. 52)

**Graham, L. A.**

No biographical data available

Fiddle de dum, fiddle de dee,  
A ring round the moon is pi times D;  
But if a hole you want repaired,  
You use the formula pi r<sup>2</sup>.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 1

Dover Publications, Inc. New York, New York, USA. 1959

Little Jack Horner sat in a corner,

Trying to evaluate pi.

He disdained rule of thumb,

Found an infinite sum,

And exclaimed "It's REAL, nary an I."

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 9

Dover Publications, Inc. New York, New York, USA. 1959

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

The value of [pi] has engaged the attention of many mathematicians and calculators from the time of Archimedes to the present day, and has been computed from so many different formulae, that a complete account of its calculation would almost amount to a history of mathematics.

In William Dunham

*The Genius of Euler: Reflections on His Life and Work*

On the History of Euler's Constant (p. 147)

The Mathematical Association of America. Washington, D.C. 2007

**Kac, Mark** 1914–84

Polish mathematician

Steinhaus, with his predilection for metaphors, used to quote a Polish proverb, "*Fortunny kolem sie toczy*" (Luck runs in circles), to explain why pi, so intimately connected with circles, keeps cropping up in probability theory and statistics, the two disciplines which deal with randomness and luck.

*Enigmas of Chance: An Autobiography*

The Search for the Meaning of Independence (p. 55)

Harper & Row, Publishers. New York, New York, USA. 1985

**Morgan, Robert**

No biographical data available

The secret relationship of line and circle, progress and return, is always known, transcendental and yet a commonplace. And though the connection is written it cannot be written out in full, never perfect, but is exact and constant, is eternal and everyday as orbits of electrons, chemical rings, noted here in one brief sign as gateway to completed turns and the distance inside circles, both compact and infinite.

*Poetry*

Pv. clxi, Number 4 (January, 1993) (p. 204)

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

Ten decimals are sufficient to give the circumference of the earth to a fraction of an inch, and thirty decimals would give the circumference of the whole visible universe to a quantity imperceptible with the most powerful microscope.

Quoted in Herbert Edwin Hawkes, William Arthur Luby and Frank Charles Touton

*Plane Geometry* (p. 273)

Ginn & Co. Boston, Massachusetts, USA. 1920

### Preston, Richard

No biographical data available

The digits of pi march to infinity in a predestined yet unfathomable code: they do not repeat periodically, seeming to pop up by blind chance, lacking any perceivable order, rule, reason, or design – “random” integers, ad infinitum.

The Mountains of Pi

*The New Yorker*, March 2, 1992

...pi is not the solution to any equation built from a less than infinite series of whole numbers. If equations are trains threading the landscape of numbers, then no train stops at pi.

The Mountains of Pi

*The New Yorker*, March 2, 1992

## PILL

### Crichton-Browne, Sir James 1840–1938

English physician

If you want fame and fortune, invent a pill.

*The Doctor's After Thoughts* (p. 14)

E. Benn Ltd. London, England. 1932

### Fuller, Thomas 1608–61

English clergyman and author

If the pills were pleasant, they would not want gilding.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*

No. 2711

Printed for Thomas and Joseph Allman. London, England. 1816

### Herrick, Robert 1591–1674

English poet

When his potion and his pill

His, or none, or little skill

Meet for nothing, but to kill;

Sweet Spirit comfort me!!

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

His Litanie, to the Holy Spirit (p. 132)

W.W. Norton & Company, Inc. New York, New York, USA. 1968

### Jerrold, Douglas William 1803–57

English playwright, journalist, and humorist

A pill that the present moment is daily bread to thousands.

*The Catspaw: A Comedy in Five Acts*

Act I, Scene I

Published at the Punch Office. London, England. 1850

### Molière (Jean-Baptiste Poquelin) 1622–1673

French playwright and actor

My lord Jupiter knows how to gild the pill.

*Amphitryon*

Act III, Scene X, I. 24

Harcourt, Brace & Company. New York, New York, USA. 1995

### Ray, John 1627–1705

English naturalist

Apothecaries would not give pills in sugar unless they were bitter.

*A Complete Collection of English Proverbs* (p. 2)

Printed for G. Cowie. London, England. 1813

### Shakespeare, William 1564–1616

English poet, playwright, and actor

When I was sick, you gave me bitter pills.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Two Gentlemen of Verona*

Act II, Scene iv, I. 149

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Stumpf, LaNore

No biographical data available

How is it that a little pill

Without a pair of eyes to see

Can travel down, and round and round

And figure out what's wrong with me?

Needed: Remote Control

*American Journal of Nursing*, April, 1969 (p. 902)

## PION

### Marshak, Robert E. 1916–92

American physicist

The cement that holds the universe together is the force of gravity. The glue holding the atom together is electro-magnetic attraction. But the glue that holds the nucleus of the atom together is a mystery that defies all our experience and knowledge of the physical world. It is a force so unlike any we know that we can hardly find words to describe it. We do have a clue, however, to which we can give a name. It is the pi meson, or pion.

Pions

*Scientific American*, Volume 196, Number 1, 1957 (p. 840)

## PIONEER

**de La Beche, Henry Thomas** 1796–1855  
English geologist

The work of pioneers is certainly laborious, and little suits minds which desire to advance rapidly and grasp all at once ...

*Sections & Views, Illustrative of Geological Phaenomena*  
Preface (p. vi)  
Treuttel & Wurtz. London, England. 1830

**Eliot, Charles William** 1834–1926  
American academic

The pioneers of science, like the pioneers in exploration and colonization, must find their way through pathless regions.

Address by President Charles W. Eliot  
*Science*, N.S. Volume 24, Number 601, July 6, 1906 (p. 15)

## PIPETTE

**Delbrück, Max** 1906–81  
German-born American biologist

...the pipette is my clarinet ...  
A Physicist's Renewed Look at Biology –  
Twenty Years Later

## PLAGIARISM

**Brewster, George**  
No biographical data available

No bold, independent and vigorous thinker – none but a mere intellectual parrot – would stoop to such servile imitation of others, when before him lies, spread out in endless perspective, a vast, unexplored, immeasurable wilderness of knowledge, which would give scope for ages upon ages, yea for eternity itself, to the untamed energies of the most powerful intellect that men or angels ever saw.

*A New Philosophy of Matter, Showing the Identity of All the Imponderables* (3rd edition)  
Chapter I  
Edward H. Fletcher. New York, New York, USA. 1858

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

If we steal thoughts from the moderns, it will be cried down as plagiarism; if from the ancients, it will be cried up as erudition.

*Lacon: or, Many Things in Few Words*  
Plagiarism (p. 232)  
William Tegg. London, England. 1866

**Lowell, James Russell** 1819–91  
American poet, critic, essayist, editor, and diplomat

...borrowed garments never keep one warm. A curse goes with them, as with Harry Gill's blankets. Nor can one get smuggled goods safely into kingdom-come. How lank and pitiful does one of these gentry look, after posterity's customs-officers have had the plucking of him!  
*Conversations on Some of the Old Poets* (3rd edition)  
Chaucer, Second Conversation (p. 65)  
David McKay, Publisher. Philadelphia, Pennsylvania, USA 1893

**Macaulay, Thomas Babington** 1800–50  
English historian and writer

There is a very pretty Eastern tale, of which the fate of plagiarists often reminds us. The slave of a magician saw his master wave his wand, and heard him give orders to the spirits who arose at the summons. He accordingly stole the wand, and waved it himself in the air; but he had not observed that his master used the left hand for that purpose. The spirits thus irregularly summoned, tore him to pieces, instead of obeying his orders.  
*Critical and Miscellaneous Essays* (Volume V)  
Mr. Robert Montgomery's Poems (p. 300)  
Carey & Hart. Philadelphia, Pennsylvania, USA. 1844

## PLAGIARIST

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

I have somewhere seen it observed, that we should make the same use of a book that the bee does of a flower: she steals sweets from it, but does not injure it; and those sweets she herself improves and concocts into honey. But most plagiarists, like the drone, have neither taste to select, nor industry to acquire, nor skill to improve, but impudently pilfer the honey ready prepared from the hive.  
*Lacon: or, Many Things in Few Words*  
Plagiarism (p. 232)  
William Tegg. London, England. 1866

## PLAINLY APPEARS

**Bowditch, Nanthaniel** 1773–1838  
American mathematician and astronomer

I never came across one of Laplace's "Thus it plainly appears" without feeling sure that I have hours of hard work before me to fill up the chasm and find out and show how it plainly appears.  
In Florian Cajori  
*The Teaching and History of Mathematics in the United States*  
Chapter III (p. 104)  
Government Printing Office. Washington, D.C. 1890

**PLAN****Charlie Chan (Fictional character)**

Best laid plans of mice and men sometimes go a little bit haywire.

*The Trap*  
Film (1946)

**PLANCK'S CONSTANT****Bohr, Niels Henrik David** 1886–1962

Danish physicist

...it seems necessary to introduce in the laws in question a quantity foreign to classical electrodynamics, i.e., Planck's constant, or as it is often called, the elementary quantum of action.

On the Constitution of Atoms and Molecules  
*Philosophical Magazine*, Volume 26, 1913 (p. 2)

**PLANET****Ackerman, Diane** 1948–

American writer

At night I lie awake  
In the ruthless Unspoken,  
knowing that planets  
come to life, bloom, and die away,  
like day-lilies  
opening one after another  
in every nook and cranny  
of the Universe...

*The Planets: A Cosmic Pastoral* (p. 138)  
William Morrow and Co. New York, New York, USA. 1977

**Author undetermined**

The discovery of a new planet in a new way, by first finding where a planet ought to be, has given a fresh impulse to the enthusiasm of astronomers. All are looking to see if the motions of heavenly bodies in some other direction does not indicate that there are more weights in the scale on that side than have yet been seen.

*Scientific American*, Volume 2, Issue 26, March 20, 1847 (p. 203)

A new planet, it is said, has lately been discovered. This is not correct. The planet is as "old as the hills."

*Scientific American*, Volume 2, Issue 9, November 21, 1846 (p. 68)

**Ball, Sir Robert Stawell** 1840–1913

Irish astronomer

The planets are all members of the great family dependent on the sun. Venus and the earth may be considered the pair of twins, alike in size and weight. Mercury and Mars are the babies of the system. The big brothers are Jupiter and Saturn.

*Star-land; Being Talks with Young People about the wonders of the Heavens*

Lecture III (pp. 134–135)

Ginn & Co. Boston, Massachusetts, USA. 1900

**Banks, Sir Joseph** 1743–1820

English explorer and naturalist

Some of our astronomers here incline to the opinion that it is a planet and not a comet; if you are of that opinion it should forthwith be provided with a name [or] our nimble neighbors, the French, will certainly save us the trouble of Baptizing it.

In Constance A. Lubbock

*The Herschel Chronicle* (p. 95)

The Macmillan Company. New York, New York, USA. 1933

**Bentley, Richard** 1662–1742

English critic and philologist

...the smallest planets are situated nearest the sun and each other; whereas Jupiter and Saturn, that are vastly greater than the rest, and have many satellites about them, are wisely removed to the extreme regions of the system, and placed at an immense distance one from the other.

In Alexander Dyce

*Sermons Preached at Boyle's Lecture*

Sermon VIII (p. 180)

Francis Macpherson. London, England. 1838

**Blackmore, Sir Richard** 1650–1729

English physician and writer

In beauteous Order all the Orbs advance,  
And in their mazy complicated Dance,  
Not in one part of all the Pathless Sky  
Did any ever halt, or step awry.

*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*

Book II, l. 91–94

Printed for C. Cooke. London, England. 1797

All these Illustrious Worlds, and many more,  
Which by the Tube Astronomers explore;  
And Millions which the Glass can ne'er descry,  
Lost in the Wilds of vast Immensity,  
Are Suns, are Centers, whose Superior Sway  
Planets of various Magnitude obey.

*The Poetical Works of Sir R. Blackmore: Containing Creation:*

*A Philosophical Poem, in Seven Books*

Book II, l. 536–541

Printed for C. Cooke. London, England. 1797

**Burroughs, John** 1837–1921

American naturalist and writer

The earth is not alone, it is not like a single apple on a tree; there are many apples on the tree, and there are many trees in the orchard.

*The Breath of Life*

Chapter XII (p. 289)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915



**Burroughs, William S.** 1914–97  
American writer

After one look at this planet any visitor from outer space would say “I WANT TO SEE THE MANAGER.”

*The Adding Machine*

Women: A Biological Mistake? (p. 125)

Arcade Publishing, New York, New York, USA. 1991

**Chapman, Clark R.**

Astronomer and asteroid researcher

Planets are like living creatures. They are born, full of life and activity. They mature, consume energy, and settle into established ways. Finally, they run down, become dormant, and die. On a human time scale planetary lives are virtually eternal. We see only a snapshot of each planet and can only surmise its evolution.

*The Inner Planets: New Light on the Rocky Worlds of Mercury, Venus, Earth, the Moon, Mars, and the Asteroids*

Chapter 6 (pp. 88–89)

Charles Scribner's Sons, New York, New York, USA. 1977

**Chaucer, Geoffrey** 1343–1400

English poet

The seven bodies I'll describe anon:

Sol, gold is, Luna's silver, as we see,

Mars iron, and quicksilver's Mercury,

Saturn is lead, and Jupiter is tin,

And Venus copper, by my father's kin!

In *Great Books of the Western World* (Volume 22)

*The Canterbury Tales*

Canon Yeoman's Tale (p. 476)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Croswell, Ken**

American astronomer

For many planet hunters, though, the ultimate goal is still greater – or actually, smaller – prey: terrestrial planets, like Earth, circling a star like the Sun. Astronomers already know that three such planets orbit at least one pulsar. But planet hunters will not rest until they are in sight of a small blue world, warm and wet, in whose azure skies and upon whose wind-whipped oceans shines a bright yellow star like our own.

*Planet Quest: The Epic Discovery of Alien Solar Systems*

Chapter 10 (p. 217)

Oxford University Press, Oxford, England. 1997

**de Bergerac, Cyrano** 1619–55

French dramatist

For my part, I...believe the Planets are Worlds about the Sun, and that the Fixed Stars are also Suns which have Planets about them, that's to say, Worlds which because of their smallness, and that their borrowed light can-not reach us, are not discernible by Men in this World...

In Roger A MacGowan and Frederick I. Ordway, III

*Intelligence in the Universe*

The Comical History of the States and Empires of the World and of the Sun (p. 1)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1966

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...you must go a great way to prove that the Earth may be a Planet, the Planets so many Earths, and all the Stars Worlds.

In Roger A MacGowan and Frederick I. Ordway, III

*Intelligence in the Universe* (p. 75)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1966

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“But the Solar System!” I protested.

“What the deuce is it to me?” [Sherlock Holmes] interrupted impatiently: “You say that we go round the sun. If we went round the moon it would not make a pennyworth of difference to me...”

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Study in Scarlet*, Chapter 2 (p. 154)

Wings Books, New York, New York, USA. 1967

**Dudley Manlove (Fictional character)**

Do you still believe it impossible we exist? You didn't actually think you were the only inhabited planet in the universe. How can any race be so stupid?

*Plan 9 from Outer Space*

Film (1959)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

If the planets of the solar system should fail us, there remain some thousands of millions of stars which we have been accustomed to regard as suns ruling attendant systems of planets. It has seemed a presumption, bordering almost on impiety, to deny them life of the same order of creation as ourselves. It would indeed be rash to assume that nowhere else has Nature repeated the strange experiment which she has performed on the earth.

Man's Place in the Universe

*Harper's Magazine*, October, 1928 (p. 573)

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Things get odder on this planet, not less so.

*The Unexpected Universe*

Chapter Ten (p. 232)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

He who knows what sweets and virtues are in the ground, the waters – the planets, the heavens, and how to come at these enchantments, is the rich and royal man.

Ralph Waldo Emerson: *Essays and Lectures*  
*Essays: Second Series*  
 Nature (p. 543)  
 The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

...what makes planets go around the sun? At the time of Kepler some people answered this problem by saying that there were angels behind them beating their wings and pushing the planets around in orbit. As you will see, the answer is not very far from the truth. The only difference is that the angels sit in a different direction and their wings push inwards.

*The Character of Physical Law*  
 Chapter 1 (p. 18)  
 BBC. London, England. 1965

**Flammarion, Camille** 1842–1925  
 French astronomer and writer

What inexhaustible variety distinguishes the planets from each other!

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
 Book I, Chapter II (p. 12)  
 Chatto & Windus. London, England. 1894

...our planet is only a province of the Infinite Heavens, so our actual existence is only a stage in Eternal Life.

Translated by Frances Alice Welby  
*Astronomy for Amateurs*  
 Chapter XII (p. 340)  
 D. Appleton. New York, New York, USA. 1915

**Hammond, Allen Lee**  
 No biographical data available

With the beginning of direct exploration of the solar system, planetary science has revived to become not only respectable but one of the active, forefront areas of research. How active can be gauged by the assessment, widely agreed on, that the rate of new discoveries and the rate of obsolescence of old ideas have never been so rapid as at present. Investigators are now confronted with such an overwhelming array of new observations and theories that what amounts to a revolution in understanding the solar system is in progress.

Exploring the Solar System(s): An Emerging New Perspective  
*Science*, Volume 186, Number 4165, 22 November, 1974 (p. 720)

**Herschel, Friedrich Wilhelm**  
**(Sir William)** 1738–1822  
 English astronomer

It has generally been supposed that it was a lucky accident that brought this new star to my view; this is an evident mistake. In the regular manner I examined every star of the heavens, not only of that magnitude but many far inferior, it was that night its turn to be discovered.

In Constance A. Lubbock  
*The Herschel Chronicle* (pp. 78–79)  
 The Macmillan Company. New York, New York, USA. 1933

The planets, which appear only as stars somewhat brighter than the rest, are to him [student who enters upon a scientific pursuit] spacious, elaborate, and habitable worlds; several of them much greater and far more curiously furnished than the earth he inhabits, as there are also others less so; and the stars themselves, properly so called, which to ordinary apprehension present only lucid sparks or brilliant atoms, are to him suns of various and transcendent glory – effulgent centres of life and light to myriads of unseen worlds.

*Outlines of Astronomy: By Sir John F. W. Herschel*  
 Introduction (pp. 22–23)  
 American Home Library Co. New York, New York, USA. 1902

**Hey, Nigel S.** 1936–  
 American science writer

I used to wonder, why bother? The other planets and moons are too inhospitable for us ever to visit, let alone colonize. But this is shallow thinking. Our destiny is in space. We will always want to explore new frontiers, even when separated physically by great gulfs of space and time. The need is in our genes. And who knows what wonders we may find out there.

*Solar System*  
 Introduction (p. 8)  
 Weidenfield & Nicolson. London, England. 2002

Each of us is part of an endless drama that started billions of years ago, when a gargantuan cloud of cosmic gas and dust began to collect within the firmament. Then our galaxy, the Milky Way, came to be, and, within it, our solar system. The Sun is the great nucleus of this little cell, radiating incredible amounts of energy to its daughter planets, furnishing all the ingredients of life and all the analogues of life that manifest themselves as simple movement and change.

*Solar System*  
 Chapter 1 (p. 11)  
 Weidenfield & Nicolson. London, England. 2002

**Homer** fl. 750 BCE  
 Greek poet

The thick tresses of gold with which Vulcan had crested the helmet floated round it, and as the evening star that shines brighter than all others through the stillness of night, even such was the gleam of the spear which Achilles poised in his right hand, fraught with the death of noble Hector.

In *Great Books of the Western World* (Volume 4)  
*The Iliad of Homer*  
 Book XXII, I. 317 (p. 158)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

At length as the Morning Star was beginning to herald the light which saffron-mantled Dawn was soon to suffuse over the sea, the flames fell and the fire began to die.

In *Great Books of the Western World* (Volume 4)  
*The Iliad of Homer*  
 Book XXIII, l. 226 (p. 163)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huygens, Christiaan** 1629–95  
 Dutch mathematician, astronomer, and physicist

...the rest of the Planets have their Dress and Furniture,  
 nay and their Inhabitants too as well as this Earth of  
 ours.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
 Book the First (p. 2)  
 Printed for T. Childe. London, England. 1698

**Lin, Douglas N. C.**  
 No biographical data available

Although they are, in cosmic terms, mere scraps – insignificant to the grand narrative of heavenly expansion – planets are the most diverse and intricate class of object in the universe.

The Genesis of Planets  
*Scientific American*, Volume 298, Number 5, May, 2008

**Lockyer, Joseph Norman** 1836–1920  
 English astronomer and physicist

The work of the true man of Science is a perpetual striving after a better and closer knowledge of the planet on which his lot is cast, and of the universe in the vastness of which that planet is lost.

*Studies in Spectrum Analysis*  
 Chapter I (p. 1)  
 D. Appleton & Company. New York, New York, USA. 1878

**Lodge, Sir Oliver** 1851–1940  
 English physicist

The stars are suns, and are most likely surrounded by planets. One planet belonging to Sirius has been discovered. It was predicted by Bessel, its position calculated by Peters, and seen by Alvan Clark in 1862. Another predicted one, belonging to Procyon, has not yet been seen.

*Pioneers of Science*  
 Notes to Lecture XIV (p. 304)  
 Macmillan & Co Ltd. London, England. 1905

**Lowell, James Russell** 1819–91  
 American poet

And each glad, obedient planet like a golden shuttle sings  
 Through the web which Time is weaving in his never-resting loom

*The Poetical Works of James Russell Lowell*  
 Anti-Apsis, Stanza 10  
 Fields, Osgood & Co. Boston, Massachusetts, USA. 1869

**Lowell, Percival** 1855–1916  
 American astronomer

A planet may in a very real sense be said to have life of its own, of which what we call life may or may not be a

subsequent detail. It is born, has its fiery youth, sobers into middle age, and just before this happens brings forth, if it be going to do so at all, the creatures on its surface which are, in a sense, its offspring.

*Mars*  
 Conclusion (p. 206)  
 Longmans, Green, & Co. London, England. 1896

**Marcy, Geoffrey**  
 American astronomer

Look at how perfect this thing is. It's like a jewel. You've got circular orbits. They're all in the same plane. They're all going around in the same direction.... It's perfect, you know. It's gorgeous. It's almost uncanny.

Jumping Jupiter! Is Our Solar System a Rarity?  
*Washington Post*, Monday, February 15, 1999 (p. A3)

**Marlowe, Christopher** 1564–93  
 English poet

... whose faculties can comprehend  
 The wondrous architecture of the world,  
 And measure every wand'ring planet's course...

*Tamburlaine the Great*  
 Scene VIII  
 Odyssey Press. Indianapolis, Indiana, USA. 1974

Mephistopheles: As are the elements, such are the spheres,

Mutually folded in each other's orb,  
 And, Faustus,

All jointly move upon one axletree,  
 Whose terminine is termed the world's wide pole:

Nor are the names of Saturn, Mars, or Jupiter Feigned,  
 but are erring stars.

In F. J. Cox  
*The Tragical History of Doctor Faustus* (p. 42)  
 Francis Griffiths. 1907

**Martin, Martha Evans**  
 No biographical data available

For far off and truly mysterious as the planets are, it still is with them as with most other objects in nature: a very little knowledge of their aspects and their ways begets a sense about them that makes the most casual observation of them interesting and, as far as it goes, intelligent.

*The Ways of the Planets*  
 Chapter I (pp. 2–3)  
 Harper & Brothers Publishers. New York, New York, USA. 1912

If the bare facts, simply and plainly told, and the view of the planets themselves as they wander through their courses in the sky, do not awaken one's understanding and imagination, no amount of poetry or romance that other people have built up around the planets will arouse anything more than a factitious interest in them.

*The Ways of the Planets*  
 Chapter I (p. 7)  
 Harper & Brothers Publishers. New York, New York, USA. 1912

The planets are members of our own family, bone of our bone and flesh of our flesh, living comparatively near to us, within the domain of our common source of life, the sun.

*The Ways of the Planets*

Chapter II (p. 11)

Harper & Brothers Publishers. New York, New York, USA. 1912

The great variety of beauty that the planets present to us is sufficient to keep us always interested in them, when once we have acquired an acquaintance with them.

*The Ways of the Planets*

Chapter XVIII (p. 258)

Harper & Brothers Publishers. New York, New York, USA. 1912

### **Miller, Hugh** 1802–56

Scottish geologist and theologian

The planet which we inhabit is but one vessel in the midst of a fleet sailing on through the vast ocean of space, under convoy of the sun.

*Geology Versus Astronomy: Or the Conditions and the Periods; Being a View of the Modifying Effects of Geologic Discovery on the Old Astronomic Inferences Respecting the Plurality of Inhabited Worlds*

Chapter II (p. 14)

Glasgow, Scotland. 1857

### **Molière (Jean-Baptiste Poquelin)** 1622–1673

French playwright and actor

We had a narrow escape, Madame, While asleep;  
A neighboring planet did pass us close by,  
Cutting a swathe right through our whirlpool;  
Had its path led to a collision with mother earth,  
She would have shattered in pieces like glass.

*Les Femmes Savantes*

Act IV, Scene iii

Oxford University Press. Oxford, England. 1974

### **Morrow, Jeff** 1907–93

American actor

A lifeless planet. And yet, yet still serving a useful purpose, I hope. Yes, a sun. Warming the surface of some other world. Giving light to those who may need it.

*This Island Earth*

Film (1955)

### **Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

Between the Earth and Sky, there hang in the Air above named, seven Stars, divided one from another at distinct Distances; and these, on account of their variable Motion, we call Wandering Planets; whereas, indeed, none wander less than they.

*Pliny's Natural History. In Thirty-seven Books*

Chapter VI (p. 34)

Printed for the Club by G. Barclay. London, England. 1847–1849

### **Redfern, Martin**

No biographical data available

We are no longer the victims of our planet, we are the custodians of it. Through our inconsiderate greed for land and our disregard for pollution, we bite the hand that feeds us. But we do so at our own peril. We still have our eggs in one basket, all our people in one planet. We need to care for that planet and take responsibility for it. But we also need to progress with the search for new homes and the technology to take us to the stars.

*The Earth: A Very Short Introduction*

Epilogue (p. 132)

Oxford University Press, Inc. Oxford, England. 2003

### **Shapley, Harlow** 1885–1972

American astronomer

Millions of planetary systems must exist, and billions is the better word. Whatever the methods of origin, and doubtless more than one type of genesis has operated, planets may be the common heritage of all stars except those so situated that planetary materials would be swallowed up by greater masses or cast off through gravitational action.

*Of Stars and Men: Human Response to an Expanding Universe*

Chapter 7 (p. 112)

Beacon Press. Boston, Massachusetts, USA. 1958

### **Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

The planets show grandeur and nicety in their operations; the question is, how did they learn this?

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #50 (p. 26)

Definition Press. New York, New York, USA. 1972

### **Standage, Tom**

English journalist and author

A planet is, by definition, an unruly object.

*The Neptune File*

Chapter 2 (p. 19)

Walker & Company. New York, New York, USA. 2000

### **Swedenborg, Emanuel** 1688–1772

Swedish scientist, theosophist, and mystic

[There are] many earths, inhabited by man...thousands, yea, ten thousands of earths, all full of inhabitants...not only in this solar system, but also beyond it, in the starry heaven.

*The Earths in Our Solar System, Which Are Called Planets, and Earths in the Starry Heavens*

New Church Board of Publication. New York, New York, USA. 1876

### **Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

Through millions and millions of years,  
The stars shine,  
Fiery whirlpools revolve and rise  
In the dark ever-moving current of time.  
In this current  
The earth is a bubble of mud...

Translated by Indu Dutt

*Our Universe* (p. 43)

Jaico Publishing House. Bombay, India. 1969

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

Despite their vastness and splendor the stars cannot carry the evolution of matter much beyond the atomic series: it is only on the very humble planets, on them alone, that the mysterious ascent of the world into the sphere of higher complexity has a chance to take place. However inconsiderable they may be in the history of sidereal bodies, however accidental their coming into existence, the planets are finally nothing less than the key-points of the Universe. It is through them that the axis of life now passes; it is upon them that the energies of an Evolution principally concerned with the building of large molecules is now concentrated.

*The Future of Man*

Chapter VI, Part I, Section I (p. 114)

Harper & Row, Publishers. New York, New York, USA. 1964

**Tennyson, Alfred (Lord)** 1809–92

English poet

This world was once a fluid haze of light,  
Till toward the centre set the starry tides,  
And eddied into suns, that wheeling cast  
The planets.

*Alfred Tennyson's Poetical Works*

The Princess, Part Second, l. 101–103

Oxford University Press, Inc. London, England. 1953

**Tombaugh, Clyde** 1906–97

American astronomer

Behold the heavens and the great vastness thereof, for a planet could be anywhere therein.  
Thou shalt dedicate thy whole being to the search project with infinite patience and perseverance.  
Thou shalt set no other work before thee, for the search shall keep thee busy enough.  
Thou shalt take the plates [photographs] at opposition time lest thou be deceived by asteroids near their stationary positions.  
Thou shalt duplicate the plates of a pair at the same hour angle lest refraction distortions overtake thee.  
Thou shalt give adequate overlap of adjacent plate regions lest the planet play hide and seek with thee.  
Thou must not become ill at the dark of the moon lest thou fall behind the opposition point.  
Thou shalt have no dates except at full moon when long-exposure plates cannot be taken at the telescope.

Many false planets shall appear before thee, hundreds of them, and thou shalt check everyone with a third plate.

In David H. Levy

*Clyde Tombaugh: Discoverer of Planet Pluto*

Chapter 12, Ten Special Commandments for a Would-Be Planet Hunter (p. 180)

University of Arizona Press. Tucson, Arizona, USA. 1991

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

It would be very singular that all Nature, all the planets, should obey eternal laws, and there should be a little animal, five feet high who, in contempt of these laws, could act as he pleased, solely according to his caprice.

In John D. Barrow

*The World Within the World* (p. 55)

Clarendon Press. Oxford, England. 1988

## MERCURY

**Ackerman, Diane** 1948–

American writer

A prowling holocaust keeling low in the sky heads westward for another milk run. The Sun never sets on the Mercurian empire: it only idles on each horizon and lurches back, broiling the same arc across the sky.

*The Planets: A Cosmic Pastoral*

Mercury (p. 15)

William Morrow & Company, Inc. New York, New York, USA. 1976

**Blackmore, Sir Richard** 1650–1729

English physician and writer

Mercurius nearest to the Central Sun,  
Does in an Oval Orbit circling run:  
But rarely is the Object of our Sight,  
In Solar Glory sunk and more prevailing Light.

*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*

Book II, l. 511–514

Printed for C. Cooke. London, England. 1797

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...Mercury is the bedlam of the universe...

*Conversations on the Plurality of Worlds*

The Fourth Evening (p. 105)

Printed for Peter Wilson. Dublin, Ireland. 1761

## VENUS

**Ball, Sir Robert Stawell** 1840–1913

Irish astronomer

The lover of nature turns to admire the sunset, as every lover of nature will. In the golden glory of the west a beauteous gem is seen to glitter; it is the evening star – the planet Venus.... All the heavenly host – even Sirius



and Jupiter – must pale before the splendid lustre of Venus, the unrivalled queen of the firmament.

*The Story of the Heavens*

Venus (p. 140)

Cassell & Company Ltd. London, England. 1885

**Blackmore, Sir Richard** 1650–1729

English physician and writer

Venus the next, whose lovely Beams adorn  
As well the Dewy Eve, as opening Morn,  
Does her fair Orb in beauteous Order turn.

*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*

Book II, l. 515–517

Printed for C. Cooke. London, England. 1797

**Hunter, Robert** 1941–

American lyricist and poet

Counting stars by candlelight, all are dim but one is bright;

The spiral light of Venus, rising first and shining best,

Oh, from the northwest corner, of a brand new crescent moon,

crickets and cicadas sing, a rare and different tune...

*Terrapin Station*

Terrapin Station

Arista Records. 1977

**Tennyson, Alfred (Lord)** 1809–92

English poet

For a breeze of morning moves,  
And the planet of love is on high,  
Beginning to faint in the light that she loves  
On a bed of daffodil sky,  
To faint in the light of the sun she loves,  
To faint in his light, and to die.

*Alfred Tennyson's Poetical Works*

Maude, Part I, Section XXII, Stanza II

Oxford University Press, Inc. London, England. 1953

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

An occultation of Venus is not half so difficult as an eclipse of the Sun, but because it comes seldom the world thinks it's a grand thing.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

More Maxims of Mark (p. 945)

The Library of America. New York, New York, USA. 1992

## EARTH

**Abbey, Edward** 1927–89

American environmentalist and nature writer

We know so very little about this strange planet we live on, this haunted world where all answers lead only to more mystery.

The Crooked Word

*Audubon Magazine*, Volume 77, Number 6, 1975 (p. 24)

We are obliged, therefore, to spread the news, painful and bitter though it may be for some to hear, that all living things on earth are kindred.

*Desert Solitaire*

The Serpents of Paradise (p. 24)

Ballantine Books. New York, New York, USA. 1968

I am not an atheist but an earthiest. Be true to the earth.

*Desert Solitaire*

Down the River (p. 208)

Ballantine Books. New York, New York, USA. 1968

Yes. Feet on earth. Knock on wood. Touch stone. Good luck to all.

*Desert Solitaire*

Bedrock and Paradox (p. 301)

Ballantine Books. New York, New York, USA. 1968

The earth is not a mechanism but an organism, a being with its own life and its own reasons, where the support and sustenance of the human animal is incidental.

*The Journey Home: Some Words in Defense of the American West*

Chapter 21 (p. 225)

E.P. Dutton. New York, New York, USA. 1977

The world is what it is, no less and no more, and therein lies its entire and sufficient meaning.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 89)

St. Martin's Press. New York, New York, USA. 1989

**Ackerman, Diane** 1948–

American writer

Long ago, Earth bunched its granite to form the continents, ground molar Alps and Himalayas, rammed Africa and Italy into Europe, gnashing its teeth, till mountain ranges buckled and churned, and oceans (salty once rivers bled flavor from the seasoned earth) gouged their kelpy graves. And the rest is history...

*The Planets: A Cosmic Pastoral*

Earth, III (p. 36)

William Morrow & Company, Inc. New York, New York, USA. 1976

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

...there was a time when our earth was in a state of igneous fusion, when no ocean bathed it and no atmosphere surrounded it, when no wind blew over it and no rain fell upon it, but an intense heat held all its materials in solution. In those days the rocks which are now the very bones and sinews of our mother Earth – her granites,



her porphyries, her basalts, her syenites – were melted into a liquid mass.

*Geological Structures*

Chapter 1 (p. 2)

Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Airy, Sir George Biddell** 1801–92

English mathematician and astronomer, Astronomer Royal from 1835 to 1881

Since Astronomy first assumed the form of a Science, the inquiry into the Figure and dimensions of the Earth has always excited the interest of Philosophers. It can hardly be doubted that in the mind of a reflecting man there would always be a desire to know the nature of the Planet upon which he existed; but without Science of an exalted order, it would be impossible for him to gratify his curiosity.

*Encyclopaedia Metropolitana*, Volume 5, 1845

**Arendt, Hannah** 1906–75

Political philosopher

The earth is the very quintessence of the human condition...

*The Human Condition*

Prologue (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1958

**Aristotle** 384 BCE–322 BCE

Greek philosopher

There is much change, I mean, in the stars which are overhead, and the stars seen are different, as one moves northward or southward. Indeed there are some stars seen in Egypt and in the neighborhood of Cyprus which are not seen in the northerly regions; and stars, which in the north are never beyond range of observation, in those regions rise and set. All of which goes to show not only that the earth is circular in shape, but also that it is a sphere of no great size: for otherwise the effect of so slight a change of place would not be so quickly apparent.

*On the Heavens*

Book II, Chapter 14

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ball, Philip** 1962–

English science writer

What is so special about the Earth, then, is not that it is a world of water, but that the water is marine blue – we have oceans, not just glassy sheets of bright ice. Perhaps, soon after the solar system was formed, blue worlds were commonplace, until one by one they turned pearly or ruddy, or became shrouded in bright acid. And then there we were, a lone blue dot, waiting for life to begin.

*Life's Matrix: A Biography of Water*

Part One, Chapter 4 (p. 111)

Farrar, Straus & Giroux. New York, New York, USA. 2000

**Barrell, Joseph** 1869–1919

American geologist

The scheme of the Universe is more profound and the unknown is a little nearer than it was recently thought to be. But such has been the progress of knowledge since man, in the days before the advent of science naively regarded the earth, his home, as firmament, created a few thousand years previously especially for his benefit.

In J.H.F. Umbgrove

*The Pulse of the Earth*

Chapter 1 (p. 2)

Martinus Nijhoff. The Hague, Netherlands. 1947

**Bellamy, David** 1933–

Botanist, author, and broadcaster

The earth has a mass of 5.97 x 10<sup>24</sup> kilograms... a big number and one that really matters because that is all the matter we have got.

*Forces of Life: The Botanic Man*

Chapter 2 (p. 24)

Crown Publishers. New York, New York, USA. 1979

**Beston, Henry** 1888–1968

American writer

Touch the earth, love the earth, honour the earth, her plains, her valleys, her hills, and her seas; rest your spirit in her solitary places.

*The Outermost House*

Chapter X (p. 222)

Rinehart & Company. New York, New York, USA. 1928

**Borland, Hal** 1900–78

American writer

I am not quite sure what the earth's business is, but I know it is not the nurturing of *Homo sapiens*, or any one species of animal or plant.

*Borland Country*

Foreword (p. 7)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

The earth, however, never forgets. While men are sleeping she is awake, silently strengthening the cords of her influence. When men make boast of their conquests she is not concerned, for she knows that the limits of human attainment are the limits she chooses to set. When they strut through the kingdom they think they have conquered, she tightens the strings that hold them to her hand.

*Autobiography of Earth*

Chapter XII (p. 331)

Coward-McCann, Inc. New York, New York, USA. 1935

The Earth is a selfish mother who would keep her children forever at her breast.

*Autobiography of Earth*  
Chapter XII (p. 331)  
Coward-McCann, Inc. New York, New York, USA. 1935

**Broad, William** 1951–  
Science writer

**Wade, Nicholas**  
British-born scientific writer

The ultimate gatekeeper of science is neither peer reviews, nor referees, nor replication, nor the universalism implicit in all three mechanisms. It is time. In the end, bad theories don't work, fraudulent ideas don't explain the world so well as true ideas do. The ideal mechanisms by which science should work are applied to a large extent in retrospect .... Time and the invisible boot that kicks out all useless science are the true gatekeepers of science. But these inexorable mechanisms take years, sometimes more than a millennium, to operate. During the interval, fraud may flourish, particularly if it can find shelter under the mantle of immunity that scientific elitism confers.

*Betrayers of the Truth* (p. 106)  
Simon & Schuster. New York, New York, USA. 1982

**Buckland, William** 1784–1856  
English geologist and palaeontologist

The earth, from her deep foundations, unites with the celestial orbs that roll through boundless space ...

The Existence of God  
*The Church of England Magazine*, Volume 2, Number 48, April 22, 1837 (p. 256)

**Burnet, Thomas** 1635–1715  
English cleric and scientist

We must therefore be impartial where the Truth requires it, and describe the Earth as it is really in itself; and though it be handsome and regular enough to the eye in certain parts of it, single tracts and single Regions; yet if we consider the whole surface of it, or the whole Exterior Region, 'tis as a broken and confus'd heap of bodies, plac'd in no order to one another, nor with any correspondency or regularity of parts: And such a body as the Moon appears to us, when 'tis look'd upon with a good Glass, rude and ragged; as it is also represented in the modern Maps of the Moon; such a thing would the Earth appear if it was seen from the Moon. They are both in my judgment the image or picture of a great Ruine, and have the true aspect of a World lying in its rubbish.

*The Sacred Theory of the Earth* (2nd edition)  
Book I, Chapter IX (p. 91)  
Printed by R. Norton. London. 1691

**Burroughs, William S.** 1914–97  
American writer

After one look at this planet any visitor from outer space would say 'I WANT TO SEE THE MANAGER.'

*The Adding Machine: Selected Essays*  
Women: A Biological Mistake (p. 124)  
Seaver Books. New York, New York, USA. 1986

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

He saw with his own eyes the moon was round,  
Was also certain that the earth was square.  
Because he had journey'd fifty miles, and found  
No sign that it was circular anywhere.

*The Complete Poetical Works of Byron*  
Don Juan  
Canto V  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Chamberlain, Rollin T.**  
American geologist

Just as the written life of some famous man properly commences with a portrayal of his family antecedents, so any real history of the earth should begin with the activities of the sun and the origin of its present family of planets.

In H.H. Newman (ed.)  
*The Nature of the World and of Man*  
The Origin and Early Stages of the Earth (p. 31)  
The University of Chicago Press. Chicago, Illinois, USA. 1927

**Chief Seattle** ca. 1784–1866  
Chief of the Duwamish, Suquamish, and allied Indian tribes

You must teach your children that the ground beneath their feet is the ashes of your grandfathers. So that they will respect the land, tell your children that the earth is rich with the lives of our kin. Teach your children what we have taught our children, that the earth is our mother. Whatever befalls the earth befalls the sons of the earth. If men spit upon the ground, they spit upon themselves.

*Catch the Whisper of the Wind: Collected Stories and Proverbs from Native Americans*  
Attributed to Chief Seattle (p. 41)  
Health Communications, Inc. Deerfield Beach, Florida, USA. 1995

**Cloos, Hans** 1885–1951  
German geologist

Earth: beautiful, round, colorful planet. You carry us safely through the emptiness and deadness of space. Graciously you cover the black abyss with air and water. You turn as towards the sun, that we may be warm and content, that we may wander, with open eyes, through your meadows, and look upon your splendor. And then you turn us away from the too fiercely burning sun, that we may rest in the coolness of the night from life's heat and the struggle of the day.

*Conversation with the Earth*  
Prologue (p. 3)  
Alfred A. Knopf. New York, New York, USA. 1953

For a billion years the patient earth amassed documents and inscribed them with signs and pictures which lay unnoticed and unused. Today, at last, they are waking up, because man has come to rouse them. Stones have begun to speak, because an ear is there to hear them. Layers become history and, released from the enchanted sleep of eternity, life's motley, never-ending dance rises out of the black depths of the past into the light of the present.

*Conversation with the Earth*

Prologue (p. 4)

Routledge & Kegan Paul. London, England. 1954

The earth is large and old enough to teach modesty; and yet it is small enough to be comprehended and to be learned from, as our understanding of it increases.

*Conversation with the Earth*

Prologue (p. 8)

Alfred A. Knopf. New York, New York, USA. 1953

The earth gives us more knowledge of ourselves than all the books, because it resists us.

*Conversations with the Earth*

Chapter VII (p. 99)

Alfred A. Knopf. New York, New York, USA. 1953

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Earth! Thou mother of numberless children, the nurse and the mother,

Sister thou of the stars, and beloved by the Sun, the rejoicer!

Guardian and friend of the moon, O Earth, whom the comets forget not,

Yea, in the measureless distance wheel round and again they behold thee!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

Hymn to the Earth (p. 328)

The Clarendon Press. Oxford, England. 1912

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

The planet Earth is a doomed ship being blown to inevitable disaster by the winds of universal dynamics, a miniscule sacrifice to the attainment of that inscrutable destiny held secret by the galaxies as they rush through the long darkness of space.

*The Endless Adventure*

Once There Was a Planet (p. 181)

Henry Regnery Company. Chicago, Illinois, USA. 1972

I peer into the endlessness of space. The lights from a host of suns leap across the millions of miles of darkness to reach this spinning bit of star stuff we call Earth. This outcropping of rock has unknowingly endureth the passage of millennia. The footpads of extinct species have pattered over it. An Indian in moccasins once stood upon it. Forests have appeared, disappeared and reappeared around it. It has been washed by floods, buried in ice and baked

by the sun. Here it will lie through the ages yet to come, silently awaiting the next phase of a planet's destiny.

*The Endless Adventure*

Once There Was a Planet (p. 185)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

[We] may say that the earth has a spirit of growth; that its flesh is the soil, its bones are the successive strata of the rocks which form the mountains, its muscles are the tufa stone, its blood the springs of its waters. The lake of blood that lies about the heart is the ocean; its breathing is by the increase and decrease of the blood in its pulses, and even so in the earth is the flow and ebb of the sea. And the heat of the spirit of the world is the fire which is spread throughout the earth; and the dwelling-place of its creative spirit is in the fires, which in diverse parts of the earth are breathed out in baths and sulphur mines, and in volcanoes...

*Leonardo da Vinci's Note Books* (pp. 130–131)

Duckworth & Company. London, England. 1906

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

The metaphysician has found that the real is the invisible. This is eminently true of the earth. The real earth is not its visible skin, but the visible skin plus the much bulkier hidden stuff within.

*Our Mobile Earth*

Chapter III (p. 125)

Charles Scribner's Sons. New York, New York, USA. 1926

**Davis, William Morris** 1850–1934

American geographer, geologist, and teacher

The earth has been explored and measured as never before. The lands have been mapped, the oceans have been charted, by original observers. The air has been followed in its circuits, great and small. The structure of the earth's crust has been patiently traced out. Thus "Go and see" came to be our watchwords one hundred years ago. As long as we, like Antaeus of old, can return to the earth for new stores of the strength that we find in facts, we need not fear being strangled by any voluminous Hercules of theory.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

(Volume 4)

The Relations of the Earth-Sciences in View of Their Progress in the Nineteenth Century (p. 488)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**de Coulevain, Pierre** 1853–1927

French writer

You must educate your mind to consider that the Universe and the Sun were not created for the Earth, but the Earth for the Universe and the Sun.

*The Heart of Life*

Chapter III (p. 133)

E.P. Dutton & Company, Inc. New York, New York, USA. 1912

**de Quincey, Thomas** 1785–1859

English author

Our mother Tellus, beyond all doubt, is a lovely little thing. At any rate, therefore, she cannot be superannuated. I am satisfied that she is very much admired throughout the Solar System: and in clear seasons, when she is seen to advantage, with her bonny wee pet of a Moon tripping round her like a lamb, I should be glad to see the planet that could fancy herself entitled to sneeze at our Earth.

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 168)

Adam & Charles Black. Edinburgh, Scotland. 1871

Let the earth have lived any number of years that you suggest, still that tells us nothing about the period of life, the stage, which she may be supposed to have reached. Is she a child, in fact, or is she an adult? And if an adult, and that you gave a ball to the Solar System, is she that kind of person that you would introduce to a waltzing partner, some fiery young gentleman like Mars; or would you rather suggest to her the sort of partnership which takes place at a whist-table?

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 169)

Adam & Charles Black. Edinburgh, Scotland. 1871

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

“What place would you advise me to visit now?” he asked.

“The planet Earth,” replied the geographer. “It has a good reputation . . .”

Translated by Katherine Woods

*The Little Prince*

Chapter Fifteen (p. 55)

Harcourt, Brace & Co. New York, New York, USA. 1943

To give you an idea of the size of the Earth, I will tell you that before the invention of electricity it was necessary to maintain, over the whole of the six continents, a veritable army of 462,511 lamplighters for the street lamps.

Translated by Katherine Woods

*The Little Prince*

Chapter Fifteen (p. 56)

Harcourt, Brace & Co. New York, New York, USA. 1943

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The incredible beauty of the earth as seen from space results largely from the fact that our planet is covered with living things. What gives vibrant colors and exciting variety to the surface of the earth is the fact that it is literally a living organism.

*Federal Highway Act of 1970 and Miscellaneous Bills*

United States Congress. Senate. 1970

The spaceship Earth is the cage within and against which man has developed in his evolutionary past and continues to develop his biological and mental characteristics. As the terrestrial environment deteriorates so does humaneness and the quality of human life.

*Reason Awake*

Chapter 5 (pp. 191–192)

Columbia University Press. New York, New York, USA. 1970

**Dunlap, Ellen L.**

No biographical data available

The building of the earth was dramatic beyond our imagination. The shaping of the continents and the ocean depths required titanic convulsions. The Supreme One did not shout the Earth into instant being anymore than an architect would order the instant erection of a skyscraper. The ground work must be laid, and, little by little, the job progresses. It required several billions of years to make the Earth what it is today, and the job is not yet done.

From Aunt Nellie's Notebook

*Nature Magazine*, January, 1958 (p. 17)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

My subject [astronomy] disperses the galaxies, but it unites the Earth.

In Arthur Beer (ed.)

*Vistas in Astronomy* (Volume 2)

Meeting of the International Astronomical Union, Cambridge, Massachusetts, USA., September, 1932 (p. i)

**Ehrenreich, Barbara** 1941–

American social critic and essayist

Some of us still get all weepy when we think about the Gaia Hypothesis, the idea that earth is a big furry goddess-creature who resembles everybody's mom in that she knows what's best for us. But if you look at the historical record – Krakatoa, Mt. Vesuvius, Hurricane Charley, poison ivy, and so forth down the ages – you have to ask yourself: Whose side is she on, anyway?

*The Worst Years of Our Lives*

The Great Syringe Tide (p. 55)

Pantheon Books. New York, New York, USA. 1981

**Einstein, Albert** 1879–1955

German-born physicist

There has been an earth for a little more than a billion years. As for the question of the end of it I advise: Wait and see.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 182)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Ficino, Marsilio** 1433–1499

Early Italian humanist philosopher

We see the Earth give birth, thanks to varieties of seeds, to a multitude of trees and animals, nourish them, and

make them grow; we see her cause even stones to grow as her teeth, vegetable life as hairs, as long as they remain connected to their roots, while if they are removed or unearthed they cease growing. Could we say that the breast of this female lacks life, she who spontaneously gives birth and nourishes so many offspring, who sustains herself and whose back carries teeth and hair?

*Theologica plantonica* (Volume 1) (p. 144)  
Harvard University Press. Cambridge, Massachusetts, USA. 1917

### **Flammarion, Camille** 1842–1925

French astronomer and writer

The earth appears to us as an immense plain, chequered with a thousand varieties of aspects and reliefs – verdant hills, flowery valleys, mountains more or less elevated, winding rivers in the plains, lakes of fresh water, vast oceans, countries of infinite variety.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter I (p. 4)  
Chatto & Windus. London, England. 1894

When men know something of the earth, and understand the modest position of our planet in infinity; when they appreciate better the grandeur and the beauty of nature, they will be fools no longer, as coarse on the one hand as credulous on the other; but they will live in peace, in the fertile study of Truth, in the contemplation of the Beautiful, in the practice of Good, in the progressive development of the reason, and in the noble exercise of the higher facilities of intelligence.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter I (p. 11)  
Chatto & Windus. London, England. 1894

As changeable as the iridescent bubble which the breath of a child blows by the aid of a simple drop of soapy water, and allows to fly away through the air in the rays of the cheerful sun, the terrestrial globe floats in space – the veritable sport of cosmical forces which carry it whirling through the vast heavens.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter IV (p. 38)  
Chatto & Windus. London, England. 1894

The study of the earth teaches us to understand the sky, and in the microscopical atom we inhabit the vibrations of the infinite are revealed.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter V (p. 52)  
Chatto & Windus. London, England. 1894

...our Earth is an orb of the Heavens ...

Translated by Frances Alice Welby  
*Astronomy for Amateurs*  
Introduction (p. 17)  
D. Appleton & Co. New York, New York, USA. 1915

...we saw the Earth hanging in space, like a globe isolated on all sides, and surrounded at vast distances by a multitude of stars.

Translated by Frances Alice Welby  
*Astronomy for Amateurs*  
Chapter II (p. 28)  
D. Appleton & Co. New York, New York, USA. 1915

### **Galilei, Galileo** 1564–1642

Italian physicist and astronomer

For my part, I consider the earth very noble and admirable precisely because of the diverse alterations, changes, generations, etc., that occur in it incessantly. If, not being subject to any change, it were a vast desert of sand or a mountain of jasper, or if at the time of the flood the waters which covered it had frozen, and it had remained an enormous globe of ice where nothing was ever born or ever altered or changed, I should deem it a useless lump in the universe, devoid of any activity and, in a word, superfluous and essentially nonexistent.

*Dialogues Concerning the Two Chief World Systems*  
The First Day (p. 58)  
University of California Press. Berkeley, California, USA. 1953

### **Giberne, Agnes** 1845–1939

English writer

What is this earth of ours?...Something very great, compared with the things upon the earth; something very little, compared with the things outside the earth.

*Sun, Moon, and Stars*  
Chapter I (p. 1)  
Seeley, Jackson, & Halliday. London, England. 1880

### **Gray, George W.**

Freelance science writer

Perhaps the Earth is a clod, but if so it is a vibrant clod, responsive to an endless symphony – or cacophony – of cosmic influences.

*The Advancing Front of Science*  
Chapter II (p. 25)  
Whittlesey House. New York, New York, USA. 1937

### **Guiterman, Arthur** 1871–1943

Poet

We dwell within the Milky Way,  
Our Earth, a paltry little mommet,  
Suspended in a grand array  
Of constellation, moon and comet.

*Gaily the Troubadour*  
Outline of the Universe (p. 70)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1936

### **Hageman, Samuel M.** 1848–1905

American clergyman and poet

Earth is but the frozen echo of the silent voice of God.

*Silence*  
Silence, Stanza XIX  
Dodd, Mead and Company. New York, New York, USA. 1877



**Hale, George Ellery** 1868–1938

American astronomer

Scattered over the heavens are millions of stars, each representing a certain degree of development. The cloud forms of the nebulae tell us of stellar origins; the white, yellow, and red stars illustrate the rise and decline of stellar life; and the Earth itself affords a picture of what may remain after light and heat have been extinguished.

*The Study of Stellar Evolution: An Account of Some Recent Methods of Astrophysical Research*

Chapter 1 (p. 8)

The University of Chicago Press. Chicago, Illinois, USA. 1908

**Hardy, Thomas** 1840–1928

English poet and regional novelist

Let me enjoy the earth no less  
Because the all-enacting Might  
That fashioned forth its loveliness  
Had other aims than my delight.

*Collected Poems of Thomas Hardy*

Let Me Enjoy the Earth

Macmillan &amp; Company Ltd. London, England. 1920

**Hayden, Horace H.** 179–1844

Geologist and botanist

The structure of the globe which we inhabit, and the infinitely varied features, either moral or physical, which are presented to human view in almost every district upon its surface, afford a subject for contemplation, that far transcends the feeble capacity of man perfectly to comprehend; much less is he able to delineate; with truth and correctness, the innumerable shades which are characteristic or indicative of some great and important change or operation, which has been wrought upon this stupendous fabric.

*Geological Essays*

Chapter I (p. 1)

Printed by J. Robinson. 1820

**Herschel, Friedrich Wilhelm****(Sir William)** 1738–1822

English astronomer

Suppose an inhabitant of the moon who has not properly considered such analogical reasonings as might induce him to surmise that our earth is inhabited, to give it as his opinion that the use of the earth is to illuminate the moon, when direct daylight cannot be had, etc.

On the Nature and Contraction of the Sun and Fixed Stars

*Philosophical Transactions of the Royal Society of London*,  
Volume 85. 1795 (p. 67)

**Hervey, James** 1714–58

English clergyman and poet

To us who dwell on its surface, the earth is by far the most extensive orb that our eyes can any where behold. It is also clothed with verdure; distinguished by trees; and

adorned with a variety of beautiful decorations. Whereas, to a spectator placed on one of the planets, it wears a uniform aspect; looks all luminous, and no larger than a spot. To beings who dwell at still greater distances, it entirely disappears.

*Meditations and Contemplations*

On the Starry Heavens (p. 177)

J. &amp; B. Williams. Exeter, England. 1836

**Hillel, Daniel**

No biographical data available

We have all come out of the earth, and are its children. The earth has always nurtured us, despite our scornful abuse, and we can no longer continue to behave as its ungrateful offspring. It is time for us, as *Homo sapiens curans*, to nurture the earth in return.

*Out of the Earth: Civilization and the Life of the Soil*

Chapter 30 (p. 283)

The Free Press. New York, New York, USA. 1991

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Once a photograph of the Earth, taken from the outside, is available once the sheer isolation of the Earth becomes plain a new idea as powerful as any in history will be let loose.

*The New Face of Science*

Epilogue (p. 129)

The World Publishing Co. New York, New York, USA. 1971

**Humphrey, Hubert H.** 1911–78

38th vice-president of the USA

As we begin to comprehend that the earth itself is a kind of manned spaceship hurtling through the infinity of space – it will seem increasingly absurd that we have not better organized the life of the human family.

Speech, 26 September, 1966

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

When we trace the parts of which this terrestrial system is composed, and when we view the general connection of those several parts, the whole presents a machine of a peculiar construction by which it is adapted to a certain end. We perceive a fabric, erected in wisdom, to obtain a purpose worthy of the power that is apparent in the production of it.

*The Theory of the Earth* (Volume 1)

Part I, Chapter I, Section I (p. 3)

Messrs. Cadwell, Junior, and Davies. London, England. 1795

This globe of the earth is a habitable world; and on its fitness for this purpose, our sense of wisdom in its formation must depend.

*The Theory of the Earth* (Volume 1)

Part I, Chapter I, Section I (p. 4)

Messrs. Cadwell, Junior, and Davies. London, England. 1795



**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

...how vast those Orbs must be, and how inconsiderable this Earth, the Theatre upon which all our mighty Designs, all our Navigations, and all our Wars are transacted, is when compared to them. A very fit Consideration, and matter of Reflection, for those Kings and Princes who sacrifice the Lives of so many People, only to flatter their Ambition in being Masters of some pitiful corner of this small Spot.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
Book the Second. The Immense Distance Between the Sun and the Planets Illustrated (pp. 141–142)  
Printed for T. Childe. London, England. 1698

**Irwin, James** 1930–91  
American astronaut

The Earth reminded us of a Christmas tree ornament hanging in the blackness of space. As we got farther and farther away it diminished in size. Finally it shrank to the size of a marble, the most beautiful marble you can imagine. That beautiful, warm, living object looked so fragile, so delicate, that if you touched it with a finger it would crumble and fall apart. Seeing this has to change a man, has to make a man appreciate the creation of God and the love of God.

In Kevin W. Kelley  
*The Home Planet*  
With Plate 38  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1988

**Jastrow, Robert** 1925–  
American space scientist

When the earth came into existence, it was a naked body of rock without air or water; but a subtle transformation taking place in the depths of the planet would soon change that.... The earth was ready; it waited for life.

*Until the Sun Dies*  
Light from the Darkness (p. 55)

**J Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

Standing on our microscopic fragment of a grain of sand, we attempt to discover the nature and purpose of the universe which surrounds our home in space and time.

*The Mysterious Universe*  
Chapter I (p. 3)  
The Macmillan Company. New York, New York, USA. 1932

So long as the earth was believed to be the center of the universe the question of life on the other worlds could hardly arise; there are no other worlds in the astronomical sense, although a heaven above and a hell beneath might form adjuncts to this world.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1942*  
s There Life on the Other Worlds (p. 145)  
Government Printing Office. Washington, D.C. 1943

**Jefferies, Richard** 1848–87  
English naturalist and author

If we had never before looked upon the earth, but suddenly came to it man or woman grown, set down in the midst of a summer mead, would it not seem to us a radiant vision? The hues, the shapes, the song and life of birds, above all the sunlight, the breath of heaven, resting on it; the mind would be filled with its glory, unable to grasp it, hardly believing that such things could be mere matter and no more. Like a dream of some spirit-land it would appear, scarce fit to be touched lest it should fall to pieces, too beautiful to be long watched lest it should fade away.

*The Open Air*  
Wildflowers (p. 31)  
Chatto & Windus. London, England. 1908

**Jeffers, Robinson** 1887–1962  
American poet

It is only a little planet  
But how beautiful it is.

*The Beginning and the End and Other Poems*  
How Beautiful It Is (p. 29)  
Random House, Inc. New York, New York, USA. 1963

**Johnson, Lyndon B.** 1908–73  
36th president of the USA

Think of our world as it looks from that rocket that's heading toward Mars. It is like a child's globe, hanging in space, the continents stuck to its side like colored maps. We are all fellow passengers on a dot of earth. And each of us, in the span of time, has really only a moment among our companions.

Inaugural Address, January 20, 1965

**Kahn, Fritz** 1888–1958  
German-born American writer and conceptual medical illustrator

This is the universe: infinity. Space without beginning, without end, dark, empty, cold. Through the silent darkness of this space more gleaming spheres, separated from each other by inconceivable distances. Around them again inconceivably far away, like bits of dust lost in immensity, circle smaller dark spheres, receiving light and life from their "mother suns." One of these little spheres in the light of one of the countless suns in endless space, is our earth. This is man's home in the universe.

*Design of the Universe*  
Chapter One (p. 2)  
Crown Publishers. New York, New York, USA. 1954

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

All these reckonings of the history of underground heat, the details of which I am sure you do not wish me to put before you at present, are founded on the very sure

assumption that the material of our present solid earth all round its surface was at one time a white-hot liquid.

The Age of the Earth As An Abode Fitted for Life  
*Science*, New Series, Volume 9, Number 229, May 19, 1898 (p. 672)

Considering the almost certain truth that the earth was built up of meteorites falling together, we may follow in imagination the whole process of shrinking from gaseous nebula to liquid lava and metals, and solidification of liquid from central regions outward.

The Age of the Earth as An Abode Fitted for Life  
*Science*, New Series, Volume 9, Number 229, May 19, 1898 (p. 706)

**Kett, Henry** 1761–1825  
English college teacher and writer

The terraneous globe presents a most glorious and most sublime prospect, equally worthy of the capacity of man to contemplate, and beautiful to his eye to behold.

*Elements of General Knowledge* (Volume 2)  
Chapter IV (p. 89)  
Printed by E. Bronson. Philadelphia, Pennsylvania, USA. 1805

**Kingsley, Charles** 1819–75  
English clergyman and author

Gradually the sunken land begins to rise again, and falls perhaps again, and rises again after that, more and more gently each time, till as it were the panting earth, worn out with the fierce passions of her fiery youth, has sobbed herself to sleep once more, and this new world of man is made.

*New Miscellanies*  
Thoughts in a Gravel-Pit (p. 315)  
Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Lorca, Federico García** 1899–1936  
Spanish poet, dramatist, and theatre director

The earth is probably paradise lost.

*A Book of Poems*  
Mar (p. 131)  
Dover Publications. Mineola, New York, USA. 2004

**MacLeish, Archibald** 1892–1982  
American poet and Librarian of Congress

To see the earth as we now see it, small and beautiful in that eternal silence where it floats, is to see ourselves as riders on the earth together, brothers on that bright loveliness in the unending night – brothers who see now they are truly brothers.

*Riders on the Earth*  
Bubble of Blue Air (p. xiv)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

**Macpherson, Hector**  
No biographical data available

...our planet [Earth] is a mere grain of sand in the ocean of infinity.

*The Romance of Modern Astronomy*

Chapter I (p. 25)  
J.B. Lippincott Co. Philadelphia, Pennsylvania, USA. 1911

**Mantell, Gideon Algernon** 1780–1852  
English obstetrician, geologist, and paleontologist

Our beautiful planet is indeed worthy of our study; it was once our cradle it will soon be our grave, between the dawn and the night of life, it is the scene of our busy action, and from it we shall rise to another state of being.

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*  
Introduction (p. 6)  
G.H. Bohn. London, England.

**Marvin, Ursula**  
American geologist

In learning about the earth – a most fundamental preoccupation of man – geologists are limited to direct examination of its outermost surface and that of its nearest neighbor, the moon. All knowledge of the deep interior of our planet and of the nature of other planets in the solar system is gathered by remote sensing devices. Characteristically, the signals from these devices are interpreted differently by different scientists and every new advance tends to raise new problems, leaving us acutely aware of the limitations of our knowledge.

*Continental Drift: Evolution of a Concept*  
Postscript (p. 207)  
Smithsonian Institution Press. Washington, D.C. 1973

**Masson, David**  
No biographical data available

Each orb has had its history. For ours,  
It blazed and steamed, cooled and contracted, till,  
Tired of mere vapping within the grasp  
Of ruthless condensation, it assumed  
The present form, proportions, magnitude –  
Our Tidy ball, axeled eight thousand miles.

In Alexander Winchell  
*World-Life or Comparative Geology*  
Chapter III (p. 338)  
S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**Momaday, N. Scott** 1934–  
Native American writer

Once in his life a man ought to concentrate his mind upon the remembered earth, I believe. He ought to give himself up to a particular landscape in his experience, to look at it from as many angles as he can, to wonder about it, to dwell upon it. He ought to imagine that he touches it with his hands at every season and listens to the sounds that are made upon it. He ought to imagine the creatures there and all the faintest motions of the wind. He ought to recollect the glare of noon and all the colors of the dawn and dusk.

*The Way to the Rainy Mountain*

The Closing, XXIV (p. 83)

University of New Mexico Press. Albuquerque, New Mexico, USA. 1969

### Montague, C. E.

No biographical data available

The earth with no history to it – what it would be if it had all been made only last night and were not a worn ancient face, seamed, stained, and engraved with endless cross-hatching of documentary wrinkles, its mountains the ruins of more wondrous height now all but erased.

In A.C. Seward

*Plant Life Through the Ages: A Geological and Botanical Retrospect*  
Chapter 1 (p. 1)

Hafner Publishing Company. New York, New York, USA. 1959

### Morton, Oliver

Science and technology editor

If the space age has opened new ways of seeing mere matter, though, it has also fostered a strange return to something reminiscent of the pre-Copernican universe. The life that Lowell and his like expected elsewhere has not appeared, and so the Earth has become unique again. The now-iconic image of a blue-white planet floating in space, or hanging over the deadly deserts of the moon, reinforces the Earth's isolation and specialness. And it is this exceptionalism that drives the current scientific thirst for finding life elsewhere, for finding a cosmic mainstream of animation, even civilization, in which the Earth can take its place. It is both wonderful and unsettling to live on a planet that is unique.

*Mapping Mars: Science, Imagination and the Birth of a World*

A Point of Warlike Light (p. 14)

Fourth Estate. London, England. 2002

### Muir, John 1838–1914

American naturalist

...when we contemplate the whole globe as one great dewdrop, striped and dotted with continents and islands, flying through space with other stars all singing and shining together as one, the whole universe appears as an infinite storm of beauty.

*Travels in Alaska*

Chapter I (p. 5)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

### Newman, Joseph S. 1892–1960

American poet

This ball was once a glowing mass  
Of mixed and superheated gas  
Which cooled to liquid, shrank in girth,  
Solidified and turned to earth.

*Poems for Penguins and Other Lyrical Lapses*

Geology

Greenburg. New York, New York, USA. 1941

### Peattie, Donald Culross 1898–1964

American botanist, naturalist, and author

Old earth is great with her children, the bulb and the grub, and the sleepy mammal and the seed.

*An Almanac for Moderns*

April Sixth (p. 19)

G.P. Putnam's Sons. New York, New York, USA. 1935

The geologist's picture of the younger stages of this our agreeable planet home resembles the Apocalyptic doom for the world that I once heard predicted to innocents in a Presbyterian Sunday School. For the geologist sees flaming jets of incandescent gas, bolts and flashes that, condensing as they cooled, became a swarm of planetesimals, fragments comparable to great meteoric masses of stone and metal. These, by all the rules of orthodox astronomy, must rush together whenever their orbits came too close.

*Flowering Earth*

Chapter 6 (p. 61)

G.P. Putnam's Sons. New York, New York, USA. 1939

### Platt, John R.

No biographical data available

The earth is finite, and when we have come to the ends of it, we have come to the ends of it.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today*, 1968

The New Biology and the Shaping of the Future (p. 124)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

### Pollard, William

No biographical data available

...the earth with its vistas of breathtaking beauty, its azure seas, beaches, mighty mountains, and soft blanket of forest and steppe is a veritable wonderland in the universe. It is a gem of rare and magic beauty hung in a trackless space filled with lethal radiations and accompanied in its journey by sister planets which are either viciously hot or dreadfully cold, arid, and lifeless chunks of raw rocks. Earth is choice, precious, and sacred beyond all comparison or measure.

In Michael Hamilton (ed.)

*This Little Planet*

God and His Creation (p. 59)

Charles Scribner's Sons. New York, New York, USA. 1970

### Pouchet, Félix Archimède 1800–72

French biologist

The earth is only an immense cemetery where each generation acquires life at the expense of the debris of that which has just expired; the particles of our corpses form new materials for the beings which will follow us.

*The Universe*

Geology, Book I, Chapter I (p. 590)

Blackie & Son. London, England. 1870

**Pupin, Michael**

Physicist

Our terrestrial globe is a celestial casting, and he who like myself learned the language of the foundry in his early youth will ask the human question: What is the mission of this celestial casting, this old celestial wanderer through the mighty stream of chaotic solar radiation? Is it only to receive its final tempering from the solar furnace which gave it its birth, and to smooth out its jagged surface by the erosive action of the waters which solar radiation carries in ceaseless succession of cycles from the oceans to the higher continental elevations? The answer to this human question is obvious; it is this: The highest mission of this celestial casting, which we call affectionately “our mother earth,” is to provide a congenial home for a new universe, “the universe of organic life.”

*The New Reformation: From Physical to Spiritual Realities*  
Chapter VII, Section IV (pp. 235–236)  
Charles Scribner’s Sons. New York, New York, USA. 1928

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

The earth in her physical aspects seems like a veritable thing of life, possessed of flesh, blood, and bones – her flesh, the soil; her blood, the rivers and the seas; her bones, the rock-ribbed mountains; her nostrils, the volcanoes; her breath, the winds; her eyelids, the skies; her tears, the dew-drops; her song, the melody of birds; her smile, the flowers; and her raiment, the sunbeams. It is the delight of her life to provide for her household, and at the same time dance to the “music of the spheres.”

*Nature and Culture*  
Chapter I (p. 26)  
Lee & Shepard. Boston, Massachusetts, USA. 1875

**Ritter, Carl** 1779–1859

German geographer

Our earth is a star among the stars; and should not we who are on it prepare ourselves by it for the contemplation of the universe and its Author?

In Arnold Guyot  
*The Earth and Man*  
Motto Title page

Gould & Lincoln. Boston, Massachusetts, USA. 1860

**Robinson, Victor** 1886–1947

Physician

Earth is her own historian, and in every age writes her story in forests and deserts, on rocks and in river-beds.

*The Story of Medicine*  
Chapter I (p. 1)  
The New York Home Library. New York, New York, USA. 1943

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

The earth in its depths must remain dead and cold, incapable except of slow crystalline change; but at its

surface, which human beings look upon and deal with, it ministers to them through a veil of strange intermediate being; which breathes, but has no voice; moves, but cannot leave its appointed place; passes through life without consciousness, to death without bitterness; wears the beauty of youth, without its passion; and declines to the weakness of age, without its regret.

*Modern Painters* (Volume 5)  
Part VI, Chapter 1 (p. 2)  
John Wiley & Sons. New York, New York, USA. 1879

**Sagan, Carl** 1934–96

American astronomer and author

The size and age of the Cosmos are beyond ordinary human understanding. Lost somewhere between immensity and eternity is our tiny planetary home.

*Cosmos*  
Chapter I (p. 1)  
Random House, Inc. New York, New York, USA. 1980

There are some hundred billion (10<sup>11</sup>) galaxies, each with, on the average a hundred billion stars. In all the galaxies, there are perhaps as many planets as stars, 10<sup>11</sup> × 10<sup>11</sup> = 10<sup>22</sup>, ten billion trillion. In the face of such overpowering numbers, what is the likelihood that only one ordinary star, the Sun, is accompanied by an inhabited planet? Why should we, tucked away in some forgotten corner of the Cosmos, be so fortunate? To me, it seems far more likely that the universe is brimming over with life. But we humans do not yet know. We are just beginning our explorations. The only planet we are sure is inhabited is a tiny speck of rock and metal, shining feebly by reflected sunlight, and at this distance utterly lost.

*Cosmos*  
Chapter I (pp. 5, 7)  
Random House, Inc. New York, New York, USA. 1980

Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves.

*Pale Blue Dot: A Vision of the Human Future In Space*  
Chapter 1 (p. 9)  
Random House, Inc. New York, New York, USA. 1994

If we are to understand the Earth, we must have a comprehensive knowledge of the other planets.

The Solar System  
*Scientific American*, Volume 233, Number 3, 1975 (p. 27)

**Schneider, Herman** 1905–2003

Polish-born American educator and author

**Schneider, Nina**

No biographical data available

The story of the earth is in a leaf and in a stone; in a cloud and in the sea. The leaf was once a stone; the cloud was once the sea. The earth tells its story over and over again—the leaf will become a stone, the cloud will become the sea again.

*Rocks, Rivers and the Changing Earth: A First Book About Geology*  
Part One. A Leaf and A Stone (p. 3)  
William R. Scott, Inc. New York, New York, USA. 1952

**Scrope, George Poulett** 1797–1876  
English geologist and political economist

Towards the end of the last century, men of science became convinced of the futility of those crude and fanciful speculations on the original state of the earth, in which cabinet geologists had for some time indulged; and justly perceived that the only sure road to the true history of our planet lies in a minute and practical study of those portions of its surface which are open to our examination, and in their comparison with the results of those changes and operations which the ever-active hand of Nature is still carrying on upon that surface.

*Memoir on the Geology of Central France*  
Preface (p. v)

Longman, Rees, Orme, Brown & Green. London, England. 1827

**Sedgewick Seti** 1854–1913  
English geologist

The earth is our cradle,  
The solar system our kindergarten,  
The galaxy our middle-school and  
The universe our university.

Filler material

*Cosmic Search Magazine*, Volume 1, Number 1, January, 1979 (p. 24)

**Serviss, Garrett Putman** 1851–1921  
American science fiction writer

Here we were, out in the middle of space; and there was the earth, hanging on nothing, like a summer cloud.

*A Columbus of Space*

Chapter II (p. 28)

D. Appleton & Co. New York, New York, USA. 1911

**Sexton, Anne** 1928–74  
American poet

God owns heaven, but He craves the earth.

*The Awful Rowing Toward God*

The Earth

Houghton Mifflin Company. Boston, Massachusetts, USA. 1975

**Shaler, Nathaniel Southgate** 1841–1906  
American geologist

...earth-lore is not a discrete science at all, but is that way of looking at the operations of energy in the physical, chemical and organic series which introduces the elements of space and time into the considerations and which furthermore endeavors to trace the combination of the various trends of action in the stages of the developments of the earth. It is in these peculiarities of geology that we find the basis of its value in education and in the general culture of society.

Relations of Geologic Science to Education  
*Bulletin of the American Geological Society*, Volume 7, Number x, 1896 (p. 319)

**Taine, Hippolyte** 1828–93  
French critic and historian

Amid this vast and overwhelming space and in these boundless solar archipelagoes, how small is our own sphere, and the earth, what a grain of sand!

Translated by John Durand

*The Ancient Regime*

Book Third, Chapter II (p. 175)

Henry Holt & Company. New York, New York, USA. 1881

**Teilhard de Chardin, Pierre** 1881–1955  
French Jesuit, paleontologist, and biologist

Without being overawed by the improbable, let us now concentrate our attention on the planet we call Earth. Enveloped in the blue mist of oxygen which its life breathes, it floats at exactly the right distance from the sun to enable the higher chemisms to take place on its surface. We do well to look at it with emotion. Tiny and isolated though it is, it bears clinging to its flanks the destiny and future of the Universe.

*The Future of Man*

Chapter VI, Part I, Section I (p. 114)

Harper & Row, Publishers. New York, New York, USA. 1964

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Many an aeon moulded earth before her highest, man,  
was born,  
Many an aeon too may pass when earth is manless and  
forlorn,

Earth so huge and yet so bounded – pools of salt and  
plots of land – Shallow skin of green and azure – chains  
of mountains, grains of sand!

*Alfred Tennyson's Poetical Works*

Locksley Hall, Sixty Years After, Stanza 103

Oxford University Press, Inc. London, England. 1953

And the homeless planet at length will be wheeled thro  
the silence of Space,  
Motherless evermore of an ever-vanishing race,  
When the worm shall have writhed its last and its last  
brother-worm will have fled  
From the dead fossil skull that is left in the rocks of an  
earth that is dead.

*The Works of Alfred Lord Tennyson, Poet Laureate*

Despair (p. 535)

The Macmillan Co. New York, New York, USA. 1898

**Thomas, Lewis** 1913–93  
American physician and biologist

I have been trying to think of the earth as a kind of organism, but it is no go. I cannot think of it this way. It is too



big, too complex, with too many working parts lacking visible connections. The other night, driving through a hilly, wooded part of southern New England, I wondered about this. If not like an organism, what is it like, what is it most like? Then, satisfactorily for that moment, it came to me: it is most like a single cell.

*The Lives of a Cell: Notes of a Biology Watcher*

The Lives of a Cell (p. 5)

The Viking Press. New York, New York, USA. 1974

Viewed from the distance of the moon, the astonishing thing about the earth, catching the breath, is that it is alive. The photographs show the dry, pounded surface of the moon in the foreground, dry as an old bone. Aloft, floating free beneath the moist, gleaming, membrane of bright blue sky, is the rising earth, the only exuberant thing in this part of the cosmos.

*The Lives of a Cell: Notes of a Biology Watcher*

The World's Biggest Membrane (p. 145)

The Viking Press. New York, New York, USA. 1974

The word for earth, at the beginning of the Indo-European language thousands of years ago (no one knows for sure how long ago) was *dhghem*. From this word, meaning simply earth, came our word humus, the handiwork of soil bacteria. Also, to teach us the lesson, [came the words] humble, human, and humane. There is the outline of a philological parable here.

In Lynn Margulis and Dorion Sagan

*Microcosmos*

Foreword (p. 12)

Summit Books. New York, New York, USA. 1986

The overwhelming astonishment, the queerest structure we know about so far in the whole universe, the greatest of all cosmological scientific puzzles, confounding all our efforts to comprehend it, is the earth.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*

The Corner of the Eye (p. 16)

Viking Press. New York, New York, USA. 1983

### **Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The earth is not a mere fragment of dead history, stratum upon stratum like the leaves of a book, to be studied by geologists and antiquaries chiefly, but living poetry like the leaves of a tree, which precede flowers and fruit – not a fossil earth, but a living earth; compared with whose great central life all animal and vegetable life is merely parasitic. Its throes will heave our exuviae from their graves... You may melt your metals and cast them into the most beautiful moulds you can; they will never excite me like the forms which this molten earth flows out into.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter XVII (p. 476)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Vitousek, Peter Mooney**

No biographical data available

### **Lubchenco, Harold A.**

No biographical data available

... we are changing Earth more rapidly than we are understanding it.

Human Domination of Earth's Ecosystems

*Science*, Volume 277, Number 5325, July 25, 1997 (p. 498)

### **Vizinczey, Stephen** 1933–

Hungarian author

Is it possible that I am not alone in believing that in the dispute between Galileo and the Church, the Church was right and the centre of man's universe is the earth?

*Truth and Lies in Literature: Essays and Reviews*

Rules of the Game (p. 269)

Atlantic Monthly Press. Boston, Massachusetts, USA. 1986

### **Voltaire (François-Marie Arouet)** 1694–1778

French writer

“But then to what end?” asked Candide, “was the world formed?”

“To make us mad,” said Martin.

*The Best Known Works of Voltaire*

*Candide*

Chapter XXI (p. 57)

Blue Ribbon Books. New York, New York, USA. 1940

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Our earth... is a spinning globe. Vast though it seems to us, it is a mere speck of matter in the greater vastness of space.

*The Outline of History* (Volume 1)

Book I, Chapter I, Section 2 (p. 13)

Garden City Books. Garden City, New York, USA. 1961

We have learned now that we cannot regard this planet as being fenced in and a secure abiding place for Man; we can never anticipate the unseen good or evil that may come upon us suddenly out of space.

*Seven Science Fiction Novels of H. G. Wells*

*The War of the Worlds*

Chapter the Tenth (p. 452)

Dover Publications, Inc. New York, New York, USA. 1934

### **Whipple, Fred L.** 1906–2004

Pioneer in comet research

Our Earth seems so large, so substantial, and so much with us that we tend to forget the minor position it occupies in the solar family of planets. Only by a small margin is it the largest of the other terrestrial planets. True, it does possess a moderately thick atmosphere that overlies a thin patchy layer of water and it does have a noble



satellite, about 1/4 its diameter. These qualifications of the Earth, however, are hardly sufficient to bolster our cosmic egotism. But, small as is the Earth astronomically, it is our best-known planet and therefore deserves and has received careful study.

*Earth, Moon and Planets*

The Earth (p. 60)

Grosset & Dunlap, Publishers. New York, New York, USA. 1958

### **Whitman, Walt** 1819–92

American poet, journalist, and essayist

The earth never tires;  
The earth is rude, silent,  
incomprehensible at first –  
Nature is rude and incomprehensible at first –  
Be not discouraged – keep on – there are divine things  
well envelop'd;  
I swear to you there are divine things more beautiful than  
words can tell.

*Complete Poetry and Collected Prose*

Song of the Open Road

The Library of America. New York, New York, USA. 1982

In this broad earth of ours,  
Amid the measureless grossness and the slag,  
Enclosed and safe within its central heart  
Nestles the seed perfection.

*Complete Poetry and Collected Prose*

Song of the Universal

The Library of America. New York, New York, USA. 1982

### **Winchell, Alexander** 1824–91

American geologist

The stability of the solid earth is instability itself.

*Walks and Talks in the Geological Field*

Part I, Chapter XVIII (p. 102)

Chautauqua Press. New York, New York, USA. 1890

### **Young, Louise B.**

Science writer

Time flows on...the planet continues to spin on its path  
through the unknown reaches of space. We cannot guess  
its destination or its destiny. The beautiful blue bubble of  
matter holds many wonders still unrealized and a mysteri-  
ous future waiting to unfold.

*The Blue Planet*

Chapter 14 (p. 266)

Little, Brown & Company. Boston, Massachusetts, USA. 1983

## **MARS**

### **Barnard, Edward Emerson** 1857–1923

American astronomer

To save my soul I can't believe in the canals as Schiaparelli draws them.... I verily believe...that the canals as

depicted by Schiaparelli are a fallacy and that they will  
be so proved before many oppositions are past.

*NASA Serial Publication*

Letter to Simon Newcomb, September 11, 1894 (p. 6)

Scientific and Information Technical Office, NASA, Washington, D.C.  
1962

### **Boynton, William**

No biographical data available

The signal we have been getting loud and clear is there is  
a lot of ice on Mars.

Evidence of Plentiful Water on Mars

*The Associated Press*, 2 March, 2002

### **Bradbury, Ray** 1920–

American writer

We are all...children of this universe. Not just Earth, or  
Mars, or this System, but the whole grand fireworks. And  
if we are interested in Mars at all, it is only because we  
wonder over our past and worry terribly about our possi-  
ble future.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan and

Walter Sullivan

*Mars and the Mind of Man*

Forward (p. x)

Harper & Row, Publishers. New York, New York, USA. 1973

### **Burroughs, Edgar Rice** 1875–1950

American writer

...it was Mars, the god of war, and for me, the fighting  
man, it had always held the power of irresistible enchant-  
ment. As I gazed at it on that far-gone night it seemed to  
call across the unthinkable void, to lure me to it, to draw  
me as the lodestone attracts a particle of iron.

*The Princess of Mars*

Chapter II (p. 21)

Grosset & Dunlap. New York, New York, USA. 1917

### **Cosmo Kramer (Fictional character)**

I've never been to Mars but I imagine it's quite lovely.

*Seinfeld*

TV series

The pilot (1) 1993

### **de Fontenelle, Bernard le Bovier** 1657–1757

French author

Mars, who affords nothing curious that I know of; his day  
is rather more than half an hour longer than ours, but his  
year is twice as long, wanting about a month and near a  
half. He is about four times less than the earth, and the  
sun seems not altogether so large and so bright to him, as  
it appears to us. But let us leave Mars, he is not worthy  
our stay...

*Conversations on the Plurality of Worlds*

The Fourth Evening (pp. 118–119)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

I dare not affirm that I am able to observe the phases of Mars; nonetheless, if I am not mistaken, I believe I have seen that it is not perfectly round.

Letter to Benedetto Castelli, December 30, 1610  
Source undetermined

**Eberhart, Jonathan**  
Journalist, singer, and poet

Ten thousand times a hundred thousand dusty years ago,  
Where now extends the Plain of Gold,  
Did once my rivers flow;  
It stroked the stones and spoke in tongues and splashed  
against my face,  
Till ages rolled,  
The sun shone cold  
On this unholy place.  
Lament for a Red Planet  
Jonathan Ebert. 1980

**Herschel, Friedrich Wilhelm**  
(**Sir William**) 1738–1822  
English astronomer

The spots on Mars are of a different nature. Their constant and determined shape, as well as remarkable color, show them to be permanent, and fastened to the body of the planet.

Astronomical Observations on the Rotation of the Planets Round their Axes made with a View to determine whether the Earth's Diurnal Motion is perfectly Equable  
*Philosophical Transactions of the Royal Society of London*,  
Volume 71, 1781 (p. 119)

From other phenomena it appears, however, that this planet is not without a considerable atmosphere; for besides the permanent spots on its surface I have often noticed changes in both bright and dark belts, and these alterations we can hardly ascribe to any other cause than the variable disposition of clouds and vapors floating in the atmosphere of that planet.

On the Remarkable Appearances at the polar regions of the Planet Mars  
*Philosophical Transactions of the Royal Society of London*,  
Volume 74, 1784 (p. 273)

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

I am apt to believe that the Land in Mars is of a blacker Colour than that of Jupiter or the Moon, which is the reason of his appearing of a Copper Colour, and his reflecting a weaker Light than is proportionable to his distance from the Sun.... His Light and Heat is twice, and sometimes three times less than ours, to which I suppose the Constitution of his Inhabitants is answerable.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
Section 11, Book 2 (p. 111)  
Printed for T. Childe. London, England. 1698

**Kepler, Johannes** 1571–1630  
German astronomer

...[the] motions [of Mars] provide the only possible access to the hidden secrets of astronomy, without which we would remain forever ignorant of those secrets.

*New Astronomy*  
Part II, 7 (p. 185)  
At The University Press. Cambridge, England. 1992

**Kuiper, Gerard P.** 1905–73  
Dutch-born American astronomer

The hypothesis of plant life...appears still the most satisfactory explanation of the various kinds of dark markings and their complex seasonal and secular changes.

In Steven J. Dick  
*Life on Other Worlds: The 20th Century Extraterrestrial Life Debate*  
Chapter 2 (p. 25)  
Cambridge University Press. Cambridge, England. 1998

**Leovy, Conway B.**  
No biographical data available

Unlike the moon, whose story appears essentially to have ended one or two billion years ago, Mars is still evolving and changing. On Mars, as on the earth, the most pervasive agent of change is the planet's atmosphere, itself the product of the sorting of the planet's initial constituents that began soon after it condensed from the primordial cloud of dust and gas that gave rise to the solar system 4.6 billion years ago.

The Atmosphere of Mars  
*Scientific American*, Volume 237, Number 1, July 1977 (p. 34)

**Longfellow, Henry Wadsworth** 1807–82  
American poet

There is no light in earth or heaven  
But the cold light of stars;  
And the first watch of night is given  
To the red planet Mars.

*The Poetical Works of Henry Wadsworth Longfellow*  
The Light of Stars, Stanza 2  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Lowell, Percival** 1855–1916  
American astronomer

To account for these phenomena, the explanation that at once suggests itself is, that a direct transference of water takes place over the face of the planet, and that the canals are so many waterways.

*Mars*  
Canals (p. 164)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

The struggle for existence in their planet's decrepitude and decay would tend to evolve intelligence to cope with circumstances growing momentarily more and more adverse. But, furthermore, the solidarity that the conditions prescribe would conduce to a breadth of

understanding sufficient to utilize it. Intercommunication over the whole globe is made not only possible, but obligatory. This would lead to the easier spreading over it of some dominant creature – especially were this being of an advanced order of intellect – able to rise above its bodily limitations to amelioration of the conditions through the exercise of the mind.

*Mars as the Abode of Life*

Part I, Chapter IV (p. 143)

The Macmillan Company. New York, New York, USA. 1908

Thus, not only do the observations we have scanned lead to the conclusion that Mars at this moment is inhabited, but they land us at the further one that these denizens are of an order whose acquaintance was worth the making. Whether we ever shall come to converse with them in anymore instant way is a question upon which science at present has no data to provide. More important to us is the fact that they exist, made all the more interesting by their precedence of us in the path of evolution.

*Mars as the Abode of Life*

Part I, Chapter VI (p. 215)

The Macmillan Company. New York, New York, USA. 1908

There are celestial sights more dazzling, spectacles that inspire more awe, but to the thoughtful observer who is privileged to see them well, there is nothing in the sky so profoundly impressive as the canals of Mars.

*Mars as the Abode of Life*

Part II, Notes (p. 228)

The Macmillan Company. New York, New York, USA. 1908

### **Malin, Michael**

Science and technology editor

The Mars we are trying to explore does not exist

In William Sheehan and Stephen James O'Meara

*Mars: The Lure of the Red Planet*

Prometheus Books. Buffalo, New York, USA. 2001

### **Morton, Oliver**

Science and technology editor

Yet if the Earth is a single isolated planet, the human world is less constrained. The breakdown of the equation between planets and worlds works both ways. If there can now be planets that are not worlds, then there can be worlds that spread beyond planets – and ours is doing so. Our spacecraft and our imaginations are expanding our world. This projection of our world beyond the Earth is for the most part a very tenuous sort of affair. It is mostly a matter of imagery and fantasy. Mars, though, might make it real – which is why Mars matters.

*Mapping Mars: Science, Imagination and the Birth of a World*

A Point of Warlike Light (p. 14)

Fourth Estate. London, England. 2002

Mars is not an independent world, held together by the memories and meanings of its own inhabitants. But nor

is it no world at all. More than any other planet we have seen, Mars is like the Earth. It is not very like the Earth. Its gravity is weak, its atmosphere thin, its surface sealess, its soil poisonous, its sunlight deadly in its levels of ultraviolet, its climate beyond frigid. It would kill you in an instant. But it is earthlike enough that it is possible to imagine some of us going there and experiencing this new part of our human world in the way we've always experienced the old part-from the inside. The fact that humans could feasibly become Martians is the strongest of the links between Mars and Earth.

*Mapping Mars: Science, Imagination and the Birth of a World*

A Point of Warlike Light (p. 14)

Fourth Estate. London, England. 2002

### **Murray, Bruce** 1932–

American planetologist

The Mars we had found was just a big moon with a thin atmosphere and no life. There were no Martians, no canals, no water, no plants, no surface characteristics that even faintly resembled Earth's.

*Journey into Space: The First Three Decades of Space Exploration*

Chapter 1 (p. 43)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

Extending out from the chaotic terrain...are some extraordinary channels, which are also found in a number of other localities on the planet. It is hard to look at these channels without considering the possibility that they were cut by flowing water.

Mars from Mariner 9

*Scientific American*, Volume 228, Number 1, January, 1973 (p. 58)

### **Newcomb, Simon** 1835–1909

Canadian-American astronomer

Life not totally unlike that on the earth may therefore exist upon this planet [Mars] for anything that we know to the contrary.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter VII (p. 131)

Harper & Brothers Publishers. New York, New York, USA. 1906

### **Oberg, James E.**

American engineer

It's possible that metals, and even diamonds, will be found on Mars. Such mining, however, is unlikely. It would be more feasible to use Mars as a home base for a richly profitable Asteroid-mining operation. But there are other scientific and practical reasons for a manned expedition. Science is not idle curiosity; it's the search to understand the operating rules of the planet, solar system, and universe. The rolling hills, steam vents, dry riverbeds, and polar caps on Mars contain unique records of the relatively recent past.

Racing the Soviets to Mars

*CONTINUUM*, Volume 7, Number 6, March, 1986

**Schiaparelli, G. V.** 1835–1910

Italian astronomer

What strange confusion! What can all this mean? Evidently the planet has some fixed geographical details, similar to those of the Earth.... Comes a certain moment, all this disappears to be replaced by grotesque poly-gonations and germinations which, evidently, attach themselves to represent apparently the previous state, but it is a gross mask, and I say almost ridiculous.

*Corrispondenza su Marte* (Volume 2)

Schiaparelli to Terby, June 8, 1888

Letter to François Terby, June 8, 1888

No. 1, 1894

Domus Galilaeana. Pisa, Italy. 1965

**Sheeham, William**

No biographical data available

**O'Meara, Stephen James**

No biographical data available

Mars is but a tiny pinprick in the vast fabric of space-time, a mere mote in the solar beam.

*Mars: The Lure of the Red Planet*

Chapter 2 (p. 27)

Prometheus Books. Amherst, New York, USA. 2001

Who is to say that [Mars] will not – like a hardy seed lying dormant beneath the snow of a long winter – come once more to life, and in so doing once more quicken our fondest hopes of life beyond Earth?

*Mars: The Lure of the Red Planet*

Epilogue (p. 323)

Prometheus Books. Amherst, New York, USA. 2001

**Swift, Jonathan** 1667–1745

Irish-born English writer

They have likewise discovered two lesser stars, or satellites, which revolve around Mars, whereof the innermost is distant from the centre of the primary planet exactly three of his diameters, and the outermost five; the former revolves in the space of ten hours, and the latter in twenty-one and a half; so that the squares of their periodical times are very near in the same proportion with the cubes of their distances from the centre of Mars, which evidently shows them to be governed by the same law of gravitation that influences the other heavenly bodies.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter III (p. 102)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

The conclusion...is therefore irresistible – that animal life, especially in its higher forms, cannot exist on

the planet. Mars, therefore, is not only uninhabited by intelligent beings such as Mr. Lowell postulates, but is absolutely UNINHABITABLE.

*Is Mars Habitable?*

Chapter VIII (p. 110)

Macmillan & Company Ltd. London, England. 1907

**Washburn, Mark**

No biographical data available

The red fire of Mars burns as bright as ever in the night sky and in the hearts of men. Mars has always been much more than just the next planet out from the sun. Mars is the place where dreams and reality meet – and form new dreams for the curious and questing people of the earth to follow.

*Mars At Last!*

Chapter 14 (p. 277)

G.P. Putnam's Sons. New York, New York, USA. 1977

**JUPITER****Ackerman, Diane** 1948–

American writer

Vibrant as an African trade-bead with bonechips in orbit round it, Jupiter floods the night's black scullery, all those whirlpools and burbling aerosols little changed since the solar-system began.

*The Planets: A Cosmic Pastoral*

Jupiter (p. 81)

William Morrow & Company, Inc. New York, New York, USA. 1976

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

But that which will excite the greatest astonishment by far, and which indeed especially moved me to call the attention of all astronomers and philosophers, is this, namely, that I have discovered four planets, neither known nor observed by anyone of the astronomers before my time, which have their orbits round a certain bright star, one of those previously known, like Venus and Mercury round the Sun, and are sometimes in front of it, sometimes behind it, though they never depart from it beyond certain limits.

Translated by Edward Stafford Carlos

*The Sidereal Messenger of Galileo Galilei, and a Part of the Preface to Kepler's Dioptrics*

The Astronomical Messenger (p. 9)

Rivingtons. London, England. 1880

**Sizzi, Francisco**

Astronomer

The satellites [Jupiter's moons] are invisible to the naked eye and therefore can have no influence on the earth, and therefore would be useless, and therefore do not exist.

In Oliver Lodge  
*Pioneers of Science and the Development of Their Scientific Theories*  
 (p. 106)  
 Dover Publications, Inc. New York, New York, USA. 1926

## SATURN

### Herschel, Friedrich Wilhelm

**(Sir William)** 1738–1822  
 English astronomer

There is not perhaps another object in the heavens that presents us with such a variety of extraordinary phenomena as the planet Saturn: a magnificent globe, encompassed by a stupendous double ring: attended by seven satellites: ornamented with equatorial belts: compressed at the poles: turning upon its axis: mutually eclipsing its ring and satellites, and eclipsed by them: the most distant of the rings also turning upon its axis, and the same taking place with the farthest of the satellites: all the parts of the system of Saturn occasionally reflecting light to each other: the rings and moons illuminating the nights of the Saturnian: the globe and satellites enlightening the dark parts of the rings: and the planet and rings throwing back the sun's beams upon the moons, when they are deprived of them at the time of their conjunctions.

*Philosophical Transactions of the Royal Society of London*  
 Observations on the Singular Figure of the Planet Saturn (p. 272)  
 Printed by W. Bulmer & Co. London, England. 1805

### Huygens, Christiaan

1629–95  
 Dutch mathematician, astronomer, and physicist

*Annulo cingitur, tenui, plano, nusquam cohaerente, ad eclipticam inclinato*

[It is surrounded by a thin flat ring, inclined to the ecliptic, and nowhere touches the body of the planet]

*De Saturni luna observatio nova*  
 The Hague, Netherlands. 1656

### Keill, John

1671–1721  
 Scottish mathematician and natural philosopher

...Saturn has an Ornament peculiar to himself, for he is dignified with a Ring which surrounds his middle, and does no where touch his Body; but by an exact Libration and Equiponderancy of all its Parts, sustains itself like an Arch, and being thus suspended by Geometry, it is kept from falling upon his Body.

*An Introduction to the True Astronomy*  
 Lecture III (p. 25)  
 Printed for Bernard Lintot. London, England. 1721

### Melville, Herman

1819–91  
 American novelist

Seat thyself sultanically among the moons of Saturn.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
 Chapter 107 (p. 343)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Pallister, William Hales

1877–1946  
 Canadian physician

The planet Saturn, to the naked eye  
 Appears an oval star; in seeking why  
 The telescope shows us a startling sight  
 Which seems some lovely vision on a night  
 Of dreams. A giant, wide, sunlit, tilted ring,  
 More strange than any other heavenly thing.

*Poems of Science*  
 Other Worlds and Ours, Saturn (p. 205)  
 Playford Press. New York, New York, USA. 1931

### Pliny (C. Plinius Secundus)

23–79  
 Roman savant and author

The Planet which they call Saturn is the highest, and therefore seemeth to be least: also he performeth his Revolution in the greatest Circle of all: and it is certain, that in thirty Years' Space he returneth again to the Point of his first Place.

*Pliny's Natural History. In Thirty-seven Books*  
 Chapter VI (p. 40)  
 Printed for the Club by G. Barclay. London, England. 1847–1849

### Thayer, John H.

If you want to see a picture painted as only the hand of God can paint it, go with me to Saturn...

Saturn. The Wonder of the Worlds  
*Popular Astronomy*, Volume 37, Number 263, March, 1919 (p. 175)

### Whipple, Fred L.

1906–2004  
 Pioneer in comet research

Among the innumerable celestial objects that may be seen through a telescope, the most beautiful of all is perhaps the planet Saturn. When viewed in the evening twilight while the sky is still bright, the yellow gold ball and its unbelievable rings shimmer in a brilliant blue medium, more like a rare work of art than a natural phenomenon.

*Earth, Moon and Planets*  
 Chapter 11 (p. 174)

## URANUS

### Author undetermined

It has generally been supposed that it was a lucky accident that brought this star [Uranus] to his view; but this is an evident mistake. In the regular manner in which he examined every star in the heavens, not only of that magnitude, but many far inferior, it was that night its turn to be discovered.

Some Account of the Life and the Writings of William Herschel  
*The Edinburgh Magazine*, February, 1785 (p. 121)

### Banks, Sir Joseph

1743–1820  
 English naturalist

... who can say but your new Star [Uranus], which exceeds Saturn so much in its distance from the Sun, may exceed



him as much in magnificence of attendance? Who knows what new rings, new satellites, or what other nameless and numberless phenomena remain behind, waiting to reward future industry and improvement?

In Charles Richard Weld (ed.)

*A History of the Royal Society, With Memoirs of the Presidents*  
(Volume 2)

Chapter V (p. 149)

John W. Parker. London, England. 1848

### **de Morgan, Augustus** 1806–71

English mathematician and logician

This name [Uranus] is appropriate, inasmuch as Uranus is the father of Saturn, in mythology, as Saturn is of Jupiter, and Jupiter of Mars; but what will be done if a new planet should be discovered still more distant than Uranus?

In Charles Richard Weld (ed.)

*A History of the Royal Society, With Memoirs of the Presidents*  
(Volume 2)

Attributed (pp. 147–148)

John W. Parker. London, England. 1848

### **Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

In the fabulous ages of ancient times the appellations of Mercury, Venus, Mars, Jupiter, and Saturn were given to the planets as being the names of their principal heroes and divinities. In the present more philosophical era, it would hardly be allowable to have recourse to the same method, and call on Juno, Pallas, Apollo, or Minerva for a name to our new heavenly body.... I cannot but wish to take this opportunity of expressing my sense of gratitude, by giving the name Georgium Sidus, to a star [Uranus], which (with respect to us) first began to shine under His auspicious reign.

In James Sime

*William Herschel and His Work*

Chapter V, Letter to Sir Joseph Banks (p. 74)

Charles Scribner's Sons. New York, New York, USA. 1900

We see it [the probable new planet] as Columbus saw America from the shores of Spain. Its movements have been felt trembling along the far-reaching line of our analysis with a certainty hardly inferior to that of ocular demonstration.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter VII (p. 175)

Macmillan & Co Ltd. London, England. 1916

On Tuesday, March 13 [1781], between 10 and 11 in the evening, while I was examining the small stars in the neighborhood of *H Geminorum*, I perceived one that appeared visibly larger than the rest. Being struck with its uncommon magnitude, I compared it to *H Geminorum* and the small star in the quartile between *Auriga* and

*Gemini*, and finding it so much larger than either of them, suspected it to be a comet.

Account of a Comet

*Philosophical Transactions of the Royal Society of London*,  
Volume LXXI (p. 154)

## NEPTUNE

### **Clerke, Agnes Mary** 1842–1907

Irish astronomer

Forever invisible to the unaided eye of man, a sister-globe to our earth was shown to circulate, in frozen exile, at 30 times its distance from the sun. Nay, the possibility was made apparent that the limits of our system were not even thus reached, but that yet profounder abysses of space might shelter obedient, though little favoured members of the solar family, by future astronomers to be recognized through the sympathetic thrillings of Neptune, even as Neptune himself was recognized through the tell-tale deviations of Uranus.

*A Popular History of Astronomy During the Nineteenth Century*

Part I, Chapter IV (p. 82)

A. & C. Black. London, England. 1908

### **Fort, Charles** 1874–1932

American writer

...in 1846, everyone who knew a sine from a cosine was out sining and cosining for a planet beyond Uranus. Two of them guessed right.

*The Book of the Damned*

Chapter X (p. 133)

Boni & Liveright. New York, New York, USA. 1919

## DWARF: PLUTO

### **Author undetermined**

In a little cluster of orbs which scampers across the side-real abyss under the name of the solar system there are, let it be known, nine instead of a mere eight, worlds. The presence of a ninth planet in the retinue of the Sun, long suspected, was definitely announced here today.

Associated Press dispatch

*New York Times*, March 14, 1930

### **Hoyt, William Graves** 1921–

American journalist and author

The planet was named Pluto, of course, the first two letters of the name as well as its planetary symbol of the superimposed letters “P” and “L” standing for the initials of Percival Lowell’s name.

*Lowell and Mars*

Chapter 14 (p. 280)

University of Arizona Press. Tucson, Arizona, USA. 1976



## PLANET, EXTRASOLAR

**van de Kamp** (1901–63)

The orbital analysis leads, therefore, to a perturbing mass of only 1.6 times the mass of Jupiter. We shall interpret this result as a companion of Barnard's star, which therefore appears to be a planet.

Astronomic Study of Barnard's Star from Plates Taken with the 24-inch Sproul Refractor  
*The Astronomical Journal*, Volume 68, Number 7, September, 1963 (p. 521)

## PLANETARY SYSTEM

**Bradford II, Gershom**

No biographical data available

The planetary system is like the horse race at a county fair; the pole horse has the advantage, but the varying speeds of the contestants soon place them at various parts of the track.

*The Whys and Wherefores of Navigation*  
Chapter II (pp. 6–7)  
D. van Nostrand Co. New York, New York, USA. 1918

## PLANETS, NATURAL HISTORY OF

**Huxley, Thomas Henry** 1825–95

English biologist

Until human life is longer and the duties of the present press less heavily, I do not think that wise men will occupy themselves with Jovian, or Martian, natural history ...

*Collected Essays*  
Prologue (p. 40)  
D. Appleton & Co. New York, New York, USA. 1900

## PLANKTON

**Hyerdahl, Thor** 1914–2002

Norwegian ethnographer and adventurer

Some looked like fringed, fluttering spooks cut out of celophane paper, while others resembled red-beaked birds with hard shells instead of feathers. There was no end to Nature's extravagant inventions in the plankton world.

Translated by F.H. Lyon  
*Kon-Tiki*  
Chapter 5 (p. 139)  
Rand McNally & Company. Chicago, Illinois, USA. 1950

## PLANT

**Allen, Grant** 1848–99

Canadian-born writer

...everyone of these English plants and weeds has a long and eventful story of its own. In the days before the

illuminating doctrine of evolution had been preached, all we could say about them was that they possessed such and such a shape, and size, and colour: and if we had been asked why they were not rounder or bigger or bluer than they actually are, we could have given no sufficient reason, except that they were made so.

*Flowers and Their Pedigrees*

Introductory (p. 2)

Longmans, Green & Co. London, England. 1883

...every plant and every animal has a long history of its own, and that this history leads us on through a wonderful series of continuous metamorphoses compared with which Daphne's or Arethusa's were mere single episodes.

*Flowers and Their Pedigrees*

Chapter I (p. 11)

Longmans, Green & Co. London, England. 1883

**Aubrey II (Fictional plant)**

I'm just a mean green mother from outer space and I'm bad!

Little Shop of Horrors (1986)

**Bailey, William Whitman** 1843–1914

American botanist

Beginners almost always collect their plants too young; they have a nervous fear that they will not last.

*The Botanical Collector's Handbook*

Naturalists' Handy Series, Number 3 (p. 29)

Publisher undetermined. Salem, Massachusetts, USA. 1881

No division of the vegetable kingdom has attracted more deserved attention than that of the sea-weeds or sea-mosses. Throughout the world they have found their earnest students and devoted admirers. It is not alone for their intrinsic beauty that they are loved. Their collection involves the visiting of romantic cliffs – of shores strewn with the ocean's debris, of caves, and hollows, and even of the deep sea itself. The pursuit is always fascinating, and sometimes even perilous. A spice of danger does not deter the heroic algologist. Like "one who gathers sapphire, fearful trade!" he hangs suspended from crags, or ventures at low tide upon the slippery rocks over which the spray is dashing. There need not, however, be danger in the study. Many ladies have been successful gatherers of sea-weeds, and in the albums of many a watering-place belle may be seen choice specimens, self-collected. The plants need not be studied at all, if one prefers the simple collection and preservation, but it is always pleasanter to know something of the habits, uses, and even names of the objects which one treasures.

*The Botanical Collector's Handbook*

Naturalists' Handy Series, Number 3 (pp. 46–47)

Publisher undetermined. Salem, Massachusetts, USA. 1881

Plants should not be personified or endowed outright with motives; but figures of speech and parables may often be employed to teach a lesson or to drive home a point.

*Botany: An Elementary Text for Schools* (4th edition)  
Paragraphs for the Teacher (p. xi)  
The Macmillan Co. New York, New York, USA. 1901

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

If a plant be uncouth, it has no attractions to us simply because it has been brought from the ends of the earth and is a “great rarity;” if it has beauty, it is none the less, but a great deal more attractive to us, because it is common.

*Star Papers*

Experiences of Nature, I (p. 95)

J.B. Ford & Co. New York, New York, USA. 1873

**Biddle, Anthony Joseph Drexel** 1896–1961  
American publisher, journalist, and miscellaneous writer

We value a plant according to the delicacy and number of flowers it produces. And what joy flowers give! We remember them long after they are withered and dead.

*The Flowers of Life* (p. 311)

Drexel Biddle Publisher. Philadelphia, Pennsylvania, USA. 1897

**Borland, Hal** 1900–78  
American writer

There are no idealists in the plant world and no compassion. The rose and the morning glory know mercy. Bindweed, the morning glory, will quickly choke its competitors to death, and the fencerow rose will just as quietly crowd out any other plant that tried to share its roothold. Idealism and mercy are human terms and human concepts.

*Book of Days*

22 July 1976 (pp. 188–189)

Alfred A. Knopf. New York, New York, USA. 1976

**Burroughs, John** 1837–1921  
American naturalist and writer

I know of nothing in vegetable nature that seems so really to be born as the ferns. They emerge from the ground rolled up, with a rudimentary and “touch-me-not” look, and appear to need a maternal tongue to lick them into shape. The sun plays the wet-nurse to them, and very soon they are out of that uncanny covering in which they come swathed and take their places with other green things.

*Signs and Seasons*

A Spring Relish (p. 193)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1886

**Clute, Willard N.**  
American botanist

One of the redeeming features of rubbish heaps, ballast grounds and waste lands is that they furnish a lurking place for numerous wanderers and outcasts of the vegetable kingdom.

A Plant Immigrant

*The American Botanist*, Volume 1, Number 2, August, 1901 (p. 18)

**de Vilmorin, Henri L.**

No biographical data available

It is a well-established fact that the life-work of plants is to make the mineral wealth of the earth fitted for the use of animals and of man.

In Washington Atlee Burpee

*Selection in Seed Growing*

Pedigree or Grade Races in Horticulture (p. 10)

W. Atlee Burpee & Co. Philadelphia, Pennsylvania, USA. 1896

**Dewar, Redcote**

No biographical data available

With the exception of specialists, few average men of intelligence know more about plants than a kitchen garden reveals and until they are led to read up the subject have no notion of the wonderful world of plant life in the planet and unconscious that they have even incipient rivals in intelligence and attainments among the vegetables.

*From Matter to Man: A New Theory of the Universe*

Chapter XI (pp. 131–132)

Chapman & Hall, Ltd. London, England. 1898

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

To every plant there are two powers; one shoots down as rootlet, and one upward as tree.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

*Letters and Social Aims*

Chapter I (p. 71)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The root of the plant is not unsightly to science...

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

*Essays: First Series*

Chapter VI (p. 196)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Plants are the young of the world, vessels of health and vigor; but they grope ever upwards towards consciousness; the trees are imperfect men, and seem to bemoan their imprisonment, rooted in the ground.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

Nature (p. 547)

The Library of America. New York, New York, USA. 1983

**Gatty, M. S.** 1809–73

English writer

It was once prettily said by a lady who cultivated flowers, that she had “buried many a care in her garden”; and the sea-weed collector can often say the same of his garden – at the shore; as many a loving disciple could testify, who, having taken up the pursuit originally as a resource against weariness, or a light possible occupation during hours of sickness, has ended by an enthusiastic love, which throws a charm over every sea-place on

the coast, however dull and ugly to the world in general; makes every day spent there too short, and every visit too quickly ended. Only let there be sea, and plenty of low, dark rocks stretching out, peninsular-like, into it; and only let the dinner-hour be fixed for high-water time – and the loving disciple asks no more of fate.

*British Sea-Weeds: Drawn from Professor Harvey's Phycologia Britannica* (Volume 1)

Introduction (p. vii)

Bell & Daldy. London, England. 1872

**Ganong, William Francis** 1864–1941

Canadian botanist, historian, and cartographer

The evidence seems to show beyond question that our present species of plants have descended by gradual evolution from simpler and fewer species which formerly existed, and which in turn were evolved from still simpler and fewer kinds – back, it is possible, to a single kind which throve in remotest antiquity.

*A Textbook of Botany for Colleges*

Chapter II (p. 10)

The Macmillan Co. New York, New York, USA. 1921

**Gerard, John** 1545–1612

English botanist

Among the manifold creatures of God (right Honorable, and my singular good Lord) that have all in all ages diversely entertained many excellent wits, and drawne them to the contemplation of the divine wisdom, none have provoked mens' studies more, or satisfied their desires so much as Plants have done, and that upon Just and worthy causes: For if delight may provoke mens' labor, what greater delight is there than to behold the earth appareled with plants, as with a robe of embroidered worke, set with Orient pearles, and garnished with great diversitie of rare and costly jewels?

*The Herball or Generall Historie of Plantes*

The Epistle Dedicatorie

Bonham and I. Norton. London, England. 1597

Although my paines have not been spent (Courteous Reader) in the gracious discoverie of golden mines, nor in the tracing after silver veines, whereby my native country might be enriched with such merchandise as it hath most in request and admiration; yet hath my labour (I trust) been otherwise profitably employed, in descrying of such a harmlesse treasure of herbes, trees, and plants, as the earth frankly without violence offereth unto our most necessarie uses.

*The Herball or Generall Historie of Plantes*

To the Courteous and Well-Willing Reader

Bonham and I. Norton. London, England. 1597

**Gleason, Henry Allan** 1882–1975

American botanist

Every species of plant is a law unto itself.

The Individualistic Concepts of the Plant Association

*Bulletin of the Torrey Botanical Club*, Volume 53, 1926 (p. 26)

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

The simplest plants, such as the green algae growing in stagnant water or on the bark of trees, are mere round cells. The higher plants increase their surface by putting out leaves and roots. Comparative anatomy is largely the story of the struggle to increase surface in proportion to volume.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 2)

On Being the Right Size (p. 954)

Simon & Schuster. New York, New York, USA. 1956

**Hemans, Felicia D.** 1793–1835

English poet

Oh! Call us not *weeds*, but flowers of the sea,  
For lovely, and gay, and bright-tinted are we!  
Our Blush is as deep as the rose of thy bowers,  
Then call us not *weeds*, we are Ocean's gay flowers.  
Not nursed like the plants of the summer parterre  
Whose gales are but sighs of an evening air  
Our exquisite, fragile and delicate forms,  
Are the prey of the Ocean, when vexed with his storms.

*The Poetical Works of Mrs. Felicia Hemans*

Ocean Flowers and Their teachings

Crosby, Nichols, Lee & Company. Boston, Massachusetts, USA. 1860

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Let us, therefore, open the book of Nature, and read in her records, if there had been a world bearing plants, at the time when this present world was forming at the bottom of the sea.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section IV (pp. 177–178)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

Scarce a plant perhaps that has not its peculiar animal which feeds upon its various productions; scarce an animal that has not its peculiar tribe of plants on which the economy of its life, its pleasure, or its prosperity must depend.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter VI (p. 185)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95

English biologist

Not only does every animal live at the expense of some other animal or plant, but the very plants are at war. The ground is full of seeds that cannot rise into seedlings; the seedlings rob one another of air, light and water, the strongest robber winning the day, and extinguishing his competitors.... The individuals of a species are like the crew of a foundered ship, and none but good swimmers have a chance of reaching the land.

*Darwiniana*

The Darwinian Hypothesis (pp. 17–18)

D. Appleton & Co. New York, New York, USA. 1894

**James, Thomas**

No biographical data available

I can endure no plants in pots – a plant in a pot is like a bird in a cage.

*The Flower Garden*

The Poetry of Gardening (pp. 100–101)  
John Murray. London, England. 1852

**Kingsley, Charles** 1819–75

English clergyman and author

...plants and animals, though they deserve all kindness, all admiration, deserve no courtesy – at least in this respect. For they are, one and all, wherever you find them, vagrants and landlopers, intruders and conquerors, who have got where they happen to be simply by the law of the strongest – generally not without a little robbery and murder.

*Scientific Essays and Lectures*

On Bio-Geology (p. 4)

Publisher undetermined

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

For wealth disappears, the most magnificent houses fall into decay, the most numerous family at some time or another comes to an end: the greatest and the most prosperous kingdoms can be overthrown: but the whole of Nature must be blotted out before the race of plants passes away, and he is forgotten who in Botany held up the torch.

*Critica Botanica*

Generic Names (p. 68)

The Ray Society. London, England. 1938

**Mills, Simeon**

No biographical data available

Plants and trees are the children of light; Flowers and fruits are condensed sun beams.

*Readings from the Book of Nature*

Cover

Charles H. Kerr & Co. Chicago, Illinois, USA. 1893

**Muir, John** 1838–1914

American naturalist

Found a lovely lily (*Calochortus albus*) in a shady adenostoma thicket near Coulterville, in company with *Adiantum chilense*. It is white with a faint purplish tinge inside at the base of the petals, a most impressive plant, pure as snow crystal, one of the plant saints...must love and be made so much the purer by every time it is seen. It puts the roughest mountaineer on his good behavior.

*My First Summer in the Sierra*

June 6 (p. 22)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Well, perhaps I may yet become a proper cultivated plant, cease my wanderings and for it a so called pillar

or something in society, but if so, I must, like a revived Methodist, care to love what I hate and to hate what I most intensely and devoutly love.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter II, Section 5. Plants and Humans (p. 90)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

The plants are as busy as the animals, every cell in a swirl of enjoyment, humming like a hive, singing the old new song of creation.

*Our National Parks*

Chapter II (p. 70)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

It drapes all the branches from top to bottom, hanging in long silver-gray skeins, reaching a length of not less than eight or ten feet, and when slowly waving in the wind they produce a solemn funereal effect singularly impressive.

*A Thousand Mile Walk to the Gulf*

Chapter IV (p. 68)

Houghton Mifflin Company, Boston Massachusetts, USA. 1916

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

The plants...are the plainest speech of the earth; every new leaf, every remarkable flower is some mystery which is trying to reveal itself, and which remains motionless and dumb only because from very joy and love it can neither move nor speak.

In George Brandes

*Main Currents in Nineteenth, Century Literature* (Volume 6)

Chapter XII (p. 196)

The Macmillan Co. New York, New York, USA. 1906

**Nuttall, Thomas** 1786–1859

English botanist

To acquire a knowledge of the vegetable world, so pleasing to all observers, it may not perhaps be amiss to anticipate the dry detail of technical phrases, which has but too often deterred, at the very portal of Flora's temple, the enquirer into the nature and character of this beautiful and useful tribe of beings, and begin, at once, by examining plants as we naturally find them, in the manner our predecessors must have done, from whom we have received their history.

*An Introduction to Systematic and Physiological Botany*

Part I, Chapter I (p. 1)

Hillard & Brown. Cambridge, England. 1830

**Osborn, Henry Stafford** 1857–1935

American paleontologist and geologist

Every little flower is a word in the wide-spread language of flowers, every fruit a sentence, every sprig of moss and blade of grass a conjunction or particle, a little word, which helps to add interest to the whole; and the history of each, in its efforts for life, forms a volume in the large

library of flowers and plants scattered from the equator even to the ice-bound regions of the farthest North.

*Plants of the Holy Land*

The Voices of Flowers (pp. 11–12)

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1861

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

It is a strange thing, and a wondrous one, that no one can tell you what a plant is. And when you meet with that which is indefinable, then indeed are you in the presence of something great.

*Flowering Earth*

Chapter 4 (p. 38)

G.P. Putnam's Sons. New York, New York, USA. 1939

The Green Kingdom lacks for definition not because, like justice or beauty, it is an ideal concept, nor yet because it is incorporeal like divinity, or too primal for synonyms, like the physicist's energy. For two reasons plants cannot be characterized in a sentence—first, because it seems impossible to separate primitive plants from primitive animals, and again because of the oneness of life.

*Flowering Earth*

Chapter 4 (p. 38)

G.P. Putnam's Sons. New York, New York, USA. 1939

[A plant] is a strange thing, and a wondrous one, that no one can tell you what a plant is. And when you meet with that which is indefinable, then indeed are you in the presence of something great.

*Flowering Earth*

Chapter 4 (p. 38)

G.P. Putnam's Sons. New York, New York, USA. 1939

Weighted in their armor of cellulose, the higher land plants, it is true, have taken up fixed stations in life. So they have rather surrendered to the animal kingdom the proverbially broadening effects of travel. But they have not lost the power of motion. Like a dancing girl who expresses dance without stirring her feet, they too gesticulate.

*Flowering Earth*

Chapter 4 (p. 41)

G.P. Putnam's Sons. New York, New York, USA. 1939

All this unambitious rooted living, this having no head to lose, no heart either to beat or stop, this sex without passion, this flowering, is plant growth. As it came first, the Green Kingdom, so it will last longest. As it is simpler than we are, so is it stronger. Moss covers our ruins, grass our battlefields. The flag of life is forever carried forward, peacefully, by our unsundering allies.

*Flowering Earth*

Chapter 4 (p. 50)

G.P. Putnam's Sons. New York, New York, USA. 1939

As plantsmen we are interested in the moment when the first plant began. For there was raised the flag of life.

*Flowering Earth*

Chapter 6 (p. 61)

G.P. Putnam's Sons. New York, New York, USA. 1939

**Phelps, Almira Hart Lincoln** 1793–1884

American educator and writer

...the vegetable world offers a boundless field of inquiry, which may be explored with the most pure and delightful emotions. Here the Almighty seems to manifest himself to us, with less of that dazzling sublimity which it is almost painful to behold in His more magnificent creations; and it would seem, that accommodating the vegetable world to our capacities of observation, He had especially designed it for our investigation and amusement, as well as our sustenance and comfort.

*Familiar Lectures on Botany, Practical, Elementary and Physiological* (5th edition)

Lecture I (p. 15)

F.J. Huntington & Co. New York, New York, USA. 1837

**Phillips, Henry** 1779–1840

English banker

It would be a difficult question to decide, whether the study of the natural history of Plants be more agreeable to the mind, or beneficial to the body. The importance of this pursuit must be deeply felt by the reflecting mind; indeed it has advantages over every other science. The study of Natural History, and particularly of Botany, calms the mind, and quiets the passions; whereas Historical research produces unpleasant reflections, and in tracing the fate of kingdoms or individuals our feelings are often as much distressed as our minds are amused.

*History of Cultivated Vegetables* (Volume 1) (2nd edition)

Introduction (p. 1)

Henry Colburn & Co. London, England. 1822

**Runge, Friedlieb Ferdinand**

German chemist

A plant is a great chemist: it distinguishes and separates substances more definitely and accurately than man can, with all his skill, his intelligence, and his appliances ...

In Celia Thaxter

*An Island Garden*

Chapter Five (pp. 87–88)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1896

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

...it is better to know the habits of one plant than the names of a thousand; and wiser to be happily familiar with those that grow in the nearest field, than arduously cognizant of all that plume the isles of the Pacific, or illumine the Mountains of the Moon.

*Proserpina* (Volume 1)

Chapter XI, 33 (p. 200)

John Wiley & Sons. New York, New York, USA. 1886



**Shelley, Percy Bysshe** 1792–1822

English poet

A Sensitive Plant in a garden grew,  
And the young winds fed it with silver dew,  
And it opened its fan-like leaves to the light,  
And clothed them beneath the kisses of night.

*The Complete Poetical Works of Percy Bysshe Shelley*

The Sensitive Plant, Part I, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Slossin, Edwin Emery** 1865–1919

Chemist and author

Plants obey the injunction of Tennyson and rise on the stepping stones of their dead selves to higher things. Each successive generation lives on what is left of the last in the soil plus what it adds from the air and sunshine.

*Creative Chemistry*

Chapter III (p. 39)

The Century Co. New York, New York, USA. 1919

**Tompkins, Peter** 1919–2000

American journalist

Short of Aphrodite, there is nothing lovelier on this planet than a flower, nor more essential than a plant.

*The Secret Life of Plants*

Introduction (p. viii)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Turner, William**

No biographical data available

Although (most mighty and Christian Prince) there be many noble and excellent arts and sciences, which no man doubteth, but that almighty God the author of all goodness hath given unto us by the hands of the heathen, as necessary unto the use of mankind, yet is there none among them all which is so openly commended by the verdict of any holy writer in the Bible, as is the knowledge of plants, herbs and trees...

In George T.L. Chapman and Marilyn N. Tweddle (eds.)

*A New Herbal*

Part I (p. 213)

Cambridge University Press. Cambridge, England. 1995

**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

Sage-brush is a very fair fuel, but as a vegetable it is a distinguished failure. Nothing can abide the taste of it but the jackass and his illegitimate child the mule.

*Roughing It* (Volume 1)

Chapter III (p. 32)

Harper &amp; Brothers Publishers. New York, New York, USA. 1899

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

We will see the entire plant world, for example, as a vast sea which is as necessary to the existence of individual

insects as the oceans and rivers are to the existence of individual fish, and we will observe that an enormous number of living creatures are born and nourished in this ocean of plants. Ultimately we will see the whole world of animals as a great element in which one species is created, or at least sustained, by and through another. We will no longer think of connections and relationships in terms of purpose or intention. This is the only road to progress in understanding how nature expresses itself from all quarters and in all directions as it goes about its work of creation.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter II (p. 55)

Suhrkamp. New York, New York, USA. 1988

The Primal Plant is going to be the strangest creature in the world, which Nature herself must envy me. With this model and the key to it, it will be possible to go on forever inventing plants and know that their existence is logical; that is to say, if they do not actually exist, they could, for they are not the shadowy phantoms of a vain imagination, but possess an inner necessity and truth. The same law will be applicable to all other living organisms.

Translated by W.H. Auden and Elizabeth Mayer

*Italian Journey*

Letter to Herder

May 17, 1787 (p. 305)

Pantheon Books. New York, New York, USA. 1962

Anyone who pays a little attention to the growth of plants will readily observe that certain of their external members are sometimes transformed so that they assume – either wholly or in some lesser degree – the form of the members nearest in the series.

Thus, for example, the usual process by which a single flower becomes double, is that, instead of filaments and anthers, petals are developed; these either show a complete resemblance in form and color to the other leaves of the corolla, or they still carry some visible traces of the origin.

If we note that it is in this way possible for the plant to take a step backwards and thus to reverse the order of growth, we shall obtain so much the more insight into Nature's regular procedure; and we shall make the acquaintance of the laws of transmutation, according to which she produces one part from another, and sets before us the most varied forms through modification of a single organ.

An Attempt to Interpret the Metamorphosis of Plants, Introduction

Section 1 and Section 3

*Chronica Botanica*, Volume 10, Number 2, Summer, 1946 (p. 91)**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Even the child longs to pass the hills or the seas which enclose his narrow home; yet, when his eager steps have borne him beyond those limits, he pines, like the plant, for his native soil; and it is by this touching and beautiful



attribute of man – this longing for that which is unknown, and this fond remembrance of that which is lost – that he is spared from an exclusive attachment to the present.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Conclusion of the Subject (p. 358)  
Harper & Brothers. New York, New York, USA. 1869

### Wink Wilkinson (Fictional character)

Gee, I wish you folks could see this. Hey Seymour, where did you get this WEEEIRD plant?

*Little Shop of Horrors*  
Film (1986)

## CAT-TAIL

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The cat-tail down puffs and swells in your hand like a mist, or the conjurer's trick of filling a hat with feathers, for when you have rubbed off but a thimbleful, and can close and conceal the wound completely, the expanded down fills your hand to overflowing.

In Harrison Gray Otis Blake (ed.)  
*The Writings of Henry David Thoreau*  
March 23, 1853 (p. 216)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

## CAULIFLOWER

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Training is everything. The peach was once a bitter almond; cauliflower is nothing but cabbage with a college education.

*Pudd'nhead Wilson*  
Chapter V, Pudd'nhead Wilson's Calendar  
Harper & Brothers. New York, New York, USA. 1899

## CRUCIFIXION THORN

**van Dyke, John Charles** 1856–1932

American art historian and critic

The crucifixion thorn is a bush or tree somewhat like the palo verde, except that it has no leaf. It is a thorn and little else. Each small twig runs out and ends in a sharp spike of which the branch is but the supporting shaft. It bears in August a small yellow flower but this grows out of the side of the spike. In fact the whole shrub seems created for no other purpose than the glorification of the thorn as a thorn.

*The Desert*  
Chapter VIII (p. 140)  
Charles Scribner's Sons. New York, New York, USA. 1930

## CUCUMBER

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

...it has been a common saying of physicians in England, that a cucumber should be well sliced, and dressed with pepper and vinegar, and then thrown out, as good for nothing.

In James Boswell  
*Life of Johnson*  
5 October, 1773

## FERN

**Burroughs, John** 1837–1921

American naturalist and essayist

I know of nothing in vegetable nature that seems so really to be born as the ferns. They emerge from the ground rolled up, with a rudimentary and "touch-me-not" look, and appear to need a maternal tongue to lick them into shape. The sun plays the wet-nurse to them, and very soon they are out of that uncanny covering in which they come swathed, and take their places with other green things.

*Signs and Seasons*  
A Spring Relish (pp. 175–176)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1914

## FLOWER

**Abbot, Anne Wales** 1808–1908

American writer

Poor dry, musty flowers! Who would believe you ever danced in the wind, drank in the evening dews, and spread sweet fragrance on the air? A touch now breaks your brittle leaves. Your odors are like attic herbs, or green tea, or moldy books. Your forms are bent and flattened into every ugly and distorted shape.

*Autumn Leaves: Original Pieces in Prose and Verse*  
My Herbarium (p. 130)  
John Bartlett. Cambridge, England. 1853

**Anderson, Hans Christian** 1805–75

Danish author and poet

What the botanist tells us after a number of imperfect lectures, the flower proclaimed in a minute.

*Anderson's Fairy Tales*  
The Shoe of Fortune (p. 98)  
John Hogg. London, England. 1883

### Author unknown

The pistol of a flower is its only protection against insects.

Source undetermined

**Barrett-Browning, Elizabeth** 1806–61

English poet

...those tall flowering-reeds which stand  
In Arno, like a sheaf of scepters left  
But some remote dynasty of dead gods  
To suck the stream for ages and get green.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book VII, l. 937–940

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

Flowers are the sweetest things God ever made and forgot to put a soul into.

*Life Thoughts* (p. 234)

Phillips, Sampson &amp; Co. Boston, Massachusetts, USA. 1858

Happy is the man that loves flowers! Happy, even if it be a love adulterated with vanity and strife. For human passions nestle in flower-lovers too.

*Star Papers*

A Discourse of Flowers (p. 93)

J.B. Ford &amp; Co. New York, New York, USA. 1873

He who only does not appreciate floral beauty is to be pitied like any other man who is born imperfect.

*Star Papers*

A Discourse on Flowers (p. 94)

Books for Libraries Press. Freeport, New York, USA. 1972

...flowers are weeds where they grow wildly and abundantly; and somewhere our rarest flowers are somebody's commonest.

*Star Papers*

Experiences of Nature, I (pp. 94–95)

J.B. Ford &amp; Co. New York, New York, USA. 1873

A very common flower adds generosity to beauty. It gives joy to the poor, the rude, and to the multitudes who could have no flowers were nature to charge a price for her blossoms. Is a cloud less beautiful, or a sea, or a mountain, because often seen, or seen by millions?

*Star Papers*

Experiences of Nature, I (p. 95)

J.B. Ford &amp; Co. New York, New York, USA. 1873

As for marigolds, poppies, hollyhocks, and valorous sunflowers, we shall never have a garden without them, both for their own sake, and for the sake of old-fashioned folks, who used to love them.

*Star Papers*

A Discourse of Flowers (p. 95)

J.B. Ford &amp; Co. New York, New York, USA. 1873

Flowers have an expression of countenance as much as men or animals. Some seem to smile; some have a sad expression; some are pensive and diffident; others again are plain, honest and upright, like the broad-faced sunflower and the hollyhock.

*Star Papers*

A Discourse on Flowers (p. 100)

Books for Libraries Press. Freeport, New York, USA. 1972

**Blake, William** 1757–1827

English poet, painter, and engraver

To create a little flower is the labor of ages.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, l. 56

University of California Press. Berkeley, California, USA. 1982

**Bloom, James Harvey**

No biographical data available

What wonder, then, that flower and fruit have played a not ignoble part in the civilization of the world, and have helped to soften many a rugged nature and have brought precious solace to many a broken heart!

*Shakespeare's Garden*

Introduction (p. 1)

Methuen &amp; Co. London, England. 1903

**Borlase, William** 1696–1772

Cornish antiquary

...the flowers and ground together make so pretty a piece of tapestry, that one might be surprised to find such colouring and workmanship hid, as it were industriously, under a rock; but the works of Nature are every where well finished, and cannot be otherwise than exact and beautiful in their degree...

*British Tunicata*, Volume 3, 1911

Printed for the Ray Society

**Bryant, William Cullen** 1794–1878

American poet

That delicate forest flower,  
With scented breath and look so like a smile,  
Seems, as it issues from the shapeless mould,  
An emanation of the indwelling Life,  
A visible token of the upholding Love,  
That are the soul of this great universe.

*Poems*

A Forest Hymn

D. Appleton. New York, New York, USA. 1874

Where are the flowers, the fair young flowers,  
That lately sprang and stood  
In brighter light and softer airs, a beauteous sisterhood?

*Poems*

The Death of the Flowers

D. Appleton. New York, New York, USA. 1874

Loveliest of lovely things are they,  
On earth, that soonest pass away.  
The rose that lives its little hour  
Is prized beyond the sculptured flower.

*Poems*

A Scene on the Banks of the Hudson

D. Appleton. New York, New York, USA. 1874

The little wind-flower, whose just opened eye  
Is blue as the spring heaven it gazes at.

*Poems*

A Winter Piece

D. Appleton. New York, New York, USA. 1874

**Child, Lydia M.** 1802–80  
American author and abolitionist

Flowers have spoken to me more than I can tell in written words. They are the hieroglyphics of angels, loved by all men for the beauty of the character, though few can decipher even fragments of their meaning.

*Letters from New York*

Letter XXVI, September 1, 1842

C.S. Francis & Company. New York, New York, USA. 1845

**Cranch, Christopher Pearse** 1813–92  
Unitarian minister, poet, and author

Majestic flower! How purely beautiful  
Thou art, as rising from thy bower of green,  
Those dark and glossy leaves so thick and full,  
Thou standest like a high-born forest queen  
Among thy maidens clustering round so fair...  
I breathe the perfume, delicate and strong,  
That comes like incense from thy petal-bower;  
My fancy roams those southern woods along,  
Beneath that glorious tree, where deep among  
The unsunned leaves thy large white flowers-cups hung!

*Collected Poems of Christopher Pearse Cranch*

Poem to the Magnolia Grandiflora

Scholars' Facsimiles & Reprints. Gainesville, Florida, USA. 1971

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

Flowers are weak creatures. They are naïve. They reassure themselves as best they can. They believe that their thorns are terrible weapons...

Translated by Katherine Woods

*The Little Prince*

Chapter VII (p. 26)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Dickens, Charles** 1812–70  
English novelist

The rich, sweet smell of the hayricks rose to his chamber window; the hundred perfumes of the little flower-garden beneath scented the air around; the deep-green meadows shone in the morning dew that glistened on every leaf as it trembled in the gentle air; and the birds sang as if every sparkling drop were a fountain of inspiration to them.

*The Posthumous Papers of the Pickwick Club*

Chapter VII (p. 72)

Dodd, Mead & Company. New York, New York, USA. 1944

**Feynman, Richard P.** 1918–88  
American theoretical physicist

There are all kinds of interesting questions that come from a knowledge of science, which only adds to the excitement and mystery and awe of a flower.

*What Do You Care What Other People Think*

W.W. Norton & Co. New York, New York, USA. 1998

**Goodale, Dora Read** 1866–1953  
American poet

Now about the rugged places  
And along the ruined way,  
Light and free in sudden graces  
Comes the careless trend of May, –  
Born of tempest, wrought in power,  
Stirred by sudden hope and fear,  
You may find a mystic flower  
In the spring-time of the year!  
*All Round the Year: Verses from Sky Farm*  
Trillium  
G.P. Putnam's Sons. New York, New York, USA. 1881

Whence is yonder flower so strangely bright?  
Would the sunset's last reflected shine  
Flame so red from that dead flush of light?  
Dark with passion is its lifted line,  
Hot, alive, amid the falling night.  
*All Round the Year: Verses from Sky Farm*  
Cardinal Flower  
G.P. Putnam's Sons. New York, New York, USA. 1881

**Holland, Josiah Gilbert** 1819–81  
American novelist and poet

There are crowds who trample a flower into the dust,  
without once thinking that they have one of the sweetest  
thoughts of God under their heels.

*Gold-foil, Hammered From Popular Proverbs*

Chapter III (p. 32)

Charles Scribner's Sons. New York, New York, USA. 1881

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

The Amen! of Nature is always a flower.

*The Autocrat of the Breakfast-table*

Chapter X (p. 225)

J.M. Dent & Co. Boston, Massachusetts, USA. 1907

**Huxley, Thomas Henry** 1825–95  
English biologist

Flowers are the primers of the morphologist; those who run may read in them uniformity of type amidst endless diversity, singleness of plan with complex multiplicity of detail. As a musician might say, every natural group of flowering plants is a sort of visible fugue, wandering about a central theme which is never forsaken, however it may momentarily, cease to be apparent.

In Michael Foster and E. Ray Lankester

*The Scientific Memoirs of Thomas Henry Huxley* (Volume 4)

Chapter XXXVIII (p. 666)

Macmillan & Co Ltd. London, England. 1902

**Jefferies, Richard** 1848–87  
English naturalist and author

The first conscious thought about wild flowers was to find out their names – the first conscious pleasure – and then I began to see so many that I had not previously noticed. Once you wish to identify them there is nothing escapes, down to the little white chickweed of the path and the moss of the wall.

*The Open Air*

Wild Flowers (pp. 36–37)

Chatto &amp; Windus. London, England. 1885

**Meredith, George** 1828–1909

English novelist and poet

Well, the flowers of the field are frail things. Pluck one, and you have in your hand the frailest of things. But reach through the charm of colour and the tale of its beneficence in frailty to the poetry of the flower, and secret of the myriad stars will fail to tell you more than does that poetry of your little flower.

*The Amazing Marriage* (Volume 2)

Chapter XIII (p. 152)

Bernhard Tauchnitz. Leipzig, Germany. 1897

**Millay, Edna St. Vincent** 1892–1950

American poet

I will be the gladdest thing  
Under the sun!  
I will touch a hundred flowers  
And not pick one.

*Collected Poems*

Afternoon on a Hill (p. 33)

Harper &amp; Row, Publishers. New York, New York, USA. 1950

**Milton, John** 1608–74

English poet

Into the blissful field, through Groves of Myrrhe,  
And flouring Odours, Cassia, Nard, and Blame;  
A Wilderness of Sweets ...

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book V, l. 294–7

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mirbeau, Octave** 1848–1917

French journalist, art critic, pamphleteer, and novelist

...flowers do not indulge in sentiment. They indulge in passion, nothing but passion. They make love all the time.

Translated by Alvah C. Bessie

*The Torture Garden*

C. Kendall. New York, New York, USA. 1931

**Muir, John** 1838–1914

American naturalist

For all the way up the long red slate slopes, that in the distance seemed barren, you find little garden beds and tufts of dwarf phlox, ivesia, and blue arctic daisies that go straight to your heart, blessed fellow mountaineers kept safe and warm by a thousand miracles.

*Our National Parks*

Chapter III (p. 94)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...Nature, like an enthusiastic gardener, could not resist the temptation to plant flowers everywhere.

*Our National Parks*

Chapter V (p. 141)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA. 1901

Around your camp fire the flowers seem to be looking eagerly at the light, and the crystals shine unweariedly, making fine company as you lie at rest in the very heart of the vast, serene, majestic night.

*Our National Parks*

Chapter V (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Flowers are born every hour.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter II, Section 1, April 9 (p. 48)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

**Murdoch, Iris** 1919–99

English writer

People from a planet without flowers would think we must be mad with joy the whole time to have such things about us.

*A Fairly Honourable Defeat*

Part I, Chapter Fifteen (p. 170)

Penguin Books. New York, New York, USA. 2001

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

Flowers exactly correspond to children...like children they are found lowest down, nearest the earth ...

*Main Currents in Nineteenth, Century Literature*

Chapter XII (p. 196)

The Macmillan Co. New York, New York, USA. 1906

**Osborn, Henry Stafford** 1857–1935

American paleontologist and geologist

There are voices that are eloquent though they utter no sounds. There are beautiful faces that speak of innocence and love with looks which affect our hearts more rapidly through our eyes than could words however skillfully presented. And on the faces of little flowers how plainly can we read thoughts of beauty, of modesty, and of design, which the longest description would fail to picture to our minds as faithfully as does one short vision!

*Plants of the Holy Land*

The Voices of Flowers (p. 11)

J.B. Lippincott &amp; Co. Philadelphia, Pennsylvania, USA. 1861

**President of the 1893 Horticultural Congress**

The loveliest symbols of thought and aspiration of sentiment and affection are flowers.

In Washington Atlee Burpee

*Selection in Seed Growing*

The Horticultural Congress (p. 7)

W. Atlee Burpee &amp; Co. Philadelphia, Pennsylvania, USA. 1896

**Rossetti, Christina Georgina** 1830–94

English poet

Flowers preach to us if we will hear.

*The Complete Poems of Christina Rossetti* (Volume 1)

Consider the Lilies of the Field (p. 76)

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1979

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Flowers seem intended for the solace of ordinary humanity. Children love them; quiet, tender, contented, ordinary people love them as they grow; luxurious and disorderly people rejoice in them gathered. They are the cottager's treasure; and in the crowded town, mark, as with a little broken fragment of rainbow, the windows of the workers in whose heart rests the covenant of peace.

*Modern Painters* (Volume 5)

Chapter X (p.101)

George Allen

London, England. 1906

But in the meantime, I must again solemnly warn my girl-readers against all study of floral genesis and digestion. How far flowers invite, or require, flies to interfere in their family affairs – which of them are carnivorous – and what forms of pestilence or infection are most favourable to some vegetable and animal growths – let them leave the people to settle who like, as Toinette says of the Doctor in the 'Malade Imaginaire' – "y mettre le nez."

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Part VII, Chapter I (p. 40)

George Allen. London, England. 1882

We must never lose hold of the principle that every flower is meant to be seen by human creatures with human eyes, as by spiders with spider eyes.

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Book IX, Chapter V (p. 123)

George Allen. London, England. 1882

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

There is a Thorn – it looks so old,  
In truth, you'd find it hard to say  
How it could ever have been young,  
It looks so old and gray.

*The Complete Poetical Works of William Wordsworth*

The Thorn, Stanza I

Crowell. New York, New York, USA. 1888

**Tennyson, Alfred (Lord)** 1809–92

English poet

Flower in the crannied wall,  
I pluck you out of the crannies,  
Hold you here, root and all, in my hand,  
Little flower – but if I could understand  
What you are, root and all, and all in all,  
I should know what God and man is.

*The Works of Tennyson*

The Voice and the Peak

The Macmillan Co. New York, New York, USA. 1913

**Titcomb, Timothy** 1819–81

American writer and editor

There are crowds who trample a flower into the 'dust',  
without once thinking that they have one of the sweetest  
thoughts of God under their heel.

*Gold-foil*

17th Chapter III (p. 42)

Charles Scribner's Sons. New York, New York, USA. 1863

**von Frisch, Karl** 1886–1982

Austrian zoologist

One can see that the colors of the flowers have been developed as an adaptation to the color sense of their visitors. It is evident that they are not designed for the human eye. But this should not prevent us from delighting in their beauty.

*Bees: Their Vision, Chemical Senses, and Language*

The Color Sense of Bees (p. 13)

Cornell University Press. Ithaca, New York, USA. 1950

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Flowers are the beautiful hieroglyphics of Nature, with which she indicates how much she loves us.

In John Stuart Blackie

*The Wisdom of Goethe*

Nature – Natural History (p. 182)

William Blackwood & Sons. Edinburgh, Scotland. 1883

**Wilcox, Ella Wheeler** 1850–1919

American poet and journalist

A weed is but an unloved flower!

*New Thought Pastels*

The Weed

E. Towne. Holyoke, Maine, USA. 1906

**Williams, Carol**

No biographical data available

Usually, children spend more time in the garden than anybody else. It is where they learn about the world, because they can be in it unsupervised, yet protected. Some gardeners will remember from their own earliest recollections that no one sees the garden as vividly, or cares about it as passionately, as the child who grows up in it.

*Bringing a Garden to Life*

Bantam Books. New York, New York, USA. 1998

**Wordsworth, William** 1770–1850

English poet

I wandered lonely as a cloud  
That floats on high o'er vales and hills,  
When all at once I saw a crowd,  
A host, of golden daffodils...

*The Complete Poetical Works of William Wordsworth*

I Wandered Lonely as a Cloud

Crowell. New York, New York, USA. 1888

For oft, when on my couch I lie  
 In vacant or in pensive mood,  
 They flash upon that inward eye,  
 Which is the bliss of solitude,  
 And then my heart with pleasure fills,  
 And dances with the Daffodils.

*The Complete Poetical Works of William Wordsworth*  
 I Wandered Lonely as a Cloud  
 Crowell. New York, New York, USA. 1888

Nor will I then thy modest grace forget,  
 Chaste Snowdrops, venturous harbinger of Spring,  
 And pensive monitor of fleeting years!

*The Complete Poetical Works of William Wordsworth*  
 To a Snow-Drop  
 Crowell. New York, New York, USA. 1888

## AMARANTH

**Barrett-Browning, Elizabeth** 1806–61  
 English poet

Nosegays! Leave them for the waking;  
 Throw them earthward where they grew;  
 Dim are such beside the breaking  
 Amaranths he looks unto  
 Folded eyes see brighter colors that the open ever do.

*The Complete Poetical Works of Elizabeth Barrett Browning*  
 A Child Asleep  
 Stanza II  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Milton, John** 1608–74  
 English poet

Bid *Amaranthus* all his beauty shed,  
 And Daffodillies fill their cup with tears,  
 To strew the laureate hearse where Lycid lies.

*Annotated Poems of English Authors*  
 Lycidas I. 149–151  
 Longmans, Green & Co. London, England. 1877

Immortal Amarant, a Flour which once  
 In Paradise, fast by the Tree of Life,  
 Began to bloom, but soon for man's offence,  
 To Heav'n remov'd, where first it grew, there grows,  
 And flours aloft shading the Fount of Life.

*In Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
 Book III, l. 353–357  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Moore, Thomas** 1779–1852  
 Irish poet

Amaranths, such as crown the maids  
 That wander through Zamara's shades...

*The Poetical Works of Thomas Moore*  
 Lalla Rookh  
 A&W Galigani. Paris, France. 1829

## AMARYLLIS

**Tennyson, Alfred (Lord)** 1809–92  
 English poet

Where, here and there, on sandy beaches  
 A milky-bell'd amaryllis blew.

*The Complete Poetical Works of Tennyson*  
 The Daisy, Stanza 4  
 Houghton Mifflin Co. Boston, Massachusetts, USA. 1898

## AMERICAN VELVET PLANT

**Beecher, Henry Ward** 1813–87  
 American Congregational preacher and orator

...we lose no fondness for eminent and accomplished flowers, we are conscious of a growing respect for the floral democratic throng. There is, for instance, the mullein, of but little beauty in each floweret, but a brave plant, growing cheerfully and heartily out of abandoned soils, ruffling its root about with broad-palmed, generous, velvet leaves, and erecting therefrom a towering spire that always inclines us to stop for a kindly look. This fine plant is left, by most people, like a decayed old gentleman, to a good-natured pity. But in other countries it is a "flower", and called the "American velvet plant."

*Star Papers*  
 Experiences of Nature, I (pp. 95–96)  
 J.B. Ford & Co. New York, New York, USA. 1873

## ANEMONE

**Bryant, William Cullen** 1794–1878  
 American poet

Within the woods,  
 Whose young and half transparent leaves scare cast  
 A shade gray circles of anemones  
 Danced on their stalks ...

*Poems*  
 The Old Man's Counsel  
 D. Appleton & Company. New York, New York, USA. 1874

**Goodale, Elaine** 1863–1953  
 American poet

Thy subtle charm is strangely given,  
 My fancy will not let thee be, –  
 Then poise not thus 'twixt earth and heaven,  
 O white anemone!

*All Round the Year*  
 Anemone, Stanza 6

**Moore, Thomas** 1779–1852  
 Irish poet

Anemones and Seas of Gold,  
 And new-blown lilies of the river,



And those sweet flow'rets that unfold  
Their buds on Camadera's quiver ...

*The Poetical Works of Thomas Moore*

Lalla Rookh

Light of the Harem (p. 258)

Lee & Shepard. Boston, Massachusetts, USA. 1873

## APHIS

**Browning, Robert** 1812–89

English poet

There's the palm-aphis, minute miracle.  
As wondrous every whit as thou or I.

*Ferishtah's Fancies*

A Bean Stripe: Also Apple-eating (p. 115)

Smith, Elder & Co. London, England. 1884

## AQUILEGIA

**Taylor, Bayard** 1825–78

American journalist and author

The aquilegia sprinkled on the rocks  
A scarlet rain; the yellow violets  
Sat in the chariot of its leaves; the phlox  
Held spikes of purple flame in meadows wet,  
And all the streams with vernal-scented reed  
Were fringed, and streaky bells of miskodeed.

*The Poetical Works of Bayard Taylor*

Mon-Da-Min, Stanza 17

Houghton, Osgood & Co, Boston, Massachusetts, USA. 1880

## ASPHODEL

**Barrett-Browning, Elizabeth** 1806–61

English poet

With her ankles sunken in asphodel  
She wept for the roses of the earth which fell ...

*The Complete Poetical Works of Elizabeth Barrett Browning*

Calls of the Heart, Stanza IV

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Pope, Alexander** 1688–1744

English poet

By the streams that ever flow,  
By the fragrant winds that blow  
O'er the Elysian flow'rs;  
By those happy souls who dwell  
In yellow mead of asphodel.

*Alexander Pope's Collected Poems*

Ode to St Celia's Day, Stanza V, l. 71–75

## ASTER

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Chide me not, laborious band,  
For the idle flowers I brought;

Every aster in my hand

Goes home loaded with a thought.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

*The Apology* (p. 119)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Whitman, Sarah Helen** 1803–78

American poet, writer, and critic

And still the aster greets us as we pass  
With her faint smile, – among the withered grass  
Beside the way, lingering as loath of heart,  
Like me, from these sweet solitudes to part.

*Hours of Life and Other Poems*

A Day of the Indian Summer

George H. Whitney. Providence, Rhode Island, USA. 1853

## AZALEA

**Goodale, Dora Read** 1866–1953

American poet

O far away in yonder leafy copse  
The wandering thrush has flown,  
And close along the wooded steep  
We know an influence passing deep,  
The Summer light, The Summer tone,  
The rare azalea makes her own, –  
And we are not alone.

*All Round the Year: Verses from Sky Farm*

Wild Azaleas

G.P. Putnam's Sons. New York, New York, USA. 1881

## BARBERRIES

**Aldrich Thomas Bailey** 1836–1907

American writer and editor

In scarlet clusters o'er the grey stone-wall  
The barberries lean in thin autumnal air:  
Just when the fields and garden-plots are bare,  
And ere the green leaf takes the tint of fall,  
They come to make the eye a festival!  
Along the road, for miles, their torches flare.

*The Poems of Thomas Bailey Aldrich*

Sonnets

Barberries

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1882

## BASIL

**Moore, Thomas** 1779–1852

Irish poet

The basil tuft, that waves  
Its fragrant blossom over graves ...

*The Poetical Works of Thomas Moore*

Lalla Rookh  
 Light of the Harem (p. 259)  
 Lee & Shepard. Boston, Massachusetts, USA. 1873

## BEAN

**Ingelow, Jean** 1820–97  
 English poet and novelist

I know the scent of bean-fields.  
*Poems*  
 Gladys and Her Island  
 Longmans, Green, Reader & Dyer. London, England. 1867

## BLOODROOT

**Bryant, William Cullen** 1794–1878  
 American poet

Of Sanguinaria, from whose brittle stem  
 The red drops fell like blood.  
*Poems*  
 The Fountain  
 D. Appleton & Company. New York, New York, USA. 1874

**Goodale, Elaine** 1863–1953  
 American poet

O bloodroot! in thy tingling veins  
 The sap of life runs cold and clear;  
 I break thy shining stem, and fear  
 No conscious guilt, no lasting stains.  
*All Round the Year: Verses from Sky Farm*  
 Bloodroot  
 G.P. Putnam's Sons. New York, New York, USA. 1881

## BORAGE

**MacDonald, George** 1824–1905  
 Scottish novelist and poet

The flaming rose gloomed swarthy red;  
 The borage gleams more blue;  
 Dim starred with white flowers, a flowering bed  
 Glimmer the rich dusk through.  
*The Poetical Works of George MacDonald*  
 Songs of the Summer Night, Part III  
 Chatto & Windus. London, England. 1893

## BRAMBLE

**Chaucer, Geoffrey** 1343–1400  
 English poet

Full many a maiden, bright in bower  
 Did long for him for paramour  
 When they were best asleep;  
 But chaste he was, no lecher sure,

And sweet as is the bramble-flower  
 That beareth a rich red hepe.  
*In Great Books of the Western World* (Volume 22)  
*The Canterbury Tales*  
 Sir Thopas (p. 397)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Elliott, Ebenezer** 1781–1849  
 English poet

Thy fruit full well the schoolboy knows,  
 Wild Brambles of the brake!  
 So put thou forth thy small white rose;  
 I love it for his sake.  
*The Poetical Works of Ebenezer Elliott*  
 To the Bramble Flower  
 William Tait. Edinburgh, Scotland. 1840

## BUTTERCUP

**Barrett-Browning, Elizabeth** 1806–61  
 English poet

He likes the poor things of the world the best,  
 I would not, therefore, if I could be rich.  
 It pleases him to stoop for buttercups..  
*The complete Poetical Works of Elizabeth Barrett Browning*  
 Aurora Leigh  
 Book IV, l. 210–212  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Hardy, Thomas** 1840–1928  
 English poet and regional novelist

As they crept along, stooping low to discern the plant, a  
 soft yellow gleam was reflected from the buttercups into  
 their shaded faces, giving them an elfish, moonlit aspect,  
 though the sun was pouring upon their backs in all the  
 strength of noon.  
*Tess of the d'Urbervilles: A Pure Woman*  
 Chapter XXII (p. 178)  
 Harper & Brothers, Publishers. New York, New York, USA. 1920

**Holmes, Oliver Wendell** 1809–94  
 American physician, poet, and humorist

Yellow japanned buttercups and star-disked dandelions –  
 just as we see them lying in the grass, like sparks that  
 have leaped from the kindling sun of summer.  
*The Professor at the Breakfast-Table*  
 Chapter X  
 Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Mulock, Dinah Maria (Mrs. Craik)** 1826–87  
 English author

The buttercups across the field  
 Made sunshine rifts of splendor ...  
*Mulock's Poems: New and Old*  
 A Silly Song  
 Hurst & Co. New York, New York, USA. 1883

**CAMOMILE**

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the camomile, the more it is trodden on the faster it grows...

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*The First Part of King Henry the Fourth*  
Act II, Scene iv, l. 438–439  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**CARDINAL-FLOWER**

**Goodale, Dora Read** 1866–1953  
American poet

Whence is yonder flower so strangely bright?  
Would the sunset's last reflected shine  
Flame so red from that dead flush of light?  
Dark with passion is its lifted line,  
Hot, alive, amid the falling night.

*All Round the Year: Verses from Sky Farm*  
Cardinal Flower  
G.P. Putnam's Sons. New York, New York, USA. 1881

**CARNATION**

**Milton, John** 1608–74  
English poet

Each Flour of slender stalk, whose head though gay  
Carnation, Purple, Azure, or specked with Gold hung  
drooping unsustained.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book IX, l.429  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The fairest flowers o' the season  
Are our carnations and streak'd gillyvors,  
Which some call nature's bastards.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Winter's Tale*  
Act IV, Scene iii, l. 81–83  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**CASSIA**

**Ingelow, Jean** 1820–97  
English poet and novelist

While cassias bloom in the zone of calms.

*Poems*  
Sand Martins  
Longmans, Green, Reader & Dyer. London, England. 1867

**CATALPA**

**Bryant, William Cullen** 1794–1878  
American poet

... the Catalpa's blossoms flew,  
Light blossoms, dropping on the grass like snow.

*Poems*  
The Winds, Stanza I  
D. Appleton & Company. New York, New York, USA. 1874

**CELANDINE**

**Wordsworth, William** 1770–1850  
English poet

Long as there's a sun that sets,  
Primroses will have their glory;  
Long as there are violets,  
They will have a place in a story:  
There's a flower that shall be mine,  
'Tis the little Celandine.

*The Complete Poetical Works of William Wordsworth*  
To the Small Celandine, Stanza I  
Crowell. New York, New York, USA. 1888

**CHAMPAC**

**Moore, Thomas** 1779–1852  
Irish poet

The maid of India, blessed again to hold  
In her full lap the Champac's leaves of gold

*The Poetical Works of Thomas Moore*  
Lalla Rookh  
The Veiled Prophet of Khorassan  
Lee & Shepard. Boston, Massachusetts, USA. 1873

**CHRYSANTHEMUM**

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Chrysanthemums from gilded argosy  
Unload their gaudy scentless merchandise.

*Poems*  
Humanitad, Stanza 11  
George Munro's Sons. New York, New York, USA. 1896

**CLEMATIS**

**Goodale, Dora Read** 1866–1953  
American poet

Where the woodland streamlets flow,  
Gushing down a rocky bed,  
Where the tasseled alders grow,  
Lightly meeting overhead,  
When the fullest August days  
Give richness that they know,

Then the wild clematis comes,  
With her wealth of tangled blooms,  
Reaching up and drooping low.

*All Round the Year: Verses from Sky Farm*

Wild Clematis

G.P. Putnam's Sons. New York, New York, USA. 1881

## COLUMBINE

**Bryant, William Cullen** 1794–1878

American poet

Or columbines, in purple dressed,  
Nod o'er the ground-bird's hidden nest.

*Poems*

To the Fringed Gentian, Stanza II

D. Appleton & Company. New York, New York, USA. 1874

**Ingelow, Jean** 1820–97

English poet and novelist

Columbine, open your folded wrapper,  
Where two twin turtle-doves dwell!  
O cuckoopint toll me the purple clapper  
That hangs in your clear green bell!

*Songs of Seven*

Seven Times One

Roberts Brothers. Boston, Massachusetts, USA. 1866

**Rusby, Henry Hurd** 1855–1940

American physician

Sweet flower of the golden horn,  
Thy beauty passeth praise!  
But why should spring thy gold adorn  
Most meet for summer days?

Source undetermined

To the Golden Columbine

## COMPASS-FLOWER

**Longfellow, Henry Wadsworth** 1807–82

American poet

Look at this vigorous plant that lifts its head from the meadow,  
See how its leaves are turned to the north, as true as the magnet;  
This is the compass-flower, that the finger of God has planted.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)

Evangeline

Part II, Stanza IV, l. 140

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

## COWSLIP

**Hood, Thomas** 1799–1845

English poet and editor

The cowslip is a country wench.

*The Complete Poetical Works of Thomas Hood*

Flowers, Stanza I

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

## DAFFODIL

**Tennyson, Alfred (Lord)** 1809–92

English poet

When the face of night is fair on the dewy downs,  
And the shining daffodil dies ...

*The Complete Poetical Works of Tennyson*

Maud

Part III, Stanza 1

Houghton Mifflin Co. Boston, Massachusetts, USA. 1898

**Wordsworth, William** 1770–1850

English poet

I wandered lonely as a cloud  
That floats on high o'er vales and hills,  
When all at once I saw a crowd,  
A host, of golden daffodils...

*The Complete Poetical Works of William Wordsworth*

I Wandered Lonely as a Cloud

Crowell. New York, New York, USA. 1888

For oft, when on my couch I lie  
In vacant or in pensive mood,  
They flash upon that inward eye,  
Which is the bliss of solitude,  
And then my heart with pleasure fills,  
And dances with the Daffodils.

*The Complete Poetical Works of William Wordsworth*

I Wandered Lonely as a Cloud

Crowell. New York, New York, USA. 1888

## DAHLIA

**Elliott, Ebenezer** 1781–1849

English poet

The Vicar's house is smother'd in its roses,  
His garden glows with dahlias large and new.

*The Poetical Works of Ebenezer Elliott*

The Vicarage

William Tait. Edinburgh, Scotland. 1840

## DAISY

**Muir, John** 1838–1914

American naturalist

...the lovely arctic daisy with many blessed companions;  
charming plants, gentle mountaineers, Nature's darlings,  
which seem always the finer the higher and stormier their homes.

*Our National Parks*

Chapter V (p. 149)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1901

### Runge, Friedlieb Ferdinand

German chemist

The little Daisy, which has painted its 'wee crimson-tipped flowers,' puts the chemist and scientific man to shame, for it has produced its leaf and stem and flowers, and has dyed these with their bright colors from materials which he can never change with all his art.

In Celia Thaxter  
*An Island Garden*  
Chapter Five (p. 88)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1896

### DANDELION

#### Beecher, Henry Ward 1813–87

American Congregational preacher and orator

You cannot forget, if you would, those golden kisses all over the cheeks of the meadow, queerly called dandelions.

*Star Papers*  
A Discourse of Flowers (p. 97)  
J.B. Ford & Co. New York, New York, USA. 1873

### FLOWER-DE-LUCE

#### Longfellow, Henry Wadsworth 1807–82

American poet

O flower-de-luce, bloom on, and let the river  
Linger to kiss thy feet!  
O flower of song, bloom on, and make forever  
The world more fair and sweet.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 33)  
Flower-de-luce  
Stanza 8  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1904–1917

### DODDER

#### Davis, Sarah E.

Poet

In the roadside thicket hiding,  
Sing, robin, sing!  
See the yellow dodder, gliding,  
Ring, Bluebells, ring!  
Like a living skein inlacing.  
Coiling, climbing, turning, chasing,  
Through the fragrant sweet-fern facing –  
Laugh, O murmuring Spring.

In Minnie Curtis Wait and Merton Channing Leonard (eds.)  
*Among the Flowers and Trees with the Poets*  
Dodder  
Lee & Shepard, Boston, Massachusetts, USA. 1901

### FLAG

#### Shelley, Percy Bysshe 1792–1822

English poet

And nearer to the river's trembling edge  
There grew broad flag-flowers, purple  
Pricked with white;  
And starry river buds among the sedge;  
And floating water-lilies broad and bright.

*Shelley: Selected Poetry, Prose and Letters*  
The Question, Stanza IV  
Nonesuch Press, London, England. 1951

### FORGET-ME-NOT

#### Coleridge, Samuel Taylor 1772–1834

English lyrical poet, critic, and philosopher

The blue and bright-eyed floweret of the brook,  
Hope's gentle gem, the sweet Forget-me-not!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)  
Windsor Forest, l. 25–26  
Houghton Mifflin Company, New York, New York, USA. 1903

### FOXGLOVE

#### Ingelow, Jean 1820–97

English poet and novelist

An empty sky, a world of heather,  
Purple of foxglove, yellow of broom;  
We two among them wading together,  
Shaking out honey, treading perfume.

*Poems*  
Divided, Stanza I  
Longmans, Green, Reader & Dyer, London, England. 1867

### FURZE

#### Goldsmith, Oliver 1728–74

Anglo-Irish writer, poet, and physician

With blossom'd furze unprofitably gay.

*Poetical Works*  
The Deserted Village, l. 194  
William Pickering, London, England. 1839

### GENTIAN

#### Bryant, William Cullen 1794–1878

American poet

And the blue gentian-flower, that, in the breeze,  
Nods lonely, of her beauteous race the last.

*Poems*  
November  
D. Appleton & Company, New York, New York, USA. 1874

**GILLYFLOUR**

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The fairest flowers o' the season  
Are our carnations and the streak'd gillyvors,  
Which some call nature's bastards.

*The Winter's Tale*

Act IV, scene iii, l. 81–83

**GORSE**

**Ingelow, Jean** 1820–97  
English poet and novelist

But I have seen  
The gay gorse bushes in their flowering time.

*Poems*

Gladys and Her Island

Longmans, Green, Reader & Dyer. London, England. 1867

**HAREBELL**

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Thou shalt not lack  
The flower that's like thy face, pale primrose not  
The azured harebell, like thy veins ...

*Cymbeline*

Act IV, scene ii, l. 220–222

**HEATH**

**Pope, Alexander** 1688–1744  
English poet

E'en wild heath displays her purple dyes,  
And 'midst the desert fruitful fields arise.

*The Complete Poetical Works*

Windsor Forest, l. 25–26

Houghton Mifflin Company. New York, New York, USA. 1903

**HELIOTROPE**

**Stedman, Edmund Clarence** 1833–1908  
American poet, critic, and essayist

O sweetest of all the flowrets  
That bloom where angels tread!  
But never such marvelous odor  
From heliotrope was shed ...

*The Poetical Works of Edmund Clarence Stedman*

Heliotrope, Stanza 2

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1888

**HEPATICA**

**Goodale, Dora Read** 1866–1953  
American poet

All the woodland path is broken  
By warm tints along the way,  
And the low and sunny slope  
Is alive with sudden hope  
When there comes the silent token  
Of an April Day, –  
Blue hepatica

*All Round the Year: Verses from Sky Farm*

Hepatica

G.P. Putnam's Sons. New York, New York, USA. 1881

**HOLLYHOCK**

**Ingelow, Jean** 1820–97  
English poet and novelist

... and Queen hollyhocks,  
With butterflies for crowns ...

*Poems*

Honors, Part I, Stanza 5

Longmans, Green, Reader & Dyer. London, England. 1867

**HONEYSUCKLE**

**Landon, Letitia Elizabeth** 1802–38  
English poet and novelist

... and scarce a beech  
Was there with a honeysuckle link'd  
Around, with its red tendrils and pink flowers ...

*The Poetical Works of Miss Landon* (Volume 1)

The Oak

E.L. Cary & H. L. Hart. Philadelphia, Pennsylvania, USA. 1838

**Tennyson, Alfred (Lord)** 1809–92  
English poet

The honeysuckle round the porch has woven its wavy  
bowers ...

*The Complete Poetical Works of Tennyson*

The May Queen, Stanza 8

Houghton Mifflin Co. Boston, Massachusetts, USA. 1898

**HYACINTH**

**Montgomery, James** 1771–1854  
Scottish poet and journalist

Here Hyacinths of heavenly blue  
Shook their rich tresses to the morn.

*Poetical Works of James Montgomery* (Volume 2)



The Adventures of a Star  
Printed for Longman, Rees, Orme, Brown, Green & Longman. London,  
England. 1836

**Shelley, Percy Bysshe** 1792–1822  
English poet

And the hyacinth purple, and white, and blue,  
Which flung from its bells a sweet peal anew  
Of music so delicate, soft and intense,  
It was felt like an odour within the sense.  
In A.S.B. Glover (ed.)  
*Shelley: Selected Poetry, Prose and Letters*  
The Sensitive Plant, Part I, Stanza 7  
Nonesuch Press. London, England. 1951

## FLOWER: IVY

**Bailey, Philip James** 1816–1902  
English poet

For ivy climbs the crumbling hall  
To decorate decay.  
*Festus: a Poem*  
Party and Entertainment (p. 272)  
George Routledge & Sons, Ltd. London, England. 1893

**Cook, Eliza** 1818–89  
English author

The citron or spicy grove for me would never yield  
A perfume half so grateful as the lilies of the field.  
*The Poetical Works of Eliza Cook*  
England, Stanza 2  
Frederick Warne & Co. London, England. 1870

## JASMINE

**Bryant, William Cullen** 1794–1878  
American poet

And at my silent window-sill  
The jessamine peeps in.  
*Poems*  
The Hunter's Serenade  
D. Appleton & Company. New York, New York, USA. 1874

## LILY

**Aldrich Thomas Bailey** 1836–1907  
American writer and editor

I like not lady-slippers,  
Not yet the sweet-pea blossoms,  
Nor yet the flaky roses,  
Red or white as snow;  
I like the chaliced lilies,  
The heavy Eastern lilies,  
The gorgeous tiger-lilies,

That in our garden grow.  
*The Poems of Thomas Bailey Aldrich*  
Tiger Lilies, Stanza I  
Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1882

## LILY-OF-THE-VALLEY

**Croly, George** 1780–1860  
Irish poet, novelist, and divine

White bud, that in meek beauty so dost lean  
Thy cloistered cheek as pale as moonlight snow,  
Thou seem'st beneath thy huge, high leaf of green,  
An Eremite beneath his mountain's brow.  
*The Poetical Works of the Rev. George Croly* (Volume 1)  
The Lily of the Valley  
Henry Colburn & Richard Bentley. London, England. 1830

## LOTUS

**Heine, Heinrich** 1797–1856  
German poet

The lotus flower is troubled  
At the sun's resplendent light;  
With sunken head and sadly  
She dreamily waits for the night.  
*Book of Songs*  
Lyrical Interlude, Number 10 (p. 52)  
The Roycrofters. East Aurora, New York, USA. 1903

## LOVE LIES BLEEDING

**Swinburne, Algernon Charles** 1837–1909  
English poet

Love lies bleeding in the bed whereover  
Roses lean with smiling mouths or pleading;  
Earth lies laughing where the sun's dart clove her:  
Love lies bleeding  
*The Collected Poetical Works of Algernon Charles Swinburne*  
Love Lies Bleeding  
W. Heinemann. 1919

## MAGNOLIA GRANDIFLORA

**Cranch, Christopher Pearse** 1813–92  
Unitarian minister, poet, and author

Majestic flower! How purely beautiful  
Thou art, as rising from thy bower of green,  
Those dark and glossy leaves so thick and full,  
Thou standest like a high-born forest queen  
Among thy maidens clustering round so fair ...  
I breathe the perfume, delicate and strong,  
That comes like incense from thy petal-bower;  
My fancy roams those southern woods along,

Beneath that glorious tree, where deep among  
The unsunned leaves thy large white flower-cups hung!

*Poems*

Poem to the Magnolia Grandiflora

Carey & Hart. Philadelphia, Pennsylvania, USA. 1844

## MARIGOLD

**Keats, John** 1795–1821

English Romantic lyric poet

Open afresh your round of starry folds,  
Ye ardent marigolds!

Dry up the moisture from your golden lips.

*The Complete Poetical Works and Letters of John Keats*

I Stood Tiptoe Upon a Little Hill, l. 47–49

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The marigold...goes to bed wi' the sun,  
And with him rising weeping.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*The Winter's Tale*

Act IV, Scene iv, l. 104–105

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## MARSH MARIGOLD

**Swinburne, Algernon Charles** 1837–1909

English poet

A little marsh-plant, yellow green  
And pricked at lip with a tender red,  
Tread close, and wither way you tread,  
Some faint black water jets between  
Least you should bruise the curious head.

*The Collected Poetical Works of Algernon Charles Swinburne*

The Sundew

W. Heinemann. 1919

## MEADOW RUE

**Goodale, Elaine** 1863–1953

American poet

When emerald slopes are drowned in song,  
When weary grows the unclouded blue,  
When warm winds sink in billow bloom,  
And flood you with a faint perfume,  
One moment leaves the rapturous throng  
To seek the haunts of meadow rue!

*All Round the Year: Verses from Sky Farm*

Meadow Rue, Stanza 4

G.P. Putnam's Sons. New York, New York, USA. 1881

## MIMOSA

**Shelley, Percy Bysshe** 1792–1822

English poet

A Sensitive Plant in a garden grew,  
And the young winds fed it with silver dew,  
And it opened its fan-like leaves to the light,  
And clothed them beneath the kisses of night.

*The Complete Poetical Works of Percy Bysshe Shelley*

The Sensitive Plant, Part I, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## MOCCASIN FLOWER

**Goodale, Elaine** 1863–1953

American poet

With careless joy we thread the woodland ways  
And reach her broad domain.

Thro' sense of strength and beauty, free as air.

We feel our savage kin, –

And thus along with conscious meaning wear

The Indian moccasin!

*In Berkshire with the Wild Flowers*

Moccasin Flower

G.P. Putnam's Sons. New York, New York, USA. 1879

## MORNING-GLORY

**Jackson, Helen Hunt** 1830–85

American writer and poet

Wondrous interlacement!

Holding fast to threads by green and silky rings,

With the dawn it spreads its white and purple wings;

Generous in its bloom, and sheltering while it clings,

Sturdy morning-glory.

*Bits of Talk, in Verse and Prose, for Young Folks,*

Morning Glory

Roberts Brothers. Boston, Massachusetts, USA. 1876

**Lowell, Maria White** 1821–53

Poet

The morning-glory's blossoming will soon be coming  
round;

We see their rows of heart-shaped leaves upspringing  
from the ground.

*The Poems of Maria Lowell*

The Morning-Glory, Stanza 6

The Riverside Press. Cambridge, England. 1907

**MYRTLE**

**Montgomery, James** 1771–1854  
Scottish poet and journalist

Dark-green and gemm'd with flowers of snow,  
With close uncrowded branches spread  
Not proudly high, nor meanly low,  
A graceful myrtle rear'd its head.

*Poetical Works of James Montgomery* (Volume 2)

The Myrtle

Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**NARCISSI**

**Plath, Sylvia** 1932–63  
American poet and novelist

... the terrible wind tries his breathing.  
The narcissi look up like children, quickly and whitely.

*Collected Poems*

Mong the Narcissi

Faber & Faber Ltd. London, England. 1981

**ORCHID**

**Taylor, Bayard** 1825–78  
American journalist and author

Around the pillars of the palm-tree bower  
The orchids cling, in rose and purple spheres;  
Shield-broad the lily floats; the aloe flower  
Foredates its hundred years.

*The Poetical Works of Bayard Taylor*

Canopus, Stanza 11

Houghton, Osgood. Boston, Massachusetts, USA. 1880

**PAINTED CUP**

**Bryant, William Cullen** 1794–1878  
American poet

Scarlet tufts  
Are glowing in the green, like flakes of fire;  
The wanderers of the prairie know them well,  
And call that brilliant flower the Painted Cup.

*Poems*

The Painted Cup

D. Appleton & Company. New York, New York, USA. 1874

**OX-EYE DAISY**

**Goodale, Dora Read** 1866–1953  
American poet

Clear and simple in white and gold,  
Meadows blossom, of sunlit spaces, –

The field is full as it well can hold  
And white with the drift of the ox-eye daisies!

*All Round the Year: Verses from Sky Farm*

Daisies

G.P. Putnam's Sons. New York, New York, USA. 1881

**POND-LILY**

**Hawthorne, Nathaniel** 1804–64  
American novelist and short story writer

A perfect pond-lily is the most satisfactory of flowers.

*The Works of Nathaniel Hawthorne* Volume 6

*American Note-books*

August 13, 1842 (p. 84)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1868

**PANSY**

**Barrett-Browning, Elizabeth** 1806–61  
English poet

... for summer has a close,  
And pansies bloom not in the snows.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Wisdom Unapplied, Stanza II

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**PAPAW**

**Fosdick, William Whiteman** 1825–62  
American poet, writer, and song writer

And brown is the papaw's shade-blossoming cup,  
In the wood, near the sun-loving maize!

*Ariel and Other Poems*

The Maize

Bunce & Brother. New York, New York, USA. 1855

**PASSION FLOWER**

**de Vere, Sir Aubrey** 1788–1846  
Irish poet

Art thou a type of beauty, or of power,  
Of sweet enjoyment, or disastrous sin?  
For each thy name denoteth, Passion flower!

*A Song of Faith*

Devout Exercises and Sonnets

The Passion Flower

William Pickering. London, England. 1842

**PIMPERNEL**

**Thaxter, Celia** 1835–94  
American poet

The turf is warm beneath her feet,  
Bordering the beach of stone and shell,

And thick about her path the sweet  
Red blossoms of the pimpernel.

*The Poems of Celia Thaxter*

The Pimpernel

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1899

## POPPY

**Bridges, Robert Seymour** 1844–1930

English poet

A Poppy grows upon the shore  
Bursts her twin cup in summer late:  
Her leaves are glaucous green and hoar,  
Her petals yellow, delicate.

*Poetical Works of Robert Bridges* (Volume 2)

Book I, 9

Smith, Elder & Co. London, England. Year unknown

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

...a sudden doubt troubles me, whether all poppies have two petals smaller than the other two. Whereupon I take down an excellent little school-book on botany – the best I've yet found, thinking to be told quickly; and I find a great deal about opium; and, apropos of opium, that the juice of common celandine is of a bright orange colour; and I pause for a bewildered five minutes, wondering if a celandine is a poppy, and how many petals it has: going on again – because I must, without making up my mind, on either question – I am told to “observe the floral receptacle of the Californian genus *Eschscholtzia*.” Now I can't observe anything of the sort, and I don't want to; and I wish California and all that's in it were at the deepest bottom of the Pacific. Next I am told to compare the poppy and waterlily; and I can't do that, neither – though I should like to; and there's the end of the article; and it never tells me whether one pair of petals is always smaller than the other, or not.

*Proserpina* (Volume 1)

Lecture IV, 12 (p. 72)

John Wiley & Sons. New York, New York, USA. 1886

**Taylor, Bayard** 1825–78

American journalist and author

And far and wide, in a scarlet tide,  
The poppy's bonfire spread.

*The Poetical Works of Bayard Taylor*

The Poet in the East, Stanza 4

Houghton, Osgood & Co, Boston, Massachusetts, USA. 1880

**Wright, Mabel Osgood** 1859–1934

American author

Look steadily at a mass of these glowing flowers blending their multicolours in the full sunlight. At first their brilliancy is blinding; then as the petals undulate on the slender stems, your attention is riveted as if a hundred

eyes returned your gaze, and drowsiness steals over you, for each flower bears the spell of the hypnotic pod, whose seeds bring sleep.

*The Garden of a Commuter's Wife*

Chapter VIII (p. 244)

The Macmillan Co. New York, New York, USA. 1905

## PRIMROSE

**Disraeli, Benjamin, First Earl of**

**Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

“I could have brought you some primroses, but I do not like to mix violets with anything.”

“They say primroses make a capital salad,” said Lord St. Jerome.

*Lothair*

Chapter XIII (p. 57)

Longmans, Green & Company. London, England. 1920

**Wilson, Andrew** 1852–1912

No biographical data available

As Huxley has remarked, it would not have roused Peter a whit from his apathy had he been informed that “the primrose is a Dicotyledonous Exogen, with a monopetalous corolla and a central placentation.” Whilst if the botanist continued his encyclopaedic chant, he might afford Peter the additional satisfaction of knowing that the flower belongs to the natural order Primulaceae; that it has oblongeolate, wrinkled, radical leaves; an inferior, gamosepalous calyx; pentandrous stamens; and a syncarpous, superior pistil!

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

Science-Culture for the Masses (p. 33)

Chatto & Windus. London, England. 1879

**Wordsworth, William** 1770–1850

English poet

A primrose by a river's brim  
A yellow primrose was to him,  
And it was nothing more.

*The Complete Poetical Works of William Wordsworth*

Peter Bell, Part I, Stanza 12

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

## RED CLOVER

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

We confess to a homely enthusiasm for clover – not the white clover, beloved of honey-bees – but the red clover.... We go through a field of red clover, like Solomon in a garden of spices.

*Star Papers*

Experiences of Nature, I (p. 96)

J.B. Ford & Co. New York, New York, USA. 1873

**REED**

**Barrett-Browning, Elizabeth** 1806–61  
English poet

Those tall flowering-reeds which stand  
In Arno, like a sheaf of sceptres left  
But some remote dynasty of dead gods  
To suck the stream for ages and get green ...  
*The Complete Poetical Works of Elizabeth Barrett Browning*  
Aurora Leigh, Book VII, l. 937–940  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1900

**RHODORA**

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

In May, when sea-winds pierced our solitudes,  
I found the fresh Rhodora in the woods,  
Spreading its leafless blooms in a damp nook,  
To please the desert and the sluggish brook.  
*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
*The Rhodora* (p. 37)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1904

**ROSE**

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

A contest of roses is better than of horses.  
*Star Papers*  
A Discourse of Flowers (p. 93)  
J.B. Ford & Co. New York, New York, USA. 1873

**Bryant, William Cullen** 1794–1878  
American poet

Loveliest of lovely things are they,  
On earth that soonest pass away.  
The rose that lives its little hour  
Is prized beyond the sculptured flower ...  
*Poems*  
A Scene on the Banks of the Hudson  
D. Appleton & Company, New York, New York, USA. 1874

**Collins, Wilkie** 1824–89  
English novelist

I haven't much time to be fond of anything.... But when  
I have a moment's fondness to bestow, most times...the  
roses get it.  
*The Moonstone*  
First Period, Chapter XII (p. 86)  
International Collectors Library, Garden City, New York, USA. 1900

**Embury, Emma** 1806–63  
American author

The gathered rose and the stolen heart  
Can charm but for a day.  
*The Poems of Emma C. Embury*  
Ballad  
Hurd & Houghton, New York, New York, USA. 1869

**Flammarion, Camille** 1842–1925  
French astronomer and writer

When I breathe the perfume of a rose, when I admire the  
beauty of form, the smoothness of colouring, the grace  
of this flower in its freshly opening bloom, what strikes  
me most is the work of the hidden, unknown, mysterious  
force which rules over the plant's life and can direct it  
in the maintenance of its existence, which chooses the  
proper molecules of air, water, and earth for its nour-  
ishment, and which knows above all how to assimilate  
those molecules and group them so delicately as to  
form this graceful stem, these dainty little green leaves,  
these soft pink petals, these exquisite tints and delicious  
fragrance.  
Translated by Augusta Rice Stetson  
*Urania*  
Chapter IV (pp. 223–224)  
Chatto & Windus, London, England. 1891

**MacDonald, George** 1824–1905  
Scottish novelist and poet

The flaming rose gloomed swarthy red;  
The borage gleams more blue;  
Dim starred with white flowers, a flowering bed  
Glimmer the rich dusk through.  
*The Poetical Works of George MacDonald*  
Songs of the Summer Night, Part III  
Chatto & Windus, London, England. 1893

**ROSMARY**

**Moore, Thomas** 1779–1852  
Irish poet

... the humble rosemary  
Whose sweets so thanklessly are shed  
To scent the desert and the dead ...  
*The Poetical Works of Thomas Moore*  
Lalla Rookh  
Light of the Harem (p. 259)  
Lee & Shepard, Boston, Massachusetts, USA. 1873

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

There's rosemary...for remembrance; pray, love, remem-  
ber; and...pansies, that's for thoughts.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Hamlet, Prince of Denmark*  
Act IV, Scene v, l. 75–77  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**SAFFLOWER**

**Ingelow, Jean** 1820–97  
English poet and novelist

And the saffron flower  
Clear as a flame of sacrifice breaks out.

*Poems*

The Doom, Book II  
Longmans, Green, Reader & Dyer. London, England. 1867

**SHAMROCK**

**Lover, Samuel** 1797–1868  
Irish songwriter and novelist

I seek a four-leaf shamrock in all the fairy dells,  
And if I find the charmed leaves, O h how I'll weave my  
spells!

*Poems of Ireland*

The Four-leaved Shamrock  
Publisher undetermined

**SNOW-DROP**

**Montgomery, James** 1771–1854  
Scottish poet and journalist

The morning star of flowers.

*Poetical Works of James Montgomery* (Volume 2)

The Snow-Drop  
Printed for Longman, Rees, Orme, Brown, Green & Longman. London,  
England. 1836

**Wordsworth, William** 1770–1850  
English poet

Now will I then thy modest grace forget,  
Chaste Snowdrops, venturous harbinger of Spring,  
And pensive monitor of fleeting years!

*The Complete Poetical Works of William Wordsworth*

To a Snow-Drop  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**SPIRAEA**

**Goodale, Dora Read** 1866–1953  
American poet

And near the unfrequented road,  
By waysides scorched with barren heat,  
In clouded pink or softer white  
She holds the Summer's generous light, —  
Our native meadow sweet!

*All Round the Year: Verses from Sky Farm*

Spiraea  
G.P. Putnam's Sons. New York, New York, USA. 1881

**SUN-FLOWER**

**Blake, William** 1757–1827  
English poet, painter, and engraver

Ah Sun-flower! weary of time,  
Who countest the steps of the Sun:  
Seeking after that sweet golden clime  
Where the traveler's journey is done.

*The Complete Poetry and Prose of William Blake*

Ah! Sun-Flower  
University of California Press. Berkeley, California, USA. 1982

**Moore, Thomas** 1779–1852  
Irish poet

But one, the lofty followers of the Sun,  
Sad when he sets, shuts up her yellow leaves  
Drooping all night; and, when the warm returns,  
Points her enamour'd bosom to his ray.

*The Poetical Works of Thomas Moore*

Summer, l. 216–219  
Lee & Shepard. Boston, Massachusetts, USA. 1873

**SWEET BASIL**

**Leland, Charles G.** 1824–1903  
American writer

I pray your Highness mark this curious herb:  
Touch it but lightly, stroke it softly, Sir,  
And it gives forth and odour sweet and rare;  
But crush it harshly and you'll make a scent  
Most disagreeable.

*The Music-Lesson of Confucius*

Sweet Basil, Stanza 6  
J.R. Osgood & Company. Boston, Massachusetts, USA. 1872

**SWEET PEA**

**Keats, John** 1795–1821  
English Romantic lyric poet

Here are sweet peas, on tiptoe for a flight;  
With wings of gentle flush o'er delicate white,  
And taper fingers catching at all things,  
To bind them all about with tiny rings.

*The Complete Poetical Works and Letters of John Keats*

I Stood Tiptoe Upon a Little Hill, l. 57–60  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**THISTLE**

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator



The thistle is a prince. Let any man that has an eye for beauty take a view of the whole plant, and where will he see more expressive grace and symmetry; and where is there a more kingly flower? To be sure, there are sharp objections to it in a bouquet.

*Star Papers*

Experiences of Nature, I (p. 96)

J.B. Ford & Co. New York, New York, USA. 1873

## THORN

**Wordsworth, William** 1770–1850

English poet

There is a Thorn – it looks so old,  
In truth, you'd find it hard to say  
How it could ever have been young,  
It looks so old and gray.

*The Complete Poetical Works of William Wordsworth*

The Thorn, Stanza I

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

## THYME

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

I know a bank where the wild thyme blows.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*A Midsummer-Night's Dream*

Act II, scene I, 1.249

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## TRAILING ARBUTUS

**Terry, Rose** 1827–92

American writer

Darlings of the forest!  
Blossoming alone  
When Earth's grief is sorest  
For her jewels gone –  
Ere the last snow-drift melts, your tender buds have  
blown.

*Poems*

Trailing Arbutus

Ticknor & Fields. Boston, Massachusetts, USA. 1861

## TRILLIUM

**Goodale, Dora Read** 1866–1953

American poet

Now about the rugged places  
And along the ruined way,  
Light and free in sudden graces

Comes the careless trend of May, –  
Born of tempest, wrought in power,  
Stirred by sudden hope and fear,  
You may find a mystic flower  
In the spring-time of the year!

*All Round the Year: Verses from Sky Farm*

Trillium

G.P. Putnam's Sons. New York, New York, USA. 1881

## TUBEROSE

**Moore, Thomas** 1779–1852

Irish poet

The tuberose, with her silvery light,  
That in the gardens of Malay  
Is call'd the Mistress of the Night,  
So like a bride, scented and bright;  
She comes out when the sun's away.

*The Poetical Works of Thomas Moore*

Lalla Rookh

Light of the Harem

Lee & Shepard. Boston, Massachusetts, USA. 1873

## TULIP

**Montgomery, James** 1771–1854

Scottish poet and journalist

Dutch tulips from the beds  
Flaunted their stately heads.

*Poetical Works of James Montgomery* (Volume 2)

The Adventure of a Star

Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Moore, Thomas** 1779–1852

Irish poet

Like tulip-beds of different shape and dyes,  
Bending beneath the invisible west-wind's sighs.

*The Poetical Works of Thomas Moore*

Lalla Rookh

The Veiled Prophet of Khorassan

Lee & Shepard. Boston, Massachusetts, USA. 1873

## VEBENA

**Barrett-Browning, Elizabeth** 1806–61

English poet

... sweet verbena which, being brushed against,  
Will hold us three hours after by the smell  
In spite of long walks on the windy hills.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book VIII, 1.439–441

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

## VERONICA

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Lastly, and for a high worthiness, in my estimate, note that it [Veronica] is *wild*, of the wildest, and proud in pure descent of race; submitting itself to no follies of the cur-breeding florist. Its species, though many resembling each other, are severally constant in aspect, and easily recognizable; and I have never seen it provoked to glare into any gigantic impudence at a flower show. Fortunately, perhaps, it is scentless, and so despised.

*Proserpina: Studies of Wayside Flowers* (Volume 2)  
Book VIII, Chapter III (p. 74)  
George Allen. London, England. 1882

## VIOLET

**Bryant, William Cullen** 1794–1878  
American poet

I know where the young May violet grows,  
In its lone and lowly nook.

*Poems*  
An Indian Story, Stanza 3  
Harper & Brothers. New York, New York, USA. 1940

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81  
English prime minister, founder of Conservative Party, and novelist

I could have brought you some primroses, but I do not like to mix violets with anything.  
“They say primroses make a capital salad,” said Lord St. Jerome.

*Lothair*  
Chapter XIII (p. 57)  
Longmans, Green & Company. London, England. 1920

**Hood, Thomas** 1799–1845  
English poet and editor

The violet is a nun ...  
*The Poetical Works of Thomas Hood* (Volume 1)  
Flowers, Stanza I  
Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1856

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Nobody in the world could draw them [violet’s flower stalk], they are so mixed up together, and crumpled and hacked about, as if some ill-natured child had snipped them with blunt scissors, and an ill-natured cow chewed them a little afterwards and left them, proved for too tough or too bitter.

*Proserpina: Studies of Wayside Flowers* (Volume 2)  
Part VII, Chapter I (p. 17)  
George Allen. London, England. 1882

## WATER-LILY

**Shelley, Percy Bysshe** 1792–1822  
English poet

And nearer to the river’s trembling edge  
There grew broad flag-flowers, purple  
prankt with white;  
And starry river buds among the sedge;  
And floating water-lilies broad and bright.

*The Complete Poetical Works of Percy Bysshe Shelley*  
The Question, Stanza IV  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Tennyson, Alfred (Lord)** 1809–92  
English poet

... the water-lily starts and slides  
Upon the level in little puffs of wind,  
Tho’ anchor’d to the bottom ...  
*The Complete Poetical Works of Tennyson*  
The Princess, IV, l. 236  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1898

## WINDFLOWER

**Bryant, William Cullen** 1794–1878  
American poet

The little wind-flower, whose just opened eye  
Is blue as the spring heaven it gazes at ...  
*Poems* (6th edition)  
A Winter Piece  
Harper & Brothers. New York, New York, USA. 1940

## WOLF FLOWER

### Book entry

[*Mariphasa lupina lumina*] The essence of the Mariphasia blossom squeezed into the wrist through the thorn at the base of the stem is the only preventive [for Lycanthrophobia] known to man.  
*Werewolf of London*  
Film (1935)

## WOODBINE

**Tennyson, Alfred (Lord)** 1809–92  
English poet

And the woodbine spices are wafted abroad,  
And the musk of the rose is blown.

*The Complete Poetical Works of Tennyson*  
Maud, Part XXII, Stanza I  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1898

**WORMWOOD**

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Among the signs of autumn I perceive  
The Roman wormwood (called by learned men  
*Ambrosia elatior*, food for gods, –  
For to impartial science the humblest weed  
Is as immortal once as the proudest flower – )  
Sprinkles its yellow dust over my shoes.  
In Robert Bly  
*The Winged Life. The Poetic Voice of Henry David Thoreau*  
Part Two. Tall Ambrosia (p. 29)  
Sierra Club Books. San Francisco, California, USA. 1986

**FUNGUS**

**Ajello, Libero** 1916–2004  
Mycologist

Some fungi produce a mycosis  
Like blaster or histoplasmosis  
But for musical sake  
The one I will take  
Is coccidioidomycosis.  
In George W. Hudler  
*Magical Mushrooms, Mischievous Molds*  
Coccidioidomycosis (p. 109)  
Princeton University Press. Princeton, New Jersey, USA. 1998

**Author undetermined**

When Flora's lovelier tribes give place,  
The Mushroom's scorn'd but curious race  
Bestud the moist autumnal earth;  
A quick but perishable birth,  
Inlaid with many a brilliant die  
Of Nature's high-wrought tapestry.  
*The British Months: A Poem, in Twelve Parts*  
September (p. 345)  
J.W. Parker. London, England. 1835

**Dickens, Charles** 1812–70  
English novelist

Mildew and mould began to lurk in closets. Fungus trees  
grew in corners of the cellars. Dust accumulated, nobody  
knew whence nor how; spiders, moths, and grubs were  
heard of every day.  
*Dombey and Sons* (Volume 1)  
Chapter XXIII (p. 334)  
James R. Osgood & Co. Boston, Massachusetts, USA. 1875

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

The rain had ceased at last, and a sickly autumn sun  
shone upon a land which was soaked and sodden with  
water. Wet and rotten leaves reeked and festered under  
the foul haze which was soaked and sodden with water.

The fields were spotted with monstrous fungi of a size  
and colour never matched before – scarlet and mauve and  
liver and black.

*Sir Nigel*  
Chapter 1 (p. 2)  
Smith, Elder & Co. London, England. 1906

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

There's a thing that grows by the fainting flower,  
And springs in the shade of the lady's bower;  
The lily shrinks, and the rose turns pale,  
When they feel its breath in the summer gale,  
And the tulip curls its leaves in pride,  
And the blue-eyed violet starts aside:  
But the lily may flaunt, and the tulip stare,  
For what does the honest toadstool care?  
*The Complete Poetical Works of Oliver Wendell Holmes*  
The Toadstool, Stanza 1  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Money, Nicholas P.**  
No biographical data available

If fungi can rot bone in a patient's leg, feast on some-  
one's brain, or devour a child's face, is the naked ape  
king of the jungle, or the king's dinner?  
*Mr. Bloomfield's Orchard: The Mysterious World of Mushrooms, Molds,*  
*and Mycologists*  
Chapter 2 (p. 21)  
Oxford University Press. New York, New York, USA. 2004

**Nicholson, Norman** 1914–87  
English poet

The toadstool towers infest the shore:  
Stink-horns that propagate and spore  
Wherever the wind blows.  
*A Local Habitation*  
Windscale (p. 282)  
Faber & Faber Ltd. London, England. 1994

**Oppenheim, E. Phillips** 1866–1946  
English novelist

There was a thick carpet upon the floor, a sofa piled with  
cushions in one corner, and several other articles of furni-  
ture. The walls, however, were uncovered and were stained  
with damp. A great pink fungus stood out within a few  
inches of the bed, a grim mixture of exquisite colouring  
and loathsome imperfections. The atmosphere was fetid.  
*The Vanished Messenger*  
Chapter 32 (p. 302)  
Little, Brown & Co. Boston, Massachusetts, USA. 1914

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

The fungi are the underworld of plant life, that lives  
clandestinely, by its unconscious wits, taking to cover in  
unfavorable times, rioting at another.

*Flowering Earth*

Chapter 18 (p. 234)

G.P. Putnam's Sons. New York, New York, USA. 1939

**Phillpotts, Eden** 1862–1960

English novelist, poet, and dramatist

Beneath trees and hedgerows the ripe mosses gleamed, and coral and amber fungi, with amanita and other hooded folk. In companies and clusters they sprang, or arose misshapen, sinister, and alone. Some were orange and orange-tawny; others white and purple; not a few peered forth livid, blotched, and speckled, as with venom spattered from some reptile's jaw.

*Children of the Mist*

Book IV, Chapter VII (p. 440)

G.P. Putnam's Sons. New York, New York, USA. 1899

Now the ruin fades back into nature like a cloud and peers ill-favouredly from lush green things. Great umbel-bearing plants, blackthorns, and briars strive to bury each lower wall; hart's tongue ferns loll from the empty joint-holes; fungus lifts its livid cowls beneath.

*The Farm of the Dagger*

Chapter I (p. 5)

Dodd, Mead &amp; Co. New York, New York, USA. 1904

**Shelley, Percy Bysshe** 1792–1822

English poet

And plants at whose name the verse feels loath,  
Fill'd the place with a monstrous undergrowth,  
Prickly and pulpous, and blistering, and blue, Livid, and  
starr'd with a lurid dew.

And agarics, and fungi, with mildew and mould,  
Started like mist from the wet ground cold; Pale, fleshy,  
as if the decaying dead

With a spirit of growth had been animated.

*The Poetical Works of Percy Bysshe Shelley*

The Sensitive Plant (p. 256)

Edward Moxon. London, England. 1839

**Spenser, Edmund** 1552–99

English poet

Working her formall rowmes in wexen frame,  
The grieslie Tode-stoole growne there mought I se  
And loather Paddocks lording on the same.

In Thomas Humphry Ward

*The English Poets: Selections With Critical Introductions* (Volume 1)

The Complaint of Age

The Macmillan Co. New York, New York, USA. 1920

**Verne, Jules** 1828–1905

French novelist

In truth, I was simply in the presence of a very ordinary product of the earth, of singular and gigantic proportions. My uncle unhesitatingly called them by their real names. "It is only," he said, in his coolest manner, "a forest of mushrooms."

*A Journey to the Center of the Earth*

Chapter XXVII

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

We crawled through stony ravines – amidst fungi that ripped like thin bladders at our thrust, emitting a watery humour, over a perfect pavement of things like puff-balls, and beneath intermingable thickets of scrub. And ever more hopelessly our eyes sought for our abandoned sphere.

*The First Men in the Moon*

Chapter XI (p. 115)

Houghton Mifflin &amp; Co. New York, New York, USA. 1917

And all this time the lunar plants were growing around us, higher and denser and more entangled, every moment thicker and taller, spiked plants, green cactus masses, fungi, fleshy and lichenous things, strangest radiate and sinuous shapes.

*The First Men in the Moon*

Chapter IX (p. 104)

George Newnes, Ltd. London, England. 1901

**MUSHROOM****Ford, John** 1586–1640

English poet and dramatist

I am... a mushroom

On whom the dew of heaven drops now and then.

*The Dramatic Works of John Ford* (Volume 1)

The Broken Heart (p. 132)

John Murray. London, England. 1831

**TOADSTOOL****Learned, Walter** 1847–915

American poet

Five little white heads peeped out of the mold,  
When the dew was damp and the night was cold;  
And they crowded their way through the soil pride;  
"Hurrah! We are going to be mushrooms!" they cried.

But the sun came up, and the sun shone down,  
And the little white heads were withered and brown;  
Long were their faces, their pride had a fall –  
They were nothing but toad-stools, after all.

*Between Times* (3rd edition)

Five Little White Heads

Frederick A. Stokes Co. New York, New York, USA. 1841

**GRASS****Hudson, William Henry**

Argentinean/English ornithologist, naturalist, and author

I am not a lover of lawns; on the contrary, I regard them, next to gardens, as the least interesting adjuncts of the country-house. Grass, albeit the commonest, is yet one of the most beautiful things in Nature when allowed to grow

as Nature intended, or when not too carefully trimmed and brushed. Rather would I see daisies in their thousands, ground ivy, hawkweed, and even the hated plantain with tall stems, and dandelions with splendid flowers and fairy down, than the too-well-tended lawn grass.

*The Book of A Naturalist*

Chapter XXIX (p. 337)

George H. Doran Co. New York, New York, USA. 1919

**Ingalls, John James** 1833–1900

American politician and author

Forests decay, harvests perish, flowers vanish, but grass is immortal.

In David Josiah Brewer

*The World's Best Essays, from the Earliest Period to the Present Time*

(Volume 6)

Blue Grass (p. 2293)

Ferd P. Kaiser. St. Louis, Missouri, USA. 1910

Beleaguered by the sullen hosts of winter, it [grass] withdraws into the impregnable fortress of its subterranean vitality, and emerges upon the first solicitation of spring.

In David Josiah Brewer

*The World's Best Essays, from the Earliest Period to the Present Time*

(Volume 6)

Blue Grass (p. 2293)

Ferd P. Kaiser. St. Louis, Missouri, USA. 1910

Grass is the forgiveness of nature – her constant benediction. Fields trampled with battle, saturated with blood, torn with the ruts of cannon, grow green again with grass, and carnage is forgotten.

In David Josiah Brewer

*The World's Best Essays, from the Earliest Period to the Present Time*

(Volume 6)

Blue Grass (p. 2293)

Ferd P. Kaiser. St. Louis, Missouri, USA. 1910

## HAWKWEED

**Gissing, George** 1857–1903

English novelist

For scientific classification I have little mind; it does not happen to fall in with my habits of thought; but I like to be able to give its name (the “trivial” by choice) to every flower I meet in my walks. Why should I be content to say, “Oh, it’s a hawkweed”? That is but one degree less ungracious than if I dismissed all the yellow-rayed as “dandelions.” I feel as if the flower were pleased by my recognition of its personality. Seeing how much I owe them, one and all, the least I can do is to greet them severally. For the same reason I had rather say “hawkweed” than “hieracium”; the homelier word has more of kindly friendship.

*The Private Papers of Henry Ryecroft* (pp. 147–148)

E.P. Dutton & Co. New York, New York, USA. 1903

## LICHEN

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...lichens which are so thin are described in the *dry* state, as they are most commonly, not most truly seen. They are, indeed, *dryly* described.

In Harrison Gray Otis Blake (ed.)

*The Writings of Henry David Thoreau*

March 23, 1853 (p. 215)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

## RADISH

**Raspe, Rudolph E.**

No biographical data available

In making war, their principal weapons are radishes, which are used as darts. Those who are wounded by them die immediately. Their shields are made of mushrooms, and their darts (when radishes are out of season) of the tops of asparagus.

*Baron Munchausen's Narrative of his Marvellous Travels and Campaigns in Russia, etc.*

Chapter XVIII (p. 72)

Trübner & Co

London, England. 1859

## SEA-WEED

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

The loosest weed that drifts and waves under the heaving of the sea, or hangs heavily on the brown and slippery shore, has a marked strength, structure, elasticity, gradation of substance; its extremities are more finely fibred than its centre, its centre than its root: every fork of its ramification is measured and proportioned; every wave of its languid lines is love. It has its allotted size, and place, and function: it is a specific creature.

*The Seven Lamps of Architecture*

Chapter IV (pp. 111–112)

George Allen. Kent, England. 1880.

## TREE

**Abbey, Edward** 1927–89

American environmentalist and nature writer

...unless the need were urgent, I could no more sink the blade of an ax into the tissues of a living tree than I could drive it into the flesh of a fellow human.

*The Journey Home: Some Words in Defense of the American West*

Chapter 19 (p. 208)

E.P. Dutton. New York, New York, USA. 1977

**Author undetermined**

At that awful hour of the Passion, when the Savior of the world felt deserted in His agony, when –  
The sympathizing sun, his light withdrew, and wonder'd how the stars their dying Lord could view – when earth shaking with horror, rung the passing bell for Deity, and universal nature groaned, then from the loftiest tree to the lowliest flower all felt a sudden thrill, and trembling, bowed their heads, all save the proud and obdurate aspen, which said, “Why should we weep and tremble, we trees, and plants, and flowers are pure and never sinned!”  
Ere it ceased to speak, an involuntary trembling seized its every leaf, and the word went forth that it should never rest, but tremble on until the day of judgment.

Legend [of the quaking aspen tree]

*Notes and Queries*, First Series, Volume 6, Number 161

**Bailey, William Whitman** 1843–1914

American botanist

Nature is especially fond of tassels. With them she clothes many of her noblest trees.

Willows: “Pussy” and Other

*The American Botanist*, Volume VI, Number 2, February, 1904 (p. 23)

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

Of all formal things in the world, a clipped hedge is the most formal; and of all the informal things in the world, a forest-tree is the most informal.

*Royal Truths*

Royal Truths (p. 89)

Fords, Howard & Hulbert. New York, New York, USA. 1887

**Borland, Hal** 1900–78

American writer

Trees are the oldest living things we know. Rooted in the earth and reaching for the stars, they partake of immortality.

*Our Natural World*

The Woodlands (p. 4)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1969

Only the unobservant sees nothing but trees in a forest. Any woodland is a complex community of plants and animal life with its own laws of growth and survival. But if you would know strength and majesty and patience, welcome the company of trees.

*Beyond Your Doorstep: A Handbook to the Country*

Chapter 4 (p. 75)

Alfred A. Knopf. New York, New York, USA. 1962

**Bronte, Emily** 1818–48

English novelist

My love for Linton is like the foliage in the woods. Time will change it, I'm well aware, as winter changes

the trees – my love for Heathcliff resembles the eternal rocks beneath – a source of little visible delight, but necessary.

*Wuthering Heights*

Chapter IX (p. 88)

J.M. Dent & Sons Ltd. London, England. 1907

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

Trees that, like the poplar, lift upwards all their boughs, give no shade and no shelter, whatever their height. Trees that most lovingly shelter and shade us, when, like the willow, the higher soar their summits, the lowlier droop their boughs.

*What Will He Do with It?* (Volume 2)

Book XI, Chapter X, Introductory lines (p. 359)

P.F. Collier & Son. New York, New York, USA. 1902

**Burns, Robert** 1759–96

English author

Green, slender, leaf-clad holly-boughs  
Were twisted graceful', round her brows;  
I took her for some Scottish Muse,  
By that same token;  
And come to stop those reckless vows,  
Would soon be broken.

*The Complete Poetical Works of Robert Burns*

The Vision, Duan First, Stanza 9

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

Dark tree – still sad when others' grief is fled,  
The only constant mourner o'er the dead!

*The Complete Poetical Works of Byron*

The Giaour, l. 286

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Comstock, Anna Botsford** 1854–1930

American illustrator, writer, and educator

The mortal who has never enjoyed a speaking acquaintance with some individual tree is to be pitied; for such an acquaintance, once established, naturally ripens into a friendliness that brings serene comfort to the human heart, whatever the heart of the tree may or may not experience. To those who know them, the trees, like other friends, seem to have their periods of reaching out for sympathetic understanding. How often this outreaching is met with repulse will never be told; for tree friends never reproach us – but wait with calm patience for us to grow into comprehension.

*Trees at Leisure*

Comstock Publishing Company. Ithaca, New York, USA. 1916



**Dampier-Whetham, William** 1867–1952  
English scientific writer

There was a young man who said, “God  
To you it must seem very odd  
That a tree as a tree simply ceases to be  
When there’s no one about in the Quad.”...  
Young man, your astonishment’s odd,  
I am always about in the Quad  
And that’s why the tree continues to be  
As observed by, Yours faithfully, God.  
In Joseph Needham and Walter Pagel (eds.)  
*Background to Modern Science*  
From Aristotle to Galileo (pp. 40–41)  
The Macmillan Company. New York, New York, USA. 1938

**Dickens, Charles** 1812–70  
English novelist

They whirled past the dark trees, as feathers would be swept before a hurricane. Houses, gates, churches, haystacks, objects of every kind they shot by, with a velocity and noise like roaring waters suddenly let loose. Still the noise of pursuit grew louder, and still my uncle could hear the young lady wildly screaming, “Faster! Faster!”  
*The Posthumous Papers of the Pickwick Club*  
Chapter XLIX (p. 597)  
Dodd, Mead & Company. New York, New York, USA. 1944

The earth covered with a sable pall as for the burial of yesterday; the clumps of dark trees, its giant plumes of funeral feathers, waving sadly to and fro: all hushed, all noiseless, and in deep repose, save the swift clouds that skim across the moon, and the cautious wind, as, creeping after them upon the ground, it stops to listen, and goes rustling on, and stops again, and follows, like a savage on the trail.  
*Martin Chuzzlewit*  
Chapter XV (p. 232)  
Dodd, Mead & Company. New York, New York, USA. 1944

**Downing, Andrew Jackson** 1815–52  
American writer

If our ancestors found it wise and necessary to cut down vast forests, it is all the more needful that their descendants should plant trees. We shall do our part, therefore, towards awakening again, that natural love of trees, which this long warfare against them – this continual laying the axe at their roots...has, in so many places, well nigh extinguished.  
*Rural Essays*  
*Trees*  
Chapter IV (p. 304)  
Leavitt & Allen. New York, New York, USA. 1858

**Forster, E. M. (Edward Morgan)** 1879–1970  
English novelist

What is the good of your stars and trees, your sunrise and the wind, if they do not enter into our daily lives?

*Howards End*  
Chapter XVI (p. 143)  
Vintage Books. New York, New York, USA. 1954

The tree rustled. It had made music before they were born, and would continue after their deaths, but its song was of the moment.  
*Howards End*  
Chapter XL (p. 315)  
Vintage Books. New York, New York, USA. 1954

**Gerard, Olf**  
No biographical data available

Graft, set, plant and nourish fruit trees in every corner of your grounds, and God shall reward your mind and diligence.  
Quoted in J.C. Austin  
President’s Annual Address  
*The Minnesota Horticulturalist*, Volume 27, Number 8, August, 1899 (p. 284)

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

To dwellers in a wood almost every species of tree has its voice as well as its feature. At the passing of the breeze the fir-trees sob and moan no less distinctly than they rock; the holly whistles as it battles with itself; the ash hisses amid its quiverings; the beech rustles while its flat boughs rise and fall.  
*Under the Greenwood Tree; or The Mellstock Quire*  
Part the First, Chapter I (p. 3)  
Harper & Brothers. New York, New York, USA. 1939

The instinctive act of humankind was to stand and listen, and learn how the trees on the right and the trees on the left wailed or chaunted to each other in the regular antiphonies of a cathedral choir; how hedges and other shapes to leeward then caught the note, lowering it to the tenderest sob; and how the hurrying gust then plunged into the south, to be heard no more.  
*Far from the Madding Crowd*  
Chapter 2 (p. 9)  
Harper & Row, Publishers. New York, New York, USA. No date

**Hay, John**  
No biographical data available

They [trees] hang on from a past no theory can recover. They will survive us. The air makes their music. Otherwise they live in savage silence, though mites and nematodes and spiders teem at their roots, and though the energy with which they feed on the sun and are able to draw water sometimes hundreds of feet up their trunks and into their twigs and branches calls for a deafening volume of sound.  
*The Undiscovered Country*  
Living with Trees (p. 110)  
W.W. Norton & Company, Inc. New York, New York, USA. 1981

**Herbert, George** 1593–1633  
English metaphysical poet

Great trees are good for nothing but shade.

*Outlandish Proverbs*

Printed by T. Maxey for T. Garthwait. London, England. 1651

**Howitt, William** 1792–1879

English author

David in his psalms, Solomon in his songs and proverbs, the Prophets in the sublime outpourings of their awful inspiration, and Christ in his parables, those most beautiful and perfect of all allegories, luxuriate in signs and similes drawn from the fair trees of the East.

*The Book of the Seasons*

October (p. 356)

Henry Colburn & Richard Bentley. London, England. 1831

**Hutton, W.**

No biographical data available

Trees – Those stupendous specimens of creating art spread not their wide extended roots, nor lift their lofty heads in vain. Beneath their cooling shades, our flocks and herds find a comfortable asylum from the scorching rays of the summer sun; the wild stragglers of the forest have a place of refuge among their woods and thickets; whilst the feathery songsters of the grove build their little dwellings in security, and sing among their branches ...

*The Book of Nature Laid Open, in a Popular Survey of the Phenomena and Constitution of the Universe*

Chapter IV (p. 30)

J. Milligan. Georgetown, District of Columbia. 1822

**Irving, Washington** 1783–1859

American essayist and short story writer

It was...a fine autumnal day; the sky was clear and serene, and nature wore that rich and golden livery which we always associate with the idea of abundance. The forests had put on their sober brown and yellow, while some trees of the tenderer kind had been nipped by the frosts into brilliant dyes of orange, purple, and scarlet.

*Essays from the Sketch Book*

The Legend of Sleepy Hollow (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Leopold, Aldo** 1886–1948

American naturalist

What kind of a wood lot or forest fauna can we support if every important tree species has to be sprayed in order to live?

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

The Outlook for Farm Wildlife (p. 325)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**Llywelyn, Morgan** 1937–

American-born Irish author

Each tree has its own name and its own personality.... You have only to touch them and open your mind. Make

your mind empty of all things that are about you, blank as a blue sky, and wait for the tree to give you its thoughts.

*Lion of Ireland*

Chapter Six (p. 55)

Tom Doherty Associates. New York, New York, USA. 2002

**Malan, Solomon Caesar** 1812–94

British divine and orientalist

Trees are the ornament of Nature ...

*Aphorisms on Drawing*

XLIX (p. 47)

Longman, Brown, Green, Longmans & Roberts. London, England. 1856

**Melville, Herman** 1819–91

American novelist

For, as when the red-cheeked, dancing girls, April and May, trip home to the wintry, misanthropic woods; even the barest, ruggedest, most thunder-cloven old oak will at least send forth some few green sprouts, to welcome such glad-hearted visitants...

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 28 (p. 91)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Milton, John** 1608–74

English poet

Awake, the morning shines, and the fresh field  
Call us; we lose the prime, to mark how spring  
Our tended Plants, how blows the Citron Grove,  
What drops the Myrrhe, & what the balmie Reed,  
How Nature paints her colours, how the Bee  
Sits on the Bloom, extracting liquid sweet.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book V, l. 20–25

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Morris, George P.**

No biographical data available

Woodman, spare that tree!  
Touch not a single bough!  
In youth it sheltered me,  
And I'll protect it now.

*Poems*

Woodman, Spare that Tree

Charles Scribner's Sons. New York, New York, USA. 1853

**Muir, John** 1838–1914

American naturalist

I never saw a discontented tree. They grip the ground as though they liked it; and though fast rooted, they travel about as far as we do.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter VII, Section 2, June-July 1890 (p. 313)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

When a man plants a tree he plants himself.

*Steep Trails*

Chapter X (p. 141)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

We all travel the milky way together, trees and men; but it never occurred to me until this stormday, while swinging in the wind, that trees are travelers, in the ordinary sense. They make many journeys, not extensive ones, it is true; but our own little journeys, away and back again, are only little more than tree wavings, many of them not so much.

*Mountains of California*

Chapter X (p. 256)

The Century Company. New York, New York, USA. 1911

The mighty trees getting their food are seen to be wide awake, every needle thrilling in the welcome nourishing storms, chanting and bowing low in glorious harmony, while every raindrop and snowflake is seen as a beneficent messenger from the sky.

*Our National Parks*

Chapter I (p. 26)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

As far as man is concerned [trees] are the same yesterday, today, and forever, emblems of permanence.

*Our National Parks*

Chapter IX (p. 269)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...many of nature's five hundred kinds of wild trees had to make way for orchards and cornfields.

*Our National Parks*

Chapter IX (p. 335)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but he cannot save them from fools, only Uncle Sam can do that.

*Our National Parks*

Chapter X (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

...it is not in the sapwood or the heartwood or the bark that the life of a tree resides. But wherever and whatever that life is, it must be of such a nature that it is possible to kill it all at the same time, and instantly. A head, a heart, a central organization of any sort, nerves, and consciousness, a tree does not own. But something runs in it that is vital, that, when it disintegrates, leaves the great body untenanted, a corpse, and departing sets the gates ajar to every sort of invader that will then march in for the sack, waving the dingy cobweb banners of decay.

*Flowering Earth*

Chapter 5 (p. 52)

G.P. Putnam's Sons. New York, New York, USA. 1939

A Tree in its old age is like a bent but mellowed and wise old man; it inspires our respect and tender admiration; it is too noble to need our pity.

*An Almanac for Moderns*

October Twenty-Seventh (p. 241)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Pownall, Thomas** 1722–1805

English statesman and soldier

The individual Trees of those Woods grow up, have their Youth, their old Age, and a Period to their Life, and die as we Men do. You will see many a Sapling growing up, many an old Tree tottering to its Fall, and many fallen and rotting away, while they are succeeded by others of their Kind, just as the Race of Man is: By this Succession of Vegetation this Wilderness is kept cloathed with Woods just as the human Species keeps the Earth peopled by its continuing Succession of Generations.

*A Topographical Description of the Dominions of the United States*

Section I, On the Face of the Country (p. 24)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1949

**Proust, Marcel** 1871–1922

French novelist

We have nothing to fear and a great deal to learn from trees, that vigorous and pacific tribe which without stint produces strengthening essences for us, soothing balms, and in whose gracious company we spend so many cool, silent and intimate hours.

Translated by Louise Varèse

*Pleasures and Regrets*

Regrets, Reveries, Changing Skies, Chapter XXVI (p. 165)

Crown Publishers. New York, New York, USA. 1948

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

...perhaps the first question which an intelligent child would think of asking about a tree: "Mamma, how does it make its trunk?", and you may open one botanical work after another, and good ones too, and by sensible men – you shall not find this child's question fairly put, much less fairly answered.

*Modern Painters* (Volume 5)

Part VI, Chapter 7

John Wiley & Sons. New York, New York, USA. 1879

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

But I am a blasted tree; the bolt has entered my soul; and I felt then that I should survive to exhibit what I shall soon cease to be – a miserable spectacle of wrecked humanity, pitiable to others and intolerable to myself.

*Frankenstein*

Chapter 19 (p. 114)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**St. Bernard of Clairvaux** 1091–1153

French monk

Believe me who have tried. Thou wilt find something more in woods than in books. Trees and rocks will teach what thou canst not hear from a master.

*Epistle 106*

Source undetermined

**The Bible (King James Version)**

I will plant in the wilderness the cedar, the shittah tree, and the myrtle, and the oil tree; I will set in the desert the fir tree, and the pine, and the box tree together: ...

Isaiah 41:19

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

On every side there is something to soothe and refresh this sense. Look up at the tree-tops and see how finely Nature finishes off her work there. See how the pines spire without end higher and higher, and make a graceful fringe to the earth. And who shall count the finer cobwebs that soar and float away from their utmost tops, and the myriad insects that dodge between them. Leaves are of more various forms than the alphabets of all languages put together; of the oaks alone there are hardly two alike, and each expresses its own character.

*A Week on the Concord and Merrimack Rivers*

Monday (p. 115)

Charles Scribner's Sons. New York, New York, USA. 1921

Trees are but rivers of sap and woody fibre flowing from the atmosphere and emptying in to the earth by their trunks – as their roots flow upward to the surface.

In Robert Sattelmeyer (ed.)

*Journal 1842–1848* (Volume 2)

Tuesday September 3 (p. 33)

Princeton University Press. Princeton, New Jersey, USA. 1984

**Wordsworth, William** 1770–1850

English poet

Of vast circumference and gloom profound  
This solitary Tree! a living thing  
Produced too slowly ever to decay;  
Of form and aspect too magnificent  
To be destroyed.

*The Complete Poetical Works of William Wordsworth*

Yew-Trees

Crowell. New York, New York, USA. 1888

**ACACIA****Barrett-Browning, Elizabeth** 1806–61

English poet

A great acacia with its slender trunk  
And overpoise of multitudinous leaves

(In which a hundred fields might spill their dew  
And intense verdure, yet find room enough)  
Stood reconciling all the place with green.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book VI, l. 536–541

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**ACORN****Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

... the russet acorn,

Fruit beloved by maid and boy.

*Holidays*

Stanza I

**ALMOND****Arnold, Sir Edwin** 1832–1904

English poet

Almond blossom, sent to teach us

That the spring days soon will reach us.

*Poems*

Almond Blossoms

Roberts Brothers. Boston, Massachusetts, USA. 1880

**Spenser, Edmund** 1552–99

English poet

Like to an almond tree mounted hie

On top of greene Selinis all alone,

With blossoms brave bedecked daintily;

Whose tender locks do tremble everyone,

At everie little breath, that under heaven is blowne.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book I, Canto VII, Stanza 32

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**APPLE****Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

The apple-tree is tough as an Indian, patient as an ox, and fruitful as the Jewish Rachael.

In William Drysdale (ed.)

*Proverbs from Plymouth Pulpit*

Nature (p. 9)

D. Appleton &amp; Co. New York, New York, USA. 1887

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

And what is more melancholy than the old apple-trees  
that linger about the spot where once stood a homestead,  
but where there is now only a ruined chimney rising out

of a grassy and weed-grown cellar? They offer their fruit to every wayfarer – apples that are bitter-sweet with the moral of time’s vicissitude.

*Mosses from an Old Manse: The Procession of Life*  
The Old Manse (p. 8)

A.L. Burt Company, Publishers. New York, New York, USA. No date

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

It is remarkable how closely the history of the apple tree is connected with that of man.

*The Writings of Henry David Thoreau* (Volume 9)  
Wild Apples (p. 356)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

## APRICOT

**Tennyson, Frederick** 1807–98

English poet

Rich apricots, that breathed of mountain flowers.

*Daphne, etc.*

*Hesperides, Hesperia*

Macmillan & Co. New York, New York, USA. 1891

## ASH

**Lowell, James Russell** 1819–91

American poet, critic, and editor

The ash her purple drops forgivingly  
And sadly, breaking not the general hush;  
The maple’s swamps glow like a sunset sea,  
Each leaf a ripple with its separate flush;  
All round the wood’s edge creeps the skirting blaze,  
Of bushes low, as when, on cloudy days,  
Ere the rain falls, the cautious farmer burns his brush.

*The Poetical Works of James Russell Lowell*

An Indian-Summer Reverie, 11

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

## ASPEN

**Ingemann, Bernhard S.** 1789–1862

Danish poet and novelist

What whispers so strange at the hour of midnight,  
From the aspen leaves trembling so wildly?  
Why in the lone wood sings it sad, when the bright  
Full moon beams upon it so mildly?

In George Barrow

*The Songs of Scandinavia and Other Poems and Ballads* (Volume 2)

The Aspen

Constable & Company Ltd. London, England. 1923

**Leyden, John** 1775–1811

Scottish poet

Beneath a shivering canopy reclined,  
Of aspen leaves that wave without a wind,

I love to lie, when lulling breezes stir  
The spiry cones that tremble on the fir.

*The Poetical Works of Dr. John Leyden*

Scenes of Infancy

W.P. Nimmo. London, England. 1875

**Moore, Thomas** 1779–1852

Irish poet

And the wind, full of wantonness, woos like a lover  
The young aspen-trees till they tremble all over.

*The Poetical Works of Thomas Moore*

Lalla Rookh, Light of the Harem

Lee & Shepard. Boston, Massachusetts, USA. 1873

## BANYON

**Bryant, Alice Franklin** 1900–77

No biographical data available

Like a cathedral in some old world town  
Rising above all mundane buildings, rears  
The banyan tree, a growth of long slow years,  
Towering above the palms. Its verdant crown  
Fashions a far-spread roof, from which falls down  
A diamond and tinted light with jeweled spears  
Of sunbeam piercing through. The whole appears  
An ornate Gothic pile of world renown.

The Banyan Tree

*Nature Magazine*, Volume 50, Number 5, May, 1957 (p. 265)

## BAOBAB

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

Now there were some terrible seeds on the planet that was the home of the little prince; and these were the seeds of the baobab. The soil of that planet was infested with them. A baobab is something you will never, never be able to get rid of if you attend to it too late. It spreads over the entire planet. It bores clear through it with its roots. And if the planet is too small, and the baobabs are too many, they split it to pieces...

Translated by Katherine Woods

*The Little Prince*

Chapter V (p. 21)

Harcourt, Brace & Company. New York, New York, USA. 1943

## BEECH

**Campbell, Thomas** 1777–1844

Scottish poet

Oh, leave this barren spot to me!  
Spare, woodman, spare the beechen tree!

*The Complete Poetical Works*

The Beech-Tree’s Petition, Stanza I

Chadwyck-Healey. Cambridge, England. 1992

**BUR OAK**

**Leopold, Aldo** 1886–1948  
American naturalist

Have you ever wondered why a thick crust of corky bark covers the whole tree (bur oak), even to the smallest twigs? This cork is armor. Bur oaks were the shock troops sent by the invading forest to storm the prairie; fire is what they had to fight.... Engineers did not discover insulation; they copied it from these old soldiers of the prairie war.

*A Sand County Almanac*

April (pp. 26–27)

Oxford University Press. New York, New York, USA. 1987

**BIRCH**

**Lowell, James Russell** 1819–91  
American poet, critic, essayist, editor, and diplomat

Rippling through thy branches goes the sunshine,  
Among thy leaves that palpitate forever,  
And in the, a pining nymph had prisoned.  
The soul, once of some tremulous inland river,  
Quivering to tell her woe, but ah! Dumb, dumb forever.

*The Poetical Works of James Russell Lowell*

The Birch Tree

Houghton Mifflin Co. Baltimore, Maryland, USA. 1891

**CHERRY**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Sweet is the air with the budding haws, and the valley  
stretching for miles below  
Is white with blossoming cherry-trees, as if just covered  
with lightest snow.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 5)

Christus, Golden Legend

Part IV (p. 265)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**CHESTNUT**

**Ingelow, Jean** 1820–97  
English poet and novelist

And when I see the chestnut letting  
All her lovely blossoms falter down, I think  
“Alas the day!”

*Poems*

The Warbling of Blackbirds

Longmans, Green, Reader & Dyer. London, England. 1867

**COCONUT**

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

I once heard a grouchy Northern invalid say that a coconut tree might be poetical, possibly it was; but it looked like a feather-duster struck by lightning.

*Roughing It* (Volume 2)

Chapter XVIII (p. 215)

Harper & Brothers. New York, New York, USA. 1899

**DURIAN**

**Hamilton, Alexander** 1755–1804  
American political philosopher

The *Durean* is another excellent Fruit, but offensive to some Peoples Noses, for it smell very much like human Excrements, but when once tasted, the Smell vanishes.

*A New Account of the East Indies* Volume 2

Chapter XXXIX (p. 82)

Printed by John Mosman. Edinburgh, Scotland. 1727

**ELM**

**Tennyson, Alfred (Lord)** 1809–92  
English poet

In crystal vapour everywhere  
Blue isles of heaven laugh'd between,  
And far, in forest-deeps unseen,  
The topmost elm-tree gather'd green  
From draughts of balmy air.

*Alfred Tennyson's Poetical Works*

Sir Lancelot and Queen Guinevere, Stanza I

Oxford University Press, Inc. London, England. 1953

**EVERGREEN**

**Joubert, Joseph** 1754–1824  
French moralist

I never like evergreen trees. There is something black in their green and cold in their shade, something dry, pointed and prickly in their leaves. As besides, they lose nothing and have nothing to fear, they seem to me without feeling, and therefore interest me little.

Translated by Katharine Lyttelton

*Joubert*

#12 (p. 118)

Dodd, Mead & Co. New York, New York, USA. 1899



**HEMLOCK**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

O hemlock-tree!  
O hemlock-tree!  
how faithful  
are thy branches!  
Green not alone in summer time,  
But in the winter's frost and rime!  
O hemlock-tree! O hemlock-tree! how faithful  
are thy branches!

*The Complete Writings of Henry Wadsworth Longfellow (Volume 6)*  
The Hemlock Tree  
Stanza 1  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**LARCH**

**Hemans, Felicia D.** 1793–1835  
English poet

I have looked on the hills of the stormy North,  
And the larch has hung all his tassels forth...  
*The Poetical Works of Mrs. Felicia Hemans*  
The Voice of Spring, Stanza 3  
Crosby, Nichols, Lee & Company. Boston, Massachusetts, USA. 1860

**LIME**

**Heine, Heinrich** 1797–1856  
German poet

If thou lookest on the lime-leaf,  
Thou a heart's form wilt discover;  
Therefore are the lindens ever  
Chosen seats of each fond lover.  
*The Book of Songs*  
New Spring, Number 23, Stanza 3 (p. 110)  
The Roycrofters. East Aurora, New York, USA. 1903

**LINDEN**

**Morris, William** 1834–96  
Poet

And at the corners stood great linden-trees,  
Humed over by innumerable bees.  
*The Life and Death of Jason: A Poem*  
Line 489–490 (p. 31)  
Bell & Daldy. London, England. 1868

**LOTOS**

**Hayne, Paul H.** 1830–1886  
American poet

Where drooping lotos-flowers, distilling balm,

Dream by the drowsy streamlets sleep hath crown'd,  
While Care forgets to sigh, and Peace hath balsamed  
Pain.

*Sonnets, and Other Poems*  
Pent in this Common Sphere  
Harper & Calvo. Charleston, South Carolina, USA. 1857

**Pope, Alexander** 1688–1744  
English poet

A spring there is, whose silver waters show  
Clear as a glass the shining sands below:  
A flowering lotos spreads its arms above,  
Shades all the banks, and seems itself a grove.

*The Complete Poetical Works*  
Sappho to Phaon, l. 177  
Houghton Mifflin Company. New York, New York, USA. 1903

**MAHOGANY**

**Thackeray, William Makepeace** 1811–63  
English writer

Christmas is here;  
Winds whistle shrill,  
Icy and chill,  
Little care we;  
Little we fear  
Weather without,  
Sheltered about  
The Mahogany-Tree.  
*The Complete Poems of W.M. Thackeray*  
The Mahogany-Tree  
White, Stokes & Allen. New York, New York, USA. 1884

**MANGROVE**

**Arnold, Sir Edwin** 1832–1904  
English poet and journalist

Maple-trees are the cows of trees (spring-milked), plain,  
good, useful, but not adorable.  
*The Voyage of Ithobal*  
The Fourth Day  
John Murray. London, England. 1901

**MAPLE**

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

Maple-trees are the cows of trees (spring-milked), plain,  
good, useful, but not adorable.  
In William Drysdale (ed.)  
*Proverbs from Plymouth Pulpit*  
Nature (p. 10)  
D. Appleton & Co. New York, New York, USA. 1887

**English, Thomas Dunn** 1819–1902  
American lawyer, physician, and poet

That was a day of delight and of wonder,  
While lying the shade of the maple-trees under –  
He felt the soft breeze at its frolicsome play;  
He smelled the sweet odor of newly mown hay...

*The Select Poems of Dr. Thomas Dunn English*

Under the Trees

Published by private subscription. Newark, New Jersey, USA. 1894

## OAK

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

The monarch oak, the patriarch of the trees,  
Shoots rising up, and spreads by slow degrees.  
Three centuries he grows, and three he stays  
Supreme in state; and in three more decays.

*The Poetical Works of Dryden*

Tales from Chaucer, Palamon and Arcite, Book III, l. 1058

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**King, Thomas Starr** 1824–64

American Unitarian clergyman

The oak roars when a high wind wrestles with it; the  
beech shrieks; the elm sends forth a long, deep groan; the  
ash pours out moans of thrilling anguish.

*The White Hills: Their Legends, Landscape, and Poetry*

The Pemigewasset Valley and Franconia (p. 91)

Crosby & Ainsworth. Boston, Massachusetts, USA. 1866

**Muir, John** 1838–1914

American naturalist

I have seen oaks of many species in many kinds of expo-  
sure and soil, but those of Kentucky excel in grandeur  
all I had ever before beheld. They are broad and dense  
and green. In the leafy bowers and caves of their long  
branches dwell magnificent avenues of shade, and every  
tree seems to be blessed with a double portion of strong  
exulting life.

*A Thousand Mile Walk to the Gulf*

Chapter I (p. 2)

Houghton Mifflin Company. Boston Massachusetts, USA. 1916

## PALM

**Bailey, Liberty Hyde** 1858–1954

American horticulturist and botanist

The heavier palms are the big game of the plant world.

*Gentes Herbarium*

Palms, and Their Characteristics, 3, Fasc. 1

L.H. Bailey Hortorium of the New York State College of Agriculture  
and Life Sciences. Ithaca, New York, USA.

**Bomhard, Miriam L.** 1898–1952

No biographical data available

If the plant kingdom were a monarchy in which but a  
single family of plants had the heredity right to rule, the  
palms would unquestionably hold this honored position.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
(1936)

The Wax Palms (p. 303)

Government Printing Office. Washington, D.C. 1937

## PINE

**Burroughs, John** 1837–1921

American naturalist and essayist

The pine has but one idea, and that is to mount heaven-  
ward by regular steps – tree of fate, tree of dark shadows  
and of mystery.

*Signs and Seasons*

Chapter II (p. 44)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Heine, Heinrich** 1797–1856

German poet

A pine tree standeth lonely

On a far norland height:

It slumbereth, while round it

The snow falls thick and white.

*The Book of Songs*

Lyrical Interlude, Number 34 (pp. 63–64)

The Roycrofters. East Aurora, New York, USA. 1903

**Lowell, James Russell** 1819–91

American poet, critic, and editor

The pine is the mother of legends.

*The Poetical Works of James Russell Lowell*

The Growth of a Legend

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Muir, John** 1838–1914

American naturalist

Few are altogether deaf to the preaching of pine trees.  
Their sermons on the mountains go to our hearts; and  
if people in general could be got into the woods, even  
for once, to hear the trees speak for themselves, all  
difficulties in the way of forest preservation would  
vanish.

The National Parks and Forest Reservations

*Sierra Club Bulletin*, Volume 1, Number 7, January, 1896

[The Sugar Pine is] the largest, noblest, and most beauti-  
ful of all the seventy or eighty species of pine trees in the  
world....

*Our National Parks*

Chapter IV (p. 109)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Taylor, Bayard** 185–78

American poet

Ancient pines!

Ye bear no record of the years of man.

Spring is your sole historian.

*The Poems*

The Pine Forest of Monterey

Ticknor & Fields. Boston, Massachusetts, USA. 1866

**REDWOOD**

**Steinbeck, John** 1902–68  
American novelist

The redwoods once seen, leave a mark or create a vision that stays with you always. . . . It's not only their unbelievable stature, nor the color which seems to shift and vary under your eyes, no, they are not just like any trees we know, they are ambassadors from another time.

*Travels with Charley: In Search of America*

Part Three (p. 168)

The Viking Press. New York, New York, USA. 1962

**SEQUOIA**

**Muir, John** 1838–1914  
American naturalist

The Big Tree (*Sequoia gigantea*) is Nature's forest masterpiece, and, so far as I know, the greatest of living things.

*Our National Parks*

Chapter IX (p. 268)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Resolute, consummate, determined in form, always beheld with wondering admiration, the Big Tree always seems unfamiliar, standing alone, unrelated, with peculiar physiognomy, awfully solemn and earnest.

*Our National Parks*

Chapter IX (p. 272)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...they never lose their god-like composure, never toss their arms or bow or wave like the pines, but only slowly, solemnly nod and sway, standing erect, making no sign of strife, none of rest, neither in alliance nor at war with the winds, too calmly unconsciously noble and strong to strive with or bid defiance to anything.

*Our National Parks*

Chapter IX (pp. 283–284)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

There is something wonderfully attractive in this king tree, even when beheld from afar, that draws us to it with indescribable enthusiasm; its superior height and massive smoothly rounded outlines proclaiming its character in any company; and when one of the oldest attains full stature on some commanding ridge it seems the very god of the woods.

*Our National Parks*

Chapter IX (p. 287)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...Sequoias, kings of their race, growing close together like grass in a meadow, poised their brave domes and spires in the sky, three hundred feet above the ferns and lilies that enameled the ground; towering serene through the long centuries, preaching God's forestry fresh from heaven.

*Our National Parks*

Chapter IX (p. 334)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**SPICE**

**Sterling, John** 1808–44  
Irish-born writer and clergyman

The Spice Tree lives in the garden green,  
Beside it the fountain flows;  
And a fair Bird sits the boughs between,  
And sings his melodious woes.

*Poems*

The Spice Tree, Stanza 1

Edward Moxon. London, England. 1839

**TULIP**

**Bryant, William Cullen** 1794–1878  
American poet

The tulip-tree, high up,  
Opened, in airs of June, her multitude  
Of golden chalices to humming-birds  
And silken-winged insects of the sky.

*Poems*

The Fountain, Stanza 3

D. Appleton & Company. New York, New York, USA. 1874

**WILLOW**

**Hamerton, Philip Gilbert** 1834–94  
English artist and art critic

I wonder how it is that so cheerful-looking a tree as the willow should ever have become associated with ideas of sadness.

*The Sylvan Year: Leaves from the Note Book of Raoul Dubois*

Chapter XIV (p. 73)

Roberts Brothers. Boston, Massachusetts, USA. 1886

**Thackeray, William Makepeace** 1811–63  
English writer

Know ye the willow-tree,  
Whose grey leaves quiver,  
Whispering gloomily  
To yon pale river?

*The Complete Poems of W.M. Thackeray*

The Willow-Tree

White, Stokes & Allen. New York, New York, USA. 1884

**VENUS FLYTRAP**

**Butler, Samuel** 1835–1902  
British writer

There is a kind of plant that eats organic food with its flowers: when a fly settles upon the blossom, the petals

close upon it and hold it fast till the plant has absorbed the insect into its system; but they will close on nothing but what is good to eat; of a drop of rain or a piece of stick they will take no notice. Curious! that so unconscious a thing should have such a keen eye to its own interest.

*Erewhon, or, Over the Range*

Chapter XXIII (p. 238)

A.C. Fifield. London, England. 1908

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

...the stimuli [to plants] are perceived and acted upon. You may see this without benefit of lens or camera, when an insect alights on the creased blade of a Venus flytrap. The blade folds along the crease, while the insect struggles in the fatal sweet gleaming droplets that allured it. By the time that Iron Maiden of a leaf again expands, only a smear, limper than a spider's victim, is left.

*Flowering Earth*

Chapter 4 (p. 43)

G.P. Putnam's Sons. New York, New York, USA. 1939

## WEED

### Author undetermined

Weeds are useless flowers.

In John Burroughs

*Birds and Bees Essays*

Introduction (p. 6)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1914

**Bailey, William Whitman** 1843–1914

American botanist

Weeds are active enemies, not to be despised so much as hated. They are cut down or uprooted whenever found. So great a pest are they that man has taken them for a type of rank, rapid and useless growth. Yet, when curiosity leads us to observe them, we find beauty even in the meanest.

*The American Botanist*, Volume I, Number 4, October, 1901 (p. 50)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

What is a weed? A plant whose virtues have not yet been discovered...

*The Complete Works of Ralph Waldo Emerson* (Volume 11)

*Miscellanies*

Chapter XXX (p. 512)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

Perhaps, if we could penetrate Nature's secrets, we should find that what we call weeds are more essential to the well-being of the world than the most precious fruit or grain.

*Passages from the American Note-books of Nathaniel Hawthorne*

(Volume 2)

1843 (p. 176)

Smith, Elder & Co. London, England. 1868

**Larcom, Lucy** 1824–93

American writer

I like these plants that you call weeds

Sedge, hardhack, mullein, yarrow, –

That knit their roots and sow their seeds

Where any grassy wheel-track leads

Through country by-ways narrow.

I Like These Plants that You Call Weeds: Historicizing American

Women's Nature Writing

*Nineteenth Century*, Volume 58, June, 2003

**Leopold, Aldo** 1886–1948

American naturalist

To live in harmony with plants is, or should be, the ideal of good agriculture. To call every plant a weed which cannot be fed to livestock or people is, I fear, the actual practice of agricultural colleges.

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

What is a Weed? (p. 306)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Now 'tis the spring and weeds are shallow rooted;

Suffer them now and they'll outgrow the garden

And choke the herbs for lack of husbandry.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Second Part of King Henry the Sixth*

Act III, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thaxter, Celia** 1835–94

American poet

With the first faint green lines that are visible along the flower beds come the weeds, yea, and even before them; a wild, vigorous, straggling army, full of health, of strength, and a most marvelous power of growth. These must be dealt with at once and without mercy; they must be pulled up root and branch, without a moment's delay.

*An Island Garden* (p. 30)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1896

**Warner, Charles Dudley** 1829–1900

American editor and author

I scarcely dare trust myself to speak of the weeds. They grow as if the devil was in them. I know a lady, a member of the church, and a very good sort of woman, considering the subject condition of that class, who says that the weeds work on her to that extent that, in going through her garden, she has the greatest difficulty in keeping

the ten commandments in anything like an unfractured condition. I asked her which one, but she said, all of them: one felt like breaking the whole lot.

*My Summer in a Garden*

Fifth Week (pp. 44–45)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1897

## PLASMA

**Alfven, Hannes** 1908–95

Swedish physicist

The same objects [the planets] are now again in the center of science – only the questions we ask are different. We now ask how to go there, and we also ask how these bodies once were formed. And if the night sky on which we observe them is at a high latitude... we may also see in the sky an aurora, which is a cosmic plasma, reminding us of the time when our world was born out of plasma. Because in the beginning was the plasma.

*Les Prix Nobel. The Nobel Prizes in 1970*

Plasma Physics, Space Research and the (p. 316)

Origin of the Solar System

Nobel Foundation. Stockholm, Sweden. 1971

## PLASTIC

**Barthes, Roland** 1915–80

French literary critic

Despite having names of Greek shepherds (Polystyrene, Polyvinyl, Polyethylene), plastic... is in essence the stuff of alchemy.

In Ben Highmore

*The Everyday Life Reader*

Plastic (p. 306)

Routledge. London, England. 2002

In the hierarchy of the major poetic substances, it [plastic] figures as a disgraced material, lost between the effusiveness of rubber and the flat hardness of metal ...

In Ben Highmore

*The Everyday Life Reader*

Plastic (p. 306)

Routledge. London, England. 2002

...more than a substance, plastic is the very idea of its infinite transformation; as its everyday name indicates, it is ubiquity made visible.

In Ben Highmore

*The Everyday Life Reader*

Plastic (p. 306)

Routledge. London, England. 2002

## PLATE TECTONICS

**Bailey, Edward Battersby** 1881–1965

English geologist

Even those who have more sympathy with man's endeavor than with the affairs of Nature may take an interest in the Science of Tectonics. Knowledge, after all, is of human creation; and, as a rule, the knowledge of the structure of a mountain chain comes as the reward of glorious struggle, both physical and mental.

*Tectonic Essays*

Introduction (p. 1)

At The Clarendon Press. Oxford, England. 1935

**King, B. C.**

No biographical data available

**King, G. C. P.**

No biographical data available

They [plates] can't curl down; they must curl up

To form a kind of dish

To stop the oceans spilling out

And losing all the fish.

Letters to Nature

*Nature*, Volume 232, Number 5305, July 2, 1971 (p. 37)

**Ovid** 43 BCE–17 AD

Roman poet

I have myself seen what once was solid land changed into sea; and again I have seen land made from the sea.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 2)

Book XV, l. 263 (p. 383)

William Heinemann. London, England. 1916

**Ward, Peter D.**

American paleontologist

**Brownlee, Donald**

American astronomer

Plate tectonics plays at least three crucial roles in maintaining animal life: It promotes biological productivity; it promotes diversity (the hedge against mass extinction); and it helps maintain equable temperatures, a necessary requirement for animal life. It may be that plate tectonics is the central requirement for life on a planet and that it is necessary for keeping a world supplied with water.

*Rare Earth: Why Complex Life Is Uncommon in the Universe*

Most Crucial Element of the Rare Earth Hypothesis? (p. 220)

Springer-Verlag. New York, New York, USA. 2000

**Wilson, John Tuzo** 1908–93

Canadian geologist and geophysicist

Formerly, most scientists of the earth thought of as one rigid body with fixed continents and permanent ocean basins, rather scientists now consider the earth to be broken into six large plates and several smaller ones, which very slowly move and jostle one another like blocks of ice on a river that is breaking up in the spring thaw.... Each continent does not constitute one plate, but rather

each is incorporated with the surrounding ocean floor into a plate that is larger than the continent, just as a raft of logs may be frozen into a sheet of ice.

In *Scientific American*

*Readings from Scientific American*

Continents Adrift and Continents Aground

Preface (p. v)

W.H. Freeman & Company, San Francisco, California, USA. 1976

## PLAUSIBLE

### Friedman, C. S.

Writer

When one is in the presence of the seemingly impossible, that which is merely unlikely becomes more plausible by contrast.

*Black Sun Rising*

1991

## PMS

### Bates, Rhonda

No biographical data available

My doctor said “I’ve got good news and I got bad news. The good news is you don’t have Premenstrual Syndrome. The bad news is – you’re a bitch!”

In Roz Warren

*Glibquips* (p. 122)

Crossing Press, Freedom, California, USA. 1994

### Hankla, Susan

Professional writer

God grant me the serenity to change the things about me and others I cannot stand

And to stand the things about me and others I cannot change

And the insight to know the difference

Between a PMS day and a normal day

So no one gets hurt.

In Roz Warren

*Glibquips* (p. 122)

Crossing Press, Freedom, California, USA. 1994

## POINT

### Berlinski, David 1942–

American mathematician

...a point, it must be remembered, is *not* a number; holding place without size and arising whimsically whenever two straight lines are crossed, it is a geometrical object, a kind of fathomless atom out of which the line is ultimately created.

*A Tour of the Calculus*

Chapter 3 (p. 17)

Pantheon Books, New York, New York, USA. 1995

### Warner, Sylvia Townsend 1893–1978

English novelist and poet

He took out his pocket knife and whittled the end of the stick. Then he tried again.

“What is this?”

“A smaller hole.”

“Point,” said Mr. Fortune suggestively.

“Yes, I mean a smaller point.”

“No, not quite. It is a point. but it is not smaller. Holes may be of different sizes, but no point is larger or smaller than another point.”

*Mr. Fortune’s Maggot*

Mr. Fortune’s Maggot (p. 108)

New York Review of Books, New York, New York, USA. 1927

...if a given point were not in a given place it would not be there at all.

*Mr. Fortune’s Maggot*

Mr. Fortune’s Maggot (p. 110)

New York Review of Books, New York, New York, USA. 1927

## POINT OF VIEW

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

No point of view has absolute, permanent validity. Each has importance only for some given end.

*The Analysis of Sensations and the Relation of the Physical to the Psychological*

Chapter I (p. 37)

The Open Court Publishing Company, Chicago, Illinois, USA. 1914

He who knows only one view or one form of a view does not believe that another has ever stood in its place, or that another will ever succeed; he neither doubts nor tests.

*History and Root of the Principle of the Conservation of Energy*

Chapter I (p. 17)

The Open Court Publishing Company, Chicago, Illinois, USA. 1911

## POLAR REGION

### Nansen, Fridtjof 1861–1930

Norwegian explorer, scientist, and diplomat

Unseen and untrodden under their spotless mantle of ice the rigid polar regions slept the profound sleep of death from the earliest dawn of time. Wrapped in his white shroud, the mighty giant stretched his clammy ice-limbs abroad, and dreamed his age-long dreams. Ages passed – deep was the silence.

*Farthest North* (Volume 1)

Chapter I (p. 1)

Harper & Brothers Publishers, New York, New York, USA. 1898



**POLARITY****Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Polarity, or action and reaction, we meet in every put of nature; in darkness and light; in heat and cold; in the ebb and flow of waters; in male and female; in the inspiration and expiration of plants and animals; in the equation of quantity and quality in the fluids of the animal body; in the systole and diastole of the heart; in the undulations of fluids and of sound; in the centrifugal and centripetal gravity; in electricity, galvanism, and chemical affinity.

*The Works of Ralph Waldo Emerson**Essays*

Essay III (p. 78)

Macmillan &amp; Company Ltd. London, England. 1883

**POLARIZATION****Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

When we make the photon meet a tourmaline crystal, we are subjecting it to an observation. We are observing whether it is polarised parallel or perpendicular to the optic axis. The effect of making the observation is to force the photon entirely into the state of perpendicular polarisation. It has to make a sudden jump from being partly in each of these two states to being entirely in one or other of them. Which of the two states it will jump into cannot be predicted, but is governed only by probability laws. If it jumps into the perpendicular state it passes through the crystal and appears on the other side preserving this state of polarisation.

*The Principles of Quantum Mechanics*

Chapter I (p. 7)

Oxford University Press. Oxford, England. 1981

**POLLUTION****Abbey, Edward** 1927–89

American environmentalist and nature writer

Our world is so full of beautiful things: fruit and ideas and women and good men and banjo music and onions with purple skins. A virtual Paradise. But even Paradise can be damned, flooded, overrun, generally mucked up by fools in pursuit of paper profits and plastic happiness.

*Down the River*

Part II, Chapter 8 (p. 233)

E.P. Dutton. New York, New York, USA. 1982

**Ames, Bruce** 1928–

American biochemist

We are living in a sea of chemicals that have not been tested for mutagenicity or carcinogenicity.

In Roger Lewin

*Cancer Hazards in the Environment**New Scientist*, Volume 69, Number 984, January 22, 1976 (p. 168)**Carson, Rachel** 1907–64

American marine biologist and author

These sprays, dusts, and aerosols are now applied almost universally to farms, gardens, forests, and homes – nonselective chemicals that have the power to kill every insect, the “good” and the “bad,” to still the song of birds and the leaping of fish in the streams, to coat the leaves with a deadly film, and to linger on in soil – all this though the intended target may be only a few weeds or insects. Can anyone believe it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called “insecticides,” but “biocides.”

*Silent Spring*

Chapter 2 (pp. 7–8)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death.

*Silent Spring*

Chapter 3 (p. 15)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

As crude a weapon as a cave man’s club, the chemical barrage has been hurled against the fabric of time.

*Silent Spring*

Chapter 17 (p. 297)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

...there are no harmless chemicals, only harmless use of chemicals.

In Robert M. Hutchins and Mortimer J. Adler

*The Great Ideas Today* 1964*Biological Sciences and Medicine* (p. 264)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1964

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

There are flood and drouth  
Over the eyes and in the mouth,  
Dead water and dead sand  
Contending for the upper hand.  
The parched eviscerate soil  
Gapes at the vanity of toil,  
Laughs without mirth.  
This is the death of earth.

*The Collected Poems and Plays 1909–1950*

Little Gidding, Part II, stanza 2 (p. 140)

Harcourt, Brace &amp; World, Inc. New York, New York, USA. 1952

**Flammarion, Camille** 1842–1925

French astronomer and writer

Without an atmosphere, without this gaseous envelope whence organised beings incessantly draw what nourishes their own existence, it is impossible for us to conceive anything but immobility and the silence of death.

Translated by John Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter V (p. 133)

Chatto &amp; Windus. London, England. 1907

**Heyerdahl, Thor** 1914–2002

Norwegian ethnographer and adventurer

Sea and soil, fumes and sewage, are all here to ride with us forever, in some form or another, on the thin crust of our spinning sphere.

In Alon Tal

*Speaking of Earth*

If Man is to Survive (p. 35)

Rutgers University Press. New Brunswick, Maine, USA. 2006

**Hornaday, William Temple** 1854–1937

American naturalist

Except within our conservation areas, an earthly paradise is being turned into an earthly Hades; and it is not savages nor primitive men who are doing this, but men and women who boast of their civilization.

*Our Vanishing Wild Life: Its Extermination and Preservation*

Foreword (p. vii)

Charles Scribner's Sons. New York, New York, USA. 1913

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Old Mother Earth must regard man as a very recent apparition indeed; he has just appeared to burrow into her, burn her forests, put her waterfalls into pipes, and generally mar the beauty of her features.

*EOS or The Wider Aspects of Cosmogony*

The Position of Man in the Universe (p. 10)

Kegan Paul, Trench, Trubner &amp; Co. London, England. 1931

**Lovelock, James Ephraim** 1919–

English scientist

There is only one pollution...people.

*Gaia: A New Look at Life on Earth*

Chapter 7 (p. 114)

Oxford University Press, Inc. Oxford, England. 2000

**Peacock, Thomas Love** 1785–1866

English writer

They have poisoned the Thames and killed the fish in the river. A little further development of the same wisdom and science will complete the poisoning of the air, and

kill the dwellers on the banks...I almost think it is the destiny of science to exterminate the human race.

*Gryll Grange*

Chapter 1 (p. 11)

Penguin Books. Harmondsworth, England. 1949

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...this most excellent canopy, the air, look you, this brave o'erhanging firmament, this majestic roof fretted with golden fire, why, it appears no other thing to me than a foul and pestilent congregation of vapours.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)*Hamlet, Prince of Denmark*

Act II, Scene ii, l. 311–315

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Taylor, John**

No biographical data available

Then by the Lords Commissioners, and also  
By my good King (whom all true subjects call so),  
I was commanded with the Water Baylie,  
To see the rivers cleaned, both night and dayly.  
Dead Hogges, Dogges, Cates and well flayed Carryon  
Horses,

Their Noysom Corpses soyled the Water Courses;  
Both Swines' and Stable dynges, beasts' guts and garbage,  
Street dirt, with Gardners' Weeds and Rotten Herbage.  
And from those Waters' filthy putrifaction  
Our Meat and Drinke were made, which bred Infection.

Myself and partner, with cost paines and Travell,

Saw all made clean, from Carryon, Mud and Gravell,

And now and then was punisht a Delinquent,

By which good meanes away the filth and stink went.

Unknown, An Echo from the Past

*The American Biology Teacher*, Volume 35, Number 4, April, 1973

(p. 208)

**Toffler, Alvin** 1928–

American writer and futurist

...industrial vomit...fills our skies and seas. Pesticides and herbicides filter into our foods. Twisted automobile carcasses, aluminum cans, non-returnable glass bottles and synthetic plastics form immense kitchen middens in our midst as more and more of our detritus resists decay. We do not even begin to know what to do with our radioactive wastes – whether to pump them into the earth, shoot them into outer space, or pour them into the oceans. Our technological powers increase, but the side effects and potential hazards also escalate.

*Future Shock*

Chapter 19 (p. 380)

Random House, Inc. New York, New York, USA. 1979

## POLYGON

**Abbott, Edwin A.** 1838–1926  
English schoolmaster and theologian

Next above these [the straight line, the triangle, quadrilateral, and the pentagon] come the Nobility, of whom there are several degrees, beginning at Six-sided Figures, or Hexagons, and from thence rising in the number of their sides till they receive the honorable title of Polygonal, or many-sided.

*Flatland: A Romance of Many Dimensions*  
Dedication (p. 19)  
Little, Brown & Co. Boston, Massachusetts, USA. 1899

## POPULATION

**Malthus, Thomas Robert** 1776–1834  
English economist and sociologist

Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison of the second.

In E.A. Wrigley and David Souden (eds.)  
*The Works of Thomas Malthus* (Volume 1)  
*An Essay on the Principle of Population* (p. 9)  
Houghton Mifflin Company. Boston, Massachusetts, USA, 1885–1886

## POSITION

**Ridley, B. K.**  
No biographical data available

Imagine a billiard ball as the only inhabitant of the universe. What position does it have? The question has no meaning, for position can only be defined with respect to another position, which we call an origin, and there is nothing to define where the origin is.

*Time, Space and Things*  
Chapter 3 (p. 41)  
Cambridge University Press. Cambridge, England. 1984

**Wren, Sir Christopher** 1632–1723  
English designer, astronomer, and geometer

Position is necessary for perfecting beauty. There are only two beautiful positions of strait lines, perpendicular and horizontal; this is from nature, and consequently necessity, no other than upright being firm.

*Lives of Eminent Persons*  
Sir Christopher Wren (p. 30)  
Baldwin & Cradock. London, England. 1833

## POSITRON

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

A positron is a hole from which an electron has been removed; it is a bung-hole which would be evened up

with its surroundings if an electron were inserted.... You will see that the physicist allows himself even greater liberty than the sculptor. The sculptor removes material to obtain the form he desires. The physicist goes further and adds material if necessary – an operation which he describes as removing negative. He fills up a bung-hole, saying he is removing a positron.

*The Philosophy of Physical Science*  
Chapter VIII, Section II (pp. 120–121)  
The Macmillan Company. New York, New York, USA. 1939

**Hacking, Ian** 1936–  
Canadian-born philosopher of science

Now how does one alter the charge on the niobium ball? “Well at that stage,” said my friend, “we spray it with positrons to increase the charge or with electrons to decrease the charge.” From that day forth I’ve been a scientific realist. So far as I’m concerned, if you can spray them then they are real.

*Representing and Intervening* (p. 23)  
Cambridge University Press. Cambridge, England. 1983

## POSSIBLE

**Dewar, Redcote**  
No biographical data available

...we know nothing of possibilities and impossibilities, but only about what has and has not taken place.

*From Matter to Man: A New Theory of the Universe*  
Chapter IV (p. 50)  
Chapman & Hall, Ltd. London, England. 1898

Everything is possible, but only the actual happens.

*From Matter to Man: A New Theory of the Universe*  
Chapter XIII (p. 213)  
Chapman & Hall, Ltd. London, England. 1898

## POSSIBILITY

**Armstrong, David Malet** 1926–  
Australian philosopher

The Naturalist theory of possibility now to be advanced will be called a Combinatorial theory. It traces the very idea of possibility to the idea of the combinations – all the combinations – of given, actual elements.

*A Combinatorial Theory of Possibility*  
Part II, Chapter 3, Section I (p. 37)  
Cambridge University Press. Cambridge, England. 1989

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

We know what a masquerade all development is, and what effective shapes may be disguised in helpless embryos – In fact, the world is full of hopeful analogies and handsome dubious eggs called possibilities.

*Middlemarch*  
Book I, Chapter X (p. 82)  
Clarendon Press. Oxford, England. 1986

## POSTAGE STAMP

**Hogben, Lancelot** 1895–1975  
English zoologist

With full responsibility for my words as a professional biologist, I do not hesitate to say that all existing and genuine scientific knowledge about the way in which the physical characteristics of human communities are related to their cultural capabilities can be written out on the back of a postage stamp.

*Dangerous Thoughts*

Chapter 3 (p. 47)

W.W. Norton & Co. New York, New York, USA. 1940

## POSTULATE

**Douglas, Norman** 1868–1952  
British writer

“The older I get,” observed Mr. van Koppen, “the more I realize that everything depends upon what a man postulates. The rest is plain sailing.”

*South Wind*

Chapter XL (p. 441)

Secker. London, England. 1934

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

The method of “postulating” what we want has many advantages; they are the same as the advantages of theft over honest toil. Let us leave them to others and proceed with our honest toil.

*Introduction to Mathematical Philosophy*

Chapter VII (p. 71)

Dover Publications, Inc. New York, New York, USA. 1993

## POWER

**Boulton, Matthew** 1728–1809  
English engineer

“Ha! Boulton,” said the king. “It is long since we have seen you at court. Pray, what business are you now engaged in?”

“I am engaged, your Majesty, in the production of a commodity which is the desire of kings.”

“And what is that? What is that?”

“POWER, your majesty!”

In Ralph Stein

*The Great Inventions*

The Steam Engine (p. 24)

Playboy Press. Chicago, Illinois, USA. 1976

**Morison, George S.** 1842–1903  
Civil engineer

Fire, animal strength, and written language have in turn advanced men and nations; something like a new

capacity was developed with the discovery of explosives and again in the invention of printing; but the capacity of man has always been limited to his own individual strength and that of the men and animals he could control. His capacity is no longer so limited; man has now learned to manufacture power, and with the manufacture of power a new epoch began.

*The New Epoch as Developed by the Manufacture of Power*

Chapter I (p. 4)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

## PRACTICAL

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

To be wholly practical is to grub for edible roots and see no flowers upon the earth, no stars overhead.

*Introduction to Science*

Chapter I (p. 11)

Henry Holt & Co. New York, New York, USA. 1911

## PRACTITIONER

**Flexner, Abraham** 1866–1959  
American educator

We have indeed in America medical practitioners not inferior to the best elsewhere; but there is probably no other country in the world in which there is so great a distance and so fatal a difference between the best, the average, and the worst.

*Medical Education in the United States and Canada*

Chapter II (p. 20)

The Carnegie Foundation. New York, New York, USA. 1910

The one person for whom there is no place in the medical school, the university, or the college, is precisely he who has hitherto generally usurped the medical field – the scientifically dead practitioner, whose knowledge has long since come to a standstill and whose lectures, composed when he first took his chair, like pebbles rolling in a brook get smoother and smoother as the stream of time washes over them.

*Medical Education in the United States and Canada*

Chapter IV (p. 57)

The Carnegie Foundation. New York, New York, USA. 1910

**Latham, Peter Mere** 1789–1875  
English physician

...he who would be a first-rate practitioner must lay his foundations broad and deep in the knowledge of morbid processes; otherwise, although he may sometimes prognosticate truly concerning life and death, he can never give an accurate diagnosis concerning the nature of diseases of which he can understand nothing. Above all, he must never hope to benefit mankind by advancing the knowledge of his profession a single step.

*Lectures on Subjects Connected With Clinical Medicine*  
Lecture IV (p. 112)  
Longman, Rees, Orme, Brown, Green & Longman. London, England.  
1836

## PRAGMATISM

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

I suppose my mind had been ruined for philosophy by studying too much physics, with its simple (some would say naive) pragmatism.

*The Dreams of Reason*  
Chapter 1 (p. 22)  
Simon & Schuster. New York, New York, USA. 1988

## PRAYER

**Ayres, Clarence Edwin** 1891–1972  
No biographical data available

I believe in atoms, molecules, and electrons, matter of heaven and earth, and electrical energy its only form. I believe in modern science, conceived by Copernicus and borne out by Newton, which suffered under the Inquisition, was persecuted and anathematized, but rose to be the right hand of civilization as a consequence of the fact it rules the quick and the dead. I believe in the National Research Council, the communion of scientists, the publication of discoveries, the control of nature, and progress everlasting. Amen.

*Science: The False Messiah*  
Chapter X (p. 129)  
The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1927

**Conoley, Gillian** 1955–  
Poet

I had only prayer, prayer and science.  
Beckon

*American Poetry Review*, Volume 25, Number 2, March-April, 1996 (p. 9)

**Fiedler, Edgar R.** 1916–2003  
American economist

Thank God for Compensating errors.  
The Three R's of Economic Forecasting – Irrational, Irrelevant and Irreverent  
*Across the Board*, June, 1977

**Hammond, Kenneth R.**  
No biographical data available

**Adelman, Leonard**  
No biographical data available

Lord, Please find me a one-armed statistician...so I won't always hear "on the other hand..."  
Paraphrasing Edmund Muskie

Science, Values, and Human Judgment  
*Science*, Volume 194, Number 4263, 22 October, 1976 (p. 390)

**Howe, E. W.**  
No biographical data available

What is the thing we call Common Sense? It is prayer practically applied, assistance given hope.

*Sinner Sermons: A Selection of the Best Paragraphs of E.W. Howe* (p. 7)  
Girard, Kansas, USA. 1926

**Kepler, Johannes** 1571–1630  
German astronomer

It remains only that I should now lift up to Heaven my eyes and hands from the table of my pursuits, and humbly and devoutly supplicate the Father of lights. O thou, who by the light of nature dost enkindle in us a desire after the light of grace, that by this thou mayst translate us into the light of glory; I give thee thanks, O Lord and Creator, that thou hast gladdened me by thy creation, when I was enraptured by the work of thy hands. Behold, I have here completed a work of my calling, with as much of intellectual strength as thou hast granted me. I have declared the praise of thy works to the men who will read the evidences of it, so far as my finite spirit could comprehend them in their infinity. My mind endeavored to its utmost to reach the truth by philosophy; but if anything unworthy of thee has been taught by me – a worm born and nourished in sin – do thou teach me that I may correct it. Have I been seduced into presumption by the admirable beauty of thy works, or have I sought my own glory among men, in the construction of a work designed for thine honour? O then graciously and mercifully forgive me; and finally, grant me this favour, that this work may never be injurious, but may conduce to thy glory and the good of souls.

*Christian Observer*  
A Layman on Scriptural Geology with Observations Thereon  
August, 1834 (p. 495)

I thank thee, O Lord, our Creator, that thou hast permitted me to look at the beauty in thy work of creation; I exult in the works of thy hands. See, I have here completed the work to which I felt called; I have earned interest from the talent that thou hast given me. I have proclaimed the glory of thy works to the people who will read these demonstrations, to the extent that the limitations of my spirit would allow.

*Harmony of the World*

**Pasteur, Louis** 1822–95  
French chemist

God grant that by my persevering labours I may bring a little stone to the frail and ill-assured edifice of our knowledge of those deep mysteries of Life and Death where all our intellects have so lamentably failed.  
In René Vallery-Radot



*The Life of Pasteur*

Chapter V (p. 88)

Doubleday, Page & Co. New York, New York, USA. 1919

**Plato** 428 BCE–347 BCE  
Greek philosopher

...I call upon God, and beg him to be our savior out of a strange and unwanted enquiry, and to bring us to the heaven of probability.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 48 (p. 456)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ross, Sir Ronald** 1857–1932  
Scottish physician

This day relenting God Hath placed within my hand A wondrous thing [the discovery of the cause of malaria]; and God Be praised. At His command, Seeking His secret deeds, With tears and toiling breath, I find thy cunning seeds, O million-murdering Death. I know this little thing A myriad men will save. O Death, where is thy sting?

Thy victory, O Grave?

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter VIII (p. 227)

Macmillan & Co Ltd. London, England. 1916

**Southgate, Theresa**  
No biographical data available

I am like a chemical compound in Your Laboratory of Life, O Lord, a compound from which the element Perfection has not yet been isolated, a compound in which the properties of the element Perfection are disguised by combination with earthly vanities. Take me then, O Lord, analyze me according to my good and evil constituents and isolate the pure element Perfection, as a chemist analyzes and separates from a substance all foreign matter. Analyze me that I may learn to know myself and that I may emerge a pure element, worthy to be included in the group of elements already freed from the bonds of their earthy life.

First, grind me in the mortar of childish whims, that I may emerge a composite sample of Your Likeness. Weigh me on the balance of Your generosity and decide how great a sample I shall be in Your Laboratory of Life. Then, ignite me in the furnace of Your love, that the carbon dioxide of earthly vanities be driven off. Cool me with the balm of Your mercy. Dissolve me in Your grace and filter me through the fine mesh of earthly trials so that Imperfections may be banished. Precipitate my evil tendencies with the strong precipitate the gelatinous silicate of earthly attachments which draw me from You. Imprison me in Your love with the mordant of sacrifice. Digest me in the length of my life, that my good deeds

will grow and that self-satisfaction shall not be occluded with them. Blast out any impurities that may be introduced and finally, seal me forever, a pure substance in the container of your Eternal Happiness.

A Chemist's Prayer

*Journal of Chemical Education*, Volume 23, Number 10, October, 1946 (p. 507)

**Tukey, John W.** 1915–2000  
American statistician

The physical sciences are used to “praying over” their data, examining the same data from a variety of points of view. This process has been very rewarding, and has led to many extremely valuable insights. Without this sort of flexibility, progress in physical science would have been much slower. Flexibility in analysis is often to be had honestly at the price of a willingness not to demand that what has already been observed shall establish, or prove, what analysis suggests. In physical science generally, the results of praying over the data are thought of as something to be put to further test in another experiment, as indications rather than conclusions.

The Future of Data Analysis

*The Annals of Mathematical Statistics*, Volume 33, Number 1, March, 1962 (p. 46)

**Turgenev, Ivan** 1818–83  
Russian novelist and dramatist

Whatever a man pray for he prays for a miracle. Every prayer reduces to this: ‘Great God, grant that twice two be not four.’

Translated by Constance Garnett

*Dream Tales and Prose Poems*

Prayer (p. 323)

William Heinemann. London, England. 1914

**Wheelock, John Hall** 1754–1817  
College president

Oh, Lord, we thank thee for the Oxygen Gas; we thank Thee for the Hydrogen Gas; and for all the gases. We thank Thee for the Cerebrum; we thank Thee for the Cerebellum; and for the Medulla Oblongata. Amen.

In Oliver Payson Hubbard

*The Early History of the New Hampshire Medical Institution* (p. 15)

The Globe Printing and Publishing House. Washington, D.C. 1880

## PRECIOUS STONE

**Burroughs, John** 1837–1921  
American naturalist and essayist

The difference between a precious stone and a common stone is not an essential difference – not a difference of substance, but of arrangement of the particles – the crystallization.

*Studies in Nature and Literature*

Style and the Man (p. 82)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1908



**de Sales, F. Francis** 1567–1622  
Catholic Bishop

All kinds of Precious Stones, cast into honey, become more brilliant thereby, each one according to its colour, and all persons become more acceptable in their vocation, when they join devotion with it: household cares are thereby rendered tranquil, the love of husband and wife more sincere, the service of the prince more faithful, and all kinds of business more easy and pleasant.

*An Introduction to a Devout Life*

Chapter III (p. 7)

M.H. Gill & Sons. Dublin, Ireland. 1708

## PRECISE

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Everything is vague to a degree you do not realize till you have tried to make it precise ...

*The Collected Papers of Bertrand Russell*

*The Philosophy of Logical Atomism*

Facts and Propositions (p. 160)

Routledge. London, England. 1986

## PRECISION

**Augustine, Norman R.**  
American businessman

The weaker the data available upon which to base one's conclusion, the greater the precision which should be quoted in order to give the data authenticity.

*Augustine's Laws*

Law Number XXXV (p. 231)

American Institute of Aeronautics & Astronautics, Inc. Reston, Virginia, USA. 1986

**Davy, Sir Humphry** 1778–1829  
English chemist

Simplicity and precision ought to be the characteristics of a scientific nomenclature: words should signify things, or the analogies of things, and not opinions.

*Elements of Chemical Philosophy*

Part I, Volume 1, Introduction (p. 46)

Printed for J. Johnson & Company. London, England. 1812

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

[Precision] is the very soul of science; and its attainment afford the only criterion, or at least the best, of the truth of theories, and the correctness of experiments.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part II, Chapter IV, Section 115 (p. 122)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Queneau, Raymond** 1903–76  
French poet, novelist, and publisher

In a bus of the S-line, 10 meters long, 3 wide, 6 high, at 3 km 600 m from its starting point, loaded with 48 people, at 12.17 p.m., a person of the masculine sex aged 27 years 3 months and 8 days, 1 m 72 cm tall and weighing 65 kg and wearing a hat 35 cm in height round the crown of which a ribbon 60 cm long, interpolated a man aged 48 years 4 months and 3 days, 1 m 68 cm tall and weighing 77 kg, by means of 14 words whose enunciation lasted 5 seconds and which alluded to some involuntary displacements of from 15 to 20 mm. Then he went and sat down about 1 m 10 cm away. 57 minutes later he was 10 meters away from the suburban entrance to the gare Saint-Lazare and was walking up and down over a distance of 30 m with a friend aged 28, 1 m 70 cm tall and weighing 71 kg who advised him in 15 words to move by 5 cm in the direction of the zenith a button which was 3 cm in diameter.

*Exercises in Style*

Precision (pp. 37–38)

New Direction Publishing Corporation. New York, New York, USA. 1981

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

Dream apart, numerical precision is the very soul of science.

*On Growth and Form* (Volume 1)

Chapter I (p. 2)

At The University Press. Cambridge, England. 1951

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...the anxious precision of modern mathematics is necessary for accuracy... [I]t is necessary for research. It makes for clearness of thought, and thence for boldness of thought and for fertility in trying new combinations of ideas. When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. Its sole criterion for judgment is that the new ideas shall look like the old ones. In other words it can only act by suppressing originality.

*An Introduction to Mathematics*

Chapter XI (p. 157)

Henry Holt & Co. New York, New York, USA. 1911

## PREDETERMINED

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

I think it incredible that the wider scheme of Nature which includes life and consciousness can be completely

predetermined; yet I have not been able to form a satisfactory conception of any kind of law or causal sequence which shall be other than deterministic.

*The Nature of the Physical World*

Chapter XIV (p. 293)

The University Press. New York, New York, USA. 1929

## PREDICT

**Whewell, William** 1794–1866

English philosopher and historian

...to predict what has not been observed, is to attempt ourselves to use the legislative phrases of nature; and when she responds plainly and precisely to that which we thus utter, we cannot but suppose that we have in a great measure made ourselves masters of the meaning and structure of her language.

*The Philosophy of the Inductive Sciences, Founded Upon Their History*  
(2nd edition)

Book XI, Chapter V (pp. 64–65)

John W. Parker. London, England. 1867

## PREDICTION

**Armstrong, Neil A.** 1930–

American astronaut

Science has not yet mastered prophecy. We predict too much for the next year and yet far too little for the next ten.

Address to Joint Sessions of Congress, September 16, 1969

**Asimov, Isaac** 1920–92

American author and biochemist

It is one thing to be able to make predictions. It is another to listen to the predictions you have made and to act upon them.

*The Road to Infinity*

Chapter 1 (p. 3)

Avon Books. New York, New York, USA. 1979

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

It is very difficult to make an accurate prediction, especially about the future.

In Timothy Ferris (ed.)

*The Mind's Sky: Human Intelligence in a Cosmic Context*

The Manichean Heresy (p. 181)

Bantam Books. New York, New York, USA. 1992

**Comte, Auguste** 1798–1857

French philosopher

The aim of every science is foresight (prevoyance). For the laws of established observation of phenomena are generally employed to foresee their succession. All men, however little advanced make true predictions, which are

always based on the same principle, the knowledge of the future from the past.

In Bertrand de Jouvenel

*The Art of Conjecture*

Chapter 11 (p. 111)

Basic Books, Inc. New York, New York, USA. 1967

**Darwin, Charles Robert** 1809–82

English naturalist

Anyone who attempts to predict the history of the next ten years is a rash man, and if he attempts to make his forecast for a century he is very properly regarded as so foolhardy as not to be worth listening to at all.

*The Next Million Years*

Introduction (p. 13)

Doubleday & Company, Inc. Garden City, New York, USA. 1953

**Dewey, John** 1859–1952

American philosopher and educator

Factual science may collect statistics and make charts. But its predictions are, as has been well said, but past history reversed.

*Art as Experience*

Chapter 14 (p. 360)

Perigee Books. New York, New York, USA. 2005

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

The aim of science is not so much to search for truth, or even truths, as to classify our knowledge and to establish relations between observable phenomena in order to be able to predict the future in a certain measure and to explain the sequence of phenomena in relation to ourselves.

*Between Knowing and Believing*

The Road to Reason (p. 188)

McKay. New York, New York, USA. 1967

The aim of science is to foresee, and not, as has often been said, to understand. Science describes facts, objects and phenomena minutely, and tries to join them by what we call laws, so as to be able to predict events in the future.

*Human Destiny*

Chapter 2 (p. 13)

Longmans, Green & Company. London, England. 1947

**Dyson, Freeman J.** 1923–

American physicist and educator

In the long run, qualitative changes always outweigh quantitative ones. Quantitative predictions of economic and social trends are made obsolete by qualitative changes in the rules of the game. Quantitative predictions of technological progress are made obsolete by unpredictable new inventions. I am interested in the long run, the remote future, where quantitative predictions are meaningless. The only certainty in that remote future is that radically new things will be happening.

*Disturbing the Universe*

Chapter 17 (p. 192)

Basic Books, Inc. New York, New York, USA. 1979

### Gregory, Bruce

No biographical data available

If we want to know whether a particular way of talking about the world is valuable, we look for the predictions the theory makes and compare these with observations.

*Inventing Reality: Physics as Language* (p. 187)

John Wiley & Sons. New York, New York, USA. 1990

### Hacking, Ian 1936–

Canadian-born philosopher of science

Cutting up fowl to predict the future is, if done honestly and with as little interpretation as possible a kind of randomization. But chicken guts are hard to read and invite flights of fancy or corruption.

*The Emergence of Probability*

An Absent Family of Ideas (p. 3)

Cambridge University Press. Cambridge, England. 1975

### Kaplan, Abraham 1918–93

American philosopher of science, author, and educator

...if we can predict successfully on the basis of a certain explanation, we have good reason, and perhaps the best of reason, for accepting the explanation.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter IX, Section 40 (p. 350)

Chandler Publishing Company. San Francisco, California, USA. 1964

### Kendrew, John 1917–99

English biochemist

Scientists cannot predict the future any better than anyone else – even about their own field of research.

*The Thread of Life*

Chapter 10 (p. 110)

Harvard University Press. Cambridge, Massachusetts, USA. 1966

### Kluckhohn, Clyde 1905–60

American anthropologist

...it is one thing to be able to make some useful predictions as to what is likely to happen.... It is quite another thing to interfere, willfully to introduce new complications into an already tortuous social maze.

*Mirror for Man: The Relation of Anthropology to Modern Life*

Chapter X (p. 263)

McGraw-Hill Book. New York, New York, USA. 1949

### Le Guin, Ursula K. 1929–

American writer of science fiction and fantasy

Legends of prediction are common through the whole Household of Man. Gods speak, spirits speak, computers speak, Oracular ambiguity or statistical probability provides loopholes, and discrepancies are expunged by Faith.

*The Left Hand of Darkness*

Chapter 5 (p. 57)

Waller & Co. New York, New York, USA. 1994

### Mill, John Stuart 1806–73

English political philosopher and economist

Of all truths relating to phenomena, the most valuable to us are those which relate to the order of their succession. On a knowledge of these is founded every reasonable anticipation of future facts, and whatever power we possess of influencing those facts to our advantage. Even the laws of geometry are chiefly of practical importance to us as being a portion of the premises from which the order of the succession of phenomena may be inferred.

*A System of Logic, Ratiocative and Inductive*

Book III, Chapter 5, Section 1 (p. 212)

Longmans, Green, Reader & Dyer. London, England. 1906

### Rowling, J. K. 1965–

English author

The consequences of our actions are always so complicated, so diverse, that predicting the future is a very difficult business indeed.

*Harry Potter and The Prisoner of Azkaban*

Chapter Twenty-Two (p. 426)

Scholastic Press. New York, New York, USA. 1999

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

Science is the attempt to discover, by means of observation, and reasoning based upon it, first, particular facts about the world, and then laws connecting facts with one another and (in fortunate cases) making it possible to predict future occurrences.

*Religion and Science*

Grounds of Conflict (p. 8)

Henry Holt & Company. New York, New York, USA. 1935

### Samuelson, Paul A.

No biographical data available

Wall Street indexes predicted nine out of the last five recessions!

Science and Stocks

*Newsweek*, September 19, 1966 (p. 92)

### Toulmin, Stephen 1922–

English philosopher

Prediction is all very well; but we must make sense of what we predict. The mainspring of science is the conviction that by honest, imaginative enquiry we can build up a system of ideas about Nature which has some legitimate claim to 'reality'.

*The Philosophy of Science: An Introduction*

Chapter 6 (p. 115)

Indiana University Press. Bloomington, Indiana, USA. 1961

### Wheeler, John Archibald 1911–

American physicist and educator

### Thorne, Kip S. 1940–

American theoretical physicist

The universe starts with a big bang, expands to a maximum dimension, then recontracts and collapses: no more awe-inspiring prediction was ever made. It is preposterous. Einstein himself could not believe his own prediction.

*Gravitation*

Part X, Chapter 44 (p. 1196)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Young, Charles Augustus** 1834–1908

American astronomer

Prediction is always hazardous, especially so in scientific matters.

In George Isles

*The Skies and the Earth*

The Astronomical Outlook (p. 53)

Doubleday, Page & Co. New York, New York, USA. 1902

**Young, Louise B.**

Science writer

Our most imaginative projections will pale beside the reality that takes shape tomorrow.

*The Unfinished Universe*

Chapter 10 (p. 197)

Simon & Schuster. New York, New York, USA. 1986

## PREHISTORIC MAN

**Aeschylus** 525 BCE–426 BCE

Greek playwright

How, first beholding, they beheld in vain,  
And hearing, heard not, but, like shapes in dreams,  
Mixed all things wildly down the tedious time,  
Nor knew to build a house against the sun  
With wickered sides, nor any woodcraft knew,  
But lived, like silly ants, beneath the ground  
In hollow caves unsunned.

There, came to them

No steadfast sign of winter, nor of spring  
Flower-perfumed, nor of summer full of fruit,  
But blindly and lawlessly they did all things...

In Elizabeth Barrett-Browning

*Prometheus Bound and Other Poems*

Prometheus Bound

Scene: At the Rocks

C.S. Francis & Co. New York, New York, USA. 1852

**James, William** 1842–1910

American philosopher and psychologist

Bone of our bone and flesh of our flesh are these half-brutish pre-historic brothers. Girdled about with the immense darkness of this mysterious universe even as we are, they were born and died, suffered and struggled. Given over to fearful crime and passion, plunged in the blackest ignorance, preyed upon by hideous and grotesque delusions, yet steadfastly serving the profoundest of ideals in their fixed faith that existence in any form is

better than non-existence, they ever rescued triumphantly from the jaws of ever-imminent destruction the torch of life, which, thanks to them, now lights the world for us.

*The Will to Believe, and Other Essays in Popular Philosophy and Human Immortality*

Human Immortality (p. 33)

Dover Publications, Inc. New York, New York, USA. 1956

**Leakey, Richard Erskine** 1944–

Kenyan paleoanthropologist and politician

Needless to say, language and consciousness, which are among the most prized features of *Homo Sapiens*, leave no trace in the prehistoric record.

*The Origin of Humankind*

Preface (p. xiv)

Basic Books, Inc. New York, New York, USA. 1994

## PREHISTORY

**Clark, Grahame** 1907–95

English archaeologist

The study of prehistory stands in no more need of justification than exploration of the physical nature and mathematical properties of the universe, the investigation of all the multifarious forms of life, or for that matter the practice of the arts or the cultivation of speculative philosophy. Each in its own way enlarges the range of human experience and enriches the quality of human life.

*Aspects of Prehistory*

Chapter 1 (p. 4)

University of California Press. Berkeley, California, USA. 1970

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Antecedently to all history, and long glimmering through it as a holy tradition, there presents itself to our imagination an indefinite period, dateless as eternity; a state rather than a time. For even the sense of succession is lost in the uniformity of the stream.

*The Complete Works of Samuel Taylor Coleridge* (Volume 2)

Essay One (p. 19)

Harper & Brothers Publishers. New York, New York, USA. 1884

**Dunnell, Robert C.** 1942–

American archaeologist

Like its sister discipline, sociocultural anthropology, prehistory has a tendency to invent a term for its own sake and then argue about what it means for twenty years rather than defining the term in the first place.

*Systematics In Prehistory*

Introduction (p. 4)

The Free Press. New York, New York, USA. 1971

**Peale, Rembrandt** 1778–1860

American neoclassical painter

The revolutions which have happened on our earth, by which its original appearance has been successively

changed, have, at all times, commanded the attention of the learned, and excited various speculations concerning the time, cause and manner; and although we may never learn much on a subject so extensive, so remote and so wonderful, yet as far as facts will authorize us, we may safely proceed....

*An Historical Disquisition on the Mammoth*

Introduction (p. 1)

Printed for E. Lawrence. London, England. 1803

**Wilson, Sir Daniel** 1816–92

English-born Canadian archaeologist

In the application of the term Prehistoric – introduced, if I mistake not, for the first time in this work – it was employed originally in reference to races which I then assigned reasons for believing had preceded the oldest historical ones in Britain and Northern Europe. But since then the term has become identified with a comprehensive range of speculative and inductive research, in which the archaeologist labours hand in hand with the geologist and ethnologist, in solving some of the most deeply interesting problems of modern science.

*Prehistoric Annals of Scotland* (Volume 1)

Preface (p. xiv)

Macmillan & Company Ltd. London, England. 1863

## PRESCRIPTION

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

What did your uncle die of?

Instead of fifteen Butkin drops, as the doctor prescribed, he took sixteen.

*Note-Book of Anton Chekhov* (p. 37)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Helmuth, William Tod** 1833–1902

American physician

Term pain “neuralgia,” or if the man be stout,  
Cry out, “Dear Sir, you have rheumatic gout.”  
Tap on the chest – some awful sounds they hear,  
Then satisfied, declare, “The case is clear,”  
Draw forth a paper, seize the magic quill,  
And write in mystic signs, “Cathartic pill.”

*Scratches of a Surgeon*

Medical Pomposity (p. 11)

W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Pliny says, in so many words, that the cerates and cataplasms, plasters, collyria, and antidotes, so abundant in his time, as in more recent days, were mere tricks to make money.

*Currents and Counter-Currents in Medical Science*

Address

Massachusetts Medical Society at the Annual Meeting, May 30, 1860  
Ticknor & Fields. Boston, Massachusetts, USA. 1861

Part of the blame of over-medication must, I fear, rest with the profession, for yielding to the tendency to self-delusion, which seems inseparable from the practice of the art of healing.

*Currents and Counter-Currents in Medical Science*

Address

Massachusetts Medical Society at the Annual Meeting, May 30, 1860

Ticknor & Fields. Boston, Massachusetts, USA. 1861

**Latham, Peter Mere** 1789–1875

English physician

To bring many important remedies together, and unite them by a lucky combination, and compress them within a small compass, and so place them within the common reach, all this gives a facility of prescribing which is hurtful to the advance of medical experience. The facility of prescribing is a temptation to prescribe; and, under this temptation, there is a lavish expenditure continually going on of important remedies in the mass, of which the prescribers have made no sufficient experiment in detail.

In William B. Bean

*Aphorisms From Latham* (p. 60)

Prairie Press. Iowa City, Iowa, USA. 1962

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

There are sure to be two prescriptions diametrically opposite. Stuff a cold and starve a cold are but two ways.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimac Rivers*

Wednesday (p. 338)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

It would be a good thing for the world at large, however unprofessional it might be, if medical men were required by law to write out in full the ingredients named in their prescriptions. Let them adhere to the Latin, or Fejee, if they choose, but discard abbreviations, and form their letters as if they had been to school one day in their lives, so as to avoid the possibility of mistakes on that account.

Damages Awarded

*San Francisco Morning Call*, 10/1/1864

**Wynter, Dr.**

No biographical data available

Tell me from whom, fat-headed Scot,  
Thou didst thy system learn;  
From Hippocrates thou hadst it not,  
Nor Celsus, not Pitcairn.  
Suppose that we own that milk is good,  
And say the same of grass;



The one for babes is only food,  
The other for an ass.  
Doctor! our new prescription try  
(A friend's advice forgive);  
Eat grass, reduce thyself, and die;-  
Thy patients then may live.  
In William Davenport Adams  
*English Epigrams*  
On Doctor Cheyne, the Vegetarian, cclxxvi  
G. Routledge. London, England. 1878

## PREJUDICE

### Brewster, George

No biographical data available

A Columbus, a Newton and a Fulton might promulgate new theories of the utmost importance and sustain and defend them with argument piled upon argument mountain high – with argument upon argument, too, the most rational, conclusive and convincing, and they would invariably fail for a long time to convince. Prejudice, like an ancient mail coat of steel, enclosed the mind, and warded off the shafts of conviction.

*A New Philosophy of Matter, Showing the Identity of All the Imponderables*

Lecture I (p. 8)

Crocker & Brewster. Boston, Massachusetts, USA. 1843

### Spallanzani, Lazzaro 1729–99

Italian biologist

If I set out to prove something, I am no real scientist – I have to learn to follow where the facts lead me – I have to learn to whip my prejudices.

In R. Coope

*The Quiet Art* (p. 4)

E.&S. Livingstone

London, England. 1958

## PREPARATION

### Herschel, Sir John Frederick William 1792–1871

English astronomer and chemist

As a first preparation, therefore, for the course he [the student who enters upon a scientific pursuit] is about to commence, he must loosen his hold on all crude and hastily adopted notions, and must strengthen himself, by something of an effort and a resolve, for the unprejudiced admission of any conclusion which shall appear to be supported by careful observation and logical argument, even should it prove of a nature adverse to notions he may have previously formed for himself, or taken up, without examination, on the credit of others.

*Outlines of Astronomy: By Sir John F. W. Herschel*

Introduction (p. 21)

American Home Library Co. New York, New York, USA. 1902

### Tait, Peter Guthrie 1831–1901

Scottish physicist and mathematician

It is only in “tall talk”(or in advertisements) that any human preparation, elementary or not, can be spoken of as *chemisch rein*.

Solar Chemistry

*Nature*, Volume XXIV, October 21, 1881 (p. 582)

## PRESCRIPTION

### Colton, Charles Caleb 1780–1832

English sportsman and writer

It is true that each disorder has a thousand prescriptions, but not a single remedy.

*Lacon: Or, Many Things in Few Words*

CCCXXXVIII (p. 160)

Longman, Rees, Orme, Brown & Green. London, England. 1826

## PRESENT

### Dillard, Annie 1945–

American poet, essayist, novelist, and writing teacher

Catch it if you can. The present is an invisible electron; its lightning path traced faintly on a blackened screen is fleet, and fleeing, and gone.

*Pilgrim at Tinker Creek*

Chapter 6, I (p. 79)

Harper's Magazine Press. New York, New York, USA. 1974

### Flammarion, Camille 1842–1925

French astronomer and writer

What, indeed, is the Present Moment? It is an open trap through which the Future falls incessantly into the gulf of the Past.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Chapter XII (p. 326)

D. Appleton. New York, New York, USA. 1915

## General Motors

The present is but an instant between an infinite past and a hurrying future.

General Motors 1964 Futurama

Audio narration accompanying the ride

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

The present is always younger than antiquity.

In Harrison Gray Otis Blake (ed.)

*The Writings of Henry David Thoreau*

March 24, 1842 (p. 223)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

### Wood, William Hamilton

No biographical data available



The present is the legitimate child of the past and will be the legitimate mother of the future.

*The Religion of Science*

Chapter VII (p.101)

The Macmillan Co. New York, New York, USA. 1922

## PRESERVATION

**Hornaday, William Temple** 1854–1937

American naturalist

Now that man's heedless and ignorant destructiveness has accomplished the extinction during our own times of a score of important animal species, and today is threatening to annihilate many others, zoological knowledge has suddenly become a practical necessity. Both to the statesman and the citizen the protection of wild life has become a solemn duty. Ignorance is dangerous alike to our forests and streams and to our wild life.

In Francis Rolt-Wheeler

*The Science-history of the Universe*

Introduction (p. xi)

The Current Literature Publishing Co. New York, New York, USA. 1910

The preservation of animal and plant life, and of the general beauty of Nature, is one of the foremost duties of the men and women of today. It is an imperative duty, because it must be performed at once, for otherwise it will be too late. Every possible means of preservation – sentimental, educational and legislative – must be employed.

*Our Vanishing Wild Life: Its Extermination and Preservation*

Foreword (p. vii)

Charles Scribner's Sons. New York, New York, USA. 1913

We no longer destroy great works of art. They are treasured, and regarded as of priceless value; but we have yet to attain the state of civilization where the destruction of a glorious work of Nature, whether it be a cliff, a forest, or a species of mammal or bird, is regarded with equal abhorrence.

*Our Vanishing Wild Life: Its Extermination and Preservation*

Foreword (p. vii)

Charles Scribner's Sons. New York, New York, USA. 1913

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist

To perpetuate the established course of nature in a continued series, the divine wisdom has thought fit, that all living creatures should constantly be employed in producing individuals, that all natural things should contribute and lend a helping hand towards preserving every species, and lastly that the death and destruction of one thing should always be subservient to the restitution of another.

Translated by B. Stillingfleet

*Miscellaneous Tracts Relating to Natural History, Husbandry, and*

*Physick* (p. 32)

R. and J. Dodsley. London, England. 1759

## PRIMARY CAUSE

**Fourier, (Jean Baptiste-) Joseph** 1768–1830

French mathematician and physicist

Primary causes are unknown to us; but are subject to simple and constant laws, which may be discovered by observation, the study of them being the object of natural philosophy.

Translated by Alexander Freeman

*The Analytical Theory of Heat*

Preliminary Discourses (p. 1)

At the University Press. Cambridge, England. 1878

## PRIME NUMBER

**Auster, Paul** 1947–

American writer

Prime numbers. It was all so neat and elegant. Numbers that refuse to cooperate, that don't change or divide, numbers that remain themselves for all eternity.

*The Music of Chance*

Chapter 4 (pp. 73–74)

Viking Penguin. New York, New York, USA. 1990

**Bombieri, Enrico** 1940–

Italian mathematician

To me, that the distribution of prime numbers can be so accurately represented in a harmonic analysis is absolutely amazing and incredibly beautiful. It tells of an arcane music and a secret harmony composed by the prime numbers.

*The Sciences*

Prime Territory: Exploring the Infinite Landscape at the Base of the

Number System, Sept/Oct 1992

**Crandall, Robert W.** 1940–

Economist

**Pomerance, Carl**

Number theorist

Prime numbers belong to an exclusive world of intellectual conceptions. We speak of those marvelous notions that enjoy simple, elegant description, yet lead to extreme – one might say unthinkable – complexity in the details. The basic notion of primality can be accessible to a child, yet no human mind harbors anything like a complete picture. In modern times, while theoreticians continue to grapple with the profundity of the prime numbers, vast toil and resources have been directed toward the computational aspect, the task of finding, characterizing, and applying the primes in other domains.

*Prime Numbers: A Computational Perspective*

Chapter 1 (p. 1)

Springer-Verlag. New York, New York, USA. 2001

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

Some order begins to emerge from this chaos when the primes are considered not in their individuality but in the aggregate; one considers the social statistics of the primes and not the eccentricities of the individuals.

*The Mathematical Experience*

The Prime Number Theorem (p. 213)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**Doxiadis, Apostolos** 1953–  
Writer

The seeming absence of any ascertained organizing principle in the distribution of the succession of the primes had bedeviled mathematicians for centuries and given Number Theory much of its fascination. Here was a great mystery indeed, worthy of the most exalted intelligence: since the primes are the building blocks of the integers and the integers the basis of our logical understanding of the cosmos, how is it possible that their form is not determined by law? Why isn't "divine geometry" apparent in their case?

*Uncle Petros and Goldbach's Conjecture* (p. 84)  
Faber & Faber Ltd. London, England. 2000

**du Sautoy, Marcus**  
English mathematician and writer

The primes are jewels studded throughout the vast expanse of the infinite universe of numbers that mathematicians have explored down the centuries. For mathematicians they instill a sense of wonder: 2, 3, 5, 7, 11, 13, 17, 19, 23... – timeless numbers that exist in the same world independent of our physical reality. They are Nature's gift to the mathematician.

*The Music of the Primes*

Chapter 1 (p. 5)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

...despite their apparent simplicity and fundamental character, prime numbers remain the most mysterious objects studied by mathematicians. In a subject dedicated to finding patterns and order, the primes offer the ultimate challenge.

*The Music of the Primes*

Chapter 1 (p. 5)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

Prime numbers present mathematicians with one of the strangest tensions in their subject. On the one hand a number is either prime or it isn't. No flip of a coin will suddenly make a number divisible by some smaller number. Yet there is no denying that the list of primes looks like a randomly chosen sequence of numbers. Physicists have grown used to the idea that a quantum die decides

the fate of the universe, randomly choosing at each throw where scientists will find matter. But it is something of an embarrassment to have to admit that these fundamental numbers on which mathematics is based appear to have been laid out by Nature flipping a coin, deciding at each toss the fate of each number. Randomness and chaos are anathema to the mathematician. Despite their randomness, prime numbers – more than any other part of our mathematical heritage – have a timeless, universal character. Prime numbers would be there regardless of whether we had evolved sufficiently to recognise them.

*The Music of the Primes*

Chapter 1 (p. 6)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

Riemann's insight followed his discovery of a mathematical looking-glass through which he could gaze at the primes. Alice's world was turned upside down when she stepped through her looking-glass. In contrast, in the strange mathematical world beyond Riemann's glass, the chaos of the primes seemed to be transformed into an ordered pattern as strong as any mathematician could hope for. He conjectured that this order would be maintained however far one stared into the never-ending world beyond the glass. His prediction of an inner harmony on the far side of the mirror would explain why outwardly the primes look so chaotic. The metamorphosis provided by Riemann's mirror, where chaos turns to order, is one which most mathematicians find almost miraculous. The challenge that Riemann left the mathematical world was to prove that the order he thought he could discern was really there.

*The Music of the Primes*

Chapter 1 (p. 9)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

The search for the secret source that fed the primes had been going on for over two millennia. The yearning for this elixir had made mathematicians all too susceptible to Bombieri's [April Fools announcement of a proof of the Riemann Hypothesis in 1997]. For years, many had simply been too frightened to go anywhere near this notoriously difficult problem.

*The Music of the Primes*

Chapter 1 (p. 13)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

...Gauss liked to call [number theory] "the Queen of Mathematics." For Gauss, the jewels in the crown were the primes, numbers which had fascinated and teased generations of mathematicians.

*The Music of the Primes*

Chapter 2 (p. 22)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

It seems paradoxical that the fundamental objects on which we build our order-filled world of mathematics should behave so wildly and unpredictably.

*The Music of the Primes*

Chapter 2 (p. 45)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Armed with his prime number tables, Gauss began his quest. As he looked at the proportion of numbers that were prime, he found that when he counted higher and higher a pattern started to emerge. Despite the randomness of these numbers, a stunning regularity seemed to be looming out of the mist.

*The Music of the Primes*

Chapter 2 (p. 47)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

The revelation that the graph appears to climb so smoothly, even though the primes themselves are so unpredictable, is one of the most miraculous in mathematics and represents one of the high points in the story of the primes. On the back page of his book of logarithms, Gauss recorded the discovery of his formula for the number of primes up to  $N$  in terms of the logarithm function. Yet despite the importance of the discovery, Gauss told no one what he had found. The most the world heard of his revelation were the cryptic words, "You have no idea how much poetry there is in a table of logarithms."

*The Music of the Primes*

Chapter 2 (p. 50)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Gauss had heard the first big theme in the music of the primes, but it was one of his students, Riemann, who would truly unleash the full force...of the hidden harmonies that lay behind the cacophony of the primes.

*The Music of the Primes*

Chapter 2 (p. 58)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Riemann had found a passageway from the familiar world of numbers into a mathematics which would have seemed utterly alien to the Greeks who had studied prime numbers two thousand years before. He had innocently mixed imaginary numbers with his zeta function and discovered, like some mathematical alchemist, the mathematical treasure emerging from this admixture of elements that generations had been searching for. He had crammed his ideas into a ten-page paper, but was fully aware that his ideas would open up radically new vistas on the primes.

*The Music of the Primes*

Chapter 2 (p. 58)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

For centuries, mathematicians had been listening to the primes and hearing only disorganised noise. These numbers were like random notes wildly dotted on a mathematical stave with no discernible tune. Now Riemann had found new ears with which to listen to these mysterious tones. The sine-like waves that Riemann had created from the zeros in his zeta landscape revealed some hidden harmonic structure.

*The Music of the Primes*

Chapter 4 (p. 93)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

[The Riemann] zeros did not appear to be scattered at random. Riemann's calculations indicated that they were lining up as if along some mystical ley line running through the landscape.

*The Music of the Primes*

Chapter 4 (p. 99)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Littlewood's proof...revealed that prime numbers are masters of disguise. They hide their true colours in the deep recesses of the universe of numbers, so deep that witnessing their true nature may be beyond the computational power of humankind. Their true behavior can be seen only through the penetrating eyes of abstract mathematical proof.

*The Music of the Primes*

Chapter 5 (p. 130)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Littlewood wrote to Hardy about [Ramanujan]: "it is not surprising that he would have been [misled], unsuspecting as he presumably is of the diabolical malice inherent in the primes."

*The Music of the Primes*

Chapter 6 (p. 139)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

We have all this evidence that the Riemann zeros are vibrations, but we don't know what's doing the vibrating.

*The Music of the Primes*

Chapter 11 (p. 280)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Maybe we have become so hung up on looking at the primes from Gauss's and Riemann's perspective that what we are missing is simply a different way to understand these enigmatic numbers. Gauss gave an estimate for the number of primes, Riemann predicted that the guess is at worst the square root of  $N$  off its mark, Littlewood showed that you can't do better than this. Maybe there is an alternative viewpoint that no one has found because we have become so culturally attached to the house that Gauss built.

*The Music of the Primes*

Chapter 12 (p. 312)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

The primes have been a constant companion in our exploration of the mathematical world yet they remain the most enigmatic of all numbers. Despite the best efforts of the greatest mathematical minds to explain the modulation and transformation of this mystical music, the primes remain an unanswered riddle.

*The Music of the Primes*

Chapter 12 (pp. 314-315)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

**Erdős, Paul** 1913–96  
Hungarian mathematician

God may not play dice with the universe, but something strange is going on with the prime numbers.

In D. Mackenzie  
Homage to an Itinerant Master  
*Science*, Volume 275, Number 5301, 7 February, 1997 (p. 759)

**Euler, Leonhard** 1707–83  
Swiss mathematician and physicist

Mathematicians have tried in vain to this day to discover some order in the sequence of prime numbers, and we have reason to believe that it is a mystery into which the human mind will never penetrate. To convince ourselves, we have only to cast a glance at tables of primes, which some have taken the trouble to compute beyond a hundred thousand, and we should perceive at once that there reigns neither order nor rule.

*Collected Works*  
Serial 1, (Volume 2) (p. 241)  
Publisher undetermined

**Gardner, Martin** 1914–  
American writer and mathematics games editor

The primes...[are] exasperating, unruly integers that refuse to be divided...by any integers except themselves and one.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of The Infinite* (p. 21)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

The problem of distinguishing prime numbers from composite numbers and of resolving the latter into their prime factors is known to be one of the most important and useful in arithmetic. It has engaged the industry and wisdom of ancient and modern geometers to such an extent that it would be superfluous to discuss the problem at length.... Further, the dignity of the science itself seems to require that every possible means be explored for the solution of a problem so elegant and so celebrated.

*Disquisitiones Arithmeticae*  
Article 329 (p. 326)  
Yale University Press. New Haven, Connecticut, USA. 1965

**Gonek, S.**  
Mathematician

If there are lots of zeros off the line – and there might be – the whole picture is just horrible, horrible, very ugly. It's an Occam's razor sort of thing, you either have absolutely beautiful behavior of prime numbers, they behave just like you want them to behave, or else it's really bad.

In K. Sabbagh  
*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 8 (p. 135)  
Farrar, Straus & Giroux. New York, New York, USA. 2002

**Gowers, Timothy** 1963–  
English mathematician

Although the prime numbers are rigidly determined, they somehow feel like experimental data.

*Mathematics: A Very Short Introduction*  
Chapter 7 (p. 121)  
Oxford University Press, Inc. Oxford, England. 2002

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

...317 is a prime, not because we think so, or because our minds are shaped in one way rather than another, but because it is so, because mathematical reality is built that way.

*A Mathematician's Apology*  
Section 24 (p. 130)  
Cambridge University Press. Cambridge, England. 1967

**Jutila, M.**  
No biographical data available

I sometimes have the feeling that the number system is comparable with the universe that the astronomer is studying...The number system is something like a cosmos.

In K. Sabbagh  
*Beautiful Mathematics*  
*Prospect*, January, 2002

**Motohashi, Yoichi**  
No biographical data available

[Primes] are full of surprises and very mysterious... They are like things you can touch.... In mathematics most things are abstract, but I have some feeling that I can touch the primes, as if they are made of a really physical material. To me, the integers as a whole are like physical particles.

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 1 (p. 22)  
Farrar, Straus & Giroux. New York, New York, USA. 2002

**Queneau, Raymond** 1903–76  
French poet, novelist, and publisher

When One made love to Zero  
spheres embraced their arches  
and prime numbers caught their breath...

*Pounding the Pavement, Beating the Bush, and Other Paraphysical Poems*  
Sines  
Unicorn Press. Greensboro, North Carolina, USA. 1985

**Sagan, Carl** 1934–96  
American astronomer and author

Do we know what the sequence of numbers is? Okay, here, we can do it in our heads...fifty-nine, sixty-one, sixty-seven...seventy-one.... Aren't these all prime numbers? A little buzz of excitement circulated through the control room. Ellie's own face momentarily revealed a flutter of something deeply felt, but this was quickly replaced by a sobriety, a fear of being carried away, an apprehension about appearing foolish, unscientific.

Contact: *A Novel*

Chapter 4 (p. 78)

Simon & Schuster. New York, New York, USA. 1985

### Smith, Henry John Stephen 1826–83

Irish mathematician

As to our knowledge of the series of the prime numbers themselves, the advance since the time of Euler has been great, if we think of the difficulty of the problem; but very small if we compare what has been done with what still remains to do.

In J.W.L. Glaisher

*The Collected Mathematical Papers of Henry John Stephen Smith*

Chapter XXXI (p. 177)

At The Clarendon Press. Oxford, England. 1894

### Stewart, Ian 1945–

English-mathematician and science writer

Who would have imagined that something as straightforward as the natural numbers (1, 2, 3, 4...) could give birth to anything so baffling as the prime numbers (2, 3, 5, 7, 11...)?

Jumping Champions

*Scientific American*, Volume 283, Number 6, December, 2000 (p. 106)

### Sylvester, James Joseph 1814–97

English mathematician

[Tschebycheff] was the only man ever able to cope with the refractory character and erratic flow of prime numbers and to confine the stream of their progression with algebraic limits, building up, if I may so say, banks on either side which that stream, devious and irregular as are its windings, can never overflow.

In E. Kramer

*The Nature and Growth of Mathematics*

Chapter 21 (p. 503)

Hawthorn Books, Inc. New York, New York, USA. 1970

I have sometimes thought that the profound mystery which envelops our conceptions relative to prime numbers depends upon the limitations of our faculties in regard to time, which like space may be in essence poly-dimensional and that this and other such sort of truths would become self-evident to a being whose mode of perception is according to *superficially* as opposed to our own limitation to *linearly* extended time.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 4)

On Certain Inequalities Relating to Prime Numbers (p. 600)

University Press. Cambridge, England. 1904–1912

### Tenenbaum, G.

No biographical data available

Addition and multiplication equip the set of positive natural numbers  $\{1, 2, 3, \dots\}$  with a double structure of Abelian semigroup. The first is associated with a total order relation, and is generated by the single number 1. The second, reflecting the partial order of divisibility has an infinite number of generators: the prime numbers. Defined since antiquity, this key concept has yet to deliver up all its secrets – and there are plenty of them.

*Introduction to Analytic and Probabilistic Number Theory* (p. 299)

Cambridge University Press. Cambridge, England. 1995

### Tenenbaum, G.

No biographical data available

### France, M. Mendés

No biographical data available

As archetypes of our representation of the world, numbers form, in the strongest sense, part of ourselves, to such an extent that it can legitimately be asked whether the subject of study of arithmetic is not the human mind itself. From this a strange fascination arises: how can it be that these numbers, which lie so deeply within ourselves, also give rise to such formidable enigmas? Among all these mysteries, that of the prime numbers is undoubtedly the most ancient and most resistant.

Translated by Philip G. Spain

*The Prime Numbers and Their Distribution* (p. 1)

American Mathematical Society. Providence, Rhode Island, USA. 2000

One of the remarkable aspects of the distribution of prime numbers is their tendency to exhibit global regularity and local irregularity. The prime numbers behave like the “ideal gases” which physicists are so fond of. Considered from an external point of view, the distribution is – in broad terms – deterministic, but as soon as we try to describe the situation at a given point, statistical fluctuations occur as in a game of chance where it is known that on average the heads will match the tail but where, at anyone moment, the next throw cannot be predicted.

Translated by Philip G. Spain

*The Prime Numbers and Their Distribution* (p. 51)

American Mathematical Society. Providence, Rhode Island, USA. 2000

Prime numbers try to occupy all the room available (meaning that they behave as randomly as possible), given that they need to be compatible with the drastic constraint imposed on them, namely to generate the ultra-regular sequence of integers. This idea underpins the majority of conjectures concerning prime numbers: everything which is not trivially forbidden should actually happen.

Translated by Philip G. Spain

*The Prime Numbers and Their Distribution* (p. 51)

American Mathematical Society. Providence, Rhode Island, USA. 2000



**Weyl, Hermann** 1885–1955  
German mathematician

The mystery that clings to numbers, the magic of numbers, may spring from this very fact, that the intellect, in the form of the number series, creates an infinite manifold of well-distinguished individuals. Even we enlightened scientists can still feel it, e.g., in the impenetrable law of the distribution of prime numbers.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter I (p. 7)

Princeton University Press, Princeton, New Jersey, USA. 1949

### Zagier D.

No biographical data available

I hope that...I have communicated a certain impression of the immense beauty of the prime numbers and the endless surprises which they have in store for us.

The First 50 Million Prime Numbers

*The Mathematical Intelligencer*, Volume 0, August, 1977

...there is no apparent reason why one number is prime and another not. To the contrary, upon looking at these numbers one has the feeling of being in the presence of one of the inexplicable secrets of creation.

The First 50 Million Prime Numbers

*The Mathematical Intelligencer*, Volume 0, August, 1977

## PRIMORDIAL

**de Maupassant, Guy** 1850–93  
French writer

Nothing is more impressive, nothing more disquieting, more terrifying occasionally, than a fen. Why should a vague terror hang over these low plains covered with water? Is it the low rustling of the rushes, the strange Will-o'-the-wisp light, the silence which prevails on calm nights, the still mists which hang over the surface like a shroud; or is it the almost inaudible splashing, so slight and so gentle, yet sometimes more terrifying than the cannons of men of the thunders of skies, which make these marshes resemble countries which none has dreamed of, terrible countries concealing an unknown and dangerous secret?

No, something else belongs to it – another mystery, profounder and graver, floats amid these thick mists, perhaps the mystery of the creation itself! For was it not in stagnant and muddy water, amid the heavy humidity of moist land under the heat of the sun, that the first germ of life pulsed and expanded to the day?

*A Selection From the Writings of Guy de Maupassant* (Volume 1)

Chapter 7, Love

Princeton Publishing Company, New York, New York, USA. 1903

**Newman, Joseph S.** 1892–1960  
American poet

A highly speculative void  
Divides the germ and anthropoid  
But we've discovered certain clues  
In fossilized primordial ooze  
Where ancient polyps lived and died  
And countless myriads multiplied.  
*Poems for Penguins and Other Lyrical Lapses*  
Biology  
Greenburg, New York, New York, USA. 1941

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

In the cauldron boil and bake;  
Eye of newt and toe of frog,  
Wool of bat and tongue of dog,  
Adder's fork and blind-worm's sting,  
Lizard's leg and howlet's wing...  
*In Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Macbeth*  
Act IV, Scene i, l. 13–17  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## PRIMORDIAL GERM

**Tyndall, John** 1820–93  
Irish-born English physicist

In the case of Mr. Darwin, observation, imagination, and reason combined have run back with wonderful sagacity and success over a certain length of the line of biological succession. Guided by analogy, in his "Origin of Species" he placed at the root of life a primordial germ, from which he conceived the amazing variety of the organisms now upon the earth's surface might be deduced. If this hypothesis were even true, it would not be final. The human mind would infallibly look behind the germ, and, however hopeless the attempt, would inquire into the history of its genesis.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 2)

Chapter 8 (p. 127)

D. Appleton & Co. New York, New York, USA. 1896

## PRINCIPLE

**Adams, John** 1735–1826  
2nd president of the USA

The reasoning of mathematicians is founded on certain and infallible principles. Every word they use conveys a determinate idea, and by accurate definitions they excite the same ideas in the mind of the reader that were in the mind of the writer. When they have defined the terms they intend to make use of, they premise a few axioms, or self-evident principles, that every man must assent to as soon as proposed. They then take for granted certain



postulates, that no one can deny them, such as, that a right line may be drawn from any given point to another, and from these plain, simple principles they have raised most astonishing speculations, and proved the extent of the human mind to be more spacious and capacious than any other science.

*Works* (Volume 2)

Diary (p. 21)

Boston, Massachusetts, USA. 1850

**Bilaniuk, Oleksa-Myron** 1926–  
Polish/Ukrainian-American physicist

**Sudarshan, E. C.** 1931–  
Indian-American physicist

There is an unwritten precept in modern physics, often facetiously referred to as Gell-Mann's totalitarian principle, which states that in physics "anything which is not prohibited is compulsory." Guided by this sort of argument we have made a number of remarkable discoveries, from neutrinos to radio galaxies.

*Particles Beyond the Light Barrier*

*Physics Today*, Volume 22, Number 5, May, 1969 (p. 44)

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

As truth is single, and consistent with itself, a principle may be as completely and as plainly elucidated by the most familiar and simple fact, as by the most imposing and uncommon phenomenon.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I (p. 14)

Longman, Brown, Green & Longmans. London, England. 1845

**Pólya, George** 1887–1985  
Hungarian mathematician

This principle is so perfectly general that no particular application is possible.

*How to Solve It: A New Aspect of Mathematical Method*

Part III. The Traditional Mathematics Professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

## PRINCIPLES

**Hamilton, Sir William Rowan** 1805–65  
Anglo-Irish mathematician, physicist, and astronomer

We are naturally disposed to refer everything we do not know to principles with which we are familiar.

In Henry Longueville Mansel and John Veitch

*Lectures on Metaphysics and Logic*

Lecture IV (pp. 71–72)

William Blackwood & Sons. Edinburgh, Scotland. 1861

**Maxwell, James Clerk** 1831–79  
Scottish physicist

[The] habit of recognising principles amid the endless variety of their action can never degrade our sense of the

sublimity of nature, or mar our enjoyment of its beauty. On the contrary, it tends to rescue our scientific ideas from that vague condition in which we too often leave them, buried among the other products of a lazy credulity, and to raise them into their proper position among the doctrines in which our faith is so assured that we are ready at all times to act on them.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell*

Chapter XII (p. 355)

Macmillan & Company Ltd. London, England. 1882

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Principles are conventions and definitions in disguise. They are, however, deduced from experimental laws, and these laws have, so to speak, been erected into principles to which our mind attributes an absolute value.

*Science and Hypothesis*

Part III, Chapter VIII (p. 138)

Dover Publications. Mineola, New York, USA. 1952

## PROBABILITY

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

FORD: Arthur, This is fantastic, we've been picked up by a ship with the new Infinite Improbability Drive, this is really incredible, Arthur.... Arthur, what's happening?

ARTHUR: Ford, there's an infinite number of monkeys outside who want to talk to us about this script for Hamlet they've worked out.

*The Original Hitchhiker Radio Script*

Fit the Second (pp. 41–42)

Harmony Books. New York, New York, USA. 1983

TRILLIAN: Five to one against and falling...four to one against and falling...three to one...two...one...Probability factor one to one...we have normality...I repeat we have normality...anything you still can't cope with is therefore your own problem.

*The Original Hitchhiker Radio Script*

Fit the Second (p. 42)

Harmony Books. New York, New York, USA. 1983

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

The Reader may here observe the Force of Numbers, which can be successfully applied, even to those things, which one would imagine are subject to no Rules. There are very few things which we know, which are not capable of being reduc'd to a Mathematical Reasoning, and when they cannot, it's a Sign our Knowledge of them is very small and confus'd; And where mathematical reasoning can be had, it's as great folly to make use of any other, as to grope for a thing in the dark, when you have

a Candle standing by you. I believe the Calculation of the Quantity of Probability might be improved to a very useful and pleasant Speculation, and applied to a great many Events which are accidental, besides those of Games...

*Of the Laws of Chance*

Preface

Benjamin Motte. London, England. 1692

**Atkins, Russell** 1926–

Poet, composer, editor, and teacher

...dogs are random.

*Probability and Birds in the Yard*

Poem

**Austen, Jane** 1775–1817

English writer

Are no probabilities to be accepted, merely because they are not certainties?

*Sense and Sensibility* (Volume 1)

Chapter 15 (p. 68)

Oxford University Press. Oxford, England. 1980

**Bagehot, Walter** 1826–77

English journalist

Life is a school of probability.

In Rudolf Flesch

*The New Book of Unusual Quotations*

Harper & Row, Publishers. New York, New York, USA. 1966

**Barrow, John D.** 1952–

English theoretical physicist

**Tipler, Frank J.** 1947–

American physicist

In a randomly infinite Universe, any event occurring here and now with finite probability must be occurring simultaneously at an infinite number of other sites in the Universe. It is hard to evaluate this idea any further, but one thing is certain: if it is true then it is certainly not original!

*The Anthropic Cosmological Principle*

Chapter 4.6 (p. 249)

Clarendon Press. Oxford, England. 1986

**Barry, Frederick** 1876–1943

Historian of science

In short, these fundamental elements of scientific knowledge assimilate and grow, coalesce and separate and recombine, shrink and wane, die and come to life again; and while they persist they are never more than probable.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 139)

Columbia University Press. New York, New York, USA. 1927

**Blake, William** 1757–1827

English poet, painter, and engraver

...all is to them a dull round of probabilities and possibilities.

*The Complete Poetry and Prose of William Blake*

The Ancient Britons

University of California Press. Berkeley, California, USA. 1982

**Bleckley, Logan E.** 1827–1907

American lawyer

...it is always probable that something improbable will happen.

Warren v. Purcell, 63 *Georgia Reports* 428, 430 (1879)

**Boole, George** 1815–64

English mathematician

Probability is expectation founded upon partial knowledge. A perfect acquaintance with all the circumstances affecting the occurrence of an event would change expectation into certainty, and leave neither room nor demand for a theory of probabilities.

*Collected Logical Works* (Volume 2)

An Investigation of the Law of Thought, Chapter XVI (p. 258)

The Open Court Publishing Company. La Salle, Illinois, USA. 1952

**Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

The principles on which the calculus of probabilities is based are extremely simple and as intuitive as the reasonings which lead an accountant through his operations.

Translated by Maurice Baudin

*Probabilities and Life*

Introduction (p. 1)

Dover Publications. New York, New York, USA. 1962

...just as price is not the sole element of our decision when we make a purchase, probability alone must not dictate our decision in the matters of a risk.

Translated by Maurice Baudin

*Probabilities and Life*

Chapter 3, Section 6 (p. 32)

Dover Publications. New York, New York, USA. 1962

Probabilities must be regarded as analogous to the measurement of physical magnitudes; that is to say, they can never be known exactly, but only within certain approximation.

Translated by Maurice Baudin

*Probabilities and Life*

Chapter Three, Section 6 (pp. 32–33)

Dover Publications. New York, New York, USA. 1962

**Born, Max** 1882–1970

German-born English physicist

As far as I can see, the only foundation of the doctrine of probability, which (though not satisfactory for a mind devoted to the “absolute”) seems at least not more mysterious than science as a whole, is the empirical attitude: The laws of probability are valid just as any other physical law in virtue of the agreement of their consequences with experience.

*Experiment and Theory in Physics* (pp. 26–27)

Cambridge University Press. Cambridge, England. 1944

If Gessler had ordered William Tell to shoot a hydrogen atom off his son's head by means of a particle and had given him the best laboratory instruments in the world instead of a cross-bow, Tell's skill would have availed him nothing. Hit or miss would have been a matter of chance.

In Sir Arthur Stanley Eddington  
*New Pathways in Science*  
Chapter IV, Section III (p. 82)  
The Macmillan Company. New York, New York, USA. 1935

**Bostwick, Arthur Elmore** 1860–1942  
American librarian

It is easier to make true misleading statements in the subject of probabilities than anywhere else.

The Theory of Probabilities  
*Science*, Volume 3, Number 54, January 10, 1896 (p. 66)

**Boswell, James** 1740–95  
Scottish biographer and diarist

JOHNSON: "If I am well acquainted with a man, I can judge with great probability how he will act in any case, without his being restrained by my judging. God may have this probability increased to certainty."

*The Life of Samuel Johnson* (Volume 2)  
April 15, 1778 (pp. 209–210)  
J.M. Dent & Sons Ltd. London, England. 1938

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91  
English statesman and poet

...fate laughs at probabilities!

*Eugene Aram*  
Book First, Chapter 10 (p. 72)  
John W. Lovell Company. New York, New York, USA. n.d.

**Burney, Fanny** 1752–1840  
English novelist and diarist

The play of imagination, in the romance of early youth, is rarely interrupted with scruples of probability.

In Edward A Bloom and Lillian D. Bloom (eds.)  
*Camilla, or, A Picture of Youth*  
Book II, Chapter V (p. 102)  
Oxford University Press. Oxford, England. 1983

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

If scientific reasoning were limited to the logical processes of arithmetic, we should not get very far in our understanding of the physical world. One might as well attempt to grasp the game of poker entirely by the use of the mathematics of probability.

As We May Think  
*Atlantic Monthly*, July 1945

**Butler, Joseph** 1692–1752  
English bishop and exponent of natural theology

But to us, probability is the very guide to life.

*The Analogy of Religion*  
Introduction (p. 76)  
Henry G. Bohn. London, England. 1852

**Cardozo, Benjamin N.** 1870–1938  
American jurist

...law, like other branches of social science, must be satisfied to test the validity of its conclusions by the logic of probabilities rather than the logic of certainty.

*The Growth of the Law* (p. 33)  
Yale University Press. New Haven, Connecticut, USA. 1924

**Coats, R. H.**  
No biographical data available

...the electron is just a "smear of probability."

Science and Society  
*Journal of the American Statistical Association*, Volume 34, Number 205, March, 1939 (p. 6)

**Cohen, John**  
No biographical data available

Unlike almost all mathematics, I agree completely with your statement that every probability evaluation is a probability evaluation, that is, something to which it is meaningless to apply such attributes as right, wrong, rational, etc.

*Chance, Skill, and Luck: The Psychology of Guessing and Gambling*  
Chapter 2, Part I (p. 28)  
Penguin Books. Baltimore, Maryland, USA. 1960

**Cohen, Morris Raphael** 1880–1947  
American philosopher

Judged by its indispensable role in our daily practical judgments, as well as in the procedure of natural science, the concept of probability is one of the most important in the whole field of philosophy. Since the failure of the romantic Naturphilosophie to derive infallible knowledge of nature a priori, and since the discovery that other than Euclidean geometry may be true in the physical world, it has become generally evident that all our factual knowledge (that is, all except purely formal or mathematical considerations) is only probable in the sense that we cannot prove the contrary to be absolutely impossible.

*A Preface to Logic*  
Chapter VI (p. 102)  
Routledge. London, England. 1946

**Coolidge, Julian L.** 1873–1954  
American professor of mathematics

However the formulae [of mathematical probability] may be derived, they frequently prove remarkably trustworthy in practice. The proper attitude is not to reject laws of doubtful origin, but to scrutinize them with care, with a view to reaching the true principles underneath. It seems to me that, in the last analysis, probability is a

statistical, that is to say, an experimental science, and the mathematical problem is to establish rules which yield correct and valuable results.

*An Introduction to Mathematical Probability*

Preface (p. vi)

Dover Publications, Inc. New York, New York, USA. 1962

**Crichton, Michael** 1942–

American novelist

Harry sighed irritably, pulled out a sheet of paper. It's a probability equation? He wrote:  $p = \text{fjnhffifc}$  "What it means," Harry Adams said, "is that the probability,  $p$ , that intelligent life will evolve in any star system is a function of the probability that the star will have planets, the number of habitable planets, the probability that simple life will evolve on a habitable planet, the probability that intelligent life will evolve from simple life, and the probability that intelligent life will attempt interstellar communication within five billion years. That's all the equation says."

*Sphere: A Novel*

The Briefing (pp. 28–29)

Ballantine Books. New York, New York, USA. 1987

But the point is that we have no facts," Harry said. "We must guess at every single one of these probabilities."

*Sphere: A Novel*

The Briefing (p. 29)

Ballantine Books. New York, New York, USA. 1987

**Crofton, M. W.**

British mathematician

The mathematical theory of probability is a science which aims at reducing to calculation, where possible, the amount of credence due to propositions or statements, or to the occurrence of events, future or past, more especially as contingent or dependent upon other propositions or events the probability of which is known.

*Encyclopædia Britannica* (9th edition)

Probability

**Dampier-Whetham, William** 1867–1952

English scientific writer

Indeed the intellectual basis of all empirical knowledge may be said to be a matter of probability, expressible only in terms of a bet.

*A History of Science*

Chapter III (p. 155)

The Macmillan Company. New York, New York, USA. 1936

**Darwin, Charles Robert** 1809–82

English naturalist

As for a future life, every man must judge for himself between conflicting vague probabilities.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VIII (p. 277)

D. Appleton & Company. New York, New York, USA. 1896

**Davy, Sir Humphry** 1778–1829

English chemist

The physical sciences involve the universe, man, and nature, in all their modifications, and all their newly acquired powers. They are at once the instruments and subjects of examination. Probabilities are the most we can hope for in our generalisations; and whenever we can trace the connection of a series of facts, without being obliged to imagine certain relations, we may esteem ourselves fortunate in our approximations.

In John Davy

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter II (p. 123)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

...I would reply that fiction is all the better the more it looks like truth, and gives the more pleasure the more probability and possibility there is about it.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part I, Chapter 47 (p. 184)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Jouvenel, Bertrand** 1903–87

French man of letters

We defined the art of conjecture, or stochastic art, as the art of evaluating as exactly as possible the probabilities of things, so that in our judgments and actions we can always base ourselves on what has been found to be the best, the most appropriate, the most certain, the best advised; this is the only object of the wisdom of the philosopher and the prudence of the statesman.

Translated by Nikita Lary

*The Art of Conjecture*

Introduction, 3 (p. 21, note 19)

Basic Books, Inc. New York, New York, USA. 1967

**de Leeuw, A. L.**

No biographical data available

The laws of chance tell us what is probable, but not what is certain to happen. They do not predict. They do not tell us what will, but what may happen.

*Rambling Through Science*

Gambling (p. 88)

Whittlesey House. London, England. 1932

**de Moivre, Abraham** 1667–1754

French-born mathematician

The Probability of an Event is greater or less, according to the number of chances by which it may happen, compared with the whole number of chances by which it may either happen or fail.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play* (3rd edition)

Introduction (p. 1)

Printed for Millar. London, England. 1756

**de Morgan, Augustus** 1806–71  
English mathematician and logician

No part of mathematics or mathematical physics involves considerations so strange or so difficult to handle correctly, and there is no subject upon which opinions have been more freely hazarded by the ignorant, or rational dissent more unambiguously expressed by the learned.

*Encyclopædia Metropolitana* (Volume 2)  
Theory of Probabilities (p. 393)

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

The statistician's report to management should not talk about probabilities. It will merely give outside margins of error for the results of chief importance.

*Sample Design in Business Research* (p. 13)  
John Wiley & Sons, Inc. New York, New York, USA. 1960

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

...when it is not in our power to determine what is true, we ought to act accordingly to what is most probable...

*Discourse on the Method of Rightly Conducting the Reason and Seeking For Truth in the Sciences*  
Part III (p. 67)  
Simpson, Marshal, and Company. London, England. 1850

**Diaconis, Persi** 1945–  
American mathematician

Our brains are just not wired to do probability problems very well.

The Search for Randomness  
*Talk*, March 29, 1989

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

We are coming now rather into the region of guesswork, said Dr. Mortimer.

Say, rather, into the region where we balance probabilities and choose the most likely. It is the scientific use of the imagination, but we have always some material basis on which to start our speculation.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Hound of the Baskervilles*, Chapter 4 (p. 24)  
Wings Books. New York, New York, USA. 1967

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We commonly have had to deal with probabilities which arise through ignorance. With fuller knowledge we should sweep away the references to probability and substitute the exact facts. But it appears to be a fundamental point in Schrödinger's theory that his probabilities are not to be replaced in that way.

*The Nature of the Physical World*  
Chapter XIV (p. 305)  
The University Press. New York, New York, USA. 1929

There can be no unique probability attached to any event or behavior: we can only speak of "probability in the light of certain given information", and the probability alters according to the extent of the information.

*The Nature of the Physical World*  
Chapter XIV (pp. 314–315)  
The Macmillan Company. New York, New York, USA. 1930

But it is necessary to insist more strongly than usual that what I am putting before you is a model – the Bohr model atom – because later I shall take you to a profounder level of representation in which the electron, instead of being confined to a particular locality, is distributed in a sort of probability haze all over the atom...

*New Pathways in Science*  
Chapter II, Section III (p. 34)  
The Macmillan Company. New York, New York, USA. 1935

In most modern theories of physics probability seems to have replaced aether as "the nominative of the verb 'to undulate'."

*New Pathways in Science*  
Chapter VI, Section I (p. 110)  
The Macmillan Company. New York, New York, USA. 1935

**Edgeworth, Francis Ysidro** 1845–1926  
Irish economist and statistician

The Calculus of Probabilities is an instrument which requires the living hand to direct it.

*Metetike, or The Method of Measuring Probability and Utility* (p. 18)  
Temple. London, England. 1887

Probability may be described, agreeably to general usage, as importing partial incomplete belief.

The Philosophy of Chance  
*Mind*, Volume 9, 1884

I hope that you flourish in Probabilities.

Quoted in Stephen M. Stigler  
*The History of Statistics*  
Letter from Edgeworth to Pearson, 11 September, 1893 (p. 326)

It is a useful discipline to walk in a world where, though the objects themselves are fixed, their images are ever vibrating through a large part of their own dimensions. The Calculus of Probabilities...conveys a lesson which is required for the study of social science, the power of contemplating general tendencies through the wavering medium of particulars.

On Methods of Ascertaining Variation in the Rate of Births, Deaths, and Marriages  
*Journal of the Royal Statistical Society*, Volume 48, 1885 (p. 633)

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Secrets are rarely betrayed or discovered according to any program our fear has sketched out. Fear is almost



always haunted by terrible dramatic scenes, which recur in spite of the best-argued probabilities against them...

*The Mill on the Floss*

Book V, V (p. 317)

J.M. Dent & Sons Ltd. London, England. 1908

Still there is a possibility – even a probability – the other way.

*The George Eliot Letters* (Volume 2) (p. 127)

Yale University Press. New Haven, Connecticut, USA. 1954–1978

But I see no probability of my being able to be with you before your other Midsummer visitors arrive.

*The George Eliot Letters* (Volume 2) (p. 160)

Yale University Press. New Haven, Connecticut, USA. 1954–1978

...ignorance gives one a large range of probabilities.

*Daniel Deronda* (Volume 1)

Book II, Chapter XIII (p. 202)

William Blackwood & Sons. Edinburgh, Scotland. 1903

### **Evanovich, Janet** 1943–

American writer

I graduated from Douglass College without distinction. I was in the top 98% of my class and damn glad to be there.

I slept in the library and daydreamed my way through history lecture. I failed math twice, never fully grasping probability theory. I mean, first off, who cares if you pick a black ball or a white ball out of the bag? And second, if you're bent over about the color, don't leave it to chance. Look in the damn bag and pick the color you want.

*Hard Eight* (pp. 227–228)

St. Martin's Press. New York, New York, USA. 2002

### **Feller, William** 1906–70

Yugoslavian-born American mathematician

Probability is a mathematical discipline with aims akin to those, for example, of geometry or analytical mechanics. In each field we must carefully distinguish three aspects of the theory: (a) the formal logical content, (b) the intuitive background, (c) the applications. The character, and the charm, of the whole structure cannot be appreciated without considering all three aspects in their proper relation.

*An Introduction to Probability Theory and Its Applications* (Volume 1)

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1957

All possible “definitions” of probability fall short of the actual practice.

*An Introduction to Probability Theory and Its Applications* (Volume 1)

Chapter I (p. 19)

John Wiley & Sons, Inc. New York, New York, USA. 1957

### **Feynman, Richard P.** 1918–88

American theoretical physicist

Nature permits us to calculate only probabilities.

*QED: The Strange Theory of Light and Matter*

Chapter I (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1985

Philosophers have said that if the same circumstances don't always produce the same results, predictions

are impossible and science will collapse. Here is a circumstance – identical photons are always coming down in the same direction to the piece of glass – that produces different results. We cannot predict whether a given photon will arrive at A or B. All we can predict is that out of 100 photons that come down, an average of 4 will be reflected by the front surface. Does this mean that physics, a science of great exactitude, has been reduced to calculating only the probability of an event, and not predicting exactly what will happen? Yes. That's a retreat, but that's the way it is: Nature permits us to calculate only probabilities. Yet science has not collapsed.

*QED: The Strange Theory of Light and Matter*

Introduction (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1985

A philosopher once said “It is necessary for the very existence of science that the same conditions always produce the same results.” Well, they do not.

*The Character of Physical Law*

Chapter 6 (p. 147)

BBC. London, England. 1965

### **Forbes, J. D.**

No biographical data available

...the ratios or probabilities of which we have been speaking have no absolute signification with reference to an event which has occurred...They represent only the state of expectation of the mind of a person before the event has occurred, or having occurred before he is informed of the results.

On the Alleged Evidence for a Physical Connection Between Stars

Forming Binary or Multiple Groups

*The London, Edinburgh and Dublin Philosophical Magazine and*

*Journal of Science*, Third Series, December, 1850 (p. 406)

### **Freeman, R. Austin** 1862–1943

British physician and mystery novelist

It is a question of probabilities....

*A Certain Dr. Thorndyke*

Thorndyke Makes a Beginning (p. 209)

Dodd, Mead & Company. New York, New York, USA. 1928

### **Froude, James Anthony** 1818–94

English historian and biographer

Philosophy goes no further than probabilities, and in every assertion keeps a doubt in reserve.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 51)

Charles Scribner's Sons. New York, New York, USA. 1890

### **Fry, Thornton C.**

No biographical data available

After all, without the experiment – either a real one or a mathematical model – there would be no reason for a theory of probability.

*Probability and Its Engineering Uses* (2nd edition)

Chapter II (p. 23)

D. van Nostrand Company. Princeton, New Jersey, USA. 1965



But if probability measures the importance of our state of ignorance it must change its value whenever we add new knowledge. And so it does.

*Probability and Its Engineering Uses* (2nd edition)  
Chapter VI (p. 145)

D. van Nostrand Company. Princeton, New Jersey, USA. 1965

**Galloway, Thomas** 1796–1851

Scottish mathematician

The doctrine of probability is an extensive and very important branch of mathematical science, the object of which is to reduce to calculation the reasons which we have for believing or expecting any contingent event, or for assenting to any conclusion which is not necessarily true. When it is considered that the whole edifice of human science, with the exception of a few self-evident truths, such as the axioms of geometry, is nothing more than an assemblage of propositions which can only be pronounced to be more or less probable, the importance of a calculus which enables us to appreciate exactly the degree of probability existing in each case, will be readily understood.

*A Treatise on Probability*

Introduction (p. 1)

Adam & Charles Black. Edinburgh, Scotland. 1839

**Gay, John** 1685–1732

English poet and dramatist

Let men suspect your tale untrue,

Keep probability in view.

*John Gay: Poetry and Prose*

Fables. The Painter Who Pleased Nobody and Everybody, I. 1  
At The Clarendon Press. Oxford, England. 1974

**Gibbon, Edward** 1737–94

English historian

Such a fact is probable, but undoubtedly false.

In *Great Books of the Western World* (Volume 40)

*The Decline and Fall of the Roman Empire*

Notes: Chapter XXIV, 116 (p. 794)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gilbert, William** 1544–1603

English scientist and physician

Men are deplorably ignorant with respect to natural things, an modern philosophers, as though dreaming in the darkness, must be aroused and taught the uses of things, the dealing with things; they must be made to quit the sort of learning that comes only from books, and that rests only on vain arguments from probability and upon conjecture.

In *Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Book First, Chapter 10

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

Of what there is no manner of doubt,  
No probable, possible, shadow of doubt,  
No possible doubt whatever.

*The Complete Plays of Gilbert and Sullivan*

*The Gondoliers*

Act I (p. 466)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Gissing, George** 1857–1903

English novelist

Of course, if your work is strong, and you can afford to wait; the probability is that half a dozen people will at last begin to shout that you have been monstrously neglected, as you have.

*New Grub Street*

Interim (p. 411)

The Modern Library. New York, New York, USA. 1926

**Good, I. J.**

No biographical data available

Although there are at least five kinds of probability, we can get along with just one kind.

Kinds of Probability...

*Science*, Volume 129, 1959

**Gracian, Baltasar** 1601–58

Spanish philosopher

Whereas wisdom favors the probabilities, folly favors only the possibilities.

In Thomas G. Corvan

*The Best of Gracian* (p. 38)

Philosophical Library. New York, New York, USA. 1964

Wisdom does not trust to probabilities; it always marches in the midday light of reason.

In Rudolf Flesch

*The New Book of Unusual Quotations*

Harper & Row, Publishers. New York, New York, USA. 1966

It is only by mature meditation on the possibilities and probabilities of future events – that we can elude the tortuous troubles of the tomorrows.

In Thomas G. Corvan

*The Best of Gracian* (p. 22)

Philosophical Library. New York, New York, USA. 1964

**Gumperson, R. F.**

Physicist

The outcome of a given desired probability will be inverse to the degree of desirability.

Gumperson's Law

*Changing Times*, Volume 11, Number 11, November, 1957 (p. 46)

...the contradictory of a welcome probability will assert itself whenever such an eventuality is likely to be most frustrating.

Gumperson's Law  
*Changing Times*, Volume 11, Number 11, November, 1957 (p. 46)

**Hamming, Wesley Richard** 1915–98  
American mathematician

Probability is too important to be left to the experts.

*The Art of Probability for Scientists and Engineers*  
Chapter 1 (p. 4)  
Westview Press. Boulder, Colorado, USA. 1991

**Hammond, Henry**

The only seasonable inquiry is, Which is of probables the most, or of impossibles the least, such.

In Robert Sanderson and Izaak Walton  
*Works* (Volume 5)  
A Letter to Dr. Sanderson (p. 319)  
At The University Press. Oxford, England. 1854

**Harris, Errol E.**  
No biographical data available

Probability is truth in some degree...

*Hypothesis and Perception: The Roots of Scientific Method*  
The Logic of Construction (p. 342)  
George Allen & Unwin Ltd. London, England. 1970

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

We have a wraithlike quantum world of ghostly waves where all is fully determined and predictable. Yet, when we translate it into our observed world of sensible things and their events, we are limited to the concept of chance and the language of probability. What happens at the interface of the quantum world and the observed world may be this or may be that.

*Masks of the Universe*  
Chapter 8 (p. 124)  
Macmillan Publishing Company. New York, New York, USA. 1985

**Herbert, Nick**  
American physicist

probability (possibility)<sup>2</sup>  
*Quantum Reality: Beyond the New Physics*  
Chapter 6 (p. 96)  
Anchor Press. Garden City, New York, USA. 1985

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Every probability – and most of our common, working beliefs are probabilities – is provided with buffers at both ends, which break the force of opposite opinions clashing against it...

*The Autocrat of the Breakfast-Table*  
Chapter III (p. 56)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

No priest or soothsayer that ever lived could hold his own against Old Probabilities.

*Pages from an Old Volume of Life*  
Chapter X (p. 327)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Hooker, Richard** 1554–1600  
English writer and theologian

As for probabilities, what thing was there ever set down so agreeable with sound reason but some probable show against it might be made.

In S. Austin Allibone  
*Prose Quotations from Socrates to Macaulay*  
Probability  
J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Howe, E. W.**  
No biographical data available

A reasonable probability is the only certainty.  
*Sinner Sermons: A Selection of the Best Paragraphs of E.W. Howe* (p. 23)  
Girard. Kansas, USA. 1926

**Hume, David** 1711–76  
Scottish philosopher and historian

...all knowledge resolves itself into probability...

*A Treatise of Human Nature*  
Book I, Part IV, Section 1 (p. 232)  
Penguin Books. Baltimore, Maryland, USA. 1969

**Hunter, Evan** 1926–2005  
American writer

Now, your Honor; in much the same way that there are laws governing our society, there are also laws governing chance, and these are called the laws of probability, and it is against these that we must examine the use of an identical division number.

*The Paper Dragon*  
Tuesday, Chapter 6  
Delacorte Press. New York, New York, USA. 1966

**Huxley, Aldous** 1894–1963  
English writer and critic

Magic and devils offend our sense of probabilities.

*Proper Studies*  
Varieties of Intelligence (p. 7)  
Chatto & Windus. London, England. 1957

**Huxley, Thomas Henry** 1825–95  
English biologist

The scientific imagination always restrains itself within the limits of probability.

*Collected Essays* (Volume 5)  
*Science and Christian Traditions*  
Science and Pseudo-Science (p. 124)  
Macmillan & Company Ltd. London, England. 1904

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

We know nothing very certainly, but everything only probably, and the probability has degrees that are widely different.

*Oeuvres*

Complètes de Christiaan Huygens (p. 298)

Publisher undetermined

In such noble and sublime Studies as these, 'tis a Glory to arrive at Probability, and the search itself rewards the pains. But there are many degrees of Probable, some nearer Truth than others, in the determining of which lies the chief exercise of our Judgment.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their inhabitants and Productions*

Book the First. Conjectures Not Useless, Because Not Certain (p. 10)

Printed for T. Childe. London, England. 1698

**James, P. D.** 1920–

English writer

Juries hate scientific evidence.

They think they won't be able to understand it so naturally they can't understand it. As soon as you step into the box you see a curtain of obstinate incomprehension clanging down over their minds. What they want is certainty. Did this paint particle come from this car body? Answer yes or Number None of those nasty mathematical probabilities we're so fond of.

*Death of an Expert Witness*

Book II, Chapter III (p. 96)

Warner Books, Inc. New York, New York, USA. 1992

**Jefferson, Thomas** 1743–1826

3rd president of the USA

Perhaps an editor might begin a reformation in some way as this. Divide his paper into four chapters, heading the first, Truth. Second, Probabilities. Third, Possibilities. Fourth, Lies.

*The Writings of Thomas Jefferson* (Volume 9)

Letter to John Norvell, June 11, 1807

G.P. Putnam's Sons. New York, New York, USA. 1898

**Jevons, William Stanley** 1835–82

English economist and logician

It [probability] is the very guide of life, and hardly can we take a step or make a decision of any kind without correctly or incorrectly making an estimation of probabilities.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter X (p. 217)

Macmillan & Company Ltd. London, England. 1892

**Kac, Mark** 1914–84

Polish mathematician

To the author the main charm of probability theory lies in the enormous variability of its applications. Few mathematical disciplines have contributed to as wide a spectrum of subjects, a spectrum ranging from number theory

to physics, and even fewer have penetrated so decisively the whole of our scientific thinking.

*Lectures in Applied Mathematics* (Volume 1)

Probability and Related Topics in Physical Sciences, Preface (p. ix)

Interscience Publishers, Ltd. London, England. 1959

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

Equiprobability in the physical world is purely a hypothesis. We may exercise the greatest care and the most accurate of scientific instruments to determine whether or not a penny is symmetrical. Even if we are satisfied that it is, and that our evidence on that point is conclusive, our knowledge, or rather our ignorance, about the vast number of other causes which affect the fall of the penny is so abysmal that the fact of the penny's symmetry is a mere detail. Thus, the statement "head and tail are equiprobable" is at best an assumption.

*Mathematics and the Imagination*

Chance and Chanceability (p. 251)

Simon & Schuster. New York, New York, USA. 1940

**Keynes, John Maynard** 1883–1946

British economist

Part of our knowledge we obtain direct; and part by argument. The Theory of Probability is concerned with that part which we obtain by argument, and it treats of the different degrees in which the results so obtained are conclusive or inconclusive.

*A Treatise on Probability*

Chapter I (p. 3)

Macmillan & Company Ltd. London, England. 1921

...others have suggested seriously a "barometer of probability."

*A Treatise on Probability*

Chapter III (p. 20)

Harper & Row, Publishers. New York, New York, USA. 1962

Probability is, so far as measurement is concerned, closely analogous to similarity.

*A Treatise on Probability*

Chapter III (p. 28)

Harper & Row, Publishers. New York, New York, USA. 1962

It is difficult to find an intelligible account of the meaning of "probability," or of how we are ever to determine the probability of any particular proposition; and yet treatises on the subject profess to arrive at complicated results of the greatest precision and the most profound practical importance.

*A Treatise on Probability*

Chapter IV (p. 51)

Harper & Row, Publishers. New York, New York, USA. 1962

It has been pointed out already that no knowledge of probabilities, less in degree than certainty, helps us to

know what conclusions are true, and that there is no direct relation between the truth of a proposition and its probability. Probability begins and ends with probability.

*A Treatise on Probability*

Part V (p. 322)

Harper & Row, Publishers. New York, New York, USA. 1962

**Kolmogorov, Andrei N.** 1903–87

Russian physicist and mathematician

The theory of probability as mathematical discipline can and should be developed from axioms in exactly the same way as *Geometry and Algebra*.

*Foundations of the Theory of Probability*

Chapter 1. Elementary Theory of Probability (p. 1)

Chelsea Publishing Company. New York, New York, USA. 1956

**Kosko, Bart**

American engineer

Probability has turned modern science into a truth casino.

*Fuzzy Thinking*

Chapter 1 (p. 12)

Hyperion. New York, New York, USA. 1993

Which is easier to believe in, probability or God?...The ultimate fraud is the scientific atheist who believes in probability.

*Fuzzy Thinking*

Chapter 3 (p. 50)

Hyperion. New York, New York, USA. 1993

**Kyburg, Jr., H. E.**

No biographical data available

**Smokler, H. E.**

No biographical data available

...there is no problem about probability: it is simply a nonnegative, additive set function, whose maximum value is unity.

*Studies in Subjective Probability*

Introduction (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1964

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The regularity which astronomy shows us in the movements of the comets doubtless exists in all phenomena.

The curve described by a simple molecule or air or vapour is regulated in a manner just as certain as the planetary orbits; the only difference between them is that which comes from our ignorance.

*A Philosophical Essay on Probabilities*

Chapter II (p. 6)

Dover Publications, Inc. New York, New York, USA. 1951

The theory of probabilities holds to considerations so delicate that it is not surprising that with the same data two persons arrive at different results,

*A Philosophical Essay on Probabilities*

Chapter II (p. 10)

John Wiley & Sons. London, England. 1902

The probability of events serves to determine the hope or the fear of persons interested in their existence.

*A Philosophical Essay on Probabilities*

Chapter IV (p. 20)

Dover Publications, Inc. New York, New York, USA. 1951

The calculation of probabilities can make appreciable the advantages and the disadvantages of the speculative sciences. Thus in order to recognize the best of the treatments in use in the healing of a malady, it is sufficient to test each of them on an equal number of patients, making all the conditions exactly similar; the superiority of the most advantageous treatment will manifest itself more and more in the measure that the number is increased; and

the calculation will make apparent the corresponding probability of its advantage and the ratio according to which it is superior to the others.

Translated by Frederick Wilson Truscott and Frederick Lincoln Emory

*A Philosophical Essay on Probabilities*

Part II, Chapter IX (pp. 104–105)

John Wiley & Sons. New York, New York, USA. 1902

We are so far from recognizing all the agents of nature and their divers modes of action that it would be unphilosophical to deny the phenomena solely because they are inexplicable in the present state of our knowledge. But we ought to examine them with an attention as much the more scrupulous as it appears the more difficult to admit them; and it is here that the calculation of probabilities becomes indispensable in determining to just what point it is necessary to multiply the observations or the experiences in order to obtain in favor of the agents which they indicate, a probability superior to the reasons which can be obtained elsewhere for not admitting them.

*A Philosophical Essay on Probabilities*

Part II, Chapter IX (p. 105)

John Wiley & Sons. New York, New York, USA. 1902

Probability based upon a daily experience, or exaggerated by fear and by hope, strikes us more than a superior probability but it is only a simple result of calculus. Thus we do not fear in return for small advantages to expose our life to dangers much less improbable than the drawing of a quint in the lottery of France; and yet no one would wish to procure for himself the same advantages with the certainty of losing his life if this quint should be drawn.

Translated by Frederick Wilson Truscott and Frederick Lincoln

*A Philosophical Essay on Probabilities*

Chapter XVI (p. 160)

John Wiley & Sons. New York, New York, USA. 1902

One of the great advantages of the calculus of probabilities is to teach us to distrust first opinions.

Translated by Frederick Wilson Truscott and Frederick Lincoln  
*A Philosophical Essay on Probabilities*  
 Chapter XVI (p. 164)  
 John Wiley & Sons. New York, New York, USA. 1902

It is remarkable that a science, which commenced with the consideration of games of chance, should be elevated to the rank of the most important subjects of human knowledge.

*A Philosophical Essay on Probabilities*  
 Chapter XVII (p. 195)  
 Dover Publications, Inc. New York, New York, USA. 1951

**Leibniz, Gottfried Wilhelm** 1646–1716  
 German philosopher and mathematician

...the art of weighing probabilities is not yet even partly explained, though it would be of great importance in legal matters and even in the management business.

*Philosophical Papers and Letters* (Volume 1)  
 Letter to John Frederick, Duke of Brunswick Hanover (p. 399)  
 The University of Chicago Press. Chicago, Illinois, USA. 1956

**Lewis, C. S. (Clive Staples)** 1898–1963  
 British author, scholar, and popular theologian

We may not be able to get certainty, but we can get probability, and half a loaf is better than no bread.

*Christian Reflections*  
 Historicism (p. 111)  
 William B. Erdmanns Publishing. Grand Rapids, Michigan, USA. 1997

**Lewis, Clarence Irving** 1883–1964  
 American philosopher

The only knowledge a priori is purely analytic; all empirical knowledge is probable only.

*Mind and the World-Order: Outline of a Theory of Knowledge*  
 Chapter X (p. 309)  
 Charles Scribner's Sons. New York, New York, USA. 1929

There is no such thing as *the* probability of four aces in one hand, or *the* probability of anything else. Given all the relevant data which there are to be known, everything is either certainly true or certainly false.

*Mind and the World-Order: Outline of a Theory of Knowledge*  
 Chapter X (p. 330)  
 Charles Scribner's Sons. New York, New York, USA. 1929

A “poor evaluation” of the probability of anything may reflect ignorance of relevant data which “ought” to be known...

*Mind and the World-Order: Outline of a Theory of Knowledge*  
 Chapter X (p. 331)  
 Charles Scribner's Sons. New York, New York, USA. 1929

...empirical knowledge is exclusively a knowledge of probabilities...

*Mind and the World-Order: Outline of a Theory of Knowledge*  
 Chapter XI (p. 345)  
 Charles Scribner's Sons. New York, New York, USA. 1929

**Lincoln, Abraham** 1809–65  
 16th president of the USA

The probability that we may fall in the struggle ought not to deter us from the support of a cause we believe to be just; it shall not deter me.

*The Sub-Treasury*  
 Speech, Springfield, Illinois, December 26, 1839

**Lindley, Dennis V.** 1923–  
 American statistician

Are we probabilists, believers, or fuzzifiers?

Comment: A Tale of Two Wells  
*Statistical Science*, Volume 2, Number 1, February, 1987 (p. 38)

**Locke, John** 1632–1704  
 English philosopher and political theorist

Probability is the appearance of agreement upon fallible proofs.

In *Great Books of the Western World* (Volume 35)  
*An Essay Concerning Human Understanding*  
 Book IV, Chapter XV, Section 1 (p. 365)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Probability is likelihood to be true...

In *Great Books of the Western World* (Volume 35)  
*An Essay Concerning Human Understanding*  
 Book IV, Chapter XV, Section 3 (p. 365)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The mind ought to examine all the grounds of probability, and upon a due balancing the whole, reject or receive it proportionably to the preponderancy of probability on the one side or the other.

In S. Austin Allibone  
*Prose Quotations from Socrates to Macaulay*  
 Probability  
 J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Ludlum, Robert** 1927–2001  
 American author

It wasn't a probability anymore, it was a reality.

*The Bourne Supremacy*  
 Chapter 18 (p. 256)  
 Random House, Inc. New York, New York, USA. 1986

It was a desperate strategy, based on probabilities, but it was all he had left.

*The Bourne Supremacy*  
 Chapter 24 (p. 365)  
 Random House, Inc. New York, New York, USA. 1986

**Masters, Dexter** 1908–89  
 American writer

If absolutes had disappeared under the inquiries of science, and apparently they had, ...then the only rational procedure, the only procedure consistent with man's development, was to follow where the probabilities led.



*The Accident*

Part I, Chapter 3 (p. 19)

Alfred A. Knopf, New York, New York, USA. 1955

**Meyer, Agnes** 1887–1970

American author and journalist

We can never achieve absolute truth but we can live hopefully by a system of calculated probabilities. The law of probability gives to natural and human sciences – to human experience as a whole – the unity of life we seek.

*Education for a New Morality*

Chapter 3 (p. 21)

Macmillan Publishing Company, New York, New York, USA. 1957

**Moroney, Michael Joseph** 1918–90

English statistician

There are certain notions which it is impossible to define adequately. Such notions are found to be those based on universal experience of nature. Probability is such a notion. The dictionary tells me that “probable” means “likely.” Further reference gives the not very helpful information that “likely” means “probable.”

*Facts from Figures*

The Laws of Chance (p. 4)

Penguin Books Ltd, Harmondsworth, England. 1951

**Muggeridge, Malcolm** 1903–90

English journalist and social critic

The probability is, I suppose that the Monarchy has become a kind of ersatz religion. Chesterton once remarked that when people [cease] to believe in God they do not believe in nothing, but in anything.

*New Statesman*, 1955**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

...errors in judgment must occur in the practice of an art which consists largely in balancing probabilities ...

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter III (p. 40)

P. Blackiston's Sons &amp; Co, Philadelphia, Pennsylvania, USA. 1905

**Pascal, Blaise** 1623–62

French mathematician and physicist

But is it probable that probability gives assurance?

In *Great Books of the Western World* (Volume 33)*Pensées*

Section XIV, 908

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Probability – Each one can employ it; no one can take it away.

In *Great Books of the Western World* (Volume 33)*Pensées*

Section XIV, 913

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Take away probability, and you can no longer please the world; give probability, and you can no longer displease it.

In *Great Books of the Western World* (Volume 33)*Pensées*

Section XIV, 918

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearl, Judea**

Computer scientist and statistician

Probabilities are summaries of knowledge that is left behind when information is transferred to a higher level of abstraction.

*Probabilistic Reasoning in Intelligent Systems: Network of Plausible Inference*

Chapter 1 (p. 21)

Morgan Kaufmann Publishers, Inc. San Mateo, California, USA. 1988

**Pearson, E. S.** 1895–1980

English statistician

Hitherto the user has been accustomed to accept the function of probability theory laid down by the mathematicians; but it would be good if he could take a larger share in formulating himself what are the practical requirements that the theory should satisfy in applications.

The Choice of Statistical Test Illustrated on the Interpretation of Data

Classed in a 2 x 2 Table

*Biometrika*, Volume 34, Number 35, 1948 (p. 142)**Pearson, Karl** 1857–1936

English mathematician

That a certain sequence has occurred and recurred in the past is a matter of experience to which we give expression in the concept *causation*; that it will continue to recur in the future is a matter of belief to which we give expression in the concept *probability*.

*The Grammar of Science* (2nd edition)

Chapter IV (p. 113)

Adam &amp; Charles Black, London, England. 1900

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

This branch of mathematics [probability] is the only one, I believe, in which good writers frequently get results entirely erroneous.

*Writings of Charles S. Peirce* (Volume 3)

The Doctrine of Chances, II (p. 279)

Indiana University Press, Bloomington, Indiana, USA. 1986

The relative probability of this or that arrangement of Nature is something which we should have a right to talk about if universes were as plenty as blackberries, if we could put a quantity of them in a bag, shake them well up, draw out a sample, and examine them to see what proportion of them had one arrangement and what proportion another. But, even in that case, a higher universe would contain us, in regard to whose arrangements the conception of probability could have no applicability.



The Probability of Induction  
*Popular Science Monthly*, Volume 12, April, 1878 (p. 714)

...it may be doubtful if there is a single extensive treatise on probabilities in existence which does not contain solutions absolutely indefensible.

*Writings of Charles Sanders Peirce* (Volume 3)  
 The Doctrine of Chances, II (p. 279)  
 Indiana University Press. Bloomington, Indiana, USA. 1986

**Planck, Max** 1858–1947  
 German physicist

Nature prefers more probable to less probable states.... Heat flows from a body of high temperature to a body of lower temperature, because the state of equal temperature is more probable than a state of unequal distribution of temperature.

Translated by R. Jones and D.H. Williams  
*A Survey of Physics: A Collection of Lectures and Essays*  
 The Unity of the Physical Universe (p. 15)  
 Methuen & Company Ltd. London, England. 1925

**Plato** 428 BCE–347 BCE  
 Greek philosopher

I know too well that these arguments from probabilities are impostors, and unless great caution is observed in the use of them, they are apt to be deceptive.

In *Great Books of the Western World* (Volume 7)  
*Phaedo*  
 Section 92 (p. 238)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Jules Henri** 1854–1912  
 French mathematician and theoretical astronomer

No matter how solidly founded a prediction may appear to us, we are never absolutely sure that experiment will not contradict it, if we undertake to verify it.... It is far better to foresee even without certainty than not to foresee at all.

*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
 Chapter IX (p. 129)  
 The Science Press. New York, New York, USA. 1913

The very name calculus of probabilities is a paradox. Probability opposed to certainty is what we do not know, and how can we calculate what we do not know?

*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
 Chapter XI (p. 155)  
 The Science Press. New York, New York, USA. 1913

Predicted facts...can only be probable.

*The Foundations of Science*  
*Science and Hypothesis*, Part IV  
 Chapter XI (p. 155)  
 The Science Press. New York, New York, USA. 1913

**Popper, Karl R.** 1902–94  
 Austrian/British philosopher of science

The most important application of the theory of probability is to what we may call “chance-like” or “random” events, or occurrences. These seem to be characterized by a peculiar kind of incalculability which makes one disposed to believe – after many unsuccessful attempts – that all known rational methods of prediction must fail in their case. We have, as it were, the feeling that not a scientist but only a prophet could predict them. And yet, it is just this incalculability that makes us conclude that the calculus of probability can be applied to these events.

*The Logic of Scientific Discovery*  
 Part II, Chapter VII, Section 49 (p. 150)  
 Basic Books, Inc. New York, New York, USA. 1959

I think that we shall have to get accustomed to the idea that we must not look upon science as a “body of knowledge” but rather as a system of hypotheses; that is to say, as a system of guesses or anticipations which in principle cannot be justified, but with which we work as long as they stand up to tests, and of which we are never justified in saying that we know that they are “true” or “more or less certain” or even “probable.”

*The Logic of Scientific Discovery*  
 New Appendices, Two Notes on Induction and Demarcation 1933–1934 (p. 317)  
 Basic Books, Inc. New York, New York, USA. 1959

**Pratchett, Terry** 1948–  
 English author

“You haven’t heard of probability math? You, and tomorrow you become Chairman of the Board of Widdershins and heir to riches untold? Then first we will talk, and then we will eat.”

*The Dark Side of the Sun* (p. 13)  
 St. Martin’s Press. New York, New York, USA. 1976

I can’t pretend to understand probability math. But if the universe is so ordered, so – immutable – that the future can be told by a handful of numbers, then why need we go on living?

*The Dark Side of the Sun* (p. 22)  
 St. Martin’s Press. New York, New York, USA. 1976

Understanding is the first step towards control. We now understand probability...

*The Dark Side of the Sun* (p. 37)  
 St. Martin’s Press. New York, New York, USA. 1976

**Prior, Matthew** 1664–1721  
 English poet and diplomat

In this case probability must atone for want of Truth.

*The Literary Works of Matthew Prior*  
 Solomon, Preface (p. 309)  
 Clarendon Press. Oxford, England. 1959

**Ramsey, Frank Plumpton** 1903–30

English mathematician

I think I perceive or remember something but am not sure; this would seem to give me some ground for believing it, contrary to Mr. Keynes' theory, by which the degree of belief in it which it would be rational for me to have is that given by the probability relation between the proposition in question and the things I know for certain.

In R.B. Braithwaite (ed.)

*The Foundation of Mathematics and Other Logical Essays*

Truth and Probability (p. 189)

Kegan, Paul, Trench, Trubner &amp; Company. London, England. 1931

**Redfield, Roy A.**

No biographical data available

Good and bad come mingled always. The long-time winner is the man who is not unreasonably discouraged by persistent streaks of ill fortune, [who is] not at other times made reckless with the thought that he is fortune's darling. He keeps a cool head and trusts in the mathematics of probability, or as often said, the law of averages.

*Factors of Growth in a Law Practice* (p. 168)

Callaghan &amp; Company, Mundelein, Illinois, USA. 1962

**Reichenbach, Hans** 1891–1953

German philosopher of science

To say that observations of the past are certain, whereas predictions are merely probable, is not the ultimate answer to the question of induction; it is only a sort of intermediate answer, which is incomplete unless a theory of probability is developed that explains what we should mean by "probable" and on what ground we can assert probabilities.

*The Rise of Scientific Philosophy*

Chapter 5 (p. 93)

University of California Press. Berkeley, California, USA. 1951

The study of inductive inference belongs to the theory of probability, since observational facts can make a theory only probable but will never make it absolutely certain.

*The Rise of Scientific Philosophy*

Chapter 14 (p. 231)

University of California Press. Berkeley, California, USA. 1951

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

Conditional probability tends to be viewed as one technique for calculating probabilities. Actually, there is more to it than meets the eye: it has an interpretation which is ordinarily passed over in silence. Philosophers take notice.

*Indiscrete Thoughts*

Chapter XX (p. 227)

Birkhäuser. Boston, Massachusetts, USA. 1997

The distance between probability and statistical mechanics is diminishing, and soon we won't be able to tell which

is which. We will be rid of the handwaving arguments with which mathematically illiterate physicists have been pestering us.

*Indiscrete Thoughts*

Chapter XX (p. 228)

Birkhäuser. Boston, Massachusetts, USA. 1997

According to quantum mechanics, it cannot be known what an atom will do in given circumstances; there are a definite set of alternatives open to it, and it chooses sometimes one, sometimes another. We know in what proportion of cases one choice will be made, in what proportion a second, or a third, and so on. But we do not know any law determining the choice in an individual instance. We are in the same position as a booking-office clerk at Paddington, who can discover, if he chooses, what proportion of travelers from that station go to Birmingham, what proportion to Exeter, and so on, but knows nothing of the individual reasons which lead to one choice in one case and another in another.

*Religion and Science*

Determinism (p. 152)

Henry Holt &amp; Company. New York, New York, USA. 1935

**Sartre, Jean-Paul** 1905–80

French existentialist philosopher and novelist

When we want something, we always have to reckon with probabilities.

*The Philosophy of Existentialism*

Part 1. The Humanism of Existentialism (p. 46)

Philosophical Library, New York, New York, USA; 1965

...all views are only probable, and a doctrine of probability which is not bound to a truth dissolves into thin air. In order to describe the probable, you must have a firm hold on the true. Therefore, before there can be any truth whatsoever, there must be absolute truth.

*The Philosophy of Existentialism*

Part 1 The Humanism of Existentialism (p. 51)

Philosophical Library, New York, New York, USA; 1965

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

...it is better to be satisfied with probabilities than to demand impossibilities and starve.

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (p. 272)

At The Clarendon Press. Oxford, England. 1917

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

'Tis pretty, sure, and very probable...

In *Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)*As You Like It*

Act III, Scene v, l. 11

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sherwood, Thomas**

No biographical data available

It is a nice idea, of course, that numbers must prove something true: after all, one patient is a case-report, two are a series. But all that numbers can do is tell us what is probable, and probability can lead us into terrible mistakes – like Bertrand Russell's chicken. Day in, day out, throughout its life, the chicken got breakfast as the farmer arrived in the morning. Thus it had clearly discovered a highly probable natural law: farmer=food – until, that is, the morning when the farmer very naturally arrived to wring its neck instead.

Science in Radiology  
*Lancet*, Volume 1, 1978 (p. 594)

**South, Robert**

No biographical data available

That is accounted probable which has better arguments producible for it than can be brought against it.

In S. Austin Alibone  
*Prose Quotations from Socrates to Macaulay*  
Probability  
J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Stoppard, Tom** 1937–

Czech-born English playwright

If we postulate...that within un-, sub- or supernatural forces the probability is that the law of probability will not operate as a factor, then we must accept that the probability of the first part will not operate as a factor within un-, sub- or supernatural forces. And since it obviously hasn't been doing so, we can take it that we are not held within un-, sub- or supernatural forces after all; in all probability, that is.

*Rosencrantz and Guildenstern Are Dead*  
Act One (p. 17)  
Grove Press, Inc. New York, New York, USA. 1967

**The Bible (King James Version)**

For we know in part, and we prophesy in part. ...  
I Corinthians 13:9

**Tillotson, John** 1630–94

Archbishop of Canterbury

Though moral certainty be sometimes taken for a high degree of probability, which can only produce a doubtful assent, yet it is also frequently used for a firm assent to a thing upon such grounds as fully satisfy a prudent man.

In S. Austin Allibone  
*Prose Quotations from Socrates to Macaulay*  
Probability  
J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Titchener, Edward Bradford** 1867–1927

English-born American psychologist

...an argument from probability is like an India-rubber ball; you hit it, and it may fly away, or it may return to you, all the more vigorously the harder you hit.

Were the Earliest Organic Movements Conscious or Unconscious?  
*The Popular Science Monthly*, Volume LX, March, 1902 (p. 469)

**Toffler, Alvin** 1928–

American writer and futurist

The management of changes is the effort to convert certain possibles into probables, in pursuit of agreed-on preferables.

*Future Shock*  
Chapter 20 (p. 407)  
Random House, Inc. New York, New York, USA. 1979

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

From generation to generation skepticism increases; and probability diminishes; and soon probability is reduced to zero.

*The Portable Voltaire*  
Philosophical Dictionary, Truth (p. 217)  
The Viking Press. New York, New York, USA. 1959

He who has heard the thing told by twelve thousand eye-witnesses, has only twelve thousand probabilities, equal to one strong probability, which is not equal to certainty.

*The Portable Voltaire*  
Philosophical Dictionary, Truth (p. 217)  
The Viking Press. New York, New York, USA. 1959

One must take a stand, but one should not take it at random. It is therefore necessary to our weak and blind human nature, always subject to error, to study probability with as much care as we learn arithmetic and geometry.

*Oeuvres* (Volume 28)  
Essays on Probabilities Applied to the Law (p. 497)

**von Clausewitz, Carl** 1780–1831

Prussian soldier

In short, absolute, so-called mathematical factors never find a firm basis in military calculations. From the very start there is an interplay of possibilities, probabilities, good luck and bad that weaves its way throughout the length and breadth of the tapestry. In the whole range the human activities war most closely resembles a game of cards.

*On War*  
Chapter 1, 21 (p. 86)  
The Modern Library. New York, New York, USA. 1943

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Whatever must be characterized as mere probability lies beyond the domain of physical description of the universe; science must not wander into the cloudland of cosmological dreams.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 4)  
Conclusion (p. 230)  
Harper & Brothers. New York, New York, USA. 1869

**von Mises, Richard** 1883–1953  
Austrian-born American mathematician

The theory of probability can never lead to a definite statement concerning a single event.

*Probability, Statistics, and Truth*  
First Lecture (p. 33)

Dover Publications, Inc. New York, New York, USA. 1981

...if one talks of the probability that the two poems known as the Iliad and the Odyssey have the same author, no reference to a prolonged sequence of cases is possible and it hardly makes sense to assign a numerical value to such a conjecture.

*Mathematical Theory of Probability and Statistics* (pp. 13–14)  
Academic Press. New York, New York, USA. 1964

**Walker, Marshall John**  
American physicist

One can locate an octopus by giving the coordinates of his beak, but it would be unwise to forget that neighboring coordinates for two or three yards out in all directions have a considerable probability of being occupied by octopus at a given instant.

*The Nature of Scientific Thought*  
Chapter V (p. 65)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1963

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...Positivistic science is solely concerned with observed fact, and must hazard no conjecture as to the future. If observed fact be all we know, then there is no other knowledge. Probability is relative to knowledge. There is no probability as to the future within the doctrine of Positivism.

*Adventures of Ideas*  
Chapter VIII (p. 160)

The Macmillan Company. New York, New York, USA. 1956

**Whyte, Lancelot Law** 1896–1972  
Scottish physicist

Only a certain probability remains of a one-to-one association of any spatial feature now with a similar feature a moment later. It is sheer luck, in a sense, that any physical apparatus stays put, for the laws of quantum mechanics allow it a finite, though small, probability of dispersing while one is not looking, or even while one is.

*Essay on Atomism: From Democritus to 1960*  
Chapter 2 (pp. 25–26)

Wesleyan University Press. Middletown, Connecticut, USA. 1961

If the universe is a mingling of probability clouds spread through a cosmic eternity of space-time, how is there as much order, persistence, and coherent transformation as there is?

*Essay on Atomism: From Democritus to 1960*  
Chapter 2 (p. 27)

Wesleyan University Press. Middletown, Connecticut, USA. 1961

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

GILBERT: No ignoble consideration of probability, that cowardly concession to the tedious repetitions of domestic or public life, effect it ever.

*Complete Writings of Oscar Wilde* (p. 143)

Nottingham Society. New York, New York, USA. 1907

**Wilder, Thornton** 1897–1975  
American playwright and novelist

Ashley had no competitive sense and no need for money, but he took great interest in the play of numbers. He drew up charts analyzing the elements of probability in the various games. He had a memory for numbers and symbols.

*The Eighth Day*

II. Illinois to Chile (p. 123)

Harper & Row, Publishers, New York, New York, USA. 1967

**Woodward, Robert Simpson** 1849–1924  
American scientist and teacher

The theory of probabilities and the theory of errors now constitute a formidable body of knowledge of great mathematical interest and of great practical importance. Though developed largely through the applications to the more precise sciences of astronomy, geodesy, and physics, their range of applicability extends to all the sciences; and they are plainly destined to play an increasingly important role in the development and in the applications of the sciences of the future. Hence their study is not only a commendable element in a liberal education, but some knowledge of them is essential to a correct understanding of daily events.

*Probability and Theory of Errors*

Author's Preface (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1906

It is a curious circumstance that a science so profoundly mathematical as the theory of probability should have originated in the games of chance which occupy the thoughtless and the profligate.

*Probability and Theory of Errors* (4th edition)

Introduction (p. 7)

John Wiley & Sons. New York, New York, USA. 1906

## PROBABILITY HAZE

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

But it is necessary to insist more strongly than usual that what I am putting before you is a model – the Bohr model atom – because later I shall take you to a profounder level of representation in which the electron instead of being

confined to a particular locality is distributed in a sort of probability haze all over the atom.

*New Pathways in Science*

Chapter II (p. 34)

At the University Press. Cambridge, England. 1935

## PROBABILITY THEORY

**Paulos, John Allen** 1945–

American mathematician

Zealots, true believers, fanatics, and fundamentalists of all types seldom hold any truck with anything as wishy-washy as probability. May they all burn in hell for  $10^{10}$  years (just kidding), or be forced to take a course in probability theory.

*Innumeracy: Mathematical Illiteracy And Its Consequences* (p. 178)

## PROBABLE ERROR

**Herschel, Sir John Frederick**

**William** 1792–1871

English astronomer and chemist

The probable error of the whole (0.0032) shews that the mean specific gravity of this our planet is, in all human probability, quite as well determined as that of an ordinary hand-specimen in a mineralogical cabinet – a marvellous result, which should teach us to despair of nothing which lies within the compass of number, weight, and measure.

*Monthly Notices of the Royal Astronomical Society*, Volume VI, Number 10, February 9, 1838 (p. 109)

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Who ever heard a theologian preface his creed, or a politician conclude his speech with an estimate of the probable error of his opinion.

In Edwin Hubble

*The Nature of Science and Other Lectures*

Part I. The Nature of Science (p. 10)

The Huntington Library. San Marino, California, USA. 1954

## Student (William Sealy Gossett)

An experiment may be regarded as forming an individual of a “population” of experiments which might be performed under the same conditions. A series of experiments is a sample drawn from this population. Now any series of experiments is only of value in so far as it enables us to form a judgment as to the statistical constants of the population to which the experiments belong. In a great number of cases the question finally turns on the value of a mean, either directly, or as the mean difference between the two quantities.

The Probable Error of a Mean

*Biometrika*, Volume 6, 1908

## PROBLEM

**Ackerman, Diane** 1948–

American writer

Part of the irony of environmentalism is questing for solutions when you know you’re part of the problem.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Insect Love (p. 156)

Vintage Books. New York, New York, USA. 1997

**Agnew, Ralph Palmer**

American mathematician

Working a problem is like cutting down a tree and reading a problem is like looking at a tree. We spend part of our time swinging axes to develop our muscles, and we spend part of our time looking around to keep us from being dolts. The mathematical and scientific forests really are interesting, and we should all enjoy chopping and looking at the scenery.

*Differential Equations*

Chapter 1 (p. 6)

McGraw-Hill Book Company. New York, New York, USA. 1972

**Alger, John R. M.**

American engineer

**Hays, Carl V.**

No biographical data available

...a problem in the stage of being “recognized” is a highly emotional subject.

*Creative Synthesis in Design* (p. 13)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1964

**Anderson, Poul** 1926–2001

American science fiction writer

I have yet to see any problem, however complicated, which, when you looked at it in the right way, did not become still more complicated.

In William Thorpe article

Reduction v. Organicism

*New Scientist*, Volume 43, Number 66, 25 September, 1969 (p. 638)

**Bach, Richard** 1936–

American writer

There is no such thing as a problem without a gift for you in its hands. You seek problems because you need their gifts.

*Illusions: The Adventures of a Reluctant Messiah* (p. 71)

**Bahn, Paul G.**

English archaeologist and writer

It takes very special qualities to devote one’s life to problems with no attainable solutions and to poking around in dead people’s garbage: words like “masochistic”, “nosy”, and “completely batty” spring readily to mind.

*Bluff Your Way in Archaeology* (p. 7)

Ravette Books. West Sussex, England. 1989



**Ball, Sir Robert Stawell** 1840–1913  
Irish astronomer

...the genuine student of Nature loves to get to the heart of a great problem like this; he loves to be able to follow it, not through mere formulae or abstract principles, but so as to be able to visualize its truth and feel its certainty.

*Essays in Astronomy*

Atoms and Sunbeams (p. 4)

D. Appleton & Co. New York, New York, USA. 1900

**Bateson, William** 1861–1926  
English geneticist

Though the problem [of evolution] is all unsolved and the old questions stand unanswered, there are those who have taken on themselves the responsibility of giving to the ignorant, as a gospel, in the name of Science, the rough guesses of yesterday that tomorrow should forget.

*Materials for the Study of Variation Treated With Especial Regard to Discontinuity in the Origins of Species*

Preface (p. xii)

Macmillan & Co Ltd. London, England. 1894

**Berkeley, Edmund C.** 1909–88  
American computer theoretician

Most problems have either many answers or no answer. Only a few problems have a single answer.

Right Answers – A Short Guide for Obtaining Them

*Computers and Automation*, Volume 18, Number 10, September, 1969 (p. 20)

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

Too often I have been able to [do] little more than indicate the difficulties likely to be met – yet merely to be forewarned is often help.

*The Art of Scientific Investigation*

Preface (p. ix)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bloch, Arthur** 1948–  
American humorist

Inside every large problem is a small problem struggling to get out.

*Murphy's Law*

Hoare's Law of Large Problems (p. 50)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Bragg, Sir William Lawrence** 1890–1971  
Australian-born English physicist

I am sure that when the first circumnavigators of the world returned from their voyage they were told by friends that some Greek philosopher...had held that the world was round and that they might have spared their trouble. The world is either round or flat, and endless discussion might have been carried on for ages between opposing schools who held one view or the other. The real contribution to settling the problem was made by the circumnavigators.

The Physical Sciences

*Science*, Volume 79, Number 2046, March 16, 1934 (p. 240)

**Chambers, Robert** 1802–71  
Scottish journalist and geologist

Man is seen to be an enigma only as an individual; in mass, he is a mathematical problem.

*Vestiges of the Natural History of Creation* (p. 333)

W.R. Chambers. Edinburgh, Scotland. 1884

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

It isn't that they can't see the solution. It is that they can't see the problem.

*The Scandal of Father Brown*

The Point of the Pin (p. 949)

Dodd, Mead & Company. New York, New York, USA. 1935

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

In the course of a few bewildering years we have found ourselves the master or indeed the servants of gigantic powers which confront us with problems never known before.

In R. James (ed.)

*Winston S. Churchill – His Complete Speeches 1897–1963*

Volume 8 (p. 8563)

Chelsea House Publishers. New York, New York, USA. 1974

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Sorry to interrupt the festivities, but we have a problem.

*2001: A Space Odyssey*

IV Abyss, Chapter 21 (p. 120)

New American Library, New York, New York, USA. 1968

**Cleaver, Eldridge** 1935–98  
American civil rights leader and author

...you're either part of the solution or part of the problem.

Speech

San Francisco, 1968

**Cohen, I. Bernard** 1914–2003  
American physicist and science historian

The fundamental postulate of the history of science is that the scientists of the past were just as intelligent as we are and that, therefore, the problems that baffled them would have baffled us too, had we been living then.

*Franklin and Newton*

Chapter Two (p. 39)

Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

You can only solve a problem which you recognize to be a problem.

*The New Leviathan; or Man, Society, Civilization and Barbarism*

Part I, Chapter I, aphorism 2.66 (p. 13)

At The Clarendon Press. Oxford, England. 1942



**Commoner, Barry** 1917–  
American biologist, ecologist, and educator

The freedom to choose his own problem is often the scientist's most precious possession.  
Is Science Getting Out of Hand?  
*The Science Teacher*, Volume 30, October, 1963

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

Neither curiosity nor ingenuity is a modern impulse.... The distinctive feature of science and technology at the present time is the accelerated pace of their development. This is partly due to continually improved techniques and organization, and it is partly due to the great accumulation of knowledge and art, because the more information and tools we have at our disposal, the more powerful can be the attack on any new problem.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (pp. 1–2)  
Undergraduate Association, Massachusetts Institute of Technology.  
Cambridge, Massachusetts, USA. 1955

**Condorcet, Marie Jean** 1743–94  
French philosopher and mathematician

If a scholar poses himself a new problem, he can attack it fortified by the pooled resources of all his predecessors.  
In Maurice Daumas  
*Scientific Instruments of the 17th and 18th Centuries and Their Makers*  
Eulogy for J. de Vaucanson before the Academie of Sciences (p. 119)

**Cross, Hardy** 1885–1959  
American professor of civil and structural engineering

In general the problems of civil engineers are given to them by God Almighty. They are the problems of nature. On the other hand mechanical and electrical work has problems which man, to a certain extent, has created for himself.  
In Lenox H. Lohr  
*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*  
Professional Aspects of Mechanical Engineering (p. 150)  
Centennial of Engineering. Chicago, Illinois. 1952

**Dantzig, George Bernard** 1914–2005  
American mathematician

If I had known that the problems were not homework but were in fact two famous unsolved problems in statistics, I probably would not have thought positively, would have become discouraged, and would never have solved them.  
In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 68)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Darbishire, Arthur Dukinfield** 1879–1915  
Statistician

...problems originate in our mind, but no sooner have they taken shape than, all unknown to us because we will not turn the eye inwards and keep guard on our mind, they are swept out, by the current of our interest, to the sea of things. When they have arrived there we become conscious of them for the first time, and so we think that we have found them there.

*An Introduction to a Biology*  
Chapter I (pp. 8–9)  
Funk & Wagnalls Co. New York, New York, USA. 1917

**Darwin, Charles Galton** 1809–82  
English naturalist

It has often and confidently been asserted, that man's origin can never be known: but ignorance more frequently begets confidence than it does knowledge: it is those who know little, and not those who know much, who so positively assert that this or that problem will never be solved by science.  
&

...it is those who know little, and not those who know much who so positively assert that this or that problem will never be solved by science.  
*The Descent of Man and Selection in Relation to Sex* (2nd edition)  
Introduction (p. 2)  
D. Appleton & Co. New York, New York, USA. 1898

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

...one does not really understand a scientific problem unless one knows at least in rough outline how it came to be formulated.  
In Robert M. Hutchins and Mortimer J. Adler  
*The Great Ideas Today* 1974  
*Advancement and Obsolescence in Science* (p. 54)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1975

**Douglas, A. Vibert** 1894–1988  
Canadian astronomer

It is a solemn thought that no man liveth unto himself. It is equally true that no star, no atom, no electron, no ripple of radiant energy, exists unto itself. All the problems of the physical universe are inextricably bound up with one another in the relations of space and time.  
From Atoms to Stars  
*The Atlantic Monthly*, Volume 144, August, 1929 (p. 165)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Every problem becomes very childish when once it is explained to you...

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of the Dancing Men* (p. 258)  
 Wings Books. New York, New York, USA. 1967

“My mind,” he said, “rebels at stagnation. Give me problems, give me work, give me the most abstruse cryptogram, or the most intricate analysis, and I am in my own proper atmosphere.”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Sign of the Four*, Chapter 1 (p. 611)  
 Wings Books. New York, New York, USA. 1967

In solving a problem of this sort, the grand thing is to be able to reason backwards. That is a very useful accomplishment, and a very easy one, but people do not practice it much. In the every-day affairs of life it is more useful to reason forwards, and so the other comes to be neglected. There are fifty who can reason synthetically for one who can reason analytically.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*A Study in Scarlet*, Chapter 14 (p. 231)  
 Wings Books. New York, New York, USA. 1967

It is quite a three pipe problem, and I beg that you won't speak to me for fifty minutes.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Red-Headed League* (p. 428)  
 Wings Books. New York, New York, USA. 1967

### **du Preez, Peter**

No biographical data available

The reason for the rapid advance of the problem-solving capacity of natural sciences is that scientists are trained to introduce theoretical variations, to test them empirically, and to preserve and propagate those innovations which survive whatever tests have been proposed.

*A Science of Mind: The Quest for Psychological Reality*  
 Part II, Chapter 7 (p. 123)  
 Academic Press Ltd. London, England. 1991

### **Dyson, Freeman J.** 1923–

American physicist and educator

The difference between a text without problems and a text with problems is like the difference between learning to read a language and learning to speak it.

*Disturbing the Universe* (p. 13)  
 Harper & Row, Publishers. New York, New York, USA. 1979

### **Easton, Elmer C.**

No biographical data available

All of the problems with which engineers are normally concerned have to do with the satisfying of some human want.

An Engineering Approach to Creative Thinking  
*Ceramic Age*, September, 1955 (p. 28)

### **Ehrenberg, A. S. C.**

No biographical data available

Many problems arise year after year. The answers, if only we knew them, should therefore also be similar year after year.

*Data Reduction*  
 Chapter 4 (p. 56)  
 John Wiley & Sons Ltd. London, England. 1975

### **Einstein, Albert** 1879–1955

German-born physicist

There are so many unsolved problems in physics. There is so much that we do not know; our theories are far from adequate.

In I. Bernard Cohen  
 An Interview with Einstein  
*Scientific American*, Volume 193, Number 1, July, 1955 (p. 69)

Recently I have been working on a difficult problem. Today I come here to battle against that problem with you.

How I Created the Theory of Relativity  
*Physics Today*, August, 1982 (p. 46)

### **Einstein, Albert** 1879–1955

German-American physicist

### **Infeld, Leopold** 1898–1968

Polish physicist

The importance of a problem should not be judged by the number of pages devoted to it.

*The Evolution of Physics*  
 Preface (p. ix)  
 Simon & Schuster. New York, New York, USA. 1961

The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill.

*The Evolution of Physics*  
 The Velocity of Light (p. 95)  
 Simon & Schuster. New York, New York, USA. 1936

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

“What we know, is a point to what we do not know.”  
 Open any recent journal of science, and weigh the problems suggested concerning Light, Heat, Electricity, Magnetism, Physiology, Geology, and judge whether the interest of natural science is likely to be soon exhausted.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)  
*Nature: Addresses, and Lectures*  
 Nature, Chapter V (p. 39)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Enriques, Federigo** 1871–1946

Italian mathematician

In a broad sense there are no insoluble problems, since every problem corresponds to a feeling, often obscure,

which may be satisfied by the discovery of some new fact that increases our power over the external world. There are only problems not yet suitably expressed, and idle discussions, void of sense, in which through defect of method, we at times wander far from our actual goal, because we do not know how to set it clearly before us, and so are seeking an answer to ill formulated questions.

*Problems of Science*

Introduction (p. 5)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

**Euler, Leonhard** 1707–83

Swiss mathematician and physicist

There must be a double method for solving mechanical problems: one is the direct method founded on the laws of equilibrium or of motion; but the other one is by knowing which formula must provide a maximum or a minimum. The former way proceeds by efficient causes: both ways lead to the same solution, and it is such a harmony which convinces us of the truth of the solution, even if each method has to be separately founded on indubitable principles. But is often very difficult to discover the formula which must be a maximum or minimum, and by which the quantity of action is represented.

In Giorgio de Santillani

*Daedalus*

The Seventeenth-century Legacy: Our Mirror of Being

Volume 87, Number 1, Winter 1958 (p. 41)

**Feynman, Richard P.** 1918–88

American theoretical physicist

No problem can be solved without it dragging in its wake new problems to be solved.

*Selected Papers of Richard Feynman with Commentary*

The Present Status of Quantum Electrodynamics (p. 134)

World Scientific. Singapore. 2000

If we want to solve a problem that we have never solved before, we must leave the door to the unknown ajar.

*What Do You Care What Other People Think?*

The Value of Science (p. 247)

W. W. Norton & Company, Inc. New York, New York, USA. 1988

**Fleming, J. A.**

No biographical data available

Whilst we derive satisfaction from the thought that so much valuable discovery and invention has already rewarded the labors of workers in many lands, we have but to glance around us to see in all directions, in connection with it, unsolved problems, untrodden paths, wide fields of knowledge ripe for harvest in which the sickle of the reaper has never yet been moved.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Recent Contributions to Electric Wave Telegraphy (p. 193)

Government Printing Office. Washington, D.C. 1908

**Flexner, Abraham** 1866–1959

American educator

...science, in the very act of solving problems, creates more of them.

*Universities: American, English, German*

Chapter I, Section v (p. 19)

Oxford University Press, Inc. Oxford, England. 1930

**Frazier, A. W.**

No biographical data available

Often problems not solved earlier have not been posed earlier.

The Practical Side of Creativity

*Hydrocarbon Processing*, Volume 45, Number 1, January, 1966

**Fredrickson, A. G.** 1932–

No biographical data available

To be aware that a problem exists is the prerequisite for any attempt to solve the problem.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 148)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

...without a commitment to science and rationality in its proper domain, there can be no solution to the problems that engulf us. Still, the Yahoos never rest.

*Ever Since Darwin: Reflections in Natural History*

Chapter 17 (p. 146)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Halmos, Paul R.** 1916–2006

Hungarian-born American mathematician

A teacher who is not always thinking about solving problems – ones he does not know the answer to – is psychologically simply not prepared to teach problem solving to his students.

*I Want to Be a Mathematician*

Chapter 14 (p. 322)

Springer-Verlag. New York, New York, USA. 1985

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

Chess problems are the hymn-tunes of mathematics.

*A Mathematician's Apology*

Section 10 (p. 87)

Cambridge University Press. Cambridge, England. 1967

**Hawkins, D.**

No biographical data available

There are many things you can do with problems besides solving them. First you must define them, pose them. But then of course you can also refine them, depose them, or expose them or even dissolve them! A given problem

may send you looking for analogies, and some of these may lead you astray, suggesting new and different problems, related or not to the original. Ends and means can get reversed. You had a goal, but the means you found didn't lead to it, so you found a new goal they did lead to. It's called play. Creative mathematicians play a lot; around any problem really interesting they develop a whole cluster of analogies, of playthings.

In Necia Grant Cooper (ed.)

*From Cardinals to Chaos*

The Spirit of Play (p. 44)

Cambridge University Press. Cambridge, England. 1988

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...only those revolutions in science will prove fruitful and beneficial whose investigators try to change as little as possible and limit themselves to the solution of a particular and clearly defined problem. Any attempt to make a clean sweep of everything or to change things arbitrarily leads to utter confusion.

*Physics and Beyond: Encounters and Conversations*

Chapter 12 (p. 148)

Harper & Row, Publishers. New York, New York, USA. 1971

### **Heller, Joseph** 1923–99

American writer

He was pinched perspiringly in the epistemological dilemma of the skeptic, unable to accept solutions to problems he was unable to dismiss as unsolvable. He was never without misery and never without hope.

*Catch-22*

Chapter 25 (p. 275)

Dell Publishing Company, Inc. New York, New York, USA. 1985

### **Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

The great problems which offer themselves on all hands for solution, problems which the wants of the age force upon us as practically interesting, and with which its intellect feels itself competent to deal, are far more complex in their conditions, and depend on data which to be of use must be accumulated in far greater masses, collected over an infinitely wider field, and worked upon with a greater and more systematized power than has sufficed for the necessities of astronomy. The collecting, arranging, and duly combining these data are operations which, to be carried out to the extent of the requirements of modern science, lie utterly beyond the reach of all private industry, mean, or enterprise. Our demands are not merely for a slight and casual sprinkling to refresh and invigorate an ornamental or luxurious product, but for a copious, steady, and well-directed stream, to call forth from a soil ready to yield it, an ample, healthful, and remunerating harvest.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Terrestrial Magnetism (pp. 110–111)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

### **Herstein, I. N.**

No biographical data available

The value of a problem is not so much in coming up with the answer as in the ideas and attempted ideas it forces on the would-be solver.

*Topics in Algebra*

Preface (p. vi)

Xerox College Publishing. Waltham, Massachusetts, USA, 1964

### **Hertz, Heinrich** 1857–94

German physicist

The most direct, and in a sense the most important, problem which our conscious knowledge of nature should enable us to solve is the anticipation of future events, so that we may arrange our present affairs in accordance with such anticipation.

Translated by Daniel Evan Jones and John Thomas Walley

*The Principles of Mechanics Presented in a New Form*

Introduction (p. 1)

Macmillan & Company Ltd. London, England. 1899

### **Hilbert, David** 1862–1943

German mathematician

As long as a branch of science offers an abundance of problems, so long is it alive; a lack of problems foreshadows extinction of the cessation of independent development. Just as every human undertaking pursues certain objects, so also mathematical research requires its problems. It is by the solution of problems that the investigator tests the temper of his steel; he finds new methods and new outlooks, and gains a wider and freer horizon.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902 (p. 438)

It is difficult and often impossible to judge the value of a problem correctly in advance; for the final award depends upon the gain which science obtains from the problem.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902 (p. 438)

### **Hodnett, Edward** 1901–84

Illustration historian

...being able to predict which problems you are not likely to solve is good for your peace of mind.

*The Art of Problem Solving*

Part I, Chapter 1 (p. 6)

Harper & Brothers. New York, New York, USA. 1955

You have to identify the real problem, and you have to identify the total problem.

*The Art of Problem Solving*

Part I, Chapter 2 (p. 12)

Harper & Brothers. New York, New York, USA. 1955

An unstated problem cannot be solved. Many problems go unsolved for centuries for lack of adequate statement.

*The Art of Problem Solving*

Part I, Chapter 3 (p. 19)

Harper & Brothers. New York, New York, USA. 1955

Problems often boil down to the simple form of a dilemma. A dilemma presents a choice of two solutions to a problem, both of which are unsatisfactory.

*The Art of Problem Solving*

Part II, Chapter 8 (p. 63)

Harper & Brothers. New York, New York, USA. 1955

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

It is almost a matter of principle that in any difficult unsolved problem the right method of attack has not been found; failure to solve important problems is rarely due to the inadequacy in the handling of technical details.

*Man in the Universe*

Chapter 2 (p. 20)

Columbia University Press. New York, New York, USA. 1966

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

The time has gone by when the intelligent public needs to be reminded of the practical utility of science, or of the fact that the investigation of any problem, however apparently remote from everyday life, may be fraught with the most valuable consequences.

Searching for the Elixir of Life

*The Century Illustrated Monthly Magazine*, Volume 103, Number 4,

February, 1922 (p. 629)

**Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

When you are trying to solve problems and are searching for new and creative ideas, let your mind be freewheeling. Enjoy unbridled fancy. After you get an idea that seems important and plausible, it can be tested by evidence and reason.

*Is It Really So?: A Guide to Clear Thinking*

Chapter 18 (p. 129)

The Westminster Press. Philadelphia, Pennsylvania, USA. 1976

**Jevons, William Stanley** 1835–82

English economist and logician

In truth men never can solve problems fulfilling the complex circumstances of nature. All laws and explanations are in a certain sense hypothetical, and apply exactly to nothing which we can know to exist.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XXI (p. 458)

Macmillan & Co Ltd. London, England. 1877

The faculties of the human mind, even when aided by the wonderful powers of abbreviation conferred by analytical methods, are utterly unable to cope with the complications of any real problem.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Chapter XXI (p. 461)

Macmillan & Co Ltd. London, England. 1887

**Kaplan, Abraham** 1918–1993

American philosopher of science, author, and educator

Give a small boy a hammer and he will find that everything he encounters needs pounding. It comes as no particular surprise that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is skilled...

*The Conduct of Inquiry: Methodology for Behavioral Science* (p. 28)

Chandler Publishing Company. San Francisco, California, USA. 1964

**Kaplansky, Irving** 1917–2006

Canadian-born American mathematician

Sometimes when you work through an example, you suddenly get an insight which you wouldn't have got if you'd just been working abstractly with the hypothesis of your future theorem. I guess both of these are obvious pieces of advice, but they are ignored more often than they should be... if the problem is worthwhile, give it a good try. Take months, maybe years if necessary, before you announce to the world, "This is as far as I can go..."

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 131)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

A problem is not solved in a laboratory. It is solved in some fellow's head. All the apparatus is for is to get his head turned around so that he can see the thing right.

In T.A. Boyd

*Professional Amateur*

Part II Chapter XII (pp. 102–103)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

But in picking that problem be sure to analyze it carefully to see that it is worth the effort. It takes just as much effort to solve a useless problem as a useful one.

*Short Stories of Science and Invention: A Collection of Radio Talks by*

*C.F. Kettering*

Research Is a State of Mind (p. 11)

General Motors, Detroit, Michigan, USA. 1955

I often think we have so many facilities that we lose track of the problem. Problems, as you know, are solved in the mind of some intensely interested person.

*Short Stories of Science and Invention: A Collection of Radio Talks by*

*C.F. Kettering*

Christmas Lecturer (p. 57)

General Motors, Detroit, Michigan, USA. 1955



No one should pick a problem, or make a resolution, unless he realizes that the ultimate value of it will offset the inevitable discomfort and trouble that always goes along with the accomplishment of anything worthwhile. So let us not waste our time and effort on some trivial thing.

*Short Stories of Science and Invention: A Collection of Radio Talks by C.F. Kettering*  
Patience (p. 59)  
General Motors. Detroit, Michigan, USA. 1955

As long as we try and patiently do our best to solve the problem, although we may not get the answer we are looking for, we always get something – even if it is only the valuable experience.

*Short Stories of Science and Invention: A Collection of Radio Talks by C.F. Kettering*  
Purple Dye, Sun Glasses and Malaria (p. 115)  
General Motors. Detroit, Michigan, USA. 1955

### Kiepenheuer, Karl

No biographical data available

For the astronomer, the inexhaustible store of problems in the world he has set out to conquer remains the real mainspring of all his arduous researches.

*The Sun*  
Conclusion (p. 158)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

### Laudan, Larry 1941–

American philosopher of science

...unsolved problems generally count as genuine problems only when they are no longer unsolved.

*Progress and Its Problems*  
Chapter One (p. 18)  
University of California Press. Berkeley, California, USA.

### Lewis, Gilbert Newton 1875–1946

American chemist

Indeed it seems hardly likely that much progress can be made in the solution of the difficult problems relating to chemical combination by assigning in advance definite laws of force between the positive and negative constituents of an atom, and then on the basis of these laws building up mechanical models of the atom.

*The Atom and the Molecule*  
*Journal of the American Chemical Society*, Volume 38, Number 1, 1916 (p. 773)

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

There is no problem in all mathematics that cannot be solved by direct counting. But with the present implements of mathematics many operations can be performed in a few minutes which without mathematical methods would take a lifetime.

*Popular Scientific Lectures*

*The Economical Nature of Physical Inquiry* (p. 197)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1898

It is characteristic of the naïve and sanguine beginnings of thought in youthful men and nations, that all problems are held to be soluble and fundamentally intelligible on the first appearance of success.

Translated by Thomas J. McCormack  
*Popular Scientific Lectures* (2nd edition)  
The Part Played by Accident in Invention and Discovery (p. 259)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

No man should dream of solving a great problem unless he is so thoroughly saturated with his subject that everything else sinks into comparative insignificance.

*Popular Scientific Lectures*  
The Part Played by Accident in Invention and Discovery (pp. 273–274)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Every real problem can and will be solved in due course without supernatural divination, entirely by accurate observation and close, searching thought.

*Popular Scientific Lectures*  
On Sensations of Orientation (p. 308)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1898

### Maddox, John Royden 1925–

Welsh chemist and physicist

The problems that remain unsolved are gargantuan. They will occupy our children and their children and on and on for centuries to come, perhaps even for the rest of time.

*What Remains to Be Discovered*  
Conclusion (p. 378)  
The Free Press. New York, New York, USA. 1998

### Maschke, Heinrich

German mathematician

...it is the *man*, not the *method*, that solves the problem.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 1  
On Present Problems of Algebra and Analysis (p. 530)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1905

### Michener, James A. 1907?–97

American novelist

At NACA [fictional space agency] we solve everything eventually. That's our job, and now it's yours.... At NACA...there are no insoluble problems. Only time-consuming ones.

*Space*  
Chapter III (p. 175)  
Random House, Inc. New York, New York, USA. 1982

### Mitchel, Ormsby MacKnight 1805–62

American astronomer

I shall...fearlessly attempt such an exposition of the processes and trains of reasoning by which great truths have been elicited, as to show every intelligent mind that the problem is not impossible; by simplicity of language, by



familiar illustrations, to fling light enough upon these mysterious propositions, to show a pathway, though it be dim and rugged, still a pathway, which if pursued shall certainly lead to a full and perfect solution.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Lecture I (p. 21)

Baker & Scribner. New York, New York, USA. 1848

**Nehru, Jawaharlal** 1889–1969

Former prime minister of India

It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people.

Speech

*Proceedings of the National Institute of Science of India*, Volume 27,  
1960 (p. 564)

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

Great and numerous as are the unsolved problems of our science, knowledge is now advancing into regions which, a few years ago, seemed inaccessible. Where it will stop none can say.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*  
Chapter I (p. 17)

Harper & Brothers Publishers. New York, New York, USA. 1906

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

There are dreadful people who, instead of solving a problem, complicate it for those who deal with it and make it harder to solve. Whoever does not know how to hit the nail on the head should [be] entreated not [to] hit it at all.

*The Complete Works of Friedrich Nietzsche* (Volume Seven)

Human, All Too Human

The Wanderer and His Shadow, Part Two, Number 326

Macmillan Publishing Company. New York, New York, USA. 1924

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

... we probably have no very good idea today of the range of problems that will be accessible to science.

*The Flying Trapeze: Three Crises for Physicists*

Space and Time (p. 2)

Oxford University Press, Inc. London, England. 1964

**Osborn, Henry Fairfield** 1857–1935

American paleontologist and geologist

As in every other branch of science, problems multiply like the heads of hydra; no sooner is one laid low than a number of new ones appear; yet we stand on the shoulders of preceding generations, so that if our philosophical vision be correct, we gain a wider horizon, while the horizon itself is constantly expanding by discovery.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 4

The Present Problems of Paleontology (p. 566)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**Pagels, Heinz R.** 1939–88

American physicist and science writer

... I solve problems, rarely through a rationally deductive process. Instead I value a free association of ideas, a jumble of three or four ideas bouncing around in my mind. As the urge for resolution increases, the bouncing around stops and I settle on just one idea or strategy.

*The Dreams of Reason*

Chapter 5 (p. 97)

Simon & Schuster. New York, New York, USA. 1988

**Pallister, William Hales** 1877–1946

Canadian physician

Science solves life's problems, but she must solve them one-at-a-time. Her course and methods are evolutionary. She cannot solve insoluble problems; they must first become soluble. She grows, like every other plant, only from powdered rock, uses only the chemical constituents which are soluble.

*Poems of Science*

The Nature of Things (p. 14)

Playford Press. New York, New York, USA. 1931

**Pearse, A. S.**

No biographical data available

A scientist has his circulating medium in problems. He deals in and develops problems as a broker deals in stocks and bonds. When his problems are completed he "sells" them to the scientific world by publication, usually at his own expense.

Adventure, Romance and Science

*Science*, Volume 58, Number 1492, 3 August, 1923 (p. 78)

**Pendry, John** 1944–

English theoretical physicist

It has been said that tackling a new scientific problem is like going into a darkened room. First you fall over the furniture, then you collide with other people in the room; arguments might develop. With time things settle down, as you learn where most of the furniture is and don't fall over so often. Eventually someone finds the light switch and everything becomes obvious.

Positively Negative

*Nature*, Volume 423, Number 6935, May 1, 2003 (p. 22)

**Poe, Edgar Allan** 1809–49

American short story writer

The great problem is at length solved! The air, as well as the earth and the ocean, has been subdued by science, and will become a common and convenient highway for mankind.

In H. Beaver (ed.)

*The Science Fiction of Edgar Allan Poe*

The Balloon Hoax (p. 11)

Penguin Books. Hammondsworth, England. 1976

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

We have had prophets of evil. They blithely reiterate that all problems capable of solution have already been solved and that nothing is left but gleaning. Happily the case of the past reassures us. Often it was thought all problems were solved or at least an inventory was made of all admitting solutions. And then the sense of the word solution enlarged, and insoluble problems became the most interesting of all, and others unforeseen presented themselves.... The pessimists thus found themselves always outflanked, always forced to retreat, so that at present I think there are no more.

In G.B. Halsted (trans.)

*The Foundations of Science**Science and Method*, Book I

Chapter II (p. 369)

The Science Press. New York, New York, USA. 1913

To give a complete mechanical explanation of electrical phenomena, reducing the laws of physics to the fundamental principles of dynamics is a problem that has attracted many investigators.... If the problem admitted of only one solution, the possession of this solution, which would be the truth, could not be bought too dearly.

In Frederick Vreeland

*Maxwell's Theory and Wireless Telegraphy. Part 1. Maxwell's Theory and Hertzian Oscillations. Part 2*

Part One, Chapter I (p. 1)

McGraw Publishing Company. New York, New York, USA. 1904

**Pólya, George** 1887–1985

Hungarian mathematician

Solving problems is a practical art, like swimming, or skiing, or playing a piano; you can learn it only by imitation and practice...

*Mathematical Discovery; or Understanding, Learning, and Teaching**Problem Solving* (Volume 1)

Preface (p. v)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1966

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Science never pursues the illusory aim of making its answers final or even probable. Its advance is rather toward an infinite yet attainable aim: that of ever discovering new, deeper, and more general problems.

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 281)

Basic Books, Inc. New York, New York, USA. 1959

...a young scientist who hopes to make discoveries is badly advised if his teacher tells him: "Go round and observe" and...well advised if his teacher tells him: "Try to learn what people are discussing nowadays in science. Find out where difficulties arise, and take an interest in disagreements. These are the questions which you should

take up." In other words, you should study the problems of the day. This means that you pick up, and try to continue, a line of inquiry which has the whole background of the earlier development of science behind it.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 4 (p. 129)

Harper &amp; Row, Publishers. New York, New York, USA. 1963

...science should be visualized as progressing from problem to problem – to problems of ever increasing depth.... Problems crop up especially when we are disappointed in our expectations, or when our theories involve us in difficulties, in contradictions; and these may arise either within a theory, or between two different theories, or as the result of a clash between our theories and our observations.... Thus science starts from problems, and not from observations; though observations may give rise to a problem, especially if they are unexpected; that is to say, if they clash with our expectations or theories.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10, Section VI (p. 222)

Harper &amp; Row, Publishers. New York, New York, USA. 1963

...I think there is only one way to science – or to philosophy, for that matter: to meet a problem, to see its beauty and fall in love with it; to get married to it, and to live with it happily, till death do ye part – unless you should meet another and even more fascinating problem, or unless, indeed, you should obtain a solution. But even if you do obtain a solution, you may then discover, to your delight, the existence of a whole family of enchanting though perhaps difficult problem children for whose welfare you may work, with a purpose, to the end of your days.

*Realism and the Aim of Science*

Preface, 1956 (p. 8)

Rowman &amp; Littlefield. Totowa, New Jersey, USA.

**Porter, George** 1920–2002

English chemist

To solve a problem is to create new problems, new knowledge immediately reveals new areas of ignorance, and the need for new experiments.

*Nobel Lectures, Chemistry 1963–1970*

Nobel lecture for award received in 1967

Flash Photolysis and Some of Its Applications (p. 261)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Rabinow, Jacob** 1910–99

Inventor

...the creating of the problem is as big an invention as the solving of the problem – sometimes, a much greater invention.

In Daniel V. DeSimone

*Education for innovation*

The Process of Invention (p. 84)

Pergamon Press. New York, New York, USA. 1968

**Ramón y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

I believe that excessive admiration for the work of great minds is one of the most unfortunate preoccupations of intellectual youth – along with a conviction that certain problems cannot be attacked, let alone solved, because of one’s relatively limited abilities.

*Advice for a Young Investigator*  
Chapter 2 (p. 9)

The MIT Press. Cambridge, Massachusetts, USA. 1999

The forging of new truth almost always requires severe abstention and renunciation. During the so-called intellectual incubation period, the investigator should ignore everything unrelated to the problem of interest, like a somnambulist attending only to the voice of the hypnotist.

*Advice for a Young Investigator*  
Chapter 3 (p. 35)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rapoport, Anatol** 1911–  
Russian-born mathematician and biologist

...the problems scientists are called on to solve are for the most part selected by the scientists themselves. For example, our Department of Defense did not one day decide that it wanted an atomic bomb and then order the scientists to make one. On the contrary, it was Albert Einstein, a scientist, who told Franklin D. Roosevelt, a decision maker, that such a bomb was possible.

*Science, Conflict and Society: Readings from Scientific American*  
The Use and Misuse of Games Theory (p. 286)

W. H. Freeman & Company. San Francisco, California, USA. 1969

**Raymond, Eric S.**  
No biographical data available

Often, the most striking and innovative solutions come from realizing that your concept of the problem was wrong.

*The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*

The Cathedral and the Bazaar (p. 40)  
O’Riley. Beijing, China. 2001

**Rigutti, Mario**  
No biographical data available

An unsolvable problem is not a mystery; it is just a problem that cannot be solved. Practically speaking, unsolvable problems and mysteries may be the same thing; but psychologically they are quite different. Confronted with a mystery, people stutter, quake, fall to their knees, build golden idols. Confronted with an unsolvable problem, at worst people give up trying, accept their limitations, and turn to more constructive activities. They do not need to invent all-powerful gods and end up feeling like powerless pawns in a game whose rules they will never know. They can keep their humanity.

Translated by Mirella Giacconi  
*A Hundred Billion Stars*  
Conclusion (p. 266)  
The MIT Press. Cambridge, Massachusetts, USA. 1984

**Roszak, Theodore** 1933–  
American social critic

If a problem does not have a technical solution, it must not be a real problem. It is but an illusion...a figment born of some regressive cultural tendency.

*The Making of a Counter Culture: Reflections on the Technocratic Society and Its Youthful Opposition*

Chapter I (p. 10)  
Doubleday & Company, Inc. Garden City, New York, USA; 1969

**Rudin, Mary Ellen** 1924–  
American mathematician

I say that there are lots of problems in mathematics that are interesting but have not been solved, and every time you solve one you think up a new one. Mathematics, therefore, is something that expands rather than contracts. And I tell that these questions are interesting just because you’ve followed a line of reasoning up to a certain point and the next natural thing to ask is what you’re looking at. But that’s really not explaining to them what kinds of things might be interesting to me. Sometimes that’s pretty hard to explain – even to another mathematician.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 301)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

I am sorry that I have had to leave so many problems unsolved. I always have to make this apology, but the world really is rather puzzling and I cannot help it.

In John G. Slater (ed.)  
*The Collected Papers of Bertrand Russell* (Volume 8)  
The Philosophy of Logical Atomism  
Lecture V (p. 211)  
George Allen & Unwin Ltd. London, England. 1986

**Russell, Henry Norris** 1877–1957  
American astronomer

The unsolved problems of Nature have a distinctive fascination, though they still far outnumber those which have even approximately been resolved.

*The Solar System and Its Origin*  
Chapter I (p. 1)  
The Macmillan Company. New York, New York, USA. 1935

**Shaw, Alan B.**  
No biographical data available

Preoccupation with the unattainable is a stultifying approach to any problem.

*Time in Stratigraphy* (p. 104)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1964

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Religion is always right. Religion solves every problem and thereby abolishes problems from the Universe. Religion gives us certainty, stability, peace and the absolute. It protects us against progress which we all dread. Science is the very opposite. Science is always wrong. It never solves a problem without raising ten more problems.

In B. Patch

*Thirty Years with G.B.S.*

Chapter Twelve (p. 235)

Dodd, Mead &amp; Company. New York, New York, USA. 1951

My business tonight will be very largely to raise difficulties. That is all the use I am really in this world.

Shaw Expounds Socialism as World Panacea

*The New York Times*, December 12, 1926

...all problems are finally scientific problems.

*The Doctor's Dilemma*

Preface on Doctors

The Technical Problem (p. lxxxiii)

Brentano's. New York, New York, USA. 1920

**Sherlock Holmes (Fictional character)**

Every problem is absurdly simple when it is explained to you.

*The Adventure of Sherlock Holmes**The Dancing Men*

Television series 1984

**Simon, Herbert Alexander** 1916–2001

American social scientist

Problem formulation in science is to be understood by looking at the continuity of the whole stream of scientific endeavor.

In Robert G. Colodny (ed.)

*Mind and Cosmos*

Scientific Discovery and the Psychology of Problem Solving (p. 37)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1966

**Simon, Herbert Alexander** 1916–2001

American social scientist

The capacity of the human mind for formulating and solving complex problems is very small compared with the size of problems whose solution is required for objectively rational behavior in the real world – or even for a reasonable approximation to such objective rationality.

*Models of Man: Social and Rational; Mathematical Essays on Rational Human Behavior in a Social Setting*

Part IV (p. 198)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1957

The more difficult and novel the problem, the greater is likely to be the amount of trial and error required to find a solution. At the same time, the trial and error is not completely random or blind; it is, in fact, rather highly selective. The new expressions that are obtained by transforming given ones are examined to see whether

they represent progress toward the goal. Indications of progress spur further search in the same direction; lack of progress signals the abandonment of a line of search. Problem solving requires selective trial and error.

*The Sciences of the Artificial*

Chapter 4 (pp. 95–96)

The MIT Press. Cambridge, Massachusetts, USA. 1969

...human problem solving, from the most blundering to the most insightful, involves nothing more than varying mixtures of trial and error and selectivity.

*The Sciences of the Artificial*

Chapter 4 (p. 97)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Simpson, N. F.** 1919–

English playwright

And suppose we solve all the problems it presents? What happens? We end up with more problems than we started with. Because that's the way problems propagate their species. A problem left to itself dries up or goes rotten. But fertilize a problem with a solution – you'll hatch out dozens.

*New English Dramatists 2*

A Resounding Tinkle, Act I, Scene 1 (pp. 80–81)

Penguin Books. London, England. 1960

**Spottiswoode, William** 1825–83

English mathematician and physicist

That which is at present beyond our ken may, at some period and in some manner as yet unknown to us, fall within our grasp; but our science teaches us, while ever yearning with Goethe for "Light, more light," to concentrate our attention upon that of which our powers are capable, and contentedly to leave for future experience the solution of problems to which we can at present say neither yea nor nay.

*Report of the Forty-eighth Meeting of the British Association for the Advancement of Science*

Address of William Spottiswoode (p. 32)

John Murray. London, England. 1879

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Somehow, problems get into my blood and they don't give me peace, they torture me. I have to get them out of my system, and there is but one way to get them out – by solving them. A problem solved is no problem at all, it just disappears.

On Scientific Creativity

*Perspectives in Biology and Medicine*, Volume 5, Number 2, Winter 1962 (p. 176)**Tatum, Edward** 1909–75

American biochemist

As in any scientific research, a problem clearly seen is already half solved.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1958  
A Case History in Biological Research (p. 610)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Thurstone, Louis Leon** 1887–1955  
American pioneer of psychometrics and psychophysics

Every scientific problem can be stated most clearly if it is thought of as a search for the nature of the relation between two definitely stated variables. Very often a scientific problem is felt and stated in other terms, but it cannot be so clearly stated in any way as when it is thought of as a function by which one variable is shown to be dependent upon or related to some other variable.

*The Fundamentals of Statistics* (p. 187)  
The Macmillan Company. New York, New York, USA. 1925

It's the same mathematics, whether it's applied or not. It's just important to think of a problem in a general context. I really think all mathematics is applicable.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 326)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Trefil, James** 1938–  
American physicist

Science is drawn by its own internal logic, by the development of instruments and ideas, so it's not always possible to predict when specific problems will be solved or specific knowledge acquired.

*The Nature of Science*  
Introduction (p. xx)  
Houghton, Mifflin, Harcourt.. New York, New York, USA. 2003

**Urquhart, Alexander**  
No biographical data available

It is possible for a vast aggregate of thinking to be performed around a particular problem without advancing its solution.

*Odd Hours With Nature*  
The Cunning of Trout (p. 61)  
Fisher Unwin. London, England. 1913

**von Baer, Carl Ernst**  
No biographical data available

Every great scientific problem is like a fortification, to which one can only approach slowly by running trenches. Generally people think at first that it is possible to take it by assault, but it very soon becomes clear that it is not the real thing, but only the appearance of it, only the image in our mind's eye which has been understood. Let us, however, go to work and sap slowly onwards, protected by the gabions of criticism, and at last we shall, in time, slowly get nearer and see the end more clearly before us, and meanwhile have got a firm footing in the outer work. If we can never completely take the fortress by digging trenches, the reason may be, to stick to our metaphor, that nature is no craven commander who surrenders as soon as the outworks are taken.

In James Hunt  
*Addresses*  
Address Given at the Second Annual Meeting of the Anthropological Society of London (p. 3)  
Trübner & Co. London, England. 1863–1867

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

In the sphere of natural science let us remember that we have always to deal with an insoluble problem. Let us prove keen and honest in attending to anything which is in any way brought to our notice, most of all when it does not fit in with our previous ideas. For it is only thereby that we perceive the problem, which does indeed lie in nature, but still more in man.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
#515 (p. 183)  
The Macmillan Co. New York, New York, USA. 1906

Man is born not to solve the problems of the universe, but to find out where the problem begins, and then to restrain himself within the limits of the comprehensible.

Translated by John Oxenford  
*Conversations of Goethe With Eckermann and Soret*  
October 15, 1825 (p. 161)  
George Bell & Sons. London, England. 1875

**Weil, Simone** 1909–43  
French philosopher and mystic

Our science is like a store filled with the most subtle intellectual devices for solving the most complex problems, and yet we are almost incapable of applying the elementary principles of rational thought.

In George A. Panichas (ed.)  
*The Simone Weil Reader*  
The Power of Words (p. 271)  
McKay. New York, New York, USA. 1977

**Wiesner, Jerome Bert** 1915–94  
Educational administrator

Some problems are just too complicated for rational logical solutions. They admit of insights, not answers.

In D. Lang  
Profiles: A Scientist's Advice, II  
*New Yorker*, 26 January, 1963

**Wilson, Edmund Beecher** 1856–1939  
American zoologist

Laying aside all merely speculative attempts to solve this problem, we must admit that our actual knowledge concerning it is still in a very backward state.

*The Physical Basis of Life* (p. 22)  
Yale University Press. New Haven, Connecticut, USA. 1923

**Wilson, Jr., E. Bright** 1908–92  
American physical chemist

Many scientists owe their greatness not to their skill in solving problems but to their wisdom in choosing them.



It is therefore worth considering the points on which this choice can be based.

*An Introduction to Scientific Research*

Chapter 1 (p. 1)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**Yalow, Rosalyn** 1921–

American medical physicist

We bequeath to you, the next generation, our knowledge but also our problems. While we still live, let us join hands, hearts and minds to work together for their solution so that your world will be better than ours and the world of your children even better.

*Les Prix Nobel. The Nobel Prizes in 1977*

Nobel banquet speech for award received in 1977

Nobel Foundation. Stockholm, Sweden. 1978

**Young, Charles Augustus** 1834–1908

American astronomer

In the present state of science many of the questions thus suggested seem to be hopelessly beyond the reach of investigation, while others appear like problems which time and patient work will solve, and others yet have already received clear and decided answers.

*A Text-book of General Astronomy for Colleges and Scientific Schools*

Chapter XXII (p. 566)

Ginn & Co. Boston, Massachusetts, USA. 1898

**PROBLEM, STATISTICAL**

**Goschen, Georg Joachim** 1752–1828

Publisher and printer

There is no study which requires more continuous and undisturbed attention than the study of complicated statistical problems.

The Increase of Moderate Incomes

*Journal of the Royal Statistical Society*, Volume L, Part IV December, 1887 (p. 589)

**PROBLEMS**

**Stewart, Ian** 1945–

English mathematician

Our world is not static: new problems constantly arise, and old answers often stop working. Like Lewis Carroll's Red Queen, we must run very fast in order to stand still.

*Nature's Numbers*

Chapter 2 (p. 29)

BasicBooks. New York, New York, USA. 1995

**PROCESS**

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Every process has laws, known or unknown, according to which it must take place. A consciousness of them is so

far from being necessary to the process, that we cannot discover what they are, except by analyzing the results it has left us.

*An Outline of the Necessary Laws of Thought*

Introduction (p. 17)

Sheldon & Co. New York, New York, USA. 1866

**PROCESSION**

**Kipling, Rudyard** 1865–1936

British writer and poet

One fine morning in the middle of the Precession of the Equinoxes.... That very next morning, when there was nothing left of the Equinoxes, because the Precession had preceded according to precedent...

*Just So Stories for Little Children*

The Elephant Child (pp. 66, 67)

Doubleday, Page & Co. Garden City, New York, USA. 1921

**PRODUCTION**

**Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

...an individual production is only significant in virtue of that which has preceded and that which is contemporary with it, it resembles a mirror which in reflecting exaggerates the size and clearness of neighbouring objects, and causes a person near it to see reflected most plainly those objects which are on the side to which it is directed.

Translated by George Kamensky

In Thomas Atkinson Lawson

*The Principles of Chemistry* (Volume I)

Author's Preface (p. vii)

Longmans, Green & Co. London, England. 1891

**PROFESSION**

**Latham, Peter Mere** 1789–1875

English physician

The different professions have one way of glorifying themselves, which is common to all. It is by setting forth a vast array of preparatory studies, and pretending they are indispensable in order to fit a man for the simple exercise of the practical duties that belong to them.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture I (p. 7)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**PROFESSIONAL HONOR**

**Truman, Percival Henry**

No biographical data available

The court mathematician and his pupil had been working together on a mathematical problem of huge



dimensions, and they had differed as to the result of one of their computations. It was a small point indeed, but when professional honor is involved there is no such thing as agreeing to disagree, as ordinary people may, even on a very insignificant point.

In Alfred Dudley Britton, Philip Richards Dunbar and Charles Fisher Hepburn

*Stories & Verse of Williams*

Applied Mathematics (p. 97)

Published by the editors. 1900

## PROFESSIONAL IDIOT

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The narrow slit through which the scientist, if he wants to be successful, must view nature constructs, if this goes on for a long time, his entire character; and, more often than not, he ends up becoming what the German language so appropriately calls a *Fachidiot* (professional idiot).

*Heraclitean Fire: Sketches from a Life before Nature*

No Hercules, No Crossroads (p. 33)

Rockefeller University Press. New York, New York, USA. 1978

## PROGRAMMING

**Dantzig, George Bernard** 1914–2005

American mathematician

I didn't discover the linear programming model all in a flash. It evolved.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 73)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

## PROGRESS

**Abbey, Edward** 1927–89

American environmentalist and nature writer

[T]here is a cloud on my horizon. A small dark cloud no bigger than my hand.

Its name is progress.

*Desert Solitaire*

Industrial Tourism and the National Parks (p. 48)

Ballantine Books. New York, New York, USA. 1968

## Advertisement

Progress begins in the mind – in the perception and appreciation of new ideas. In the past the ideas that sparked progress too often had to wait on the random interest of genius. Today more and more new ideas come from men trained to an awareness of that which is yet to be accomplished.

Advertisement by Bell Telephone Laboratories

*Scientific American*, Volume 198, Number 3, March, 1958 (p. 13)

**Belinsky, Vissarion Grigorievich** 1811–48

Russian writer and literary critic

Without the striving for infinity there is no life, no development, and no progress.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiererson

Progress Publishers. Moscow, Russia. 1979

**Boorstin, Daniel J.** 1914–2004

American historian

One of the great obstacles to progress is not ignorance, but the illusion of knowledge.

*The Discoverers*

Part One, Chapter II (p. 86)

Random House, Inc. New York, New York, USA. 1983

**Brown, E. Parmly**

No biographical data

Putting your shoulder to the wheel makes progress. Many shoulders to the wheel make much progress. Let us all resolve that our shoulders shall do their duty. Let us steer between the two strands of wearing out and rusting out; then will we be sure of holding out.

The Past, Present, and Future of Dentistry

*The Practical Dentist*, Volume 1, Number 1, April, 1888 (p. 2)

The age of slow progress is buried deep beneath the ground where grows the tree of knowledge and advancement; the carcass of the past is fertilizing the luxuriant growth of the present ...

The Past, Present, and Future of Dentistry

*The Practical Dentist*, Volume 1, Number 1, April, 1888 (p. 2)

**Chernyshevsky, Nikolai Gavrilovich** 1828–89

Russian socialist reformer

To renounce progress is as silly as to renounce the Earth's force of gravitation.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiererson

Progress Publishers. Moscow, Russia. 1979

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

Progress is the result, not so much of sudden flights of genius, as of sustained, patient, often commonplace endeavor; and the true lesson of scientific history lies in the close connection which it discloses between the most brilliant developments of knowledge and the faithful accomplishment of his daily task by each individual thinker and worker.

*A Popular History of Astronomy During the Nineteenth Century*  
Part I, Chapter VI (p. 108)  
A. & C. Black, London, England. 1908

**Curie, Marie Sklodowska** 1867–1934  
Polish-born French physical chemist

...I was taught that the way of progress is neither swift nor easy...

*Pierre Curie*  
Autobiographical Notes  
Chapter I (p. 167)  
The Macmillan Company, New York, New York, USA. 1926

**Davy, Sir Humphry** 1778–1829  
English chemist

I hardly know which we ought most to rejoice at – the progress that *has* been made in natural knowledge, or the progress that *is* to be made.

In John Davy (ed.)  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
Chapter III (p. 217)  
Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

**de Bono, Edward** 1933–  
Maltese psychologist and writer

When you have got somewhere interesting, that is the time to look back and pick out the surest way of getting there again. Sometimes it is very much easier to see the surest route to a place only after you have arrived. You may have to be at the top of a mountain to find the easiest way up.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas*  
(p. 132)  
Avon Books  
New York, New York, USA. 1971

**Dirac, Paul Adrien Maurice** 1902–84  
English theoretical physicist

One does not get anywhere simply by going over the successes again and again, whereas talking over the difficulties people can hope to make some progress.

The Evolution of the Physicist's Picture of Nature  
*Scientific American*, Volume 208, Number 5, May, 1963 (p. 48)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The knowledge that progress will inevitably lead to a readjustment of ideas must instill a writer with caution; but I believe that excessive caution is not to be desired. There can be no harm in building hypotheses, and weaving explanations which seem best fitted to our present partial knowledge. These are not idle speculations if they help us, even temporarily, to grasp the relations of scattered facts, and to organise our knowledge.

*Stellar Movements and the Structure of the Universe*  
Preface (p. v)  
Macmillan & Company Ltd. London, England. 1914

**Ellis, Havelock** 1859–1939  
English sexuality researcher

...what we call "Progress" is the exchange of one Nuisance for another Nuisance.

*Impressions and Comments*  
July 31 (p. 5)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1915

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

The only principle that does not inhibit progress is: Anything goes.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 1 (p. 23)  
Verso, London, England. 1978

**Flammarion, Camille** 1842–1925  
French astronomer and writer

...the torch of progress was lit and could not be extinguished.

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter I (p. 6)  
Chatto & Windus, London, England. 1894

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer, and statistician

If we summon before our imagination in a single mighty host, the whole number of living things from the earliest date at which terrestrial life can be deemed to have probably existed, to the latest future at which we may think it can probably continue, and if we cease to dwell on the miscarriages of individual lives or single generations, we shall plainly perceive that the actual tenantry of the world progresses in a direction that may in some sense be described as the greatest happiness of the greatest number.

*Inquiries into Human Faculty and Its Development*  
The Observed Order of Events (pp. 194–195)  
AMS Press, New York, New York, USA. 1973

**Goddard, Robert H.** 1882–1945  
American physicist

How many more years I shall be able to work on the problem, I do not know; I hope, as long as I live. There can be no thought of finishing, for "aiming at the stars," both literally and figuratively, is a problem to occupy generations, so that no matter how much progress one makes, there is always the thrill of just beginning.

*The Papers of Robert H. Goddard* (Volume 2)  
R.H. Goddard to H.G. Wells

April 20, 1932 (p. 823)  
McGraw-Hill Book Company. New York, New York, USA. 1970

**Gull, Sir William Withey** 1816–90  
English physician

A word rightly imposed is a landmark indicating so much recovered from the region of ignorance; a step in progress.

*A Collection of the Published Writings of William Withey Gull*  
(Volume 2)  
Address I (p. 10)  
The New Sydenham Society. London, England. 1896

**Jastrow, Joseph** 1863–1944  
Polish-born psychologist

Mind in the making follows no straightforward progression; its many wanderings in the quest for truth compose a cyclopedia of error and vain solutions far more than orderly annals of successful advance.

In Joseph Jastrow (ed.)  
*The Story of Human Error*  
Introduction (p. 2)  
D. Appleton-Century Company, Inc. New York, New York, USA. 1936

**Lavrov, Pyotr**  
No biographical data available

The physical, intellectual, and ethical development of the personality and the embodiment of truth and justice in social forms – this, it seems to me, is the brief formula that encompasses everything we can regard as progress.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

**Lawrence, Ernest** 1901–58  
American physicist

No individual is alone responsible for a single stepping stone along the path of progress, and where the path is smooth progress is most rapid.

*Les Prix Nobel. The Nobel Prizes in 1939*  
Nobel banquet speech for award received in 1939  
Nobel Foundation. Stockholm, Sweden. 1940

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

Progress depends on our sagacity in finding intermediate ideas. Those who are ignorant of *algebra* cannot imagine the wonderful things that may be done in this field by means of this science. And I do not see that it is easy to determine what new means of perfecting other parts of our knowledge may yet be found out by a penetrating mind.

*New Essays Concerning Human Understanding*  
Book IV, Chapter III (p. 432)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1916

**Lodge, Sir Oliver** 1851–1940  
English physicist

The present is an epoch of astounding activity in physical science. Progress is a thing of months and weeks, almost days. The long line of isolated ripples of past discovery seen blending into a might wave, on the crest of which one begins to discern some oncoming magnificent generalization. The suspense is becoming feverish, at times almost painful. One feels like a boy who has been long strumming on the silent keyboard of a deserted organ, into the chest of which an unseen power begins to blow a vivifying breath.

*Modern View of Electricity*  
Lecture III  
The Discharge of a Leyden Jar (pp. 382–382)  
Macmillan & Company Ltd. London, England. 1889

**Maury, Matthew Fontaine** 1806–1873  
American historian, astronomer, and oceanographer

... long as we are making progress in any field of physical research, so long must the results continue to increase in value; and just so long must what at first was conjecture grow and gain as truth, or fade and fall as error.

*The Physical Geography of the Sea, and its Meteorology*  
Introduction (p. xiv)  
Sampson Low, Marston & Co. London, England. 1891

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

To deride the hope of progress is the ultimate fatuity, the last word in poverty of spirit and meanness of mind.

*The Hope of Progress*  
Introduction (p. 1)  
Anchor Books. Garden City, New York, USA. 1973

**Nirenberg, Marshall W.** 1927–  
American biochemist and geneticist

One individual alone creates only a note or so that blends with those produced by others.

*Les Prix Nobel. The Nobel Prizes in 1968*  
Nobel banquet speech for award received in 1968  
Nobel Foundation. Stockholm, Sweden. 1969

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Measure as we may the progress of the world – materially, in the advantages of steam, electricity, and other mechanical appliances; sociologically, in the great improvement in the conditions of life; intellectually, in the diffusion of education; morally, in a possibly higher standard of ethics – there is no one measure which can compare with the decrease of physical suffering in man, woman, and child when stricken by disease or accident. This is the one fact of supreme personal import to everyone of us. This is the Promethean gift of the century to man.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
Chapter XIII  
P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

**Poincaré, Lucien** 1862–1920  
French physicist

There are no limits to progress, and the field of our investigations has no boundaries. Evolution will continue with invincible force. What we today call the unknowable, will retreat further and further before science, which will never stay her onward march. Thus physics will give greater and increasing satisfaction to the mind by furnishing new interpretations of phenomena; but it will accomplish, for the whole of society, more valuable work still, by rendering, by the improvements it suggests, life every day more easy and more agreeable, and by providing mankind with weapons against the hostile forces of Nature.

*The New Physics and Its Evolution*  
Chapter XI (p. 328)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Ramsay, Sir William** 1852–1916  
English chemist

Progress is made by trial and failure; the failures are generally a hundred times more numerous than the successes; yet they are usually left unchronicled.

*Essays Biographical and Chemical*  
Chemical Essays

Radium and Its Products (p. 179)  
Archibald Constable & Company Ltd. London, England. 1908

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

The history of science is the only history which can illustrate the progress of mankind. In fact, progress has no definite and unquestionable meaning in fields other than the fields of science.

*The Study of The History of Science* (p. 5)  
Harvard University Press. Cambridge, Massachusetts, USA. 1936

The saints of today are not necessarily more saintly than those of a thousand years ago; our artists are not necessarily greater than those of early Greece; they are likely to be inferior; and, of course, our men of science are not necessarily more intelligent than those of old; yet one thing is certain, their knowledge is at once more extensive and more accurate. The acquisition and systemization of positive knowledge is the only human activity that is truly cumulative and progressive.

*Introduction to the History of Science* (Volume 1)  
Introductory Chapter (p. 3)  
The Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**Schmidt, O. Y.**  
No biographical data available

There can be no progress in science and education in the absence of political progress.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierston  
Progress Publishers. Moscow, Russia. 1979

**Serres, Michel** 1930–  
French philosopher

But, irresistibly, I cannot help thinking that this idea is the equivalent of those ancient diagrams we laugh at today, which place the Earth at the center of everything, or our galaxy at the middle of the universe, to satisfy our narcissism. Just as in space we situate ourselves at the center, at the navel of things in the universe, so for time, through progress, we never cease to be at the summit, on the cutting edge, at the state-of-the-art of development. It follows that we are always right, for the simple, banal, and naïve reason that we are living in the present moment. The curve traced by the idea of progress thus seems to me to sketch or project into time the vanity and fatuousness expressed spatially by that central position. Instead of inhabiting the heart or the middle of the world, we are sojourning at the summit, the height, the best of truth.

*Conversations on Science, Culture, and Time*  
Second Conversation  
Method (pp. 48–49)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1995

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Sir Patrick: Lord! Yes. Modern science is a wonderful thing. Look at your great discovery! Look at all the great discoveries! Where are they leading to? Why, right back to my poor dear old father's ideas and discoveries. He's been dead now over forth years. Oh, it's very interesting. Ridgeton: Well, there's nothing like progress, is there?

*The Doctor's Dilemma*  
Act I (p. 11)  
Brentano's. New York, New York, USA. 1909

**Stoppard, Tom** 1937–  
Czech-born English playwright

Don't confuse progress with perfectibility. A great poet is always timely. A great philosopher is an urgent need. There's no rush for Isaac Newton. We were quite happy with Aristotle's cosmos. Personally, I preferred it. Fifty-five crystal spheres geared to God's crankshaft is my idea of a satisfying universe.

*Arcadia*  
Act II, Scene Five (p. 61)  
Faber & Faber Ltd. London, England. 1993

**Tilden, Sir William Augustus** 1842–1926  
English chemist

...until men began to observe and interrogate Nature for the sake of learning her ways, and without concentrating their attention on the expectation of useful applications of such knowledge, little or no progress was made. In other words, until a sufficient foundation of pure science has

been successfully laid there can be no applied science. Real progress comes from the pursuit of knowledge for its own sake.

Quoted in Richard Arman Gregory  
*Discovery, Or, The Spirit and Service of Science*  
Chapter IX (p. 237)  
Macmillan & Co Ltd. London, England. 1916

**von Liebig, Justus** 1803–73  
German organic chemist

To resolve an enigma, we must have a perfectly clear conception of the problem. there are many ways to the highest pinnacle of a mountain, but those only can hope to reach it who keep the summit constantly in view. All our labour and all our efforts, if we strive to attain it through a morass, only serve to cover it more completely with mud; our progress is impeded by difficulties of our own creation, and at last even the greatest strength must give way when so absolutely wasted.

*Animal Chemistry*  
Part II  
The Metamorphosis of Tissues (p. 125)  
Johnson Reprint Corporation. New York, New York, USA. 1964

**Walker, Kenneth** 1882–1966  
No biographical data available

We travel through life with so much mental luggage that it is advisable occasionally to pause and take stock of it in order that we may get rid of those ideas which impede our progress.

*Meaning and Purpose*  
Chapter I (p. 14)  
Jonathan Cape. London, England. 1944

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Too many apples from the tree of systematized knowledge lead to the fall of progress.

*Modes of Thought*  
Chapter I, Lecture Three (p. 79)  
The Macmillan Company. New York, New York, USA. 1938

## PROJECTILE MOTION

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

I have succeeded in proving; and what I consider more important, there have been opened up to this vast and most excellent science, of which my work is merely the beginning, ways and means by which other minds more acute than mine will explore its remote corners.

Translated by Henry Crew and Alfonso de Salvio  
*Dialogues Concerning Two New Sciences*  
Third Day (pp. 153–154)  
The Macmillan Co. New York, New York, USA. 1914

## PROJECTIVE GEOMETRY

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

...Projective Geometry: a boundless domain of countless fields where reals and imaginaries, finites and infinities, enter on equal terms, where the spirit delights in the artistic balance and symmetric interplay of a kind of conceptual and logical counterpoint – an enchanted realm where thought is double and flows throughout in parallel streams.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter XI (p. 278)  
Columbia University Press. New York, New York, USA. 1916

## PROLIX

**Poe, Edgar Allan** 1809–49  
American short story writer

...it is better to be a good deal prolix than even a very little obscure.

*Poems and Essays of Edgar Allan Poe*  
Eureka (p. 128)  
W.J. Widdleton, Publisher. New York, New York, USA. 1881

## PROOF

**Atiyah, Sir Michael** 1922–  
English mathematician

I think it is said that Gauss had ten different proofs for the law of quadratic reciprocity. Any good theorem should have several proofs, the more the better. For two reasons: usually, different proofs have different strengths and weaknesses, and they generalize in different directions – they are not just repetitions of each other.

24th of May, 2004 prior to the Abel prize celebrations  
Interview with Michael Atiyah and Isadore Singer  
Martin Raussen and Christian Skau are the interviewers

**Auster, Paul** 1947–  
American writer

I had made an empirical discovery and it carried all the weight of a mathematical proof.

*The Book of Illusions* (pp. 9–10)  
Picador. New York, New York, USA. 2002

## Author undetermined

The virtue of a logical proof is not that it compels belief but that it suggests doubts. The proof tells us where to concentrate our doubts.

Quoted in Morris Kline  
*Mathematics: The Loss of Certainty*  
Chapter XIV (p. 315)  
Oxford University Press. New York, New York, USA. 1982



**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

There is a sharp disagreement among competent men as to what can be proved and what cannot be proved, as well as an irreconcilable divergence of opinions as to what is sense and what is nonsense.

*Debunking Science* (p. 18)  
University of Washington Book Store. Seattle, Washington, USA. 1930

**Bernal, John Desmond** 1901–71  
Irish-born physicist and X-ray crystallographer

...the cardinal rule in science is that a statement must be provable – but that does not mean that it has to be proved now.

In S.W. Fox (ed.)  
*The Origins of Prebiological Systems and of Their Molecular Matrices*  
The Folly of Probability, Discussion (pp. 53–55)  
Academic Press. New York, New York, USA. 1965

**Blake, William** 1757–1827  
English poet, painter, and engraver

What is now proved was once only imagined.

*The Complete Poetry and Prose of William Blake*  
The Marriage of Heaven and Hell  
University of California Press. Berkeley, California, USA. 1982

**Buchanan, Scott** 1895–1968  
American educator and philosopher

The best proofs in mathematics are short and crisp like epigrams, and the longest have swings and rhythms that are like music.

*Poetry and Mathematics*  
Chapter 1 (p. 36)  
The University of Chicago Press. Chicago, Illinois, USA. 1975

...anything worth discovering in mathematics does not need proof; it needs only to be seen or understood.

*Poetry and Mathematics*  
Chapter 1 (p. 37)  
The University of Chicago Press. Cambridge, England. 1975

**Cabell, James Branch** 1879–1958  
American essayist and novelist

“But I can prove it by mathematics, quite irrefutably. I can prove anything you require of me by whatever means you may prefer,” said Jurgen, modestly, “for the simple reason that I am a monstrous clever fellow.”

*Jurgen: A Comedy of Justice*  
Chapter 32 (p. 236)  
Robert M. McBride & Company. New York, New York, USA. 1925

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

Like the goblin ‘Puck,’ it has led me “up and down, up and down,” through many a wakeful night: but always, just as I thought I had it [the proof], some unforeseen fallacy was sure to trip me up, and the tricky sprite would “leap out, laughing ho, ho, ho!”

*Curiosa Mathematica* Part I (3rd edition)  
Introduction (p. xxi)  
Macmillan & Co Ltd. London, England. 1890

## Catherine (Fictional character)

[Reading Robert’s Notebook] “Let X equal the quantity of all quantities of X. Let X equal the cold. It is cold in December. The months of cold equal November through February. There are four months of cold, and four of heat, leaving four months of indeterminate temperature. In February it snows. In March the Lake is a lake of ice. In September the students come back and the bookstores are full. Let X equal the month of full bookstores. The number of books approaches infinity as the number of months of cold approaches four. I will never be as cold now as I will in the future. The future of cold is infinite. The future of heat is the future of cold. The bookstores are infinite and so are never full except in September...”

*Proof*  
Film (2005)

## Collins, Frederick Howard

No biographical data available

...lack of facts are an obstacle to proof.

*An Epitome of the Synthetic Philosophy* (p. 44)  
D. Appleton & Co. New York, New York, USA. 1889

## Colton, Charles Caleb

1780–1832  
English sportsman and writer

He that, standing on the shore, foretells, with truth, many of the undiscovered treasures of the ocean of science, even before the vessel that is to navigate it, can be fully equipped for the voyage, gives us a convincing proof of exalted wisdom, and of profound penetration.

*Lacon: Or, Many Things in Few Words*  
CXLI (p. 81)  
Longman, Rees, Orme, Brown & Green. London, England. 1826

## Davis, Philip J.

1923–  
American mathematician

## Hersh, Reuben

1927–  
American mathematician

He rests his faith on rigorous proof; he believes that the difference between a correct proof and an incorrect one is an unmistakable and decisive difference. He can think of no condemnation more damning than to say of a student, “He doesn’t even know what a proof is.”

*The Mathematical Experience*  
The Ideal Mathematician (p. 34)  
Birkhäuser. Boston, Massachusetts, USA. 1981

Proof is for cosmetic purposes and also to reduce somewhat the edge of insecurity on which one always lives.

*The Mathematical Experience*  
A Physical Look at Mathematics (p. 48)  
Birkhäuser. Boston, Massachusetts, USA. 1981



Proof serves many purposes simultaneously.... Proof is respectability. Proof is the seal of authority. Proof, in its best instance, increases understanding by revealing the heart of the matter. Proof suggests new mathematics.... Proof is mathematical power, the electric voltage of the subject which vitalizes the static assertions of the theorems.

*The Mathematical Experience*

Proof (p. 151)

Birkhäuser. Boston, Massachusetts, USA. 1981

### **de Morgan, Augustus** 1806–71

English mathematician and logician

Would Mathematics – forsooth –  
If true, have failed to prove truth?  
Would not they – if they could – submit  
Some overwhelming proofs of it?

*A Budget of Paradoxes*

The Moon's Rotation (p. 262)

Longmans, Green. London, England. 1872

Proof requires a person who can give and a person who can receive...

*A Budget of Paradoxes*

The Moon's Rotation (p. 262)

Longmans, Green. London, England. 1872

### **Dedekind, Richard** 1831–1916

German mathematician

In science nothing capable of proof ought to be accepted without proof.

Translated by Wooster Woodruff Beman

*Essays on the Theory of Numbers*

The Nature and Meaning of Numbers

Preface to the First Edition (p. 31)

The Open Court Publishing Company. Chicago, Illinois, USA. 1901

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Proof is an idol before whom the pure mathematician tortures himself. In physics we are generally content to sacrifice before the lesser shrine of plausibility.

*The Nature of the Physical World*

Chapter XV (p. 337)

The Macmillan Company. New York, New York, USA. 1930

### **Euclid of Alexandria** 325 BCE–265 BCE

Greek mathematician

#### *Quod erat demonstrandum* (Q.E.D.)

Which was to be proved.

*The Thirteen Books of Euclid's Elements*

Element I, Proposition 5

At The University Press. Cambridge, England. 1906

### **Evans, Bergen** 1904–78

Author

“You can't prove it isn't so!” is as good as Q.E.D. in folk logic.

*The Natural History of Nonsense*

Chapter 19 (p. 264)

Alfred A. Knopf. New York, New York, USA. 1947

### **Gleason, Andrew M.**

Mathematician

...proofs really aren't there to convince you that something is true – they're there to show why it is true.

In D. Albers, G. Alexanderson, and C. Reid (eds.)

*More Mathematical People: Contemporary Conversations*

Andrew M. Gleason (p. 86)

Harcourt Brace Jovanovich. New York, New York, USA. 1990

Often enough mathematicians have been caught off base with some pathological wrinkle in some funny function or something so, you know, you do have to do the proof, but still in the end that much more important function of a proof in my view is to figure out why it works.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 97)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

### **Hamming, Wesley Richard** 1915–98

American mathematician

Some people believe that a theorem is proved when a logically correct proof is given; but some people believe a theorem is proved only when the student sees why it is inevitably true. The author tends to belong to this second school of thought.

*Coding and Information Theory*

Chapter 9 (p. 155)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1980

### **Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

...there is, strictly, no such thing as mathematical proof; that we can::: do nothing but *point*; that proofs are what Littlewood and I call *gas*, rhetorical flourishes designed to affect psychology, pictures on the board in the lectures, devices to stimulate the imagination of pupils.

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematical Proof (p. 59)

Mathematical Association of America. Washington, D.C. 2004

...it is not disputed that mathematics is full of proofs, of undeniable interest and importance, whose purpose is not in the least to secure conviction. Our interest in these proofs depends on their formal and aesthetic properties. Our object is *both* to exhibit the pattern and to obtain assent. We cannot exhibit the pattern completely, since it is far too elaborate; and we cannot be content with parallel streams.

*Musings of the Masters: An Anthology of Mathematical Reflections*

Mathematical Proof (p. 59)

Mathematical Association of America. Washington, D.C. 2004

### **Hilbert, David** 1862–1943

German mathematician

...it is an error to believe that rigor in the proof is the enemy of simplicity...

Hilbert: Mathematical Problems  
*Bulletin of the American Mathematical Society*, Volume 8, 2nd Series,  
 October 1901–July 1902 (p. 441)

**Hoyle, Sir Fred** 1915–2001  
 English mathematician and astronomer

What constitutes proof in one generation is not the same thing as proof in another.

*Of Men and Galaxies*  
 Motives and Aims of the Scientist (pp. 16–17)  
 University of Washington Press. Seattle, Washington, USA. 1964

**Kingsley, Charles** 1819–75  
 English clergyman and author

You must not say that this cannot be, or that that is contrary to nature. You do not know what Nature is, or what she can do; and nobody knows; not even Sir Roderick Murchison, or Professor Huxley, or Mr. Darwin, or Professor Faraday, or Mr. Grove, or any other of the great men whom good boys are taught to respect. They are very wise men; and you must listen respectfully to all they say: but even if they should say, which I am sure they never would, “That cannot exist. That is contrary to nature,” you must wait a little, and see; for perhaps even they may be wrong.

*The Water-babies*  
 Chapter II (pp. 69–70)  
 The Macmillan Co. New York, New York, USA. 1917

**Lenstra, Jr., H. W.**  
 No biographical data available

A math talk without a proof is like a movie without a love scene.

AMS-MAA 2002 annual meeting  
 San Diego, January 8, 2002

**Locke, John** 1632–1704  
 English philosopher and political theorist

Mathematical proofs are out of the reach of topical arguments, and are not to be attacked by the equivocal use of words or declamation, that make so great a part of other discourses; nay, even of controversies.

*The Works of John Locke*  
 Mr. Locke’s Second Reply to the Bishop of Worcester (p. 428)  
 Printed for Thomas Tegg. London, England. 1823

...for mathematical proofs, like diamonds, are hard as well as clear, and will be touched by nothing but strict reasoning.

*The Works of John Locke* (Volume 4)  
 Mr. Locke’s Second Reply to the Bishop of Worcester (p. 428)  
 Printed for Thomas Tegg. London, England. 1823

**Lowell, Percival** 1855–1916  
 American astronomer

Now, between the truths we take for granted because of their age, and those we question because of their youth,

we are apt to forget that in both, proof is nothing but preponderance of probability.

*Mars*  
 Chapter I, 1 (p. 6)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Manin, Yu I.**  
 No biographical data available

A proof only becomes a proof after the social act of “accepting it as a proof”.

*A Course in Mathematical Logic*  
 Part I, Chapter II (p. 48)  
 Springer-Verlag. New York, New York, USA. 1977

...a good proof is one that makes us wiser.

*A Course in Mathematical Logic* (p. 51)  
 Springer-Verlag. New York, New York, USA. 1977

**Nicholas Bourbaki**  
 Mathematical discussion group

Indeed every mathematician knows that a proof has not been “understood” if one has done nothing more than verify step by step the correctness of the deductions of which it is composed and has not tried to gain a clear insight into the ideas which have led to the construction of this particular chain of deductions in preference to every other one.

Quoted in Douglas M. Campbell and John C. Higgins  
*Mathematics: People, Problems, Results* (Volume 3)  
 In Richard A. de Millo, Richard J. Lipton and Alan J. Perlos  
 Social Processes and Proofs of Theorems and Programs (p. 25)  
 Wadsworth, Inc. Belmont, California, USA. 1984

**Pearson, Karl** 1857–1936  
 English mathematician

...we must remember that because a proposition has not yet been proved, we have no right to infer that its converse must be true.

*The Grammar of Science*  
 Chapter IV, Section 17 (p. 179)  
 Charles Scribner’s Sons. London, England. 1892

**Platt, John R.**  
 No biographical data available

There is no such thing as proof in science – because some later alternative explanation may be as good or better – so that science advances only by disproofs. There is no point in making hypotheses that are not falsifiable, because such hypotheses do not say anything: it must be possible for an empirical scientific system to be refuted by experience.

Strong Inference  
*Science*, Volume 146, Number 3641, 16 October, 1964 (p. 350)

**Popper, Karl R.** 1902–94  
 Austrian/British philosopher of science

In point of fact, no conclusive disproof of a theory can ever be produced; for it is always possible to say that the

experimental results are not reliable or that the discrepancies which are asserted to exist between the experimental results and the theory are only apparent and that they will disappear with the advance of our understanding. If you insist on strict proof (or strict disproof) in the empirical sciences, you will never benefit from experience, and never learn from it how wrong you are.

*The Logic of Scientific Discovery*  
Part I, Chapter 2 (p. 28)  
Routledge, London, England. 2002

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

Be sure of it: give me the ocular proof. . .

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Othello, The Moor of Venice*  
Act III, Scene iii, l. 360  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

And this may help to thicken other proofs  
That do demonstrate thinly.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*Othello, The Moor of Venice*  
Act III, Scene iii, l. 429–431  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Stewart, Ian** 1945–

English mathematician and science writer

Proofs knit the fabric of mathematics together, and if a single thread is weak, the entire fabric may unravel.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 3 (p. 45)  
Basic Books, Inc. New York, New York, USA. 1995

An intuitive proof allows you to understand why the theorem must be true; the logic merely provides firm grounds to show that it is true.

*Concepts of Modern Mathematics*  
Chapter 1 (p. 5)  
Dover Publications, Inc. New York, New York, USA. 1995

### **Sylvester, James Joseph** 1814–97

English mathematician

*Divide et impera*: is as true in algebra as in statecraft; but no less true and even more fertile is the maxim *auge et impera*. The more to do or to prove, the easier the doing or the proof.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 3)  
Proof of the Fundamental Theorem of Invariants (1878) (p. 126)  
At The University Press. Cambridge, England. 1904–1912

It always seems to me absurd to speak of a complete proof, or of a theorem being rigorously demonstrated. An incomplete proof is no proof, and a mathematical truth not rigorously demonstrated is not demonstrated at all.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2) (p. 200)  
At The University Press. Cambridge, England. 1904–12

### **Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

A proof in science does more than eliminate doubt. It eliminates inconsistencies and provides the underlying logical basis of the statement.

*The Pursuit of Simplicity*  
Chapter I (p. 20)  
Pepperdine University Press. Malibu, California, USA. 1981

### **Thurston, William Paul** 1946–

American mathematician

Why do we try to prove things anyway? I think because we want to understand them. We also want a sense of certainty. Mathematics is a very deep field. It's results are stacked very high, and they depend on each other a lot. You build a tower of blocks but if one block is a bit wobbly, you can't build the tower very high before it will fall over. So I think mathematicians are concerned about rigor, which gives us certainty. That's one reason that we concentrate so much more on proof than do other scientists. But I also think proofs are so that we can understand. I guess I like explanations rather than step-by-step rigorous demonstrations.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (pp. 340–341)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

### **Truzzi, Marcello** 1935–2003

Danish-born American sociology professor

And when such claims are extraordinary, that is, revolutionary in their implications for established scientific generalizations already accumulated and verified, we must demand extraordinary proof.

Editorial  
*Zetetic Scholar*, Volume 1, Number 1, Fall/Winter, 1976 (p. 4)

### **Tymoczko, Thomas** 1943–86

Logician

A proof is a construction that can be looked over, reviewed, verified by a rational agent. We often say that a proof must be perspicuous or capable of being checked by hand. It is an exhibition, a derivation of the conclusion, and it needs nothing outside itself to be convincing. The mathematician surveys the proof in its entirety and thereby comes to know the conclusion.

The Four Color Problems  
*Journal of Philosophy*, Volume 76, 1979

### **van Orman Quine, Willard** 1908–2000

American philosopher

Mathematics is where the proofs are.

*The Ways of Paradox, and Other Essays*  
Chapter 3 (p. 22)  
Harvard University Press. Cambridge, Massachusetts, USA. 1976

### **Ward, Peter D.**

American paleontologist

**Brownlee, Donald**

No biographical data available

Proof is a rarity in science.

*Rare Earth: Why Complex Life Is Uncommon in the Universe*

Preface (p. ix)

Springer-Verlag New York, Inc. New York, New York, USA. 2000

**Weil, André** 1906–98

French mathematician

A tediously laborious proof may be a sign that the writer has been less than felicitous in expressing himself; but more often than not, as we know, it indicates that he has been laboring under limitations which prevented him from translating directly into words or formulas some very simple ideas.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

History of Mathematics (p. 210)

Mathematical Association of America. Washington, D.C. 2004

**White, Arthur**

No biographical data available

A teacher once, having some fun,

In presenting that two equals one,

Remained quite aloof

From his rigorous proof;

But his class was convinced and undone.

*Mathematical Magazine*, Volume 64, Number 2, April, 1991 (p. 91)**PROPHECY****Clarke, Arthur C.** 1917–

English science and science fiction writer

With monotonous regularity, apparently competent men have laid down the law about what is technically possible or impossible – and have been proved utterly wrong, sometimes while the ink was scarcely dry from their pens.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 1 (p. 1)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

Before one attempts to set up in business as a prophet, it is instructive to see what success others have made of this dangerous occupation – and it is even more instructive to see where they have failed.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 1 (p. 1)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

...if we have learned one thing from the history of invention and discovery, it is that, in the long run – and often in the short one – the most daring prophecies seem laughably conservative.

*The Exploration of Space*

Chapter 11 (p. 111)

Harper &amp; Brothers Publishers. New York, New York, USA. 1951

**PROPORTION****Dalton, John** 1766–1844

English chemist and physicist

The doctrine of definite proportions appears to me mysterious unless we adopt the atomic hypothesis. It appears like the mystical ratios of Kepler, which Newton so happily elucidated. The prosecution of the investigation can terminate, I conceive, in nothing but in the system which I adopt of particle applied to particle, as exhibited in my diagrams.

In Henry Enfield Roscoe and Arthur Harden

*A New View of the Origin of Dalton's Atomic Theory*

Chapter V (p. 159)

Macmillan &amp; Co Ltd. London, England. 1896

**Duke of Argyll (George Douglas****Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

The active principles of these two substances [tea and strychnine], “theine” and “strychnine,” are identical so far as their elements are concerned, and differ from each other only in the proportions in which they are combined. Such is the power of numbers in the laboratory of Nature! What havoc in this world, so full of life, would be made by blind chance gambling with such powers as these! What confusion, unless they were governed by laws whose certainty makes them capable of fine adjustment, and therefore subject to accurate control!

*The Reign of Law* (4th American edition)

George Routledge &amp; Sons. New York, New York, USA. 1873

**Swift, Jonathan** 1667–1745

Irish-born English writer

What vexes me most is, that my female friends, who could bear me very well a dozen years ago, have now forsaken me, although I am not so old in proportion to them as I formerly was: which I can prove by arithmetic, for then I was double their age, which now I am not.

*The Works of Alexander Pope, Esq.* Volume 9

Letter from Alexander Pope (p. 200)

Printed for J.&amp;P. Knapton. London, England. 1751

**PROPORTIONAL****Lanchester, Frederick William** 1868–1946

English polymath and engineer

...the *fighting strength* of a force may be broadly defined as proportional to *the square of its numerical strength multiplied by the fighting value of its individual units.*

*Aircraft In Warfare*

Chapter V (p. 48)

Constable &amp; Co. London, England. 1916

## PROPOSITION

**Cohen, Morris Raphael** 1880–1947

American philosopher

Propositions have been treated linguistically as declarative sentences, psychologically as judgments, and logically as that which is true or false. The division of intellectual workers into grammarians, psychologists and logicians has tended to make us treat these supplementary modes of approach as if they were mutually exclusive. And this tendency to emphasize one element to the exclusion of others shows itself in the strife between nominalists, conceptualists or mentalists, and logical realists.

*A Preface to Logic*

Chapter II (p. 23)

Routledge. London, England. 1946

**de Morgan, Augustus** 1806–71

English mathematician and logician

In all matters we have learnt to say that we do not know what things *are*, we only know something *about them*: that is, we have subjects with attributes, and therefore propositions which can be affirmed.

*Transactions of the Cambridge Philosophical Society*

On Infinity: and on the Sign of Equality (p. 151)

At the University Press. Cambridge, England. 1871

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

For my part, I am quite unable to say whether the proposition is true or not. I can deduce it by trustworthy reasoning from certain other propositions or axioms, which are supposed to be still more elementary. If these axioms are true, the proposition is true; if the axioms are not true, the proposition is not true universally. Whether the axioms are true or not I cannot say, and it is outside my province to consider.

*Space, Time and Gravitation*

Prologue (p. 1)

At the University Press. Cambridge, England. 1921

**Keyser, Cassius Jackson** 1862–1947

American mathematician

If he contend, as sometimes he will contend, that he has defined all his terms and proved all his propositions, then either he is a performer of logical miracles or he is an ass; and, as you know, logical miracles are impossible.

*Mathematical Philosophy: A Study of Fate and Freedom*

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The belief or unconscious conviction that all propositions are of the subject-predicate form – in other words, that every fact consists in some thing having some

quality – has rendered most philosophers incapable of giving any account of the world of science and daily life.

*Our Knowledge of the External World*

Lecture II (p. 45)

The Open Court Publishing Company. Chicago, Illinois. 1914

...it is undesirable to believe a proposition when there is no ground whatever for supposing it true.

*Sceptical Essays*

Introduction (p. 1)

George Allen & Unwin. London, England. 1928

...I wish to propose for the reader's favourable consideration a doctrine which may, I fear, appear wildly paradoxical and subversive. The doctrine in question is this: that it is undesirable to believe a proposition when there is no ground whatever for supposing it true...

*Skeptical Essays*

Chapter I (p. 11)

W.W. Norton & Company, Inc. New York, New York, USA. 1928

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

My method for examining any proposition is to take its two extremes, both of them impracticable; make a scale between them; and try to determine at what point on the scale it can best be put into practice. A mother who has to determine the temperature of her baby's bath has two fixed limits to work between. The baby must not be boiled and must not be frozen.

*Everybody's Political What's What?*

Chapter 20 (p. 162)

Dodd, Mead & Company. New York, New York, USA. 1944

**Stewart, Dugald** 1753–1828

Scottish philosopher

...the speculative propositions of mathematics do not relate to facts; and that all we are convinced of by any demonstration in the science, is of a necessary connexion subsisting between certain suppositions and certain conclusions. When we find these suppositions actually take place in a particular instance, the demonstration forces us to apply the conclusion.

*Elements of the Philosophy of the Human Mind*

Part Third, Chapter I, Section III (p. 180)

Carey, Lea & Carey. Philadelphia, Pennsylvania, USA. 1827

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

It is more important that a proposition be interesting than that it be true. This statement is almost a tautology. For the energy of operation of a proposition in an occasion of experience is its interest and is its importance. But of course a true proposition is more apt to be interesting than a false one.

*Process and Reality: An Essay in Cosmology*

Part III, Chapter IV, Section II (pp. 395–396)

The Macmillan Company. New York, New York, USA. 1929



**PROTEIN**

**Asimov, Isaac** 1920–92  
American author and biochemist

You see, proteins, as I probably needn't tell you, are immensely complicated groupings of amino acids and certain other specialized compounds, arranged in intricate three-dimensional patterns that are as unstable as sunbeams on a cloudy day. It is this instability that is life, since it is forever changing its position in an effort to maintain its identity – in the manner of a long rod balanced on an acrobat's nose.

*Pebbles in the Sky*

Chapter 3 (p. 33)

Doubleday & Co. Garden City, New York, USA. 1950

**PROTON**

**Ball, Philip** 1962–  
English science writer

As far as atoms are concerned, protons and electrons are like knives and forks at the dinner table; no matter how big the table, there are equal numbers of each.

*Life's Matrix: A Biography of Water*

Part One, Chapter 1 (p. 7)

Farrar, Straus & Giroux. New York, New York, USA. 2000

**Dyson, Freeman J.** 1923–  
American physicist and educator

The most serious uncertainty affecting the ultimate fate of the universe is the question whether the proton is absolutely stable against decay into lighter particles. If the proton is unstable, all matter is transitory and must dissolve into radiation.

Time Without End: Physics and Biology in an Open Universe

*Reviews of Modern Physics*, Volume 51, Number 3, July 1979

**PROTOPLASM**

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Life carries on. Through all the tortures inflicted by a changing earth, through glacial cold and desert thirst, through flood and famine, the protoplasm has climbed with unabating vigor toward the future.

*Parade of the Living*

Part III, Chapter XVIII (p. 248)

Coward-McCann, Inc. New York, New York, USA. 1930

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

Like most mysterious things this vital stuff is under our noses and yet we do not perceive it. But with intricate differential stains, with special illuminations and lenses, men at the microscope have sighted it, distant in

the perspectives of the minute. Chemists have assayed it delicately in vitro, and physicists have predicted its structure. It is colorless, neither solid nor fluid, yet a blind man touching what is composed of it, recognizes its unique quality. For it is the body of life, and its name is protoplasm.

*Flowering Earth*

Chapter 5 (p. 52)

G.P. Putnam's Sons. New York, New York, USA. 1939

Protoplasm, the almost invisible, is the organizer of all the inconceivable multiplicity of life's organisms. In the fantastic lip of the orchid, the two microscopic atoms of the diatom, the lashing sperms of the bull kelp, in the lonely wind-contorted cypress, in the banyan's hundred stems, protoplasm is present, directing, determining. For in one cell-full of that translucent ambiguous stuff lies the complete authority for an organism's future. So, sucking at the same breasts of earth, putting out leaves to catch the same sunlight, a windflower and a walking-fern hold to their small discrete identities.

*Flowering Earth*

Chapter 5 (p. 53)

G.P. Putnam's Sons. New York, New York, USA. 1939

**PROVE**

**Mellor, Joseph William** 1863–1938  
Chemist

Untutored minds are very prone to mistake inferences for observations, and prepossessions for facts; their observations and their judgments are alike vitiated by dogma and prejudice; they do not seek to investigate, they seek to prove.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
(Volume 1)

Chapter I (p. 7)

Longman, Green & Co. London, England. 1922

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

It would be foolish for a man not to believe in his mistress's love because she could not prove it to him mathematically. She can mathematically prove her dowry, but not her love.

*Conversations of Goethe With Eckermann and Soret*

Wed., Dec. 20 (p. 181)

George Bell & Sons. London, England. 1883

**PROVINCIAL REGION**

**Forbes, Edward** 1815–54  
English naturalist

Everyone knows that the same animals and plants are not found everywhere...but that they are distributed so as to be gathered together in distinct zoological and botanical



provinces, of greater or less extent, according to their degree of limitation by physical conditions, whether features of the earth's outline or climate.

*The Natural History of the European Seas*

Chapter 1 (p. 1)

John van Voorst. London, England. 1859

## PSEUDOSCIENCE

**de Morgan, Augustus** 1806–71

English mathematician and logician

The pseudomath is a person who handles mathematics as the monkey handled the razor.

*A Budget of Paradoxes*

Pseudomath, Philomath, and Graphomath (p. 473)

Longmans, Green. London, England. 1872

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

A Pseudo-science consists of a *nomenclature*, with a self-adjusting arrangement, by which all positive evidence, or such as favors its doctrines, is admitted, and all negative evidence, or such as tells against it, is excluded.

*The Professor at the Breakfast-table*

A Short Lecture on Phrenology (p. 283)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Sagan, Carl** 1934–96

American astronomer and author

Pseudoscience is embraced, it might be argued, in exact proportion as real science is misunderstood.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 1 (p. 15)

Random House, Inc. New York, New York, USA. 1995

I worry that, especially as the Millennium edges nearer, pseudoscience and superstition will seem year by year more tempting, the siren song of unreason more sonorous and attractive. Where have we heard it before? Whenever our ethnic or national prejudices are aroused, in times of scarcity, during challenges to national self-esteem or nerve, when we agonize about our diminished cosmic place and purpose, or when fanaticism is bubbling up around us-then, habits of thought familiar from ages past reach for the controls. The candle flame gutters. Its little pool of light trembles. Darkness gathers. The demons begin to stir.

*Demon-Haunted World: Science As a Candle in the Dark*

Chapter 2 (pp. 26–27)

Random House, Inc. New York, New York, USA. 1995

## PSYCHICAL CONSTITUTION

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Essentially only one thing in life interests us: our psychical constitution, the mechanism of which was and is

wrapped in darkness. All human resources, art, religion, literature, philosophy and historical sciences, all of them join in bringing light in this darkness.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1904

Physiology of Digestion (pp. 154–155)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## PUBLIC SPEAKING

**Sylvester, James Joseph** 1814–97

English mathematician

When called upon to speak in public [the mathematician] feels as a man might...who has passed all his life in peering through a microscope, and is suddenly called upon to take charge of an astronomical observatory. He has to get out of himself, as it were, and change the habitual focus of his vision.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 3)

An Inquiry into Newton's Rule for the Discovery of Imaginary Roots

(p. 73)

University Press. Cambridge, England. 1904–1912

## PUBLICATION

**Anderson, Martin** 1936–

[E]very article authored in a prestigious journal in a scholars field of study is like a notch in the six-gun of an Old West gun-fighter, a proof of talent and visible building block of the academic intellectual's reputation pyramid.

*Imposters in the Temple* (p. 81)

**Brewster, George**

No biographical data available

It has long been our impression, and is so still, that no author should appear before the public in the publication of any work unless he can produce, first. SOMETHING NEW. Second. SOMETHING IMPORTANT. Third. SOMETHING TRUE. Fourth. SOMETHING INTELLIGIBLE.

*A New Philosophy of Matter, Showing the Identity of All the*

*Imponderables* (3rd edition)

Chapter 1 (p. 14)

Edward H. Fletcher. New York, New York, USA. 1858

**Buckle, Henry Thomas** 1821–62

English historian

The publications of our scientific institutions, and of our scientific authors, overflow with minute and countless details, which perplex the judgment, and which no memory can retain. In vain do we demand that they should be generalized, and reduced into order. Instead of that, the heap continues to swell. We want ideas, and get more facts. We hear constantly what nature is doing, but we rarely hear what man is thinking.

*History of Civilization in England* (Volume 2), Part II  
Chapter VI (p. 396)  
Hearst's International Library Co. New York, New York, USA. 1913

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

The learned have often amused themselves by publishing the follies of the dunces; but if the dunces would retaliate by publishing the blunders of the learned, they might for once put forth a volume that would not be dull, although it would be large.

*Lacon: Or, Many Things in Few Words*  
CCCCIII (p. 176)  
Longman, Rees, Orme, Brown & Green. London, England. 1826

**Glaisher, James Whitbread Lee** 1848–1928  
English mathematician

In other branches of science, where quick publication seems to be so much desired, there, may possibly be some excuse for giving to the world slovenly or ill-digested work, but there is no such excuse in mathematics. The form ought to be as perfect as the substance and the demonstrations as rigorous as those of Euclid. The mathematician has to deal with the most exact facts of nature, and he should spare no effort to render his interpretation worthy of his subject, and to give to his work its highest degree of perfection. ‘*l’aura sed maturii*’ was Gauss’s motto.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*  
Presidential address (p. 725)  
John Murray. London, England. 1891

**Logan, Wilson** 1907–1990  
American teacher and university administrator

There is the necessity of bringing results to light in the form of publication, for in the academic scheme of things results unpublished are little better than those never achieved.

*The Academic Man* (p. 197)

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

It would seem that in this situation I should abstain from all publication so long as I have not solved the problem, but after fruitless efforts for many months it seems to me wisest to let the whole problem ripen during several years. That would indeed be well, were I sure of someday being able to take it up again, but at my age I cannot go bail for this. On the other hand, the importance of the subject is great...and the totality of results so far obtained is too considerable for me to resign myself to definitively allowing them to become unfruitful. I may hope that the mathematicians who interest themselves in the problem

and who will be more fortunate than I without doubt will find some means to resolve it.

In James Byrnie Shaw  
*Henri Poincare as An Investigator*  
*Popular Science Monthly*, March, 1913 (p. 223)

## PUBLISH

**Heald, Franklin Hermann**  
No biographical data available

...I do not care to longer delay the copyrighting of present discoveries, lest some more active fellow mortal should anticipate me and carry my message to Garcia.

*The Procession of Planets* (2nd edition) (p. 8)  
Franklin H. Head. 1901

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

It is madness to harass the mind, as some have done, with attempts to measure the world, and to publish these attempts

In John Bostock and H.T. Riley  
*Natural History*  
Book II, Chapter 1  
Taylor & Francis. London, England. 1855

## PUBLISH OR PERISH

**Douglas, George H.** 1934–

[T]he old edict “publish or perish” has something rather comical about it. For the most part, professors don’t publish a great deal, but they usually don’t perish either.

*Education without Impact*  
Chapter 10 (p. 91)  
Carol Publishing Group. New York, New York, USA. 1992.

**Pelikan, Jaroslav** 1923–

...the scholarly record is ultimately a written one: this is the foundation for the principle, often maligned and sometimes abused of “publish or perish.”

*Scholarship and Its Survival*  
Chapter V (p. 61)  
The Carnegie Foundation for the Advancement of Teaching. Princeton, New Jersey, USA. 1983

**Smith, Page** 1917–1995  
No biographical data available

Under the publish-or-perish standard, the university is perishing. Research *and* publication are not necessarily related.

*Killing the Spirit*  
Chapter 13 (p. 180)  
Journal of Chemical Education. Easton Pennsylvania, USA. 1956  
Viking Penguin. New York, New York, USA. 1990

**PURITY****Nilson, Lars Fredrik**

No biographical data available

On the purity of substances depends the perfection of the whole.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 407)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**PURPOSE****Einstein, Albert** 1879–1955

German-born physicist

How strange is the lot of us mortals! Each of us is here for a brief sojourn; for what purpose he knows not, though he sometimes thinks he senses it. But without deeper reflection one knows from daily life that one exists for other people – first of all for those upon whose smiles and well-being our own happiness is wholly dependent, and then for the many, unknown to us, to whose destinies we are bound by the ties of sympathy. A hundred times every day I remind myself that my inner and outer life are based on the labors of other men, living and dead, and that I must exert myself in order to give in the same measure as I have received and am still receiving.

*Ideas and Opinions*

The World as I See It (p. 8)

Crown Publishers, Inc. New York, New York, USA. 1954

**Townson, Robert** 1763–1827

Australian scholar and scientist

Plan and design are in all Nature's works, though universal discord and confusion seem to prevail, and though certain ruin awaits her fairest productions.

*Philosophy of Mineralogy*

Chapter III (p. 32)

Printed for the author. London, England. 1798

**PUTRID****Tyndall, John** 1820–93

Irish-born English physicist

Secured from the danger of putrefaction, it is amazing how, under the hands of a really able surgeon, the human, flesh and bones may be cut, torn, and crunched with impunity.

*Fragments of Science for Unscientific People*

Chapter XI (p. 302)

D. Appleton &amp; Co. New York, New York, USA. 1875

**PYRAMID****Bonaparte, Napoleon** 1765–1821

French general

From the top of those pyramids, forty centuries look down on you.

In Ralph Waldo Emerson

*English Traits and Representative Men*

Representative Men, Chapter VII (p. 324)

Oxford University Press, Inc. Oxford, England. 1934

**Fuller, Thomas** 1608–61

English clergyman and author

...the pyramids themselves, dotting with age, have forgotten the names of their founders.

*The Holy State, And The Profane State*

Book III, V (p. 180)

Printed for Thomas Tegg. London, England. 1841

**Kipling, Rudyard** 1865–1936

British writer and poet

Who shall doubt "the secret hid  
Under Cheops' pyramid"

Was that the contractor did

Cheops out of several million?

*Rudyard Kipling's Verse*

A General Summary

Hodder &amp; Stoughton. London, England. 1919

**Loti, Pierre** 1850–1923

French author

...behind this monster face, far away in the rear, on the top of those undefined and gently undulating sandhills, three apocalyptic signs rise up against the sky, three rose-coloured triangles, regular as the figures of geometry, hut so vast in the distance that they inspire you with fear. They seem to be luminous of themselves, so vividly do they stand out in their clear rose against the deep blue of the star-spangled vault.

Translated by W. P. Baines

*Egypt*

Chapter 1 (pp. 3–4)

Duffield &amp; Co. New York, New York, USA. 1910

**Muller, Herbert Joseph** 1905–80

American historian and educator

It is fitting that her [Egypt's] most enduring works remain the pyramids. They are the monuments to the majesty of her ideal, and to its basic absurdity; to the promise of her beginning, and to its curse.

*The Loom of History*

Chapter IV (p. 106)

Oxford University Press. New York, New York, USA. 1966

**Shelley, Percy Bysshe** 1792–1822

English poet

Nile shall pursue his changeless way;

Those Pyramids shall fall;

Yea! Not a stone shall stand to tell

The spot where on they stood.

Their very site shall be forgotten,

As is their builder's name.

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

As for the pyramids, there is nothing to wonder in at them so much as the fact that so many men could be found degraded enough to spend their lives constructing a tomb for some ambitious booby, whom it would have been wiser and manlier to have drowned in the Nile, and then given the body to the dogs.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter I (p. 93)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

...the Pyramids, rising above the palms, looked very clean-cut, very grand and imposing, and very soft and filmy, as well. They swam in a rich haze that took from them all suggestions of unfeeling stone, and made them seem only the airy nothings of a dream – structures which might blossom into tiers of vague arches, or ornate colonnades, maybe, and change and change again into all graceful forms of architecture while we looked, and then melt deliciously away and blend with the tremulous atmosphere.

*The Innocents Abroad: or, The new Pilgrim's Progress* Volume 2

Chapter XXXI (p. 407)

Harper & Brothers Publishers. New York, New York, USA. 1906

## PYTHAGORAS

**Browne, Sir Thomas** 1605–82

English author and physician

I have often admired the mystical way of Pythagoras, and the secret magic of numbers.

*Religio Medici*

12

Elliot Stock. London, England. 1883

**James, Jamie**

No biographical data available

Pythagoras defies categorization: a primary thinker in philosophy, mathematics, music and cosmology, he may in fact be best thought of as one who challenges the legitimacy of categories. Anyone who conceives of Pythagoras as the inventor of a geometric theorem, the formulator of laws of music theory, and the utterer of cryptic aphorisms will miss the essence of his thought entirely, for the

whole point of what he taught is the interrelatedness of all human knowledge.

*The Music of the Spheres: Music, Science, and the Natural Order of the Universe*

Chapter 2 (p. 23)

Springer. New York, New York, USA. 1995

**Koestler, Arthur** 1905–83

Hungarian-born English writer

The sixth century scene evokes the image of an orchestra expectantly tuning up, each player absorbed in his own instrument only, deaf to the caterwaulings of the others. Then there is a dramatic silence, the conductor enters the stage, raps three times with his baton, and harmony emerges from the chaos. The maestro is Pythagoras of Samos, whose influence on the ideas, and thereby on the destiny, of the human race was probably greater than that of any single man before or after him.

*The Sleepwalkers*

Part I, Chapter I (p. 25)

The Macmillan Co. New York, New York, USA. 1968

**Thompson, William Irvin**

No biographical data available

If you listen to Werner Heisenberg lecturing about Pythagoreanism in his own work on the quantum theory, you will hear him emphasize that the basic building blocks of nature are number and pattern, that the universe is not made out of matter but out of music. The historians of science I worked with in the University regarded Pythagoras as a magician, a shamanistic madman from the cults of the Near East; Yet both Whitehead and Heisenberg regarded him as a genius of the highest order who laid the foundation upon which our entire Western civilization is based.

*Darkness and Scattered Light* (p. 110)

Anchor Books. London, England. 1978

## PYTHAGOREAN THEOREM

**Smith, David Eugene** 1860–1945

Mathematician

Before Mars was, or the Earth, or the Sun, and long after each has ceased to exist; there and here and in the most remote regions of stellar space – the square on the hypotenuse was and is, and ever shall be equivalent to the sum of the squares on the sides. All our little theories of life, all our childish speculations as to death, all our trivial bickerings of the schools – all these are but vanishing motes in the sunbeam compared with the double eternity, past and future, of such a truth as this.

*Mathematics in the Training for Citizenship*

*Teachers College Record*, Volume XVIII, Number 3, May, 1917 (p. 218)

## Q

### QUACK

**Aesop** ca. 620 BCE–560 BCE  
Greek fabulist and author

A frog once upon a time came forth from his home in the marsh and proclaimed to all the beasts that he was a learned physician, skilled in the use of drugs and able to heal all diseases. A Fox asked him, “How can you pretend to prescribe for others when you are unable to heal your own lame gait and wrinkled skin?”

*The Quack Frog*

SeaStar Books. New York, New York, USA. 2000

**Ames, Nathaniel** 1708–64  
American almanac maker

Where silly quacks are most respected, there honest doctors are neglected. Petty Attorneys and Quack Doctors are like Wolves and scabbed Sheep among the Flock. One devours and the other breeds the rot.

*An Astronomical Diary, or, an Almanac for...1734*

Printed for the Booksellers and sold at their shops. Boston, Massachusetts, USA. 1734

**Bernstein, Al**  
American writer and stage performer

You can usually tell a quack doctor by his bill.  
*Quote, the Weekly Digest, July 28, 1968 (p. 77)*

**Bishop, Samuel**  
No biographical data available

When quacks, as quacks may by good luck, to be sure,  
Blunder out at haphazard a desperate cure,  
In the prints of the day, with due pomp and parade,  
Case, patient, and doctor are amply display'd.  
And this is quite just – and no mortal can blame it;  
If they save a man's life, they've a right to proclaim it  
But there's reason to think they might save more lives still,  
Did they publish a list of the numbers they kill!

In William Davenport Adams

*English Epigrams*

Audi Alteram Partem, cclxxxv

G. Routledge. London, England. 1878

**Browne, Borden Parker** 1847–1910  
American Christian philosopher and theologian

... science acts like an enchantment to disarm criticism;  
and mental quacks perceiving this, hasten to call their  
nostrums science.

*Studies in Theism*

Chapter II (p. 86)

Phillips & Hunt. New York, New York, USA. 1879

**Clowes, William** 1540–1604  
Surgeon and medical author

Yea, nowadays, it is too apparent to see how tinkers, tooth-drawers, peddlers, ostlers, carters, porters, horse-gelders, and horse-leeches, idiots, apple-squires, broom-men, bawds, witches, conjurers, soothsayers and sow-gelders, rogues, ratcatchers, runagates and proctors of Spittle-houses, with such other like rotten and stinking weeds do in town and country, without order, honesty or skill, daily abuse both Physic and Surgery, having no more perseverance, reason or knowledge in this art than has a goose, but only a certain blind practice, without wisdom or judgment, and most commonly use one remedy for all diseases and one way of curing to all persons, both old and young, men, and women and children, which is as possible to perform or to be true as for a shoemaker with one last to make a shoe fit for every man's foot, and this is one principal cause [why] so many perish.

*Selected Writings*

Of Blind Buzzards and Cracking Cumbatters (pp. 77–78)

Harvey & Blythe. London, England. 1948

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

It is better to have recourse to a quack, if he can cure the disorder, although he cannot explain it, than to a physician, if he can explain our disease, but cannot cure it.

*Lacon; or Many Things in a Few Words*

1:170

William Gowans. New York, New York, USA. 1849

**Crabbe, George** 1754–1832  
English poet

A potent quack, long versed in human ills,  
Who first insults the victim whom he kills...

*The Poetical Works of George Crabbe*

The Village L. 282–283 (p. 15)

Oxford University Press, Inc. London, England. 1908

**Graves, Richard**  
No biographical data available

A doctor, who, for want of skill,  
Did sometimes cure – and sometimes kill;  
Contriv'd at length, by many a puff,  
And many a bottle fill'd with stuff,  
To raise his fortune, and his pride;  
And in a coach, forsooth! must ride.  
His family coat long since worn out,  
What arms to take, was all the doubt.  
A friend, consulted on the case,  
Thus answer'd with a sly grimace:  
“Take some device in your own way,  
Neither too solemn nor too gay;  
Three ducks, suppose; white, grey, or black;  
And let your motto be, Quack! quack!”



In William Davenport Adams

*English Epigrams*

A Doctor's Motto, cclxxxii

G. Routledge. London, England. 1878

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

The charlatan is always the pioneer. From the astrologer came the astronomer, from the alchemist the chemist, from the mesmerist the experimental psychologist. The quack of yesterday is the professor of to-morrow.

The Leather Funnel

*McClure's Magazine*, Volume 20, Number 1, November, 1902 (p. 19)

**Hood, Thomas** 1799–1845

English poet and editor

Not one of these self-constituted saints,

Quacks – not physicians – in the cure of souls.

*The Complete Poetical Works of Thomas Hood*

Ode to Rae Wilson ESQ.

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Jenner, Edward** 1749–1823

English physician

I've dispatc'd, my dear madam, this scrap of a letter,  
To say that Miss –

– is very much better.

A Regular Doctor no longer she lacks,

And therefore I've sent her a couple of Quacks.

In William Davenport Adams

*English Epigrams*

Sent to a Patient, with the Present of a Couple of Ducks, cclxxxiii

G. Routledge. London, England. 1878

**Lydston, George Frank** 1858–1923

American urologist

The quack doesn't find out what the matter is but, to the patient's cost, he does find a lot of things that do not exist, and all because the reputable physician flouted as imaginary conditions which, to the patient's sensitive and morbid mind, are always terribly real.

Sexual Neurasthenia and the Prostate

*Medical Record*, Volume 81, 1912

**Massinger, Philip** 1583–1640

English dramatic poet

Out, you impostors!

Quacksalving, cheating mountebanks! your skill

Is to make sound men sick, and sick men kill.

*The Plays of Philip Massinger* (Volume 1)

The Virgin-Martyr, Act IV, Scene I (p. 78)

G. & W. Nicol. London, England. 1805

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Did I hear from the fireside armchair the bow-wow of the old school defending its drugs? Ah, believe me, Paddy,

the world would be healthier if every chemist's shop in England were demolished. Look at the papers! full of scandalous advertisements of patent medicines! a huge commercial system of quackery and poison. Well, whose fault is it? Ours. I say, ours. We set the example. We spread the superstition. We taught the people to believe in bottles of doctor's stuff; and now they buy it at the stores instead of consulting a medical man.

*The Doctor's Dilemma*

Act I (p. 27)

Brentano's. New York, New York, USA. 1920

**Wycherley, William** 1640–1760

English dramatist

A quack is as fit for a pimp as a midwife for a bawd: they are still but in their way, both helpers of nature.

*The Country Wife*

Act I (p. 5)

Random House, Inc. New York, New York, USA. 19 –

## QUADRATIC

### Author undetermined

Beneath the great pyramid, upon a gorgeous throne cast in the furnaces of Tubal-Cain, sat the Grand Quadratic, surrounded by the Dukes, Marshals, Tetrarchs and Captains of the realm. The majesty of an hundred kings clothed him as a garment. The Lord High Coefficient, stood at his right hand, the First Fluxion of the Empire at his left, both in magnificent apparel, and holding certain singular emblems appertaining to the crown.

The Symbol of Darkness

*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 213)

## QUALITIES

**Darwin, Charles Robert** 1809–82

English naturalist

I am inclined to agree with Francis Galton in believing that education and environment produce only a small effect on the mind of anyone, and that most of our qualities are innate.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter I (p. 21)

D. Appleton & Company. New York, New York, USA. 1896

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The only qualifications required for the study of Nature's story-book are devotion to truth, and sincerity of spirit; all the other qualities will come to the possessor of these, and a habit of mind will be developed that tries to face all facts squarely and honestly, despises shams and false conventions, and exposes superstition whenever it is encountered.



*Discovery; or, The Spirit and Service of Science*  
Chapter III (p. 44)  
Macmillan & Company Ltd. London, England. 1918

## QUANTIFICATION

### Platt, John R.

No biographical data available

Today we preach that science is not science unless it is quantitative. We substitute correlation for causal studies., and physical equations for organic reasoning. Measurements and equations are supposed to sharpen thinking, but...they more often tend to make the thinking non-causal and fuzzy.

Strong Inference

*Science*, Volume 146, Number 3641, 16 October, 1964 (pp. 351–352)

### Sagan, Carl 1934–96

American astronomer and author

Quantify. If whatever it is you're explaining has some measure, some numerical quantity attached to it, you'll be much better able to discriminate among competing hypotheses. What is vague and qualitative is open to many explanations.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 12 (p. 211)

Random House, Inc. New York, New York, USA. 1995

### Whitehead, Alfred North 1861–1947

English mathematician and philosopher

Elegant intellects which despise the theory of quantity are but half developed.

*The Aims of Education*

Presidential Address

Mathematical Association of England, 1916

## QUANTITY

### Hamilton, William 1788–1856

Scottish philosopher

In Mathematics, quantity, when not divorced from form, is itself really presented to the intellect in a lucid image of phantasy, or in a sensible diagram; and the quantities which cannot thus be distinctly construed to imagination and sense, are, as only syntheses of unity, repetitions of identity, adequately, though conventionally, denoted in the vicarious combination of a few simple symbols.

*Discussions on Philosophy and Literature, Education and University Reform*

On the Study of Mathematics as an Exercise of the Mind (p. 274)

Harper & Brothers Publishers. New York, New York, USA. 1861

## QUANTUM

### Bohr, Niels Henrik David 1886–1962

Danish physicist

There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.

Quoted in A. Petersen

*The Philosophy of Niels Bohr*

*Bulletin of Atomic Scientists*, Volume 19, Number 7, 1963 (p. 12)

### Wheeler, John Archibald 1911-

American physicist and educator

The quantum is the crack in the armor that covers the secret of existence.

In Denis Brian

*The Voice of Genius*

Chapter Six (p. 122)

Perseus Publishing. Cambridge, Massachusetts, USA. 1995

## QUANTUM FIELD THEORY

### Witten, Edward 1951–

American theoretical physicist

The Quest to understand string theory may well prove to be a central theme in physics of the twenty-first century. To understand this quest in mathematical terms and reap the full fruits, it will be necessary to develop QFT as a mathematical subject.

Physical Law and the Quest for Mathematical Understanding

*Bulletin of the American Mathematical Society*, Volume 40, Number 1, October 2, 2002 (p 24).

## QUANTUM MECHANICS

### Abbey, Edward 1927–89

American environmentalist and nature writer

Quantum mechanics provides us with an approximate, plausible, conjectural explanation of what actually is, or was, or may be taking place inside a cyclotron during a dark night in February.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 10 (p. 93)

St. Martin's Press. New York, New York, USA. 1989

### Barrow, John D. 1952–

English theoretical physicist

We live in the in-between world...betwixt the "devil" of the quantum world and the "deep blue sea" of curved space.

*The World Within the World* (p. 161)  
Clarendon Press. Oxford, England. 1988

**Belinfante, Frederik Jozef** 1913–1991  
Dutch-born American physicist

If I get the impression that Nature itself makes the decisive choice what possibility to realize, where quantum theory says that more than one outcome is possible, then I am ascribing personality to Nature, that is to something that is always everywhere. Omnipresent eternal personality which is omnipotent in taking the decisions that are left undetermined by physical law is exactly what in the language of religion is called God.

In John D. Barrow  
*The World Within the World* (p. 157)  
Clarendon Press. Oxford, England. 1988

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Anyone who is not shocked by quantum theory has not understood it.

In N.C. Panda  
*Maya in Physics* (p. 73)  
Motilal Banarsdass Publishers. Delhi, India. 1991

If anybody says he can think about quantum problems without getting giddy, that only shows he has not understood the first thing about them.

In Ruth Moore  
*Niels Bohr* (p. 127)  
MIT Press. Cambridge, Massachusetts, USA. 1985

There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.

The Philosophy of Niels Bohr  
*Bulletin of the Atomic Scientists*, Volume 19, Number 7, September, 1963 (p. 12)

...the fundamental postulate of the indivisibility of the quantum is itself from the classical point of view, an irrational element which inevitably requires us to forgo a causal mode of description and which, because of the coupling between phenomena and their observation, forces us to adopt a new mode of description designated as complementary in the sense that any given application of classical concepts precludes the simultaneous use of other classical concepts which in a different connection are equally necessary for the elucidation of the phenomena.

*Atomic Theory and the Description of Nature*  
Introductory Survey (p. 10)  
Cambridge University Press. Cambridge, England. 1934

[Quantum mechanics requires] a final renunciation of the classical ideal of causality and a radical revision of our attitude towards the problem of physical reality.

*Atomic Physics and Human Knowledge*

Unity of Knowledge (p. 60)  
John Wiley & Sons. New York, New York, USA. 1958

...in quantum mechanics, we are not dealing with an arbitrary renunciation of a more detailed analysis of atomic phenomena, but with a recognition that such an analysis is in principle excluded.

*Atomic Physics and Human Knowledge*  
Unity of Knowledge (p. 62)  
John Wiley & Sons. New York, New York, USA. 1958

**Born, Max** 1882–1970  
German-born English physicist

[In quantum mechanics] we have the paradoxical situation that observable events obey laws of chance, but that the probability for these events itself spreads according to laws which are in all essential features causal laws.

*Natural Philosophy of Cause and Chance*  
Chapter IX (p. 103)  
At The Clarendon Press. Oxford, England. 1949

**Bridgman, Percy Williams** 1882–1961  
American physicist

The explanatory crisis which now confronts us in relativity and quantum phenomena is but a repetition of what has occurred many times in the past.... Every kitten is confronted with such a crisis at the end of nine days.

*The Logic of Modern Physics*  
Chapter II (p. 42)  
The Macmillan Company. New York, New York, USA. 1927

**Calvin, William H.** 1939–  
Theoretical neurophysiologist

Quantum mechanics is probably essential to consciousness in about the same way as crystals were once essential to radios, or spark plugs are still essential to traffic jams. Necessary, but not sufficient.

*How Brains Think: Evolving Intelligence, Then and Now*  
Chapter 3 (p. 36)  
Basic Books, Inc. New York, New York, USA. 1996

### Captain Janeway (Fictional character)

Who wanted to muck around in the dirt when you could be studying quantum mechanics?

*STAR TREK: Voyager*  
Resolutions  
Television program  
Season 2, 1996

**Cole, K. C.** 1946–  
American science writer

The introduction of quantum theory in the early 1920s marked one of the greatest revolutions in all of physical science. It could not (cannot) adequately be described in metaphors borrowed from our previous view of reality, because many of those metaphors no longer apply. This inability to imagine quantum goings-on led to the

popular perception that the realm of the inner atom is fuzzy, elusive, murky, and uncertain. On the contrary, most physicists would agree that what quantum theory has brought to science is exactly the opposite – concreteness and clarity.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter Seven (p. 113)

Harcourt Brace & Co. Orlando, Florida, USA. 1999

### **DeWitt, Bryce** 1923–2004

American theoretical physicist

### **Graham, Neill**

No biographical data available

No development of modern science has had a more profound impact on human thinking than the advent of quantum theory. Wrenched out of centuries-old thought patterns, physicists of generation ago found themselves compelled to embrace a new metaphysics. The distress which the reorientation caused continues to the present day. Basically physicists have suffered a severe loss: their hold on reality.

Resource IQM-1 on the Interpretation of Quantum Mechanics

*American Journal of Physics*, Volume 39, 1971

### **Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

...the main object of physical science is not the provision of pictures, but in the formulation of laws governing phenomena and the application of these laws to the discovery of new phenomena. If a picture exists, so much the better; but whether a picture exists or not is a matter of only secondary importance. In the case of atomic phenomena no picture can be expected to exist in the usual sense of the word “picture,” by which is meant to model functioning essentially on classical lines. One may extend the meaning of the word “picture” to include any way of looking at the fundamental laws which make their self-consistency obvious. With this extension, one may acquire a picture of atomic phenomena by becoming familiar with the laws of quantum theory.

*The Principles of Quantum Mechanics* (2nd edition)

Chapter I, Section 4 (p. 10)

At The Clarendon Press. Oxford, England. 1935

### **Dirac, Paul Adrien Maurice** 1902–84

English theoretical physicist

The general theory of quantum mechanics is now almost complete, the imperfections that still remain being in connection with the exact fitting of the theory with relativity ideas. These give rise to difficulties only when high-speed particles are involved, and are therefore of no importance in the consideration of atomic and molecular structure and ordinary chemical reactions ...

In Richard Henry Dalitz (rd)

*The Collected Works of P.A.M. Dirac, 1924–1948*

Quantum Mechanics of Many Electron Systems (p. 391)

*Proceeding of the Royal Society*

Cambridge University Press. Cambridge, England. 1995

### **Dyson, Freeman J.** 1923–

American physicist and educator

...Dick Feynman told me about his “sum over histories” version of quantum mechanics. “The electron does anything it likes,” he said. “It goes in any direction at any speed, forward or backward in time, however it likes, and then you add up the amplitudes and it gives you the wave function.” I said to him, “You’re crazy.” But he wasn’t.

In Harry Woolf (ed.)

*Some Strangeness in the Proportion*

Chapter 23 (p. 376)

Addison-Wesley Publishing Company, Inc. Reading, Massachusetts,

USA. 1980

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Rather against my better judgment I will try to give a rough impression of the theory. It would probably be wiser to nail up over the door of the new quantum theory a notice, “Structural alterations in progress – No admittance except on business”, and particularly to warn the doorkeeper to keep out prying philosophers.

*The Nature of the Physical World*

Chapter X (p. 211)

The Macmillan Company. New York, New York, USA. 1930

A very useful kind of operator is the selective operator. In my schooldays a foolish riddle was current – “How do you catch lions in the desert?” Answer: “In the desert you have a lot of sand and a few lions; so you take a sieve and sieve out the sand and the lions remain.” I recall it because it describes one of the most usual methods used in quantum theory for obtaining anything that we wish to study.

*New Pathways in Science*

Chapter XII, Section III (p. 263)

The Macmillan Company. New York, New York, USA. 1935

### **Einstein, Albert** 1879–1955

German-born physicist

This theory [quantum theory] reminds me a little of the system of delusions of an exceedingly intelligent paranoiac, concocted of incoherent elements of thoughts.

In Arthur Fine

*The Shaky Game: Einstein, Realism, and the Quantum Theory*

Letter of July 5, 1952 to D. Lipkin (p. 1)

University of Chicago Press. Chicago, Illinois, USA. 1986

Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not bring us any closer to the secret of the Old One. I, at any rate, am convinced that He does not throw dice.

In Ronald W. Clark

*Einstein: The Life and Times*

Letter to Max Born, 1926 (p. 340)

The World Publishing Company. New York, New York, USA. 1971

The quantum theory gives me a feeling very much like yours. One really ought to be ashamed of its success, because it has been obtained with the Jesuit maxim: "Let not thy left hand know what thy right hand doeth."

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*

Letter to Max Born, June 4, 1919 (p. 11)

Walker & Company. New York, New York, USA. 1971

I cannot seriously believe in [the quantum theory] because it cannot be reconciled with the idea that physics should represent a reality in time and space, free from spooky actions at a distance.

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*

Letter to Max Born, March, 1948 (p. 158)

Walker & Company. New York, New York, USA. 1971

[Quantum theory] If this is correct, it signifies the end of physics as a science.

In L.I. Ponomarev

*The Quantum Dice* (p. 80)

Institute of Physics Publishing. Bristol, England. 1993

The more one chases after quanta, the better they hide themselves.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter to Paul Ehrenfest, 12 July, 1924 (p. 69)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Ekert, Artur** 1961

Polish/British quantum physicist

Possibly the best way to agitate a group of jaded but philosophically inclined physicists is to buy them a bottle of wine and mention interpretations of quantum mechanics. It is like opening a Pandora's box. I have been amused to discover that the number of viewpoints often exceeds the number of participants.

Pet Theories of Quantum Mechanics

*Physics World*, December 1995

**Ferris, Timothy** 1944–

American science writer

Gertrude Stein said of modern art, "A picture may seem extraordinarily strange to you and after some time not only does it not seem strange but it is impossible to find what there was in it that was strange." Quantum physics isn't like that. The longer you look at it, the stranger it gets.

*The Whole Shebang: A State-of-the Universe's Report*

Quantum Weirdness (p. 265)

Simon & Schuster. New York, New York, USA. 1996

**Feynman, Richard P.** 1918–88

American theoretical physicist

The theory of quantum electrodynamics describes Nature as absurd from the point of view of common sense. And it

agrees with experiment. So I hope you can accept Nature as She is – absurd.

*QED: The Strange Theory of Light and Matter*

Chapter 1 (p. 10)

Princeton University Press. Princeton, New Jersey, USA. 1985

There was a time when the newspapers said that only twelve men understood the theory of relativity. I do not believe that there ever was such a time. There might have been a time when only one man did, because he was the only guy who caught on, before he wrote his paper. But after people read the paper a lot of people understood the theory of relativity in some way or other, certainly more than twelve. On the other hand I think I can safely say that nobody understands quantum mechanics.... Do not keep saying to yourself, if you can possibly avoid it, "But how can it be like that?" because you will get "down the drain", into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that.

*The Character of Physical Law*

Chapter 6 (p. 129)

BBC. London, England. 1965

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

It is possible in quantum mechanics to sneak quickly across a region which is illegal energetically.

*The Feynman Lectures on Physics* (Volume 3)

Chapter 8–6 (p. 8–12)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...there are certain situations in which the peculiarities of quantum mechanics can come out in a special way on a large scale.

*The Feynman Lectures on Physics* (Volume 3)

Chapter 21–1 (p. 21–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Gell-Mann, Murray** 1929–

American physicist

All of modern physics is governed by that magnificent and thoroughly confusing discipline called quantum mechanics, invented more than fifty years ago. It has survived all tests and there is no reason to believe that there is any flaw in it. We suppose that it is exactly correct. Nobody understands it, but we all know how to use it and how to apply it to problems; and so we have learned to live with the fact that nobody can understand it.

In Frank Durham and Robert D. Purrington (eds.)

*Some Truer Method: Reflections on the Heritage of Newton*

Chapter 2 (p. 51)

Columbia University Press. New York, New York, USA. 1990

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

...in the impalpable and seemingly inconsequential entities of the quantum world, one finds the true music and magic of nature.

*Masks of the Universe*

Chapter 8 (p. 123)

Macmillan Publishing Company, New York, New York, USA. 1985

**Hawking, Stephen William** 1942–  
English theoretical physicist

You would have to fly around the world four hundred million times to add one second to your life; but your life would be reduced by more than that by all those airline meals.

*Black Holes and Baby Universes and Other Essays*

Chapter Eight (p. 72)

Bantam Books, New York, New York, USA. 1987

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Quantum theory reminds us of the old wisdom that when searching for harmony in life we must forget that in the drama of existence we are ourselves both players and spectators.

In Denis Alexander

*Beyond Science*

Chapter Two (p. 48)

Lion Publishing, Berkhamsted, Herts, England. 1972

Quantum theory thus provides us with a striking illustration of the fact that we can fully understand a connection though we can only speak of it in images and parables.

*Physics and Beyond: Encounters and Conversations*

Chapter 17 (p. 210)

Harper & Row, Publishers, New York, New York, USA. 1971

The problem of quantum theory centers on the fact that the particle picture and the wave picture are merely two different aspects of one and the same physical reality.

*The Physical Principles of the Quantum Theory*

Translated by Carl Eckhart and Frank C. Hoyt (p. 177)

The University of Chicago Press, Chicago, Illinois, USA. 1930

If anything like mechanics were true then one would never understand the existence of atoms. Evidently there exists another [type of mechanics – ] “quantum mechanics.”

In Keith Hannabuss

*An Introduction to Quantum Theory*

Letter to Wolfgang Pauli, June 21, 1925 (p. 21)

Oxford University Press, Inc. Oxford, England. 1997

**Joyce, James** 1882–1941  
Irish-born author

I am working out a quantum theory about it for it is really most tantalizing state of affairs.

*Finnegans Wake*

Book I (p. 149)

The Viking Press, New York, New York, USA. 1939

**Kaku, Michio**  
Theoretical physicist

...it is often stated that of all the theories proposed in this century, the silliest is quantum theory. In fact, some say that the only thing that quantum theory has going for it is that it is unquestionably correct.

*Hyperspace: A Scientific Odyssey Through Parallel Universes, Time*

*Warp, and the 10th Dimension*

Chapter 12 (p. 262)

Oxford University Press, Inc. New York, New York, USA. 1995

**Kramers, Hendrick Anthony** 1894–1952  
Physicist

The theory of quanta is similar to other victories in science; for some months you smile at it, and then for years you weep.

In L.I. Ponomarev

*The Quantum Dice* (p. 80)

Institute of Physics Publishing, Bristol, England. 1993

The theory of quanta can be likened to a medicine that cures the disease but kills the patient.

In L.I. Ponomarev

*The Quantum Dice* (p. 81)

Institute of Physics Publishing, Bristol, England. 1993

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

...what we really should be discussing is “the interpretation of classical mechanics” – that is, how can the classical world we see – which is only an approximation of the underlying reality, which in turn is quantum mechanical in nature – be understood in terms of the proper quantum mechanical variables? If we insist on interpreting quantum mechanical phenomena in terms of classical concepts, we will inevitably encounter phenomena that seem paradoxical, or impossible.

*The Physics of Star Trek*

Chapter Nine (pp. 150–151)

Harp Perennial Publishers, New York, New York, USA. 1995

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

I like relativity and quantum theories because I don't understand them and they make me feel as if space shifted about like a swan that can't settle, refusing to sit still and be measured; and as if the atom were an impulsive thing Always changing its mind.

In Vivian de Sola Pinto and Warren Roberts (eds.)

*The Complete Poems of D.H. Lawrence*

Relativity (p. 524)

Viking Press, New York, New York, USA. 1973

**Lindley, David** 1956–  
English astrophysicist and author



[I]t is misleading to say that “measurement affects the thing measured” because that can seem to imply that a quantum object was in some definite but unknown state, but was then disturbed by an act of measurement and is now in some other state. Rather, measurement gives definition to quantities that were previously indefinite; there is no meaning that can be given to a quantity until it is measured.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*

Which Way Did the Photon Go? (p. 60)

Basic Books, Inc. New York, New York, USA. 1996

Although quantum mechanics provides explanations of the results of experiments, those explanations tend not, in our minds, to add up to an understanding. But why should they? It’s the job of science to provide theories and models that give us an accurate picture of the way the world works, but we are not free also to demand that these theories should conform to our prior expectations of the way we would like the world to work, or think it ought to work. If science sometimes provides explanations without giving us what we would regard as an understanding, the deficiency belongs to us, not to science.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*

You Can Push It Around, But You Can’t Get Rid of It (p. 125)

Basic Books, Inc. New York, New York, USA. 1996

The Moon really is there, after all, when no one’s looking. In a general sense, Einstein’s comment was correct: quantum mechanics demands that a measurement be made in order for the Moon really to exist at a particular spot. But the new insight afforded by the decoherence argument is that the rain of solar photons onto the Moon’s surface is enough of a physical process to constitute a “measurement” – it’s enough to get rid of superposed states, which is what we want a measurement to accomplish. No actual observation is required, and the whole process carries on efficiently and relentlessly without any intervention of human action, let alone human consciousness. The world works in its own way, and doesn’t need us to look at it.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*

In Which Einstein’s Moon Is Restored (p. 204)

Basic Books. New York, New York, USA. 1996

The microworld is not a simple place, and physicists have therefore not been able to keep their theories of it simple.

*The End of Physics: The Myth of a Unified Theory*

Part I (p. 24)

Basic Books, Inc. New York, New York, USA. 1993

### **Moser, David**

No biographical data available

Quantum Particles: the dreams that stuff is made of.

In Douglas Hofstadter

*Metamagical Themas: Questing for the Essence of Mind and Pattern*  
Section IV, Chapter 20 (p. 473)

Basic Books, Inc. New York, New York, USA. 1985

### **National Research Council (U.S.)**

There is no good analogy to the advent of quantum mechanics, but if a political-social analogy is to be made, it is not a revolution but the discovery of the New World.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 62)

National Academy of Sciences

Washington, D.C. 1972

As a scientist, or as any thinking person with curiosity about the basic workings of nature, the reaction to quantum mechanics would have to be: “Ah! So that’s the way it really is!”

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 62)

National Academy of Sciences

Washington, D.C. 1972

### **Pagels, Heinz R.** 1939–88

American physicist and science writer

Another way the old physics differs from the quantum physics is the way the determinism of a clock differs from the contingency of a pinball machine.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Foreword (p. 13)

Simon & Schuster. New York, New York, USA. 1982

### **Pauli, Wolfgang** 1900–58

Austrian-born physicist

Physics is a blind alley again. In any case, it has become too difficult for me, and I would prefer to be a comedian in the cinema, or something like that, and hear no more about physics.

In L.I. Ponomarev

*The Quantum Dice* (p. 81)

Institute of Physics Publishing. Bristol, England. 1993

I know a great deal. I know too much. I am a quantum ancient.

In Jeremy Bernstein

*Experiencing Science*

Part 1. Two Faces of Physics. Chapter 2. Rabi: The Modern Age (p. 102)

Basic Books, Inc. New York, New York, USA. 1978

### **Peat, F. David** 1938–

English holistic physicist and author

The choice before us is either to abandon any hope of knowing the nature of quantum reality or to accept a non-local universe.

*Einstein’s Moon* (p. 124)

Contemporary Books. Chicago, Illinois, USA. 1990

### **Planck, Max** 1858–1947

German physicist



My futile attempts to fit the elementary quantum of action somehow into the classical theory continued for a number of years and they cost me a great deal of effort. Many of my colleagues saw in this something bordering on a tragedy. But I feel differently about it, for the thorough enlightenment I thus received was all the more valuable. I now knew for a fact that the elementary quantum of action played a far more significant part in physics than I had originally been inclined to suspect, and this recognition made me see clearly the need for the introduction of totally new methods of analysis and reasoning in the treatment of atomic problems.

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (pp. 44–45)

Philosophical Library. New York, New York, USA. 1949

### **Polkinghorne, John** 1930–

British physicist, Episcopal priest, and writer

Quantum theory is both stupendously successful as an account of the small-scale structure of the world and it is also the subject of unresolved debate and dispute about its interpretation. That sounds rather like being shown an impressively beautiful palace and being told that no one is quite sure whether its foundations rest on bedrock or shifting sand.

*The Quantum World*

Chapter 1 (p. 1)

Princeton University Press. Princeton, New Jersey, USA. 1984

### **Robinson, Arthur L.**

No biographical data available

In short, quantum mechanics, special relativity, and realism cannot all be true.

Quantum Mechanics Passes Another Test

*Science*, Volume 217, Number 4558, July 30, 1982 (p. 435)

### **Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

Quantum mechanics is the imaginary square root of probability theory.

*Indiscrete Thoughts*

Chapter XX (p. 227)

Birkhäuser. Boston, Massachusetts, USA. 1997

### **Rothman, Tony** 1953–

American cosmologist

Quantum mechanics – the theory that explains phenomena on the size of atoms – is right. It is also so conceptually weird that physicists to this day feel uncomfortable with it.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 7 (p. 159)

Ballentine Books. New York, New York, USA. 1995

### **Sagan, Carl** 1934–96

American astronomer and author

How can light simultaneously be a wave and a particle? It might be better to think of it as something else, neither a wave nor a particle, something with no ready counterpart in the everyday world of the palpable, that under some circumstances partakes of the properties of a wave, and, under others, of a particle. This wave-particle dualism is another reminder of a central humbling fact: Nature does not always conform to our predispositions and preferences, to what we deem comfortable and easy to understand.

*Billions & Billions: Thoughts on Life and Death at the Brink of the Millennium*

Chapter 4 (p. 37)

Random House, Inc. New York, New York, USA. 1997

### **Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

I don't like it, and I'm sorry I ever had anything to do with it.

In John Gribbin

*In Search of Schrödinger's Cat: Quantum Physics and Reality* (p. v)

Bantam Books. New York, New York, USA. 1984

If all this damned quantum jumping were really here to stay, I should be sorry I ever got involved with quantum theory.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 75)

Harper & Row, Publishers. New York, New York, USA. 1971

### **Stapledon, Olaf** 1886–1950

English author

...whenever a creature was faced with several possible courses of action, it took them all, thereby creating many distinct temporal dimensions and distinct histories of the cosmos. Since in every evolutionary sequence of the cosmos there were very many creatures, and each was constantly faced with many possible courses, and the combinations of all their courses were innumerable, an infinity of distinct universes exfoliated from every moment of every temporal sequence in this cosmos.

*Last and First Man and Star Maker*

Chapter XV, 2 (p. 426)

Dover Publications, Inc. New York, New York, USA. 1968

### **Stenger, Victor J.** 1935–

American physicist

This type of schizophrenic behavior is not confined to photons alone. Electrons, neutrons, and other entities that normally appear as localized particles also can't seem to decide whether they are waves or particles. It all depends on what you try to measure. If you look for localized electrons, neutrons, or photons, you find them. If, on the other hand, you set up an experiment designed to measure wave properties, you find these too. We look

at the world through colored glasses, and so it should not surprise us that the world appears a different color when we change to another pair.

*Physics and Psychics: The Search for a World Beyond the Senses*  
Chapter 10 (p. 215)  
Prometheus Books. Buffalo, New York, USA. 1990

**Trefil, James** 1938–  
American physicist

But...we recognize that the wave-particle duality does not arise because of anything paradoxical about the behavior of elementary particles, but simply from the fact that we have asked the wrong question. If we had asked "How does an elementary particle behave?" instead of asking "Does it behave like a particle or a wave?", we would have been able to give a perfectly sensible answer. An elementary particle is not a particle in the sense that a bullet is, and it is not a wave like the surf. It exhibits some properties that we normally associate with each of these kinds of things, but it is an entirely new kind of phenomenon.

*From Atoms to Quarks: An Introduction to the Strange World of Particle Physics* (Revised edition), 1994  
Charles Scribner's Sons. New York, New York, USA. 1980

**Wheeler, John Archibald** 1911–  
American theoretical physicist and educator

There may be no such thing as the "glittering central mechanism of the universe" to be seen behind a glass wall at the end of the trail. Not machinery but magic may be the better description of the treasure that is waiting.

In Nick Herbert  
*Quantum Reality: Beyond the New Physics*  
Chapter 2 (p. 29)  
Anchor Press. Garden City, New York, USA. 1985

Nothing is more important about quantum physics than this: it has destroyed the concept of the world as "sitting out there." The universe afterwards will never be the same.

Quoted by Jefferson Hane Weaver  
*The World of Physics* (Volume 2)  
N. 10 (p. 427)  
Simon & Schuster. New York, New York, USA. 1987

So the quantum, fiery creative force of modern physics, has burst forth in eruption after eruption and for all we know the next may be the greatest of all.

In Franco Selleri  
*Quantum Mechanics Versus Local Realism: The Einstein-Podolsky-Rosen Paradox*  
Chapter 1, Section 3 (p. 47)  
Plenum Press. New York, New York, USA. 1988

...if one really understood the central point and its necessity in the construction of the world, one ought to be able to state it in one clear, simple sentence. Until we see the quantum principle with this simplicity we can well believe that we do not know the first thing about the universe, about ourselves, and about our place in the universe.

In Francesco de Finis (ed.)

*Relativity, Quanta and Cosmology in the Development of the Scientific Thought of Albert Einstein* (Volume 2)  
The Quantum and the Universe

**Yang, Chen Ning** 1922–  
Chinese-born American theoretical physicist

To those of us who were educated after light and reason had struck in the final formulation of quantum mechanics, the subtle problems and the adventurous atmosphere of these pre-quantum mechanics days, at once full of promise and despair, seem to take on an almost eerie quality. We could only wonder what it was like when to reach correct conclusions through reasonings that were manifestly inconsistent constituted the art of the profession.

*Elementary Particles: A Short History of Some Discoveries in Atomic Physics*  
Chapter 1 (p. 9)  
Princeton University Press. Princeton, New Jersey, USA. 1962

**von Baeyer, Hans Christian** 1938–  
German-born physicist and author

That, in a nutshell, is the mystery of the quantum: When an electron is observed, it is a particle, but between observations its map of potentiality spreads out like a wave. Compared to the electron, even a platypus is banal.

*Taming the Atom*  
Chapter 3 (p. 51)  
Random House, Inc. New York, New York, USA. 1992

**Wolf, Fred Alan** 1934–  
American theoretical physicist, writer, and lecturer

The quantum is that embarrassing little piece of thread that always hangs from the sweater of space-time. Pull it and the whole thing unravels.

*Star Wave: Mind Consciousness of Quantum Physics*  
The Macmillan Company. New York, New York, USA. 1984

**Zee, Anthony**  
American physicist

Welcome to the strange world of the quantum, where one cannot determine how a particle gets from here to there. Physicists are reduced to bookies, posting odds on the various possibilities.

*Fearful Symmetry*  
Chapter 10 (p. 141)  
Macmillan Publishing Company. New York, New York, USA. 1986

## QUANTUM PHYSICS

**Goertzel, Ted George**  
No biographical data available

One might say that deriving the behavior of a molecule by quantum physics is like deriving the behavior of a group of people from a knowledge of the personalities of the individual people.

*Linus Pauling: A Life in Science and Politics*  
Chapter 4 (p. 73)  
Basic Books, Inc. New York, New York, USA. 1995

## QUANTUM THEORY

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In Einstein's theory of relativity the observer is a man who sets out in quest of truth armed with a measuring-rod. In quantum theory he sets out armed with a sieve.

*New Pathways in Science*

Chapter XII (p. 267)

The Macmillan Co. New York, New York, USA. 1935

## QUARK

**Atkins, Peter William** 1940-  
English theoretical chemist

...quarks appear to be without spatial extent and to lack a deeper structure: they have character without extension and are substance without inside.

*The Creation*

Chapter 1 (p. 15)

W.H. Freeman & Co. Oxford, England. 1981

### Author undetermined

O! O! you eight colourful guys  
You won't let quarks materialize  
You're tricky, but now we realize  
You hold together our nucleus.

In Frank Wilczek and Betsy Devine

*Longing for the Harmonies*

Chapter 18 (p. 200)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Even if quarks should be found (and I do not believe that they will be), they will not be more elementary than other particles, since a quark could be considered as consisting of two quarks and one anti-quark, and so on. I think we have learned from experiments that by getting to smaller and smaller units, we do not come to fundamental units, or indivisible units, but we do come to a point where division has no meaning. This is a result of the experiments of the last twenty years, and I am afraid that some physicists simply ignore this experimental fact.

In Paul Buckley and F. David Peat

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 15)

University of Toronto Press. Toronto, Ontario, Canada. 1996

**Joyce, James** 1882–1941  
Irish-born author

Three quarks for Muster Mark!  
Sure he hasn't got much of a bark  
And sure any he has it's all beside the mark.

*Finnegans Wake*

Book II (p. 383)

The Viking Press. New York, New York, USA. 1939

**Melnechuk, Theodore**  
Neuroscientist

Poor Gell-Man seeks  
But fails to find  
The fractioned freaks  
He bore in mind.  
And yet a Quark,  
Yea, better, three,  
Exist in stark  
Reality.

The Hunting of the Quark

*The Physics Teacher*, Volume 7, Number 7, October, 1969 (p. 415)

**Stenger, Victor J.** 1935–  
American physicist

Today's quarks and leptons can be viewed as metaphors of the underlying reality of nature, though metaphors that are objectively and rationally defined and are components of theories that have great predictive power. And that's the difference between the metaphors of science and those of myth: scientific metaphors work.... In the pragmatic view of truth of William James, science is true because it works. Science may not be the only path to the truth, but it is the best one we have yet been able to discover.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 4 (p. 79)

Prometheus Books. Buffalo, New York, USA. 1990

**Taylor, Richard E.** 1929–  
Canadian-born American physicist

The quarks and the stars were here when you came, and they will be here when you go. They have no sense of humor so, if you want a world where more people smile, you will have to fix things yourselves.

*Les Prix Nobel. The Nobel Prizes in 1990*

Nobel banquet speech for award received in 1990

Nobel Foundation. Stockholm, Sweden. 1991

## QUASAR

**Chiu, Hong-Yee** 1932–  
Astronomer

So far, the clumsily long name "quasistellar radio sources" is used to describe these objects. Because the nature of these objects is entirely unknown, it is hard to prepare a short, appropriate nomenclature for them so that their essential properties are obvious from their name. For convenience, the abbreviated form "quasar" will be used throughout this paper.

Gravitational Collapse

*Physics Today*, Volume 17, May, 1964 (p. 21)

**Mundell, Carole**

English astronomer

...observing quasars is like observing the exhaust fumes of a car from a great distance and then trying to figure out what is going on under the hood.

A New Look at Quasars

*Scientific American*, Volume 278, Number 6, June, 1998 (p. 57)**National Research Council (U.S.)**

Quasars are the dinosaurs of the cosmos.

*The Decade of Discovery in Astronomy and Astrophysics*

The Life History of Galaxies (p. 40)

National Academy Press. Washing, District of Columbia. 1991

**QUATERNION****Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

...Frenchmen, Germans, and Italians, urging their respective substitutes for quaternions, added to the din. By the second decade of the twentieth century there was a babble of conflicting vector algebras, each fluently spoken only by its inventor and his few chosen disciples. If, at any time in the brawling half-century after 1862, the bickering sects had stopped quarreling for half an hour to listen attentively to what Grassmann was doing his philosophical best to tell them, the noisy battle would have ended as abruptly as a thunderclap. Such, at any rate, seems to have been the opinion of Gibbs. In retrospect, the fifty-year war between quaternions and its rivals for scientific favor, appears as an interminable sequence of duels fought with stuffed clubs in a vacuum over nothing.

*The Development of Mathematics* (p. 208)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**QUESTION****Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

“I checked it very thoroughly,” said the computer, “and that quite definitely is the answer. I think the problem, to be quite honest with you, is that you’ve never actually known what the question is.”

*The Ultimate Hitchhiker’s Guide to the Galaxy**The Hitchhiker’s Guide to the Galaxy*

Chapter 28 (p. 121)

The Ballantine Book Company. New York, New York, USA. 2002

**Alvarez, Luis Walter** 1911–88

American experimental physicist

Much of the work we do as scientists involves filling in the details about matters that are basically understood already, or applying standard techniques to new specific cases. But occasionally there is a question that offers an

opportunity for a really major discovery.

*T. Rex and the Crater of Doom*

Chapter 2 (p. 42)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Author undetermined**

Approach your problems from the right end and begin with the answers. Then one day, perhaps you will find the final question.

Source undetermined

Where would we be without rhetorical questions?

Source undetermined

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

Never ask a question if you can help it; and never let a thing go unknown for the lack of asking a question if you can’t help it.

In James Orton

*Comparative Zoology, Structural and Systematic*

Preceding Chapter XXI (p. 222)

Harper &amp; Brothers. New York, New York, USA. 1877

**Berlinski, David** 1942–

American mathematician

The question belongs to the great good-hearted congregation of questions asked by the hopelessly lost.

*A Tour of the Calculus*

Chapter 5 (p. 33)

Pantheon Books. New York, New York, USA. 1995

**Bloor, David**

English sociologist and philosopher of science

To ask questions of the sort which philosophers address to themselves is usually to paralyze the mind...

*Knowledge and Social Imagery*

Chapter Three (p. 52)

The University of Chicago Press. Chicago, Illinois, USA. 1991

**Bohm, David** 1917–92

American physicist

...it is frequently realised that half the battle is over when we know what are the right questions to ask.

On the Relationship Between Methodology in Scientific Research and the Content of Scientific Knowledge

*British Journal for the Philosophy of Science*, Volume 12, Number 46, 12 August, 1961 (p. 105)**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

If a general intends to conquer a hostile city, he will not consult his map for the shortest road leading there; rather he will be found to make the most various detours, and every hamlet, even if quite off the path, will become a valuable point of leverage for him, if only he can take it; impregnable places will be isolated. Likewise, the

scientist asks not what are the currently most important questions, but, “Which are at present solvable?”, or sometimes simply, “In which can we make some small but genuine advance?”

In Brian McGuinness (ed.)

*Theoretical Physics and Philosophical Problems. Selected Writings*

The Second Law of Thermodynamics (p. 13–14)

Reidel Publishing Company. Boston, Massachusetts, USA. 1974

...but all the more splendid is the success when, groping in the thicket of special questions, we suddenly find a small opening that allows a hitherto undreamt of outlook on the whole.

In Brian McGuinness (ed.)

*Theoretical Physics and Philosophical Problems. Selected Writings*

The Second Law of Thermodynamics (p. 14)

Reidel Publishing Company. Boston, Massachusetts, USA. 1974

### **Bombieri, Enrico** 1940–

Italian mathematician

When things get too complicated, it sometimes makes sense to stop and wonder: Have I asked the right question?

Prime Territory: Exploring the Infinite Landscape at the Base of the Number System

*The Sciences*, Volume 32, Number 5, 1992

### **Browne, Sir Thomas** 1605–82

English author and physician

What song the Syrens sang, or what name Achilles assumed when he hid himself among women, though puzzling questions, are not beyond all conjecture.

*Religio Medici: To Which Is Added Hydriothaphia, Or Urn-burial*

*Urn Burial*

Chapter V (p. 256)

Henry Washbourne. London, England. 1845

### **Burroughs, John** 1837–1921

American naturalist and essayist

One must always cross-question nature if he would get at the truth, and he will not get at it then unless he frames his questions with great skill. Most persons are unreliable observers because they put only leading questions, or vague questions.

*Signs and Seasons*

Chapter I (p. 14)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

Science is wonderfully equipped to answer the question “How?” But it gets terribly confused when you ask it the question “Why?”

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 8)

The Seabury Press. New York, New York, USA. 1977

The kind of questions we ask is conditioned by the kind of answers we expect.

*Voices in the Labyrinth: Nature, Man and Science* (p. 43)

The Seabury Press. New York, New York, USA. 1977

The manner in which questions are asked, i.e., experiments designed, is either completely random or conditioned by our ideas of a preestablished harmony, a harmony that we seldom recognize as a contract with God that He has never signed.

*Heracleitean Fire: Sketches from a Life Before Nature* (p. 169)

The Rockefeller University Press. New York, New York, USA. 1978

### **Charlie Chan (Fictional character)**

Questions are the key to the door of truth.

*Charlie Chan in Monte Carlo*

Film (1937)

Question without answer, like faraway water, no good for nearby fire.

*Charlie Chan at the Circus*

Film (1936)

### **Colby, Frank Moore** 1865–1925

American educator and writer

Every man ought to be inquisitive through every hour of his great adventure down to the day when he shall no longer cast a shadow in the sun. For if he dies without a question in his heart, what excuse is there for his continuance?

In Hans Selye

*From Dream to Discovery: On Being a Scientist*

Why Should You Do Research (p. 10)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

### **Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

There may be some deep questions about the cosmos that are forever beyond science. The mistake is to think that they are therefore not beyond religion too.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 149)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

### **Disraeli, Benjamin, First Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Questions are always easy.

*Sybil; or, The Two Nations*

Chapter IX (p. 288)

Longmans, Green & Co. London, England. 1907

### **Einstein, Albert** 1879–1955

German-born physicist

...we have achieved something if we have succeeded in formulating a meaningful and precise question.



On the Generalized Theory of Gravitation  
*Scientific American*, Volume 182, Number 4, April, 1950 (p. 17)

**Elliot, Hugh Samuel Roger** 1881–1930  
 No biographical data available

...where rational questions cannot be framed, there can be no hope that rational answers will ever be given.

*Modern Science and Materialism*  
 Chapter I (p. 19)  
 Longmans, Green & Co. London, England. 1919

**Farrar, Frederic William** 1831–1903  
 English clergyman and author

To put a question well is no mean attainment.

*Essays on a Liberal Education* (2nd edition)  
 Essay Six (p. 285)  
 Macmillan & Co Ltd. London, England. 1868

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

There are all kinds of interesting questions that come from a knowledge of science, which only adds to the excitement and mystery and awe of a flower. It only adds. I don't understand how it subtracts.

*What Do You Care What Other People Think?*  
 Further Adventures of a Curious Character, The Making of a Scientist (p. 11)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1988

So right away I found out something about biology: it was very easy to find a question that was very interesting, and that nobody knew the answer to. In physics you had to go a little deeper before you could find an interesting question that people didn't know.

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*  
 A Map of a Cat? (p. 71)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1985

**Fischer, D. H.**  
 No biographical data available

Questions are the engines of intellect, the cerebral machines which convert energy to motion, and curiosity to controlled inquiry.

*Historian's Fallacies: Toward a Logic of Historical Thought*  
 Chapter I (p. 3)  
 Harper & Row, Publishers. New York, New York, USA. 1970

**Geroch, Robert**  
 American theoretical physicist

To answer a physical question, one first translates that question into various objects ... in the mathematics, with various properties describing the physical setup. Then one manipulates these objects within the mathematics and translates results back into the physical terms. (These "translations" ultimately become automatic.)

*Mathematical Physics*  
 Chapter 15 (p. 86)  
 University of Chicago Press. Chicago, Illinois, USA. 1985

**Gore, George** 1826–1909  
 English electrochemist

The area of scientific discovery enlarges rapidly as we advance; every scientific truth now known yields many questions yet to be answered. To some of these questions it is possible to obtain answers at the present time, others may only be decided when other parts of science are more developed.

*The Art of Scientific Discovery*  
 Part I, Chapter III (p. 27)  
 Longmans, Green & Company. London, England. 1878

**Gould, Stephen Jay** 1941–2002  
 American paleontologist and evolutionary biologist

Questions are not neutral; they presuppose a list of assumptions that may be long and complex.

*Dinosaur in a Haystack: Reflections in Natural History*  
 Part Three, Chapter 11 (p. 136)  
 Random House, Inc. New York, New York, USA. 1995

Supporters assume that the greatness and importance of a work correlates directly with its stated breadth of achievement: minor papers solve local issues, while great works claim to fathom the general and universal nature of things. But all practicing scientists know in their bones that successful studies require strict limitations. One must specify a particular problem with an accessible solution, and then find a sufficiently simple situation where attainable facts might point to a clear conclusion. Potential greatness then arises from cascading implications toward testable generalities. You don't reach the generality by direct assault without proper tools. One might as well dream about climbing Mount Everest wearing a T-shirt and tennis shoes and carrying a backpack containing only an apple and a bottle of water.

Writing in the Margins  
*Natural History*, Volume 7, Number 9, 1998 (p. 19)

**Greene, Brian** 1963–  
 American physicist

Sometimes attaining the deepest familiarity with a question is our best substitute for actually having the answer.

*The Elegant Universe*  
 Chapter 14 (p. 365)  
 W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Gruber, Levi Franklin**  
 No biographical data available

To the thoughtful mind the questions, *Whence? What? Why? and Whither?* spontaneously suggest themselves on every side.

*Creation Ex Nihilo*  
 Introduction (p. 9)  
 The Gorham Press. Boston, Massachusetts, USA. 1918

**Heisenberg, Werner Karl** 1901–76  
 German physicist and philosopher



We ask, “What does a proton consist of? Can an electron be divided or is it indivisible? Is a photon simple or compound?” But all these questions are wrongly put, because words such a “divide” or “consists of” have to a large extent lost their meaning. It must be our task to adapt our thinking and speaking – indeed our scientific philosophy – to the new situation created by the experimental evidence. Unfortunately this is very difficult. Wrong questions and wrong pictures creep automatically into particle physics and lead to developments that do not fit the real situation in nature.

The Nature of Elementary Particles  
*Physics Today*, Volume 29, Number 3, March, 1976 (p. 37)

Our scientific work in physics consists in asking questions about nature in the language that we possess and trying to get an answer from experiment by the means that are at our disposal. In this way quantum theory reminds us, as Bohr has put it, of the old wisdom that when searching for harmony in life one must never forget that in the drama of existence we are ourselves both players and spectators. It is understandable that in our scientific relation to nature our own activity becomes very important when we have to deal with parts of nature into which we can penetrate only by using the most elaborate tools.

*Physics and Philosophy: The Revolution in Modern Science*  
Chapter III (p. 58)  
Harper & Row, Publishers. New York, New York, USA. 1958

### Hoffer, Eric 1902–83

American longshoreman and philosopher

To spell out the obvious is often to call it in question.

*The Passionate State of Mind, and Other Aphorisms*  
No. 220  
Harper & Brothers. New York, New York, USA. 1955

### Horrobin, David F. 1939–2003

Medical researcher

One needs to be neither particularly observant nor particularly arrogant to realise that the majority of the human race is capable of understanding the nature of the universe in only the simplest and crudest terms. The truth about the universe is clearly beyond the comprehension of most men. Most human brains are incapable of framing appropriate questions, let alone of providing adequate answers.

*Science Is God*  
Chapter 2 (p. 16)  
Medical and Technical Publishing Company Ltd. Aylesbury, England. 1969

### Hoyle, Sir Fred 1915–2001

English mathematician and astronomer

...in science answers are not important, it is the questions that are important.

In Philip Morrison  
*Nothing Is Too Wonderful to Be True*

Less May Be More (p. 219)  
The American Institute of Physics. Woodbury, New York, USA. 1995

### Hutton, James 1726–97

Scottish geologist, chemist, and naturalist

It is only in science that any question concerning the origin and end of things is formed; and it is in science only that the resolution of those questions is to be attained.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)  
Chapter XIV (p. 563)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

### Huxley, Elspeth 1907–97

English writer

The best way to find things out... is not to ask questions at all. If you fire off a question, it is like firing of a gun; bang it goes, and everything takes flight and runs for shelter. But if you sit quite still and pretend not to be looking, all the little facts will come and peck round your feet, situations will venture forth from thickets, and intentions will creep out and sun themselves on a stone; and if you are very patient you will see and understand a great deal more than a man with a gun.

*The Flame Trees of Thika*  
Chapter Twenty-Eight (p. 272)  
William Morrow & Company. New York, New York, USA. 1959

### Huxley, Thomas Henry 1825–95

English biologist

It is much easier to ask such questions than to answer them, especially if one desires to be on good terms with one's contemporaries; but, if I must give an answer, it is this: The growth of physical science is now so prodigiously rapid, that those who are actively engaged in keeping up with the present, have much ado to find time to look at the past, and even grow into the habit of neglecting it.

*Method and Results: Essays*  
Animal Automism (p. 202)  
D. Appleton & Co. New York, New York, USA. 1898

### J Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

It is frequently more difficult to frame a sensible question than to obtain an answer to a nonsensical one.

*The New Background of Science*  
Chapter II (p. 51)  
The University of Michigan Press. 1959

### Jevons, William Stanley 1835–82

English economist and logician

We must learn to distinguish between what we can know and cannot know – between the questions which admit of solution, and those which only seem to be solved.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Chapter XXI (p. 454)  
Macmillan & Co Ltd. London, England. 1887

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Questions of personal priority...however interesting they may be to the persons concerned, sink into insignificance in the prospect of any gain of deeper insight into the secrets of nature.

In Silvanus P. Thompson  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
The Kelvin Lecture: The Life and Work of Lord Kelvin (p. 752)  
Government Printing Office. Washington, D.C. 1909

**Kundera, Milan** 1929–  
Czech-born writer

...the only truly serious questions are the ones that even a child can formulate. Only the most naive of questions are truly serious. They are questions with no answers. A question with no answer is a barrier that cannot be breached. In other words, it is questions with no answers that set the limits of human possibilities, describe the boundaries of human existence.

Translated by Michael Henry Heim  
*The Unbearable Lightness of Being*  
Part Four, Section 6 (p. 139)  
Harper & Row, Publishers. New York, New York, USA. 1984

**Langer, Susanne Katherina Knauth** 1895–1985  
American philosopher

The “technique,” or treatment, of a problem begins with its first expression as a question. The way a question is asked limits and disposes the ways in which any answer to it – right or wrong – may be given.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite, and Art*  
Chapter I (p. 3)  
Harvard University Press. Cambridge, Massachusetts, USA. 1942

A question is really an ambiguous proposition; the answer is its determination.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite, and Art*  
Chapter I (p. 4)  
Harvard University Press. Cambridge, Massachusetts, USA. 1942

**Landau, Lev** 1908–68  
Russian physicist

Physicists have learned that certain questions cannot be asked, not because the level of our knowledge does not yet permit us to find the answer, but because such an answer simply isn't stored in nature.

In Alexandre Dorozynski  
*The Man They Wouldn't Let Die*  
Chapter 7 (p. 108)  
Secker & Warburg. London, England. 1966

**Leggett, A. J.**  
No biographical data available

In those exciting but frustrating fields of knowledge, or perhaps one should say ignorance, where physics tangles

with philosophy, the difficulties usually lie less in finding answers to well-posed questions than in formulating the fruitful questions in the first place.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*  
The “Arrow of Time” and Quantum Mechanics (p. 102)  
Pergamon Press. Oxford, England. 1977

**Little, T. M.**  
No biographical data available

The purpose of an experiment is to answer questions. The truth of this seems so obvious, that it would not be worth emphasizing were it not for the fact that the results of many experiments are interpreted and presented with little or no reference to the questions that were asked in the first place.

Interpretation and Presentation of Results  
*Hortscience*, Volume 16, 1981 (pp. 637–640)

**Lull, Richard Swann** 1867–1957  
Lull, Richard Swann

The great problem of the whence and whither of man has been before the minds of thinkers from time immemorial. This has, of course, also extended to questions concerning animal and plant origins and that of the world and of the universe itself. These questions, after centuries of thought, are still far from their ultimate solution.

*The Ways of Life*  
Chapter X (p. 299)  
Harper & Brothers Publishers. New York, New York, USA. 1925

**MacRobert, Alan**  
Editor

Valid physical questions face us for which our physics is utterly inadequate. This can only be a sign that we stand at a great frontier of science, one that will form a cutting edge of inquiry for generations to come, with results we cannot guess.

Beyond the Big Bang  
*Sky & Telescope*, Volumes 65–66, March, 1983 (p. 213)

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The question, “Why?” which is always appropriate where the explanation of a contradiction is concerned, like all proper habitudes of thought, can overreach itself and be asked where nothing remains to be understood.

Translated by Thomas J. McCormack  
*Popular Scientific Lectures* (2nd edition)  
On the Economical Nature of Physical Inquiry (p. 199)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Marett, Robert Randolph** 1866–1943  
Social anthropologist

In science the word is questionbegging; and the only sound rule in science is to beg as few philosophical questions as you possibly can.

*Anthropology*

Chapter I (p. 15)  
Henry Holt & Co. New York, New York, USA. 1912

**Marsh, George Perkins** 1801–82  
American diplomat, scholar, and conservationist

...the great question, whether man is of nature or above her.

*Man and Nature: or, Physical Geography as Modified by Human Action*  
Chapter VI (p. 549)  
Charles Scribner & Co. New York, New York, USA. 1865

**Maxwell, James Clerk** 1831–79  
Scottish physicist

There are some questions in Astronomy, to which we are attracted rather on account of their peculiarity, as the possible illustration of some unknown principle, than from any direct advantage which their solution would afford to mankind.

*On the Stability of the Motion of Saturn's Rings*  
Macmillan & Company Ltd. London, England. 1859

Some years ago I encountered a gentleman whose main object was to discover the musical relations of the number eleven. I hear on good authority that the question is not only more perplexed but more interesting than ever.

Quoted in Lewis Campbell and William Garnett  
*The Life of James Clerk Maxwell: With a Selection from His Correspondence and Occasional Writings*  
Chapter VIII (p. 233)  
Macmillan & Co Ltd. London, England. 1882

The mind of man has perplexed itself with many hard questions. Is space infinite, and if so, in what sense? Is the material world infinite in extent, and are all places within that extent equally full of matter? Do atoms exist, or is matter infinitely divisible?

A Discourse on Molecules  
*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Volume XLVI, December, 1873 (p. 453)

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

I do not believe that there is any intrinsic limitation upon our ability to answer the questions that belong to the domain of natural knowledge and fall therefore within the agenda of scientific enquiry.

*The Strange Case of the Spotted Mice and Other Classic Essays on Science*  
On "The Effecting of All Things Possible"  
Oxford University Press, Inc. New York, New York, USA. 1996

**Midgley, Mary** 1919–  
English moral philosopher

The astonishing successes of western science have not been gained by answering every kind of question, but precisely by refusing to. Science has deliberately set narrow limits to the kinds of questions that belong to it, and further limits to the questions peculiar to each branch.

It has practiced an austere modesty, a rejection of claims to universal authority.

Can Science Save Its Soul?  
*New Scientist*, 1 August, 1992 (p. 25)

**Morris, Desmond** 1928–  
Zoologist and ethnologist

We never stop investigating. We are never satisfied that we know enough to get by. Every question we answer leads on to another question. This has become the greatest survival trick of our species.

*The Naked Ape*  
Chapter Four (p. 130)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Moulton, Forest Ray** 1872–1952  
American astronomer

There are transcendental questions which, from their nature, can never be answered with certainty, but which the human mind ever persists in attacking. Among such questions is that of the infinity of the physical universe in space and in time.

*An Introduction to Astronomy*  
Chapter XIII, 3 (p. 548)  
The Macmillan Co. New York, New York, USA. 1916

**Payne-Gaposchkin, Cecilia** 1900–79  
British-American astronomer

Whenever we look in nature we can see spiral forms in the uncurling fern, the snail, the nautilus shell, the hurricane, the stirred cup of coffee, the water that swirls out of a wash bowl. Perhaps we shouldn't be surprised to see spirals in the great star systems whirling in space. Yet they remain a great, intriguing question.

Why Do Galaxies Have a Spiral Form?  
*Scientific American*, Volume 189, Number 3, September, 1953 (p. 89)

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

Who would have said, a few years ago, that we could ever know of what substances stars are made of whose light may have been longer in reaching us than the human race existed? Who can be sure of what we shall now know in a few hundred years? Who can guess what would be the result of continuing the pursuit of science for ten thousand years, with the activity of the last hundred? And if it were to go on for a million, or a billion, or any number of years you please, how is it possible to say that there is any question which might not ultimately be solved.

*Values in a Universe of Chance*  
How to Make Ideas Clear (p. 134)  
Stanford University Press. Stanford, California, USA. 1958

...all the followers of science are fully persuaded that the processes of investigation, if only pushed far enough, will give one certain solution to each question to which they can be applied .... This great law is embodied in

the conception of truth and reality. The opinion which is fated to be ultimately agreed to by all who investigate is what we mean by the truth, and the object represented in this opinion is the real.

In H.S. Thayer (ed.)

*Pragmatism: The Classic Writings*

How to Make Ideas Clear (p. 97)

New American Library. New York, New York, USA. 1970

### **Piccard, Auguste** 1884–1962

Swiss physicist, inventor and explorer

So many questions, so many mysteries.

Translated by Christina Stead

*Earth, Sky and Sea*

Part Three, Chapter 3 (p. 147)

Oxford University Press. New York, New York, USA. 1956

### **Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...a young scientist who hopes to make discoveries is badly advised if his teacher tells him, “Go round and observe,” and he is well advised if his teacher tells him: “Try to learn what people are discussing nowadays in science. Find out where difficulties arise, and take an interest in disagreements. These are the questions which you should take up.”

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 4 (p. 129)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Ramsay, Sir William** 1852–1916

English chemist

Whosoever asks shall receive, but he must ask sensible questions in definite order, so that the answer to the first suggests a second, and the reply to the second suggests a third, and so on.

*Essays Biographical and Chemical*

Chemical Essays

How Discoveries Are Made (p. 128)

Archibald Constable & Company Ltd. London, England. 1908

### **Revelle, Richard**

No biographical data available

Every science worthy of the name progresses, once it has passed the pioneering stage, by asking the right questions of nature.

In Mary Sears

*Oceanography; Invited Lectures Presented at the International Oceanographic Congress Held in New York, 31 August–12 September, 1959*

Preface (p. v)

American Association for the Advancement of Science. Washington, D.C. 1961

### **Roscoe, Henry E.** 1833–1915

English chemist

...we must put a question to Nature for her to answer, and we shall always find that our question, if properly asked, is always clearly and certainly answered.

*Chemistry*

Fire, article 2 (p. 2)

D. Appleton & Co. New York, New York, USA. 1867

### **Sonneberg, Walter**

No biographical data available

Questions of science will only be settled when the last scientist is dead.

*Social Eccentricities*

Social Eccentricities (p. 45)

Broadway Publishing Co. New York, New York, USA. 1906

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Clearly our first problem must be to define the issue, since nothing is more prolific of fruitless controversy than an ambiguous question.

*Determinism and Physics*

*Proceeding of the University of Durham Philosophical Society*, 1936

### **Sagan, Carl** 1934–96

American astronomer and author

There are no forbidden questions in science, no matters too sensitive or delicate to be probed, no sacred truths.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 31)

Random House, Inc. New York, New York, USA. 1995

### **Seignobos, Charles** 1854–1942

French historian

It is useful to ask oneself questions, *but very dangerous to answer them.*

In Marc Bloch

*The Historian's Craft*

Introduction (p. 14)

Manchester University Press. Manchester, England. 2004

### **Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

No question is so difficult to answer as that to which the answer is obvious.

*Saturday Review*, January 26, 1895

### **Silver, Brian L.**

Israeli professor of physical chemistry

The Big Questions may be beyond the capabilities of the human computer, just as dogs will never understand jokes. We understand a very great deal about what forces do but are far from finalizing the discussion about what forces are. Maybe we never will. Newton very specifically refused to commit himself as to what gravitational force was, but he nevertheless accounted for the movements of Earth and Moon and deduced the masses of the Earth and the Sun by knowing only what gravity does. We have discovered forces that Newton never knew, but basically we still only define force by what it does.

*The Ascent of Science*

Part II, Chapter 3 (p. 30)

Solomon Press Book. New York, New York, USA. 1998

**Stein, Sherman K.**

No biographical data available

What one age considers a pressing question, another may not ask at all. The pure mathematics of one era may be applied in another, perhaps centuries later.

The Mathematician as an Explorer

*Scientific American*, Volume 204, Number 5, May, 1961 (p. 149)

**Steinbeck, John** 1902–68

American novelist

The literature of science is filled with answers found when the question propounded had an entirely different direction and end.

*Sea of Cortez*

Chapter 17 (pp. 179–180)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Thurston, William Paul** 1946–

American mathematician

Personally I like to see lots of relations between lots of different things. I really enjoy that kind of integration you can have when you take very particular nitty-gritty questions and tie them together in very abstract theories.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 336)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Trefil, James** 1938–

American physicist

Great questions in science – questions like the ones Herschel raised about the structure of the universe – are seldom answered by ivory-tower types engaging in pure thought. They are answered by people who are willing to get down into the trenches and grapple with nature. If that means casting your own telescope mirrors, as Herschel did, so be it.

*Reading the Mind of God: In Search of the Principle of Universality*

Charles Scribner's Sons. New York, New York, USA. 1989

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

If only people would finally stop finding points of disagreement in the personal characteristics and external circumstances of investigators! It does not matter at all whether someone is a professor of clinical medicine or of theoretical pathology, whether he is a practitioner or a hospital physician, if only he possesses material for observation. In addition, it is not of decisive significance whether he confronts an overwhelming or a modest amount of material, if only he understands how to exploit it. And to do this he must know what he wants: in other

words, he must be in a position to put the right questions and to find the right methods for answering them.

Translated by Lelland J. Rather

*Disease, Life, and Man*

Cellular Pathology (p. 77)

Stanford University Press. Stanford, California, USA. 1958

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Ignorant people raise questions which were answered by the wise thousands of years ago.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

532 (p. 187)

The Macmillan Co. New York, New York, USA. 1906

**Walker, Kenneth** 1882–1966

Physician

We must accept the fact that the scientist can answer only a few of the questions we ask him and never the question of “why?.”

*Meaning and Purpose*

Chapter VIII (p. 80)

Jonathan Cape. London, England. 1944

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

It was absolutely marvelous working for Pauli. You could ask him anything. There was no worry that he would think a particular question was stupid, since he thought all questions were stupid.

Working for Pauli

*American Journal of Physics*, Volume 45, Number 5, May, 1977

(p. 422)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

I asked a question, devised some method of getting an answer, and got – a fresh question.

*Seven Science Fiction Novels of H. G. Wells*

*The Island of Dr. Moreau*

Chapter the Fourteenth (pp. 133–134)

Dover Publications, Inc. New York, New York, USA. 1934

**Whately, Richard** 1787–1863

English theologian

A fool can ask more questions than a wise man can answer; but a wise man cannot ask more questions than he will find a fool ready to answer.

*Thoughts and Apophthegms*

Section VI (p. 164)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1856

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Questions are never indiscreet. Answers sometimes are.



*The Plays of Oscar Wilde*

*An Ideal Husband*

Act I (p. 10)

The Modern Library. New York, New York, USA. No date

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

As long as I continue to come across questions in more remote regions which I can't answer, it is understandable that I should still not be able to find my way around regions that are less remote. For how do I know that what stands in the way of an answer here is not precisely what is preventing me from clearing away the fog over there?

Translated by Peter Winch

*Culture and Value* (p. 66e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

I may find scientific questions interesting, but they never really grip me. Only conceptual and aesthetic questions do that. At bottom I am indifferent to the solution of scientific problems; but not the other sort.

Translated by Peter Winch

*Culture and Value* (p. 79e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Zinkernagel, Rolf M.** 1944–

Swiss immunologist and pathologist

To ask questions, to search for answers, to do research – I mean re-search in nature what is already there, but has not been revealed, so far is the most fascinating and the most exciting thing we can dream of doing and what we would like to continue doing.

*Les Prix Nobel. The Nobel Prizes in 1996*

Nobel banquet speech for award received in 1996

Nobel Foundation. Stockholm, Sweden. 1997

## QUESTION, SCIENTIFIC

**Gore, George** 1826–1909

English electrochemist

In every scientific question, even with the most intense meditation, men find that they soon come to the limits of new thoughts; a barrier, like a prison chamber, rises in every direction, which is impassable until new experiments are made, or new knowledge which bears upon the question is attained.

*The Art of Scientific Discovery*

Chapter XXXI (p. 304)

Longmans, Green & Co. London, England. 1878

## QUESTIONNAIRE

**Hauge, Bernt K.**

No biographical data available

[One] feature of questionnaires is that they give [an] excellent opportunity to gather useless information in such a way that it can be handled by data machines, a handling that can give a mysterious authority of exactness to the most incredible nonsense.

Etcetera

*The Physics Teacher*, Volume 15, Number 9, December, 1977 (p. 575)

## QUOTATION

**Disraeli, Isaac** 1766–1846

British writer and scholar

The wisdom of the wise, and the experience of ages, may be preserved by Quotation.

*Curiosities of Literature* Volume 3

Quotation (p. 168)

Riverside Press. Cambridge, England. 1864

It is generally supposed that where there is no Quotation, there will be found most originality.

*Curiosities of Literature* Volume 3

Quotation (p. 168)

Riverside Press. Cambridge, England. 1864

Quotation, like much better things, has its abuses. One may quote till one compiles.

*Curiosities of Literature* Volume 3

Quotation (p. 169)

Riverside Press. Cambridge, England. 1864

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

History is replete with anecdotes and *bons mots* relating to statesmen, soldiers, artists, philosophers, and most other types of notables; but even a well-informed man finds it difficult to enliven talk with quotations from scientists.

*The Dreams of Reason*

Chapter 3 (p. 40)

Columbia University Press. New York, New York, USA. 1961

**Proctor, Richard Anthony** 1837–88

English astronomer

He quotes a passage...without comment, but, unfortunately, not without serious alteration.

*Nature*



*Explanatory*

*Nature*

Explanatory

December 12, 1878 (p. 121)

**Skeats, Walter W.**

No biographical data available

A quotation without a reference is like a geological specimen of unknown locality.

*Notes and Queries*

Sixth Series, Volume IX (p. 499)

**Swift, Jonathan** 1667–1745

Irish-born English writer

Quotations must be plentifully gathered, and booked in alphabet; to this end, though authors need lie little consulted, yet critics, and commentators, and lexicons carefully must. But above all, those judicious collectors of bright parts, and flowers, and *observandas*, are to be nicely dwelt on, by some called the sieves and boulders of learning; though it is left undetermined, whether they dealt in pearls or meal; and consequently, whether we are more to value that which passed through, or what staid behind.

*A Tale of a Tub*

A Digression on Praise of Digressions (pp. 134–135)

William Durell & Co. New York, New York, USA. 1812

## R

### RACISM

**Huntington, Ellsworth** 1876–1947  
American geographer

The climate of many countries seems to be one of the great reasons why idleness, dishonesty, immorality, stupidity, and weakness will prevail. If we can conquer climate, the whole world will become stronger and nobler.

*Civilization and Climate* (p. 294)  
University Press of the Pacific. Honolulu, Hawaii, USA. 2001

**Lewin, Roger Amos**  
Anthropologist

Racism, as we would characterize it today, was explicit in the writings of virtually all the major anthropologists of the first decades of this century, simply because it was the generally accepted world view. The language of the epic tale so often employed by Arthur Keith, Grafton Elliot Smith, Henry Fairfield Osborn, and their contemporaries fitted perfectly an imperialistic view of the world, in which Caucasians were the most revered product of a grand evolutionary march to nobility.

*Bones of Contention*  
Chapter 13, Man's Place in Nature (p. 307)  
Simon & Schuster Inc. New York, New York, USA. 1987

**Mandela, Nelson** 1918–  
First president of South Africa

The doctors and nurses treated me in a natural way as though they had been dealing with blacks on a basis of equality all their lives. It reaffirmed my long-held belief that education was the enemy of prejudice. These were men and women of science, and science had no room for racism.

*The Long Walk to Freedom: The Autobiography of Nelson Mandela* (p. 492)  
Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1994

### RADAR

**Marconi, Guglielmo** 1874–1937  
Italian inventor

As was first shown by Hertz, electric waves can be completely reflected by conducting bodies. In some of my tests I have noticed the effects of reflection and deflection of these waves by metallic objects miles away.

It seems to me that it should be possible to design apparatus by means of which a ship could radiate or project a divergent beam of these rays in any desired direction, which rays, if coming across a metallic object, such as

another steamer or ship, would be reflected back to a receiver screened from the local transmitter on the sending ship, and thereby immediately reveal the presence and bearing of the other ship in fog or thick weather.

Radio Telegraphy  
*Proceedings of the Institute of Radio Engineers*, Volume 10, Number 4, August, 1922 (p. 237)

### RADIATION

**Bryson, Bill** 1951–  
American-born travel author

Incidentally, disturbance from cosmic background radiation is something we have all experienced. Tune your television to any channel it doesn't receive, and about 1% of the dancing static you see is accounted for by this ancient remnant of the Big Bang. The next time you complain that there is nothing on, remember that you can always watch the birth of the universe.

*A Short History of Nearly Everything*  
Chapter 1 (p. 12)  
Broadway Books. New York, New York, USA. 2003

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

It has been widely supposed that the ultimate fate of protons and electrons is to annihilate one another, and release the energy of their constitution in the form of radiation. If so it would seem that the universe will finally become a ball of radiation, becoming more and more rarefied and passing into longer and longer wavelengths. The longest waves of radiation are Hertzian waves of the kind used in broadcasting. About every 1500 million years this ball of radio waves will double its diameter; and it will go on expanding in geometrical progression forever. Perhaps then I may describe the end of the physical world as – one stupendous broadcast.

*New Pathways in Science*  
Chapter III, Section VI (p. 71)  
The Macmillan Company. New York, New York, USA. 1935

**Faraday, Michael** 1791–1867  
English physicist and chemist

The view which I am so bold as to put forth considers, therefore, radiation as a high species of vibration in the lines of force which are known to connect particles and also masses of matter together.

*Experimental Researches in Electricity* (Volume 3)  
May, 1846 (p. 451)  
Bernard Quaritch. London, England. 1855

**Gamow, George** 1904–68  
Russian-born American physicist

Radiation is like butter, which can be bought or returned to the grocery store only in quarter-pound packages,

although the butter as such can exist in any desired amount (not less, though, than one molecule!).

*Thirty Years That Shook Physics*

Chapter 1 (pp. 22–23)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

Perhaps too the sun as he shines aloft with rosy lamp has roundabout him much fire with heats that are not visible, and thus the fire may be marked by no radiance, so that fraught with heat it increases to such a degree the stroke of the rays.

Translated by H.A.J. Munro

*T. Lucreti Cari De rerum natura libri sex* (4th edition) (pp. 131–132)

Deighton Bell & Co. London, England. 1891

**Planck, Max** 1858–1947

German physicist

Either the quantum of action was a fictional quantity, then the whole deduction of the radiation law was in the main illusionary and represented nothing more than an empty nonsignificant play on formulae, or the derivation of the radiation law was based on sound physical conception.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2) No. 1 (p. 284)

Simon & Schuster. New York, New York, USA. 1987

**Rutherford, Ernest** 1871–1937

English philosopher, logician, and social reformer

These experiments show that the uranium radiation is complex and that there are present at least two distinct types of radiation – one that is very readily absorbed, which will be termed for convenience the alpha-radiation, and the other of more penetrative character which will be termed the beta-radiation.

*Nobel Lectures, Chemistry 1901–1921*

*Philosophical Magazine*

Uranium Radiation and the Electrical Conduction Produced by It

Volume 47 1899

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

## RADICAL

**von Liebig, Justus** 1803–73

German organic chemist

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

...in inorganic chemistry the radicals are simple; in organic chemistry they are compounds – that is the sole difference.

In William H. Brock

*Justus von Liebig*

Chapter 3 (p. 81)

Cambridge University Press. Cambridge, England. 1997

**Mark, Herman F.** 1898–1992

Polymer chemist

The concept of “free radicals” was not known in 1920 – well perhaps in politics, but not in chemistry.

*From Small Organic Molecules to Large: A Century of Progress*

Chemistry Study in Vienna (p. 15)

American Chemical Society, Washington, D.C. 1993

## RADIO

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Be not afeared; the isle is full of noises,  
Sounds and sweet airs, that give delight and hurt not.  
Sometimes a thousand twangling instruments  
Will hum about mine ears, and sometimes voices...

*In Great Books of the Western World* (Volume 27)

*The Tempest*

Act III, sc ii

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

## RADIO ASTRONOMY

**Christiansen, Chris**

No biographical data available

Radio astronomy was not born with a silver spoon in its mouth. Its parents were workers. One parent was the radio-telescope, the other was radar.

*Daily Telegraph* (Sydney), August 25, 1952

## Commentary

It has been demonstrated that a receiving set of great delicacy in New Jersey will get a new kind of static from the Milky Way. This is believed to be the longest distance anybody ever went to look for trouble.

*The New Yorker Magazine*, June 17, 1933

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

It is a striking thought that ten years of radio astronomy have taught humanity more about the creation and organization of the universe than thousands of years of religion and philosophy.

*Space and Time in the Modern Universe* (p. 211)

Cambridge University Press. Cambridge, England. 1977

**Gingerich, Owen** 1930–

American astronomer

But even if radio astronomy has not so much destroyed our older astronomical viewpoint, it has enormously enlarged and enriched it. It is like that magical moment in the old Cinerama, when the curtains suddenly opened still further, unveiling the grandeur of the wide screen.

Optical astronomy in the 1950s, on that narrow, central screen, offered a quiescent view of a slowly burning universe, the visible radiations from thermal disorder. But then the curtains abruptly parted, adding a grand and breathtaking vista, a panorama of swift and orderly motions that revealed themselves through the synchrotron radiation they generated – the so-called violent universe.

In W.T. Sullivan III

*The Early Years of Radio Astronomy: Reflections Fifty Years After Jansky's Discovery*

Radio Astronomy and the Nature of Science (p. 404)

Cambridge University Press. Cambridge, England. 1984

### **Kraus, John** 1910–2004

Radio astronomer

The radio sky is no carbon copy of the visible sky; it is a new and different firmament, one where the edge of the universe stands in full view and one which bears the tell-tale marks of a violent past.

*Big Ear*

Chapter 21 (p. 166)

Cygnus-Quasar Books. Powell, Ohio, USA. 1976

### **Mitton, Simon**

No biographical data available

During the last 20 years radio astronomers have led a revolution in our knowledge of the Universe that is paralleled only by the historic contributions of Galileo and Copernicus. In particular, the poetic picture of a serene Cosmos populated by beautiful wheeling galaxies has been replaced by a catalogue of events of astonishing violence: a primeval fireball, black holes, neutron stars, variable quasars and exploding galaxies.

Newest Probe of the Radio Universe

*New Scientist*, Volume 56, Number 816, October 19, 1972 (p. 138)

### **Unsold, Albrecht** 1905–95

Astrophysicist

The old dream of wireless communication through space has now been realized in an entirely different manner than many had expected. The cosmos' short waves bring us neither the stock market nor jazz from distant worlds. With soft noises they rather tell the physicist of the endless love play between electrons and protons.

In W.T. Sullivan, III

*Classics in Radio Astronomy*

Preface (p. xiii)

R. Reidel Publishing Company. Dordrecht, Netherlands. 1982

## **RADIOACTIVITY**

### **Rutherford, Ernest** 1871–1937

English philosopher, logician, and social reformer

This theory [spontaneous disintegration] is found to account in a satisfactory way for all the known facts of

radioactivity, and welds a mass of disconnected facts into one homogeneous whole. On this view, the continuous emission of energy from the active bodies is derived from the internal energy inherent in the atom, and does not in any way contradict the law of the conservation of energy.

*Radioactivity*

Chapter I (p. 2)

1905

## **RAIN FOREST**

### **Forsyth, Adrian**

American writer of natural history

### **Miyata, Kenneth** 1951–83

American writer of natural history

...the subtle beauty of a rain forest must be seen close up and in detail. The ecological and evolutionary messages conveyed by the flanges, folds, colors, and fragrances of tropical flowers can only be divined by intimate study.

*Tropical Nature*

Chapter 6 (p. 75)

Charles Scribner's Sons. New York, New York, USA. 1984

It is no simple task to unravel the messages that rain forest creatures hold in their appearance. Many things are not what they seem to be, and certain messages have different meanings to different receivers.

*Tropical Nature*

Chapter 11 (p. 187)

Charles Scribner's Sons. New York, New York, USA. 1984

### **Fuertes, Louis Agassiz** 1874–1920

American ornithologist

The principal sensation one gets in the tropical forests is the mystery of the unknown voices. Many of these remain forever mysteries unless one stays long and seeks diligently.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1915*

Impressions of the Voices of Tropical Birds (p. 313)

Government Printing Office. Washington, D.C. 1916

## **RAINBOW**

### **Burroughs, John** 1837–1921

American naturalist and essayist

...the rainbow is truly an apparition; you cannot approach it; you cannot grasp it, or find its end. I has no end, and no beginning. It is also born of the spray of cataracts, but sways not as the spray sways. It is one of the oldest and most striking phenomena in nature, and one of the most subtle and elusive.

*The Heart of Burroughs's Journals*

July 15, 1911 (p. 263)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

But why should not the glorious Rainbow be included among the gods? It is beautiful enough, and its marvelous loveliness has given rise to the legend that Iris is the daughter of Thaumus. And if the rainbow is a divinity, what will you do about the clouds?

*De Natura Deorum*

3.20 (p. 335)

Putnam's Sons. New York, New York, USA. 1933

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

...beautiful as the rainbow – that smiling daughter of the storm ...

*Lacon: or, Many Things in Few Words*

Early Happiness (p. 178)

W.S. Trounce. London, England. 1865

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

A rainbow described in the symbolism of physics is a band of aethereal vibrations arranged in systematic order of wavelength from about 000040 cm to 000072 cm.

*The Nature of the Physical World*

Chapter XV (p. 328)

The University Press. New York, New York, USA. 1929

**Goodwin, Maud Wilder** 1856–1935

The artist shrugged his shoulders. "I have no taste for panoramic chromos of sunrise," he said; "I should as soon undertake to paint a rainbow, that section of aerial watermelon..."

*Claims and Counterclaims*

Chapter I (p. 6)

Doubleday, Page & Co. New York, New York, USA. 1907

**Hilliard, George Stillman** 1808–79  
American politician

Surely, the rainbow is a more glorious vision to him who comprehends the beautiful law by which its rich scarf is flung upon the dark skirts of the retiring storm.

*The Relation of the Poet to His Age*

Discourse (p. 38)

Charles C. Little & James Brown. Boston, Massachusetts, USA. 1843

**Huntley, H. E.**  
No biographical data available

If a poet sees beauty in a rainbow...so does the physicist in the laws governing its manifestation. The surface beauty of the rainbow...is appreciated by all men: it is given. But the buried beauty, uncovered by the industrious researches of the physicist, is understood only by the scientifically literate. It is acquired: education is essential.

*The Divine Proportion: A Study in Mathematical Beauty*

Chapter I (pp. 10–11)

Dover Publications. New York, New York, USA. 1970

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

The arc [of the rainbow] bended and strengthened itself till it arched indomitable, making great architecture of light and colour and the space of heaven, its pedestals luminous in the corruption of new houses on the low hill, its arch the top of heaven.

*The Rainbow*

The Rainbow (p. 467)

B.W. Huebsch. New York, New York, USA. 1921

**MacDonald, George** 1824–1905  
Scottish novelist and poet

They climbed out of the earth; and, still climbing, rose above it. They were in the rainbow. Far abroad, over ocean and land, they could see through its transparent walls the earth beneath their feet. Stairs beside stairs wound up together, and beautiful beings of all ages climbed along with them. They knew that they were going up to the country where the shadows fail.

*Works of Fancy and Imagination* (Volume 9)

The Golden Key (p. 122)

Strahan & Co. Publishers. London, England. 1871

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

Those which we call Rainbows, are seen often without any Wonder, or betokening Portent: for they foretel not so much as rainy or fair Days, in a Manner that we can trust them. But it is manifest that the Sunbeams striking upon an hollow Cloud, when their Edge is repelled, are beaten back against the Sun: and thus ariseth a Variety of Colours by the Mixture of Clouds, Air, and fiery Light.

*Pliny's Natural History. In Thirty-seven Books*

Book II, Chapter LIX (pp. 97–98)

Printed for the Club by G. Barclay. London, England. 1847–1849

**Tennyson, Frederick** 1807–98  
English poet

A rainbow painted on a thundercloud...

*The Isles of Greece*

Eumenides (p. 89)

Macmillan & Company Ltd. London, England. 1890

**The Bible (King James Version)**

And God said, This is the token of the covenant which I make between me and you and every living creature that is with you, for perpetual generations:...

*Genesis 9:12*

**Thomson, James** 1700–48  
Scottish poet

Meantime, refracted from yon eastern cloud,  
Bestriding earth, the grand ethereal bow  
Shoots up immense; and every hue unfolds,  
In fair proportion running from the red

To where the violet fades into the sky.  
 Here, awful Newton, the dissolving clouds  
 Form, fronting on the sun, thy showery prism;  
 And to the sage-instructed eye unfold  
 The various twine of light, by thee disclosed  
 From the white mingling maze.

*The Seasons*

Spring

Longman, Brown, Green & Longmans. London, England. 1847

## Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910

American author and humorist

We have not the reverent feeling for the rainbow that the  
 savage has, because we know how it is made. We have  
 lost as much as we gained by prying into that matter.

*A Tramp Abroad*

Chapter XLIII (p. 318)

Penguin Books. New York, New York, USA. 1997

One can enjoy a rainbow without necessarily forgettingw  
 the forces that made it.

*Europe and Elsewhere*

Queen Victoria's Jubilee (p. 210)

Harper & Brothers. New York, New York, USA. 1923

## RAMAN EFFECT

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

**Krishnan, K. S.**

No biographical data available

If we assume that the X-ray scattering of the 'unmodi-  
 fied' type observed by Prof. Compton corresponds to  
 the normal or average state of the atoms and molecules,  
 while the 'modified' scattering of altered wavelength  
 corresponds to their fluctuations from that state, it would  
 follow that we should expect also in the case of ordinary  
 light two types of scattering, one determined by the nor-  
 mal optical properties of the atoms or molecules, and  
 another representing the effect of their fluctuations from  
 their normal state. It accordingly becomes necessary to  
 test whether this is actually the case. The experiments we  
 have made have confirmed this anticipation, and shown  
 that in every case in which light is scattered by the mol-  
 ecules in dust-free liquids or gases, the diffuse radiation  
 of the ordinary kind, having the same wavelength as the  
 incident beam, is accompanied by a modified scattered  
 radiation of degraded frequency.

A New Type of Secondary Radiation

*Nature*, Volume 121, Number 3048, March 31, 1928 (p. 501)

## RAMIFICATION

**Sylvester, James Joseph** 1814–97

English mathematician

The theory of ramification is one of pure colligation, for  
 it takes no account of magnitude or position; geometrical  
 lines are used, but these have no more real bearing on the  
 matter than those employed in genealogical tables have  
 in explaining the laws of procreation.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

On Recent Discoveries in Mechanical Conversion of Motion (p. 23)

University Press. Cambridge, England. 1904–1912

## RANDOM

### Author undetermined

Random is not haphazard.

Source undetermined

**Hillerman, Tony** 1925–2008

American author

...from where we stand the rain seems random. If we could  
 stand somewhere else, we would see the order in it.

*Coyote Waits*

Chapter 15 (p. 214)

Harper & Row, Publishers. New York, New York, USA. 1990

## RANDOMNESS

**Cohen, John**

No biographical data available

...nothing is so alien to the human mind as the idea of  
 randomness.

*Chance, Skill, and Luck*

Chapter 2, Part IV (p. 42)

Penguin Books. Baltimore, Maryland, USA. 1960

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The postulate of randomness thus resolves itself into the  
 question, "of what population is this a random sample?"  
 which must frequently be asked by every practical stat-  
 istician.

On the Mathematical Foundation of Theoretical Statistics

*Philosophical Transactions of the Royal Society of London*, Volume  
 A222, 1922 (p. 313)

**James, William** 1842–1910

American philosopher and psychologist

If I should throw down a thousand beans at random upon  
 a table, I could doubtless, by eliminating a sufficient  
 number of them, leave the rest in almost any geometrical  
 pattern you might propose to me, and you might then say  
 that that pattern was the thing prefigured beforehand, and  
 that the other beans were mere irrelevance and packing  
 material. Our dealings with Nature are just like this.

*The Varieties of Religious Experience*

Lecture XVIII (p. 429)

The Modern Library. New York, New York, USA. 1967



**Leucippus** Fifth century BCE  
Greek philosopher of Atomism

Nothing occurs at random, but everything for a reason and by necessity.

In G.S. Kirk, J.E. Raven and M. Schofield (eds.)  
*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*  
Aetius I.25.4 (p. 420)  
At The University Press. Cambridge, England. 1963

**Peterson, Ivars**  
Mathematics and computer writer and editor

We are surrounded by jungles of randomness. With our mathematical and statistical machetes, we can hack out extensive networks of trails and clearings that provide for most of our day-to-day needs and make sense of some fraction of human experience. The vast jungle, however, remains close at hand, never to be taken for granted, never to reveal all its secrets – and always teasing the inquiring mind.

*The Jungle of Randomness: A Mathematical Safari*  
Chapter 10 (p. 203)  
John Wiley & Sons, Inc. New York, New York, USA. 1998

**Sophocles** 496 BCE–406 BCE  
Greek playwright

IOCLASTA: Nay, what should mortal[s] fear, for whom the degree of fortune are supreme, and who hath clear foresight of nothing? 'Tis best to live at random, as one may.  
In *Great Books of the Western World* (Volume 5)  
*The Plays of Sophocles*  
*Oedipus the King*, l. 997  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Szent-Györgyi, Albert** 1893–1986  
Hungarian-born American biochemist

The usual answer to this question is that there was plenty of time to try everything. I could never accept this answer. Random shuttling of bricks will never build a castle or a Greek temple, however long the available time. A random process can build meaningful structures only if there is some kind of selection between meaningful and nonsense mutations.

*Molecular Evolution: Prebiological and Biological*  
The Evolutionary Paradox and Biological Stability (p. 111)  
Plenum Press. New York, New York, USA. 1972

## RANDOM DIGITS

**Dickens, Charles** 1812–70  
English novelist

Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin.

*Oliver Twist*  
Chapter LI  
P.F. Collier & Son, Company. New York, New York, USA. 1912

## RATIOCINATION

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

When the greatest of American logicians, speaking of the powers that constitute the born geometrician, had named Conception, Imagination, and Generalization, he paused. Thereupon from one of the audience there came the challenge, “What of reason?” The instant response, not less just than brilliant, was: “Ratiocination – that is but the smooth pavement on which the chariot rolls.”

In Columbia University  
*Lectures on Science, Philosophy and Art 1907–1908* (p. 31)  
New York, New York, USA. 1908

## RATIONAL ORDERING

**Planck, Max** 1858–1947  
German physicist

It is only when we have planted our feet on the firm ground which can be won only with the help of the experience of real life, that we have a right to feel secure in surrendering to our belief in a philosophy of the world based upon a faith in the rational ordering of this world.

Translated by W.H. Johnston  
*The Philosophy of Physics*  
Chapter IV (p. 125)  
W.W. Norton & Co. New York, New York, USA. 1936

## RATIONALE

**Lewis, George Cornwall** 1806–63  
British statesman and man of letters

There cannot be a body of rules without a rationale, and this rationale constitutes the science.

*A Treatise on the Methods of Observation and Reasoning in Politics*  
(Volume 2) (p. 148)  
John W. Parker & Son. London, England. 1852

## REACTION

**Baudrimont, A. E.**  
No biographical data available

A chemical reaction cannot take place without a movement of the atoms. Consequently a reaction...cannot and will never be able to indicate the arrangement of the atoms in a combination.... For a reaction, by establishing a molecular movement, destroys the preceding arrangements of the atoms. Therefore, being able to extract a compound substance from a combination does not mean that this compound already existed in this combination.

In S.C. Kapoor  
*The Origins of Laurent's Organic Classification*  
*Isis*, Volume 60, 1960 (p. 493)

**Hoffmann, Roald** 1937–

Polish-born American chemist

there was no question that the reaction  
but transient colors were seen  
in the slurry of sodium methoxide in dichloromethane  
and we got a whole lot of products  
for which we can't sort out the kinetics  
the next slide will show  
the most important part  
very rapidly  
within two minutes  
and I forgot to say on further warming  
we get in fact the ketone...

*The Metamict State*

Next Slide Please (p. 51)

University of Central Florida Press. Orlando, Florida, USA. 1987

**Lippmann, Walter** 1889–1974

American journalist and author

The reaction of one chemical element to another chemical element is always correct, is never misled by misinformation, by untruth, and by illusion.

*Essays in the Public Philosophy*

Chapter VIII (p. 92)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1955

**READ****Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

People in general do not willingly read, if they can have anything else to amuse them.

*The Life of Samuel Johnson*

Chapter XX (p. 399)

Hutchinson &amp; Co. London, England. 1791

**READER****Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Readers may be divided into four classes: (1) Sponges, who absorb all they read, and return it nearly in the same state, only a little dirtied. (2) Sand-glasses, who retain nothing, and are content to get through a book for the sake of getting through the time. (3) Strain-bags, who retain merely the dregs of what they read. (4) Mogul diamonds, equally rare and valuable, who profit by what they read, and enable others to profit by it also.

In John Payne Collier

*Seven Lectures on Shakespeare and Milton*

The Second Lecture (p. 13)

Chapman &amp; Hall, Ltd. London, England. 1856

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I have much to fear from the expert philosophical critic, but I am filled with even more apprehension at the thought of readers who may look to see whether the book is “on the side of the angels” and judge its trustworthiness accordingly.

*The Nature of the Physical World*

Preface (p. viii)

The University Press. New York, New York, USA. 1929

**READING****Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Read not to contradict and confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider.

*Bacon's Essays*

Of Studies (p. 210)

Donohue, Henneberry &amp; Company. Chicago, Illinois, USA. 1883

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

Fairly large print is a real antidote to stiff reading.

In J.H. Bennett (ed.)

*Natural Selection, Heredity, and Eugenics*

Letter to K. Sisam, May 31, 1929 (p. 20)

Clarendon Press. Oxford, England. 1983

**Gore, George** 1826–1909

English electrochemist

Reading, however, is only a means towards research. The object is not to amass existing knowledge, but to apply it to facilitate the discovery of more. It is not usually the man who possesses the greatest amount of scientific knowledge who makes the most discoveries. Time occupied in reading and study cannot be employed in experimenting. An excess of reading and study usually also results in the production of an unnecessarily large number of questions and hypotheses, far more than any one man, or even many men, can satisfactorily examine.

*The Art of Scientific Discovery*

Part III, Chapter XXX (p. 295)

Longmans, Green &amp; Co. London, England. 1878

If a man reads inattentively or too rapidly, the chief effect is confusion; if he reads with moderate attention and is not occupied by preconceived opposite views, his mind is drawn into the groove of that of the author, whether the latter be right or wrong; but if he attentively considers what he is reading, with a determination to understand clearly the author's meaning, he acquires a proper basis of knowledge on which to raise hypotheses.

*The Art of Scientific Discovery*

Part III, Chapter XXX (p. 297)

Longmans, Green &amp; Co. London, England. 1878

**Huxley, Thomas Henry** 1825–95  
English biologist

I MUST adopt a fixed plan of studies, for unless this is done I find time slips away without knowing it – and let me remember this – that it is better to read a little and thoroughly, than cram a crude undigested mass into my head, though it be great in quantity.

*The Life and Letters of Thomas Henry Huxley* (Volume 1)  
Chapter I. 1  
Macmillan & Company Ltd. London, England. 1903

## REAL (BEING)

**Bianco, Margery Williams** 1880–1944  
Author

“What is REAL?” asked the Rabbit one day, when they were lying side by side near the nursery fender, before Nana came to tidy up the room. “Does it mean having things that buzz inside you and a stick-out handle?”

*The Velveteen Rabbit: Or How Toys Become Real*  
Athenaeum Books for Young Readers. New York, New York, USA. 2002

You become. It takes a long time. That’s why it doesn’t often happen to people who break easily, or have sharp edges, or who have to be carefully kept. Generally, by the time you are Real, most of your hair has been loved off, and your eyes drop out, and you get loose in the joints and very shabby. But these things don’t matter at all, because once you are Real you can’t be ugly, except to people who don’t understand.

*The Velveteen Rabbit: Or How Toys Become Real*  
Athenaeum Books for Young Readers. New York, New York, USA. 2002

**Einstein, Albert** 1879–1955  
German-born physicist

The important point for us to observe is that all these constructions and the laws connecting them can be arrived at by the principle of looking for the mathematically simplest concepts and the link between them. In the limited number of mathematically existent simple field types, and the simple equations possible between them, lies the theorist’s hope of grasping the real in all its depth.

*Ideas and Opinions*  
On the Methods of Theoretical Physics (p. 275)  
Crown Publishers, Inc. New York, New York, USA. 1954

## REALITY

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

The conception of the objective reality of the elementary particles has evaporated in a curious way, not into the fog of some new, obscure reality concept, but into the transparent clarity of a mathematics that represents no

longer the behavior of the elementary particles but rather our knowledge of this behavior.

*The Representation of Reality in Contemporary Physics*  
*Daedalus*, 87(3), 1958

...an independent reality in the ordinary physical sense can neither be ascribed to the phenomena nor to the agencies of observation.

*Atomic Theory and the Description of Nature*  
Chapter II (p. 54)  
Cambridge University Press. Cambridge, England. 1934

**Born, Max** 1882–1970  
German-born English physicist

The simple and unscientific man’s belief in reality is fundamentally the same as that of the scientist.

*Physics in My Generation*  
On the Meaning of Physical Theories (p. 16)  
Springer-Verlag New York, Inc. New York, New York, USA. 1969

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Reality is not an exhibit for man’s inspection, labeled “Do not touch.” There are no appearances to be photographed, no experiences to be copied, in which we do not take part. Science, like art, is not a copy of nature but a re-creation of her.

*Science and Human Values*  
The Creative Mind (p. 20)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Brooks, Harvey**  
No biographical data available

A more problematic example is the parallel between the increasingly abstract and insubstantial picture of the physical universe which modern physics has given us and the popularity of abstract and non-representational forms of art and poetry. In each case the representation of reality is increasingly removed from the picture which is immediately presented to us by our senses.

*Scientific Concepts and Cultural Change*  
*Daedalus*, Winter 1965

**Burt, E. A.**  
No biographical data available

Man begins to appear for the first time in the history of thought as an irrelevant spectator and insignificant effect of the great mathematical system which is the substance of reality.

*The Metaphysical Foundations of Modern Physical Science* (p. 80)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1954

**Cerf, Bennett** 1898–1971  
American publisher and editor

The best of them was the conversation between Ginsberg, who demanded to know what reality was, and Garfinkle, who brazenly attempted to explain it to him.

*Try and Stop Me: A Collection of Anecdotes and Stories, Mostly Humorous*

Jokes About Relativity (p. 163)

Simon & Schuster. New York, New York, USA. 1944

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Through each of the great scientific-technological exploits, the points of contact between humanity and reality are diminished irreversibly.

*Voices in the Labyrinth: Nature, Man and Science* (p. 33)

The Seabury Press. New York, New York, USA. 1977

**Cromer, Alan** 1935–

American physicist and educator

Reality has far more wonders than all the tales of Arabia, giving us in return for our lost feeling of omnipotence some knowledge of the external world, some control over and responsibility for our lives, and even a touch of humility.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 10 (p. 207)

Oxford University Press, Inc. New York, New York, USA. 1993

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

Reality is never skin-deep.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1929)

X-Raying the Earth (p. 261)

Government Printing Office. Washington, D.C. 1930

**Dampier-Whetham, William** 1867–1952

English scientific writer

The physicist analyzes matter into particles, and finds that their forces and motions can be described in mathematical terms. The materialist pushes this scientific result into philosophy, and says that there is no other reality.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 14 (p. 181)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Dilthey, Wilhelm** 1833–1911

German historian

On the whole, the question whether some aspect of reality can be treated scientifically is like the question whether the knife lying before me is sharp. One must simply try to cut with it.

In Rudolf A. Makkreel and Frithjof Rodi

*Introduction to the Human Sciences: Selected Works of William Dilthey*

Book 1, Chapter 13 (p. 134)

Princeton University Press. Princeton, New Jersey, USA. 1989

**Drees, Willem B.**

Dutch philosopher of science and religion

That natural reality is assumed rather than explained is not proof for the existence of a creator. Introducing god

as an explanatory notion only shifts the locus of the question: why would such a god exist? And, it is possible that the universe just happens to exist, without explanation.

In Victor J. Stenger

*Has Science Found God?: The Latest Results in the Search for Purpose in the Universe*

Chapter Seven (p. 163)

Prometheus Books. Amherst, New York, USA. 2003

**Dürrenmatt, Friedrich** 1921–90

Swiss playwright and novelist

Our researches are perilous, our discoveries are lethal. For us physicists there is nothing left but to surrender to reality.

Translated by James Kirkup

*The Physicists*

Act Two (p. 81)

Grove Press, Inc. New York, New York, USA. 1964

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

It is by looking into our own nature that we first discover the failure of the physical universe to be co-extensive with our experience of reality. The “something to which truth matters” must surely have a place in reality whatever definition of reality we may adopt.

*New Pathways in Science*

Chapter XIV, Section II (p. 317)

The Macmillan Company. New York, New York, USA. 1935

**Egler, Frank E.** 1911–96

American botanist and ecologist

Reality is not what is; it is what the layman wishes it to be.

*The Way of Science*

Science Concepts (p. 22)

Hafner Publishing Company. New York, New York, USA. 1970

**Einstein, Albert** 1879–1955

German-born physicist

Physics is an attempt conceptually to grasp reality as it is thought independently of its being observed. In this sense one speaks of “physical reality.”

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Autobiographical Notes (p. 81)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty of reality.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Einstein’s Conception of Science (p. 391)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

Space has devoured ether and time; it seems to be on the point of swallowing up also the field and the

corpuscles, so that it alone remains as the vehicle of reality.

In R. Thiel

*And There Was Light* (p. 345)

New American Library. New York, New York, USA. 1960

All our science, measured against reality, is primitive and childlike – good yet it is the most precious thing we have.

*The Physics Teacher*, April, 1970 (p. 200)

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

In our endeavor to understand reality we are somewhat like a man trying to understand the mechanism of a closed watch. He sees the face and moving hands, and even hears the ticking, but he has no way of opening the case. If he is ingenious enough he may form some picture of a mechanism which could be responsible for all the things he observes, but he may never be quite sure his picture is the only one which could explain his observations.

*The Evolution of Physics*

On Clew Remains (p. 31)

Simon & Schuster. New York, New York, USA. 1961

**Frankel, Felice** 1945–

Science photographer

**Whitesides, George M.**

American chemist

Our reality is illusion: We don't know for sure what's out there.

*On the Surface of Things: Images of the Extraordinary in Science*

Illusion (p. 121)

Chronicle Books. San Francisco, California, USA. 1997

**Frost, Robert** 1874–1963

American poet

You're searching, Joe

For things that don't exist.

I mean beginnings

Ends and beginnings

Ends and beginnings – there are no such things

There are only middles.

*Complete Poems of Robert Frost*

Mountain Interval

Henry Holt & Company. New York, New York, USA. 1949

**Gore, George** 1826–1909

English electrochemist

Realities are often very different from appearances; many phenomena which are essentially the same often exhibit no likeness, except to those who are disciplined in looking beneath the surface of things, and in detect-

ing fundamental truths. By the progress of science the most apparently remote phenomena are not unfrequently brought together, and shown to be due to the same cause, and apparently similar ones are shown to be essentially different.

*The Art of Scientific Discovery*

Part III, Chapter XXXV (p. 326)

Longmans, Green & Co. London, England. 1878

**Gregory, Bruce**

Astrophysicist

For better or for worse, there is little evidence that we have any idea of what reality looks like from an absolute point of view. We only know what the world looks like from our point of view.

*Inventing Reality: Physics as Language* (p. 184)

John Wiley & Sons. New York, New York, USA. 1990

**Gribbin, John**

English science writer and astronomer

Don't look here for any "eastern mysticism", spoon bending or ESP. Do look here for the true story of quantum mechanics, a truth far stranger than any fiction.... The question this book addresses is "What is reality?" The answer(s) may surprise you; you may not believe them.

*In Search of Schrödinger's Cat: Quantum Physics and Reality*

Introduction (p. xvi)

Bantam Books. New York, New York, USA. 1984

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

[The probability wave] meant a tendency for something. It was a quantitative version of the old concept of "Potentia" in Aristotelian philosophy. It introduced something standing in the middle between the idea of an event and the actual event, a strange kind of physical reality just in the middle between possibility and reality.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter II (p. 41)

Harper & Row, Publishers. New York, New York, USA. 1958

**Hilbert, David** 1862–1943

German mathematician

It has become perfectly clear that physics does not deal with the material world or with the contents of reality, but rather, what it perceives is merely the formal constitutions of reality.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 10, Section 10. 1 (p. 240)

The Macmillan Company. New York, New York, USA. 1967

**Hubble, Edwin Powell** 1889–1953

American astronomer

...sometimes, through the strangely compelling experience of mystical insight, a man knows beyond the shadow



of a doubt, that he has been in touch with a reality that lies behind mere phenomena. He himself is completely convinced, but he cannot communicate the certainty. It is a private revelation. He may be right, but unless we share his ecstasy we cannot know.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 19)

The Huntington Library, San Marino, California, USA. 1954

### **Jackson, Shirley** 1916–65

American author

No live organism can continue for long to exist sanely under conditions of absolute reality. Even larks and katydids are supposed, by some, to dream.

*The Haunting of Hill House*

Chapter 1 (p. 3)

Viking Press. New York, New York, USA. 1959

### **Jacobi, Abraham** 1830–1919

Pioneer of pediatrics

It is one thing to build an educational tower in the air at your library table, and another to face its actual appearance under the existing circumstances.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter IV (p. 41)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

### **J Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...the most outstanding achievement of twentieth-century physics is not the theory of relativity with its welding together of space and time, or the theory of quanta with its present apparent negation of the laws of causation, or the dissection of the atom with the resultant discovery that things are not what they seem; it is the general recognition that we are not yet in contact with ultimate reality.

*The Mysterious Universe*

Chapter V (pp. 150–151)

The Macmillan Company. New York, New York, USA. 1932

### **Kaufmann, William J., III** 1942–94

American astronomer

From the moment of birth, our daily experiences strongly enforce the notion that reality is comprehensible. The fact that a rock released from your hand always falls down or that the moon goes through its phases every 29 1/2 days implies order rather than chaos to the rational human mind. To discover this order, to understand the basic and underlying qualities of all physical objects, to comprehend the fundamental principles that dictate the behavior of reality: this is the business of science.

*Particles and Fields: Readings from "scientific American"* (p. 1)

W. H. Freeman & Co. New York, New York, USA. 1980

### **Leighton, Joseph Alexander**

No biographical data available

It is impossible to formulate a theory of truth or knowledge without formulating a theory of reality.

*Man and the Cosmos: An Introduction to Metaphysics*

Chapter 1 (p. 2)

D. Appleton & Co. New York, New York, USA. 1922

### **Lewis, Gilbert Newton** 1875–1946

American chemist

In every new and growing science there are many working hypotheses that never attain to any sort of reality. On the other hand, in the old and abstract sciences of mathematics, where it is hard to tell how much is mere definition or convention, the problem of reality is not so much doubtful as it is meaningless.

*The Anatomy of Science*

Chapter 1 (p. 19)

Yale University Press. New Haven, Connecticut, USA. 1926

### **Margenau, Henry** 1901–97

American physicist

A quest for the real inspires...the scientist with curiosity and zeal for new adventures; it sets the mind of the philosopher to a contemplation of past pinnacles of thought; it leads the historian to scrutinize the recorded deeds of man for constant patterns.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter I (p. 1)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

In quantum mechanics the problem of reality seems to center in the meaning of states. Here it became clear for the first time, and not without a shock to the physicist, that even a physical state, previously regarded as a nice and tidy collection of possessed observables geared together and running like wheels in a clock, is in fact a composite of latent observables loosely coupled to Nature by rules of correspondence of a statistical sort.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 21 (p. 452)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1950

### **Mead, George H.** 1863–1931

American philosopher, sociologist, and psychologist

...the ultimate touchstone of reality is a piece of experience found in an unanalyzed world. The approach to the crucial experiment may be a piece of torturing analysis, in which things are physically and mentally torn to shreds, so that we seem to be viewing the dissected tissues of objects in ghostly dance before us, but the actual objects in the experimental experience are the common things of which we say that seeing is believing, and of whose reality we convince ourselves by handling. We extravagantly advertise the photograph of the path of an electron, but in fact we could never have given as much reality to the



electrical particle as does now inhabit it if the photograph had been of naught else than glistening water vapour.

*The Philosophy of the Act*

Chapter II (p. 32)

The University of Chicago, Chicago, Illinois, USA; 1938

**Olson, Sigurd F.** 1899–1982

American conservationist

Flashes of insight or reality are sunbursts of the mind.

*Reflections from the North Country*

Flashes of Insight (p. 131)

Alfred A. Knopf. New York, New York, USA. 1976

**Pagels, Heinz R.** 1939–88

American physicist and science writer

We may begin to see reality differently simply because the computer...provides a different angle on reality.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1988

**Palmieri, M.**

No biographical data available

Since the dawn of human intelligence man has tried to form for himself a conception of the outside world which would correspond to the truest reality. But to determine what this reality is has proved to be a task of no mean import, and we still stand bewildered and wondering at the door of what has been and remains for mankind the greatest of all mysteries: the nature of ultimate reality.

*Relativity: An Interpretation of Einstein's Theory*

Introduction

Forbush Publishing Company. Los Angeles, California, USA. 1931

**Raymo, Chet** 1936–

American physicist and science writer

Science is a map of reality.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 16 (p. 147)

The Viking Press. New York, New York, USA. 1991

**Reeve, F. D.**

No biographical data available

Because all things balance – as on a wheel – and we cannot see nine-tenths of what is real, our claims of self-reliance are pieced together by unpanned gold. The whole system is a game: the planets are the shells; our earth, the pea. May there be no moaning of the bar. Like ships at sunset in a reverie, We are shadows of what we are.

Coasting

*The American Poetry Review*, Volume 24, Number 4, July–August, 1995 (p. 38)

**Riordan, Michael**

Physicist

Subatomic reality is a lot like that of a rainbow, whose position is defined only relative to an observer. This is

not an objective property of the rainbow-in-itself but involves such subjective elements as the observer's own position. Like the rainbow, a subatomic particle becomes fully "real" only through the process of measurement.

*The Hunting of the Quark*

Chapter 1 (p. 39)

Touchstone Books/Simon & Schuster. New York, New York, USA. 1987

**Smith, David**

No biographical data available

Everything imagined is reality. The mind cannot conceive unreal things.

The Private Thoughts of David Smith

*Vogue*, November 15, 1968 (p. 198)

**Tischner, August**

No biographical data available

It is very indifferent, what ideas one feigns about the mechanism of the heaven, if they are but more or less rational; but one will never attain so far as to be able to affirm that they are the only true explanation of reality.

*The Fixed Idea of Astronomical Theory* (p. 32)

Gustav Fock. Leipzig, Germany. 1885

**Trilling, Lionel** 1905–75

American critic, author, and teacher

In the American metaphysic, reality is always material reality, hard, resistant, unformed, impenetrable, and unpleasant.

*The Liberal Imagination*

Reality in America, ii (p. 13)

Charles Scribner's Sons. New York, New York, USA. 1950

**Wald, George** 1906–97

American biologist and biochemist

A scientist lives with all reality. There is nothing better. To know reality is to accept it, and eventually to love it.

*Lex Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

**Walgate, Robert**

No biographical data available

...what the scientist must now admit is that in many problems of great consequence to people reality may not be accessible, in practice, through entirely manipulative and analytical methods.

Breaking Through the Disenchantment

*New Scientist*, September 18, 1975 (p. 667)

**Weinberg, Steven** 1933–

American nuclear physicist

When we say that a thing is real we are simply expressing a sort of respect.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Chapter II (p. 46)

Pantheon Books. New York, New York, USA. 1992

Physical reality remains so mysterious even to physicists because of the extreme improbability that it was constructed to be understood by the human mind.

The Form of Nature

*Bulletin of the American Academy of Arts and Sciences*, Volume 29, Number 4, 1976

**Weyl, Hermann** 1885–1955

German mathematician

A picture of reality drawn in a few sharp lines cannot be expected to be adequate to the variety of all its shades. Yet even so the draftsman must have the courage to draw the lines firm.

*Philosophy of Mathematics and Natural Science*

Appendix D (p. 274)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Wheeler, John Archibald** 1911–

American physicist and educator

What we call reality consists...of a few iron posts of observation between which we fill an elaborate papier-mâché of imagination and theory.

In Harry Woolf (ed.)

*Some Strangeness in the Proportion*

Chapter 22

Fig. 22. 10 (p. 358)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1980

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Progress in truth – truth of science and truth of religion – is mainly a progress in the framing of concepts, in discarding artificial abstractions or partial metaphors, and in evolving notions which strike more deeply into the root of reality.

*Religion in the Making*

Truth and Criticism (p. 127)

New American Library. New York, New York, USA. 1960

**Yeats, William Butler** 1865–1939

Irish poet and playwright

II LLE: The rhetorician would deceive his neighbors,  
The sentimentalist himself; while art  
Is but a vision of reality.

*The Collected Poems of W.B. Yeats*

Ego Dominus Tuus (p. 159)

The Macmillan Company. New York, New York, USA. 1956

## REALITY CHECK

**Stewart, Ian** 1945–

English mathematician

**Cohen, Jack**

Scientists cannot make objects float skywards merely by agreeing among themselves that the force of gravity

acts up rather than down. There has to be a reality check. Science has more stringent reality checks than any other area of human activity, and applies them more frequently. Religion hinges upon faith, politics hinges upon who can tell the most convincing lies or maybe just shout the loudest, but science hinges upon whether its conclusions resemble what actually happens.

*Figments of Reality*

## REALITY, PHYSICAL

**Ellis, John** 1946–

English theoretical physicist

Physical reality is *neither* some objective truth “out there” nor a purely subjective experience “in here.” It is a uniquely human description of the *interaction* between humanity and Nature, involving elements of both inner and outer realms.

*The Hunting of the Quark*

Epilogue (p. 368)

Simon & Schuster. New York, New York, USA. 1987

## REASON

**Arago, Francois** 1786–1853

French physicist

He who, outside of pure mathematics, says a thing is impossible, speaks without reason.

Quoted in S. Sandaram Iyer

*Thoughts on the Metaphysics of Theosophy* (2nd edition)

*The Paradoxes of the Highest Science*

Synthetic Recapulation (p. 91)

The Calcutta Central Press. Calcutta, India. 1883

**Barnett, Percy Arthur** 1858–1941

English educator

...the reasoning of mathematics is a type of perfect reasoning.

*Common Sense in Education and Teaching: An Introduction to Practice* (4th edition)

Chapter IX (p. 222)

Longmans, Green & Co. London, England. 1905

**Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

Disputes are not to be decided by the weight of authority, but by the force of reason.

*The Works of George Berkeley* (Volume 2)

First Dialogue (p. 57)

At The Clarendon Press. Oxford, England. 1901

**Blake, William** 1757–1827

English poet, painter, and engraver

In the midst of the highest flights of the fancy or imagination, reason ought to preside.

In Edwin John Ellis  
*The Real Blake: A Portrait Biography*  
 Chapter XXXII (p. 394)  
 Chatto & Windus. London, England. 1907

**Butler, Nicholas Murray** 1862–1947  
 American philosopher, diplomat, and educator

The analytical geometry of Descartes and the calculus of Newton and Leibniz have expanded into the marvelous mathematical method – more daring in its speculations than anything that the history of philosophy records – of Lobachevsky and Riemann, Gauss and Sylvester. Indeed, mathematics, the indispensable tool of the sciences, defying the senses to follow its splendid flights, is demonstrating today, as it has never been demonstrated before, the supremacy of the pure reason.

*The Meaning of Education, and Other Essays and Addresses*  
 What Knowledge is of Most Worth? (p. 45)  
 The Macmillan Co. New York, New York, USA. 1904

**da Vinci, Leonardo** 1452–1519  
 Italian High Renaissance painter and inventor

Without reason no effect is produced in nature; understand the reason and you will not need experience.

Translated by Maurice Baring  
*Thoughts on Art and Life*  
 Thoughts on Science (p. 168)  
 The Merrymount Press. Boston, Massachusetts, USA. 1906

**Davis, Andrew Jackson**  
 No biographical data available

In the old wilderness of Superstition now blooms the immortal flower of Reason.

*The Present Age and Inner Life* (3rd edition)  
 A Survey of Human Needs (p. 7)  
 W. White & Co. Boston, Massachusetts, USA. 1873

**Dewey, John** 1859–1952  
 American philosopher and educator

Pure reasoning as a means of arriving at truth is like the spider who spins a web out of himself.

*Reconstruction in Philosophy*  
 Chapter II (p. 32)  
 Henry Holt & Co. New York, New York, USA. 1920

**Enriques, Federigo** 1871–1946  
 Italian mathematician

...all observations and experiments are of scientific value only in so far as they are supported by a reasoning process. Otherwise we should be obliged to wait until nature should be so obliging as to teach us, by answering at random those questions which we should neither know how to ask nor to interpret.

*Problems of Science*  
 Chapter II (p. 83)  
 The Open Court Publishing Co. La Salle, Indiana, USA. 1914

**Galilei, Galileo** 1564–1642  
 Italian physicist and astronomer

...where the senses fail us, reason must step in ...

Translated by Henry Crew and Alfonso de Salvio  
*Dialogues Concerning Two New Sciences*  
 First Day (p. 60)  
 The Macmillan Co. New York, New York, USA. 1914

**Hobbes, Thomas** 1588–1679  
 English philosopher and political theorist

In sum, in what matter so ever there is place for “addition” and “subtraction.” there also is place for “reason;” and where these have no place, there “reason” has nothing to do at all.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (2nd edition)  
 Chapter V (p. 27)  
 George Routledge & Sons. London, England. 1886

When a man “reasoneth,” he does nothing else but conceive a sum total, from “addition” of parcels; or conceive a remainder, from “subtraction” of one sum from another; which, if it be done by words, is conceiving of the consequence of the names of all the parts, to the name of the whole; or from the names of the whole and one part, to the name of the other part. And though in some things, as in numbers, besides adding and subtracting, men name other operations, as “multiplying” and “dividing,” yet they are the same; for multiplication is but adding together of things equal; and division but subtracting of one thing, as often as we can.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (2nd edition)  
 Chapter V (p. 27)  
 George Routledge & Sons. London, England. 1886

**Hutton, James** 1726–97  
 Scottish geologist, chemist, and naturalist

...so far as we know our error, or the deficiency in our operation, we proceed in science, and shall conclude in reason.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
 Chapter I, Section IV (p. 187)  
 H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

...reason without data is nothing but delusion.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
 Chapter III (p. 281)  
 H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**James, Henry** 1843–1916  
 American-born English author and literary critic

Reason is the light of science. Revelation is the light of philosophy.

*The Social Significance of Our Institutions* (p. 44)  
 Ticknor & Fields  
 Boston, Massachusetts, USA. 1861

**Kant, Immanuel** 1724–1804  
German philosopher

Human reason, in one sphere of its cognition, is called upon to consider questions, which it cannot decline, as they are presented by its own nature, but which it cannot answer, as they transcend every faculty of the mind.

Translated by J.M.D. Meiklejohn

*Critique of Pure Reason*

Preface to the First Edition (p. 13)

P.F. Collier & Son. New York, New York, USA. 1901

Reason, holding in one hand its principles, according to which concordant phenomena alone can be admitted as laws of nature, and in the other hand the experiment, which it has devised according to those principles, must approach nature, in order to be taught by it: but not in the character of a pupil, who agrees to everything the master likes, but as an appointed judge, who compels the witnesses to answer the questions which he himself proposes.

Translated by F. Max, Muller

*Immanuel Kant's Critique of Pure Reason*

Method of Transcendentalism, Chapter IV (p. 691)

The Macmillan Co. New York, New York, USA. 1896

When GALILEI experimented with balls of a definite weight on the inclined plane, when TORKIOKLLI caused the air to sustain a weight which he had calculated beforehand to be equal to that of a definite column of water, or when STAHL, at a later period, converted metals into lime, and reconverted lime into metal, by the addition and subtraction of certain elements; a light broke upon all natural philosophers. They learned that reason only perceives that which it produces after its own design; that it must not be content to follow, as it were, in the leading-strings of nature, but must proceed in advance with principles of judgment according to unvarying laws, and compel nature to reply to its questions.... Reason must approach nature with the view, indeed, of receiving information from it, not, however, in the character of a pupil, who listens to all that his master chooses to tell him, but in that of a judge, who compels the witnesses to reply to those questions which he himself thinks fit to propose. To this single idea must the revolution be ascribed, by which, after groping in the dark for so many centuries, natural science was at length conducted into the path of certain progress.

Translated by J.M.D. Meiklejohn

*Critique of Pure Reason*

Preface to the Second Edition (p. 24)

P.F. Collier & Son. New York, New York, USA. 1901

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

God forbid; we should have neither science nor law, nay, not even reason.

*New Essays Concerning Human Understanding*

Book I, Chapter II (p. 98)

The Open Court Publishing Co. Chicago, Illinois, USA. 1916

**McNair, Fred W.**  
No biographical data available

If you can teach your student to take vigorous hold of a problem, to first assemble all of the facts which bear on the question, then from the facts to reason logically to a sound and safe conclusion, you have started him well whether his aim be engineering or otherwise.

The Teaching of Mathematics to Students of Engineering

*Science*, New Series, Volume 28, Number 713, August, 1908 (p. 268)

**Mivart, St. George Jackson** 1827–1900  
English biologist

Reason cannot be satisfied until it has probed, to the utmost of its power, the depths of science itself, and either ascertained what is and must be its ultimate foundations, or assured itself that such fundamental knowledge is beyond the scope and power of human endeavor.

*The Groundwork of Science; A Study of Epistemology*

Chapter I (pp. 1–2)

G.P. Putnam's Sons. New York, New York, USA. 1898

**Pearson, Karl** 1857–1936  
English mathematician

The hard and stony path of classifying facts and reasoning upon them is the only way to ascertain truth. It is the reason and not the imagination which must ultimately be appealed to.

*The Grammar of Science* (2nd edition)

Chapter I (p. 17)

Adam & Charles Black. London, England. 1900

**Planck, Max** 1858–1947  
German physicist

In Physics...as in every other science, common sense alone is not supreme; there must also be a place for Reason.

Translated by W.H. Johnson

*The Universe in the Light of Modern Physics* (p. 10)

George Allen & Unwin. London, England. 1931

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

*Reason* we call that faculty innate in us of discovering laws and applying them with thought.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

First Series

On the Conservation of Force (p. 319)

D. Appleton & Co. New York, New York, USA. 1897

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

It would be a denial of the dignity of human nature and the relative importance of the faculties with which we are endowed, were we to condemn at one time austere reason engaged in investigating causes and their natural

connections, and at another that exercise of the imagination which prompts and excites discoveries by its creative powers.

Translated by E. C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 78)

Harper & Brothers Publishers. New York, New York, USA. 1858

## REASONING

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Reason is the newest and rarest thing in human life, the most delicate child of human history.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 10 (p. 91)

St. Martin's Press. New York, New York, USA. 1989

**Arbuthnot, John** 1667–1735

Scottish mathematician and physician

...mathematical knowledge is a habit of clear, demonstrative, and methodical reasoning. We are contrived by nature to learn by imitation more than by precept; and I believe in that respect reasoning is much like other inferior arts – as dancing, singing, &c. – acquired by practice.

In Robert Chambers & Robert Carruthers

*Cyclopaedia of English Literature* (Volume 3) (3rd edition)  
Usefulness of Mathematical Learning (p. 362)

American Book Exchange. New York, New York, USA. 1879

**Arnauld, Antoine** 1612–94

French philosopher, lawyer, and mathematician

We use Reason for improving the Sciences; whereas we ought to use the Sciences for improving our Reason.

*The Port-Royal Logic*

Preface

Printed for T.B. and J. Taylor. London, England. 1696

**Barnett, Percy Arthur** 1858–1941

English educator

...the reasoning of mathematics is a type of perfect reasoning.

*Common Sense in Education and Teaching*

Chapter IX (p. 222)

Longmans, Green & Company. London, England. 1899

**Beaumarchais, Pierre-Augustin Caron de** 1732–99

French dramatist

It is not necessary to believe things in order to reason about them.

*The Barber of Seville*

Act V, Scene 4

Pioneer Classics. Long Beach, California, USA. 1994

**Beck, Lewis White** 1913–97

American scholar in German philosophy

In the logic of science there is a principle as important as that of parsimony: it is that of sufficient reason.

The "Natural Science Ideal" in the Social Sciences

*The Scientific Monthly*, Volume LXVIII, June, 1949 (p. 393)

**Bernard, Claude** 1813–78

French physiologist

Reasoning will always be correct when applied to accurate notions and precise facts; but it can lead only to error when the notions or facts on which it rests were originally tainted with error or inaccuracy.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 2)

Henry Schuman, Inc. New York, New York, USA. 1927

Pile up facts or observations as we may, we shall be none the wiser. To learn, we must necessarily reason about what we have observed, compare the facts and judge them by other facts used as controls.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section iv (p. 16)

Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

The role of reason in research is not so much in exploring the frontiers of knowledge as in developing the findings of the explorers.

*The Art of Scientific Investigation*

Chapter Seven (p. 91)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

Every experience and history teach us that in the biological and medical sciences reason seldom can progress far from the facts without going astray.

*The Art of Scientific Investigation*

Chapter Seven (p. 81)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

A useful habit for scientists to develop is that of not trusting ideas based on reason only.... Practically all reasoning is influenced by feelings, prejudice and past experience, albeit often subconsciously.

*The Art of Scientific Investigation*

Chapter Seven (p. 87)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Brophy, Brigid** 1929–95

English novelist

Reason is necessarily the language of moral, political, and scientific argument: not because reason is holy or on some elevated plane, but because it isn't; because it is accessible to all humans; because, as well as working, it can be seen to work.

In Stanley and Rosiland Godlovitch and John Harris (eds.)

*Animals, Men and Morals: An Enquiry into the Maltreatment of Non-Humans*  
In Pursuit of Fantasy (p. 126)

Taplinger Publishing Company. New York, New York, USA. 1972



**Browne, Sir Thomas** 1605–82  
English author and physician

Every man's own reason is his best Oedipus.

*Religio Medici*  
Part I, Section 6

Elliot Stock. London, England. 1883

**Bryant, William Cullen** 1794–1878  
American poet

I would make  
Reason my guide.

*Poems*

Conjunction of Jupiter and Venus

D. Appleton & Company. New York, New York, USA. 1874

**Burton, Sir Richard Francis** 1821–90  
English explorer

Reason is Life's sole arbiter, the magic Laby'rinth's  
single clue...

*The Kasidah of Haji Abdu El-Yezdi*

Part vii, Stanza xxxi

Citadel Press. New York, New York, USA. 1965

**Chrysostom, John** 349–c.407  
Archbishop of Constantinople and preacher

...there is nothing that has been created without some  
reason, even if human nature is incapable of knowing  
precisely the reason for them all.

*Homilies on Genesis*

7. 14

Catholic University of American Press. Washington, D.C. 1986

**Congreve, William** 1670–1729  
English dramatist

...error lives  
Ere reason can be born.

*The Mourning Bride*

Act III, Scene I

J. Dicks. London, England. 1883

**Darwin, Charles Robert** 1809–82  
English naturalist

It is a fatal fault to reason whilst observing, though so  
necessary beforehand and so useful afterwards.

*The Autobiography of Charles Darwin, 1809–1882: With Original  
Omissions Restored*

Appendix, Quotations (p. 159)

Harcourt, Brace. New York, New York, USA. 1959

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

Those long chains of reasoning, simple and easy as they  
are, of which geometricians make use in order to arrive  
at the most difficult demonstrations, had caused me to  
imagine that all those things which fall under the cogni-  
zance of man might very likely be mutually related in the  
same fashion...

In *Great Books of the Western World* (Volume 31)  
*Discourse on the Method of Rightly Conducting the Reason*  
Part II (p. 47)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I believe that all those to whom God has given the use  
of reason are bound to use it mainly to know Him and to  
know themselves. This is where I endeavored to begin  
my own research, and I can say that I would have been  
unable to find the foundation of physics had I not sought  
after them in this way

In William R. Shea

*The Magic of Numbers and Motion: The Scientific Career of René  
Descartes*

Chapter Eight (p. 166)

Science History Publications Canton, Massachusetts, USA. 1991

**Dewey, John** 1859–1952  
American philosopher and educator

Reason is experimental intelligence, conceived after the  
pattern of science, and used in the creation of social arts;  
it has something to do. It liberates man from the bond-  
age of the past, due to ignorance and accident hardened  
into custom. It projects a better future and assists man  
in its realization. And its operation is always subject to  
test in experience...The principles which man projects  
as guides...are not dogmas. They are hypotheses to be  
worked out in practice, and to be rejected, corrected and  
expanded as they fail or succeed in giving our present  
experience the guidance it requires. We may call them  
programmes of action, but since they are to be used in  
making our future acts less blind, more directed, they are  
flexible. Intelligence is not something possessed once for  
all. It is in constant process of forming, and its retention  
requires constant alertness in observing consequences, an  
open-minded will to learn and courage in re-adjustment.

*Reconstruction in Philosophy*

Chapter IV (p. 96)

Beacon Press. Boston, Massachusetts, USA. 1920

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

You reasoned it out beautifully, I exclaimed in unfeigned  
admiration. It is so long a chain, and yet every link rings  
true.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*The Red Headed League* (p. 438)

Wings Books. New York, New York, USA. 1967

Like all Holmes's reasoning the thing seemed simplicity  
itself when it was once explained.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*Stockbroker's Clerk* (p. 154)

Wings Books. New York, New York, USA. 1967

Ah! my dear Watson, there we come into those realms of  
conjecture where the most logical mind may be at fault.



In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of the Empty House* (p. 348)  
 Wings Books. New York, New York, USA. 1967

I can see nothing, said I, handing it back to my friend.  
 On the contrary, Watson, you can see everything. You fail, however, to reason from what you see. You are too timid in drawing your inferences.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
*The Adventure of the Blue Carbuncle* (p. 453)  
 Wings Books. New York, New York, USA. 1967

I feel that there is reason lurking in you somewhere, so we will patiently grope round for it.

*The Lost World*  
 Chapter IV (p. 52).  
 The Colonial Press. Clinton, Massachusetts, USA. 1959

### **Drummond, William, Sir**

No biographical data available

...he who will not reason is a bigot; he who cannot is a fool; and he who dares not is a slave.

*Academical Questions*  
 Preface (p. xv)  
 Scholar's Facsimiles & Reprints. Delmar, New York, USA. 1984

### **Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Reason dreams of an empire of knowledge, a mansion of the mind. Yet sometimes we end up living in a hotel by its side.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*  
 Chapter 14 (p. 333)  
 Simon & Schuster. New York, New York, USA. 1988

### **Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

...our reasoning appears to become more accurate as our ignorance becomes more complete; that when we have embarked upon chaos we seem to drop down into a cosmos.

*The Philosophy of Chance*  
*Mind*, Volume 9, 1884 (p. 229)

### **Einstein, Albert** 1879–1955

German-born physicist

We have thus assigned to pure reason and experience their places in a theoretical system of physics. The structure of the system is the work of reason: the empirical contents and their mutual relations must find their representation in the conclusions of the theory. In the possibility of such a representation lie the sole value and justification of the whole system, and especially of the concepts and fundamental principles which underlie it. Apart from that, these latter are free inventions of human intellect, which

cannot be justified either by the nature of that intellect or in any other fashion a priori.

*Ideas and Opinions*  
 On the Methods of Theoretical Physics (p. 272)  
 Crown Publishers, Inc. New York, New York, USA. 1954

### **Eldridge, Paul** 1888–1982

American educator

Reason is the shepherd trying to corral life's vast flock of wild irrationalities.

*Maxims for a Modern Man*  
 2194  
 T. Yoseloff. New York, New York, USA. 1965

### **Epictetus** ca. 55–135

Greek philosopher

Since it is Reason which shapes and regulates all other things, it not ought itself to be left in disorder.

*Discourses*  
 Chapter XVII  
 G. Bell & Sons. London, England. 1908

### **Fersman, A. E.** 1883–1945

Geochemist and mineralogist

There are no bounds to fantasy, no limits to the penetration of reason, and none to the technical powers that conquer nature.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
 Translated by Vic Schneierman  
 Progress Publishers. Moscow, Russia. 1979

### **Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Copernicanism and other essential ingredients of modern science survived only because reason was frequently overruled in their past.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
 Analytical Index (p. 13)  
 Verso. London, England. 1978

### **Galilei, Galileo** 1564–1642

Italian physicist and astronomer

SALVIATI: Now, since I wish to convince you by demonstrative reasoning rather than to persuade you by mere probabilities, I shall suppose that you are familiar with present-day mechanics...

In *Great Books of the Western World* (Volume 28)  
*Dialogues Concerning the Two New Sciences*  
 First Day (p. 133)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In science the authority embodied in the opinion of thousands is not worth a spark of reason in one man.

In Pedro Redondi  
*Galileo: Heretic*  
 Chapter 2 (p. 37)  
 Princeton University Press. Princeton, New Jersey, USA. 1987

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

The scientific glory of a country may be considered in some measure, as an indication of its innate strength. The exaltation of Reason must necessarily be connected with the exaltation of the other faculties of the mind; and there is one spirit of enterprise, vigor and conquest in science, arts, and arms.

In Maurice Crosland  
*Gay-Lussac: Scientist and Bourgeois*  
Chapter 4 (p. 80)  
Cambridge University Press. Cambridge, England. 1978

**Gore, George** 1826–1909  
English electrochemist

That which is beyond reason at present may not be so in the future; but it has now no place in science for want of a basis of verified truth.

*The Art of Scientific Discovery*  
Chapter III (p. 25)  
Longmans, Green & Company. London, England. 1878

**Grew, Nehemiah** 1641–1712  
Scientific writer and journalist

He that speaketh Reason may be rather satisfied in being understood, than believed.

*The Anatomy of Vegetables Begun*  
Preface  
Printed for Spencer Hickman. London, England. 1672

**Hamilton, William** 1788–1856  
Scottish philosopher

The art of reasoning *right* is assuredly not to be taught by a process in which there is no reasoning *wrong*. We do not learn to swim in water by previous practice in a pool of quicksilver. Yet, if mathematics are to be recommended as counteracting our natural tendency to err, why not also propose the mercury as counteracting our natural tendency to sink?

*Discussions on Philosophy and Literature, Education and University Reform*  
On the Study of Mathematics as an Exercise of the Mind (p. 278)  
Harper & Brothers Publishers. New York, New York, USA. 1861

**Hubbard, Elbert** 1856–1915  
American editor, publisher, and author

REASON: The arithmetic of the emotions.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 126)  
The Roycrofters. East Aurora, New York, USA. 1914

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

In reasoning...from appearances which are particular, care must be taken how we generalise; we should be cautious not to attribute to nature, laws which may perhaps

be only of our own invention.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter I, Section III (p. 143)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

...to reason without data is nothing but delusion.

*The Theory of the Earth* (Volume 1)  
Part I, Chapter III (p. 281)  
Messrs. Cadwell, Junior & Davies. London, England. 1795

**John of Salisbury** ca. 1115–80  
English author and diplomatist

Reason, therefore, is a mirror in which all things are seen...

In John van Laarhoven (ed.)  
*Entheticus Maior and Minor* (Volume 1)  
Part II, Section I, Notes from Epicurus, I. 657  
E.J. Brill. Leiden, Netherlands. 1987

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

We may take fancy for a companion, but must follow Reason as our guide.

*The Life of Samuel Johnson* (Volume 1)  
Letter to Boswell, 1774 (p. 474)  
Sir Isaac Pitman & Sons, Ltd. London, England. 1907

Memory is the purveyor of reason, the power which places those images before the mind upon which the judgment is to be exercised, and which treasures up the determinations that are once passed, as the rules of future action, or grounds of subsequent conclusions.

*The Rambler* (Volume 1)  
No. 41, August 7, 1750 (p. 296)  
Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Joos, Georg** 1894–1959  
German physicist

As soon as we inquire into the reasons for the phenomena, we enter the domain of theory, which connects the observed phenomena and traces them back to a single “pure” phenomena, thus bringing about a logical arrangement of an enormous amount of observational material.

*Theoretical Physics*  
Introduction (p. 1)  
Blackie & Son Ltd. London, England. 1968

**Kant, Immanuel** 1724–1804  
German philosopher

Human reason has this peculiar fate that in one species of its knowledge it is burdened by questions which, as prescribed by the very nature of reason itself, it is not able to ignore, but which, as transcending all its powers, it is also not able to answer.

In *Great Books of the Western World* (Volume 42)  
*Critique of Pure Reason*  
Preface to First Edition (p. 1)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Mathematics and physics are the two theoretical sciences of reason, which have to determine their objects a priori.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Preface to the Second Edition (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

One of the difficulties arising out of the subjective view of probability results from the principle of insufficient reasons. This principle...holds that if we are wholly ignorant of the different ways an event can occur and therefore have no reasonable ground for preference, it is as likely to occur one way as another.

*Mathematics and the Imagination*

Chance and Chanceability (p. 229)

Simon & Schuster. New York, New York, USA. 1940

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

Reason is not a faculty; still less is it a torch or entity of any kind; but it is a special condition of the individual's intellectual faculties; a condition that is altered by experience, gradually improves and controls the judgments, according as the individual exercises his intellect.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VIII (p. 401)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

Reason hates the false décor by which advocates of error try to make her more impressive. She recognizes that one should doubt where reasons are not sufficient, that one should present each reason stripped of all that makes it apparent, and then she will assist if proper tools are on hand, and reserve for herself to pronounce the sentence, or if she suspends it, to indicate what is required to proceed to the conclusion.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Twentieth Letter (p. 186)

Science History Publications. New York, New York, USA. 1976

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

...scientific reasoning is a kind of dialogue between the possible and the actual, what might be and what is in fact the case...

*Induction and Intuition in Scientific Thought*

Chapter III, Section 1 (p. 48)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

**Miller, Hugh** 1802–56

Scottish geologist and theologian

In the geologic, as in other departments,

What can we reason but from what we know?

*The Old Red Sandstone*

Geological Evidences in Favour of Revealed Religion (p. 280)

J.M. Dent & Sons Ltd. London, England. 1922

**Minnick, Wayne C.** 1915–2006

Professor of communications

This kind of reasoning has weaknesses, of course, as do all forms of reasoning. If the correspondence between two things compared is not complete, that is, if significant differences can be shown to exist, then the argument collapses.

*The Art of Persuasion* (p. 16)

Houghton Mifflin Company. New York, New York, USA. 1968

**Moulton, Forest Ray** 1872–1952

American astronomer

...reason and the laws of nature...have become a sort of intellectual telescope, as it were, with which modern science looks back across the geological ages and discerns, at least in outline, the chief steps of the evolution of the inanimate and of the organic world; and, similarly, penetrates the future to a time when this earth will cease to be suited for the abode of life.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

A Vulgar Mechanick can practice what he has been taught or seen done, but if he is an error he knows not how to find it out and correct it, and if you put him out of his road, he is at a stand; Whereas he that is able to reason nimbly and judiciously about figure, force and motion is never at rest till he gets over every rub.

In Richard S. Westfall

*Never at Rest: A Biography of Isaac Newton*

Letter to Nathaniel Hawes, May 25, 1694 (p. ii)

Cambridge University Press. Cambridge, England. 1980

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

With reason, science never parts company, but with feeling, emotion, passion, what has she to do? They are not of her; they owe her no allegiance. She may study, analyze, and define, she can never control them, and by no possibility can their ways be justified to her.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 93)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Parkington, J. E.**

No biographical data available

The ability to sort out stone implements into “types” as one would playing-cards into suits is of minor importance compared to the reasons underlying the tendency for implements to cluster into “ideal forms.” It is not the group “handaxes” which is important but, as Plato might have said, “handaxeness.”

Stone Implements as Information

*The Interpretation of Archaeological Evidence*, Goodwin Series, Number 1, June, 1972 (p. 12)

**Pascal, Blaise** 1623–62

French mathematician and physicist

The last proceeding of reason is to recognise that there is an infinity of things which are beyond it.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section IV, 267

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

Every work of science great enough to be remembered for a few generations affords some exemplification of the defective state of the art of reasoning of the time when it was written; and each chief step in science has been a lesson in logic.

Inquiry and Belief

*The Popular Science Monthly*, Volume 12, 1877–1878

**Pólya, George** 1887–1985

Hungarian mathematician

Heuristic reasoning is good in itself. What is bad is to mix up heuristic reasoning with rigorous proof. What is worse is to sell heuristic reasoning for rigorous proof.

*How to Solve It: A New Aspect of Mathematical Method*

Heuristic Reasoning (p. 113)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Pope, Alexander** 1688–1744

English poet

What can we reason but from what we know?

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle I, l. 18

Houghton Mifflin Company. New York, New York, USA. 1903

**Price, Bartholomew** 1818–98

English mathematician and educator

...the reasoning process [employed in mathematics] is not different from that of any other branch of knowledge...but there is required, and in a great degree, that attention of mind which is in some part necessary for the acquisition of all knowledge, and in this branch [it] is indispensably necessary. This must be given in

its fullest intensity.... [T]he other elements especially characteristic of a mathematical mind are quickness in perceiving logical sequence, love of order, methodical arrangement and harmony, distinctness of conception.

*Treatise on Infinitesimal Calculus* (Volume 3) (p. 6)

At The Clarendon Press. Oxford, England. 1868

**Recorde, Robert** 1510?–58

English mathematician and writer

If reasons reache transcende the skye,  
Why shoulde it then to earthe be bounde?  
The witte is wronged and leadde awrye,  
If mynde be maried to the grounde.

*The Castle of Knowledge*

The Preface

Imprinted by R. Wolfe. London, England. 1556

...who so ever will travail in the sciences with profit, must lean rather to reason, than to authority, else he may be deceived.

*The Castle of Knowledge*

The Fourth Treatise (p. 182)

Imprinted by R. Wolfe. London, England. 1556

You are to farre deceived, and therefore I interrupt your wordes, for all things are to be governed by reason.

*The Castle of Knowledge*

The Fourth Treatise (p. 243)

Imprinted by R. Wolfe. London, England. 1556

**Robinson, James Harvey** 1863–1936

American historian and educator

...most of our so-called reasoning consists in finding arguments for going on believing as we already do.

*The Mind in the Making*

Chapter II (p. 41)

Harper & Brothers Publishers. New York, New York, USA. 1921

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Reasoning goes beyond the analysis of facts.

*Encyclopedia of Thoughts*

Aphorisms 1973

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Reason is a harmonizing, controlling force rather than a creative one.

*Our Knowledge of the External World*

Lecture I (p. 21)

The Open Court Publishing Company. Chicago, Illinois. 1914

Supposing you got a crate of oranges that you opened, and you found all the top layer of oranges bad, you would not argue, “The underneath ones must be good, so as to redress the balance”; You would say, “Probably the

whole lot is a bad consignment”; and that is really what a scientific person would say about the universe.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Why I Am Not A Christian (p. 13)

Watts. London, England. 1927

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

FOOL: “The reason why the seven stars are no more than seven is a pretty reason.”

LEAR: “Because they are not eight?”

FOOL: “Yes, indeed. Thou wouldst make a good fool.”

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*King Lear*

Act I, Scene v, l. 38–40

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Good reason must, of force, give place to better.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Julius Caesar*

Act IV, Scene iii, l. s03

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

His reasons are as two grains of wheat hid in two bushels of chaff: you shall seek all day ere you find them, and when you have them, they are not worth the search.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Merchant of Venice*

Act I, Scene i, l. 115

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Simmons, Charles** 1798–1856

American clergy and litterateur

Reasoning from analogy is often most plausible and most deceptive.

*A Laconic Manual and Brief Remarker* (p. 36)

Charles Simmons. North Wrentham, Massachusetts, USA. 1852

**Spencer-Brown, George** 1923–

English mathematician and polymath

The concept of randomness arises partly from games of chance. The word “chance” derives from the Latin *cadentia* signifying the fall of a die. The word “random” itself comes from the French *randir* meaning to run fast or gallop.

*Probability and Scientific Inference*

Chapter VII (p. 35)

Longmans, Green & Company. London, England. 1957

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Reason is applied to what is developing, practical understanding to what is developed. The former does not ask, What is the Purpose? and the latter does not ask, What is

the source? Reason takes pleasure in development; practical understanding tries to hold things fast so that it can use them.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 308)

Suhrkamp. New York, New York, USA. 1988

The texture of this world is made up of necessity and chance. Human reason holds the balance between them, treating necessity as the basis of existence, but manipulating and directing chance, and using it.

In Eric A. Blackall (ed.)

*Wilhelm Meister's Apprenticeship*

Book One, Chapter Seventeen (p. 38)

Princeton University Press. Princeton, New Jersey, USA. 1995

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

The iron labor of conscious logical reasoning demands great perseverance and great caution; it moves on but slowly, and is rarely illuminated by brilliant flashes of genius. It knows little of that facility with which the most varied instances come thronging into the memory of the philologist or historian. Rather is it an essential condition of the methodical progress of mathematical reasoning that the mind should remain concentrated on a single point, undisturbed alike by collateral ideas on the one hand, and by wishes and hopes on the other, and moving on steadily in the direction it has deliberately chosen.

*Vorträge and Reden*

Ueber das Verhältniss der Naturwissenschaften zur Gesamtheit der

Wissenschaft, Bd. 1, 1896 (p. 178)

English novelist, historian, and sociologist

Friedrich Viewig & Sohn. Brunswick, Germany. 1896

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Meanwhile solitary inquirers are always from time to time appearing who become so deeply entangled in complicated trains of reasoning that they can no longer discover their mistakes and believe they have solved the problem.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

Second Series

On the Origin and Significance of Geometrical Axioms (p. 32)

Longmans, Green & Co. London, England. 1903

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

“It’s against reason?” said Filby.

“What reason?” said the Time Traveler.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1971

*The Time Machine*

Chapter One (p. 451)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971



**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The art of reasoning consists in getting hold of the subject at the right end, of seizing on the few general ideas that illuminate the whole, and of persistently organizing all subsidiary facts round them. Nobody can be a good reasoner unless by constant practice he has realized the importance of getting hold of the big ideas and hanging on to them like grim death.

In W.W. Sawyer

*Prelude to Mathematics*

Presidential Address to the London Branch of the Mathematical Association, 1914 (p. 183)

Penguin Books Limited, London, England, 1960

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

The great mathematician fully, almost ruthlessly, exploits the domain of permissible reasoning and skirts the impermissible. That his recklessness does not lead him into a morass of contradiction is a miracle in itself. Certainly it is hard to believe that our reasoning power was brought, by Darwin's process of natural selection, to the perfection which it seems to possess.

The Unreasonable Effectiveness of Mathematics in Natural Science  
*Communications on Pure and Applied Mathematics*, Volume 13, Number 1, 1960 (p. 3)

**Wright, Frances** 1795–1852  
Scottish-born American reformer

The best road to correct reasoning is by physical science; the way to trace effects to causes is through physical science; the only corrective, therefore, of superstition is physical science.

*Course of Popular Lectures*

Lecture 3

Published by the author. Philadelphia, Pennsylvania, USA. 1836

## RECKON

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

I could reckon before I could talk.

Apocryphal

Carl Friedrich Gauss

*Nature*, April 19, 1877 (p. 534)

## RECOGNITION

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Whatever the individual motivation and belief of the scientist, without the recognition from his fellow men of the value of his work, in the long term science will perish.

Atomic Weapons

*Proceeding of the American Philosophical Society*, Volume 90, Number 1, 1946

**Tait, Peter Guthrie** 1831–1901  
Scottish physicist and mathematician

...it a duty to bring forward the claims of a true prophet, be his nationality what it may; if these have suffered from his own modesty or carelessness, or from the neglect or disparagement of others.

*Lectures on Some Recent Advances in Physical Science, With a Special Lecture on Force* (3rd edition)

Preface to the Third edition (p. xi)

Macmillan & Co Ltd, London, England, 1885

## RECORD

**Coues, E.**

No biographical data available

Don't trust your memory; it will trip you up; what is clear now will grow obscure; what is found will be lost. Write down everything while it is fresh in your mind; write it out in full. Time so spent will be time saved in the end, when you offer your researches to the discriminating public.

*Field Ornithology* (pp. 44–45)

Naturalist's Agency, Salem, Massachusetts, USA. 1874

**Dickens, Charles** 1812–70  
English novelist

When found, make a note of.

*The Works of Charles Dickens*

*Dombey and Son* (part I)

Chapter XV (p. 217)

P.F. Collier & Son, New York, New York, USA. 1911

**Grove, Sir William** 1811–96  
English chemist

It would be vain to attempt specifically to predict what may be the effect of Photography on future generations. A Process by which the most transient actions are rendered permanent, by which facts write their own annals in a language that can never be obsolete, forming documents which prove themselves, – must interweave itself not only with science but with history and legislature.

Lecture

Progress of Physical Science since the opening of the London Institution (January 19, 1842)

## RECOVERY

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

Despair of all recovery spoils longevity,  
And makes men's miseries of alarming brevity.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza LXIV

Houghton Mifflin Company, Boston, Massachusetts, USA. 1933



**Massinger, Philip** 1583–1640  
English dramatic poet

O my Doctor,  
I never shall recover.

*The Bondman*  
Act I, Scene I

Printed for A. Bettesworth. London, England. 1719

**Petrarch (Francesco Petrarca)** 1304–74  
Italian poet and humanist

I once heard a physician of high standing in his profession say: ...If a hundred men, or a thousand of the same age and general constitution and accustomed to the same diet, should all fall victim to a disease at the same time, and if half of them should follow the prescriptions of our contemporary doctors, and if the other half should be guided by their natural instinct and common sense, with no doctors at all, I have no doubt that the latter group would do better.

In M. Bishop

*Letters from Petrarch*  
Book V, 3 (p. 250)

Indiana University Press. Bloomington, Indiana, USA. 1966

## RECTANGLE

**Frere, John Hookham** 1769–1846  
British diplomat and man of letters

Alas! that partial Science should approve  
The sly RECTANGLE'S too licentious love!

In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 75–76

Printed for J. Wright, by W. Bulmer & Company. London, England. 1801

## RECURSION

**Papert, Seymour** 1928–  
South African mathematician

Of all ideas I have introduced to children, recursion stands out as the one idea that is particularly able to evoke an excited response.

*Mindstorms: Children, Computers and Powerful Ideas*

Chapter 3 (p. 71)

Basic Books, Inc. New York, New York, USA. 1980

**Young, Louise B.**  
Science writer

Whatever can be done once can always be repeated.

*The Mystery of Matter*

Introduction (p. 15)

Oxford University Press, Inc. New York, New York, USA. 1965

## RED SHIFT

**Boas, Jr., Ralph P.** 1913–92  
Mathematician

Consider the Pitiful Plight  
Of a runner who wasn't too bright,  
But sprinted so fast  
He vanished at last  
By red-shifting himself out of sight.

Reprinted in Ralph P. Boas, Jr.

*Lion Hunting & Other Mathematical Pursuits* (p. 103)

Mathematical Association of America. Washington, D.C. 1995

**Gamow, George** 1904–68  
Russian-born American physicist

The discovery of the red shift in the spectra of distant stellar galaxies revealed the important fact that our universe is in the state of uniform expansion, and raised an interesting question as to whether the present features of the universe could be understood as the result of its evolutionary development.... We conclude first of all that the relative abundance of various atomic species (which were found to be essentially the same all over the observed region of the universe) must represent the most ancient archaeological document pertaining to the history of the universe.

The Evolution of the Universe

*Nature*, Volume 162, Number 4122, October, 1948 (p. 680)

**Gray, George W.**  
Free lance science writer

...just as the shifting of bookkeeping accounts into the red measures disintegrating, scattering, dissipating financial resources, so the shifting of starlight into the red indicates disintegrating, scattering, dissipating physical resources. It says that the universe is running down.... To entertain this preposterous idea of all these massive star systems racing outward was to accept a radically new picture of the cosmos – a universe in expansion, a vast bubble blowing, distending, scattering, thinning out into gossamer, losing itself. The snug, tight, stable world of Einstein had room for no such flights.

Universe in the Red

*The Atlantic Monthly*, Volume 1151, Number 2, February, 1933 (p. 233, 236)

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

Another possibility... is that the universe retains its size, while we and all material bodies shrink uniformly. The red shift we observe in the spectra of the nebulae is then due to the fact that the atoms which emitted the light millions of years ago were larger than the present-day atoms with which we measured the light – the shift is, of course, proportional to distance.

Contributions to a British Association Discussion on the Evolution of the Universe

*Supplement to Nature*, Volume 128, Number 3234, November, 1931 (pp. 703–704)

**Stapledon, Olaf** 1886–1950  
English author

I noticed that the sun and all the stars in his neighborhood were ruddy. Those at the opposite pole of the heaven were of an icy blue. The explanation of this strange phenomenon flashed upon me. I was still traveling, and traveling so fast that light itself was not wholly indifferent to my passage. The overtaking undulations took long to catch me. They therefore affected me as slower pulsations than they normally were, and I saw them therefore as red. Those that met me on my head-long flight were congested and shortened, and were seen as blue.

*Last and First Men and Star Maker*  
Star Maker, Chapter III (p. 262)  
Dover Publications, Inc. New York, New York, USA. 1968

## REDUCTIONISM

**Commoner, Barry** 1917–  
American biologist, ecologist, and educator

There is, indeed, a specific fault in our system of science, and in the resultant understanding of the natural world.... This fault is reductionism, the view that effective understanding of a complex system can be achieved by investigating the properties of its isolated parts. The reductionist methodology, which is so characteristic of much of modern research, is not an effective means of analyzing the vast natural systems that are threatened by degradation.

*The Closing Circle: Nature, Man and Technology*  
Chapter 10 (p. 189)  
Alfred A. Knopf. New York, New York, USA. 1971

**d'Abro, Abraham**  
No biographical data available

...in spite of its achievements, thermodynamics suffers from the limitations common to all phenomenological theories. Because it restricts its attention to the macroscopic properties of bodies, it fails to anticipate many phenomena which find their interpretation in the interplay of underlying microscopic processes, and which have since been clarified by the more speculative theories of the hidden-occurrence type.

*The Rise of the New Physics* (Volume 1)  
Chapter XXI (pp. 371–372)  
Dover Publications, Inc. New York, New York, USA. 1951

**Dyson, Freeman J.** 1923–  
American physicist and educator

My message is that science is a human activity, and the best way to understand it is to understand the individual human beings who practice it. Science is an art form and not a philosophical method. The great advances in

science usually result from new tools rather than from new doctrines. If we try to squeeze science into a single philosophical viewpoint such as reductionism, we are like Procrustes chopping off the feet of his guests when they do not fit onto his bed.

*The Scientist as Rebel*  
*New York Times Book Review*, May 25, 1995

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

In the end, science as we know it has two basic types of practitioners. One is the educated man who still has a controlled sense of wonder before the universal mystery, whether it hides in a snail's eye or within the light that impinges on that delicate organ. The second kind of observer is the extreme reductionist who is so busy stripping things apart that the tremendous mystery has been reduced to a trifle, to intangibles not worth troubling one's head about.

*The Star Thrower*  
Science and the Sense of the Holy (p. 190)  
Times Books. New York, New York, USA. 1978

## REFEREE

**Broad, William** 1951–  
Science writer

**Wade, Nicholas**  
British-born scientific writer

The ultimate gatekeeper of science is neither peer reviews, nor referees, nor replication, nor the universalism implicit in all three mechanisms. It is time. In the end, bad theories don't work, fraudulent ideas don't explain the world so well as true ideas do. The ideal mechanisms by which science should work are applied to a large extent in retrospect .... Time and the invisible boot that kicks out all useless science are the true gatekeepers of science. But these inexorable mechanisms take years, sometimes more than a millennium, to operate. During the interval, fraud may flourish, particularly if it can find shelter under the mantle of immunity that scientific elitism confers.

*Betrayers of the Truth* (p. 106)  
Simon & Schuster. New York, New York, USA. 1982

**Magueijo, Joao** 1967–  
Theoretical physicist and cosmologist

Peer review is an unpaid and usually anonymous activity. Perhaps for this reason the average referee report is sloppy and sleazy. Reports usually reveal that the referee has not read the paper. Acceptance or rejection often reflects the personal relationship between authors and referee. Publishers have always been reluctant to open their files to historians of science and sociologists. Clearly they are

embarrassed to reveal how little science, and how much sociology, there is in their files.

*Electronic Archives and the Death of Journals*  
<http://theory.ic.ac.uk/~magueijo/com.pdf>

### Zoman, John M.

No biographical data available

The referee is the lynchpin about which the whole business of Science is pivoted.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 6 (p. 111)

At The University Press. Cambridge, England. 1968

## REFORM

### Hilbert, David 1862–1943

German mathematician

We have reformed mathematics, the next thing is to reform physics, and then we'll go on to chemistry.

*Hilbert – Courant*

Hilbert

Chapter XVI (p. 129)

Springer-Verlag. New York, New York, USA. 1986

## REFUTABLE

### Friedlander, Michael W.

Physicist

A theory which is not refutable by any conceivable event is nonscientific. Irrefutability is not a virtue of a theory (as people often think) but a vice.

*At the Fringes of Science* (p. 45)

Westview Press. Boulder, Colorado, USA. 1998

## REFUTE

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

All scientists know of colleagues whose minds are so well equipped with the means of refutation that no new idea has the temerity to seek admittance. Their contribution to science is accordingly very small.

*The Uniqueness of the Individual*

Chapter 3 (p. 74)

Basic Books, Inc. New York, New York, USA. 1957

## REGRESSION

### Cardozo, Benjamin N. 1870–1938

American jurist

Where the line is to be drawn the important and the trivial cannot be settled by a formula.

*Jacob & Youngs v. Kent*, 230

*New York Reports* 239, 243, 1921

### Fiedler, Edgar R. 1916–2003

American economist

Most economists think of God as working great multiple regressions in the sky.

The Three R's of Economic Forecasting – Irrational, Irrelevant and Irreverent

*Across the Board*, June, 1977

### Juster, Norton 1929–

American architect and author

Once upon a time, there was a sensible straight line who was hopelessly in love with a dot.

*The Dot and the Line: A Romance in Lower Mathematics*

Film (1965)

## RELATION

### Buchanan, Scott 1895–1968

American educator and philosopher

Science is an allegory that asserts that the relations between the parts of reality are similar to the relations between terms of discourse.

*Poetry and Mathematics*

Chapter 5 (pp. 96–97)

The University of Chicago Press. Chicago, Illinois, USA. 1975

### Dingle, Herbert 1890–1978

English astrophysicist

...if, as we must surely do, we wish to characterize science by the elements in it that persist and grow, and not by that which continually changes, we must recognize...the progressive discovery of relations between the various constituents of our experience.... Amid all the changes of theories and pictures and conceptions, the relations remain and steadily accumulate. Franklin found that lightning was a manifestation of the electric ether revealed in laboratory experiments. The electric ether has disappeared, and other theories of electricity have in turn succeeded it and disappeared also, but the relation between lightning and laboratory sparks remains. Maxwell established a relation between light and electromagnetic oscillations. His ether also has gone, but the relation stays. All permanent advances in science are discoveries of relations between phenomena, and the factor in science that shows a steady uninterrupted growth is the extent of the field of related observations.

*The Scientific Adventure: Essays in the History and Philosophy of Science*  
 Chapter One (p. 40)

Pitman. London, England. 1952

### Durant, William James 1885–1981

American historian and essayist

Science tells us how to heal and how to kill; it reduces the death rate in retail and then kills us wholesale in war;

but only wisdom – desire coordinated in the light of all experience – can tell us when to heal and when to kill. For a fact is nothing except in relation to a purpose and a whole.

*The Story of Philosophy*

Introduction (p. 2)

Simon & Schuster. New York, New York, USA. 1953

**Fiske, John** 1842–1901

American philosopher and historian

The ability to imagine relations is one of the most indispensable conditions of all precise thinking. No subject can be named in the investigation of which it is not imperatively needed; but it can be nowhere else so thoroughly acquired as in the study of mathematics.

*Darwinism and Other Essays* (p. 296)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Keyser, Cassius Jackson** 1862–1947

American mathematician

To be is to be related.

*Mole Philosophy and Other Essays*

Chapter XVII (p. 94)

E.P. Dutton & Company, Inc. New York, New York, USA. 1927

**Schukarev, A. N.**

No biographical data available

At present one can consider it universally acknowledged that among the phenomena of inanimate nature there is no arbitrary will; here the unshakable connection between phenomena rule with complete authority – relations which we call laws. In the invariance of these relations we are even inclined to see the characteristic sign which differentiates the inanimate from the living.

In Michael D. Gordin

*A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table*

Chapter 2 (p. 15)

Basic Books, Inc. New York, New York, USA. 2004

## RELATIONSHIP

**Mivart, St. George Jackson** 1827–1900

English biologist

Everything which can be an object of study has multitudinous relations, of most varied orders, to other objects and to the mind which studies it. A sphere of crystal, as being a single object, solid, transparent, spherical, of a definite weight, of a certain chemical composition, of a certain temperature, capable of projection in various directions and at definite velocities, as a manufactured object, made in a certain locality, for a definite purpose, etc., obviously possesses numerous relations, and cannot be fully understood save from many points of view and by the aid of abstract ideas of very different orders.

*The Groundwork of Science; A Study of Epistemology*

Chapter II (p. 16)

G.P. Putnam's Sons. New York, New York, USA. 1898

## RELATIVITY

**Asimov, Isaac** 1920–92

American author and biochemist

No physicist who is even marginally sane doubts the validity of special relativity.

In Timothy Ferris (ed.)

*The World Treasury of Physics, Astronomy and Mathematics*

The Two Masses (p. 186)

Little Brown & Company. Boston, Massachusetts, USA. 1991

Special relativity is so much a part not only of physics but also of everyday life, that it is no longer appropriate to view it as the special “theory” of relativity. It is a fact...

*Was Einstein Right?* (p. 246)

Basic Books, Inc. New York, New York, USA.

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

**Gribbin, John** 1946–

English science writer and astronomer

All the implications of special relativity... have been confirmed by direct experiments. There are still people who believe it is “just a theory.” But they are wrong.

*The Matter Myth: Dramatic Discoveries That Challenge Our Understanding of Physical Reality* (p. 85)

Simon & Shuster. New York, New York, USA. 1992

**Durell, Clement V.** 1882–1968

English mathematician

Relativity without mathematics may be compared with “Painless Dentistry,” or “Skiing without Falling,” or “Reading without Tears.”

*Readable Relativity*

Preface (p. ix)

Harper & Brothers. New York, New York, USA. 1960

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Results of measurements are the subject-matter of physics; and the moral of the theory of relativity is that we can only comprehend what the physical quantities stand for if we first comprehend what they are.

*The Mathematical Theory of Relativity*

Conclusion (p. 240)

At The University Press. Cambridge, England. 1930

We walk the stage of life, performers of a drama for the benefit of the cosmic spectator. As the scene proceeds, he notices that the actors are growing smaller and the action quicker. When the last act opens the curtain rises on midgets rushing through their parts at frantic speed.

*The Expanding Universe*

Chapter III, Section VI (pp. 91–92)

The University Press. Cambridge. 1933

**Einstein, Albert** 1879–1955  
German-born physicist

There is something attractive in presenting the evolution of a sequence of ideas in as brief a form as possible, and yet with a completeness sufficient to preserve throughout the continuity of development. We shall endeavor to do this for the Theory of Relativity, and to show that the whole ascent is composed of small, almost self-evident steps of thought.

A Brief Outline of the Development of the Theory of Relativity  
*Nature*, Volume 106, Number 2677, February 17, 1921 (p. 782)

When you are courting a nice girl an hour seems like a second. When you sit on a red-hot cinder a second seems like an hour. That's relativity.  
*News Chronicle*, March 14, 1949

Ought we to smile at the man and say that he errs in his conclusion? I do not believe we ought to if we wish to remain consistent; we must rather admit that his mode of grasping the situation violates neither reason nor known mechanical laws. Even though it is being accelerated with respect to the "Galilean space" first considered, we can nevertheless regard the chest as being at rest. We have thus good grounds for extending the principle of relativity to include bodies of reference which are accelerated with respect to each other, and as a result we have gained a powerful argument for a generalised postulate of relativity.

Translated by Robert W. Lawson  
*Relativity: The Special and General Theory*  
Part II, Chapter 20 (p. 88)  
Pi Press. New York, New York, USA. 2005

I sometimes ask myself how it came about that I was the one to develop the theory of relativity. The reason, I think, is that a normal adult never stops to think about problems of space and time. These are things which he has thought of as a child. But my intellectual development was retarded, as a result of which I began to wonder about space and time only when I had already grown up.

In John D. Barrow  
*Theories of Everything: The Quest for Ultimate Explanation*  
Chapter Three (p. 68)  
The Clarendon Press. Oxford. London. 1991

The meaning of relativity...has been widely misunderstood. Philosophers play with the word, like a child with a doll. Relativity, as I see it, merely denotes that certain physical and mechanical facts, which have been regarded as positive and permanent, are relative with regard to certain other facts in the sphere of physics and mechanics. It does not mean that everything in life is mischievously topsy-turvy.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 17)

...the theory of relativity is like a house with two separate stories, the special relativity theory and the general theory of relativity.

Time, Space and Gravitation  
*Science*, Volume LI, Number 1305, January 2, 1920 (p. 8)

It is known that Maxwell's electrodynamics – as usually understood at the present time – when applied to moving bodies, leads to asymmetries which do not appear to be inherent in the phenomena.

Translated by Anna Beck  
*The Collected Papers of Albert Einstein: The Swiss Years, Writings, 1900–1909* Volume 2

On the Electrodynamics of Moving Bodies (p. 140)  
Princeton University Press. Princeton, New Jersey, USA. 1989

**Greene, Brian** 1963–  
American physicist

...general relativity and quantum mechanics, when combined, begin to shake, rattle, and gush with steam like a red-lined automobile.

*The Elegant Universe*  
Chapter 1 (p. 4)  
W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Haldane, R. B.** 1856–1928  
British liberal and labor politician

It is only a world embodying the principle of relativity, in the form which the doctrine entails, that can be said to exhibit the character of mind, with its exclusion of disconnected fragments and relations.

*The Reign of Relativity* (p. 138)  
Yale University Press. New Haven, Connecticut, USA. 1921

**Harrison, B.**  
No biographical data available

**Thorne, Kip S.** 1940–  
American theoretical physicist

If one intends to abandon Relativity, here is the place [black holes] to do so. Otherwise one is on the way to a new world of physics, both classical and quantum. Here we go!

In Jean-Pierre Luminet  
*Black Holes* (p. 117)  
Cambridge University Press. New York, New York, USA. 1992

**Holton, Gerald** 1922–  
Research professor of physics and science history

Relativity theory, of course, does not find that truth depends on the point of view of the observer but, on the contrary, reformulates the laws of physics so that they hold good for all observers, no matter how they move or where they stand. Its central meaning is that the most valued truths in science are independent of the point of view.... Einstein did not prove the work of Newton



wrong; he provided a larger setting within which some limitations, contradictions, and asymmetries in the earlier physics disappeared.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part 1, Chapter 2 (p. 48)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

The cliché became, erroneously, “everything is relative”; whereas the point is that out of the vast flux one can distill the very opposite: “some things are invariant.”

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part 1, Chapter 6 (p. 131)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Krauss, Lawrence M.** 1954–

American theoretical physicist

Einstein was thus faced with the following apparent problem. Either give up the principle of relativity, which appears to make physics possible by saying that the laws of physics are independent of where you measure them, as long as you are in a state of uniform motion; or give up Maxwell’s beautiful theory of electromagnetism and electromagnetic waves. In a truly revolutionary move, he chose to give up neither.... It is a testimony to his boldness and creativity not that he chose to throw out existing laws that clearly worked, but rather that he found a creative way to live within their framework. So creative, in fact, that it sounds nuts.

*Fear of Physics: A Guide for the Perplexed*

Chapter 3 (p. 78)

Basic Books, Inc. New York, New York, USA. 1993

Indeed, long before the Star Trek writers conjured up warp fields, Einstein warped spacetime, and, like the Star Trek writers, he was armed with nothing other than his imagination. Instead of imagining twenty-second-century starship technology, however, Einstein imagined an elevator. He was undoubtedly a great physicist, but he probably never would have sold a screenplay.

*The Physics of Star Trek*

Chapter Three (p. 31)

Harp Perennial Publishers. New York, New York, USA. 1995

**L. L. Cool J.** 1968–

American hip hop artist and actor

Grab hold of a hot pan and a second can seem like an hour. Put your hands on a hot woman and an hour can seem like a second.

*Deep Blue Sea*

Film (1999)

**Lindley, David** 1956–

English astrophysicist and author

Relativity removes from physics the authoritarian rule of classical physics, with its absolute space and

time, and replaces it not with anarchy, in which all participants have their own rules, but with perfect democracy, in which the same rules govern all.... It may seem unsatisfactory to respond that there can be only one correct theory of space and time, and that Einstein’s happens to be it, but for the physicist such an answer has to suffice. Relativity, like other physical theories, is a set of rules based on a number of crucial assumptions, and experiment and observation bear it out. That is all we ever ask of physical theories, and to ask for some further statement of why the special theory of relativity supplanted absolute Newtonian spacetime is to search for a truth beyond the domain of science.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 2 (pp. 60, 61)

Basic Books, Inc. New York, New York, USA. 1993

**Lindon, J. A.**

English writer of comic verse

When they questioned her, answered Miss Bright,  
“I was there when I got home that night;  
So I slept with myself,  
Like two shoes on a shelf,  
Put-up relatives shouldn’t be tight!”

In Martin Gardner

*Time Travel and Other Mathematical Bewilderments*

Chapter One (p. 9)

W.H. Freeman & Company. New York, New York, USA. 1988

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

I can accept the theory of relativity as little as I can accept the existence of atoms and other such dogmas.

In Stephen Pile

*The Book of Heroic Failures*

Routledge & Kegan Paul. London, England. 1979

**Nabokov, Vladimir Vladimirovich** 1899–1977

Russian-born American novelist

At this point, I suspect, I should say something about my attitude to “Relativity.” It is not sympathetic. What many cosmogonists tend to accept as an objective truth is really the flaw inherent in mathematics which parades as truth.

*Ada or Ardor: A Family Chronicle*

Part Four (p. 543)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

General relativity has very few connections with any other part of physics and, as I said, is something that we might just now be beginning to discover...

*The Flying Trapeze: Three Crises for Physics*

Space and Time (p. 23)

Oxford University Press, Inc. London, England. 1964



**Page, Leigh** 1884–1952  
American physicist

The rotating armatures of every generator and motor in this age of electricity are steadily proclaiming the truth of the relativity theory to all who have ears to hear.

Filler material

*American Journal of Physics*, Volume 43, Number 4, April, 1975 (p. 330)

**Rindler, Wolfgang** 1952–  
German writer

Relativity has taught us to be wary of time.

*Essential Relativity* (p. 203)

van Nostrand Company, Inc. New York, New York, USA. 1969

**Rogers, Eric**  
No biographical data available

Since Relativity is a piece of mathematics, popular accounts that try to explain it without mathematics are almost certain to fail.

*Physics for the Inquiring Mind*

Chapter 31 (p. 472)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Rothman, Tony** 1953–  
American cosmologist

Relativity does not mean everything is relative. And the brilliance of Einstein's discoveries is so great that no amount of journalistic overkill has managed to dim it. Einstein and Bach are the only two people who deserve their reputations.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 5 (p. 115)

Ballantine Books. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Einstein's theory of relativity is probably the greatest synthetic achievement of the human intellect up to the present time.

*The New York Times*, April 19, 1955

**Sciamia, Dennis** 1926–99  
English physicist

General relativity contains within itself the seeds of its own destruction.

In John D. Barrow

*The World Within the World* (p. 306)

Clarendon Press. Oxford, England. 1988

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

The orbit of the electron observes no law: it chooses one path and rejects another: it is as capricious as the planet Mercury, who wanders from his road to warm his hands at the sun. All is caprice: the calculable world has become incalculable.

*Bernard Shaw's Plays*

*Too True to Be Good: A Political Extravaganza*

Act III

W.W. Norton & Company, Inc. New York, New York, USA. 1970

**Thomson, Sir Joseph John** 1856–1940  
English physicist

It [relativity] was not a discovery of an outlying island, but of a whole continent of new scientific ideas of the greatest importance to some of the most fundamental questions connected with physics.

Eclipse Showed Gravity Variation: Hailed as Epochmaking

*The New York Times*, November 9, 1919 (p. 6)

**Weyl, Hermann** 1885–1955  
German mathematician

It is as if a wall which separated us from Truth has collapsed. Wider expanses and greater depths are now exposed to the searching eye of knowledge, regions of which we had not even a presentiment. It has brought us much nearer to grasping the plan that underlies all physical happening.

Translated by Henry L. Brose

*Space – Time – Matter*

Preface to the First Edition (p. ix)

Dover Publications, Inc. New York, New York, USA. 1922

**Williams, W.**  
No biographical data available

You hold that time is badly warped,  
That even light is bent;  
I think I get the idea there,  
If this is what you meant;  
The mail the postman brings me today,  
Tomorrow will be sent.

In Ronald W. Clark

*Einstein: The Life and Times*

Part Four, Chapter 12 (p. 330)

The World Publishing Company. New York, New York, USA. 1971

## RELATIVITY, THEORY OF

**Einstein, Albert** 1879–1955  
German-born physicist

It is not easy to talk about how I reached the idea of the theory of relativity; there were so many hidden complexities to motivate my thought, and the impact of each thought was different at different stages in the development of the idea.

Translated by Yoshimasa A. Ono

How I Created the Theory of Relativity

*Physics Today*, August, 1982 (p. 46)

**Noll, Walter**  
Mathematician

I believe the coordinate-free approach fosters the cultivation of intuition, a scarce commodity in relativity because

the phenomena this theory is intended to describe are as yet rather remote from our daily experience.

Euclidean Geometry and Minkowskian Chronometry  
*The American Mathematical Monthly*, February, 1964 (p. 129)

## RELEVANCE

### National Research Council (USA)

Relevance is not always obvious at first, and its discovery requires serious intellectual effort from both scientists and potential users of science.

*Physics in Perspective* (Volume 1)  
Chapter 2 (p. 23)  
National Academy of Sciences. Washington, D.C. 1972

## RELIABILITY

**Adams, George** 1750–95  
English instrument maker

The mind of man admits with reluctance the truth of every testimony concerning matters of fact, which happen to be repugnant to the uniform experience of his senses; hence the general backwardness to believe the miracles in the Bible: and hence the Dutchman, who informed the king of Siam that water in his country would sometimes in cold weather be found so hard, that men walked upon it, and that it would bear an elephant, was esteemed a person unworthy of credit. Hitherto, says the king, I have believed the strange things you told me, because I looked upon you as a sober man, but now I am sure you lie.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture VI (pp. 279–280)  
Printed by R. Hindmarsh. London, England. 1794

## RELIC

**Grove, William Robert** 1811–96  
Judge and physical scientist

The relic is to the past as is the germ to the future.

*The Correlation and Conservation of Forces*  
Introductory Remarks (p. 12)  
D. Appleton & Co. New York, New York, USA. 1885

## RELIGION

**Barrow, John D.** 1952–  
English theoretical physicist

If a “religion” is defined to be a system of ideas that contains unprovable statements, then Gödel has taught us that, not only is mathematics a religion, it is the only religion that can prove itself to be one.

*Between Inner Space and Outer Space* (p. 88)  
Oxford University Press, Inc. New York, New York, USA. 1999

**Einstein, Albert** 1879–1955  
German-born physicist

It is quite clear to me that the religious paradise of youth, which [I] lost, was a first attempt to free myself from the chains of the “merely personal,” from an existence which is dominated by wishes, hopes, and primitive feelings.

In Gerald Holton  
*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*  
Part Two, Chapter 8 (p. 172)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

[My] deep religiosity...found an abrupt ending at the age of twelve, through the reading of popular scientific books.

In Gerald Holton  
*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*  
Part Two, Chapter 8 (p. 172)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Ferrer, Francisco** 1849–1909  
Spanish anarchist

When the masses become better informed about science, they will feel less need for help from supernatural Higher Powers. The need for religion will end when man becomes sensible enough to govern himself.

In James A. Haught (ed.)  
*2000 Years of Disbelief: Famous People with the Courage to Doubt*  
Part Six: The Early Twentieth Century Chapter 52 (p. 224)  
Prometheus Books. Amherst, New York, USA. 1996

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

I do get discouraged when some of my colleagues tout their private atheism (their right, of course, and in many ways my own suspicion as well) as a panacea for human progress against a caricature of “religion,” erected as a straw man for rhetorical purposes.... If these colleagues wish to fight superstition, irrationalism, philistinism, ignorance, dogma, and a host of other insults to the human intellect, then God bless them – but don’t call this enemy “religion.”

*Rocks of Ages*  
The Two False Paths of Irenics (pp. 209–210)  
The Ballantine Publishing Group. New York, New York, USA. 1999

## RENORMALIZATION

**Berry, Sir Michael Victor** 1941–  
English mathematical physicist

In The Renormalization Group method you take a structure you don’t understand and convert it to another structure you don’t understand. You keep doing it until you finally understand.

2002 Gibbs Lecture, San Diego, California, January 6, 2002

**REPAIR****Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

The major difference between a thing that might go wrong and a thing that cannot possibly go wrong is that when a thing that cannot possibly go wrong goes wrong, it usually turns out to be impossible to get at and repair.

*The Ultimate Hitchhiker's Guide to the Galaxy**Mostly Harmless*

Chapter 12 (p. 720)

Ballantine Books. New York, New York, USA. 2002

**REPLICA****Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

For, whereas you can make a replica of an ancient statue, there is no possible replica of an ancient state of mind. There can be no nearer approximation [of one] than that which a masquerade bears to real life.

*Science and the Modern World*

Chapter IX (p. 200)

The Macmillan Company. New York, New York, USA. 1929

**REPORT****Kettering, Charles Franklin** 1876–1958

American engineer and inventor

Some technical reports are so dry and dusty...that if you put a pile of them in a hydraulic press and apply millions of pounds of pressure to it, not a drop of juice will run out.

*Professional Amateur*

Part III, Chapter XXI (p. 215)

E.P. Dutton &amp; Company, Inc. New York, New York, USA. 1957

**REPRODUCTION****Bateson, William** 1861–1926

English biologist and geneticist

I know nothing which to a man well trained in scientific knowledge and method brings so vivid a realisation of our ignorance of the nature of life as the mystery of cell-division.... It is this power of spontaneous division which most sharply distinguishes the living from the non-living.... The greatest advance I can conceive in biology would be the discovery of the instability which leads to the continued division of the cell. When I look at a dividing cell I feel as an astronomer might do if he beheld the formation of a double star: that an original act of creation is taking place before me.

In Louise B. Young (ed.)

*The Mystery of Matter*

Aspects of Immortality, Death, and Reproduction (p. 403)

Oxford University Press, Inc. New York, New York, USA. 1965

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

We can set no limit to human potentialities; all that is best in man can be bettered...The ordinary social reformer sets out with a belief that no environment can be too good for humanity; it is without contradicting this that the eugenist may add that man can never be too good for his environment.

Some Hopes of a Eugenist

*Eugenics Review*, 5:309, 1914**Fletcher, Joseph** 1905–91

Anglican theologian and founder of the theory of situational ethics

Our basic ethical choice as we consider man's new control over himself, over his body and his mind as well as over his society and environment, is still what it was when primitive men holed up in caves and made fires. Chance versus control. Should we leave the fruits of human reproduction to take shape at random, keeping our children dependent on accidents of romance and genetic endowment, of sexual lottery or what one physician calls "the meiotic roulette of his parents' chromosomes?" Or should we be responsible about it, that is, exercise our rational and human choice, no longer submissively trusting to the blind worship of raw nature?

*The Ethics of Genetic Control: Ending Reproductive Roulette*

Chapter I. Trying to be Natural (p. 36)

Prometheus Books. Buffalo, New York, USA. 1988

**Harvey, William** 1578–1657

English physician

All animals are in some sort produced out of an egge ...

*Exercitations Concerning the Generation of Living Creatures* (p. 381)

1653

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

The pioneers of Eugenic Insemination by Donor...will be accused of mortal sin, of theological impropriety, of immoral and unnatural practices. But they can take heart from what has happened in the field of birth control, and can be confident that the rational control of reproduction aimed at the prevention of human suffering and frustration and the promotion of human well-being and fulfillment will in the not too distant future come to be recognized as a moral imperative.

*Eugenics Review*, Volume 54, 1963 (p. 123)**Pearson, Karl** 1857–1936

English mathematician

A majority of the community would probably also admit today that the physical characters of man are inherited with practically the same intensity as the like characters in cattle and horses. But few, however..., apply the

results which flow from such acceptance to their own conduct in life.

On the Laws of Inheritance in Man  
*Biometrika*, Volume 3, 1904 (p. 131)

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

One snowflake is not born of another. For true reproduction is the genius only of life. There is nothing, in all the ponderous and vasty world of rock and star, comparable with the rhythm of man, sperm, babe, man. The distance to the farthest galaxy does not so stir me as the ages between the simplicity of two fused cells and the potential king who is lifted out of the whirlwind and agony and slapped into breathing.

*Flowering Earth*

Chapter 4 (p. 46)

G.P. Putnam's Sons, New York, New York, USA. 1939

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...impregnation will be regarded in an entirely different manner, more in the light of a surgical operation, so that it will be thought not ladylike to have it performed in the natural manner.

*The Scientific Outlook*

Chapter XVI (p. 262)

George Allen & Unwin Ltd, London, England. 1931

**Zihlman, Adrienne**

American paleoanthropologist

As with most things in life, the debate centers on two themes: food and sex; or to give it a proper academic tone: diet and reproduction.

Sex, Sexes and Sexism in Human Origins

*Yearbook of Physical Anthropology*, Volume 30, April 12, 1985 (p. 11)

**RESEARCH**

**Abbe, Cleveland** 1838–1916

American meteorologist

The ultimate goal of scientific research is not the collection of facts furnished by explorations and surveys, not even the exact data furnished by the most laborious measurements as in astronomy, geodesy, chemistry, and physics. Neither is it the framing of a few generalizations and inductions, such as the general idea of evolution; nor is it the establishment of some isolated fundamental laws, such as the attraction of gravitation, the conservation of energy, the mechanical equivalent of heat, the atomic weights and their periodic law. Research aims to go deeper than all this and show how these laws and phenomena result necessarily from a few simple premises – not premises in the sense of assumption, but axioms that are just as truly the basis of the physical universe as Euclid's axioms are the basis of geometry.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

The Progress of Science as Illustrated by the Development of Meteorology (p. 287)

Government Printing Office, Washington, D.C. 1908

**Adams, George** 1750–95

English instrument maker

The more diligent our search, the more accurate our scrutiny, the more we are convinced that our labours can never finish, and that subjects inexhaustible remain behind still unexplored.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture X (p. 421)

Printed by R. Hindmarsh, London, England. 1794

The best directed and most successful researches only inform us how little is known, and give us no cause to be satisfied with the discoveries they have made.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXXV (p. 512)

Printed by R. Hindmarsh, London, England. 1794

**Agnew, Neil McK.**

No biographical data available

**Pyke, Sandra W.**

No biographical data available

Research is like a love affair. The ingredients include: (1) your image of the girl; (2) the real girl as she would appear to you if you...had access to all information about her; and (3) the bits, pieces, or samples of information you have, some of it clear, some of it vague, some of it twisted by memory or biased senses.... Changing a once-loved picture is a very painful process, and we know the degrees to which a lover will go to ignore, twist, and blink away negative data...

*The Science Game*

Leaping to Conclusions (p. 128)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1969

**Asimov, Isaac** 1920–92

American author and biochemist

...One can appreciate and take pleasure in the achievements of science even though he does not himself have a bent for creative work in science.... Initiation into the magnificent world of science brings great aesthetic satisfaction, inspiration to youth, fulfillment of the desire to know, and a deeper appreciation of the wonderful potentialities and achievements of the human mind.

*Asimov's New Guide to Science*

What Is Science? (p. 15)

Basic Books, Inc. New York, New York, USA. 1984

**Author undetermined**

Great cabinets may be unlocked by little keys.

Astronomical Observations

*Nature*, Volume 4, May 11, 1871 (p. 31)

Research is like gold-finding. When a new auriferous region is first opened up the nuggets lie on or near the surface and may be secured with little preparation, skill, or effort. By degrees the placers are exhausted, and gold is obtained only by crushing quartz reef and extracting the precious metal by processes which require ample capital, costly machinery, and technical skill. Just so it is or has been the case in chemical research. A century ago important facts as yet undetected lay, so to speak, on the surface, and might be stumbled upon by random experimentalists. Rough and simple apparatus was quite sufficient. In our days all this is changed. Truth lies now at the bottom of very deep wells.

Address to students

*The Chemical News*, Volume 52, Number 1347, September 18, 1883 (p. 141)

### **Bachrach, Arthur J.**

No biographical data available

...people don't usually do research the way people who write books about research say that people do research.

*Psychological Research: An Introduction*

Introduction (pp. 19–20)

Random House, Inc. New York, New York, USA. 1965

### **Ball, Sir Robert Stawell** 1840–1913

Irish astronomer

Just as the astronomer staggers our powers of conception by the description of appalling distances and stupendous periods of time, and relies with confidence on the evidence which convinces him of the reality of his statements, so the physicist avails himself of a like potent method of research to study distances so minute and time so brief that the imagination utterly fails to realize them.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1893

Atoms and Sunbeams (p. 127)

Government Printing Office. Washington, D.C. 1894

### **Barrie, Sir James M.** 1860–1937

Scottish journalist, writer, and dramatist

...those hateful persons...Original Researchers...

*My Lady Nicotine*

Chapter XIII (p. 85)

Charles Scribner's Son's. New York, New York, USA. 1921

### **Bates, Marston** 1906–74

American zoologist

Research is the process of going up alleys to see if they are blind.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2)

K.6 (p. 63)

Simon & Schuster. New York, New York, USA. 1987

### **Baum, Lyman Frank.** 1856–919

American author

“But, dear me, in that case you will never find your lost brother!” exclaimed the girl.

“Maybe not; but it's my duty to try,” answered Shaggy.

“I've wandered so far without finding him, but that only proves he is not where I've been looking.”

*Tik-Tok of Oz*

Chapter Six

The Reilly & Lee Company. Chicago, Illinois, USA. 1914

### **Belloc, Hilaire** 1870–1953

French-born poet and historian

...anyone of common mental and physical health can practice scientific research.... Anyone can try by patient experiment what happens if this or that substance be mixed in this or that proportion with some other under this or that condition. Anyone can vary the experiment in any number of ways. He that hits in this fashion on something novel and of use will have fame.... The fame will be the product of luck, and industry. It will not be the product of special talent.

*Essays of a Catholic*

Science as the Enemy of Truth (pp. 226–227)

The Macmillan Company. New York, New York, USA. 1931

### **Betjeman, John** 1906–84

English poet

Research is the curse of our age. “Research” is the first step on the way to expertdom. There is so much research going on nowadays that teachers are becoming scarce. Already in the universities complaints are being made about there being too many research students and research fellowships. And what, you may ask, is all this research for? Goodness knows.

*First and Last Loves* (p. 62)

### **Beveridge, William Ian Beardmore** 1908–

Australian zoologist

Research is one of those highly complex and subtle activities that usually remain quite unformulated in the minds of those who practice them. This is probably why most scientists think that it is not possible to give any formal instruction in how to do research.

*The Art of Scientific Investigation*

Preface (pp. ix–x)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

The research worker remains a student all his life.

*The Art of Scientific Investigation*

Chapter One (p. 1)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

Anyone with an alertness of mind will encounter in the course of an investigation numerous interesting side issues that might be pursued. It is a physical impossibility to follow up all of these. The majority are not worth following, a few will reward investigation and the occasional one provides the opportunity of a lifetime. How to



distinguish the promising clues is the very essence of the art of research.

*The Art of Scientific Investigation*

Chapter Three (p. 35)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

People in most other walks of life can allow themselves the indulgence of fixed ideas and prejudices which make thinking so much easier...but the research worker must try to keep his mind malleable and avoid holding set ideas in science. We have to strive to keep our mind receptive and to examine suggestions made by others fairly and on their own merits, seeking arguments for as well as against them. We must be critical, certainly, but beware lest ideas be rejected because an automatic reaction causes us to see only the arguments against them. We tend especially to resist ideas competing with our own.

*The Art of Scientific Investigation*

Chapter Seven (p. 86)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Birch, Arthur J.** 1915–1995

Australian chemist

The details of a research career are dictated partly by accident, but largely by inclinations and temperament.

*To See the Obvious*

Prelude, and Evolution of a Chemist (p. 7)

American Chemical Society, Washington, D.C. 1995

### **Bradley, A. C.** 1851–1935

English literary scholar

Research, though toilsome, is easy; imaginative vision, though delightful, is difficult.

*Oxford Lectures on Poetry*

Shakespeare's Theatre and Audience (p. 362)

Macmillan & Company Ltd. London, England. 1909

### **Brown, J. Howard**

No biographical data available

A man may do research for the fun of doing it but he cannot expect to be supported for the fun of doing it.

The Biological Approach to Bacteriology

*Journal of Bacteriology*, Volume 18, Number 1, January, 1932 (p. 9)

### **Browning, Robert** 1812–89

English poet

...as is your sort of mind,

So is your sort of search: you'll find

What you desire.

*The Poems and Plays of Robert Browning*

Easter Day, Part vii, l. 3 (p. 501)

The Modern Library. New York, New York, USA. 1934

### **Bunge, Mario** 1919–

Argentine philosopher and physicist

Most scientists are prepared to grant that the chief theoretical (that is, nonpragmatic) aim of scientific research is

to answer, in an intelligible, exact, and testable way, five kinds of questions, namely those beginning with what (or how), where, when, whence, and why.... [T]he Five W's of Science. (Only radical empiricists deny that science has an explanatory function, and restrict the task of scientific research to the description and prediction of observable phenomena.) Also, most scientists would agree that all five W's are gradually (and painfully) being answered through the establishment of scientific laws, that is, general hypotheses about the patterns of being and becoming.

*Causality: The Place of the Causal Principle in Modern Science*

Chapter 10 (p. 248)

Harvard University Press. Cambridge, Massachusetts, USA. 1959

### **Bush, Vannevar** 1890–1974

American electrical engineer and physicist

Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.

*Endless Horizons*

Chapter 5 (pp. 52–53)

Public Affairs Press. Washington, D.C. 1946

In these circumstances it is not at all strange that the workers sometimes proceed in erratic ways. There are those who are quite content, given a few tools, to dig away, unearthing odd blocks, piling them up in the view of fellow workers and apparently not caring whether they fit anywhere or not.... Some groups do not dig at all, but spend all their time arguing as to the exact arrangement of a cornice or an abutment. Some spend all their days trying to pull down a block or two that a rival has put in place. Some, indeed, neither dig nor argue, but go along with the crowd, scratch here and there, and enjoy the scenery. Some sit by and give advice, and some just sit.

*Endless Horizons*

Chapter 17 (p. 180)

Public Affairs Press. Washington, D.C. 1946

### **Campbell, Norman R.** 1880–1949

English physicist and philosopher

Men of his own [Faraday] and of the preceding era had founded 'natural philosophy': they had made discoveries and had elaborated theories which still form part of the frame-work of the physical sciences. But their work has little interest for us today. Their aims, their conceptions, their whole attitude toward the problems which they investigated differ so widely from our own, that, while their results may be the basis of modern research, their methods afford little inspiration for it.

*Modern Electrical Theory*

Part I, Chapter 1 (p. 1)

University Press. Cambridge, England. 1907



**Capra, Fritjof** 1939–  
Austrian-born American physicist

Scientists, therefore, are responsible for their research not only intellectually but also morally...the results of quantum mechanics and relativity theory have opened up two very different paths for physics to pursue. They may lead us – to put it in extreme terms – to the Buddha or to the bomb, and it is up to each of us to decide which path to take.

*The Turning Point*

Chapter II (p. 87)

A Bantam Book. New York, New York, USA. 1983

**Carrel, Alexis** 1873–1944

French surgeon and biologist

In researches dealing with physics and chemistry, and also with physiology, one always attempts to isolate relatively simple systems, and to determine their exact conditions.

*Man the Unknown*

Chapter 2, Section 5 (pp. 50–51)

Harper & Brothers. New York, New York, USA. 1939

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Now this field of Mathematical research, with all its wealth of hidden treasure, is all too apt to yield nothing to our research: for it is haunted by certain *ignes fatui* – , delusive phantoms, that float before us, and seem so fair, and are all but in our grasp, so nearly that it never seems to need more than one step further, and the prize shall be ours!

*Curiosa Mathematica* Part I (3rd edition)

Introduction (p. xvi)

Macmillan & Co Ltd. London, England. 1890

**Caullery, Maurice** 1868–1958

French biologist

The double danger of research into this type of phenomenon lies, on the one hand, in bringing...preconceived ideas of too subjective a nature, bordering on an illusory anthropomorphism, and on the other hand, trying to reduce complex facts to simple elementary reactions.

Translated by Averil M. Lysaght

*Parasitism and Symbiosis*

Chapter I (p. 2)

Sidgwick & Jackson Limited. London, England. 1952

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Research is the search of people who don't know what they want.

*The G.K. Chesterton Calendar*

May 25

Cecil Palmer & Hayward. London, England. 1916

**Coulter, John Merle** 1851–1928

American botanist and educator

Research is like the exploration of a new country. It must be traversed throughout; all trails must be followed and mapped. Some trails will lead to rich lands and valuable mines; others will not. No one can tell until everything has been explored.

The Social, Educational, and Scientific Value of Botanic Gardens

*Science*, N.S. Volume 45, Number 1174, June 29, 1917 (p. 647)

**Crampton, Henry Edward** 1875–1956

American paleontologist

So widely the impelling energy of research has driven the soldiers of investigation that only when, as in the present series of addresses, they return to the council-fires of an intellectual bivouac can they come to realize how far-flung indeed are the battle-lines of the armies of science – how rich and diversified is the territory from which knowledge has driven ignorance and superstition.

*Lectures on Science, Philosophy and Art, 1907–1908*

Zoology (pp. 5–6)

The Columbia University Press. New York, New York, USA. 1908

**Crichton, Michael** 1942–

American novelist

...scientific research was much like prospecting: you went out and you hunted, armed with you maps and your instruments, but in the end your preparations did not matter, or even your intuition. You needed your luck, and whatever benefits accrued to the diligent, through sheer, grinding hard work.

*The Andromeda Strain*

Chapter 20 (p. 222)

HarperCollins Publishers. New York, New York, USA. 2003

**Crick, Francis Harry Compton** 1916–2004

English biochemist

In research the front line is almost always in a fog.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 3 (p. 35)

Basic Books, Inc. New York, New York, USA. 1988

**Cussler, Clive**

American author

**Dirgo, Craig**

No biographical data available

Research is the key. You can never do enough research. This is so vital I'll repeat it. You can never to enough research.... Research can either lower the odds or tell you it's hopeless.

*The Sea Hunters*

Introduction (p. 28)

Simon & Schuster. New York, New York, USA. 1996

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Nothing can be written as the result of new researches.

*Leonardo da Vinci's Note Books* (p. 53)  
Duckworth & Company. London, England. 1906

**Dampier, Sir William Cecil** 1867–1952

English scientific writer

The more we learn, the more various and intricate are the new avenues of research which open before us.

*The Recent Development of Physical Science*  
Chapter I (p. 16)  
John Murray. London, England. 1904

**Dantzig, George Bernard** 1914–2005

American mathematician

I find it amusing that there could be these two very different ways to organize research – one anarchistic, the other dictatorial, and yet both highly efficient. Apparently any form of government can be made to work if the people are motivated enough.

In D. Albers, G. Alexanderson and C. Reid  
*More Mathematical People: Contemporary Conversations* (p. 77)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

Existing science must be overthrown not by casual anecdotes but by the most rigorous research, repeated, dissected, and repeated again.

Putting Away Childish Things  
*Skeptical Inquirer*, Jan/Feb 1995 (p. 31)

**Day, R. A.**

No biographical data available

The goal of scientific research is publication. Scientists, starting as graduate students, are measured primarily not by their innate knowledge of either broad or narrow scientific subjects, and certainly not by their wit or charm; they are measured, and become known (or remain unknown), by their publications.

*How to Write and Publish a Scientific Paper* (3rd edition) (p. vii)  
Oryx Press. Phoenix, Arizona, USA. 1988

**Dessauer John** 1792–1871

English astronomer and chemist

All the efforts of the researcher to find other models, conceptions, different mathematical forms, better linguistic modes of expression, to do justice to newly discovered layers of being mean self-transformation. The researcher in his place is the human being in self-transformation to more profound insight into what is given.

*Universitas: A Quarterly German Review of the Arts and Sciences*,  
Volume 26, Number 4, April 6, 1984 (p. 316)

**Dr. Gil**

No biographical data available

There! Little Research, don't you cry –  
You'll be a paper by and by.  
Three observations – half a page of notes,  
Will bring prostration to seven other blokes.

The Professor Sings to His Brain Child  
*Industrial and Engineering Chemistry: News Edition*, Volume 11, Number 9, May 19, 1933 (p. 149)

**Dylan, Bob** 1941–

American pop-folk singer, composer, and musician

Well the world of research is going berserk

Too much paperwork

Released August 29, 2006 by Sony BMG  
*Modern Times*  
Nettue Moore

**Einstein, Albert** 1879–1955

German-born physicist

When a man after long years of searching chances upon a thought which discloses something of the beauty of this mysterious universe, he should not therefore be personally celebrated. He is already sufficiently paid by his experience of seeking and finding.

*The New York Times*, 128:18, Section 4, November 10, 1978

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1896

Polish physicist

The results of scientific research very often force a change in the philosophical view of problems which extend far beyond the restricted domain of science itself.

*The Evolution of Physics*  
The Philosophical Background (p. 55)  
Simon & Schuster. New York, New York, USA. 1936

**Eisenhower, Dwight David** 1890–1969

34th president of the USA

Scientific research has never been amenable to rigorous cost accounting in advance. Nor, for that matter, has exploration of any sort. But if we have learned one lesson, it is that research and exploration have a remarkable way of paying off – quite apart from the fact that they demonstrate that man is alive and insatiably curious. And we all feel richer for knowing what explorers and scientists have learned about the universe in which we live.

Introduction to Outer Space

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

...in scientific research there is no...division of function. The investigator is at once judge, jury, and witness.

His knowledge is first-hand, and hence he knows the exact value of his evidence. He can hold a suspended judgment. He can form alternative opinions and act upon both alternatives. He can construct hypotheses and try them out. He is hampered by no rules but those of his own making. Above all, he is able to interrogate things as well as persons.

*A Certain Dr. Thorndyke*

Thorndyke Connects the Links (pp. 277–278)

Dodd, Mead & Company. New York, New York, USA. 1928

### **Frothingham, Octavius Brooks** 1822–95

American clergyman and author

The actual Jesus is, thus understood, inaccessible to scientific research.

*The Cradle of the Christ: A Study in Primitive Christianity*

Chapter IV (p. 53)

G.P. Putnam's Sons. New York, New York, USA. 1887

### **George, William H.**

No biographical data available

Scientific research is not itself a science: it is still an art or craft.

*The Scientist in Action: A Scientific Study of His Methods*

Four Qualities of Scientific Research (p. 29)

Williams & Norgate Ltd. London, England. 1936

### **Gibbs, J. Willard** 1839–1903

American mathematician

One of the principal objects of theoretical research in any department of knowledge is to find the point of view from which the subject appears in its greatest simplicity.

In G. K. Batchelor

Preoccupations of a Journal Editor

*Journal of Fluid Mechanics*, Volume 106, 1981

### **Gies, William J.** 1872–1956

US biochemist and dentist

Research without *imagination* is pursuit rather than enquiry.

Research in Dentistry

*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xcvi)

Research is inquisitiveness *in action* guided by common sense, and dominated by good judgment.

Research in Dentistry

*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xciv)

Through research we seek to *learn* more in order that we may *do* more and *be* more.

Research in Dentistry

*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xciv)

### **Gore, George** 1826–1909

English electrochemist

Next in importance to the skilful use of a gifted mind in research comes dexterous employment of the human hand.

*The Art of Scientific Discovery*

Chapter XXXIII (p. 313)

Longmans, Green & Co. London, England. 1878

...the most extensive research is never complete, and never can be until it extends to the utmost bounds of knowledge.

*The Art of Scientific Discovery*

Chapter XLIII (p. 397)

Longmans, Green & Co. London, England. 1878

### **Green, Celia** 1935–

English philosopher and psychologist

Research is a way of taking calculated risks to bring about incalculable consequences.

*The Decline and Fall of Science*

Aphorisms (p. 1)

Hamilton. London, England. 1976

The way to do research is to attack the facts at the point of greatest astonishment.

*The Decline and Fall of Science*

Aphorisms (p. 1)

Hamilton. London, England. 1976

### **Gregg, Alan** 1890–1957

American medical educator and philosopher

Research has been defined as a guerrilla warfare on the unknown. In the rigorous uncertainties of such campaigns the investigator must be prepared to swap horses in mid-stream and to discard some very dear items of accumulated baggage of belief or personal pride, whenever intellectual honesty calls for such sacrifices.

*The Furtherance of Medical Research*

Chapter III (pp. 87–88)

Yale University Press. New Haven, Connecticut, USA. 1941

### **Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

There are many highly respected motives which may lead men to prosecute research, but three which are much more important than the rest. The first (without which the rest must come to nothing) is intellectual curiosity, desire to know the truth. Then, professional pride, anxiety to be satisfied with one's performance, the shame that overcomes any self-respecting craftsman when his work is unworthy of his talent. Finally, ambition, desire for reputation, and the position, even the power or the money, which it brings.

*A Mathematician's Apology*

Section 7 (pp. 78–79)

Cambridge University Press. Cambridge, England. 1967

### **Hastings, Horace Lorenzo** 1831–99

No biographical data available

There are none so blind as those who will not see; and no man searches honestly for that which he is afraid to find.

*Atheism & Arithmetic: Or, Mathematical Law in Nature*

Chapter I (p. 12)

H.L. Hastings. Boston, Massachusetts, USA. 1889

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

If I were asked what was Christopher Columbus' greatest achievement in discovering America, my answer would not be that he took advantage of the spherical shape of the earth to get to India by the western route – this idea had occurred to others before him – or that he prepared his expeditions meticulously and rigged his ships most expertly – that, too, others could have done equally well. His most remarkable feat was the decision to leave the known regions of the world and to sail westward, far beyond the point from which provisions could have gotten him back home again.

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 70)

Harper & Row, Publishers. New York, New York, USA. 1971

...the subject matter of research is no longer nature in itself, but nature subjected to human questioning...

In Aldous Huxley

*Literature and Science*

Chapter 25 (p. 76)

Harper & Row, Publishers. New York, New York, USA. 1963

**Heschel, Abraham J.** 1907–72

Jewish theologian

Scientific research is an entry into the endless, not a blind alley; Solving one problem, a greater one enters our sight. One answer breeds a multitude of new questions; explanations are merely indications of greater puzzles. Everything hints at something that transcends it; the detail indicates the whole, the whole, its idea, the idea, its mysterious root. What appears to be a center is but a point on the periphery of another center. The totality of a thing is actual infinity.

*Analog Science Fiction/Science Fact Magazine*, Volume CIV, Number 12, December, 1984 (p. 63)

**Herschel, Friedrich Wilhelm****(Sir William)** 1738–1822

English astronomer

When I pursued these researches [pertaining to the existence of a self-luminous fluid]...I was in the situation of a natural philosopher who follows the various species of animals and insects from the height of their perfection down to the lowest ebb of life; when arriving at the vegetable kingdom, he can scarcely point out the precise boundary where the animal ceases and the plant begins, and may even go so far as to suspect them not to be essentially different. But recollecting himself, he compares, for instance, one of the human species with a tree, and all doubt upon the subject vanishes before him. In the same manner we pass by gentle steps from a coarse cluster down through others more remote, and therefore of finer texture, without any hesitation, till we

find ourselves brought to an object such as the nebula in Orion, when we are still inclined to remain in our once adopted idea of stars exceedingly remote and inconceivably crowded, as being the occasion of that remarkable occurrence. It seems, therefore, to require a more dissimilar object to bring us right again. A glance like that of the naturalist, who casts his eye from the perfect vegetable to the perfect animal, is wanting to remove the veil from the mind of astronomers.

Quoted in Dionysius Lardner

*Popular Lectures on Science and Art* (Volume 2)

The Stellar Universe (Second Lecture) (p. 394)

Greeley & McElrath. New York, New York, USA. 1846

**Hillery, George A.**

No biographical data available

The process of scientific research is a curious mixture of careful planning and accident, of cold logic and extreme passion, of startling flashes of insight and laborious, soul-wearying labor. Scientific research does not go "by the book," and yet the "book" is necessary. We need a conception of what "should" be done, if only to remind us of where to go and what to do next after we have violated most if not all of the prescriptions.

*A Research Odyssey: Developing and Testing a Community Theory*

Introduction (p. 1)

Transaction Publishers

New Brunswick, New Jersey, USA. 1982

**Holbach, Paul Henri Thiry** 1723–89

French philosopher

Man seeks to range out of his sphere: notwithstanding the reiterated checks his ambitious folly experiences, he still attempts the impossible; strives to carry his researches beyond the visible world; and hunts out misery in imaginary regions.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World* (Volume 1)

Author's Preface (p. 2 )

J.P. Mendum. Boston, Massachusetts, USA. 1889

**Hubble, Edwin Powell** 1889–1953

American astronomer

Research men attempt to satisfy their curiosity, and are accustomed to use any reasonable means that may assist them toward the receding goal. One of the few universal characteristics is a healthy skepticism toward unverified speculations. These are regarded as topics for conversation until tests can't be devised. Only then do they attain the dignity of subjects for investigation.

*The Realm of the Nebulae*

Introduction (p. 6)

Dover Publications, Inc. New York, New York, USA. 1958

**Hurston, Zora Neale** 1891–1960

American author and anthropologist

Research is formalized curiosity. It is poking and prying with a purpose.

*Dust Tracks on a Road*

Chapter X (p. 174)

University of Illinois Press. Urbana, Illinois, USA. 1984

**Jaffe, Bernard** 1896–1968

American science writer

There is no last word or ultimate solution in the adventure of scientific research.

*Michelson and the Speed of Light*

Chapter XII (p. 171)

Doubleday & Company, Inc. Garden City, New York, USA. 1960

**Jevons, William Stanley** 1835–82

English economist and logician

So-called original research is now regarded as a profession, adopted by hundreds of men, and communicated by a system of training.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XXVI (p. 574)

Macmillan & Company Ltd. London, England. 1887

**Johnson, Harry G.** 1923–79

American economist

To an important extent, indeed, scientific research has become the secular religion of materialistic society; and it is somewhat paradoxical that a country whose constitution enforces the strict separation of church and state should have contributed so much public money to the establishment and propagation of scientific pessimism.

In National Academy of Sciences

*Basic Research and National Goals: A Report to the Committee on Science and Astronautics Federal Support of Basic Research: Some Economic Issues*

Note 4 (p. 141)

US Government Printing Office. Washington, D.C. 1965

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

We find that in research a certain amount of intelligent ignorance is essential to progress; for if you know too much, you won't try the thing.

In T.A. Boyd

*Professional Amateur*

Part II (p. 106)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

**Smith, Beverly**

No biographical data available

[Research] may use a laboratory or it may not. It is purely a principle, and everybody can apply it in his own life. It is simply a way of trying to find new knowledge and ways of improving things which you are not satisfied with.

Ten Paths to Fame and Fortune

*The American Magazine*, December, 1937 (p. 14)

**Kline, Morris** 1908–92

American mathematics professor and writer

Mathematical research is also becoming highly professionalized in the worst sense of that term. Research performed voluntarily and sincerely by devoted souls, research as a relish of knowledge, is to be welcomed even if the results are minor. But hothouse-grown research, which crowds the journals and promotes only promotion, is a drag on science.

*Why the Professor Can't Teach: Mathematics and the Dilemma of University Education*

Chapter 3 (p. 67)

St. Martin's Press. New York, New York, USA. 1977

**Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

...all great researches, all discoveries revolutionizing science, have been made outside academies and universities, wither by men rich enough to remain independent, like Darwin and Lyell, or by men who undermined their health by working in poverty, and often in great straits, losing endless time for want of a laboratory, and unable to procure the instruments or books necessary to continue their researches, but persevering against hope, and often dying before they had reached the end in view. Their name is legion.

*The Conquest of Bread*

Chapter IX, Section IV (p. 103)

Vanguard Press. New York, New York, USA. 1926

**Lasker, Albert D.** 1901–70

“Research,” he said, “is something that tells you that a jackass has two ears.”

In John Gunther

*Taken at the Flood: The Story of Albert D. Lasker* (p. 96)

Harper & Brothers. New York, New York, USA. 1960

**Locke, John** 1632–1704

English philosopher and political theorist

...he who has raised himself above the alms-basket, and, not content to live lazily on scraps of begged opinions, sets his own thoughts on work, to find and follow truth, will (whatever he lights on) not miss the hunter's satisfaction; every moment of his pursuit will reward his pains with some delight, and he will have reason to think his time not ill spent, even when he cannot much boast of any great acquisition.

*An Essay Concerning Human Understanding*

Epistle to the Reader (p. v)

Printed for Thomas Tegg. London, England. 1841

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The aim of research is the discovery of the equations which subsist between the elements of phenomena.

*Popular Scientific Lectures*



The Economical Nature of Physical Inquiry (p. 205)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1898

...scientific research is somewhat like unraveling complicated tangles of strings, in which luck is almost as vital as skill and accurate observation.

*Knowledge and Error: Sketches on the Psychology of Enquiry*  
Chapter I (p. 10)  
D. Reidel Publishing Company. Dordrecht, Netherlands. 1976

**Mallove, Eugene F.** 1947–2004  
Editor

The image of a searching man held by Einstein and by Isaac Newton two hundred years before him is of a being wading in the shallows of the ocean of physical reality – trying to fathom the entirety by sampling only a part.

*The Quickening Universe: Cosmic Evolution and Human Destiny*  
Prologue (p. xvi)  
St. Martin's Press. New York, New York, USA. 1987

Human beings individually have only a brief time in this world to form an image of the cosmos. Their minds are like film in a camera of awareness. Birth and death are the opening and closing of the shutters. Yet generations of striving to understand have led to a picture of the universe far more complete than any of us alone could have hoped to develop.

*The Quickening Universe: Cosmic Evolution and Human Destiny*  
Prologue (pp. xviii–xix)  
St. Martin's Press. New York, New York, USA. 1987

**Mayr, Ernst** 1904–2005  
German-born American biologist

...research not only brings us abundant joy but it also gives us a deep sense of humility.

In Walter Shropshire, Jr. (ed.)  
*The Joys of Research*  
Evolutionary Biology (p. 157)  
Smithsonian Institution Press. Washington, D.C. 1981

**MacPhail, Sir Andrew** 1864–1938  
Professor of the history of medicine

The lonely worker in the laboratory, who deals with truth in the abstract, is monitor of those who work publicly in the wards. He is looked upon with respect and fear. He is to the school what the eye of God is to the world.

In Students of William Osler  
*Contributions to Medical and Biological Research*  
The Education of Graduates (p. 131)  
Paul B. Hoeber. New York, New York, USA. 1919

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

The scientist values research by the size of its contribution to that huge, logically articulated structure of ideas which is already, though not yet half built, the most glorious accomplishment of mankind.

Two Conceptions of Science  
*Encounter*, Volume 143, August, 1965

If politics is the art of the possible, research is surely the art of the soluble. Both are immensely practical-minded affairs.

The Act of Creation  
*New Statesman*, Volume 19, June, 1964 (p. 950)

What is research but learning – and what scientist ever feels that, being complete, his research is now at last finished? The nature of science is such that a scientist goes on learning all his life – and must – and exults in the obligation upon him to do so.

*The Limits of Science* (p. 73)  
Harper & Row Publishers. New York, New York, USA. 1984

**Minot, George R.** 1885–1950  
American physician

...upon the foundations laid by previous investigators, do medical art and science build a structure which will in its turn be the foundation of future knowledge.

*Nobel Lectures, Physiology or Medicine 1922–1941*  
The Development of Liver Therapy in Pernicious Anemia  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Mizner, Wilson** 1876–1933  
American playwright

If you steal from one author, it's plagiarism; if you steal from many, it's research.

In Alva Johnson  
*The Legendary Mizners*  
Chapter 4, The Sport (p. 66)  
Farrar, Straus & Young. New York, New York, USA. 1953

**Morgan, Thomas Hunt** 1866–1945  
American zoologist and geneticist

...we look to medical research to discover remedial measures to insure better health and more happiness for mankind.

*Nobel Lectures, Physiology or Medicine 1922–1941*  
The Relation of Genetics to Physiology and Medicine  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1967

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

Research is action; and the question I want to leave in a very raw and uncomfortable form with you is how to communicate this sense of action to our fellow men who are not destined to devote their lives to the professional pursuit of new knowledge.

*The Open Mind*  
Chapter VII (p. 129)  
Simon & Schuster. New York, New York, USA. 1955

We have done the devil's work. Now we have come back to our real job, which is to devote ourselves exclusively to research.

In Karl Jasper  
*La Bombe Atomique et l' Avenir de L'Homme* (p. 360)  
Buchet-Chassel. Paris, France. 1963



**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Observe, record, tabulate, communicate.

In W.S. Thayer

*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*

Osler, The Teacher (p. 51)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Peabody, A. P.**  
No biographical data available

No man becomes proficient in any science who does not transcend system, and gather up new truth for himself in the boundless field of research.

In James Orton

*Comparative Zoology, Structural and Systematic*

Preceding Chapter XXI (p. 222)

Harper & Brothers. New York, New York, USA. 1877

**Perutz, Max F.** 1914–2002  
Austrian-born English biochemist

...research consists of formulation of imaginative hypotheses that are open to falsification by experiment.

*Is Science Necessary?*

How to Become a Scientist (p. 199)

E.P. Dutton & Company, Inc. New York, New York, USA. 1989

**Planck, Max** 1858–1947  
German physicist

Conscientiousness and truth are as necessary in research in pure science as in practical life. The experimenter must not be blinded by the first results of a new intellectual discovery and must not neglect to prove conscientiously and thoroughly the results obtained in his researches.

Translated by R. Jones and D.H. Williams

*A Survey of Physical Theory*

Dynamical Laws and Statistical Laws (p. 56)

Courier Dover Publications, New York, USA. 1990

**Platt, Sir Robert** 1900–78  
English physician

The conventional picture of the research worker is that of a rather austere man in a white coat with a background of complicated glassware. My idea of a research worker, on the other hand, is a man who brushes his teeth on the left side of his mouth only so as to use the other side as a control and see if tooth-brushing has any effect on the incidence of caries.

*British Medical Journal*, Volume 1, 1953 (p. 577)

**Preston, Thomas** 1860–1900  
Irish scientist

It is but a short time since the pursuit of experimental research was regarded merely as a matter of individual curiosity; but owing to the high commercial value and important bearings of many of the recent discoveries in

the fields of science, the public mind has now become awakened to the conviction that knowledge is wealth, and that the scientific education of the people is a matter of national importance.

*The Theory of Heat* (2nd edition)

Preface to the First Edition (p. v)

Macmillan & Co Ltd. London, England. 1904

**Recordé, Robert** 1510?–58  
English mathematician and writer

The time seemeth longe (bee it never so shorte indeed) to hym that desirously looketh for anything: for as the obtaining of it bringeth great pleasure, namelye the thinge itselfe being profitable, so the wante thereof causeth displeasure and cotinuall grief tyll the desire be eyther fully satisfied, other partly (at the least) accomplished.

*The Castle of Knowledge*

The First Treatise (p. 1)

Imprinted by R. Wolfe. London, England. 1556

**Reichenbach, Hans** 1891–1953  
German philosopher of science

The reliance on the concrete is the basis of both the charm and the power of physical research.

*Atom and Cosmos*

Chapter 4 (p. 75)

The Macmillan Company. New York, New York, USA. 1933

**Richards, Herbert Maul** 1871–1928  
No biographical data available

...the world demands research, and any fact no matter how humble, if accurately established, helps on the cause.

*Lectures on Science, Philosophy and Art, 1907–1908*

Botany (p. 36)

The Columbia University Press. New York, New York, USA. 1908

**Richet, Charles** 1850–1935  
French physiologist

The gift for investigation appears at an early age: the demon of research speaks to men whilst they are still young.

*The Natural History of a Savant*

Chapter VI (pp. 38–39)

J.M. Dent & Sons Ltd. London, England. 1927

Understand this clearly; that the right method, even for obtaining a useful practical result, is not to worry about the practice, but to concentrate intensely on pure investigation, without being hampered by any parasitic considerations other than whatever conduces to greater facility for research.

*The Natural History of a Savant*

Chapter XII (p. 134)

J.M. Dent & Sons Ltd. London, England. 1927

**Robinson, James Harvey** 1863–1936  
American historian

Research is mainly looking for things that are not there and attempting processes that will not occur.

*The Humanizing of Knowledge*

Chapter II (p. 32)

George H. Doran Company. New York, New York, USA. 1923

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Scientific research provides the shortest route to useful practice.

*Encyclopedia of Thoughts*

Aphorisms 112

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Scientific research is based chiefly on creative thinking.

*Encyclopedia of Thoughts*

Aphorisms 219

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Sarewitz, Daniel**

No biographical data available

A lone scientist, frizzy-haired and bespectacled – the absent-minded, benevolent genius lost in thought; or perhaps the dedicated experimentalist clad in a white coat and laboring madly among the condensers, van de Graaf generators, computers, and even electrode-covered cadavers: These are typical public images of scientific research.

*Frontiers of Illusion*

Chapter 3 (p. 31)

Temple University Press. Philadelphia, Pennsylvania, USA. 1996

**Sarnoff, David** 1891–1971

Russian-born American broadcasting executive

The wonderful thing about research is that the more of it you do, the more of it there is left to do.

Address to the Board of Directors of the Stanford Research Institute

*Research and Industry: Partners in Progress*, November 14, 1951 (p. 13)

**Scalera, Mario**

No biographical data available

There is no practical purpose here. There is simply man's insatiable curiosity, his abhorrence of the unknown – the desire to see, in the confusing phenomena of nature, the law, the order, that underlies them. This kind of urge has its own reward...the reward that comes to a man who suddenly sees order shaping out of chaos – this is what we call fundamental research.

An Industrial Research Director Views Fundamental Research

*Chemical and Engineering News*, April 21, 1958 (p. 85)

**Schild, Alfred** 1921–77

Physicist

If one can tell ahead of time what one's research is going to be, the research problem cannot be very deep and may be said to be almost nonexistent.

On the Matter of Freedom: The University and the Physical Sciences Bulletin

*Canadian Association of University Teachers*, Volume 11, Number 4, 1963

**Schön, Donald A.** 1930–97

American philosopher of practice and learning theory

He emphasizes the key issue of the starting point of research. In real-world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling and uncertain. In order to convert a problematic situation to a problem, a practitioner must do a certain kind of work.

*The Reflective Practitioner: How Professionals Think in Action* (p. 40)

Basic Books, Inc. New York, New York, USA. 1983

**Singer, Ignatius**

No biographical data available

**Berens, Lewis Henry**

No biographical data available

At last, after years of patient plodding in dim regions, where the footprints are few and the pitfalls many, the time has arrived when we are enabled to place before the world of science the first-fruits of our explorations.

*Some Unrecognized Laws of Nature*

Preface (p. v)

D. Appleton & Co. New York, New York, USA. 1897

**Smith, Homer W.**

Renal physiologist

On every scientist's desk there is a drawer labeled UNKNOWN in which he files what are at the moment unsolved questions, lest through guess-work or impatient speculation he come upon incorrect answers that will do him more harm than good. Man's worst fault is opening the drawer too soon. His task is not to discover final answers but to win the best partial answers that he can, from which others may move confidently against the unknown, to win better ones.

*From Fish to Philosopher*

Chapter XIII (p. 210)

Little, Brown & Company. Boston, Massachusetts, USA. 1953

**Smith, Theobald** 1859–1934

American pathologist

The joy of research must be found in doing, since every other harvest is uncertain.

Letter from Dr. Theobald Smith,

*Journal of Bacteriology*, Volume 27, Number 1, January, 1934 (p. 20)

...it is the care we bestow on apparently trifling, unattractive and very troublesome minutiae which determines the results.

*New York Medical Journal*, Volume lii, 1890 (p. 485)

**Stewart, Ian** 1945–

English mathematician and science writer

The really important breakthroughs are always unpredictable. It is their very unpredictability that makes them

important: they change our world in ways we didn't see coming.... There is nothing wrong with goal-oriented research as a way of achieving specific feasible goals. But the dreamers and the mavericks must be allowed some free rein, too. Our world is not static: new problems constantly arise, and old answers often stop working. Like Lewis Carroll's Red Queen, we must run very fast in order to stand still.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 2 (p. 29)  
Basic Books, Inc. New York, New York, USA. 1995

**Sutherland, Jr., Earl W.** 1915–74

American pharmacologist and physiologist

I am fully convinced that medical research can offer one a happy and productive life. And if one has a little Viking spirit he can explore the world and people as no one else can do. The whole medical research area is wide open for exploration.

*Les Prix Nobel. The Nobel Prizes in 1971*  
Nobel banquet speech for award received in 1971  
Nobel Foundation. Stockholm, Sweden. 1972

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Research means going out into the unknown with the hope of finding something new to bring home.... The unknown is the unknown because one does not know what is there. If one knows what one will do and find in it, then it is not research anymore and is not worth doing.

Research Grants  
*Perspectives in Biology and Medicine*, Volume 18, Number 1, Autumn, 1974 (p. 41)

**Terence** 190 BCE–158 BCE

Roman comic dramatist

Nothing is so difficult but that it may be found out by seeking.

Translated by Alexander Harvey  
*Heauton Timorumenos*  
Act iv, Scene 2, l. 675  
Haldeman-Julius Company. Girard, Kansas, USA. 1925

**The Bible (King James Version)**

... seek, and ye shall find; knock, and it shall be opened unto you: ...  
Matthew 7:7

**Thomas, Lewis** 1913–93

American physician and biologist

In science in general, one characteristic feature is the awareness of error in the selection and pursuit of a problem. This is the most commonplace of criteria: if a scientist is going to engage in research of any kind, he has to have it on his mind, from the outset, that he may be

onto a dud. You can tell a world-class scientist from the run-of-the-mill investigator by the speed with which he recognizes that he is heading into a blind alley. Blind alleys and garden paths leading nowhere are the principal hazards in research.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*  
Viking Press. New York, New York, USA. 1983

**Thompson, Elihu** 1853–1937

American electrical engineer

Physical research by experimental methods is both a broadening and a narrowing field. There are many gaps yet to be filled, data to be accumulated, measurements to be made with great precision, but the limits within which we must work are becoming, at the same time, more and more defined.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*  
The Field of Experimental Research (p. 119)  
Government Printing Office. Washington, D.C. 1901

**Thorne, Kip S.** 1940–

American theoretical physicist

In scientific research, as in life, many themes are pursued simultaneously by many different people; and the insights of one decade may spring from ideas that are several decades old but were ignored in the intervening years.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*  
Preface (p. 18)  
W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Thwing, Charles Franklin** 1853–1937

American educator and writer

The duty of research in the USA is urgent. The peril of a democracy is that it will search for truth not for truth's own sake, but for the sake of what truth will do or bring. It makes investigation into electricity to get light, or heat, or power, not to discover the laws, nature, and relations of electricity. Let it ever be known that truth is primary, and the search for truth for its own sake is a primary duty. The great thinker who gave as a reason for his passion for the theory of numbers that it is a pure virgin that never has been and never can be prostituted to any practical application whatsoever represents the type of the wisest investigator. This lesson of the value of truth for its own sake is a lesson that every democracy should learn.

*A History of Higher Education in America*  
Chapter XXII (p. 471)  
D. Appleton & Co. New York, New York, USA. 1906

**Veblen, Thorstein** 1857–1929

Economist, social critic, and author

...the outcome of any serious research can only be to make two questions grow where only one grew before.

*The Place of Science in Modern Civilization and Other Essays*  
The Evolution of the Scientific Point of View (p. 33)  
The Viking Press, Inc. New York, New York, USA. 1942

**von Braun, Wernher** 1912–77

German-American rocket scientist

Basic research is when I'm doing what I don't know I'm doing.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2)

K.6 (p. 63)

Simon &amp; Schuster. New York, New York, USA. 1987

**von Liebig, Justus** 1803–73

German organic chemist

We were the first pioneers in unknown regions, and the difficulties in the way of keeping on the right path were sometimes insuperable. Now, when the paths of research are beaten roads, it is a much easier matter; but all the wonderful discoveries which recent times have brought forth were then our own dreams, whose realization we surely and without doubt anticipated.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1891*

Autobiography (p. 267)

Government Printing Office. Washington, D.C. 1893

**Weber, Robert L.**

No biographical data available

Much of the misunderstanding of scientists and how they work is due to the standard format of articles in scientific journals. With their terse accounts of successful experiments and well-supported conclusions they show little of the untidy nature of research at the frontiers of knowledge.

*A Random Walk in Science*

Introduction (p. xv)

Institute of Physics Publishing. Bristol, England. 1973

**Weiskopf, Victor Frederick** 1908–2002

Austrian-American physicist

It is difficult to distinguish clearly between fundamental and applied science, and any considerations of this kind can lead to dangerous oversimplifications. The success of basic research derives to a large extent from the close cooperation of basic and applied science. This close relation – often within the same scientist – provided tools of high quality, without which many fundamental discoveries could not have been made.

*Physics in the Twentieth Century: Selected Essays*

The Significance of Science (pp. 354–355)

The MIT Press. Cambridge, Massachusetts, USA. 1972

**Wells, Carolyn** 1862–1942

American writer

I think, for the rest of my life, I shall refrain from looking up things. It is the most ravenous time-snatcher I know. You pull one book from the shelf, which carries a hint or a reference that sends you posthaste to another book, and that to successive others. It is incredible, the number of books you hopefully open and disappointedly close, only to take down another with the same results.

*The Rest of My Life*

Chapter 8

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1937

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The whole difference of modern scientific research from that of the Middle Ages, the secret of its immense success, lies in its collective character, in the fact that every fruitful experiment is published, every new discovery of relationships explained.

*New Worlds For Old*

Chapter II (p. 22)

The Macmillan Company. New York, New York, USA. 1918

In a sense scientific research is a triumph over natural instinct, over that mean instinct that makes men secretive, that makes a man keep knowledge to himself and use it slyly to his own advantage.

*New Worlds for Old*

Chapter II (pp. 22–23)

The Macmillan Company. New York, New York, USA. 1918

**Wheeler, John Archibald** 1911–

American physicist and educator

There is an age-old longing to understand the inner mystery of this strange and beautiful world of ours and our own little place in the scheme of things. Whoever knows a little and can give a little to the search wants to know more and give more.

*At Home in the Universe*

Be the Best to Give the Most (p. 80)

The American Institute of Physics. Woodbury, New York, USA. 1994

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

The valuable attributes of [researchers] are conscious ignorance and active curiosity.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry

*Science*, Volume LXXV, Number 1862, March 25, 1927 (p. 289)**Wilson, Jr., E. Bright** 1908–92

American physical chemist

Though the road may seem long and arduous, with many stretches of pure drudgery, when the end of a particular stage is reached, where the bits of evidence all fall together into a clear and unexpected pattern, there are few other human activities which can provide as much satisfaction; especially if, as is so often the case, the results turn out later to have applications in all sorts of unanticipated directions and help to give a clearer picture of the universe we live in and to make life in that universe more worthwhile.

*An Introduction to Scientific Research*

Conclusion (p. 364)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**Wittig, Georg** 1897–1987  
German chemist

Chemical research and mountaineering have much in common. If the goal or the summit is to be reached, both initiative and determination as well as perseverance are required. But after the hard work it is a great joy to be at the goal or the peak with its splendid panorama.

*Nobel Lectures, Chemistry 1971–1980*

Nobel lecture for award received in 1979

From Diyls to Ylides to My Idyll (p. 368)

World Scientific Publishing Company, Singapore. 1993

**Wordsworth, William** 1770–1850  
English poet

Lost in the gloom of uninspired research.

*The Complete Poetical Works of William Wordsworth*

The Excursion, Despondency Corrected, l. 626

Crowell. New York, New York, USA. 1888

**Yang, Chen Ning** 1922–  
Chinese-born American theoretical physicist

The necessary tendency toward bigness is unfortunate, as it hinders free and individual initiative. It makes research less intimate, less inspiring, and less controllable. However, it must be accepted as a fact of life. Let us take courage then in the knowledge that despite their physical bigness, the machines, the detectors, and indeed the experiments themselves are still based on ideas that have the same simplicity, the same intimacy and controllability that have always made research so exciting and inspiring.

*Elementary Particles: A Short History of Some Discoveries in Atomic Physics*

Chapter 2 (p. 40)

Princeton University Press, Princeton, New Jersey, USA. 1962

**Yeats, William Butler** 1865–1939  
Irish poet and playwright

I had discovered, early in my researches, that their doctrine was no mere chemical fantasy, but a philosophy they applied to the world, to the elements, and to man himself.

*Stories of Red Hanrahan, the Secret Rose, Rosa Alchemica*

Rosa Alchemica (p. 192)

The Macmillan Company. New York, New York, USA. 1914

## RESEARCH ORGANIZATION

**Ziman, John M.** 1925–2005  
English physicist

*Any research organization requires generous measures of the following: (1) Social space for personal initiative and creativity; (2) Time for ideas to grow to maturity; (3)*

*Openness to debate and criticism; (4) Hospitality towards novelty; and (5) Respect for specialized expertise.*

*Prometheus Bound*

Chapter 9 (p. 276)

Cambridge University Press, Cambridge, England. 1994

## RESEARCH PLAN

**van Noordwijk, A. J.** 1949  
Dutch-Canadian genetical ecologist

...however excellent multiannual planning, research-project management, and time recording may be, the scientist should always have some opportunity to test the idea that he got that morning while shaving.

The Bioassyst

*Perspectives in Biology and Medicine*, Volume 29, Number 2, Winter

1986 (p. 307)

**Richter, Curt P.** 1894–1988  
American psychobiologist

...good researchers use research plans merely as starters and are ready to scrap them at once in the light of actual findings...

Free Research versus Design Research

*Science*, Volume 118, Number 3056, July 24, 1953 (p. 92)

**Waksman, Selman A.** 1888–1973  
Ukrainian-born American biochemist

...a new problem has arisen – namely “planned research” versus the “individual investigator.” There is a place for planned research. It can take a defined body of knowledge and lay out a set of experiments which will exploit this knowledge to its foreseeable limits. It can take a set of postulates and drive them home to their logical conclusions. It can do this with exhaustive thoroughness, economy, and speed. Within its limitations, it is efficient, expeditious, and authoritative. But there is a place also and a more important place for the random investigator. The role of planned research is to consolidate ground already won; the role of the random investigator is to seek out new worlds to conquer.

Searchers and Researchers

*Perspectives in Biology and Medicine*, Volume 7, Number 3, Spring

1964 (p. 311)

Good scientists use research plans merely as outlines to begin their investigations and are ready to give them up once they are not justified by actual findings. Experimental designs tend to give rise to “team research”, which serves a purpose in developing and applying ideas; it rarely produces new ideas.

Searchers and Researchers

*Perspectives in Biology and Medicine*, Volume 7, Number 3, Spring

1964 (p. 312)



## RESEARCH, INDUSTRIAL

### National Research Council (USA)

The benefit to the nation's industry as a whole, resulting from any typical piece of industrial research, can usually be shown to be considerably greater than the benefit received by the particular industry that supported this research.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 24)

National Academy of Sciences. Washington, D.C. 1972

## RESEARCHER

### Rickert, Heinrich 1863–1936

German philosopher

It would no doubt be generally agreed today among philosophers and those engaged in specialized research that the various sciences can be divided into two main branches and that a common interest unites theologians and jurists, historians and philologists, on the one hand, and, in like manner, physicists and chemists, anatomists and physiologists, biologists and geologists, on the other. But while those who cultivate the field of the natural sciences will never be in doubt about what name should be given to the domain that they all have in common, in the case of the other group unanimity among individual scientists in regard to what their joint enterprise is to be called is not so readily forthcoming.

Translated by George Goddard

*Science and History*

Chapter 1 (p. 1)

D. van Nostrand Company. Princeton, New Jersey, USA. 1962

## RESIDUAL

### Herschel, Sir John Frederick William 1792–1871

English astronomer and chemist

Almost all the greatest discoveries in astronomy have resulted from the consideration of what we have elsewhere termed RESIDUAL PHENOMENA, of a quantitative or numerical kind, that is to say, of such portions of the numerical or quantitative results of observations as remain outstanding and unaccounted for after subtracting and allowing for all that would result from the strict application of known principles.

*Outlines of Astronomy*

Part III, Chapter XVI (856) (p. 584)

Longman, Brown, Green & Longmans. London, England. 1849

## RESPIRATION

### Lavoisier, Antoine Laurent 1743–94

French chemist

Of all the phenomena of animal economy, none are more striking, nor more worthy of attention from physicists and physiologists than those accompanying respiration. If, on the other hand, we know little of the object of this singular function, we know, on the other hand, that it is so essential to life that it cannot be suspended for any time without exposing the animal to danger of immediate death.

*Experiments on the Respiration of Animals and the Changes Which Happen to Air in Its Passage Through Their Lungs*

Read to the Academie des Sciences

May 3, 1777

## RESPONSIBILITY

### Teller, Edward 1908–2003

Hungarian-born American nuclear physicist

Beyond the scientific responsibility to search the horizon of human knowledge, the responsibilities of scientists cannot be any greater than those of any other citizen in our democratic society. The consequences of scientific discoveries are the responsibility of the people.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 9 (p. 85)

The Free Press. New York, New York, USA. 1987

## REST

### Born, Max 1882–1970

German-born English physicist

It is odd to think that there is a word for something which, strictly speaking, does not exist, namely, "rest."

*The Restless Universe*

Chapter 1 (p. 1)

Dover Publications, Inc. New York, New York, USA. 1951

### Huxley, Thomas Henry 1825–95

English biologist

...the more we learn of the nature of things, the more evident is it that what we call rest is only unperceived activity; that seeming peace is silent but strenuous battle. In every part, at every moment, the state of the cosmos is the expression of a transitory adjustment of contending forces; a scene of strife, in which all the combatants fall in turn.

*Collected Essays*

Evolution And Ethics (p. 49)

Macmillan & Co Ltd. London, England. 1894

## RESULT

### Adams, Douglas 1952–2001

English author, comic radio dramatist, and musician

He decided not to mind the fact that with the extraordinary jumble of rules of thumb, wild approximations and



arcane guesswork he was using he would be lucky to hit the right galaxy; he just went ahead and got a result.

*So Long, and Thanks for All the Fish*

Chapter 17 (p. 93)

Harmony Books. New York, New York, USA. 1984

**Dante, Alighieri** 1265–1321

Italian poet

Great flame follows a little spark.

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Paradise

Canto I, l. 34

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

I have had my results for a long; but I do not yet know how I am to arrive at them.

In L. Nelson

*Socratic Method and Critical Philosophy*

Attributed

Chapter IV (p. 89)

Yale University Press. New Haven, Connecticut, USA. 1949

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

I only present these conclusions with the greatest reserve, knowing myself how I have still to vary my experiments and how easy it is to err in the interpretation of results.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 4 (p. 87)

Cambridge University Press. Cambridge, England. 1978

**Gregory, Sir Richard Arman** 1864–1952

English scientific writer and journalist

A truthful mind is necessary for the discovery of truth in Nature. There is often a vast difference between the result an investigator expects to find and what he does obtain, but he must put his hopes aside and follow the new light if he is to be a worthy contributor to scientific knowledge. By this method alone are the conclusions and principles reached which form the refined gold of science.

*Discovery, Or, The Spirit and Service of Science*

Chapter II (p. 25)

Macmillan & Co Ltd. London, England. 1916

**Jordan, David Starr** 1851–1931

American scientist and university administrator

Knowing the law, and knowing the facts, we should foretell the results. To be able in some degree to do this is the art of life.

*Evolution and Animal Life*

Chapter I (p. 9)

D. Appleton & Co. New York, New York, USA. 1907

**Maxwell, James Clerk** 1831–79

Scottish physicist

The first process therefore in the effectual study of science must be one of simplification and reduction of results of previous investigation to a form in which the mind can grasp them. The results of this simplification may take the form of a purely mathematical formula or of a physical hypothesis.

On Faraday's Lines of Force

*Transactions of the Cambridge Philosophical Society*, 1856

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

Never work too closely with experimenters. Allow the results to settle.

In Silvan S. Schweber

*QED and the Men Who Made It: Dyson, Feynman, Schwinger, and Tomonaga*

Chapter 10 (p. 594)

Princeton University Press. Princeton, New Jersey, USA. 1994

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

To obtain a result of real worth it will not suffice to grind it out or to have a machine for putting our facts in order. It is not alone order but the unexpected order which is of real worth. The machine may grind upon the mere fact, but the soul of the fact will always escape it.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 127)

Government Printing Office. Washington, D.C. 1910

**Sagan, Carl** 1934–96

American astronomer and author

Every scientist feels an affection for his or her ideas and scientific results. You feel protective of them. But you don't reply to critics: "Wait a minute, wait a minute; this is a really good idea. I'm very fond of it. It's done you no harm. Please don't attack it." That's not the way it goes. The hard but just rule is that if the ideas don't work, you must throw them away. Don't waste any neurons on what doesn't work. Devote those neurons to new ideas that better explain the data. Valid criticism is doing you a favor.

Wonder and Skepticism

*Skeptical Inquirer*, January/February, 1995 (p. 24)

**Wilson, Jr., E. Bright** 1908–92

American physical chemist

One of the most difficult decisions which an experimenter has to make is whether or not to reject a result which seems unreasonably discordant.... The best procedure to use depends on what is known about the frequency of occurrence of wild values, on the cost of additional

observations, and on the penalties for the various types of errors.... There is often a desire to disregard negative results on the grounds that conditions were not right or that the operator was not in the right mood. This is undoubtedly responsible for much pseudo science, psychic phenomena, and similar material.

*An Introduction to Scientific Research*

Chapter 9 (pp. 256, 257)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

## RESULTANT

**Huxley, Thomas Henry** 1825–95

English biologist

...throughout Nature, [there is not] a law of wider application than this, that a body impelled by two forces takes the direction of their resultant.

*Darwiniana*

The Origin of Species (p. 32)

D. Appleton & Co. New York, New York, USA. 1894

## RESULTS

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...I shall mix together results which may prove to be of scientific importance and results that are probably no more than mathematical curiosities. The plan is to set down anything that seems worthy of note, even though we cannot see that it has any ultimate importance in nature.

*The Expanding Universe*

Chapter III, Section I (p. 66)

At the University Press. Cambridge, England. 1952

## RETROGRADE MOTION

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

HELENA: Monsieur Parolles, you were born under a charitable star.

PAROLLES: Under Mars, I.

HELENA: I especially think, under Mars.

PAROLLES: Why under Mars?

HELENA: The wars have so kept you under that you must needs be born under Mars.

PAROLLES: When he was predominant.

HELENA: When he was retrograde, I think, rather.

PAROLLES: Why think you so?

HELENA: You go so much backward when you fight.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*All's Well That Ends Well*

Act I, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## REVOLUTION

**Krauss, Lawrence M.** 1954–

American theoretical physicist

Physics progresses not by revolutions, which do away with all that went before, but rather by evolutions, which exploit the best about what is already understood. Newton's laws will continue to be as true a million years from now as they are today, no matter what we discover at the frontiers of science.

*The Physics of Star Trek*

Chapter One (p. 8)

Harp Perennial Publishers. New York, New York, USA. 1995

## REVIEWER

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

The crying sin of modern criticism is that it is overloaded with personality. If an author commit an error, there is no wish to set him right for the sake of truth, but for the sake of triumph – that the reviewer may show how much wiser, or how much abler he is than the writer.

In John Payne Collier

*Seven Lectures on Shakespeare and Milton*

The First Lecture (p. 4)

Chapman & Hall, Ltd. London, England. 1856

## REWARD

### Author undetermined

A woman scientist had been working for some time with a chimpanzee teaching it to carry out various tasks such as opening a box and rewarding it with fruit. One day, after a session with the chimpanzee, she came into the coffee room half laughing and half crying, obviously very emotional. Her colleagues, a little alarmed, finally managed to get out of her what had happened. She had decided to leave the laboratory area temporarily, and had undone the bolt on the door – whereupon the chimpanzee had solemnly handed her a stick of celery.

In Ian Stewart and Jack Cohen

*Figments of Reality*

Chapter 1 (p. 5)

Cambridge University Press. Cambridge, England. 1997

**Davy, Sir Humphry** 1778–1829

English chemist

No motive for exertion is so strong as that founded upon the sympathy of the good and the wise; no reward so sweet as that of being held up to public admiration as a benefactor of the species; no glory so pure, so calculated to awaken great minds, as that of immortality.

In John Davy (ed.)  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
 Chapter III (p. 213)  
 Longman, Rees, Orme, Brown, Green & Longman. London, England.  
 1836

## RHETORIC

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
 Roman orator, politician, and philosopher

Whatever be the subject of a speech, therefore, in whatever art or branch of science, the orator, if he has made himself master of it, as of his client's case, will speak on it better and more elegantly than even the very originator and author of it can.

Translated by J. S. Watson  
*On Oratory & Orators*  
 Book I, Chapter XII (p. 19)  
 Harper & Brothers Publishers. New York, New York, USA. 1878

## RHYTHM

**Barrell, Joseph** 1869–1919  
 American geologist

Nature vibrates with rhythms, climatic and diastrophic, those finding stratigraphic expression ranging in period from the rapid oscillation of surface waters, recorded in ripple-mark, to those long-deferred stirrings of the deep imprisoned titans which have divided earth history into periods and eras. The flight of time is measured by the weaving of composite rhythms – day and night, calm and storm, summer and winter, birth and death – such as these are sensed in the brief life of man. But the career of the Earth recedes into a remoteness against which these lesser cycles are as unavailing for the measurement of that abyss of time as would be for human history the beating of an insect's wing. We must seek out, then, the nature of those longer rhythms whose very existence was unknown until man by the light of science sought to understand the Earth. The larger of these must be measured in terms of the smaller, and the smaller must be measured in terms of years. Sedimentation is controlled by them, and the stratigraphic series constitutes a record, written on tablets of stone, of these lesser and greater waves of change which have pulsed thru geologic time

Rhythm and the Measurement of Geologic Time  
*Bulletin of the Geographical Society of America*, Volume 28, 1917 (p. 746)

**Stewart, Ian** 1945–  
 English mathematician

Nature is nothing if not rhythmic, and its rhythms are many and varied.

Chapter 7 (p. 91)  
 BasicBooks. New York, New York, USA. 1995

## RIDDLE

**Einstein, Albert** 1879–1955  
 German-born physicist

Out yonder there was this huge world, which exists independently of us human beings and which stands before us like a great, eternal riddle...

Translated by Paul Arthur Schlipp  
*Albert Einstein: Autobiographical Notes* (p. 5)  
 Open Court. La Salle, Illinois, USA. 1979

## RIEMANN HYPOTHESIS

**Berry, Sir Michael Victor** 1941–  
 English mathematical physicist

**Keating, Jonathan P.**  
 Niversity professor

If the Riemann Hypothesis is true...the function  $f(u)$  constructed from the primes has discrete spectrum; that is, the support of its Fourier transform is discrete. If the Riemann Hypothesis is false this is not the case. The frequencies then are reminiscent of the decomposition of a musical sound into its constituent harmonics. Therefore there is a sense in which we can give a one-line non technical statement of the Riemann hypothesis: "The primes have music in them."

The Riemann Zeros and Eigenvalue Asymptotics  
*SIAM Review*, 41, Number 2, 1999 (p. 238)

**Bombieri, Enrico** 1940–  
 Italian mathematician

The failure of the Riemann hypothesis would create havoc in the distribution of prime numbers. This fact alone singles out the Riemann hypothesis as the main open question of prime number theory.

Prime Territory: Exploring the Infinite Landscape at the Base of the Number System  
*The Sciences*, September/October 1992

**Conrey, J. Brian**  
 American mathematician

The Riemann Hypothesis (RH) has been around for more than 140 years, and yet now is arguably the most exciting time in its history to be working on RH. Recent years have seen an explosion of research stemming from the confluence of several areas of mathematics and physics.

*The Riemann Hypothesis*  
 Notices of the AMS (March, 2003)

**du Sautoy, Marcus** 1965–  
 English mathematician and writer

As mathematicians navigate their way across the mathematical terrain, it as though all paths will necessarily lead

at some point to the same awesome vista of the Riemann Hypothesis.

*The Music of the Primes*

Chapter 1 (p. 10)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

A solution to the Riemann Hypothesis offers the prospect of charting the misty waters of the vast ocean of numbers. It represents just a beginning in our understanding of Nature's numbers. If we can only find the secret of how to navigate the primes, who knows what else lies out there, waiting for us to discover?

*The Music of the Primes*

Chapter 1 (p. 18)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

As we shall see, Riemann's Hypothesis can be interpreted as an example of a general philosophy among mathematicians that, given a choice between an ugly world and an aesthetic one, Nature always chooses the latter.

*The Music of the Primes*

Chapter 2 (p. 55)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

In an interview, Hilbert explained that he believed the Riemann Hypothesis to be the most important problem "not only in mathematics but absolutely the most important."

*The Music of the Primes*

Chapter 5 (p. 114)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

We have all this evidence that the Riemann zeros are vibrations, but we don't know what's doing the vibrating.

*The Music of the Primes*

Chapter 11 (p. 280)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Until [the RH is proved], we shall listen enthralled by this unpredictable mathematical music, unable to master its twists and turns. The primes have been a constant companion in our exploration of the mathematical world yet they remain the most enigmatic of all numbers. Despite the best efforts of the greatest mathematical minds to explain the modulation and transformation of this mystical music, the primes remain an unanswered riddle. We still await the person whose name will live forever as the mathematician who made the primes sing.

*The Music of the Primes*

Chapter 12 (p. 312)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

### **Erdős, Paul** 1913–96

Hungarian mathematician

To conclude, a somewhat daunting quote about the prime numbers from someone who was as familiar with them as anyone has ever been: "It will be millions of years before we'll have any understanding, and even then it won't be a complete understanding, because we're up against the infinite."

Interview with P. Hoffman

*Atlantic Monthly*, November, 1987 (p. 74)

### **Heath-Brown, R.**

Mathematician

[The Riemann Hypothesis has] no longer just analytic number theorists involved, but all mathematicians know about the problem, and many realize that they may have useful insights to offer. As far as I can see, a solution is as likely to come from a probabilist, geometer or mathematical physicist, as from a number theorist.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 17 (pp. 267–268)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### **Ivic, A.**

No biographical data available

...I don't believe or disbelieve the Riemann Hypothesis. I have a certain amount of data and a certain amount of facts. These facts tell me definitely that the thing has not been settled. Until it's been settled it's a hypothesis, that's all. I would like the Riemann Hypothesis to be true, like any decent mathematician, because it's a thing of beauty, a thing of elegance, a thing that would simplify many proofs and so forth, but that's all.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 17 (p. 269)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### **Klarreich, E.**

No biographical data available

Proving the Riemann hypothesis won't end the story. It will prompt a sequence of even harder, more penetrating questions. Why do the primes achieve such a delicate balance between randomness and order? And if their patterns do encode the behavior of quantum chaotic systems, what other jewels will we uncover when we dig deeper? Those who believe mathematics holds the key to the Universe might do well to ponder a question that goes back to the ancients: What secrets are locked within the primes?

Prime Time

*New Scientist*, November 11, 2000

### **Montgomery, H.**

No biographical data available

So if you could be the Devil and offer a mathematician to sell his soul for the proof of one theorem – what theorem would most mathematicians ask for? I think it would be the Riemann Hypothesis.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 2 (p. 36)

Farrar, Straus & Giroux. New York, New York, USA. 2002

Sometimes I think that we essentially have a complete proof of the Riemann Hypothesis except for a gap. The problem is, the gap occurs right at the beginning, and so

it's hard to fill that gap because you don't see what's on the other side of it.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 17 (p. 267)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### Motohashi, Yoichi

No biographical data available

...the Riemann Hypothesis will be settled without any fundamental changes in our mathematical thoughts, namely, all tools are ready to attack it but just a penetrating idea is missing.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 17 (p. 268)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### Sabbagh, K.

No biographical data available

For many mathematicians working on it, \$1m is less important than the satisfaction that would come from finding a proof. Throughout my researches among the mathematicians' tribe (I have interviewed 30 in the past year), Riemann's Hypothesis was often described to me in awed terms. Hugh Montgomery of the University of Michigan said this was the proof for which a mathematician might sell his soul. Henryk Iwaniec, a Polish-American mathematician, sounded as if he were already discussing terms with Lucifer.

"I would trade everything I know in mathematics for the proof of the Riemann Hypothesis. It's gorgeous stuff. I'm only worried that I'll be unable to understand it. That would be the worst..."

Beautiful Mathematics

*Prospect*, January, 2002

### Sarnak, P. 1953–

South African-born American mathematician

Right now, when we tackle problems without knowing the truth of the Riemann hypothesis, it's as if we have a screwdriver. But when we have it, it'll be more like a bulldozer.

In E. Klarreich

Prime Time

*New Scientist*, November 11, 2000

If [the Riemann Hypothesis is] not true, then the world is a very different place. The whole structure of integers and prime numbers would be very different to what we could imagine. In a way, it would be more interesting if it were false, but it would be a disaster because we've built so much round assuming its truth.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 2 (p. 37)

Farrar, Straus & Giroux. New York, New York, USA. 2002

The Riemann Hypothesis is the central problem and it implies many, many things. One thing that makes it rather unusual in mathematics today is that there must be over five hundred papers – somebody should go and count – which start Assume the Riemann Hypothesis, and the conclusion is fantastic. And those [conclusions] would then become theorems...With this one solution you would have proven five hundred theorems or more at once.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 14 (p. 222)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### Stewart, Ian 1945–

English mathematician and science writer

One of the biggest problems of mathematics is to explain to everyone else what it is all about.

*The Problems of Mathematics*

Chapter 1 (p. 5)

Oxford University Press, Inc. Oxford, England. 1987

## RIGHT

### Darbishire, Arthur Dukinfield 1879–1915

Statistician

The more certain a man is that he is right the more probable is it that he is wrong; because it means that facts are as soft clay in his hands, and his certainty moulds them to his purpose.

*An Introduction to a Biology*

Chapter I (p. 32)

Funk & Wagnalls Co. New York, New York, USA. 1917

## RIGOR

### Hilbert, David 1862–1943

German mathematician

The requirement of rigor, which has become proverbial in mathematics corresponds to a universal philosophic necessity of our understanding; and, on the other hand, only by satisfying this requirement do the thought content and the suggestiveness of the problem attain their full effect. Besides, it is an error to believe that rigor in the proof is the enemy of simplicity. On the contrary we find it confirmed by numerous examples that the rigorous method is at the same time the simpler and the more easily comprehended. The very effort for rigor forces us to find out simpler methods of proof.

Quoted by G.B. Halsted

The Message of Non-Euclidean Geometry

*Proceedings of the American Association for the Advancement of Science*, December 1903–January 1904 (p. 360)



**Keyser, Cassius Jackson** 1862–1947  
American mathematician

...the ideal of thought is rigor; mathematics is the name that usage employs to designate, not attainment of the ideal, for it cannot be attained, but its devoted pursuit and close approximation.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Human Significance of Mathematics (p. 50)  
Columbia University Press. New York, New York, USA. 1916

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

In mathematics rigor is not everything, but without it there would be nothing; a demonstration which is not rigorous is void.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
The Future of Mathematics (p. 127)  
Government Printing Office. Washington, D.C. 1910

## RIP CURRENT

**Hite, M. P.**

No biographical data available

It [a rip current] is a sort of river, a stream showing on the surface deep and powerful, easily perceptible, running with the velocity of a mill race. So swift and powerful is it that a motorboat could not stem its sweeping current. It will carry brick, large rocks and even chunks of lead far out to sea. The most powerful swimmer will find himself helpless as a babe in its rushing grasp.

*Science*  
Discussion and Correspondence  
Volume 63, Number 1592, July 3, 1925 (p. 32)

## RISK

**Fisher, Irving** 1867–1947  
American economist

Risk varies inversely with knowledge.

*The Theory of Interest*  
Chapter IX (p. 221)  
Porcupine Press. Philadelphia, Pennsylvania, USA. 1977

**Florman, Samuel C.** 1925–  
Author and professional engineer

Good intentions and high moral standards do not help an engineer establish the limits of acceptable risk.

*Blaming Technology*  
Moral Blueprints (p. 173)  
St. Martin's Press. New York, New York, USA. 1981

**Scott, Sir Walter** 1771–1832  
Scottish historical novelist and poet

One hour of life, crowded to the full with glorious action, and filled with noble risks, is worth whole years of those mean observances of paltry decorum...

*Tales of My Landlord* (Volume 3)  
Chapter I (pp. 8–9)  
Printed for Robert Cadell. Edinburgh, Scotland. 1832

## RIVER

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

For the rest of the afternoon, keeping to the shady side, we drift down the splendid river, deeper and deeper and deeper into the fantastic.

*Desert Solitaire*  
Down the River (p. 205)  
Ballantine Books. New York, New York, USA. 1968

**Burroughs, John** 1837–1921  
American naturalist and writer

The river idealizes the landscape. It multiplies and heightens the beauty of the day and season. A fair day it makes more fair, and a wild, tempestuous day it makes more wild. The face of winter makes it doubly rigid and corpse-like, and to the face of spring it adds new youth and sparkle.

*The Heart of Burroughs's Journals*  
May 2, 1883 (p. 94)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

From dark and icy caverns called you forth,  
Down those precipitous, black, jagged rocks,  
Forever shattered, and the same forever?  
Who gave you your invulnerable life,  
Your strength, your speed, your fury and your joy,  
Unceasing thunder and eternal foam?

*A Library of Poetry*  
Hymn, Before Sunrise In the Vale of Chamouni, l. 41–46  
J.B. Ford & Company. New York, New York, USA. 1874

**Confucius** 551 BCE–479 BCE  
Chinese philosopher and reformer

Men of practical knowledge find their gratification among rivers.

In Lionel Giles (ed.)  
*The Analects of Confucius*  
Chinese University Press. Hong Kong. 1983

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

Going up that river was like travelling back to the earliest beginnings of the world, when vegetation rioted on the earth and the big trees were kings.

*Youth: And Two Other Stories*  
*Heart of Darkness*  
Chapter II (pp. 92–93)  
Doubleday, Doran & Co., Inc. Garden City, New York, USA. 1928



**Dyer, John** 1700?–58  
Welsh clergyman and poet

And see the rivers how they run  
Through woods and meads, in shade and sun,  
Sometimes swift, sometimes slow, –  
Wave succeeding wave, they go  
A various journey to the deep,  
Like human life to endless sleep!

In Thomas Campbell  
*Specimens of the British Poets*  
Granger Hill, l. 93  
John Murray. London, England. 1841

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

I do not know much about gods; but I think that the river  
Is a strong brown god – sullen, untamed and intractable  
Patient to some degree, at first recognized as a frontier;  
Useful, untrustworthy as a conveyor of commerce;  
Then only a problem confronting the builder of bridges.  
The problem once solved, the brown god is almost forgotten

By the dwellers in cities – ever, however, implacable,  
Keeping his seasons and rages, destroyer, reminder  
Of what men choose to forget.

Unhonoured, unpropitiated

By worshippers of the machine.

*The Collected Poems and Plays 1909–1950*  
The Dry Salvages (p. 130)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The river knows the way to the sea:

Without a pilot it runs and falls,  
Blessing all lands with its charity.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
Woodnotes  
Part ii, Line 272 (p. 57)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fort, Charles** 1874–1932  
American writer

A river...is water expressing the gravitational relation of  
different levels.

*The Book of the Damned*  
Chapter III (p. 39)  
Boni & Liveright. New York, New York, USA. 1919

**Gilpin, Laura** 1891–1971  
American photographer

A river seems a magic thing. A magic, moving, living  
part of the very earth itself – for it is from the soil, both  
from its depth and from its surface, that a river has its  
beginning.

*The Rio Grande, River of Destiny* (p. xi)  
Duell, Sloan and Pearce. NEW York, New York, USA. 1949

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

It is as difficult for a river as for a man to get out of a  
groove.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter VIII (p. 279)  
The Macmillan Company. New York, New York, USA. 1893

**Maury, Matthew Fontaine** 1806–73  
American hydrographer and naval officer

There is a river in the ocean. In the severest droughts  
it never fails, and in the mightiest floods it never over-  
flows. Its banks and its bottoms are of cold water, while  
its current is of warm. The Gulf of Mexico is its foun-  
tain, and its mouth is in the Arctic Seas. It is the Gulf  
Stream. There is in the world no other such majestic flow  
of waters. Its current is more rapid than the Mississippi  
or the Amazon.

*The Physical Geography of the Sea*  
Chapter I (p. 25)  
Harper & Brothers. New York, New York, USA. 1855

**Muir, John** 1838–1914  
American naturalist

Tracing rivers to their fountains makes the most charm-  
ing of travels. As the life blood of the landscapes, the best  
of the wilderness comes to their banks, and not one dull  
passage is found in all their eventful histories.

*Steep Trails*  
Chapter V (p. 101)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Murray, Richard William**  
No biographical data available

It seems to me that the river is like a human life; it is  
going on without pausing for one moment, without the  
possibility of turning to retrace one step; straight on it  
must go in the way marked out for it, straight on to the  
ocean – the ocean of eternity.

*The Milners, Or, The River Diggings*  
Chapter XV (p. 126)  
Chapman & Hall, Ltd. London, England. 1891

**Palmer, Tim** 1948–  
No biographical data available

Rivers are exquisite in their abilities to nurture life, sub-  
lime in functioning detail, impressive in contributions of  
global significance.

*Lifelines: The Case for River Conservation*  
Chapter One (p. 10)  
Island Press. Washington, D.C. 1994

...rivers are magnets for the imagination, for conscious  
pondering and subconscious dreams, thrills, fears. People  
stare into the moving water, captivated, as they are when  
gazing into a fire. What is it that draws and holds us?

The rivers' reflections of our lives and experiences are endless.

*Lifelines: The Case for River Conservation*  
Chapter One (p. 8)  
Island Press. Washington, D.C. 1994

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Rivers are roads which move, and which carry us whither we desire to go.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section I, 17  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

A river, of which the course is both serpentine and deeply excavated in the rock, is among the phenomena by which the slow waste of the land, and also the cause of that waste, are most directly pointed out.

*Illustrations of the Huttonian Theory of the Earth*  
Section 101 (p. 104)  
Dover Publications, Inc. New York, New York, USA. 1964

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Rivers are the natural highways of all nations, not only leveling and removing obstacles from the path of the traveler – quenching his thirst – and bearing him on their bosom, but conducting him through the most interesting scenery of a country most rich in natural phenomena, through the most populous portions of the globe where the animal and vegetable kingdoms attain the greatest perfection.

In Robert Sattelmeyer (ed.)  
*Journal 1842–1848* Volume 2  
Tuesday (p. 30)  
Princeton University Press. Princeton, New Jersey, USA. 1984

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

The face of the water, in time, became a wonderful book... which told its mind to me without reserve, delivering its most cherished secrets as clearly as if it uttered them with a voice. And it was not a book to be read once and thrown aside, for it had a new story to tell every day.

*Life on the Mississippi*  
Chapter IX (p. 77)  
Harper & Row, Publishers. New York, New York, USA. 1951

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

These various-coloured waters may, we believe, readily be accounted for by the nature of the country the stream flows through. The fact that the most purely black-water

rivers flow through districts of dense forest, and have granite beds, seems to show that it is the percolation of the water through decaying vegetable matter which gives it its peculiar colour. Should the stream, however, flow through any extent of alluvial country, or through any districts where it can gather much light-coloured sedimentary matter, it will change its aspect, and we shall have the phenomenon of alternating white and black water rivers. The Rio Branco and most of its tributaries rise in an open, rocky country, and the water there is pure and uncoloured; it must, therefore, be in the lower part of its course that it obtains the sediment that gives it so remarkably light a colour; and it is worthy of note, that all the other white-water tributaries of the Rio Negro run parallel to the Rio Branco, and, therefore, probably obtain their sediment from a continuation of the same deposits; only as they flow entirely through a forest district producing brown water, the result is not such a strikingly light tint as in the case of that river.

*Journal of the Royal Geographical Society*, Volume 23, 1853 (p. 213)

**Walton, Izaak** 1593–1683  
English writer

**Cotton, Charles** 1630–87  
English writer and poet

And an ingenious Spaniard says, that “rivers and the inhabitants of the watery element were made for wise men to contemplate and fools to pass by without consideration.”

*The Complete Angler*  
Part I, First Day (p. 31)  
Routledge, Warnes & Routledge. London, England. 1859

## AFTON

**Burns, Robert** 1759–96  
English author

Flow gently, sweet Afton, Among thy green braes,

Flow gently, I'll sing thee a song in thy praise.

In Allan Cunningham (ed.)  
*The Works of Robert Burns*  
Afton Water  
Henry G. Bohn. London, England. 1845

## ALPH

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

In Xanadu did Kubla Khan  
A stately pleasure-dome decree;  
Where Alph, the sacred river ran,  
Through caverns measureless to man  
Down to a sunless sea.

In W.G.T. Shedd (ed.)  
*The Complete Works of Samuel Taylor Coleridge* Volume 7  
 Kubla Khan  
 Harper & Brothers Publishers. New York, New York, USA. 1884

## ARNO

**Akenside, Mark** 1721–70  
 English poet and physician

At last the Muses rose...And scattered...As they flew,  
 Their blooming wreaths from fair Valelusa's bowers  
 To Arno's myrtle border.

*Select Works of the British Poets* (10th edition)  
 The Pleasures of the Imagination  
 J. Wetham & Son. Philadelphia, Pennsylvania, USA. 1841

## AVON

**Webster, Daniel** 1782–1852  
 American statesman

The Avon to the Severn runs,  
 The Severn to the sea,  
 And Wickliff's dust shall spread abroad  
 Wide as the waters be.

In Edward Everett (ed.)  
*The Works of Daniel Webster* (Volume 2) 18th Festival of the Sons of  
 New Hampshire (p. 515) Co  
 Little, Brown, & Co. Boston, Massachusetts, USA. 1881

## AYR

**Burns, Robert** 1759–96  
 English author

Ayr, gurgling, kiss'd his pebbled shore,  
 O'erhung with wild woods, thick'ning green;  
 The fragrant birch and hawthorn hoar  
 Twin'd am'rous round the raptur'd scene.

In Robert Aris Willmott (ed.)  
*The Poetical Works of Robert Burns*  
 To Mary in Heaven  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1882

## BRONX

**Drake, Joseph Rodman** 1795–1820  
 American poet

Yet I will look upon thy face again,  
 My own romantic Bronx, and it will be  
 A face more pleasant than the face of men.  
 Thy waves are old companions ...

*The Culprit Fay*  
 Bronx  
 van Norden & King. New York, New York, USA. 1847

## CHATTAHOOCHEE

**Lanier, Sidney** 1842–81  
 American musician and poet

Out of the hills of Habersham,  
 Down the valleys of Hall,  
 I hurry amain to reach the plain;  
 Run the rapid and leap the fall,  
 Split at the rock, and together again  
 Accept my bed, or narrow or wide,  
 And flee from folly on every side  
 With a lover's pain to attain the plain,  
 Far from the hills of Habersham,  
 Far from the valleys of Hall.

In Mary Day Lanier (ed.)  
*Poems of Sidney Lanier*  
 Song of the Chattahoochee  
 Charles Scribner's Sons. New York, New York, USA. 1922

## CLYDE

**Park, Andrew**  
 No biographical data available

How sweet to move at summer's eve  
 By Clyde's meandering stream,  
 When Sol in joy is seen to leave  
 The earth with crimson beam;  
 When islands that wandered far  
 Above his sea couch lie,  
 And here and there some gem-like star  
 Re-opes its sparkling eye.

The Banks of Clyde

## COLORADO

**Abbey, Edward** 1927–89  
 American environmentalist and nature writer

Floating down a portion of Rio Colorado in Utah a rare  
 month in spring, twenty-two years ago, a friend and  
 I found ourselves passing through a world so beautiful  
 it seemed and had to be eternal. Such perfection of being,  
 we thought – these glens of sandstone, these winding cor-  
 ridors of mystery, leading each to its solitary revelation –  
 could not possibly be changed.

*Down the River*  
 Part IV, Chapter 19 (p. 231)  
 E.P. Dutton. New York, New York, USA. 1982

**Ives, Joseph Christmas** 1828–68  
 American soldier, botanist, and explorer

The region last explored [the Grand Canyon] is, of course,  
 altogether valueless. It can be approached only from the  
 south, and after entering it there is nothing to do but to  
 leave. Ours has been the first, and will doubtless be the

last...to visit this profitless locality. It seems intended by nature that the Colorado river, along the greater portion of its lonely and majestic way, shall be forever unvisited and undisturbed.

*Report Upon the Colorado River of the West*  
Chapter VIII (p. 110)  
Government Printing Office. Washington, D.C. 1861

**van Dyke, John Charles** 1856–1932  
American art historian and critic

You may see on the face of the globe numerous muddy Missouris, blue Rhones, and yellow Tibers; but there is only one red river and that is the Colorado.

*The Desert*  
Chapter IV (p. 66)  
Charles Scribner's Sons. New York, New York, USA. 1930

## DEE

**Tait, John** 1748–1817  
Poet

Flow on, lovely Dee, flow on, thou sweet river,  
Thy banks' purest stream shall be dear to me ever.

In James Grant Wilson (ed.)  
*The Poets and Poetry of Scotland: From Thomas Campbell to Marquis of Lorne* Volume 2  
The Banks of Dee  
Harper & Brothers Publishers. New York, New York, USA. 1876

## DOON

**Burns, Robert** 1759–96  
English author

Ye banks and braes o' bonny Doon,  
How can ye bloom sae fresh and fair;  
How can ye chant, ye little birds,  
And I sae weary fu' o' care!

*The Poetical Works of Robert Burns* (Volume 3)  
The Banks of Doon  
Little, Brown & Company. Boston, Massachusetts, USA. 1863

## DOVE

**Cotton, Charles** 1630–87  
English writer and poet

Oh, my beloved nymph, fair Dove,  
Princess of rivers, how I love  
Upon thy flowery banks to lie,  
And view thy silver stream,  
When gilded by a summer's beam!

In Jr. R. Tutin (ed.)  
*Poems*  
The Retirement. 34  
Published by the editor 1903

## ISAR

**Campbell, Thomas** 1777–1844  
Scottish poet

Oh Linden, when the sun was low,  
All bloodless lay the untrodden snow,  
And dark as winter was the flow  
Of Isar, rolling rapidly.

*The Poetical Works of Thomas Campbell: including Theodric Hohenlinden*  
J. Crissy & J. Grigg. Philadelphia, Pennsylvania, USA. 1835

## LEE

**Father Prout (Francis Mahoney)** 1804–66  
Irish humorist

On this I ponder  
Where'er I wander,  
And thus grow fonder,  
Sweet Cork, of thee, –  
With thy bells of Shandon,  
That sound so grand on  
The pleasant waters  
Of the river Lee.

In Daphne Dale (ed.)  
*Living Thoughts in Words That Burn, from Poet, Sage and Humorist*  
The Shandon Bells  
Elliott & Beezley. Philadelphia, Pennsylvania, USA. 1891

## NIAGARA

**Brooks, Maria** 1794–1845  
American poet

Niagara! Wonder of this western world,  
And half the world beside! Hail, beautiful queen  
Of cataracts!

*The Female Poets of America*  
To Niagara  
J.J. Little & Co. New York, New York, USA. 1878

## NILE

**Hunt, Leigh** 1784–1859  
English poet

It flows through old hushed Egypt and its sands,  
Like some grave mighty thought threading a dream.

In Leigh Hunt and Samuel Adams Lee (eds.)  
*The Book of the Sonnet* (Volume 1)  
The Nile  
Robert Brothers. Boston, Massachusetts, USA. 1867

## RHINE

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Beneath me flows the Rhine, and like the stream of Time,  
it flows amid the ruins of the Past.

*Hyperion*

Book I, Chapter III

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1883

## ROBOT

**Hey, Nigel S.** 1936–

American science writer

The craft is a space robot that is invested with the equivalents of eyes, ears, voice, and muscle. Each spacecraft takes with it the hopes and dreams of thousands of scientists and engineers and, most importantly, the special sense of wonder and imagination that is so great a part of human nature.

*Solar System*

Chapter 5 (p. 120)

Weidenfield & Nicolson. London, England. 2002

## ROBOTS, THREE LAWS OF

**Asimov, Isaac** 1920–92

American author and biochemist

One, a robot may not injure a human being, or through inaction, allow a human being to come to harm;

Two, a robot must obey the orders given it by human beings except where such orders would conflict with the First Law;

Three, a robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

*I Robot*

1950

## ROCK

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Rocks, like louseworts and snail darters and pupfish and third-world black, lesbian, feminist, militant poets, have rights, too. Especially the right to exist.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 86)

St. Martin's Press. New York, New York, USA. 1989

**Alvarez, Luis Walter** 1911–88

American experimental physicist

Rocks are the key to Earth history, because solids remember but liquids and gasses forget. Retrieving these long-lost memories is the business of geologists and paleontologists, of people who have chosen to be the historians of the Earth.

*T. Rex and the Crater of Doom*

Chapter I (p. 17)

Princeton University Press. Princeton, New Jersey, USA. 1997

## Author undetermined

There are no books like a rock,

And nothing looks like a rock;

There are no meals like a rock,

And nothing feels like a rock;

Nothing stays like a rock,

Or decays like a rock.

There is nothing wrong with any man here

That can't be cured by putting him near

A lithic, igneous, metamorphic, sedimentary rock.

Roquiescat (Sung to "There Is Nothing Like a Dame")

*The Pick and Hammer Club*, Washington, D.C., May 2, 1952

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Rocks are the graveyards of the past, and the student of fossil shells and bones sees the grim phenomenon in every guise.

*Parade of the Living*

Part III, Chapter XVII (p. 238)

Coward-McCann, Inc. New York, New York, USA. 1930

**Burroughs, John** 1837–1921

American naturalist and writer

Even if we do not know our geology, there is something in the face of a cliff and in the look of a granite boulder that gives us pause and draws us thitherward in our walk. We linger beneath the cliff, or muse and dream amid its ruins as amid the ruins of some earth temple; we pause beside the huge boulder, or rest upon it and survey the landscape from its coign of vantage; we lay our hand upon it as upon some curious relic from a world that we know not of. The elemental, the primordial, the silence of ages, the hush and repose of a measureless antiquity look out upon us from the face of the rocks.

*Under the Apple-Trees*

Chapter II (p. 41)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

Rocks have literally come down to us from a foreworld. The youth of the earth is in the soil and in the trees and verdure that springs from it; its age is in the rocks; in the great stone book of the geologic strata its history is written. Even if we do not know our geology, there is something in the face of a cliff and in the look of a granite boulder that gives us pause and draws us thitherward in our walk.

*Under The Apple Tree*

The Friendly Rocks (pp. 40–41)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

Rocks do not recommend the land to the tiller of the soil, but they recommend it to those who reap a harvest of another sort – the artist, the poet, the walker, the student and lover of all primitive open-air things.

*The Writings of John Burroughs* (Volume 19)

Chapter II (p. 40)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

...its [the Earth's] age is in the rocks; in the great stone book of the geologic strata its history is written.

*The Writings of John Burroughs* (Volume 19)

Chapter II (pp. 40–41)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

Next to the trees, rocks are points of interest in the landscape. Slumbering here and there upon the turf, they enhance the sense of repose. How expressionless and uninteresting the landscape in one of the prairie States ...

*The Writings of John Burroughs* (Volume 19)

Chapter II (pp. 41–42)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

A landscape without rocks lacks something. Without the outcropping ledge, the faces of the hills lack eyebrows; without a drift boulder here and there, the fields lack the rugged elemental touch.

*Under the Apple-Trees*

Chapter II (p. 41)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

...they [rocks] are veterans of many battles; they have most of them marched in the ranks of vast stone brigades during the ice age; they have been torn from the hills, recruited from the mountain-tops, and marshaled on the plains and in the valleys; and now the elemental war is over, there they lie waging a gentle but incessant warfare with time, and slowly, oh, so slowly, yielding to its attacks!

*Under the Apple-Trees*

Chapter II (p. 42)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

The rocks have a history; gray and weather-worn, they are veterans of many battles; they have most of them marched in the ranks of vast stone brigades during the ice age; they have been torn from the hills, recruited from the mountain-tops, and marshaled on the plains and in the valleys; and now the elemental war is over, there they lie waging a gentle but incessant warfare with time, and slowly, oh, so slowly, yielding to its attacks!

*Under the Apple-Trees*

Chapter II (p. 42)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

### **Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

A final philosophy of the Earth's crust must be largely founded upon the unshakable facts known about igneous rocks.

*Igneous Rocks and the Depths of the Earth: Containing Some Revised Chapters of "Igneous Rocks and their Origin"*

Chapter I (p. 1)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1933

Rocks are like human beings; they will bend before force, if you give them time enough and are not too rough with them.

*Our Mobile Earth*

Chapter VI (p. 223)

Charles Scribner's Sons. New York, New York, USA. 1926

### **Darwin, Charles Robert** 1809–82

English naturalist

On first examining a new district nothing can appear more hopeless than the chaos of rocks; but by recording the stratification and nature of the rocks and fossils at many points, always reasoning and predicting what will be found elsewhere, light soon begins to dawn on the district, and the structure of the whole becomes more or less intelligible.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 52)

D. Appleton & Company. New York, New York, USA. 1896

### **de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

A rock pile ceases to be a rock pile the moment a single man contemplates it, bearing within him the image of a cathedral.

Translated by Bernard Lamotte

*Flight to Arras*

Chapter XXII (p. 219)

Reynal & Hitchcock. New York, New York, USA. 1942

### **Fort, Charles** 1874–1932

American writer

"I shall be scientific about it." Said Sir Isaac Newton – or virtually said he – "If there is no change in the direction of a moving body, the direction of a moving body is not changed." "But," continued he, "if something be changed, it is changed as much as it is changed." How do geologists determine the age of rocks? By the fossils in them. And how do they determine the age of fossils? By the rocks they're in. Having started with the logic of Euclid, I go on to the wisdom of Newton.

*The Books of Charles Fort*

Lo! (pp. 547–548)

Henry Holt & Company. New York, New York, USA. 1941

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The hips and elbows and other bones of Nature stick out here and there in the shape of rocks which give character to the scenery ...

*The Writings of Oliver Wendell Holmes*

*Pages from an Old Volume of Life*

Chapter II (p. 74)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1891

### **Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

A rock or stone is not a subject that, of itself, may interest a philosopher to study; but, when he comes to see



the necessity of those hard bodies, in the constitution of this earth, or for the permanency of the land on which we dwell, and when he finds that there are means wisely provided for the renovation of this necessary decaying part, as well as that of every other, he then, with pleasure, contemplates this manifestation of design, and thus connects the mineral system of this earth with that by which the heavenly bodies are made to move perpetually in their orbits.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter III (p. 276)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

### **Kingsley, Charles** 1819–75

English clergyman and author

These rocks, at least, tell me no lies, as men do.

*Alton Locke*

Chapter XVIII (p. 143)

Macmillan & Co Ltd. London, England. 1862

### **Le Guin, Ursula K.** 1929–

American writer of science fiction and fantasy

The first thing about rocks is, they're old.... Rocks are in time in a different way than living things are, even the ancient trees. But then, the other thing about rocks is that they are place. Rocks are what a place is made of to start with and after all.... The stone is at the center.

*Buffalo Gals and Other Animal Presences*

Capra Press. Santa Barbara, California, USA. 1987

### **LeConte, John** 1818–91

American physician and physicist

Here, then, we have the oldest known rocks. Are they, then, absolutely the oldest – the primitive rocks, as some imagine? By no means. They are stratified rocks, and therefore consolidated sediments, and therefore, also, the debris of still older rocks, of which we know nothing. Thus, we seek in vain for the absolutely oldest, the primitive crust.

*A Compend of Geology*

Part III, Chapter II (pp. 263–264)

American Book Company. New York, New York, USA. 1884

### **Levenson, Thomas**

No biographical data available

Rock is the ultimate historian – what it is, and what remnants it contain are the only records of what the earth was like through virtually its entire lifetime.

*Ice Time: Climate, Science, and Life on Earth*

Chapter 1 (p. 3)

Harper & Row, Publishers. New York, New York, USA. 1989

### **Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist

The stony rocks are not primeval, but daughters of Time.

*Systema Naturae*

Ed. 5, Stockholm, 1748 (p. 219)

### **Muir, John** 1838–1914

American naturalist

Patient observation and constant brooding above the rocks, lying upon them for years as the ice did, is the way to arrive at the truths which are graven so lavishly upon them.

In William Frederic Badé

*The Life and Letters of John Muir* (Volume 1)

Letter to Mrs. Ezra S. Carr, October, 1871 (p. 300)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1924

...all the rocks seemed talkative, and more telling and lovable than ever. They are dear friends, and seemed to have warm blood gushing through their granite flesh; and I love them with a love intensified by long and close companionship.

*Steep Trails*

Chapter II (p. 19)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

### **O'Keefe, J. A.**

No biographical data available

Liquids and gases forget, but rocks remember.

In G. Brent Dalrymple

*The Age of the Earth*

Chapter 7 (p. 305)

Stanford University Press. Stanford, California, USA. 1991

### **Read, Herbert Harold** 1899–1970

English geologist

### **Watson, Janet**

No biographical data available

...the best geologist is the one who has seen the most rocks.

*Beginning Geology*

Preface

Macmillan & Company Ltd. London, England. 1966

### **Seward, A. C.** 1863–41

No biographical data available

Rocks are the source-books of geological history...

*Plant Life Through the Ages*

Chapter II (p. 5)

Hafner Publishing Company. New York, New York, USA. 1959

### **von Bubnoff, S.**

No biographical data available

The materials from which the geologist draws his conclusions are rocks.

*Fundamentals of Geology*

Chapter II (p. 12)

Oliver & Boyd. Edinburgh, Scotland. 1963

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The Record of the Rocks is like a great book that has been carelessly misused. All its pages are torn, worn, and defaced, and many are altogether missing.

*The Outline of History* (Volume 1)  
Book I, Chapter III, Section 3 (p. 29)  
Garden City Books. Garden City, New York, USA. 1961

**White, Bailey** 1950–  
American writer

My Aunt Belle loves rocks. Her whole house used to be filled with rocks. Every flat surface was covered with slabs of amethyst crystal, piles of rainbow-colored labradorite, bowls full of fossilized sharks' teeth as big as a child's hand, and agate geodes lined with quartz crystals.... Every afternoon my Aunt Belle takes a bagful of rocks down to Shoney's Restaurant where she spreads them out on the Formica tabletop and says incantations over them while she drinks iced tea.

*Sleeping at the Starlite Motel and Other Adventures on the Way Back Home*  
Rocks (p. 63)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

## ROCK FORMATIONS

**Lapworth, Charles** 1842–1920  
English Geologist

It is as true now, as it was in the days when Werner first drew his far-reaching inferences before his charmed listeners, that on the characteristic phenomena and varying distribution of the grand mineral masses of the rock-formations, almost all that concerns the relative habitability of a land depends.

*The Relations of Geology*  
*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1902 (p. 409)

## ROCK PILE

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

A rock pile ceases to be a rock pile the moment a single man contemplates it, bearing within him the image of a cathedral.

*Flight to Arras* (p. 129)  
Harcourt, Brace & Co. Orlando, Florida, USA. 1942

## ROCKS, MOTION OF

**Burroughs, John** 1837–1921  
American naturalist and essayist

It is hard even for the rocks to keep still in this world of motion, but it takes the hour-hand of many years to mark their progress.

*The Writings of John Burroughs* (Volume 19)  
Chapter II (p. 42)  
Houghton, Mifflin. Boston, Massachusetts, USA. 1916

When a rock, loosened from its ties in the hills, once becomes a wanderer, it is restless ever after, and stirs in its sleep. Heat and cold expand and contract it, and make it creep down an incline. Hitch your rock to a sunbeam, and come back in a hundred years, and see how much it has moved.

*The Writings of John Burroughs* (Volume 19)  
Chapter II (p. 42)  
Houghton, Mifflin. Boston, Massachusetts, USA. 1916

I know a great platform of rock weighing hundreds of tons, and large enough to build a house upon, that has slid down the hill from the ledges above, and that is pushing a roll of turf before it as a boat pushes a wave, but stand there till you are gray, and you will see no motion; return in a century, and you will doubtless find that the great rock raft has progressed a few inches. What a sense of leisure such things give us hurrying mortals!

*The Writings of John Burroughs* (Volume 19)  
Chapter II (p. 43)  
Houghton, Mifflin. Boston, Massachusetts, USA. 1916

## ROCKET

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

We do not have to wait until someone produces “anti-gravity” before we can travel to the planets: the means is already at hand. It is the rocket.

*The Exploration of Space*  
Chapter 2 (p. 16)  
Harper & Brothers Publishers. New York, New York, USA. 1951

The crossing of space... may do much to turn men's minds outwards and away from their present tribal squabbles. In this sense, the rocket, far from being one of the destroyers of civilisation, may provide the safety-value that is needed to preserve it.”

*The Exploration of Space*  
Chapter 18 (p. 194)  
Harper & Brothers Publishers. New York, New York, USA. 1951

We stand now at the turning point between two eras. Behind us is a past to which we can never return.... The coming of the rocket brought to an end a million years of isolation... the childhood of our race was over and history as we know it began.

*The Exploration of Space*  
Chapter 18 (p. 195)  
Harper & Brothers Publishers. New York, New York, USA. 1951

**Goddard, Robert H.** 1882–1945  
American physicist

... I still seem to be alone in my enthusiasm for liquid-fueled rockets, but have a hunch that the time is coming when a good many will want to get aboard the bandwagon...

*The Papers of Robert H. Goddard* (Volume 3)  
R.H. Goddard to T.E. Thompson

March 7, 1941 (p. 1386)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Woolley, Richard** 1906–1986  
 Astronomer Royale of England

The whole procedure [of shooting rockets into space]... presents difficulties of so fundamental a nature, that we are forced to dismiss the notion as essentially impracticable, in spite of the author's insistent appeal to put aside prejudice and to recollect the supposed impossibility of heavier-than-air flight before it was actually accomplished.

Reviewing P.E. Cleator's "Rockets in Space"  
*Nature*, March 14, 1936

## ROCKFALL

**Muir, John** 1838–1914  
 American naturalist

The sound was inconceivably deep and broad and earnest, as if the whole earth, like a living creature, had at last found a voice and were calling to her sister planets.

*Our National Parks*  
 Chapter VIII (p. 263)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## ROTATION, DIURNAL

**Herschel, Friedrich Wilhelm (Sir William)** 1738–1822  
 English astronomer

The reason why this [diurnal motion] has not been looked into is probably the difficulty of finding a proper standard to measure it by; since it is itself the standard by which we measure all the other motions.

Astronomical Observations on the Rotation of the Planets Round their Axes made with a View to determine whether the Earth's Diurnal Motion is perfectly Equable  
*Philosophical Transactions of the Royal Society of London*, Volume 71, 1781 (p. 116)

While every one of the motions of the earth that arise from the actions of the sun, moon, and planets, etc., have been investigated by astronomers, there is one motion which has hitherto escaped the scrutiny of observers – the diurnal rotation round its axis.

Astronomical Observations on the Rotation of the Planets Round their Axes made with a View to determine whether the Earth's Diurnal Motion is perfectly Equable  
*Philosophical Transactions of the Royal Society of London*, Volume 71, 1781 (p. 115)

## ROTATION OF EARTH

**Archimedes of Syracuse** 287 BCE–212 BCE  
 Sicilian mathematician

But Aristarchus of Samos brought out a book consisting of certain hypotheses, in which the premises lead to the

conclusion that the universe is many times greater than that now so called. His hypotheses are that the fixed stars and the sun remain motionless, that the earth revolves about the sun in the circumference of a circle, the sun lying in the middle of the orbit, and that the sphere of the fixed stars, situated about the same center as the sun, is so great that the circle in which he supposes the earth to revolve bears such a proportion to the distance of the fixed stars as the center of the sphere bears to its surface.

In *Great Books of the Western World* (Volume 11)  
*The Sand-Reckoner* (p. 520)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

Nevertheless, in the system of Copernicus there are found many and great inconveniences; for both the loading of the earth with a triple motion is very incommodious, and the separation of the sun from the company of the planets, with which it has so many passions in common, is likewise a difficulty, and the introduction of so much immobility in nature, by representing the sun and stars as immovable, especially being of all bodies the highest and most radiant, and making the moon revolve about the earth in an epicycle, and some other assumptions of his, are the speculations of one who cares not what fictions he introduces into nature, provided his calculations answer.

*Descriptio Globi Intellectualis*  
 Source undetermined

**Blundeville, Thomas** fl. 1561  
 English author

Some also deny that the earth is in the midst of the world, and some affirm that it is moveable, as also Copernicus by way of supposition, and not for that he thought so in deede: who affirmeth that the earth turneth about, and that the sunne standeth still in the midst of the heavens, by help of which false supposition he hath made truer demonstrations of the motions and revolutions of the celestiall Sphaeres, than ever were made before...

*M. Blundeville His Exercises*  
 Source undetermined

**Brahe, Tycho** 1546–1601  
 Danish astronomer

If Nicolaus Copernicus, the distinguished and incomparable master, in this work had not been deprived of exquisite and faultless instruments, he would have left us this science far more well-established. For he, if anybody, was outstanding and had the most perfect understanding of the geometrical and arithmetical requisites for building up this discipline. Nor was he in any respect inferior to Ptolemy; on the contrary, he surpassed him greatly in certain fields, particularly as far as the device of fitness and compendious harmony in hypotheses is concerned. And his apparently absurd opinion that the Earth revolves

does not obstruct this estimate, because a circular motion designed to go on uniformly about another point than the very center of the circle, as actually found in the Ptolemaic hypotheses of all the planets except that of the Sun, offends against the very basic principles of our discipline in a far more absurd and intolerable way than does the attributing to the Earth one motion or another which, being a natural motion, turns out to be imperceptible. There does not at all arise from this assumption so many unsuitable consequences as most people think.

Letter to Christopher Rothman, January 20, 1587  
Source undetermined

**Plutarch** 46–119  
Greek biographer and author

Some think that the earth remains at rest. But Philolaus the Pythagorean believes that, like the sun and moon, it revolves around the fire in an oblique circle. Heraclides of Pontus and Ecphantus the Pythagorean make the earth move, not in a progressive motion, but like a wheel in rotation from west to east around its own center.

In Nicholas Copernicus  
*On the Revolutions of the Heavenly Spheres*  
Preface (p. 508)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## RUIN

**Macaulay, Rose** 1881–1958  
English writer

Of all ruins, possibly the most moving are those of long-deserted cities, fallen century by century into deeper decay, their forsaken streets grown over by forest and shrubs, their decadent buildings quarried and plundered down the years, gaping ruinous, the haunts of lizards and owls...the marble and gold of palaces, the laurel and jasmine of gardens, are now brambles and lagoons; the house built for Caesar is now dwelt in by lizards....

*Pleasure of Ruins*  
Chapter III (p. 255)  
Walker & Company. New York, New York, USA. 1953

## RULE

**Arnheim, Rudolf** 1904–  
German-born author, film theorist, and psychologist

An orgy of self-expression is no more productive than blind obedience to rules.

*Art and Visual Perception*  
Introduction (p. vii)  
University of California Press. Berkeley, California, USA. 1957

**Burton, Robert** 1577–1640  
English clergyman and scholar

No rule is so general, which admits not some exception...

*The Anatomy of Melancholy* (Volume 1)  
Part I, Sect. II, Memb. II, Subsec. 3 (p. 264)  
AMS Press, Inc. New York, New York, USA. 1973

**de Cervantes, Miguel** 1547–1616  
Spanish novelist, playwright, and poet

There is no rule without an exception.  
In *Great Books of the Western World* (Volume 29)  
*The History of Don Quixote de la Mancha*  
Part II, Chapter 18 (p. 258)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

...given any rule, however “fundamental” or “necessary” for science, there are always circumstances when it is advisable not only to ignore the rule, but also to adopt its opposite.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 1 (p. 23)  
Verso. London, England. 1978

**Feynman, Richard P.** 1918–88  
American theoretical physicist

...the fact that there are rules at all to be checked is a kind of miracle; that it is possible to find a rule, like the inverse square law of gravitation, is some sort of miracle. It is not understood at all, but it leads to the possibility of prediction – that means it tells you what you would expect to happen in an experiment you have not yet done.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter 1 (p. 23)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Galsworthy, John** 1867–1933  
English novelist and dramatist

KEITH: ...I don't see the use in drawin' hard and fast rules. You only have to break 'em.

*Eldest Son*  
Act I, Scene 2 (p. 13)  
Charles Scribner's Sons. New York, New York, USA. 1913

**Gardner, Martin** 1914–  
American writer and mathematics games editor

I shall add only the fantasy that God or Nature may be playing thousands, perhaps a countless number, of simultaneous Eleusis games [card games with secret rules] with intelligences on planets in the universe...Prophets and False Prophets come and go, and who knows when one round will end and another begin? Searching for any kind of truth is an exhilarating game. It is worth remembering that there would be no game at all unless the rules were hidden.

*Mathematical Games*  
*Scientific American*, Volume 237, Number 4, October, 1977 (p. 25)

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

A rule always presupposes a repetition.

Translated by Thomas J. McCormack  
*Popular Scientific Lectures* (2nd edition)  
The Economical Nature of Physical Inquiry (p. 91)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Norton, Robert** 1875–1932  
No biographical data available

...every Art hath certain Rules and Principles...without the knowledge of which no man can attain unto a necessary perfection for practice thereof....

*The Gunner*  
The Preface to the Courteous Readers (second page)  
J. Long. London, England. 1928

**Spencer, Herbert** 1829–1903  
English social philosopher

General truths to be of due and permanent use, must be earned. "Easy come easy go," is a saying as applicable to knowledge as to wealth. While rules, lying isolated in the mind – not joined to its other contents as outgrowths from them – are continually forgotten, the principles which those rules express piecemeal, become, when once reached by the understanding, enduring possessions.

*Education: Intellectual, Moral, and Physical*  
Chapter II (p. 104)  
D. Appleton & Co. New York, New York, USA. 1891

**Wilson, John** 1626–96  
No biographical data available

...the Exception proves the Rule.

*The Cheats*  
Appendix, The Author to the Reader, l. 27  
W. Patterson. Edinburgh, Scotland. 1874

## RULE OF THUMB

**Huxley, Thomas Henry** 1825–95  
English biologist

The practical men believed that the idol whom they worship – rule of thumb – has been the source of the past

prosperity, and will suffice for the future welfare of the arts and manufactures.

Science and Culture.  
*Nature*, Volume 22, October 7, 1880

## RULES

**Singer, Kurt** 1886–1962  
German economist and philosopher

...the true mathematician and physicist know very well that the realms of the small and the great often obtain quite different rules.

*Mirror, Sword and Jewel: A Study of Japanese Characteristics*  
The Law of Small Numbers (p. 75)  
Routledge. London, England. 1997

## RUST

**Chaucer, Geoffrey** 1343–1400  
English poet

If gold ruste, what shal iren do?

In *Great Books of the Western World* (Volume 22)  
*The Canterbury Tales*  
Prologue  
The Parson, l. 50  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kreutzberg, E. C.**  
No biographical data available

Rust and corrosion mean an enormous loss to Americans, greater than that caused by fire and flood combined, a loss of at least one billion dollars a year. Rust is a skin disease. Corrosion is an infectious internal disease like tuberculosis.

Nickel-Chromium Steels More Widely Used  
*Iron Trade Review*, Volume 86, Number 16, April 17, 1930

**Tennyson, Alfred (Lord)** 1809–92  
English poet

How dull it is to pause, to make an end,  
To rust unburnish'd, not to shine in use.

*Alfred Tennyson's Poetical Works*  
Ulysses, l. 22–23  
Oxford University Press, Inc. London, England. 1953

## S

### SACCHARIN

**Remsen, Ira** 1846–1927

American chemist and university president

Any practical man would unhesitatingly have condemned the work [a complicated chemical investigation] as being utterly useless, and I may add that some did condemn it. There was no hope, no thought entertained by us that anything practical would come of it. But lo! one day it appeared that one of the substances discovered in the course of the investigation is the sweetest thing on earth; and then it was shown that it can be taken into the system without injury; and finally that it can be manufactured at such a price as to furnish sweetness at a cheaper rate than it is furnished by the sugar cane or the beet. And soon a great demand for it was created, and today it is manufactured in surprising quantities and used extensively in all corners of the globe.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter IX (p. 253)

Macmillan & Co Ltd. London, England. 1916

### SAFETY

**Agricola, Georgius** 1494–1555

German mineralogist

...there is no compensation which should be thought great enough to equalize the extreme dangers [in mining] to safety and life.

Translated by Herbert Hoover and Lou Henry Hoover

*De Re Metallica*

Book I (p. 6)

The Mining magazine

London, England. 1912

### SAGACITY

**Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

I picture the vast realm of the sciences as an immense landscape scattered with patches of dark and light. The goal towards which we must work is either to extend the boundaries of the patches of light, or to increase their number. One of these tasks falls to the creative genius; the other requires a sort of sagacity combined with perfectionism.

In D. Adams (ed.)

*Thoughts on the Interpretation of Nature and Other Philosophical Works*

Section XIV (p. 42)

Clinamen Press. Manchester, England. 1999

**Locke, John** 1632–1704

English philosopher and political theorist

Those intervening ideas, which serve to show the agreement of any two others, are called proofs; and where the agreement or disagreement is by this means plainly and clearly perceived, it is called demonstration; it being shown to the understanding, and the mind made to see that it is so. A quickness in the mind to find out these intermediate ideas (that shall discover the agreement or disagreement of any other), and to apply them right, is, I suppose, that which is called sagacity.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book VI, Chapter II, Section 3 (p. 310)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whewell, William** 1794–1866

English philosopher and historian

The Conceptions by which Facts are bound together, are suggested by the sagacity of discoverers. This sagacity cannot be taught. It commonly succeeds by guessing; and this success seems to consist in framing several tentative hypotheses and selecting the right one. But a supply of appropriate hypotheses cannot be constructed by rules, nor without inventive talent.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, VIII (pp. 467–468)

John W. Parker. London, England. 1847

### SAMPLE

**Bell, Joseph Asbury** 1904–68

American physician

The first problem was that of locating for observation a group of children to be vaccinated, identical, in all attributes, which might influence the occurrence and recognition of pertussis, with another group to receive no vaccine. It is impossible to select such identical groups because many of the attributes involved are not known, and many of those that are known cannot be quantitatively assessed; and, furthermore, even if such attributes could be made identical in the two groups at any one moment, they would not remain identical throughout the time necessary for adequate observation. Some attributes without apparent influence on the results may under certain circumstances be of real importance.... The only practical approach appeared to rest in the selection of two groups, each of which is a random sample of the combined groups in the exact sense of the word.

*Public Health Report*

Pertussis prophylaxis with two doses of alum-precipitated vaccine

Report 56, 1941



**Bloch, Arthur** 1948–  
American humorist

After painstaking and careful analysis of a sample, you are always told that it is the wrong sample and doesn't apply to the problem.

*Murphy's Law*

Fourth Law of Revision (p. 48)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Cochran, William G.** 1909–80  
Scottish-born American statistician

Our knowledge, our attitudes, and our actions are based to a very large extent on samples.

*Sampling Techniques* (p. 1)

John Wiley & Sons. New York, New York, USA. 1953

A person's opinion of an institution that conducts thousands of transactions every day is often determined by the one or two encounters which he has had with the institution in the course of several years.

*Sampling Techniques* (p. 1)

John Wiley & Sons. New York, New York, USA. 1953

**Cochran, William G.** 1909–80  
Scottish-born American statistician

**Mosteller, Frederick** 1916–2006  
American statistician

In 1905, a physicist measuring the thermal conductivity of copper would have faced, unknowingly, a very small systematic error due to the heating of his equipment and sample by the absorption of cosmic rays, then unknown to physics. In early 1946, an opinion poller, studying Japanese opinion as to who won the war, would have faced a very small systematic error due to the neglect of the 17 Japanese holdouts, who were discovered later north of Saipan. These cases are entirely parallel. Social, biological and physical scientists all need to remember that they have the same problem, the main difference being the decimal place in which they appear.

*Principles of Sampling*

*Journal of the American Statistical Association*, Volume 49, 1954 (p. 31)

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

Sampling is the science and art of controlling and measuring the reliability of useful statistical information through the theory of probability.

*Some Theory of Sampling* (p. 3)

John Wiley & Sons. New York, New York, USA. 1950

If the cost of classifying a sampling unit were zero, one could always safely recommend fantastic plans of stratified sampling, with no worry about costs. The fact is, though, that there is always a price to pay...

*Sample Design in Business Research* (p. 320)

John Wiley & Sons. New York, New York, USA. 1960

A good sample-design is lost if it is not carried out according to plans.

*Some Theory of Sampling* (p. 241)

John Wiley & Sons. New York, New York, USA. 1950

**Diconis, Persi** 1945–  
American mathematician

**Mosteller, Frederick** 1916–2006  
American statistician

The law of truly large numbers states: With a large enough sample, any outrageous thing is likely to happen.

*Methods for Studying Coincidences*

*Journal of the American Statistical Association*, Volume 84, 1989 (p. 859)

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

I've got a little list – I've got a little list...

I've got him on the list...

They never would be missed – they never would be missed!

*The Complete Plays of Gilbert and Sullivan*

The Mikado

Act I

The Modern Library. New York, New York, USA. 1936

**Gissing, George** 1857–1903  
English novelist

He pointed to a heap of five or six hundred letters, and laughed consumedly.

"Impossible to read them all, you know. It seemed to me that the fairest thing would be to shake them together, stick my hand in, and take our one by chance. If it didn't seem very promising, I would try a second time."

*New Grub Street*

The Way Hither (p. 62)

The Modern Library. New York, New York, USA. 1926

**Jevons, William Stanley** 1835–82  
English economist and logician

To prove the exact similarity of two portions of commodity, we need not bring one portion beside the other. It is sufficient that we take a sample which exactly represents the texture, appearance, and general nature of one portion, and according as this sample agrees or not with the other, so will the two portions of commodity agree or differ. Whatever is true as regards the colour, texture, density, material of the sample will be true of the goods themselves.

*The Principles of Science: A Treatise on Logic and Scientific Method* (2nd edition)

Chapter I (p. 9)

Macmillan & Co Ltd. London, England. 1877

**McNemar, Quinn** 1900–86  
American statistician

One does not have to read much of the current research literature in psychology, particularly in individual and social psychology, to realize that there exists a great deal of confusion in the minds of investigators as to the necessity of obtaining a truly representative sample, describing carefully how the sample was secured, and restricting generalizations to the universe, often ill-defined, from which the sample was drawn.

Sampling in Psychological Research

*Journal of the American Statistical Association*, Volume 37, Number 6, June, 1940 (p. 33)

### Medical Research Council

Determination of whether a patient would be treated by streptomycin and bed-rest (S case) or by bed-rest alone (C case) was made by reference to a statistical series based on random sampling numbers drawn up for each sex at each centre by Professor Bradford Hill; the details of the series were unknown to any of the investigators or to the co-ordinator and were contained in a set of sealed envelopes, each bearing on the outside only the name of the hospital and a number. After acceptance of a patient by the panel, and before admission to the streptomycin centre, the appropriate numbered envelope was opened at the central office; the card inside told if the patient was to be an S or a C case, and this information was then given to the medical officer of the centre.... It was important for the success of the trial that the details of the control scheme remain confidential.

Medical Research Council. Streptomycin treatment of pulmonary tuberculosis: a Medical Research Council investigation  
*British Medical Journal*, Volume 2, 1948

**Mosteller, Frederick** 1916–2006  
American statistician

...weighing a sample appropriately is no more fudging the data than is correcting a gas volume for barometric pressure.

Principles of Sampling

*Journal of the American Statistical Association*, Volume 49, Number 265, 1964 (p. 33)

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Supposing you got a crate of oranges that you opened, and you found all the top layer of oranges bad, you would not argue, 'The underneath ones must be good, so as to redress the balance'; You would say, 'Probably the whole lot is a bad consignment'; and that is really what a scientific person would say about the universe.

In Louis Greenspan and Stefan Anderson

*Russell on Religion: Selections from the Writings of Bertrand Russell*  
Why I Am Not A Christian (p. 84)  
Routledge. London, England. 1999

**Slonim, Morris James**  
No biographical data available

Everyone who has poured a highball into the nearest potted plant after taking one sip has had some experience in sampling.

*Sampling in a Nutshell* (p. 1)

Simon & Schuster. New York, New York, USA. 1960

Sampling is only one component, but undoubtedly the most important one, of that broad based field of scientific method known as statistics.

*Sampling in a Nutshell* (p. 7)

Simon & Schuster. New York, New York, USA. 1960

### SAMPLE SELECTION

**Fibiger, Johannes Andreas Grib** 1867–1928  
Danish pathologist

In many cases a trustworthy verdict can only be reached when a large number of randomly selected patients are treated with the new remedy and, at the same time, an equally large number of randomly selected patients are treated as usual.

The Controlled Clinical Trial Turns 100 Years: Fibiger's Trial of Serum Treatment of Diphtheria

*British Medical Journal*, Volume 317, October 31, 1998 (p. 1244)

### SAND

**Carson, Rachel** 1907–64  
American marine biologist and author

Sand is a substance that is beautiful, mysterious, and infinitely variable; each grain on a beach is the result of processes that go back into the shadowy beginnings of life, or of the earth itself.

*The Edge of the Sea*

Chapter IV (p. 125)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

### Charlie Chan (Fictional character)

Earthquake may shatter the rock, but sand upon which rock stood, in same old place.

*Dark Alibi*

Film (1946)

**Cronstedt, Axel Fredrik** 1722–65  
Swedish chemist and mineralogist

Sand in reality is nothing else than very small stones...

Translated by Gustav von Engeström

*An Essay Towards a System of Mineralogy* (Volume 1) (p. xxiii)

Printed for Charles Dilly. London, England. 1788

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

From a few elevated points we triangulate vast spaces, inclosing infinite unknown details. We cast the lead, and

draw up a little sand from abysses we may never reach with our dredges.

*The Writings of Oliver Wendell Holmes* (Volume 9)

*Medical Essays: 1842–1882*

Chapter IV (p. 211)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

**McCord, David** 1897–1997

American poet

A handful of sand is an anthology of the universe...

*Once and For All*

Once and For All (p. 1)

Coward-McCann. New York, New York, USA. 1929

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

We cannot look at a grain of sand, insignificant as it may seem, without seeing in its composition the material which enables us to read the golden record of the heavens.

*Nature and Culture*

Chapter III (p. 129)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**Simon, Anne W.**

No biographical data available

The end product, rock's irreducible minimum, is sand. Hold it in your hands and you are in touch with the planet's essence. Each grain has been part of the Earth's solid crust at one time or another, eventually to be freed from rock to exist as a grain again, its particular structure intact.

*The Thin Edge: Coast and Man in Crisis*

Chapter 2 (pp. 17–18)

Harper & Row, Publishers. New York, New York, USA. 1978

**van Dyke, John Charles** 1856–1932

American art historian and critic

The shifting sands! Slowly they move, wave upon wave, drift upon drift; but by day and by night they gather, gather, gather. They overwhelm, they bury, they destroy, and then a spirit of restlessness seizes them and they move off elsewhere, swirl upon swirl, line upon line, in serpentine windings that enfold some new growth or fill in some new valley in...

*The Desert*

Chapter II (p. 28)

Charles Scribner's Sons. New York, New York, USA. 1930

## SANITATION

**Sonneberg, Walter**

No biographical data available

Sanitation curiously enough, may push sanity to the extreme.

*Social Eccentricities*

Social Eccentricities (p. 11)

Broadway Publishing Co. New York, New York, USA. 1906

## SATELLITE

**van Allen, James** 1914–2006

American space scientist

The satellite is a natural extension of rockets, which are natural extensions of planes and balloons, which are natural extensions of man's climbing trees and mountains in order to get up higher and thus have a better view.

Science: Reach Into Space

*Time*, May 4, 1959

## SAVANT

**Richet, Charles** 1850–1935

French physiologist

For the savant, Science must be a religion. Everything that is discovered, be it great or small, has its origin in this faith.

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter VI (p. 47)

J.M. Dent & Sons Ltd. London, England. 1927

## SAY WHAT

**Carey, Henry** 1687–1743

English poet and songwriter

Aldeborontiphoscophornio! Where left you Chrononhotonthologos?

*Chrononhotonthologos*

Act I, sc. I

London, England.

## Oswald, Felix Leopold

Our nearest relatives in the large family of the animal kingdom are undoubtedly the frugivorous four-handers, with some of their nocturnal congeners, but it would be difficult to classify the *Quadrumana* after the degree of that relationship: no naturalist could name the most man-like ape.

*Zoological Sketches*

Chapter I (p. 21)

W.H. Allen & Co. London, England. 1883

## SCATTERING

**Rutherford, Ernest** 1871–1937

English physicist

It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you. On consideration, I realized that this scattering backward must be the result of a single collision, and when I made calculations I saw that it was

impossible to get anything of that order of magnitude unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus. It was then that I had the idea of an atom with a minute massive center carrying a charge.

In Joseph Needham and W. Pagel (ed.)

*Background to Modern Science*

From Aristotle to Galileo

The Development of the Theory of Atomic Structure (p. 68)

The Macmillan Company. New York, New York, USA. 1938

## SCAVENGER

**Austin, Mary Hunter** 1868–1934

American novelist and essayist

Once at Red Rock, in a year of green pasture, which is a bad time for the scavengers, we saw two buzzards, five ravens, and a coyote feeding on the same carrion, and only the coyote seemed ashamed of the company.

*The Land of Little Rain*

The Scavengers (pp. 53–54)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

## SCENERY

**Muir, John** 1838–1914

American naturalist

The scenery is mostly of a comfortable, assuring kind, grand and inspiring without too much of that dreadful overpowering sublimity and exuberance which tend to discourage effort and cast people into inaction and superstition.

*Steep Trails*

Chapter XXI (p. 272)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## SCHOLAR

**Everett, Edward** 1794–1865

Whig Party politician

Calm and pure the satisfactions of the scholar, who, aloof from the competitions and the prizes, the mean jealousies, the hollow pretences, the brutal vilifyings, the base intrigues, the measureless corruptions of public life, holds converse in his inoffensive seclusion with the unenviable wise and gifted of every country and every age.

*Inauguration of Washington University at Saint Louis, Missouri.*

April 23, 1857

Mr. Everett's Inaugural Address on Academical Education (p. 76)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

## SCHOOL

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

A school may be regarded as a single individual who talks to himself for a hundred years, and takes an extraordinary pleasure in his own being, however, foolish and silly it may be.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#569 (p. 198)

The Macmillan Co. New York, New York, USA. 1906

## SCHOOLMASTER

**Goldsmith, Oliver** 1728–74

Anglo-Irish writer, poet, and physician

Let schoolmasters puzzle their brain...

*Poetical Works*

Song

William Pickering. London, England. 1839

## SCIENCE

**Abbey, Edward** 1927–89

American environmentalist and nature writer

That which today calls itself science gives us more and more information, an indigestible glut of information, and less and less understanding.

*Down the River*

Part I

Down the River with Henry Thoreau

November 7, 1980 (p. 29)

E.P. Dutton & Company. New York, New York, USA. 1982

**Adams, Henry Brooks** 1838–1918

American man of letters

No sand-blast of science had yet skimmed off the epidermis of history, thought, and feeling.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter VI (p. 90)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

Man has mounted science, and is now run away with. I firmly believe that before many centuries more, science will be the master of man. The engines he will have invented will be beyond his strength to control. Someday science may have the existence of mankind in its power, and the human race commit suicide by blowing up the world.

In Worthington Chauncey Ford

*A Cycle of Adams Letters, 1861–1865* (Volume 1)

Letter to Charles Francis Adams, Jr. (p. 135)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1920

**Adler, Mortimer Jerome** 1902–2001

American educator, philosopher, and popular author

Science, like philosophy, differs from opinion in that the scientist looks upon disagreement as a condition which can always be remedied by an examination of the

evidence. But unlike philosophy, science is like opinion in that the scientist looks upon instability and fluctuation as a condition which is intrinsic to the nature of scientific achievement.

*Art and Prudence*

Part III, Chapter 9 (p. 249)

Longmans, Green. New York, New York, USA. 1978

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

...science cannot submit to dictation, it must build up what it seeks upon the premises which it finds.

*The Structure of Animal Life*

Lecture I (p. 2)

Sampson Low, Son & Marston. London, England. 1866

**Akenside, Mark** 1721–70

English poet and physician

Speak, ye, the pure delight, whose favour'd steps

The lamp of science, through the jealous maze

Of nature guides, when haply you reveal

Her secret honours.

*The Poetical Works of Mark Akenside*

The Pleasures of Imagination, Part II

Associated University Presses. Cranbury, New Jersey, USA. 1996

**Alfvén, Hannes** 1908–95

Swedish physicist

The center of gravity of the physical sciences is always moving. Every new discovery displaces the interest and the emphasis.

*Les Prix Nobel. The Nobel Prizes in 1970*

Plasma Physics, Space Research and the Origin of the Solar System (p. 306)

Nobel Foundation. Stockholm, Sweden. 1971

**Alighieri, Dante** 1265–1321

Italian poet and writer

...no Science demonstrates its own subject, but presupposes it.

*The Convivio of Dante Alighieri*

The Second Treatise, Chapter XIV (p. 114)

J.M. Dent & Sons Ltd. London, England. 1912

**Allport, Susan** 1950–

Naturalist and science writer

Science advances, it seems, less through scientific consensus than by means of a scientific melee, a free-for-all in which every scientist pushes his or her piece of the truth, knowing that only time will tell which piece best fits reality.

*Explorers of the Black Box: The Search for the Cellular Basis of Memory*

Chapter Ten (p. 263)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

Society lives by faith, develops by science.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

May 7, 1870 (p. 216)

A.L. Burt Company, Publishers. New York, New York, USA. 1897

**Appleyard, Bryan** 1951–

English author and journalist

Science is not a neutral or innocent commodity which can be employed as a convenience.... Rather it is spiritually corrosive, burning away at ancient authorities and traditions. It has shown itself unable to coexist with anything.

*Understanding the Present: Science and the Soul of Modern Man*

Chapter 1 (p. 9)

Doubleday. New York, New York, USA. 1992

**Asimov, Isaac** 1920–92

American author and biochemist

Science does not promise absolute truth, nor does it consider that such a thing necessarily exists. Science does not even promise that everything in the Universe is amenable to the scientific process.

*"X" Stands for Unknown*

Introduction (p. 10)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

Science doesn't purvey absolute truth. Science is a mechanism, a way of trying to improve your knowledge of nature.

In Carl Freedman

In Bill Moyer

*Conversations With Isaac Asimov*

*Isaac Asimov Speaks* (p. 143)

University Press of Mississippi. Jackson, Mississippi, USA. 2005

Science will not stand still. It is a panorama that subtly dissolves and changes even while we watch. It cannot be caught in its every detail at any one moment of time without leaving us behind at once.

*Asimov's New Guide to Science*

Preface (p. xv)

Basic Books, Inc. New York, New York, USA. 1984

## Author undetermined

Science has no fear for dissent or for heresy. She collects facts eagerly, steadily, from generation to generation, the labors of one investigator being added to those of another, the speculations of one coalescing with those of another, in virtue of a necessary and admirable solidarity. Then, from these facts patiently observed, brought together, coordinated, classified, science deduces a law, a positive law, which is the expression of reality, of truth itself.

Scientific Miscellany

*The Galaxy*, Volume 17, January, 1874 (p. 130)



...science has given us a new reading of nature, has opened the higher questions of life and human relations, has furnished a new method to the mind, and is fast becoming a new power in literature.

Scientific Miscellany  
*The Galaxy*, Volume 11, January, 1871 (p. 135)

The wonders of the heavens seem inexhaustible; each new adventure of science tasks the imagination and almost staggers the reason.

Scientific Miscellany  
*The Galaxy*, Volume 11, February, 1871 (p. 297)

I love science as other women love men. If I am to give up science, why not die?

A Woman Hater, Part VII  
*Blackwood's Edinburgh Magazine*, Volume 120, Number 784, December, 1876 (p. 657)

If there be any lesson which is taught us by Science it is this – that to be helped we must help ourselves; and that which is a meaningless accident to some, is the material of a discovery to those from whose eyes previous thought has removed the scales.

The Teaching of Science (Second Part)  
*The American Educational Monthly*, Volume VII, April, 1870 (p. 139)

No science can be constructed on the mere foundation of facts, and independently of metaphysics. Every science must set out from evident principles, which form the basis of all certain cognition.

In Charles George Herbermann  
*The Catholic Encyclopedia*  
Ethics (p. 557)  
The Encyclopedia Press, Inc. New York, New York, USA. 1913

The age in which we live is not less distinguished by a vigorous and successful cultivation of physical science, than by its numerous and important applications to the practical arts, and to the common purposes of life.

Introductory Remarks  
*The American Journal of Science*, Volume 1, Number 1, 1819 (p. 1)

Science may be likened to a forest-tree, which loses its beauty and vigor if we confine its roots, or bend and torture its branches.

Some Account of the Universities of Germany  
*The Gentleman's Magazine*, Volume I, Number 5, November, 1837 (p. 294)

The sciences progress to the limit of the senses, but there they must stop unless they intend to investigate more than the senses can teach.

*Matter and Some of Its Dimensions*  
Book cover  
Woodward & Lothrop. Washington, D.C. 1910

Today, science has withdrawn into realms that are hardly understood of the people. Biology means very largely histology, the study of the cell by difficult and elaborate microscopical processes. Chemistry has passed from the mixing of simple substances with ascertained reactions,

to an experimentation of these processes under varying conditions of temperature, pressure, and electrification – all requiring complicated apparatus and the most delicate measurement and manipulation. Similarly, physics has outgrown the old formulas of gravity, magnetism, and pressure; has discarded the molecule and atom for the ion, and may in its recent generalizations be followed only by an expert in the higher, not to say the transcendental mathematics.

Exit the Amateur Scientist  
*The Nation*, Volume 83, August 23, 1906

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Those who have treated of the sciences have been either empirics or dogmatical. The former like ants only heap up and use their store, the latter like spiders spin out their own webs. The bee, a mean between both, extracts matter from the flower of the garden and the field, but works and fashions it by its own efforts.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 95 (p. 126)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Even the effects already discovered are due to chance and experiment, rather than to the sciences; for our present sciences are nothing more than peculiar arrangements of matters already discovered, and not methods for discovery or plans for new operations.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 8 (p. 107)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

All sciences are connected, and support each other with mutual aid, as parts of the same whole, of which each performs its work, not for itself alone, but for the others as well : as the eye directs the whole body, and the foot supports the whole; so that any part of knowledge taken from the rest is like an eye torn out or a foot cut off.

*Opus Tertium*  
Cap. Iv (p. 18)

**Bagehot, Walter** 1826–77  
English lawyer, statesman, and essayist

Science tries to find in each bit of earth the record of the causes which made it precisely what it is; those forces have left their trace, she knows, as much as the tact and hand of the artist left their mark on a classical gem.

*Physics and Politics*  
Chapter I (p. 2)  
D. Appleton & Co. New York, New York, USA. 1906

**Bailey, F. G.**  
No biographical data available

Science, it may be said by those who are not scientists, deals in objective truth. But the scientists themselves do



not see their work that way. They see it as dealing not with objective truth but with convenient fictions that are upheld so long as they continue to be useful.

*The Prevalence of Deceit* (p. xxi)  
Cornell University Press. Ithaca, New York, USA. 1991

**Barclay, John** 1758–1826  
Anatomist

Everything in Science ought to be real, ingenuous and open; every expression that indicates duplicity, or equivocation, reservation, wavering or inconsistency, is a reproach to it.

*A New Anatomical Nomenclature, Relating to the Terms Which Are Expressive of Position and Aspect in the Animal System* (p. 89)  
Edinburgh, Scotland. 1803

**Barnett, Lincoln Kinnear** 1909–79  
American science writer

The quick harvest of applied science is the useable process, the medicine, the machine. The shy fruit of pure science is Understanding.

*Life*, January 9, 1950

**Baruch, Bernard M.** 1870–1965  
American presidential advisor

Science has taught us how to put the atom to work. But to make it work for good instead of evil lies in the domain dealing with the principles of human duty. We are now facing a problem more of ethics than physics.

The Baruch Plan for Banning the Atom Bomb  
*Life*, June 24, 1946 (p. 35)

**Barzun, Jacques** 1907–  
French-born American educator, historian, and educator

It is not clear to anyone, least of all the practitioners, how science and technology in their headlong course do or should influence ethics and law, education and government, art and social philosophy, religion and life of the affections. Yet science is an all-pervasive energy, for it is at once a mode of thought, a source of strong emotion, and a faith as fanatical as any in history.

*Science: The Glorious Entertainment*  
To the Reader (p. 3)  
Harper & Row, Publishers. New York, New York, USA. 1964

**Bass, William M.**  
American forensic anthropologist

Always think of the consequences of your actions both in the field and in the laboratory.

*Human Osteology: A Laboratory and Field Manual of the Human Skeleton* (3rd edition)  
Missouri Archaeological Society. Columbia, Missouri, USA. 1987

**Bates, Marston** 1906–74  
American zoologist

Science has put man in his place; one among the millions of kinds of living things crawling around on the surface of a minor planet circling a trivial star.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
Chapter 1 (p. 5)  
Random House, Inc. New York, New York, USA. 1960

**Baudrillard, Jean** 1929–  
French cultural theorist

We can no longer say things appear unintelligible because science does not know enough about them. It seems that the more we know about them, the more unintelligible they become.

Translated by Chris Turner  
*Cool Memories*  
October, 1983 (p. 144)  
Verso. London, England. 1990

**Bauer, Henry H.** 1931–  
American chemist

Quite in general, it is not the case that, because science has changed its mind in the past, therefore it might change its mind again in any direction and by any amount.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 4 (p. 66)  
University of Illinois Press. Urbana, Illinois, USA. 1992

Science may be better served when some scientists generate novel ideas while others carp at everything new than if all scientists could somehow become disinterestedly skeptical.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 5 (p. 91)  
University of Illinois Press. Urbana, Illinois, USA. 1994

That science is not everything should not blind us to the fact that it is the very best of what we do have. Just as those who benefit from individual therapy can take pride from the persistent acts of will they exerted along the way, so humankind can take collective pride from the persistent determination to submit to reality therapy that has produced not only the science we now know but also an understanding of how to go about learning more.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 7 (p. 150)  
University of Illinois Press. Urbana, Illinois, USA. 1992

**Beard, Charles A.** 1874–1948  
American historian

A revolution in thought is at hand, a revolution as significant as the Renaissance: the subjection of science to ethical and esthetic purpose. Hence the next great survey undertaken in the name of the social sciences may begin boldly with a statement of values agreed upon, and then utilize science to discover the conditions, limitations, and methods involved in realization.

Limitations to the Application of Social Science Implied in Recent Social Trends  
*Social Forces*, Volume 11, Number 4, May, 1933 (p. 510)

**Beattie, James** 1735–1803  
Scottish poet and essayist

‘Twas thus by the glare of false science betray’d,  
That leads, to bewilder; and dazzles, to blind...

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*

The Hermit, Stanza 5

J. Blackwood. London, England. 1800

**Beebe, William** 1877–1962

American ornithologist

Thus was the ending still unfinished, the finale buried in the future – and in this we find the fascination of Nature and of Science. Who can be bored for a moment in the short existence vouchsafed us here; with dramatic beginnings barely hidden in the dust, with the excitement of every moment of the present, and with all of cosmic possibility lying just concealed in the future, whether of Betelgeuze, of Amoeba or – of ourselves?

*Edge of the Jungle*

Chapter XII (p. 294)

Garden City Publishing Company, Inc. Garden City, New York, USA. 1925

**Belloc, Hilaire** 1870–1953

French-born poet and historian

Life is a vale, its paths are dark and rough  
Only because we do not know enough.  
When Science has discovered something more  
We shall be happier than we were before.

*Lambkin's Remains*

The Only Hope of Humanity is in Science (p. 20)

The Proprietors of the J.C.R. at J. Vincent's. Oxford, England. 1900

**Bennett, William Cox** 1820–95

American poet

To what new realms of marvel, say,  
Will conquering science war its way?

*Poems*

To a Boy, Stanza 1

Chapman & Hall. London, England. 1850

**Bernal, John Desmond** 1901–71

Irish-born physicist and X-ray crystallographer

...it is not possible in any published book to speak freely and precisely about the way science is run. The law of liable, reasons of State, and still more the unwritten code of the scientific fraternity itself forbid particular examples being held up alike for praise or blame.

*The Social Function of Science* (p. xv)

The Macmillan Company. New York, New York, USA. 1939

**Bernard, Claude** 1813–78

French physiologist

...my idea of the science of life...it is a superb and dramatically lighted hall which may be reached only by passing through a long and ghastly kitchen.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter III, Section iii (p. 15)

Henry Schuman, Inc. New York, New York, USA. 1927

Real science exists, then, only from the moment when a phenomenon is accurately defined as to its nature and rigorously determined in relation to its material conditions, that is, when its law is known. Before that, we have only groping and empiricism.

Translated by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

Science has just the privilege of teaching us what we do not know, by replacing feeling with reason and experience and clearly showing us the present boundaries of our knowledge.

Translated by Henry C. Greene

*An Introduction to the Study of Experimental Medicine*

Chapter III

Henry Schuman, Inc. New York, New York, USA. 1927

Science does not grow successively and regularly. It goes by bounds and revolutions. It is the changes in theories that mark the bounds. Science is revolutionary.

Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin

*The Cahier Rouge of Claude Bernard* (p. 102)

Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

Science iz smart, but she kant tell yu what makes the flowers blush so menny different colors, but phaith can. Science on a deth bed iz a pigmy, but phaith iz a giant.

*Josh Billings' Wit and Humor*

Snails, Snaiks and Babys (p. 83)

George Routledge & Sons. London, England. 1874

**Birch, Arthur J.** 1915–95

Australian chemist

Some people derive satisfaction from accumulating data, whereas others are content to dream and leave experiments to colleagues. Still others flit from flower to flower rather than learning more and more about one situation. The difference in approach is a matter of temperament, and we all must understand our own strengths. All workers ultimately contribute to the matrix of facts, ideas, understandings, techniques, and visions that we know as science.

*To See the Obvious*

Random Conversations with the Editor (p. 195)

American Chemical Society. Washington, D.C. 1995

**Black, Joseph** 1728–99

Scottish chemist and physician

...if science be the discovery of the laws of nature, the knowledge of these laws will enable us to foresee what will be the result of any process, and must point out to us, in all cases, the means, and the best means, for producing any desired chemical effect: and here does our science repay, with a liberality unparalled in any other science, all her former obligations to the arts of life. From them

did she borrow the many facts which excited her to speculate; and her occupation has at last enabled her to repay her debts with large interest, while she has grown rich in knowledge almost beyond hope.

*Lectures on the Elements of Chemistry* (Volume 1)

Lectures on Chemistry

Definitions (p. 20)

Printed for Mathew Carey. Philadelphia, Pennsylvania, USA. 1807

**Blackstone, Sir William** 1723–80

English jurist

...sciences are of a sociable disposition, and flourish best in the neighborhood of each other: nor is there any branch of learning, but may be helped and improved by assistances drawn from other arts.

*Commentaries on the Laws of England* (Volume 1)

Introduction, section 33

Bancroft-Whitney Co. San Francisco, California, USA. 1915

**Blake, William** 1757–1827

English poet, painter, and engraver

Art is the Tree of Life; Science is the Tree of Death

*The Complete Poetry and Prose of William Blake*

The Laocoön

University of California Press. Berkeley, California, USA. 1982

**Blavatsky, Helena Petrovna** 1831–91

Russian-born American theosophist

If there were such a thing as a void, a vacuum in Nature, one ought to find it produced, according to a physical law, in the minds of helpless admirers of the “lights” of Science, who pass their time in mutually destroying their teachings.

*The Secret Doctrine*

Section 17

Theosophy Company. Los Angeles, California, USA. 1925

**Bloom, Allan** 1930–92

American philosopher

Science, in freeing men, destroys the natural condition that makes them human. Hence, for the first time in history, there is the possibility of a tyranny grounded not on ignorance, but on science.

*The Closing of the American Mind: How Higher Education Has Failed Democracy and Impoverished the Souls of Today's Students*

Part Three, Swift's Doubts (p. 295)

Simon & Schuster. New York, New York, USA. 1987

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

The importance of physical science for the development of general philosophical thinking rests not only on its contributions to our steadily increasing knowledge of that nature of which we ourselves are part, but also on the opportunities which time and again it has offered for examination and refinement of our conceptual tools.

*Atomic Physics and Human Knowledge*

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1958

The task of science is both to extend the range of our experience and reduce it to order.

*Atomic Theory and the Description of Nature*

Introductory Survey (p. 1)

Cambridge University Press. Cambridge, England. 1934

It is, indeed, perhaps the greatest prospect of humanistic studies to contribute through an increasing knowledge of the history of cultural development to that gradual removal of prejudices which is the common aim of all science.

*Atomic Physics and Human Knowledge*

Natural Philosophy and Human Cultures (p. 31)

John Wiley & Sons, Inc. New York, New York, USA. 1958

...it is important to realize that science, which knows no national boundaries and whose achievements are the common possession of mankind, has through the ages united men in their efforts to elucidate the foundations of our knowledge.

On Atoms and Human Knowledge

*Daedalus*, Volume 87, Number 2, Spring, 1958 (p. 164)

**Bolton, Henry Carrington** 1843–1903

American chemist, bibliographer, and historian

So rapid are the strides made by science in this progressive age and so boundless is its range, that those who view its career from without find great difficulty in following its diverse and intricate pathways, while those who have secured a footing within the same road are often quite unable to keep pace with its fleet movements and would fain retire from the unequal contest. It is not surprising, then, that those actually contributing to the advancement of science, pressing eagerly upward and onward, should neglect to look back upon the labors of those who precede them and should sometimes lose sight of the obligations which science owes to forgotten generations.

Notes on the Early Literature of Chemistry

Reprinted from *The American Chemist*, November, 1875

**Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

The sciences, which have revealed so many secrets and destroyed so many prejudices, are destined to render us yet greater service. New truths, new discoveries will unveil secrets still more essential to the happiness of men – but only if we give our esteem to the scientists and our protection to the sciences.

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (p. 135)

Columbia University Press. New York, New York, USA. 1955

**Bondi, Sir Hermann** 1919–2005

English mathematician and cosmologist

Throughout science there is a constant alternation between periods when a particular subject is in a state of order, with all known data falling neatly into their places, and a state of puzzlement and confusion, when new observations throw all neatly arranged ideas into disarray.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1966

Astronomy and the Physical Sciences (p. 245)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

**Boone, Richard Gause** 1849–1923

American educator

Science must be held superior to personal bias, and honor truth for its own sake.

*Science of Education*

Part II, Chapter XIII (pp. 177–178)

Charles Scribner's Sons. New York, New York, USA. 1904

**Born, Max** 1882–1970

German-born English physicist

Science has undoubtedly two aspects: it can be regarded from the social standpoint as a practical collective endeavor for the improvement of human conditions, but it can also be regarded from the individualistic standpoint, as a pursuit of mental desires, the hunger for knowledge and understanding, a sister of art, philosophy, and religion.

*Natural Philosophy of Cause and Chance*

Chapter X (p. 128)

Clarendon Press. Oxford, England. 1949

It is not nature that is economical but science. All our knowledge starts with collecting facts, but proceeds by summarizing numerous facts by simple laws, and these again by more general laws. This process is very obvious in physics.

*Physics in My Generation* (p. 75)

Pergamon Press. Oxford, England. 1956

**Bosler, Jean**

No biographical data available

As science advances, new questions appear before indeed the older ones, often badly put, are solved. But the latter often lose their interest, and as we proceed many untenable hypotheses which darkened our path are destroyed. And so, little by little, the knowledge we have of things progresses with a tidal motion which will doubtless end only with humanity.

*Annual Report of the Board of Regents of the Smithsonian Institution,*

1914

Modern Theories of the Sun (p. 160)

Government Printing Office, Washington, D.C. 1915

**Boswell, James** 1740–95

Scottish biographer and diarist

...no one science is so little connected with the rest, as not to afford many principles whose use may extend considerably beyond the science to which they primarily belong; and that no proposition is so purely theoretical as to be totally incapable of being applied to practical purposes.

*The Life of Samuel Johnson* (Volume 1) V (9th edition)

1784 (pp. 397–398)

Printed for T. Caldwell. London, England. 1822

**Bourne, Borden P.**

No biographical data available

...But science cannot complain, if we use its own language.

Aspects of Theism

*The New Englander*, Volume XXXI, Number 3, July, 1872 (p. 462)**Bowman, Isaiah** 1878–1950

Canadian-born American geographer

Science today, it should be remembered means not merely the physical and biological (including medical) sciences, but also the social sciences – modern economics, sociology, statistics, and related subjects – that we now seek to develop in a way as nearly objective as the nature of the human materials and the available techniques of investigation permit. In our time the highest hope of social advancement is based on a reasoned relationship of man to man, not a haphazard relationship. We have come to believe that the affairs of man are not subject to a malign fatalism as he goes forward in his “dark striving toward the good.” Science is in relentless pursuit of power to diminish the darkness of that striving and to “shape reality from hope’s vast dream”.

*A Design for Scholarship*

Other Men (p. 113)

Books for Libraries Press. Freeport, New York, USA. 1971

**Bradbury, Ray** 1920–

American writer

At base, science is no more than an investigation of a miracle we can never explain, and art is an interpretation of that miracle.

*Ray Bradbury: 100 of His Most Celebrated Tales*

June, 2001: And the Moon Still Be as Bright (p. 421)

HarperCollins Publishers, Inc. New York, New York, USA. 2003

**Branford, Benchara**

Mathematician

Science is born anew in the deliberate will and intention of each of us when we succeed in thinking about the principles of our work in a clear, logical, and systematic way, and courageously put our conclusions to the test of experiment; and the so-called sciences are the written records of such thinking, only more extensive, clear, systematic, and consistent, and more true to reality,

because they have been tested by countless experiments and experiences in the race.

In John Arthur Thomson

*Introduction to Science*

Chapter I (p. 32)

Henry Holt & Co. New York, New York, USA. 1911

### **Branford, Victor**

No biographical data available

If science cannot direct us, we must direct science.

*Science and Citizenship*

Section I (p. 3)

George Allen. London, England. 1906

### **Brecht, Bertolt** 1898–1956

German writer

**GALILEO:** One of the main reasons why the sciences are so poor is that they imagine they are so rich. It isn't their job to throw open the door to infinite wisdom but to put a limit to infinite error.

Translated by John Willett

*Life of Galileo*

Scene 9 (p. 74)

Arcade Publishing. New York, New York, USA. 1994

**ANDREA:** Science makes only one demand: contribute to science.

Translated by John Willett

*Life of Galileo*

Scene 14 (p. 107)

Arcade Publishing. New York, New York, USA. 1994

### **Bremer, J.**

No biographical data available

What, then, is science according to common opinion? Science is what scientists do. Science is knowledge, a body of information about the external world. Science is the ability to predict. Science is power, it is engineering. Science explains, or gives causes and reasons.

*What Is Science? Notes on the Nature of Science* (pp. 37–38)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

### **Brewster, Edwin Tenney** 1866–1960

Educator

Science, in fact, begins only as men confine themselves to accounting for the unknown by the known – not by the unknown by something about which they know still less.

*This Puzzling Planet*

Chapter V (p. 93)

The Bobbs-Merrill Company. Indianapolis, Indiana. 1928

### **Bridgman, Percy Williams** 1882–1961

American physicist

Science is intelligence in action with no holds barred.

In Theodore Schick, Jr., and Lewis Vaughn

*How to Think About Weird Things*

Chapter 7 (p. 164)

The McGraw-Hill Companies. New York, New York, USA. 2002

The attitude which the man in the street unconsciously adopts toward science is capricious and varied. At one moment he scorns the scientist for a highbrow, at another anathematizes him for blasphemously undermining his religion; but at the mention of a name like Edison he falls into a coma of veneration.

*Reflections of a Physicist*

Chapter 10 (p. 167)

Philosophical Library. New York, New York, USA. 1955

### **Brieux, Eugène** 1858–1932

French dramatist

Science! science! science! – ah, ah! – One imagines a million things are the matter! – one wants to formulate laws of life – and is present, powerless, at one's own agony! We understand nothing that happens about us, we understand nothing that is happening within us. Why am I going to die? My arteries will begin to harden. Why? How? What is hardening of the arteries? Do you want me to tell you? We know nothing about it, nothing, nothing, nothing! – we have found nothing but words! (a small pause) I'm better again. I'm quite relieved.

Translated by Frederick Eisemann

*Blanchette, and The Escape* (p. 238)

John W. Luce & Co. Boston, Massachusetts, USA. 1913

### **Broad, William** 1951–

Science writer

### **Wade, Nicholas**

British-born scientific writer

In the acquisition of new knowledge, scientists are not guided by logic and objectivity alone, but also by such nonrational factors as rhetoric, propaganda, and personal prejudice. Scientists do not depend solely on rational thought, and have no monopoly on it. Science should not be considered the guardian of rationality in society, but merely one major form of its cultural expression.

*Betrayers of the Truth* (p. 9)

Simon & Schuster. New York, New York, USA. 1982

### **Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

The world today is made, it is powered by science; and for any man to abdicate an interest in science is to walk with open eyes towards slavery.

*Science and Human Values*

The Creative Mind (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1965

All science is the search for unity in hidden likenesses.

*Science and Human Values*

The Creative Mind (p. 13)

Harper & Row, Publishers. New York, New York, USA. 1965

Science has nothing to be ashamed of even in the ruins of Nagasaki. The shame is theirs who appeal to other



values than the human imaginative value which science has evolved.

*Science and Human Values*

The Sense of Human Dignity (p. 73)

Harper & Row, Publishers. New York, New York, USA. 1965

Like the voyages of the Spaniards into the fabulous West, Science even at its boldest does the will of history, and in turn helps to determine its movement.

*The Common Sense of Science*

Chapter VII, Section 1 (p. 97)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

[Science] does not watch the world, it tackles it.

*The Common Sense of Science*

Chapter VII, Section 4 (p. 104)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Bryan, William Jennings** 1860–1925

American lawyer, orator, and politician

Evolution seems to close the heart to some of the plainest spiritual truths while it opens the mind to the wildest guesses advanced in the name of science.

*The New York Times*, Letter, February 22, 1922

Christians desire that their children shall be taught all the sciences, but they do not want them to lose sight of the Rock of Ages while they study the age of rocks...

Speech

Prepared for the Scopes Trial, 1925

**Bryson, Bill** 1951–

American author

The remarkable position in which we find ourselves is that we don't actually know what we actually know.

*A Short History of Nearly Everything*

Chapter 23 (p. 362)

Broadway Books. New York, New York, USA. 2003

**Buchner, Ludwig** 1824–99

German physician and philosopher

Science has gradually taken all the positions of the childish belief of the peoples; it has snatched thunder and lightning from the hands of the gods; the eclipse of the stars, and the stupendous powers of the Titans of the olden time have been grasped by the fingers of man.

*Force and Matter*

Chapter VI (p. 34)

Trubner & Company. London, England. 1864

Science has gradually taken all the positions of the childish belief of the peoples; it has snatched thunder and lightning from the hands of the gods; the eclipse of the stars, and the stupendous powers of the Titans of the olden time, have been grasped by the fingers of man.

*Force and Matter*

Chapter VI (p. 34)

Trübner & Co. London, England. 1864

The power of spirits and gods dissolved in the hands of science.

*Force and Matter*

Chapter VI (p. 34)

Trübner & Co. London, England. 1864

**Buckham, John Wright**

No biographical data available

...the mind that has been trained simply or predominately in Science is an unconsciously meager and ill-furnished mind. The range of its interests is mainly technical and specialized. To look into a mind of this type is like looking into a laboratory. It is excellent as a workshop, but there are no pictures on the walls, no books, no flowers.... What are the resources of such a mind, its points of contact with human-kind?

The Passing of the Scientific Era

*The Century Illustrated Monthly Magazine*, August, 1929 (p. 435)

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91

English statesman and poet

...science is not a club, it is an ocean; it is open to the cockboat as the frigate. One man carries across it a freightage of ingots, another may fish there for herrings. Who can exhaust the sea? who say to intellect, "the deeps of philosophy are preoccupied?"

*The Caxtons*

Book IV, III

G. Routledge & Company. London, England. 1848

**Budiansky, Stephen**

No biographical data available

Science eschews the personal. Although it is commonplace to ascribe this tendency to some fundamental coldness on the part of scientists, in fact it is really one of the great intellectual triumphs of the 20th century that scientists have learned to discount the experiences of individuals when searching for cause and effect in the natural world.

*Washington Post Book World*

The Meat of the Matter

April 22, 1984

Edinburgh, Scotland

**Bulwer Lytton, Edward** 1831–91

English statesman and poet

...science is not a club, it is an ocean; it is open to the cockboat as the frigate. One man carries across it a freightage of ingots, another may fish there for herrings. Who can exhaust the sea?

*The Caxtons* (Volume 1)

Part IV, Chapter III (p. 122)

Little, Brown & Company. Boston, Massachusetts, USA. 1899



**Bunge, Mario** 1919–  
Argentine philosopher and physicist

The motto of science is not just *Pauca* but rather *Plurima ex paucissimis* – the most out of the least.

*The Myth of Simplicity: Problems of Scientific Philosophy*  
Chapter 5, Section 4 (p. 82)  
Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1963

**Bunting, Basil** 1900–85  
English modernist poet

I hate Science. It denies a man's responsibility for his own deeds, abolishes the brotherhood that springs from God's fatherhood. It is a hectoring, dictating expertise, which makes the least lovable of the Church Fathers seem liberal by contrast. It is far easier for a Hitler or a Stalin to find a mock-scientific excuse for persecution than it was for Dominic to find a mock-Christian one.

In Victoria Forde

*The Poetry of Basil Bunting*

Chapter 6, Letter of January 1, 1947 to Louis Zukofsky (p. 156)  
Bloodaxe Books, Newcastle upon Tyne, England. 1991

**Burke, Edmund** 1729–97  
English statesman and philosopher

Nothing tends so much to the corruption of science as to suffer it to stagnate: *these waters must! if troubled before they can exert their virtues.*

In Chauncey Allen Goodrich

*Select British Eloquence*

Detached Sentiments and Maxims (p. 380)

Edmund

Harper & Brothers Publishers. New York, New York, USA. 1853

**Burroughs, John** 1837–1921  
American naturalist and writer

If we take science as our sole guide, if we accept and hold fast that alone which is verifiable, the old theology, with all its miraculous machinery, must go.

*The Light of Day*

Chapter III (p. 19)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1901

Science strips Nature to her bare bones; literature and philosophy clothe the bones with something analogous to flesh and blood and warmth and color.

*Under The Apple Tree*

Literature and Science (pp. 177–178)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

Science explains the rainbow, but literature sees it as a symbol and a promise. So with the sunset or the sunrise. Science knows all about the diamond, but knows not why it is so prized by us. It explains the pearl, but not the pearl necklace.

*Under The Apple Tree*

Literature and Science (p. 179)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

Science, as such, neither fears, nor dreads, nor wonders, nor trembles, nor scoffs, nor scorns; is not puffed up; thinketh no evil; has no prejudices; turns aside for nothing. Though all our gods totter and fall, it must go its way. It dispels our illusions because it clears our vision. It kills superstition because it banishes our irrational fears.

*Under the Apple-Trees*

Chapter XI (pp. 194–195)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

...one man's science must be another man's science; all science is a whole – a pushing farther and farther of the lines of knowledge into nature.

The Corroboration of Professor Huxley

*The North American Review*, Volume 149, Number 346, November, 1889 (p. 567)

Science has made or is making the world over for us. It has builded us a new house – builded it over our heads while we were yet living in the old, and the confusion and disruption and the wiping-out of the old features and the old associations, have been, and still are, a sore trial – a much finer, more spacious and commodious house... but new, new, all bright and hard and unfamiliar....

In the Noon of Science

*The Atlantic Monthly*, Volume 110, Number 3, September, 1912 (p. 327)

Science enables us to understand our own ignorance and limitations, and so puts us at our ease amid the splendors and mysteries of creation.

*The Writings of John Burroughs* (Volume 17)

The Summit of the Years

In the Noon of Science (pp. 65–66)

Houghton Mifflin Company. New York, New York, USA. 1913

Science puts great weapons in men's hands for good or for evil, for war or for peace, for beauty or for ugliness, for life or for death, and how these weapons are used depends upon the motives that actuate us.

*The Writings of John Burroughs* (Volume 17)

The Summit of the Years

In the Noon of Science (p. 67)

Houghton Mifflin Company. New York, New York, USA. 1913

**Bury, John Bagnell** 1861–1927  
English historian and classical scholar

Science has been advancing without interruption during the last three or four hundred years; every new discovery has led to new problems and new methods of solution, and opened up new fields for exploration. Hitherto men of science have not been compelled to halt, they have always found means to advance further. But what assurance have we that they will not come up against impassable barriers?

*The Idea of Progress: An Inquiry into Its Origin and Growth*

Introduction (p. 3)

Dover Publications. New York, New York, USA. 1955

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

Science has a simple faith, which transcends utility. Nearly all men of science, all men of learning for that matter, and men of simple ways too, have it in some form and in some degree. It is the faith that it is the privilege of man to learn to understand, and that this is his mission. If we abandon that mission under stress we shall abandon it forever, for stress will not cease. Knowledge for the sake of understanding, not merely to prevail, that is the essence of our being. None can define its limits, or set its ultimate boundaries.

*Science Is Not Enough*  
Chapter X (p. 191)  
William Morrow & Company, Inc. New York, New York, USA. 1967

Science does not exclude faith.... Science does not teach a harsh materialism. It does not teach anything beyond its boundaries, and those boundaries have been severely limited by science itself.

*Modern Arms and Free Men*  
Threat and Bulwark (p. 183)  
The MIT Press, Cambridge, Massachusetts, USA. 1968

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

If [science] tends to thicken the crust of ice on which, as it were, we are skating, it is all right. If it tries to find, or professes to have found, the solid ground at the bottom of the water it is all wrong.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
Science (p. 110)  
Jonathan Cape. London, England. 1951

**Buttimer, Anne**  
Geographer

Strange indeed sounds the language of poets and philosophers; stranger still the refusal of science to read and hear its message.

Grasping the Dynamism of Lifeworld  
*Annals of the Association of American Geographers*, Volume 66, 1976 (p. 277)

**Campbell, Norman R.** 1880–1949  
English physicist and philosopher

...science [is] the study of those judgments concerning which universal agreement can be obtained.

*What Is Science?*  
Chapter II (p. 32)  
Dover Publications. New York, New York, USA. 1952

An audience of children of all ages gapes amazedly while the lecturer discourses glibly of times reckoned in millions of years and distances in thousands of millions of miles. But science has something better to offer than sensational journalism; nothing could be less characteristic of its spirit. The mere fact that the interest of

the uninitiated can thus be easily stimulated with serious training suggests doubts of the value of the stimulus; nothing worth having in this world is to be had without effort.

*Physics: The Elements*  
Chapter VIII (p. 226)  
At The University Press. Cambridge, England. 1920

**Campbell, Thomas** 1777–1844  
Scottish poet

When Science from Creation's face  
Enchantment's veil withdraws,  
What lovely visions yield their place  
To cold material laws!

*The Complete Poetical Works*  
To the Rainbow, l. 13–16  
Chadwyck-Healey. Cambridge, England. 1992

Oh! star-eyed Science, hast thou wandered there,  
To waft us home the message of despair?

*The Complete Poetical Works*  
Pleasures of Hope, Part II, l. 325  
Chadwyck-Healey. Cambridge, England. 1992

**Camus, Albert** 1913–60  
Algerian-French novelist, author, essayist, and philosopher

At the final stage you teach me that this wondrous and multicolored universe can be reduced to the atom and that the atom itself can be reduced to the electron. All this is good and I wait for you to continue. But you tell me of an invisible planetary system in which electrons gravitate around a nucleus. You explain this world to me with an image. I realize then that you have been reduced to poetry: I shall never know. Have I the time to become indignant? You have already changed theories. So that science that was to teach me everything ends up in a hypothesis, that lucidity founders in metaphor, that uncertainty is resolved in a work of art.

Translated by Justin O'Brien  
*The Myth of Sisyphus and Other Essays*  
An Absurd Reasoning (pp. 19–20)  
Alfred A. Knopf. New York, New York, USA. 1961

**Carlyle, Thomas** 1795–1881  
English historian and essayist

This world, after all our science and sciences, is still a miracle; wonderful, inscrutable, magical and more, to whosoever will think of it.

*On Heroes and Hero Worship*  
Lecture I (p. 12)  
John B. Alden, Publisher. New York, New York, USA. 1887

Science rests on reason and experiment, and can meet an opponent with calmness.

In James Anthony Froude  
*Thomas Carlyle: A History of His Life in London, 1834–1881*  
(Volume 2) (4th edition)  
Chapter XXV (p. 244)  
Longmans, Green & Co. London, England. 1885

**Carpenter, William Benjamin** 1813–85

English physiologist and naturalist

But when Science, passing beyond its own limits, assumes to take the place of Theology, and sets up its own conception of the Order of Nature as a sufficient account of its Cause, it is invading a province of Thought to which it has no claim, and not unreasonably provokes the hostility of those who ought to be its best friends.

*Report of the Forty-second Meeting of the British Association for the Advancement of Science*

Address by the President (p. lxxxiv)

John Murray. London, England. 1872

**Carrel, Alexis** 1873–1944

French surgeon and biologist

There is a strange disparity between the sciences of inert matter and those of life. Astronomy, mechanics, and physics are based on concepts which can be expressed, tersely and elegantly, in mathematical language. They have built up a universe as harmonious as the monuments of ancient Greece. They weave about it a magnificent texture of calculations and hypotheses. They search for reality beyond the realm of common thought up to unutterable abstractions consisting only of equations of symbols. Such is not the position of biological sciences. Those who investigate the phenomena of life are as if lost in an inextricable jungle, in the midst of a magic forest, whose countless trees unceasingly change their place and their shape. They are crushed under a mass of facts, which they can describe but are incapable of defining in algebraic equations.

*Man, The Unknown*

Chapter I (p. 1)

Harper &amp; Brothers Publishers. New York, New York, USA. 1935

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

There is so much *written* Science that no living person has ever *read*: and there is so much *thought-out* Science that hasn't yet been *written*.

*Sylvie And Bruno*

Chapter 2 (pp. 22–23)

Macmillan &amp; Co Ltd. London, England. 1890

**Carson, Rachel** 1907–64

American marine biologist and author

There is one quality that characterizes all of us who deal with the science of the earth and its life – we are never bored.

In Paul Brooks

*The House of Life: Rachel Carson at Work*

The Closing Journey (p. 324)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1972

The winds, the sea, and the moving tides are what they are. If there is wonder and beauty and majesty in them,

science will discover these qualities. If they are not there, science cannot create them.

Acceptance Speech

1952 National Book Award

**Carus, Paul** 1852–1919

American philosopher

Science is not the monopoly of the naturalist or the scholar, nor is it anything mysterious or esoteric. Science is the search for truth, and truth is the adequacy of a description of facts.

*Philosophy as a Science: A Synopsis of Writings of Dr. Paul Carus*

Introduction (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1909

**Cassell, Eric J.**

No biographical data available

The changes in medicine that are occurring today are part of a larger social upheaval.... This social movement... is marked by a turning away from science and technology – even, on occasion, from reason itself.... With time it will become apparent again that science and technology are not the enemies; and... “reason” is not inherently atomistic or reductionist, nor science the enemy of persons. Then the search for the solutions to the problems faced by medicine... will inevitably involve the development of new and exciting intellectual tools.

*The Place of the Humanities in Medicine* (pp. 6–7)

The Hastings Center. New York, New York, USA. 1984

**Cassirer, Ernst** 1874–1945

German philosopher

Science is the last step in man's mental development and it may be regarded as the highest and most characteristic attainment of human culture.

*An Essay on Man: An Introduction to a Philosophy of Human Culture*

Chapter XI (p. 207)

Yale University Press. New Haven, Connecticut, USA. 162

**Chadwick, John White** 1840–1904

American clergyman

It is Science which has damped down the fires of hell and despoiled the Almighty of those attributes which an English Churchman tells us made him “the most horrible being it is possible for the imagination to conceive.” It is only Orthodoxy as *transformed by Science* that has any beauty that the kind-hearted and the merciful should desire it for their own. If one had to choose between Orthodoxy as it was before the mystery of Science began working in its hideous bulk and Science in its most negative statement or its most painful implications, the man would be a fiend who would not choose the Science ten to one.

*The Possible Life: And Other Sermons*

Twenty-First Series, Chapter VI (p. 82)

Geo. H. Ellis. Boston, Massachusetts, USA. 1897

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

I am convinced that one's knowledge of the Physical Sciences is incomplete without a study of the Principia in the same way that one's knowledge of Literature is incomplete without a study of Shakespeare.

On Reading Newton's Principia at Age Apat Eighty  
*Current Science*, Volume 67, Number 7, 10 October, 1994 (p. 499)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

To the scientist nature is like a mirror that breaks every thirty years; and who cares about the broken glass of past times?

*Voices in the Labyrinth: Nature, Man and Science*  
Chapter 3 (p. 24)  
The Seabury Press. New York, New York, USA. 1977

With very few exceptions, it is not the men that make science; it is science that makes the men.

*Voices in the Labyrinth: Nature, Man and Science* (p. 12)  
The Seabury Press. New York, New York, USA. 1977

The so-called exact sciences often are not as exact as is commonly believed. How often they infer the existence of a hat from the emergence of a rabbit!

*Voices in the Labyrinth: Nature, Man and Science*  
Chapter 3 (p. 20)  
The Seabury Press. New York, New York, USA. 1977

What counts in science is to be not so much the first as the last.

*Voices in the Labyrinth: Nature, Man and Science* (p. 24)  
The Seabury Press. New York, New York, USA. 1977

Science is a way to investigate, not to define, reality.

*Voices in the Labyrinth: Nature, Man and Science* (p. 52)  
The Seabury Press. New York, New York, USA. 1977

The sciences, like other professions, cannot endure if their practitioners are unable to know more than an ever smaller portion of what they must know in order to function properly.

*Voices in the Labyrinth: Nature, Man and Science* (p. 53)  
The Seabury Press. New York, New York, USA. 1977

A classic in science is a man who no longer has to be quoted.

*Voices in the Labyrinth: Nature, Man and Science* (p. 99)  
The Seabury Press. New York, New York, USA. 1977

In science you don't ask why, you ask how much.

*Voices in the Labyrinth: Nature, Man and Science*  
Ouroboros (p. 128)  
The Seabury Press. New York, New York, USA. 1977

Science has become an eye without a head, a desperate attempt to fill holes with gaps. It came up to a lock, so it looked for the key; but it was a lock without a key-hole. The priests of truth are soiled with blood; their discoveries have become inventions, their pledges far

from eternal. In a science in which one can say: "this is no longer true," nothing is true.

*Voices in the Labyrinth: Nature, Man and Science*  
Chimaera (p. 151)  
The Seabury Press. New York, New York, USA. 1977

What counts, however, in science is to be not so much the first as the last.

Preface to a Grammar of Biology  
*Science*, Volume 172, Number 3984, May, 1971 (p. 639)

...in most sciences the question Why? is forbidden and the answer is actually to the question, How? Science is much better in explaining than in understanding, but it likes to mistake one for the other.

*Voices in the Labyrinth*  
*Perspectives in Biology and Medicine*, Volume 18, Spring, 1975 (p. 322)

Science cannot be a mass occupation, anymore than the composing of music or the painting of pictures.

In Praise of Smallness – How Can We Return to Small Science  
*Perspectives in Biology and Medicine*, Volume 23, Number 3, Spring, 1980 (p. 373)

In science we always know much less than we believe we do.

Uncertainties Great, Is the Gain Worth the Risk?  
*Chemical and Engineering News*, May 30, 1977

The sciences are extremely pedigree-conscious, and the road to the top of Mount Olympus is paved with letters of recommendation, friendly whispers at meetings, telephone calls at night.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Part I

No Hercules, No Crossroads (p. 32)  
Rockefeller University Press. New York, New York, USA. 1978

To be a pioneer in science has lost much of its attraction: significant scientific facts and, even more, fruitful scientific concepts pale into oblivion long before their potential value has been utilized. New facts, new concepts keep crowding in and are in turn, within a year or two, displaced by even newer ones.... Now, however, in our miserable scientific mass society, nearly all discoveries are born dead; papers are tokens in a power game, evanescent reflections on the screen of a spectator sport, news items that do not outlive the day on which they appeared.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Part II

A Bouquet of Mortelles (pp. 78, 81)  
Rockefeller University Press. New York, New York, USA. 1978

In science there is always one more Gordian knot than there are Alexanders.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 116)  
The Rockefeller University Press. New York, New York, USA. 1978

The vested interest in a scientific subject compresses as it intensifies; it restricts as it deepens.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 137)  
The Rockefeller University Press. New York, New York, USA. 1978

Science is the attempt to learn the truth about those parts of nature that are explorable.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 156)  
The Rockefeller University Press. New York, New York, USA. 1978

...never before has science become so alienated from the common man, and he, in turn, so suspicious of science.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Part III  
The Great Dilemma of the Life Sciences (p. 158)  
Rockefeller University Press. New York, New York, USA. 1978

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

When one longs for a drink, it seems as though one could drink a whole ocean – that is faith; but when one begins to drink one can drink altogether two glasses – that is science.

Translated by S.S. Kotliansky and Leonard Woolf  
*Note-book of Anton Chekhov* (p. 104)  
B.W. Huebsch. New York, New York, USA. 1922

### **Chernin, Kim**

No biographical data available

Science is not neutral in its judgments, not dispassionate, nor detached....

*The Obsession: Reflections on the Tyranny of Slenderness*  
Chapter 3 (p. 37)  
Harper & Row, Publishers. New York, New York, USA. 1981

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

When once one believes in a creed, one is proud of its complexity, as scientists are proud in the complexity of science. It shows how right it is in its discoveries. If it is right at all, it is a compliment to say that it is elaborately right. A stick might fit a hole or a stone a hollow by accident. But a key and a lock are both complex. And if a key fits a lock, you know it is the right key.

*Orthodoxy*  
Chapter VI (p. 152)  
John Lane Company. New York, New York, USA. 1918

Science, that nameless being, declared that the weakest must go to the wall; especially in Wall Street.

*The Well and the Shallows*  
The Return to Religion (p. 74)  
Sheed & Ward, Inc., New York, New York, USA. 1935

Science in the modern world has many uses; its chief use, however, is to provide long words to cover the errors of the rich.

*Heretics*  
Cells and Celtophiles (p. 171)  
Books for Libraries Press. Freeport, New York, USA. 1970

...physical science is like simple addition: it is either infallible or it is false.

*All Things Considered*  
Science and Religion (p. 187)  
John Lane Company. New York, New York, USA. 1908

### **Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

Science bestowed immense new powers on man and at the same time created conditions which were largely beyond his comprehension and still more beyond his control.

Speech  
March 31, 1949

Science has given to this generation the means of unlimited disaster or of unlimited progress. There will remain the greater task of directing knowledge lastingly towards the purpose of peace and human good.

Speech  
New Delhi, January 3, 1944

My experience – and it is somewhat considerable – is that in these matters when the need is clearly explained by military and political authorities, science is always able to provide something. “Seek and ye shall find” has been borne out.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, June 7, 1935 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

I have seldom seen a precise demand made upon science by the military which has not been met.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, March 16, 1950 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

It is arguable whether the human race have been gainers by the march of science beyond the steam engine. Electricity opens a field of infinite conveniences to ever greater numbers, but they may well have to pay dearly for them. But anyhow in my thought I stop short of the internal combustion engine which has made the world so much smaller. Still more must we fear the consequences of entrusting to a human race so little different from their predecessors of the so-called barbarous ages such awful agencies as the atomic bomb. Give me the horse.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Royal College of Physicians, July 10, 1951 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

### **Clive, Colin**

American actor

This isn't science! It's more like black Magic.

*The Bride of Frankenstein*  
Film (1935)

### **Cobbe, Frances P.** 1822–1904

English author

Then the Sorcerer Science entered, and where e'er he waved his wand

Fresh wonders and fresh mysteries rose on every hand.

*The Pageant of Time*, Stanza 1  
Source undetermined



**Cohen, I. Bernard** 1914–2003  
American physicist and science historian

...all revolutionary advances in science may consist less of sudden and dramatic revelations than a series of transformations, of which the revolutionary significance may not be seen (except afterwards, by historians) until the last great step. In many cases the full potentiality and force of a most radical step in such a sequence of transformations may not even be manifest to its author.

*The Newtonian Revolution: With Illustrations of the Transformation of Scientific Ideas*

Chapter 4 (p. 162)

Cambridge University Press. Cambridge, England. 1980

**Colbert, Edwin H.** 1905–2001  
American vertebrate paleontologist

It is too easy to think of science as something large and impersonal, as something outside the understanding of most of us, as something rather distant, and removed from the affairs of the average person. Even in this day, when the lives of all of us are touched every hour, and almost every minute, by the products of technology, the handmaiden of science, we are still inclined to accept the impersonal view of science. Science is so manifestly complex, so compartmentalized by specialization, and to all but those who are initiated into the priesthoods of these specializations, so largely incomprehensible, that we can hardly think of it in other than impersonal terms.

*Men and Dinosaurs*

Preface (p. v)

E.P. Dutton & Company, Inc. New York, New York, USA. 1968

**Cole, K. C.**  
Science writer

Science... involves looking mostly at things we can never see.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter One (p. 15)

Harcourt Brace & Co. Orlando, Florida, USA. 1999

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Science drives full tilt towards the destruction of personal responsibility: it relegates every act of man to the inevitable results of fore-ordained causes; we are all in the toils of a blind invincible law; we are cogs in an infinite machine over which we have no control; good and bad conduct are the results of equally irresistible impellers, and praise and blame are empty words. This is the world into which Science seeks to force us, and a dreary world it is.

*The Idolatry of Science*

Chapter II (pp. 6–7)

John Lane Co. London, England. 1920

**Coles, Abraham** 1813–91  
American physician, hymnist, and poet

I value science – none can prize it more –  
It gives ten thousand motives to adore.  
Be it religious, as it ought to be,  
The heart it humbles, and it bows the knee.

*The Microcosm: And Other Poems*

Christian Science

D. Appleton & Company. New York, New York, USA. 1880

**Collins, Wilkie** 1824–89  
English novelist

Oh, Science, be merciful to the fanatics, and the fools!

*Heart and Science*

Chapter LXII (p. 289)

Chatto & Windus. London, England. 1883

**Commoner, Barry** 1917–  
American biologist, ecologist, and educator

Science is triumphant with far-ranging success, but its triumph is somehow clouded by growing difficulties in providing for the simple necessities of human life on the earth.

*Science and Survival*

Chapter 2 (p. 9)

The Viking Press. New York, New York, USA. 1966

We seem to be entering a new world of technology, but the vehicle which is carrying us – science – shows dangerous signs of inadequacy for the voyage ahead.

*Science and Survival*

Chapter 4 (p. 63)

The Viking Press. New York, New York, USA. 1966

Science can reveal the depth of this [political] crisis, but only social action can resolve it. Science can now serve society by exposing the crisis of modern technology to the judgment of all mankind. Only this judgment can determine whether the knowledge that science has given us shall destroy humanity or advance the welfare of man.

*Science and Survival*

Chapter 7 (p. 132)

The Viking Press. New York, New York, USA. 1966

**Compton, Arthur H.** 1892–1962  
American physicist

For those who know science, its inhumanness is a fiction. It serves to satisfy the human hunger for a better understanding of man's place in his world.

*Annual Report of the Board of Regents of the Smithsonian Institution (1941)*

Science Shaping American Culture (p. 180)

Government Printing Office

Washington, D.C. 1942

**Compton, Karl Taylor** 1887–1954  
American educator and physicist



Fundamentally, science means simply knowledge of our environment. Combined with ingenuity, science becomes power.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 2)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Condon, Edward Uhler** 1902–74

American physicist

Society is at this moment at the threshold of an undreamed-of mastery of our material environment, for science, which provides that mastery, is in its Golden Age.

*Selected Popular Writings of E.U. Condon*  
Science and the National Welfare (p. 145)  
Springer-Verlag. New York, New York, USA. 1991

The sciences, like those other truth-seeking activities of man, require a free environment, an environment, above all, free from fear, petty arbitrariness, and tyranny.

*Selected Popular Writings of E.U. Condon*  
Science and the National Welfare (p. 155)  
Springer-Verlag. New York, New York, USA. 1991

**Condorcet, Marie Jean** 1749–1827

French mathematician, astronomer, and physicist

In every century Princes have been found to love the sciences and even to cultivate them, to attract Savants to their palaces and to reward by their favors and their amity men who afforded them a sure and constant refuge from world-weariness, a sort of disease to which supreme power seems particularly prone.

*Eloge des académiciens de l'Académie royal des sciences*  
Forward, I  
Publisher undetermined

**Cooke, Josiah Parsons** 1827–94

American chemist

Science offers us not only a mass of phenomena to be observed, but also a body of truths which have been deduced from these observations; and, without the power of drawing correct inferences from the data acquired, exact observations would be of little value.

*Scientific Culture: And Other Essays* (2nd edition)  
Scientific Culture (p. 35)  
D. Appleton & Co. New York, New York, USA. 1855

**Cooper, Bernard** 1951–

Physicist

At the rate science proceeds, rockets and missiles will one day seem like buffalo – slow, endangered grazers in the black pasture of outer space.

*Harper's*, January, 1990

**Cooper, Leon** 1930–

American physicist

To say that science is logical is like saying that a painting is paint....

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*  
The Memory Machine (p. 194)  
Alfred A. Knopf. New York, New York, USA. 1991

**Coulter, John Merle** 1851–1928

American botanist and educator

All science is one. Pure science is often immensely practical; applied science is often very pure science; and between the two there is no dividing line.

The Evolution of Botanical Research  
*Science*, Volume 51, Number 1305, January 2, 1920 (p. 2)

**Crichton, Michael** 1942–

American novelist

Finally, I would remind you to notice where the claim of consensus is invoked. Consensus is invoked only in situations where the science is not solid enough. Nobody says the consensus of scientists agrees that  $E = mc^2$ . Nobody says the consensus is that the sun is 93 million miles away. It would never occur to anyone to speak that way.

Lecture  
Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

I expected science to be, in Carl Sagan's memorable phrase, "a candle in a demon haunted world." And here, I am not so pleased with the impact of science. Rather than serving as a cleansing force, science has in some instances been seduced by the more ancient lures of politics and publicity. Some of the demons that haunt our world in recent years are invented by scientists.

Lecture  
Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

In recent years, much has been said about the post-modernist claims about science to the effect that science is just another form of raw power, tricked out in special claims for truth-seeking and objectivity that really have no basis in fact. Science, we are told, is no better than any other undertaking. These ideas anger many scientists, and they anger me. But recent events have made me wonder if they are correct.

Lecture  
Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

**Crick, Francis Harry Compton** 1916–2004

English biochemist

One of the striking characteristics of modern science is that it often moves so fast that a research worker can see rather clearly whether his earlier ideas, or those of his contemporaries, were correct or incorrect.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Introduction (p. 3)  
Basic Books, Inc. New York, New York, USA. 1988

**Cromer, Alan** 1935–  
American physicist and educator

The notion that science and objective thinking are unnatural human activities seems quite radical at first. But when you think about it, monogamy, honesty, and democratic government are unnatural human behaviors as well. We are truly a species that has invented itself out of rather unpromising material. Our only claim to greatness is that we have at times gone against the grain of our own egocentrism to forge a higher vision of the world.

*Uncommon Sense: The Heretical Nature of Science*

Preface (p. ix)

Oxford University Press, Inc. New York, New York, USA. 1993

**Crothers, Samuel McChord** 1857–1927  
American clergyman and writer

Science will not tolerate half knowledge nor pleasant imaginings, nor sympathetic appreciations; it must have definite demonstrations. The knowledge of the best that has been said and thought may be consoling, but it implies an unscientific principle of selection. It can be proved by statistics that the best things are exceptional.

*The Gentle Reader*

The Hinter-Land of Science (p. 228)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

On the coasts of the Dark Continent of Ignorance the several sciences have gained a foothold. In each case there is a well-defined country carefully surveyed and guarded. Within its frontiers the laws are obeyed, and all affairs are carried on in an orderly fashion. Beyond it is a vague “sphere of influence,” a Hinter-land over which ambitious claims of suzerainty [foreign authority] are made; but the native tribes have not yet been exterminated, and life goes on very much as in the olden time.

*The Gentle Reader*

The Hinter-Land of Science (p. 231)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Crowley, Aleister** 1875–1947  
Poet and author

...science is always discovering odd scraps of magical wisdom and making a tremendous fuss about its cleverness!

*The Confessions of Aleister Crowley: An Autobiography*

Part Four, Chapter 64 (p. 593)

Arkana. 1989

**Crowther, James Arnold**  
No biographical data available

Science since its beginning has traveled many paths, and explored many territories. It has asked many questions, seeking to sift gold from dross, truth from illusion, and by its quest has brought to light many wonderful and precious things from the rich storehouse of nature.

In Francis Mason (ed.)

*The Great Design*

Radiation (p. 61)

The Macmillan Co. New York, New York, USA. 1934

**Cudmore, Lorraine Lee**  
American cell biologist

Almost anyone can do science; almost no one can do good science.

*The Center of Life: A Natural History of the Cell*

Biochemical Evolution (p. 35)

New York Times Book Company. New York, New York, USA. 1977

...good science is almost always so very simple. After it has been done by someone else, of course.

*The Center of Life: A Natural History of the Cell*

Biochemical Evolution (p. 36)

New York Times Book Company. New York, New York, USA. 1977

**Curie, Eve** 1904–  
French concert pianist and journalist

What does it matter to Science if her passionate servants are rich or poor, happy or unhappy, healthy or ill? She knows that they have been created to seek and to discover, and that they will seek and find until their strength dries up at its source. It is not in a scientist's power to struggle against his vocation: even on his days of disgust or rebellion his steps lead him inevitably back to his laboratory apparatus.

*Madame Curie*

Chapter XV (p. 193)

The Literary Guild of America, Inc. New York, New York, USA. 1937

**Curie, Marie Skłodowska** 1867–1934  
Polish-born French physicist and chemist

In science we must be interested in things, not in persons.

In Eve Curie

*Madame Curie*

Chapter XVI (p. 222)

The Literary Guild of America, Inc. New York, New York, USA. 1937

After all, science is essentially international, and it is only through lack of the historical sense that national qualities have been attributed to it.

*Memorandum*

Intellectual Cooperation, June 16, 1926

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

All science which end in words are dead the moment they come to life, except for their manual part, that is to say, the writing, which is the mechanical part.

*The Literary Works of Leonardo da Vinci* (Volume 1)

7a1148 (p. 35)

University of California Press. Berkeley, California, USA. 1977

There is no human experience that can be termed true science unless it can be mathematically demonstrated.

Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 141)

The Merrymount Press. Boston, Massachusetts, USA. 1906

...if thou sayest that sciences which begin and end in the mind are true, this cannot be conceded, but must

be denied for many reasons, and firstly because in such mental discourses experience is eliminated, and without experience there can be no certainty.

Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 141)

The Merrymount Press. Boston, Massachusetts, USA. 1906

### Dahlke, Paul

Established the first German Buddhist monastery

Science in its relations to nature resembles an old body-servant who has studied his master's ways long enough to be able to prophesy with tolerable accuracy what his master will do then and then under this or other circumstances – provided only that he does not do something else!

Translated by the Bhikkhau Silacara

*Buddhism & Science*

Chapter 6 (p. 90)

Macmillan & Co Ltd. London, England. 1913

With her [science] hypotheses science acts like a man who, in order to relieve himself of troublesome daily disbursements, pays out one lump sum of money for the settlement of all these petty claims. So science, in the place of countless daily, hourly – yea, in the amplest sense of the words – continuous incomprehensibilities of life, pays out one single, great incomprehensibility in the shape of central forces, atoms, ethers, out of which all the trifling requirements of the day – the running expenses, so to say – can now be met.

Translated by the Bhikkhau Silacara

*Buddhism & Science*

Chapter 6 (pp. 98–99)

Macmillan & Co Ltd. London, England. 1913

...we moderns are accustomed to look upon science as the mediator betwixt us and truth, – as the high-priest of truth, so to speak, from whose hands we receive the sacred host.

Translated by the Bhikkhau Silacara

*Buddhism & Science*

Chapter 6 (p. 81)

Macmillan & Co Ltd. London, England. 1913

Science, to the question as to when she finally means to pay what she owes to humanity, a genuine world-conception, has always but this one answer, "Tomorrow!"

*Buddhism & Science*

Chapter 6 (p. 103)

Macmillan & Co Ltd. London, England. 1913

### Dampier, Sir William Cecil 1867–1952

English scientific writer

The different sciences are not even parts of a whole; they are but different aspects of a whole, which essentially has nothing in it corresponding to the divisions we make; they are, so to speak, sections of our model of Nature in certain arbitrary planes, cut in directions to suit our convenience.

*The Recent Development of Physical Science*

Chapter I (p. 16)

John Murray. London, England. 1904

### Darwin, Charles Robert 1809–82

English naturalist

As for myself, I believe that I have acted rightly in steadily following, and devoting my life to Science. I feel no remorse from having committed any great sin, but have often and often regretted that I have not done more direct good to my fellow creatures.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter XVI (p. 530)

D. Appleton & Company. New York, New York, USA. 1896

### Darwin, Sir Francis 1848–1925

English botanist

But in science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs.

First Galton Lecture Before the Eugenics Society

*Eugenics Review*, Volume 6, Number 1, 1914

### Data (Fictional character)

Captain, the most elementary and valuable statement in science: "The beginning of wisdom is 'I do not know.'"

*Star Trek: The Next Generation*

Where Silence Has Lease

Television program

Season 2, 1988

### Davies, Paul Charles William 1946–

British-born physicist, writer, and broadcaster

There is a popular misconception that science is an impersonal, dispassionate, and thoroughly objective enterprise. Whereas most other human activities are dominated by fashions, fads, and personalities, science is supposed to be constrained by agreed rules of procedure and rigorous tests. It is the results that count, not the people who produce them.

This is, of course, manifest nonsense.

In Richard Feynman

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Preface (p. ix)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

Conventional science attempts to explain things exactly, in terms of general principles. Any sort of explanation for the shape of a snowflake or a coastline could not be of this sort.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 3 (p. 22)

Simon & Schuster. New York, New York, USA. 1988

Science may explain all the processes whereby the universe evolves its own destiny, but that still leaves room for there to be a meaning behind it all.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*  
Chapter 14 (p. 203)  
Simon & Schuster. New York, New York, USA. 1988

Science remains a sort of witchcraft, its practitioners regarded with a mixture of awe and suspicion...

*God and the New Physics*

Chapter 1 (p. 3)

Simon & Schuster. New York, New York, USA. 1983

...it is the job of science to solve mysteries without recourse to divine intervention.

*The Fifth Miracle: The Search for the Origin of Life*

Chapter 1 (p. 31)

Simon & Schuster. New York, New York, USA. 1996

### **Davies, Robertson** 1913–95

Canadian novelist

Science, during the past hundred and fifty years, has gained formidable new authority, and it is to Science that we owe the increased longevity of the race, and the control of many of the terrible ills that afflict mankind. Science may cure disease, but can it confer health? Like all powerful gods, Science seeks to be the One True God, and as it writhes about the staff of Hermes it seeks to diminish and perhaps drive out the other god, the god of Humanism.

*The Merry Heart*

Chapter 5 (p. 98)

McClelland & Stewart. Toronto, Ontario, Canada. 1996

### **Davis, Kenneth S.** 1912–99

American historian

In our time it has become all too easy to regard science as a vast impersonal force – a kind of Frankenstein's monster that, escaping human control, has forcibly seized us and carries us at terrifying speeds in directions we have not chosen towards ends unknown.

*The Cautionary Scientists: Priestley, Lavoisier, and the Founding of*

*Modern Chemistry*

Introduction (p. 7)

Putnam. New York, New York, USA. 1966

### **Davis, William Morris** 1850–1934

American geomorphologist

Science is therefore not final anymore than it is infallible.

In H. Shapley, H. Wright, and S. Rapport (eds.)

*Readings in the Physical Sciences*

The Reasonableness of Science (p. 25)

Appleton-Century-Crofts. New York, New York, USA. 1948

### **Davy, Sir Humphry** 1778–1829

English chemist

There is now before us a boundless prospect of novelty in science; a country unexplored, but noble and fertile in aspect; a land of promise in philosophy.

*The Collected Works of Sir Humphry Davy* (Volume 1)

*Memories of the Life of Sir Humphry Davy*

Chapter III (p. 117)

Smith, Elder & Company. London, England. 1839–1840

There are very few persons who pursue science with true dignity.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (p. 226)

J. Murray. London, England. 1830

Science has done much for man, but it is capable of doing still more; its sources of improvement are not yet exhausted; the benefits that it has conferred ought to excite our hopes of its capability of conferring new benefits; and, in considering the progressiveness of our nature, we may reasonably look forwards to a state of greater cultivation and happiness than that which we at present enjoy.

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 17)

Press of the Royal Institution of Great Britain. London. 1802

Science for its progression requires patronage, – but it must be a patronage bestowed, a patronage received, with dignity. It must be preserved independent. It can bear no fetters, not even fetters of gold, and least of all those fetters in which ignorance or selfishness may attempt to shackle it.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (pp. 209–210)

Longman, Rees, Orme, Brown, Green & Longman London, England.

1836

In all cases in science, it is our business to analyse every principle, and to ascertain to what expressions of facts it relates, or to what simpler laws it may be referred. It is our duty to separate propositions from human passions, and to reason on them as mere representations of things.

In John Davy (ed.)

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter III (p. 213)

Longman, Rees, Orme, Brown, Green & Longman London, England.

1836

...there are few persons who pursue science with true dignity; it is followed more as connected with objects of profit than those of fame, and there are fifty persons who take out patents for supposed inventions for one who makes a real discovery.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (pp. 157–158)

Cassell & Co., Ltd. London, England. 1889

Science is in fact nothing more than the refinement of common sense making use of facts already known to acquire new facts.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 163)

Cassell & Co., Ltd. London, England. 1889

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

Science, like proper literary studies, can be hard and challenging but science is – also like proper literary studies – wonderful.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 2 (p. 25)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

Far from science not being useful, my worry is that it is so useful as to overshadow and distract from its inspirational and cultural value. Usually even its sternest critics concede the usefulness of science, while completely missing the wonder. Science is often said to undermine our humanity, or destroy the mystery on which poetry is thought to thrive.

*Science, Delusion and the Appetite for Wonder*

Richard Dimbleby Lecture, BBC1 Television, November 12th, 1996

**de Balzac, Honoré** 1799–1850

French novelist

Science is the language of the temporal world; love is that of the spiritual world. Man, indeed, describes more than he explains; while the angelic spirit sees and understands. Science saddens man; love enraptures the angel; science is still seeking, love has found. Man judges of nature in relation to itself; the angelic spirit judges of it in relation to heaven. In short to the spirits everything speaks.

*The Works of Honoré Balzac* (Volume 2)

*Seraphita*

Part II (p. 58)

Nottingham Society. New York, New York, USA. 1901

**de Bono, Edward** 1933–

Maltese psychologist and writer

When you have got somewhere interesting, that is the time to look back and pick out the surest way of getting there again. Sometimes it is very much easier to see the surest route to a place only after you have arrived. You may have to be at the top of a mountain to find the easiest way up.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas*  
(p. 132)

Avon Books. New York, New York, USA. 1971

**de Gourmont, Rémy** 1858–1915

French critic and novelist

Science is the food of the intelligence.

Translated by Glenn S. Burne

*Selected Writings*

Art and Science (p. 171)

The University of Michigan Press, Ann Arbor, Michigan, USA. 1966

Science is the only truth and it is the great lie. It knows nothing, and people think it knows everything. It is misrepresented. People think that science is electricity, automobilism, and dirigible balloons. It is something

very different. It is life devouring itself. It is the sensibility transformed into intelligence. It is the need to know stifling the need to live. It is the genius of knowledge vivisectioning the vital genius.

Translated by Glenn S. Burne

*Selected Writings*

Art and Science (p. 172)

The University of Michigan Press, Ann Arbor, Michigan, USA. 1966

**de Morgan, Augustus** 1806–71

English mathematician and logician

The two eyes of exact science are mathematics and logic: the mathematical sect puts out the logical eye, the logical sect puts out the mathematical eye; each believing that it sees better with one eye than with two.

In Charles Lutwidge Dodgson

*Euclid and His Modern Rivals*

Appendix II (p. 246)

**de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

Science exists only in personal consciousness and thanks to it; astronomy, mathematics, have no other reality than that which they possess as knowledge in the minds of those who study and cultivate them.

Translated by J.E. Crawford Fritch

*The Tragic Sense of Life in Men and in Peoples*

The Starting-Point (pp. 30–31)

Macmillan & Company Ltd. London, England. 1921

True science teaches, above all, to doubt and be ignorant.

Translated by J.E. Crawford Fritch

*The Tragic Sense of Life in Men and in Peoples*

Chapter V (p. 93)

Macmillan & Company Ltd. London, England. 1921

**de Waal, Frans**

Professor of Scientific Communication

Instead of marching onward with perfect vision, science stumbles along behind leaders who occasionally take the wrong alley, after which it turns to other leaders who seem to know the way, then corrects itself again, until sufficient progress is made for the next generation to either thrust aside or build upon. In hindsight, the path taken may look straight, running from ignorance to profound insight, but only because our memory for dead ends is so much worse than that of a rat in a maze.

*The Ape and the Sushi Master: Cultural Reflections by a Primatologist*

Chapter 2 (p. 85)

Basic Books, Inc. New York, New York, USA. 2001

**del Rio, A. M.**

No biographical data available

It is impossible that he who has once imbibed a taste for science can ever abandon it.

Analysis of an Alloy of Gold and Rhodium from the Parting House at Mexico

*Annals of Philosophy*, Volume 10, Number 2, October, 1825



**Delbrück, Max** 1906–81

German-born American biologist

With science we can transcend our intuitions, just as with electronics we can transcend our eyes and ears. To the question of how such transcendence can have arisen in the course of biological evolution I have no satisfactory answer.

*Mind from Matter*

Twenty (p. 280)

Blackwell Scientific Publications, Inc. Palo Alto, California, USA. 1986

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

The sciences are now masked, but when the masks are lifted, they will be seen in their beauty. Upon inspecting the chain of the sciences, it will not appear more difficult to remember them than a series of numbers.

In William R. Shea

*The Magic of Numbers and Motion: The Scientific Career of René**Descartes*

Chapter Five (p. 101)

Science History Publications Canton, Massachusetts, USA. 1991

Science is like a woman: if she stays faithful to her husband she is respected; if she becomes common property she grows to be despised.

In William R. Shea

*The Magic of Numbers and Motion: The Scientific Career of René**Descartes*

Chapter Five (p. 114)

Science History Publications. Canton, Massachusetts, USA. 1991

**Dewar, James** 1842–1923

English physicist and chemist

To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavor, is enough to satisfy the legitimate ambition of every earnest student of nature.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

History of Cold and the Absolute Zero (p. 240)

Government Printing Office. Washington, D.C. 1903

In a legitimate sense all genuine scientific workers feel that they are ‘the inheritors of unfulfilled renown.’ The battlefields of science are the centres of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of Nature. To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavor, is enough to satisfy the legitimate ambition of every earnest student of Nature. The real warranty that the march of progress in the future will be as glorious

as in the past lies in the perpetual reinforcement of the scientific ranks by recruits animated by such a spirit, and proud to obtain such a reward.

*Report of the Seventy-second Meeting of the British Association for the Advancement of Science*

History of Cold and the Absolute Zero (p. 50)

John Murray. London, England. 1903

**Dewey, John** 1859–1952

American philosopher and educator

We define science as systematized knowledge, but the definition is wholly ambiguous. Does it mean the body of facts, the subject-matter? Or does it mean the processes by which something fit to be called knowledge is brought into existence, and order introduced into the flux of experience?

Science as Subject-Matter and as Method

*Science*, N.S. Volume 31, Number 787, January 28, 1910 (p. 125)**Dickens, Charles** 1812–70

English novelist

I don’t know where this here science is to stop, mind you; that’s what bothers me.

*Sketches*

Vauxhil-Gardens by Day (p. 126)

Leipzig, Germany. 1843

**Dickinson, Emily** 1830–86

American lyric poet

I climb the “Hill of Science,”

I view the landscape o’er;

such transcendental prospects,

I ne’er beheld before!

*The Complete Poems of Emily Dickinson*

No. 3 (p. 5)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1960

**Dickinson, G. Lowes** 1862–1932

English historian and political activist

Science hangs in a void of nescience, a planet turning in the dark.

*A Modern Symposium* (p. 159)

Doubleday, Page &amp; Company. Garden City, New York, USA. 1920

**Disraeli, Benjamin, First Earl****of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

What Art was to the ancient world, Science is to the modern...

*Coningsby*

Book IV, Chapter I (p. 126)

J.M. Dent &amp; Sons Ltd. London, England. 1911

...the pursuit of science leads only to the insoluble.

*Lothair*

Chapter XVII (p. 70)

Longmans, Green &amp; Co. London, England. 1879



Science may prove the insignificance of this globe in the scale of creation...but it cannot prove the insignificance of man.

*Lothair*

Chapter LXXVII (p. 409)

Longmans, Green & Co. London, England. 1879

**Dobie, J. Frank** 1888–1964

American folklorist

Putting on the spectacles of science in expectation of finding the answer to everything looked at signifies inner blindness.

*The Voice of the Coyote*

Introduction (p. xvi)

Little, Brown & Company. Boston, Massachusetts, USA. 1949

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Science does more than collect facts; it makes sense of them. Great scientists are virtuosi of the art of discovering the meaning of what otherwise might seem barren observations.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1974

Advancement and Obsolescence in Science (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1974

Science has been called “the endless frontier.” The more we know, the better we realize that our knowledge is a little island in the midst of an ocean of ignorance.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1974

Advancement and Obsolescence in Science (p. 61)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1974

**Dott, Jr., Robert H.**

No biographical data available

**Batten, Henry L.**

No biographical data available

Science consists simply of the formulation and testing of hypotheses based on observational evidence; experiments are important where applicable, but their function is merely to simplify observation by imposing controlled conditions.

*Evolution of the Earth* (2nd edition)

Chapter 3 (p. 40)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Douglas, Mary** 1921–

No biographical data available

**Wildavsky, A.**

No biographical data available

In our modern world people are supposed to live and die subject to known, measurable natural forces, not subject to mysterious moral agencies. That mode of reasoning, indeed, is what makes modern man modern. Science wrought this change between us and nonmoderns. It is hardly true,

however, that their universe is more unknown than ours. For anyone disposed to worry about the unknown, science has actually expanded the universe about which we cannot speak with confidence.... This is the double-edge thrust of science, generating new ignorance with new knowledge. The same ability to detect causes and connections or parts per trillion can leave more unexplained than was left by cruder measuring instruments.

*Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers*

Chapter III (p. 49)

University of California Press. Berkeley, California, USA. 1982

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Science seeks knowledge. Let the knowledge lead us where it will, we still must seek it. To know once for all what we are, why we are, where we are, is that not in itself the greatest of all human aspirations?

*The Land of Mist; The Maracot Deep; and Other Stories*

When the World Screamed (p. 430)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**Drew, Joseph**

No biographical data available

...let science remove the scales from our eyes, and lift the pall of ignorance from our minds, and we at once recognise the grandeur and the magnificence of the heavens. What bright vistas of imperishable glory are immediately opened up for our contemplation! Those rolling worlds and glittering atoms that congregate through the fields of space, begin at once to fascinate our minds and arrest our attention, and we feel desirous to know more of their secret history and their use.

*Our Home in the Stars*

Our Home in the Stars (p. 20)

Elliot Stock. London, England. 1872

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Science distinguishes a Man of Honour from one of those Athletick Brutes whom undeservedly we call Heroes.

*Fables Ancient and Modern*

Dedication

Printed for Jacob Tonson. London, England. 1700

...science perfects genius; and also moderates that fury of the fancy which cannot contain itself within the bounds of reason; but often carries a man into dangerous extremes.

*The Works of John Dryden* (Volume 17)

The Art of Painting (p. 345)

Printed for William Miller. London, England. 1808

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

Science is very young when compared to the moral, spiritual, and religious ideas of humanity. It enjoys the prestige

of a new toy. But we must not be misled. In spite of its youth and imperfections, it constitutes the best means of convincing us of the immensity and harmonious beauty of the universe, revealed by the infinite complexity of the apparently most simple phenomena. It is an orderly and confounding complexity which is a thousand times better qualified than ignorance to make us feel the omnipotence of the Creator.

*Between Knowing and Believing*

The Future of Spirit 1941 (p. 216)

McKay. New York, New York, USA. 1967

Either we have absolute confidence in our science and in the mathematical and other reasonings which enable us to give a satisfactory explanation of the phenomena surrounding us – in which case we are forced to recognize that certain fundamental problems escape us and that their explanation amounts to admitting a miracle – or else we doubt the universality of our science and the possibility of explaining all natural phenomena by chance alone; and we fall back on a miracle or a hyperscientific intervention.

*Human Destiny*

Chapter 3 (p. 36)

Longmans, Green & Company. London, England. 1947

### **Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Science is still the versatile, unpredictable hero of the play, creating endless new situations, opening romantic vistas and challenging accepted concepts.

*Louis Pasteur: Free Lance of Science*

Chapter I (p. 15)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation because that nation will remain the first which carries the furthest the works of thought and intelligence.

*Louis Pasteur: Free Lance of Science*

Chapter III (p. 85)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

Science is not the product of lofty meditations and genteel behavior, it is fertilized by heartbreaking toil and long vigils – even if, only too often, those who harvest the fruit are but the laborers of the eleventh hour.

*Louis Pasteur: Free Lance of Science*

Chapter XIV (p. 389)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

Science shows us what exists but not what to do about it.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 14 (p. 325)

Simon & Schuster. New York, New York, USA. 1988

### **Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

The bondage under which all true science lies to fact the necessity of groping among the detail of little and common things this is a hard lesson for the human intellect to learn conscious as that intellect is of its own great powers of its own high aims of its own large capacities of intuitive understanding. But it is a lesson which must be learned. There are no short cuts in Nature. Her results are always attained by method. Her purposes are always worked out by law.

*The Reign of Law* (4th American edition)

Chapter VII (p. 331)

George Routledge & Sons. New York, New York, USA. 1873

### **Durant, William James** 1885–1981

American historian and essayist

Every science begins as philosophy and ends as art; it arises in hypothesis and flows into achievement.

*The Story of Philosophy*

Introduction (p. 2)

Simon & Schuster Paperback. New York, New York, USA. 2005

### **Dyson, Freeman J.** 1923–

American physicist and educator

Science is even more unpredictable than history. Every important discovery in science is by definition unpredictable. If it were predictable, it would not be an important discovery. The purpose of science is to create opportunities for unpredictable things to happen. When nature does something unexpected, we learn something about how nature works.

*From Eros to Gaia*

Chapter 6 (p. 68)

Pantheon Books. New York, New York, USA. 1992

It used to be said, before the recent era of revolutionary discoveries, that science was organized common sense. In the modern era it would be more accurate to define science as organized unpredictability.

*From Eros to Gaia*

Chapter 6 (p. 68)

Pantheon Books. New York, New York, USA. 1992

### **Eakin, Richard M.**

American zoologist

If I had any advice to [give] you it is just this: love science but do not worship it. Put science in its proper place, ranking it along with philosophy and history, music and religion, literature and art. If I had my life to live again (Darwin says), I would make it a rule to read some poetry and listen to some music at least once every week.

*Great Scientists Speak Again*  
Chapter 6 (p. 107)  
University of California Press, Berkeley, California, USA, 1975

### **Eben, Aubrey**

No biographical data available

Science is not a sacred cow. Science is a horse. Don't worship it. Feed it.

*Reader's Digest*, March, 1963 (p. 67)

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

To imagine that Newton's great scientific reputation is tossing up and down in these latter-day revolutions is to confuse science with omniscience.

*The Nature of the Physical World*

Chapter X (p. 202)

The Macmillan Company. New York, New York, USA. 1930

We need scarcely add that the contemplation in natural science of a wider domain than the actual leads to a far better understanding of the actual.

*The Nature of the Physical World*

Chapter XII (p. 267)

Cambridge University Press. Cambridge, England. 1928

Science has its showrooms and its workshops. The public today, I think rightly, is not content to wander round the showrooms where the tested products are exhibited; they demand to see what is going on in the workshops. You are welcome to enter; but do not judge what you see by the standards of the showroom. We have been going round a workshop in the basement of the building of science. The light is dim, and we stumble sometimes. About us is confusion and mess which there hasn't been time to sweep away. The workers and their machines are enveloped in murkiness. But I think that something is being shaped here – perhaps something rather big. I do not quite know what it will be when it is completed and polished for the showroom.

*The Expanding Universe*

Chapter IV, Section VII (p. 126)

The University Press. Cambridge, England. 1933

...unless science is to degenerate into idle guessing, the test of value of any theory must be whether it expresses with as little redundancy as possible the facts which it intended to cover.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*  
Chapter I (p. 29)

At The University Press. Cambridge, England. 1921

...where science has progressed the farthest, the mind has but regained from nature that which the mind has put into nature.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (pp. 200–201)

At The University Press. Cambridge, England. 1921

...science is no longer disposed to identify reality with concreteness. Materialism in its literal sense is long since dead. But its place has been taken by other philosophies which represent a virtually equivalent outlook. The tendency today is not to reduce everything to manifestations of matter – since matter now has only a minor place in the physical world – but to reduce it to manifestations of the operation of natural law.

*Science and the Unseen World*

Lecture V (p. 50)

The Macmillan Co. New York, New York, USA. 1929

### **Editor**

“Science” that is simply inquiring into the mysteries of the universe, is not science. True science has already inquired and knows. Science is knowledge.

*The Flaming Sword*

In the Editorial Perspective

December 3, 1897 (p. 10)

### **Editorial**

...Science cannot now be propelled on its onward course by the efforts of unassisted individuals only, and...the State must itself, sooner or later, put its shoulder vigorously to the wheel, that there is some danger least we should be thought to undervalue the force of private enterprise.

The Government of the Royal Society

*Nature*, Volume III, November 3, 1870 (p. 3)

### **Egler, Frank E.** 1911–96

American botanist and ecologist

...science...ever [reflects] a faith in the intelligibility of nature.

*The Way of Science*

The Nature of Science (p. 2)

Hafner Publishing Company. New York, New York, USA. 1970

### **Einstein, Albert** 1879–1955

German-born physicist

One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike – and yet it is the most precious thing we have.

In Banesh Hoffman

*Albert Einstein: Creator and Rebel*

Preface (p. v)

The Viking Press. New York, New York, USA. 1972

Science as something existing and complete is the most objective thing known to man. But science in the making, science as an end to be pursued, is as subjective and psychologically conditioned as any other branch of human endeavor – so much so, that the question “what is the purpose and meaning of science?” receives quite different answers at different times and from different sorts of people.

*The World as I See It*

Address at Columbia University, New York (p. 137)  
Philosophical Library, New York, New York, USA. 1949

Strange that science, which in the old days seemed harmless, should have evolved into a nightmare that causes everyone to tremble.

In G.J. Whitrow

*Einstein: The Man and His Achievement*

Chapter III (p. 89)

BBC. London, England. 1967

Science will stagnate if it is made to serve practical goals.

In Otto Nathan and Heinz Norden

*Einstein on Peace*

Chapter Thirteen (p. 402)

Simon & Schuster. New York, New York, USA. 1960

...science can only ascertain what is, but not what should be, and outside of its domain value judgments of all kinds remain necessary.

*Out of My Later Years*

Science and Religion, II (p. 25)

Thames & Hudson. London, England. 1950

The whole of science is nothing more than a refinement of everyday thinking.

*Out of My Later Years*

Physics and Reality, I (p. 59)

Thames & Hudson. London, England. 1950

...the fact that in science we have to be content with an incomplete picture of the physical universe is not due to the nature of the universe itself but rather to us.

In Max Planck

*Where Is Science Going?*

Prologue (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

The belief in an external world independent of the perceiving subject is the basis of all natural science.

*Essays in Science*

Clerk Maxwell's Influence on the Evolution of the Idea of Physical Reality (p. 40)

Philosophical Library. New York, New York, USA. 1934

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Science is not just a collection of laws, a catalogue of unrelated facts. It is a creation of the human mind, with its freely invented ideas and concepts.

*The Evolution of Physics*

Physics and Reality (p. 294)

Simon & Schuster. New York, New York, USA. 1961

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Thus science, as it leads men further and further from the first world they inhabited, the world we call natural, into a new and unguessed domain, is beguiling them.

*The Invisible Pyramid*

Chapter Four (p. 106)

University of Nebraska Press. Lincoln, Nebraska, USA.

**Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

Science seeks to build, not to destroy; to aid, not to hinder.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part One (p. 8)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Men can do nothing without the make-believe of a beginning. Even Science, the strict measurer, is obliged to start with a make-believe unit, and must fix on a point in the stars' unceasing journey when his sidereal clock shall pretend that time is Nought.

*Daniel Deronda*

Book I, Chapter I (p. 3)

Harper & Brothers. New York, New York, USA. 1876

**Emelyanov, A. S.**

No biographical data available

Science provides mankind with a great tool of cognition which makes it possible to reach unprecedented heights of abundance and equality. This determines the most important and most fruitful aspect of the social role of science, and as a result the social responsibility of scientists is growing.

In Maurice Goldsmith and Alan Mackay (eds.)

*Society and Science*

Scientist and Public Affairs (p. 31)

Simon & Schuster. New York, New York, USA. 1965

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

All science has one aim, namely, to find a theory of nature.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Introduction (p. 7)

The Library of America. New York, New York, USA. 1983

Empirical science is apt to cloud the sight, and, by the very knowledge of functions and processes, to bereave the student of the manly contemplation of the whole. The savant becomes unpoetic.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Prospects (p. 43)

The Library of America. New York, New York, USA. 1983

What drops of all the sea of our science are baled up! and by what accident it is that these are exposed, when so many secrets sleep in nature!

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

The Poet (p. 466)

The Library of America. New York, New York, USA. 1983

Science is a search after identity, and the scientific whim is lurking in all corners.

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Beauty (p. 1108)

The Library of America. New York, New York, USA. 1983

Intellectual science has been observed to beget invariably a doubt of the existence of matter.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

*Nature: Addresses and Lectures*

Nature (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science is cold.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

*Nature: Addresses and Lectures*

An Address (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

It is this domineering temper of the sensual world that creates the extreme need of the priests of science....

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

*Nature: Addresses and Lectures*

Literary Ethics (p. 186)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

...as the power or genius of nature is ecstatic, so must its science or the description of it be.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

*Nature: Addresses and Lectures*

The Method of Nature (p. 213)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

When science is learned in love, and its powers are wielded by love, they will appear the supplements and continuations of the material creation.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

*Essays: First Series*

Art (p. 369)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Something is wanting to science until it has been humanized.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

*Representative Men*

Chapter I (p. 10)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

It is the last lesson of modern science that the highest simplicity of structure is produced, not by few elements, but by the highest complexity.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

*Representative Men*

Goethe; or, The Writer (p. 290)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science in England, in America, is jealous of theory, hates the name of love and moral purpose. There's revenge for this humanity. What manner of man does science make?

The boy is not attracted. He says, I do not wish to be such a kind of man as my professor is.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

*The Conduct of Life*

Beauty (p. 284)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Scraps of science, of thought, of poetry are in the coarsest sheet, so that in every house we hesitate to burn a newspaper until we have looked it through.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

*Society and Solitude*

Chapter II (p. 24)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science has shown the great circles in which Nature works....

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

*Society and Solitude*

Chapter VI (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

You must have eyes of science to see in the seed its nodes....

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

*Letters and Social Aims*

Chapter I (p. 71)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science surpasses the old miracles of mythology, to fly with them over the sea, and to send their messages under it.

*Letters and Social Aims*

Progress of Culture (p. 207)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

Science...necessitates a faith commensurate with the grander orbits and universal laws which it discloses. Yet it does not surprise the moral sentiment. That was older, and awaited expectant these larger insights.

*Letters and Social Aims*

Progress of Culture (pp. 216-217)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1888

In science we have to consider two things: power and circumstance.

*The Conduct of Life*

Fate (p. 14)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

All our science lacks a human side. The tenant is more than the house. Bugs and stamens and spores, on which we lavish so many years, are not finalities, and man, when his powers unfold in order, will take Nature along with him, and admit light into all her recesses. The human heart concerns us more than the poring into microscopes, and is larger than can be measured by the pompous figures of the astronomer.



*The Conduct of Life*

Beauty (p. 222)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1894

Science is a search after identity, and the scientific whim is lurking in all corners.

*The Conduct of Life*

Illusions (p. 314)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

Science corrects the old creeds; sweeps away, with every new perception, our infantile catechisms; and necessitates a faith commensurate with the grander orbits and universal laws which it discloses.

*Works of Ralph Waldo Emerson* (Volume 4)

*Progress of Culture* (p. 183)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1880

The sciences, even the best, – mathematics, and astronomy, – are like sportsmen, who seize whatever prey offers, even without being able to make any use of it.

*Representative Men* (p. 65)

Bernard Tauchnitz. Leipzig, Germany 1907

When science is learned in love, and its powers are wielded by love, they will appear the supplements and continuation, of the material creation.

*Essays, Lectures and Orations*

Art (p. 192)

William S. Orr & Co. London, England. 1848

... every good reader will easily recall expressions or passages in works of pure science which have given him the same pleasure which he seeks in professed poets.

*Letters and Social Aims*

Poetry and Imagination (p. 50)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Emmeche, Claus** 1956–

Danish theoretical biologist

It has been said that science demystifies the world. It is closer to the truth to say that science, when it is at its best, opens the world up for us, bringing daily realities under a kind of magic spell and providing the means to see the limits of what we think we know, and the scope of what we do not at all understand.

Translated by Steven Sampson

*The Garden in the Machine: The Emerging Science of Artificial Life*

Chapter One (p. 13)

Princeton University Press. Princeton, New Jersey, USA. 1994

**Enriques, Federigo** 1871–1946

Italian mathematician

Science would never have reached its present state, had it not been constantly changing the form and the statement of its problems, adapting the scope of its researches to the changed conditions of thought.

Translated by Katharine Royce

*Problems of Science*

Introduction (p. 5)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

To the pride of spirit, which believes itself sole lord of a world of dreams, and would discover all laws within itself, science replies by showing a reality which spreads about and beyond us, and so escapes the vain claim that it should be subject to our sentiments or to our will.

*Problems of Science*

Introduction (p. 9)

The Open Court Publishing Co. La Salle, Indiana, USA. 1914

Science, considered as to its growth, not only rises to ever greater objectivity, but by contrast carries to a higher point the subjectivity of its representations which are its means of conquest.

*Problems of Science*

Introduction (p. 29)

The Open Court Publishing Co. La Salle, Indiana, USA. 1914

**Everett, Edward** 1794–1865

American statesman, educator, and orator

It usually happens in scientific progress, that when a great fact is at length discovered, it approves itself at once to all competent judges. It furnishes a solution to so many problems, and harmonizes with so many other facts, – that all the other data as it were crystallize at once about it.

*The Uses of Astronomy*

An Oration Delivered at Albany on the 28th of July, 1856 (p. 30)

Ross & Tousey. New York, New York, USA. 1856

Unspeaking are the attractions of patient enthusiastic science, now following the traces of creative wisdom, along the minutest fibres of microscopic life, and now clinging to the folds of the streaming robe of Omnipotence, as it floats over the transcendent galaxies of the highest heavens.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

An Address (p. 76)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Farley, Harriet** 1817–1907

American writer and editor

Science has been beautifully compared to a Hill; may it not also be likened to a vast Garden? Its different branches are the various paths, and its facts, experiments and theories, are the many plants and flowers. This garden has been redeemed by much toil and care from the vast wastes of Ignorance, and its verge is now but too barren. The shades of the dark Forest of Mystery throw a gloom upon its borders, and but few of its walks give evidence of long continued cultivation.



*Shells from the Strand of the Sea of Genius*

The Garden of Science (p. 14)

J. Munroe and Co. Boston, Massachusetts, USA. 1847

### Feigl, H.

No biographical data available

...science, properly interpreted, is not dependent on any sort of metaphysics. It merely attempts to cover a maximum of facts by a minimum of laws.

Naturalism and Humanism

*American Quarterly*, Volume 1, Number 2, Summer, 1949 (p. 148)

### Ferré, Nels F. S. 1908–71

Swedish-American theologian

It is a sad experience to hear someone denounce science as the cause of modern chaos and destruction. Our technological advance may be abused and make of what could be a near heaven a near hell, but that is surely not the fault of science as such. Science has not failed man, but man has failed science.

*Faith and Reason*

Chapter II (p. 38)

Harper & Brothers. New York, New York, USA. 1946

Science is supposed by many to have banished every realm of the sacred; and behold, science becomes the sacred cow.

*Faith and Reason*

Chapter II (p. 43)

Harper & Brothers. New York, New York, USA. 1946

### Ferris, Timothy 1944–

American science writer

Far too many students accept the easy belief that they need not bother learning much science, since a revolution will soon disprove all that is currently accepted anyway. In such a climate it may be worth affirming that science really is progressive and cumulative, and that well-established theories, though they may turn out to be subsets of larger and farther-reaching ones – as happened when Newtonian mechanics was incorporated by Einstein into general relativity – are seldom proved wrong....

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1996

Science is not perfect, but neither is it just one more sounding board for human folly.

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1996

### Feyerabend, Paul K. 1924–94

Austrian-born American philosopher of science

Science is an essentially anarchistic enterprise....

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Analytical Index (p. 10)

Verso. London, England. 1978

Science is neither a single tradition, nor the best tradition there is, except for people who have become accustomed to its presence, its benefits and its disadvantages. In a democracy it should be separated from the state just as churches are now separated from the state.

*Against Method: Outline of an Anarchistic Theory of Knowledge* (p. 238)  
Verso. London, England. 1978

Science is not a closed book that is understood only after years of training. It is an intellectual discipline that can be examined and criticised by anyone who is interested, and that looks difficult and profound only because of a systematic campaign of obfuscation carried out by many scientists...

In E.D. Klemke, Robert Hollinger and A. David Kline

*Introductory Reading in the Philosophy of Science*

How to Defend Society Against Science (p. 62)

Prometheus Books. Buffalo, New York, USA. 1980

### Feynman, Richard P. 1918–88

American theoretical physicist

...science is of value because it can produce something.

*What Do You Care What Other People Think?*

The Value of Science (p. 241)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

We must, incidentally, make it clear from the beginning that if a thing is not a science, it is not necessarily bad. For example, love is not a science. So, if something is said not to be a science, it does not mean that there is something wrong with it; it just means that it is not a science.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

The Relation of Physics to Other Sciences (p. 47)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

Is science of any value?

I think a power to do something is of value. Whether the result is a good thing or a bad thing depends on how it is used, but the power is a value.

Once in Hawaii I was asked to see a Buddhist temple. In the temple a man said, "I am going to tell you something that you will never forget." And then he said, "To every man is given the key to the gates of heaven. The same key opens the gates of hell."

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 6)

Perseus Books. Reading, Massachusetts, USA. 1998

And so it is with Science. In a way it is key to the gates of heaven, and the same key opens the gates of hell, and we do not have any instructions as to which is which gate. Shall we throw away the key and never have a way to enter the gates of heaven? Or shall we struggle with the problem of which is the best way to use the key? That is, of course, a very serious question, but I think that we cannot deny the value of the key to the gates of heaven.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (pp. 6–7)  
Perseus Books. Reading, Massachusetts, USA. 1998

[An] aspect of science is its contents, the things that have been found out. This is the yield. This is the gold. This is the excitement, the pay you get for all the disciplined thinking and hard work. The work is not done for the sake of an application. It is done for the excitement of what is found out. ...it is almost impossible for me to convey in a lecture this important aspect, this exciting part, the real reason for science. And without understanding this you miss the whole point.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 9)  
Perseus Books. Reading, Massachusetts, USA. 1998

You cannot understand science and its relation to anything else unless you understand and appreciate [it as] the great adventure of our time. You do not live in your time unless you understand that this is...a wild and exciting thing.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 9)  
Perseus Books. Reading, Massachusetts, USA. 1998

Science alone of all the subjects contains within itself the lesson of the danger of belief in the infallibility of the greatest teachers in the preceding generation.... As a matter of fact, I can also define science another way: Science is the belief in the ignorance of experts.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 8 (p. 188)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

If you thought before that science was certain – well, that is just an error on your part.

*The Character of Physical Law*  
Chapter 3 (p. 77)  
BBC. London, England. 1965

Although it is uncertain, it is necessary to make science useful. Science is only useful if it tells you about some experiment that has not been done; it is not good if it only tells you what just went on.

*The Character of Physical Law*  
Chapter 7 (p. 164)  
BBC. London, England. 1965

...it is imperative in science to doubt; it is absolutely necessary, for progress of science, to have uncertainty as a fundamental part of your inner nature.

*Engineering and Science*, Volume 19, 1956 (p. 21)

Science can be defined as a method for, and a body of information obtained by, trying to answer only questions which can be put into the form: If I do this, what will happen?

*Engineering and Science*, Volume 19, 1956 (p. 23)

**Fischer, Emil Hermann** 1852–1919  
German chemist

The sciences are not abstract constructions, but rather the result of human endeavor; they are closely connected with the personalities and the fates of the dedicated researchers who developed them.

In Rolf Huisgen  
*Adolf von Baeyer's Scientific Achievements – A Legacy*  
*Angewandte Chemie International Edition in English*, Volume 25, Number 4, April, 1986 (p. 297)

...science is and remains international.

In Albert Einstein  
*The World as I See It*  
*The International Science* (p. 50)  
Philosophical Library. New York, New York, USA. 1949

**Fiske, John** 1842–1901  
American philosopher and historian

...all human science is but the increment of the power of the eye....

*The Destiny of Man Viewed in the Light of His Origin*  
Chapter VII (p. 60)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

...there are moments when one passionately feels that this cannot be all. On warm June mornings in green country lanes, with sweet pine-odours, wafted in the breeze which sighs through the branches, and cloud-shadows flitting over far-off blue mountains, while little birds sing their love-songs, and golden-haired children weave garlands of wild roses; or when in the solemn twilight we listen to wondrous harmonies of Beethoven and Chopin that stir the heart like voices from an unseen world; at such times one feels that the profoundest answer which science can give to our questionings is but a superficial answer after all.

*The Unseen World, and Other Essays*  
I. The Unseen World, Part II (p. 56)  
Houghton Mifflin Company. New York, New York, USA. 1876

**Flaubert, Gustave** 1821–90  
French novelist

My kingdom is as wide as the universe and my desire has no limits. I am always going about enfranchising the mind and weighing the world, without hate, without fear, without love, and without God. I am called Science.

*Works: The Temptation of St. Anthony*  
Chapter V (p. 141)  
St. Dunstan Society. Akron, Ohio, USA. 1904

**Forbes, Edward** 1815–54  
English naturalist

People without independence have no business to meddle with science. It should never be linked with lucre.

In George Wilson and Archibald Geikie  
*Memoir of Edward Forbes, F.R.S.*  
Chapter XII (p. 392)  
Macmillan & Company Ltd. Cambridge, England. 1861

**Forel, Auguste** 1848–1931

Swiss neuroanatomist, psychiatrist, and entomologist

There is a growing tendency amongst the laity to tread not only the broad highways of science, but to explore its more fascinating by-paths.

*The Senses of Insects*

Translators Preface (p. vii)

Methuen &amp; Co. London, England. 1908

**Foster, Sir Michael** 1836–1907

English physiologist

Man does not live by bread alone, and science brings him more than bread. It is a great thing to make two blades of grass grow where before one alone grew; but it is no less great a thing to help a man to come to a just conclusion on the questions with which he has to deal.

The President's Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 130)**Fort, Charles** 1874–1932

American writer

Every science is a mutilated octopus. If its tentacles were not clipped to stumps, it would feel its way into disturbing contacts.

In Damon Knight

*Charles Fort: Prophet of the Unexplained*

A Charles Fort Sampler (p. vi)

Gollancz. London, England. 1971

**Fox, Robin** 1934–

English anthropologist, poet, and essayist

Since science has no value agenda of its own it is always subject to hijacking by fanaticism and idealism.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 329)

New York Academy of Sciences. New York, New York, USA. 1996

The point that science can be used for evil purposes is beside the point. Art and music can be used for evil purposes, but no one proposes abandoning either. Anything can be used for evil purposes. I am not going to stop listening to Wagner just because Hitler liked him.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 332)

New York Academy of Sciences. New York, New York, USA. 1996

**Franck, Georg** 1946–

No biographical data available

Success in science is rewarded with attention. You gain full membership in the scientific community only by receiving the attention of your fellow scientists. Earning this attention “income” is a prime motive for becoming a scientist and for practicing science. In order to maximize

this income, you have to employ your own attention in the most productive way. It does not pay to find things out anew that have been discovered already. Nor is reinvention rewarding in terms of the attention paid. It pays no pay attention to the work done by others.

Scientific Communication – A Vanity Fair?

*Science*, Volume 286, Number 5437, 1 October, 1999 (p. 53)**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

No, our science is no illusion. But an illusion it would be to suppose that what science cannot give us we can get elsewhere.

*The Future of an Illusion*

Chapter X (p. 56)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1961

Science in her perpetual incompleteness and insufficiency is driven to hope for her salvation in new discoveries and new ways of regarding things. She does well, in order not to be deceived, to arm herself with skepticism and to accept nothing new unless it has withstood the strictest examination.

*Collected Papers*

The Resistance to Psycho-Analysis (p. 4121)

The Hogarth Press. London, England. 1953

**Friend, Julius W.**

European historian

**Feibleman, James K.** 1904–87

American philosopher

The modern world, which has lost faith in so many causes, still accepts science nearly unchallenged. Science today occupies the position held by the Roman Church in the Middle Ages: as the single great authority in a world divided on almost every object of loyalty.

*What Science Really Means*

Chapter I (p. 11)

George Allen &amp; Unwin Ltd. London, England. 1937

**French Apothegm***Le scepticisme est le vrai flambeau de la science.*

Doubt is the true torch of science.

In John Epps

*The Life of Dr. Walker*

Chapter IV (p. 101)

Whittaker, Treacher. London, England. 1831

**Frost, Robert** 1874–1963

American poet

And how much longer a story has science  
Before she must put out the light on the children  
And tell them the rest of the story is dreaming?

*Complete Poems of Robert Frost*

Too Anxious for Rivers

Henry Holt &amp; Company. New York, New York, USA. 1949

Where have those flowers and butterflies all gone  
That science may have staked the future on?  
He seems to say the reason why so much  
Should come to nothing must be fairly faced....

*Complete Poems of Robert Frost*

Pod of the Milkweed

Henry Holt & Company, New York, New York, USA. 1949

Sarcastic Science, she would like to know,  
In her complacent ministry of fear,  
How we propose to get away from here  
When she has made things so we have to go  
Or be wiped out.

*Complete Poems of Robert Frost*

Why Wait for Science

Henry Holt & Company, New York, New York, USA. 1949

**Frye, Northrop** 1912–91

Canadian literary critic

Science begins with the world we have to live in, accepting its data and trying to explain its laws. From there, it moves toward the imagination: it becomes a mental construct, a model of a possible way of interpreting experience. The further it goes in this direction, the more it tends to speak the language of mathematics, which is really one of the languages of the imagination, along with literature and music.

*The Educated Imagination*

The Motive for Metaphor (p. 6)

The House of Ansi. Toronto, Ontario, Canada. 2002

**Fulbright, James William** 1905–95

American politician

What a curious picture it is to find man, *Homo sapiens*, of divine origin, we are told, seriously considering going underground to escape the consequences of his own folly. With a little wisdom and foresight, surely it is not yet necessary to forsake life in the fresh air and in the warmth of the sunlight. What a paradox if our own cleverness in science should force us to live underground with the moles.

The Effect of the Atomic Bomb on American Foreign Policy

*Congressional Record*, November 2, 1945, Volume 91, Appendix

(p. A4654)

Science has radically changed the conditions of human life on earth. It has expanded our knowledge and our power but not our capacity to use them with wisdom.

*Old Myths and New Realities*

Conclusion (p. 142)

Random House, Inc. New York, New York, USA. 1964

**Gäbor, Dennis** 1900–79

Hungarian-English physicist

Science has never quite given man what he desired, not even in applied science. Man dreamt of wings; science gave him an easy chair which flies through the air.

*Inventing the Future*

The Future of the Uncommon Man (p. 162)

Secker & Warburg, London, England. 1963

**Garrod, Archibald** 1857–1936

English physician

Science is not, as so many seem to think, something apart, which has to do with telescopes, retorts, and test tubes, and especially with nasty smells, but it is a way of searching out by observation, trial, and classification; whether the phenomenon investigated be the outcome of human activities, or of the more direct workings of nature's laws. Its methods admit of nothing untidy or slipshod, its keynote is accuracy and its goal is truth.

In Alexander G. Bearn

*Archibald Garrod and the Individuality of Man*

Chapter 8 (p. 97)

Clarendon Press, Oxford, England. 1993

**Gerould, Katherine Fullerton** 1879–1944

American writer

Science has done great things for us; it has also pushed us hopelessly back. For, not content with filling its own place, it has tried to supersede everything else. It has challenged the super-eminence of religion; it has turned all philosophy out of doors except that which clings to its skirts; it has thrown contempt on all learning that does not depend on it; and it has bribed the skeptics by giving us immense material comforts.

*Modes and Morals*

The Extirpation of Culture (p. 85)

Charles Scribner's Sons, New York, New York, USA. 1920

**Gideonse, H. D.**

No biographical data available

Science, as usually taught to liberal arts students, emphasizes results rather than method, and tries to teach technique rather than to give insight into and understanding of the scientific habit of thought. What is needed, however, is not a dose of metaphysics but a truly humanistic teaching of science.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 2)

Chapter 36 (p. 529)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1941

**Ginger, Ray** 1924–75

American historian

Science has explained everything it could explain, and it will continue to do so. Every effort to bar science from some areas on the ground that they were not susceptible to empirical investigation has had the effect of inhibiting science in other areas also. Man has progressed by exercising a humble confidence in the might of his own

mind, not by throwing up his hands and shrugging his shoulders.

*Six Days or Forever: Tennessee v. John Thomas Scopes*  
Chapter 11, Section III (p. 231)  
Quadrangle Books. Chicago, Illinois, USA. 1958

**Gissing, George** 1857–1903  
English novelist

Science brings forth its newest discoveries in earth and heaven; it speaks to the philosopher in his solitude, and to the crowd in the market-place.

*The Private Papers of Henry Ryecroft* (p. 59)  
E.P. Dutton & Co. New York, New York, USA. 1903

Somebody has been making a speech, reported at a couple of columns' length in the paper. As I glance down the waste of print, one word catches my eye again and again. It's all about "science – and therefore doesn't concern me. I wonder whether there are many men who have the same feeling with regard to "science" as I have?

*The Private Papers of Henry Ryecroft* (p. 252)  
E.P. Dutton & Co. New York, New York, USA. 1903

It [science] is something more than a prejudice; often it takes the form of a dread, almost a terror. Even those branches of science which are concerned with things that interest me – which deal with plants and animals and the heaven of stars – even these I cannot contemplate without uneasiness, a spiritual disaffection; new discoveries, new theories, however they engage my intelligence, soon weary me, and in some way depress.

*The Private Papers of Henry Ryecroft* (p. 252)  
E.P. Dutton & Co. New York, New York, USA. 1903

Oh, the generous hopes and aspirations of forty years ago! Science, then, was seen as the deliverer; only a few could prophesy its tyranny, could foresee that it would revive old evils and trample on the promises of its beginning. This is the course of things; we must accept it. But it is some comfort to me that I – poor little mortal – have had no part in bringing the tyrant to his throne.

*The Private Papers of Henry Ryecroft* (p. 254)  
E.P. Dutton & Co. New York, New York, USA. 1903

**Glass, H. Bentley** 1906–2005  
American geneticist

...the general citizen of his country, the man in the street, must learn what science is, not just what it can bring about. Surely this is our primary task. If we fail in this, then within a brief period of years we may expect either nuclear devastation or worldwide tyranny. It is not safe for apes to play with atoms. Neither can men who have relinquished their birthright of scientific knowledge expect to rule themselves.

In Hilary J. Deason  
*A Guide to Science Reading*  
Revolution in Biology (pp. 25–26)  
The New American Library. New York, New York, USA. 1966

**Goddard, Robert H.** 1882–1945  
American physicist

Each must remember that no one can predict to what heights of wealth, fame, or usefulness he may rise until he has honestly endeavored, and he should derive courage from the fact that all sciences have been, at some time, in the same condition as he, and that it has often proved true that the dream of yesterday is the hope of today and the reality of tomorrow.

*The Papers of Robert H. Goddard* (Volume 1)  
On Taking Things for Granted  
Graduation oration (p. 66)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Gore, George** 1826–1909  
English electrochemist

Science, more than anything else, causes us to be obedient to law. It is recognition of law which distinguishes science from superstition, intelligent men from savages.

*The Art of Scientific Discovery*  
Part I, Chapter I (p. 5)  
Longmans, Green & Co. London, England. 1878

**Gorky, Maxim** 1868–1938  
Russian writer

Humanity has no force more powerful and victorious than science.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

**Gortner, Ross Aiken**  
No biographical data available

Science will stagnate only when all will agree that only one interpretation can be drawn from a given series of data.

*Selected Topics in Colloid Chemistry with Especial Reference to Biochemical Problems*  
Preface (p. vii)  
Cornell University Press. Ithaca, New York, USA. 1937

**Goss, John**  
No biographical data available

O Science, thou thought-clad leader of the company of pure and great souls that toil for their race and love their kind, measurer of the depths of earth and the recesses of heaven, apostle of civilization, handmaid of religion, teacher of human equality and human right, perpetual witness for the divine wisdom, be ever, am now, the great minister of peace! Let thy starry brow and benign front still gleam in the van of progress, brighter than the sword of the conqueror, and welcome as the light of heaven.

*Forensic Eloquence*  
Chapter III (pp. 107–108)  
Pacific Press. Oakland, California, USA. 1891



**Gould, Laurence M.** 1896–1995  
American polar explorer and geologist

Today, there is no other influence comparable with science in changing the foundations, indeed the very character of our lives. Science and its products determine our economy, dominate our industry, affect our health and welfare, alter our relations to all other nations, and determine the conditions of war and peace. Everyone who breathes is affected, and cannot remain impervious to them.

Science and the Culture of Our Times  
*UNESCO Courier*, February, 1968 (p. 4)

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Science does progress toward more adequate understanding of the empirical world, but no pristine, objective reality lies “out there” for us to capture as our technologies improve and our concepts mature.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Four, Chapter 16 (p. 214)  
Random House, Inc. New York, New York, USA. 1995

Humanity has in course of time had to endure from the hand of science two great outrages upon its naive self-love. The first was when it realized that our earth was not the center of the universe, but only a speck in a world-system of a magnitude hardly conceivable.... The second was when biological research robbed man of his particular privilege of having been specially created and relegated him to a descent from the animal world.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*  
Chapter 1 (p. 1)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

**Grassé, Pierre P.** 1895–1985  
French zoologist

There is no law against day dreaming, but science must not indulge in it.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter IV (p. 104)  
Academic Press. New York, New York, USA. 1977

**Graubard, Stephen R.**  
No biographical data available

To say that science is a mystery for great numbers – that it appears to be largely inaccessible even to men and women who believe themselves educated – and that this condition is scarcely improving, is now commonly accepted.

Preface to the Issue: “Scientific Literacy”  
*Daedalus*, Volume 112, Number 2, Spring, 1983 (p. v)

**Gray, Thomas** 1716–71  
English poet

Here rests his head upon the lap of Earth,  
A youth to fortune and to fame unknown.  
Fair Science frown's not on his humble birth,  
And Melancholy mark's him for her own.  
*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*  
Elegy Written in a Country Churchyard, The Epitaph, Stanza 1  
J. Blackwood. London, England. 1800

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

...science is not to be measured by practical service alone, though it may contribute to material prosperity: it is an intellectual outlook, a standard of truth and a gospel of light.

*Discovery; or, The Spirit and Service of Science*  
Preface (p. vi)  
Macmillan & Company Ltd. London, England. 1918

...I hope that my children, at least, if not I myself, will see the day, when ignorance of the primary laws and facts of science will be looked on as a defect, only second to ignorance of the primary laws of religion and morality.

*Discovery; or, The Spirit and Service of Science*  
Chapter V (p. 92)  
Macmillan & Company Ltd. London, England. 1918

Science advances by opening completely new fields of knowledge upon which the literary man or investigator may exercise their intellectual activities, and the directions in which these domains are to be found are rarely indicated with success in romantic or in scientific literature.

*Discovery; or, The Spirit and Service of Science*  
Chapter VI (p. 164)  
Macmillan & Company Ltd. London, England. 1918

When science permits itself to be controlled by the spirit of profitable application it becomes merely the galley-slave of short-sighted commerce.

*The Message of Science*  
*Science*, Volume LIV, Number 1402, November, 1921 (p. 448)

Like the gifts of God, those of science can be made either a blessing or a curse, to glorify the human race or to destroy it; and upon civilized man himself rests the decision as to the course to follow. With science as an ally, and the citadels of ignorance and self as the objective, he can transform the world, but if he neglects the guidance which knowledge can give, and prefers to be led by the phrases of rhetoricians, this planet will become a place of dust and ashes.

*The Message of Science*  
*Science*, Volume LIV, Number 1402, November, 1921 (p. 448)

**Grove, Sir William** 1811–96  
English chemist

For my part I must say that science to me generally ceases to be interesting as it becomes useful.



In H.B.G. Casimir

*Haphazard Reality: Half a Century of Science*

Chapter 8 (p. 226)

Harper & Row, Publishers. New York, New York, USA. 1983

It would be vain to attempt specifically to predict what may be the effect of Photography on future generations. A Process by which the most transient actions are rendered permanent, by which facts write their own annals in a language that can never be obsolete, forming documents which prove themselves, – must interweave itself not only with science but with history and legislature.

Lecture

Progress of Physical Science Since the Opening of the London Institution (January 19, 1842)

### **Gruenberg, Benjamin C.**

No biographical data available

To vast numbers of men and women science appears as something altogether too remote from their interests or capacities to justify even a glance or a hope of grasping. It is something for the “highbrows” or wizards.

*Science and the Public Mind*

Chapter XIV (p. 152)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1935

### **Guye, Charles Eugene**

Swiss scientist

It is because we do not possess “science” that we have “sciences.”

*Physico-Chemical Evolution* (p. 8)

Methuen & Company Ltd. London, England. 1925

### **Haggard, Howard W.**

Physician

There is another class of explorers whose exploits are rarely heralded by the waving of flags, to whom few monuments are erected, and whose names find small place in world history. They are the explorers in science. They change no maps, but they change our ways of living.

In Bernard Jaffe

*New World of Chemistry*

Chapter 10 (p. 113)

Silver, Burdett & Company. New York, New York, USA. 1935

### **Haldane, John Burdon Sanderson** 1892–1964

English biologist

Science is vastly more stimulating to the imagination than are the classics.

*Daedalu or Science and the Future*

Paper read to the Heretics, Cambridge, February 4, 1923

### **Hall, Alfred Rupert** 1920–

English historian of science

### **Hall, Marie Boas** 1919–

English historian of science

It is hardly too much to say that the Middle Ages studied science as though it were theology and Aristotle’s Physics as though it were the Bible.

*A Brief History of Science*

Chapter 6 (p. 78)

Iowa State University Press. Ames, Iowa, USA. 1988

### **Hamilton, Sir William Rowan** 1805–65

Anglo-Irish mathematician, physicist, and astronomer

...I think there is nothing that so exalts the mind, or so raises one man above his fellow-creatures, as the researches of Science. Who would not rather have the fame of Archimedes than that of his conqueror Marcellus, or than any of those learned commentators on the Classics, whose highest ambition was to be familiar with the thoughts of other men?

*Life of Sir William Rowan Hamilton* (Volume 1)

Letter from W.R. Hamilton to his Aunt Mary Hutton (p. 110)

Hodges, Figgis & Co. Dublin, Ireland. 1882

The design of physical science in general is to record and explain appearances; to classify and generalise facts; to discover the secret unity and constancy of nature, amid its seeming diversity and mutability; to construct, at least in part, a history of the outward world, adapted to the understanding of man; to account for past and to foresee future phenomena; to learn the language and interpret the oracles of the universe.

In Robert Perceval Graves

*Life of Sir William Rowan Hamilton*

Chapter XI (p. 501)

Hodges, Figgis & Co. Dublin, Ireland. 1882

### **Hammond, George S.** 1921–2005

American chemist

Through science, we have an automatic and absolutely necessary vehicle for outreach which joins the people of the world in a common enterprise perhaps unparalleled in its self-sustaining nature by any of the other many and important common enterprises of humankind.

*Science: A Resource for Humankind*

Welcome (p. 3)

National Academy of Sciences. Washington, D.C. October 10–14, 1976

### **Handler, Philip** 1917–81

No biographical data available

My own belief is that science remains the most powerful tool we have yet generated to apply leverage for our future. It is the instrument which is most useful for guiding our own destinies, for assuring the condition of man in the years to come. I have much to hope that we will not abandon that tool, leaving us to our own brute devices.

*Hearings*

1971 National Science Foundation Authorization, Subcommittee on Science, Research and Development, House Committee on Science and Astronautics, 91st Congress, 2nd Session 1970 (p. 16)

**Hanotaux, Gabriel** 1853–1944  
French statesman

Science begins by giving names; it then reasons on those names. It shuts itself up in abstractions as in a dark room; sometimes a sudden perception, like a flash of lightning, discovers a corner of reality; then Night, darker than ever, resumes its sway.

*Contemporary France* (Volume 2)  
Chapter XII, Section III (p. 641)  
Archibald Constable & Co. London, England. 1905

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

...a science ... may be said to be ‘useful’ if its development increases, even indirectly, the material well-being and comfort of men...

*A Mathematician’s Apology*  
Section 19 (pp. 115–116)  
Cambridge University Press. Cambridge, England. 1967

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

Well: what we gain by science is, after all, sadness, as the Preacher saith. The more we know of the laws & nature of the Universe the more ghastly a business we perceive it all to be – & the non-necessity of it.

In Richard Little Purdy and Michael Millgate (eds.)  
*The Collected Letters of Thomas Hardy* (Volume 3)  
Letter, February 27, 1902  
Clarendon Press. Oxford, England. 1978

**Harrison, Jane** 1850–1928  
English classical scholar

Science has given us back something strangely like a World-Soul...

*Ancient Art and Ritual*  
Chapter VII (p. 238)  
Henry H. Holt. New York, New York, USA. 2002

**Harvey, Moses** 1820–1901  
Irish clergyman, essayist, and naturalist

It [science] is a sealed volume: and only by patient study, and humble labour can the mystic seals be unloosed. The face of nature is veiled, and it is for man, who had been so wondrously endowed for the task by his Creator, reverently yet fearlessly to lift the veil, and gaze into that awful but lovely face which dimly yet truly mirrors the Omnipotent One.

Science and Religion  
*The Maritime Monthly*, Volume II, Number 5, November, 1873 (p. 478)

It [science] has largely dispersed that dread of nature, which is the offspring of ignorance, and the fruitful parent of superstition with its progeny of woes. It has taught man to look fearlessly into the face of nature, and

see there a divine order and beauty, not the features of a ferocious monster, “red in tooth and claw.”

Science and Religion  
*The Maritime Monthly*, Volume II, November, 1873 (p. 479)

We hail Science as man’s truest friend and noblest helper.

Science and Religion  
*The Maritime Monthly*, Volume II, November, 1873 (p. 479)

**Harvey, William** 1578–1657  
English physician

Although there is but one road to science, that, to wit, in which we proceed from things more known to things less known, from matters more manifest to matters more obscure; and universals are principally known to us, science bringing by reasoning from universals to particulars; still the comprehension of universals by the understanding is based upon the perception of individual things by the senses.

In *Great Books of the Western World* (Volume 28)  
*Anatomical Exercises on the Generation of Animals*  
Of the Manner and Order of Acquiring Knowledge (p. 332)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Havel, Václav** 1936–  
Czech dramatist and essayist

Modern science abolishes as mere fiction the innermost foundations of our natural world: it kills God and takes his place on the vacant throne so henceforth it would be science that would hold the order of being in its hand as its sole legitimate guardian and so be the legitimate arbiter of all relevant truth. People thought they could explain and conquer nature – yet the outcome is that they destroyed it and disinherited themselves from it.

In L. Wolpert  
*The Unnatural Nature of Science*  
Introduction (p. ix)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Hawking, Stephen William** 1942–  
English theoretical physicist

The whole history of science has been the gradual realization that events do not happen in an arbitrary manner, but that they reflect a certain underlying order, which may or may not be divinely inspired.

*A Brief History of Time: From the Big Bang to Black Holes*  
Chapter 8 (p. 122)  
Bantam Books. Toronto, Ontario, Canada. 1988

In effect, we have redefined the task of science to be the discovery of laws that will enable us to predict events up to the limits set by the uncertainty principle.

*A Brief History of Time: From the Big Bang to Black Holes*  
Chapter 11 (p. 173)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Hazen, Robert M.**

No biographical data available

**Trefil, James** 1938–

American physicist

Science is not the only way, nor always the best way, to gain an understanding of the world in which we find ourselves.... You don't need calculus to tell you whether a symphony or a poem has meaning for you. Science complements these other ways of knowing.

*Science Matters* (p. 2)

Publisher undetermined

**Hazlitt, William Carew** 1834–1913

English bibliographer

The origin of all science is in the desire to know causes; and the origin of all false science and imposture is in the desire to accept false causes rather than none; or, which is the same thing, in the unwillingness to acknowledge our own ignorance.

*The Atlas*

February 15, 1829

Burke and the Edinburgh Phrenologists

This article is unsigned in the atlas but appears in P.P. Howe's *New Writings* by William Hazlitt, 1925

**Heidel, W. A.**

No biographical data available

It is an unwarranted assumption that ancient science differed in principle at any point from that of today.

In Julius W. Friend and James Feibleman

*What Science Really Means*

Chapter II (p. 26)

George Allen & Unwin Ltd. London, England. 1937

**Heinlein, Robert A.** 1907–88

American science fiction writer

If it can't be expressed in figures, it is not science; it is opinion.

*Time Enough for Love*

Intermission (p. 257)

G.P. Putnam's Sons. New York, New York, USA. 1973

The difference between science and the fuzzy subjects is that science requires reasoning, while those other subjects merely require scholarship.

*Time Enough for Love*

Second Intermission (p. 366)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The assumption [is] that in the end it will always be possible to understand nature, even in every new field of experience, but that we may make no a priori assumptions about the meaning of the word "understand."

In Heinrich O. Proskauer

*The Rediscovery of Color: Goethe versus Newton Today*

Preface (p. ix)

Anthroposophic Press. Spring Valley, New York, USA. 1986

Science no longer confronts nature as an objective observer, but sees itself as an actor in this interplay between man and nature. The scientific method of analysing, explaining, and classifying has become conscious of its limitations.... Method and object can no longer be separated.

*The Physicist's Conception of Nature*

Chapter I (p. 29)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

Almost every progress in science has been paid by a sacrifice, for almost every new intellectual achievement previous positions and conceptions had to be given up. Thus, in a way, the increase of knowledge and insight diminishes continually the scientist's claim to "understand" nature.

In A. Sarlemijn and M.J. Sparnaay (eds.)

*Physics in the Making: Essays on Developments in 20th Century Physics: In Honour of H.B.G. Casimir on the Occasion of His 80th Birthday*

Chapter I (p. 9)

North-Holland Publishing Company. Amsterdam, Netherlands. 1989

In science...it is impossible to open up new territory unless one is prepared to leave the safe anchorage of established doctrine and run the risk of a hazardous leap forward. With his relativity theory, Einstein had abandoned the concept of simultaneity, which was part of the solid ground of traditional physics, and, in so doing, outraged many leading physicists and philosophers and turned them into bitter opponents. In general, scientific progress calls for no more than the absorption and elaboration of new ideas – and this is a call most scientists are happy to heed.

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 70)

Harper & Row, Publishers. New York, New York, USA. 1971

**Henderson, Lawrence** 1878–1942

American biochemist

Science has finally put the old teleology to death. Its dismembered spirit, freed from vitalism and all material ties, immortal, alone lives on, and from such a ghost, science has nothing to fear.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*

Chapter VIII, Section III, B (p. 311)

The Macmillan Company. New York, New York, USA. 1913

**Henry Frankenstein (Fictional character)**

This isn't science! It's more like black magic.

*The Bride of Frankenstein*

Film (1935)

**Henry, Joseph** 1797–1878  
Scottish-born American scientist

...narrow minds think nothing of importance but their own favorite pursuit, but liberal views exclude no branch of science or literature...

Inscription on the National Museum of American History, Washington, D.C.

### Henry Rycroft (Fictional character)

I hate and fear “science” because of my conviction that, for long to come if not forever, it will be the remorseless enemy of mankind. I see it destroying all simplicity and gentleness of life, all the beauty of the world; I see it restoring barbarism under a mask of civilization; I see it darkening men’s minds and hardening their hearts; I see it bringing a time of vast conflicts, which will pale into insignificance “the thousand wars of old,” and, as likely as not, will whelm all the laborious advances of mankind in blood-drenched chaos.

In George Gissing

*The Private Papers of Henry Rycroft*

Winter (p. 253)

E.P. Dutton & Co. New York, New York, USA. 1903

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Every student who enters upon a scientific pursuit, especially if at a somewhat advanced period of life, will find not only that he has much to learn, but much also to unlearn.

*Outlines of Astronomy* (2nd edition)

Part I, Introduction (p. 1)

Longman, Brown, Green & Longmans. London, England. 1849

...if science may be vilified by representing it as opposed to religion, or trammelled by mistaken notions of the danger of free enquiry, there is yet another mode by which it may be degraded from its native dignity, and that is by placing it in the light of a mere appendage to and caterer for our pampered appetites.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 7 (p. 10)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Herzen, Aleksandr** 1812–70  
Russian political author

Superficial dilettantism and the narrow specialization of the scientists ex officio are the two banks of science which prevent the fertilizing waters of this Nile from overflowing.

*Selected Philosophical Works*

Dilettantism in Science (p. 52)

Foreign Languages Publishing House. Moscow, Russia. 1956

Science, in the best sense of the word, shall come to be accessible to the people, and when it does it shall claim a voice in all practical matters.

*Selected Philosophical Works*

Dilettantism in Science (p. 69)

Foreign Languages Publishing House. Moscow, Russia. 1956

### Hill, Alexander

No biographical data available

[Science ] has no traffic with the unknowable; nor can it cross the border-line which separates the world of the senses from the world of consciousness, or barter its facts, gathered from the external universe, for the equally real facts which the individual learns by self-examination. further than knowledge.

*Introduction to Science*

Chapter I (p. 11)

The Macmillan Co. New York, New York, USA. 1900

Proficiency in science is shown by a masterly skill in cross-examining nature; and, as every lawyer knows, no case is proved as long as any antagonistic fact, however trivial, cannot be explained away.

*Introduction to Science*

Chapter I (p. 22)

The Macmillan Co. New York, New York, USA. 1900

### Hilts, Philip

No biographical data available

In all human activities, it is not ideas of machines that dominate; it is people. I have heard people speak of “the effect of personality on science.” But this is a backward thought. Rather, we should talk about the effect of science on personalities. Science is not the dispassionate analysis of impartial data. It is the human, and thus passionate, exercise of skill and sense on such data.

*Scientific Temperaments: Three Lives in Contemporary Science*

Preface (pp. 11–12)

Simon & Schuster. New York, New York, USA. 1982

Science is not an exercise in which objectivity is prized.

*Scientific Temperaments: Three Lives in Contemporary Science*

Preface (pp. 11–12)

Simon & Schuster. New York, New York, USA. 1982

**Hinshelwood, Sir Cyril** 1897–1967  
English chemist

Science is not the mere collection of facts, which are infinitely numerous and mostly uninteresting, but the attempt by the human mind to order these facts into satisfying patterns.

*On the Structure of Physical Chemistry*

Clarendon Press. Oxford, England. 1951

### Hinton, James

No biographical data available

Science, in a word, can teach us – it is her loftiest function and her greatest boon – not only respecting nature, but respecting ourselves, and so can enable us to look

with purged eyes on objects which only to our blinded senses can seem trivial.

*Life in Nature*

Introduction (p. xx)

Smith, Elder & Co. London, England. 1875

### **Hippocrates** 460 BCE–377 BCE

Greek physician

There are, indeed, two things, knowledge and opinion, of which the one makes its possessor really to know, the other to be ignorant.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Law, 4 (p. 144)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hoagland, Hudson** 1899–1982

American physiologist

The fictions – that is, the hypotheses and theories – of science are not sacrosanct.

Science and the New Humanism

*Science*, Volume 143, Number 3062, 10 January, 1964 (p. 112)

### **Hobbes, Thomas** 1588–1679

English philosopher and political theorist

As much experience, is “prudence;” so, is much science “sapience.”

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth,*

*Ecclesiastical and Civil* (2nd edition)

Chapter V (p. 30)

George Routledge & Sons. London, England. 1886

...yet they that have no “science,” are in better and nobler condition, with their natural prudence, than men, that by misreasoning, or by trusting them that reason wrong, fall upon false and absurd general rules. For ignorance of causes, and of rules, does not set men so far out of their way, as relying on false rules, and taking for causes of what they aspire to, those that are not so, but rather causes of the contrary.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth,*

*Ecclesiastical and Civil* (2nd edition)

Chapter V (p. 30)

George Routledge & Sons. London, England. 1886

Science, like dress, has its fashions, and the changes in the one are almost as sudden and radical as in the other. Many a time has a theory become old and given place to a newer sensation, only to be later rehabilitated after its earlier service has been forgotten.

*Earthquakes: An Introduction to Seismic Geology*

Chapter I (p. 13)

D. Appleton & Co. New York, New York, USA. 1907

### **Hocking, R.**

No biographical data available

It is an oversimplification to compare the impersonal aspect of science with the impersonal aspects of industrial

society, and to deplore both in one breath. The former is an achievement of self-forgetful concentration upon truths about nature. The latter are deplorable to the extent that they exhibit crude power of men over men. By contrast, the selflessness of the scientific calling does silent honor to personal existence.

In T.J.J. Altizer, William A. Beardslee, and J. Harvey Young (eds.)

*Truth, Myth, and Symbol*

The Problem of Truth (p. 5)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

### **Hodgson, Leonard** 1889–1969

English theologian

...science can only deal with what is, and can say nothing about what ought to be, which is the concern of ethics; science can tell us about means to ends, but not about what the ends should be.

*Theology in an Age of Science*

An Inaugural Lecture, November 3, 1944 (p. 9)

The Clarendon Press. Oxford, England. 1944

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Go on, fair science; soon to thee

Shall nature yield he idle boast;

He vulgar fingers formed a tree,

But thou hast trained it to a post.

*The Complete Poetical Works of Oliver Wendell Holmes*

The Meeting of the Dryads (p. 412)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

Science represents the thought of God discovered by man.

*The Writings of Oliver Wendell Holmes*

*Pages from an Old Volume of Life*

Chapter X (p. 331)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1891

### **Holton, Gerald James** 1922–

Research professor of physics and science history

Science has always had...a metaphoric function – that is, it generates an important part of a culture’s symbolic vocabulary and provides some of the metaphysical bases and philosophical orientations of our ideology. As a consequence the methods of argument of science, its conceptions and its models, have permeated first the intellectual life of the time, then the tenets and usages of everyday life. All philosophies share with science the need to work with concepts such as space, time, quantity, matter, order, law, causality, verification, reality.

*Einstein, History, and Other Passions*

The Public Image of Science (p. 43)

Harvard University Press. Cambridge, Massachusetts, USA. 2000

### **Holton, Gerald** 1922–

Research professor of physics and science history



**Roller, Duane H. D.** ?–1994

Science historian

...science has grown almost more by what it has learned to ignore than by what it has had to take into account.

*Foundations of Modern Physical Science*

Chapter 2 (p. 25)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1950

**Horgan, J.**

No biographical data available

...to pursue science in a speculative, postempirical mode: that I call ironic science. Ironic science resembles literary criticism in that it offers points of view, opinions, which are, at best, interesting, which provoke further comment. But it does not converge on the truth. It cannot achieve empirically verifiable surprises that force scientists to make substantial revisions in their basic description of reality.

*The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*

Introduction (p. 7)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1996

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Science progresses by extending the territory over which its theories hold good...

*Ten Faces of the Universe*

The Origin of the Universe (p. 105)

W.H. Freeman & Company, San Francisco, California, USA. 1977

**Hrdlicka, Ales** 1869–1943

Czech anthropologist

The phenomena of the universe, brought within the range of human understanding and preserved in memory or writing, constitute knowledge; and systematic search for knowledge, on the basis of the highest standards of learning, is science.

Physical Anthropology and Its Aims

*Science*, New Series, Volume 28, Number 706, July 10, 1908

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

SCIENCE: (1) The knowledge of the common people classified and carried one step further. (2) Accurate organized knowledge grounded on fact. (3) Classified superstition.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 134)

The Roycrofters, East Aurora, New York, USA. 1914

**Hubbard, Gardiner G.** 1822–97

American lawyer and educator

That which was unknown, science hath revealed.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1893*

Relations of Air and Water to Temperature and Life (p. 265)

Government Printing Office, Washington, D.C. 1894

**Hubbard, Ruth** 1924–

American biologist

To overturn orthodoxy is no easier in science than in philosophy, religion, economics, or any of the other disciplines through which we try to comprehend the world and the society in which we live.

*Women Look at Biology Looking at Women*

Have Only Men Evolved? (p. 10)

Schenkman Publishing Company, Cambridge, USA. 1979

**Hubble, Edwin Powell** 1889–1953

American astronomer

There is a unity in science, connecting all its various fields. Men attempt to understand the universe, and they will follow clues which excite their curiosity wherever the clues may lead.

*The Nature of Science and Other Lectures*

Part I. The Nature of Science (p. 6)

The Huntington Library, San Marino, California, USA. 1954

**Huggins, Sir William** 1824–1910

English astronomer

Scienza vince [science conquers], – whether it be on the field of battle, on the waves of the ocean, amid the din and smoke of the workshop, or on the broad acres under the light of heaven; and assuredly, in the future, even more than in the past, not only the prosperity, but even the existence of the Empire will be found to depend upon the “improvement of Natural Knowledge.” – that is, upon the more complete application of scientific knowledge and methods to every department of industrial and national activity.

*The Royal Society; Or, Science in the State and in the Schools*

Science in Education (pp. 116–117)

Methuen & Co. London, England. 1906

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Science says the first word on everything, and the last word on nothing.

*Victor Hugo's Intellectual Autobiography*

Things of the Infinite

Funk & Wagnalls, New York, New York, USA. 1907

Science has but the right to put a visa on facts; she should verify and distinguish.

Translated by Melville Best Anderson

*William Shakespeare*

Part I, Book I, Chapter V (p. 38)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

The unexpected ought always to be expected by Science. Her duty is to stop it in its course and search it, rejecting the chimerical, establishing the real.

Translated by Melville Best Anderson

*William Shakespeare*

Part I, Book I, Chapter V (p. 38)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887



In Science, all tends to stir, to change, to form fresh surfaces. All denies, destroys, creates, replaces all. What was ground yesterday is put into the hopper again today. The colossal machine, Science, never rests. It is never satisfied; it is insatiable for improvement, of which the absolute knows nothing.

Translated by Melville Best Anderson

*William Shakespeare*

Part Second, Book I, Chapter IV (p. 105)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

...Claude – saddened, his faith in human affection shaken – threw himself with frenzied ardour into the arms of science, that sister who at least never laughs at you in derision, and who always repays you, albeit at times in somewhat light coin, for the care you have lavished on her.

Translated by Jessie Haynes

*Notre Dame de Paris*

Book IV, Chapter V (p. 156)

P.F. Collier & Son. New York, New York, USA. 1902

Oh, how hollow does science sound when a head full of passion strikes against it in despair!

Translated by Jessie Haynes

*Notre Dame de Paris*

Book VIII, Chapter III (p. 327)

P.F. Collier & Son. New York, New York, USA. 1902

### **Huizinga, Johan** 1872–1945

Dutch historian

Science, unguided by a higher abstract principle, freely hands over its secrets to a vastly developed and commercially inspired technology, and the latter, even less restrained by a supreme culture saving principle, with the means of science creates all the instruments of power demanded from it by the organization of Might.

Translated by J.H. Huizinga

*In the Shadow of Tomorrow*

Chapter 9 (p. 93)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

### **Huxley, Aldous** 1894–1963

English writer and critic

We are living now, not in the delicious intoxication induced by the early successes of science, but in a rather grisly morning-after, when it has become apparent that what triumphant science has done hitherto is to improve the means for achieving unimproved or actually deteriorated ends.

*Ends and Means*

Chapter XIV (p. 268)

Chatto & Windus. London, England. 1938

Science is dangerous; we have to keep it most carefully chained and muzzled.

*Brave New World*

Chapter Sixteen (p. 270)

Harper & Brothers. New York, New York, USA. 1950

For Science in its totality, the ultimate goal is the creation of a monistic system in which – on the symbolic level and in terms of the inferred components of invisibility and intangibly fine structure – the world's enormous multiplicity is reduced to something like unity, and the endless successions of unique events of a great many different kinds get tidied and simplified into a single rational order. Whether this goal will ever be reached remains to be seen. Meanwhile we have the various sciences, each with its own system coordinating concepts, its own criterion of explanation.

*Literature and Science*

Chapter 3 (p. 9)

Harper & Row, Publishers. New York, New York, USA. 1963

Science is a matter of disinterested observation, patient ratiocination within some system of logically correlated concepts. In real-life conflicts between reason and passion the issue is uncertain. Passion and prejudice are always able to mobilize their forces more rapidly and press the attack with greater fury; but in the long run (and often, of course, too late) enlightened self-interest may rouse itself, launch a counterattack and win the day for reason.

*Literature and Science*

Chapter 23 (p. 68)

Harper & Row, Publishers. New York, New York, USA. 1963

To the twentieth century man of letters science offers a treasure of newly discovered facts and tentative hypotheses. If he accepts this gift and if, above all, he is sufficiently talented and resourceful to be able to transform the new materials into works of literary art, the twentieth century man of letters will be able to treat the age-old, and perennially relevant, theme of human destiny with a depth of understanding, a width of reference of which, before the rise of science, his predecessors (through no fault of their own, no defect of genius) were incapable.

*Literature and Science*

Chapter 29 (p. 87)

Harper & Row, Publishers. New York, New York, USA. 1963

Science sometimes builds new bridges between universes of discourse and experience hitherto regarded as separate and heterogeneous. But science also breaks down old bridges and opens gulfs between universes that, traditionally, had been connected.

*Literature and Science*

Chapter 37 (p. 111)

Harper & Row, Publishers. New York, New York, USA. 1963

...science has "explained" nothing; the more we know the more fantastic the world becomes and the profounder the surrounding darkness.

*Along the Road*

Part II. Views of Holland (p. 108)

Nan'-do. Tokyo, Japan. 1954

All science is based upon an act of faith – faith in the validity of the mind's logical processes, faith in the ultimate explicability of the world, faith that the laws of thought are laws of things.

*Ends and Means*

Chapter XIV (p. 258)

Chatto & Windus. London, England. 1938

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Science...has not only turned her face outwards from man, but stripped him of all the robes of his divinity, turned him out of the palace that he had so laboriously built in the center of the world, and left him in rags, pitifully insignificant and suddenly transported to an outlying corner of the cosmos.

Will Science Destroy Religion

*Harper's Monthly Magazine*, April, 1926 (p. 535)

Science, like Empires, have their rise and their time of flourishing, though not their decay.

*What Dare I Think?: The Challenge of Modern Science to Human Action and Belief, Including the Henry La Barre Jayne Foundation Lectures*

Chapter I (p. 1)

Harper & Brothers. New York, New York, USA. 1931

**Huxley, Thomas Henry** 1825–95

English biologist

You have no idea of the intrigues that go on in this blessed world of science. Science is, I fear, no purer than any other region of human activity; though it should be. Merit alone is very little good; it must be backed by tact and knowledge of the world to do very much.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter VII

Letter to his sister, March 5, 1852 (p. 105)

D. Appleton & Company. New York, New York, USA. 1901

Science in England does everything – but pay. You may earn praise but not pudding.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter VII

Letter to his sister, April 17, 1852 (p. 108)

D. Appleton & Company. New York, New York, USA. 1901

Science reckons many prophets, but there is not even a promise of a Messiah.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 2)

Letter dated March, 1894 (p. 396)

D. Appleton and Company. New York, New York, USA. 1901

No delusion is greater than the notion that method and industry can make up for lack of mother-wit, either in science or in practical life.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 46)

Macmillan & Company Ltd. London, England. 1904

Nothing great in science has ever been done by men, whatever their powers, in whom the divine afflatus [inspiration] of the truth-seeker was wanting.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 56)

Macmillan & Company Ltd. London, England. 1904

In science, as in art, and, as I believe, in every other sphere of human activity, there may be wisdom in a multitude of counselors, but it is only [obvious] in one or two of them.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 57)

Macmillan & Company Ltd. London, England. 1904

...whatever evil voices may rage, Science, secure among the powers that are eternal, will do her work and be blessed.

*Collected Essays* (Volume 1)

*Method and Result*

Descartes' Discourse on Method (p. 198)

Macmillan & Company Ltd. London, England. 1904

Extinguished theologians lie about the cradle of every science as the strangled snakes beside that of Hercules...

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 52)

Macmillan & Company Ltd. London, England. 1904

Science commits suicide when it adopts a creed.

*Collected Essays* (Volume 2)

*Darwiniana*

The Darwin Memorial (p. 252)

Macmillan & Company Ltd. London, England. 1904

The vast results obtained by Science are won by no mystical faculties, by no mental processes, other than those which are practiced by everyone of us, in the humblest and meanest affairs of life. A detective policeman discovers a burglar from the marks made by his shoe, by a mental process identical with that by which Cuvier restored the extinct animals of Montmartre from fragments of their bones.

*Collected Essays* (Volume 3)

*Science and Education*

On the Educational Value of the National History Sciences (p. 45)

Macmillan & Company Ltd. London, England. 1904

Books are the money of Literature, but only the counters of Science.

*Collected Essays* (Volume 3)

*Science and Education*

Universities: Actual and Ideal (p. 213)

Macmillan & Company Ltd. London, England. 1904

Anybody who knows his business in science can make anything subservient to that purpose. You know it was said of Dean Swift that he could write an admirable poem upon a broomstick, and the man who has a real knowledge of science can make the commonest object in the

world subservient to an introduction to the principles and greater truths of natural knowledge.

*Collected Essays* (Volume 3)

*Science and Education*

Address on Behalf of the National Association for the Promotion of Technical Education (p. 432)

Macmillan & Company Ltd. London, England. 1904

Whatever happens, science may bide her time in patience and in confidence.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

An Episcopal Trilogy (p. 143)

Macmillan & Company Ltd. London, England. 1904

Of the affliction caused by persons who think that what they have picked up from popular exposition qualifies them for discussing the great problems of science, it may be said, as the Radical toast said of the power of the Crown in bygone days, that it "has increased, is increasing, and ought to be diminished." The oddities of "English as she is spoke" might be abundantly paralleled by those of "science as she is misunderstood" in the sermon, the novel, and the leading article; and a collection of the grotesque travesties of scientific conceptions in the shape of essays on such trifles as "the Nature of Life" and the "Origin of All Things," which reach me, from time to time, might well be bound up with them.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

Preface (p. viii)

Macmillan & Company Ltd. London, England. 1904

The whole of modern thought is steeped in science; it has made its way into the works of our best poets, and even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit, and indebted for his best products to her methods.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

I believe that the greatest intellectual revolution mankind has yet seen is now slowly taking place by her agency. She is teaching the world that the ultimate court of appeal is observation and experiment, and not authority; she is teaching it to estimate the value of evidence; she is creating a firm and living faith in the existence of immutable moral and physical laws, perfect obedience to which is the highest possible aim of an intelligent being.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

Posterity will cry shame on us if we do not remedy this deplorable state of things. Nay, if we live twenty years longer, our own consciences will cry shame on us.

It is my firm conviction that the only way to remedy it is

to make the elements of physical science an integral part of primary education. I have endeavored to show you how that may be done for that branch of science which it is my business to pursue; and I can but add, that I should look upon the day when every schoolmaster throughout this land was a centre of genuine, however rudimentary, scientific knowledge as an epoch in the history of the country. But let me entreat you to remember my last words. Addressing myself to you, as teachers, I would say, mere book learning in physical science is a sham and a delusion-what you teach, unless you wish to be impostors, that you must first know; and real knowledge in science means personal acquaintance with the facts, be they few or many.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 227)

Macmillan & Company Ltd. London, England. 1904

Ecclesiasticism in science is only unfaithfulness to truth.

*Critiques and Addresses*

Chapter X (p. 240)

D. Appleton & Co. New York, New York, USA. 1881

The generalizations of science sweep on in ever-widening circles, and more aspiring flights, through limitless creation.

Letter

*London Times*, December 26, 1859

Many persons seem to believe that what is termed Science is of a widely different nature from ordinary knowledge, and that the methods by which scientific truths are ascertained involve mental operations of a recondite and mysterious nature, comprehensible only by the initiated, and as distinct in their character as in their subject matter, from the processes by which we discriminate between fact and fancy in ordinary life.

*The Crayfish: An Introduction to the Study of Zoology* (p. 1)

C. Kegan Paul & Co. London, England. 1880

The whole of modern thought is steeped in science; it even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit, and indebted for his best products to her methods. I believe that the greatest intellectual revolution mankind has yet seen is now slowly taking place by her agency. She is teaching the world that the ultimate court of appeal is observation and experiment, and not authority; she is teaching it to estimate the value of evidence; she is creating a firm and living faith in the existence of immutable moral and physical laws, perfect obedience to which is the highest possible aim of an intelligent being.

*Lay Sermons, Addresses and Reviews*

Chapter VI (pp. 117-118)

D. Appleton & Co. New York, New York, USA. 1903

Whatever happens, science may bide her time in patience and in confidence.

An Episcopal Trilogy (p. 319)

... whatever evil voices may rage, Science, secure among the powers that are eternal, will do her work and be blessed.

*Method and Results: Essays*

Descartes' Discourse on Method (p. 198)

D. Appleton & Co. New York, New York, USA. 1898

... science, like Nature, may be driven out with a fork, ecclesiastical or other, yet she surely comes back again.

*Collected Essays*

Prologue (p. 28)

D. Appleton & Co. New York, New York, USA. 1898

## Ines, George

No biographical data available

A generation or so ago the word "universe" had a significance faulty and meagre in comparison with its meaning today.

In Richard Anthony Proctor

*The Skies and the Earth*

General Introduction (p. viii)

Doubleday, Page & Co. New York, New York, USA. 1902

## Ingersoll, Robert Green 1833–99

American lawyer, public official, and orator

I do not know what science will do for us. I do not know that science did just take a handful of sand and make the telescope, and with it read all the starry leaves of heaven; I know that science took the thunderbolts from the hands of Jupiter, and now the electric spark, freighted with thought and love, flashes under waves of the sea; I know that science stole a tear from the cheek of unpaid labor, converted it into steam, and created a giant that turns with tireless arms the countless wheels of toil; I know that science broke the chains from human limbs and gave us instead the forces of nature for our slaves...

*Wit, Wisdom, Eloquence, and Great Speeches of Col. R. G. Ingersoll*

Liberty of Mind (p. 23)

Rhodes & McClure Publishing Co. Chicago, Illinois, USA. 1831

... it can be truthfully said that science was thrust into the brain of Europe upon the point of a Moorish lance.

*Wit, Wisdom and Eloquence of Col. R.G. Ingersoll*

A Government Duty (p. 182)

Rhodes & McClure Publishing Co. Chicago, Illinois, USA. 1894

## Jacob, François 1920–

French biologist

Science advances metaphorically. It does not proceed in an orthogenic fashion moving inexorably forward in a straight line. It does not radiate along many branches like a growing tree. It moves from one view to another by a large leap, preceded by a radical shift in the scientist's mode of thought.

Translated by Betty E. Spillmann

*The Logic of Life: A History of Heredity*

Pantheon Books. New York, New York, USA. 1974

For science, there are many possible worlds; but the interesting one is the world that exists and has already shown itself to be at work for a long time. Science attempts to confront the possible with the actual.

*The Possible and the Actual*

Myth and Science (p. 12)

Pantheon Books. New York, New York, USA. 1982

## Jacobi, Karl Gustav Jacob 1804–51

German mathematician

... Monsieur Fourier was of the opinion that the principal aim of Mathematics is to serve mankind and to explain natural phenomena; but a philosopher such as he ought to have known that the sole aim of science is the fulfillment of the human spirit, and that, accordingly, a question about numbers has as much significance as a question about the workings of the world.

*Gesammelte Werke* (Volume 1)

Letter to Legendre

July 2, 1830 (p. 454)

Publisher undetermined

## James, William 1842–1910

American philosopher and psychologist

Science herself consults her heart when she lays it down that the infinite ascertainment of fact and correction of false belief are the supreme goods for man.

*The Will to Believe and Other Essays in Popular Philosophy*

The Will to Believe

Section IX (p. 22)

Dover Publications, Inc. New York, New York, USA. 1956

Science as such assuredly has no authority, for she can only say what is, not what is not.

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living? (p. 56)

Dover Publications, Inc. New York, New York, USA. 1956

Science like life feeds on its own decay. New facts burst old rules; then newly developed concepts bind old and new together into a reconciling law.

*The Will to Believe and Other Essays in Popular Philosophy*

Psychical Research (p. 320)

Dover Publications, Inc. New York, New York, USA. 1956

Science... must be constantly reminded that her purposes are not the only purposes, and that the order of uniform causation which she has use for, and is therefore right in postulating, may be enveloped in a wider order, on which she has no claims at all.

*The Principles of Psychology* (Volume 2)

Chapter XXVIII (p. 676)

Henry Holt & Co. New York, New York, USA. 1916

## Jastrow, Joseph 1863–1944

Polish-born psychologist

Theories rise and fall as better, truer theories replace them; yet it is unwarranted to conclude that science is truth for a day.

In Joseph Jastrow (ed.)  
*The Story of Human Error*  
 Introduction (p. 34)  
 D. Appleton-Century Company, Inc. New York, New York, USA. 1936

Science, unlike the Bible, has no explanation for the occurrence of that extraordinary event. The universe, and everything that has happened in it since the beginning of time, are a grand effect without a known cause.

*Until the Sun Dies*  
 Chapter 2 (p. 21)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Jeans, Sir James Hopwood** 1877–1946  
 English physicist and mathematician

To this present-day science adds that, at the farthest point she has so far reached, much, and possibly all, that was not mental has disappeared, and nothing new has come in that is not mental. Yet who shall say what we may find awaiting us round the next corner?

*The New Background of Science*  
 Chapter VIII (p. 307)  
 The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

For as the wind bloweth where it listeth, so no one can control the direction in which science will advance; the investigator in pure science does not know himself whether his researches will result in a mere labor-saving device or a new industry.

*Annual Report of the Board of Regents of the Smithsonian Institution (1934)*  
 The New World-Picture of Modern Physics (p. 98)  
 Government Printing Office. Washington, D.C. 1935

The infinitely great is never very far from the infinitely small in science...

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*  
 The Wider Aspect of Cosmogony (p. 170)  
 Government Printing Office. Washington, D.C. 1929

Science usually advances by a succession of small steps, through a fog in which even the most keen-sighted explorer can seldom see more than a few paces ahead. Occasionally the fog lifts, an eminence is gained, and a wider stretch of territory can be surveyed – sometimes with startling results. A whole science may then seem to undergo a kaleidoscopic rearrangement, fragments of knowledge being found to fit together in a hitherto unsuspected manner. Sometimes the shock of readjustment may spread to other sciences; sometimes it may divert the whole current of human thought.

*Physics and Philosophy*  
 Chapter I (p. 1)  
 The University Press. Cambridge, England. 1943

...there is a wide measure of agreement which, on the physical side of science approaches almost unanimity, that the stream of knowledge is heading towards a non-mechanical reality; the universe begins to look more like a great thought than a great machine. Mind no longer appears as an accidental intruder into the realm of matter.

We are beginning to suspect that we ought rather to hail mind as the creator and governor of the realm of matter – not of course our individual minds, but the mind in which the atoms out of which our individual minds have grown, exist as thoughts.

*The Mysterious Universe*  
 Chapter V (p. 137)  
 At The University Press. Cambridge, England. 1944

**Jefferson, Thomas** 1743–1826  
 3rd president of the USA

The main objects of all science, the freedom and happiness of man...[are] the sole objects of all legitimate government.

In Andrew A. Lipscomb (ed.)  
*The Writings of Thomas Jefferson* (Volume 12) (p. 369)  
 G. Putnam's Sons. New York, New York, USA. 1892–99

**Jevons, William Stanley** 1835–82  
 English economist and logician

Science arises from the discovery of Identity amidst Diversity.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
 Book I, Chapter I (p. 1)  
 Macmillan & Company. London, England. 1887

The whole value of science consists in the power which it confers upon us of applying to one object the knowledge acquired from like objects; and it is only so far, therefore, as we can discover and register resemblances that we can turn our observations to account.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
 Introduction (p. 1)  
 Macmillan & Co Ltd. London, England. 1887

**Joad, Cyril Edwin Mitchinson** 1891–1953  
 English philosopher and broadcasting personality

Man by the light of science can see his hands, and can catch a glimpse of himself, his past, and the patch upon which he stands; but around him in place of that known comfort and beauty he had anticipated, and in the first few moments falsely thought that he saw, is darkness still.

*Philosophical Aspects of Modern Science*  
 Chapter XI (p. 342)  
 George Allen & Unwin Ltd. London, England. 1939

**Joffe, A. F.**  
 No biographical data available

Science with its strict analysis of the facts, its persevering search for new, more consummate truths, and its relentless struggle against discovered mistakes and prejudices – science must saturate all or techniques, our culture, and everyday life.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
 Translated by Vic Schneiersson  
 Progress Publishers. Moscow, Russia. 1979



**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

The Sciences having long seen their votaries labouring for the benefit of mankind without reward, put up their petitions to Jupiter for a more equitable distribution of riches and honor.... A synod of the celestials was therefore convened, in which it was resolved that Patronage should descend to the assistance of the Sciences.

*The Rambler* (Volume 2)

No. 91, January 29, 1751 (p. 231)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

In science, which, being fixed and limited, admits of no other variety than such as arises from new methods of distribution, or new arts of illustration, the necessity of following the traces of our predecessors is indisputably evident; but there appears no reason why imagination should be subject to the same restraint.... The roads of science are narrow, so that they who travel them, must either follow or meet one another; but in the boundless regions of possibility, which fiction claims for her dominion, there are surely a thousand recesses unexplored, a thousand flowers unplucked, a thousand fountains unexhausted, combinations of imagery yet unobserved, and races of ideal inhabitants not hitherto described.

*The Rambler* (Volume 3)

No. 121, May 14, 1751 (pp. 89–90)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

...science cannot be defined as distinct from faith without destroying it: there can be no science without conscious or unconscious forms of faith, – faith in the faculties, faith in nature, faith in law and in unity.

*Lectures, Essays, and Sermons*

Gain in Loss (p. 357)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1883

**Jones, Rufus M.** 1863–1948  
American writer and journal editor

Science has not closed, and will never close the soul's east window of divine surprise.

*A Preface to Christian Faith in a New Age*

Chapter II, Section IV (pp. 55–56)

The Macmillan Company. New York, New York, USA. 1932

**Jones, Steve**

No biographical data available

This is the essence of science. Even though I do not understand quantum mechanics or the nerve cell membrane, I trust those who do. Most scientists are quite ignorant about most sciences but all use a shared grammar that allows them to recognize their craft when they see it. The motto of the Royal Society of London is “*Nul-lius in verba*”: trust not in words.

Review of *How the Mind Works* by Steve Pinker

*The New York Review of Books*, November 6, 1997 (p. 13)

**Jordan, David Starr** 1851–1931  
American scientist and educator

Science must stop where the facts stop, or thereabout, the limit of “thereabout” covering all legitimate diversions and excursions of philosophy.

In Frances Mason

*Creation by Evolution*

Evolution – Its Meaning (p. 4)

The Macmillan Company. New York, New York, USA. 1928

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Science is not indeed a perfect instrument, but it is a superb and invaluable tool that works harm only when it is taken as an end in itself. Science must serve; it errs when it usurps the throne. It must be ready to serve all its branches, for each, because of its insufficiency, has need of support from the others. Science is the tool of the western mind, and with it one can open more doors than with bare hands. It is part and parcel of our understanding, and the understanding it conveys is the only kind there is.

Translated by R.F.C. Hull

*Alchemical Studies*

Difficulties Encountered by a European in Trying to Understand the East (pp. 6–7)

Princeton University Press. Princeton, New Jersey, USA. 1967

**Kaczynski, Theodore** 1942–

American anarchist

Science marches on blindly...without regard to the real welfare of the human race or to any other standard, obedient only to the psychological needs of the scientists and of the government officials and corporate executives who provide the funds for research.

In Anne Eisenberg

The Unabomber and the Bland Decade

*Scientific American*, Volume 274, Number 4, April, 1998 (p. 35)

**Kapitza, Pyetr Leonidovich** 1894–1984

Russian physicist

The year that Rutherford died there disappeared forever the happy days of free scientific work which gave us such delight in our youth. Science has lost her freedom. Science has become a productive force. She has become rich but she has become enslaved and part of her is veiled in secrecy.

Address to the Royal Society in Honour of Lord Rutherford

*Nature*, Volume 210, Number 5038, May 17, 1966 (p. 783)

**Kauffman, Stuart A.**

American theoretical biologist

Paradise has been lost, not to sin, but to science.

*At Home in the Universe: The Search for Laws of Self-organization and Complexity*

Chapter 1 (p. 4)

Oxford University Press. New York, New York, USA. 1995



**Keller, Helen** 1880–1968

American author and lecturer

Science may have found a cure for most evils; but it has found no remedy for the worst of them all – the apathy of human beings.

*My Religion*

Part 1, Chapter 6

Swedenborg &amp; Foundation, Inc. New York, New York, USA. 1927

**Kellogg, Vernon Lyman** 1867–1937

American zoologist

Science does not assume that it knows – despite the great deal that it does know – more than a very small part of the order of nature.

Some Things Science Doesn't Know

*The World's Work*, March, 1926 (p. 528)**Kennedy, John F.** 1917–63

35th president of the USA

Science contributes to our culture in many ways, as a creative intellectual activity in its own right, as the light which has served to illuminate man's place in the universe, and as the source of understanding of man's own nature.

Address to the National Academy of Sciences

Washington, D.C., October 22, 1963

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

So that we might kill one another more expertly, science found wonderful ways to live more comfortably, richly, to communicate more rapidly. So that we might exterminate one another more successfully, science showed us how we might all live longer and stronger...

In Paul de Kruif

America Comes Through a Crisis

*Saturday Evening Post*, May 13, 1933 (p. 3)**Keyser, Cassius Jackson** 1862–1947

American mathematician

Science does not seek emancipation in order to become a drudge, she consents to serve indeed but her service aims at freedom as an end.

*Lectures on Science, Philosophy and Art, 1907–1908*

Mathematics (p. 43)

The Columbia University Press. New York, New York, USA. 1908

**Kingsley, Charles** 1819–75

English clergyman and author

...Science was the child of Courage, and Courage the child of Knowledge.

*Health and Education*

Science (p. 259)

W. Isbister &amp; Company London, England. 1874

For from blind fear of the unknown, science does certainly deliver man. She does by man as he does by an unbroken colt. The colt sees by the road side some quite new object – a cast-away boot, an old kettle, or what not. What a

fearful monster! What unknown terrific powers may it not possess! And the colt shies across the road, runs up the bank, rears on end; putting itself thereby, as many a man does, in real danger. What cure is there? But one, experience. So science takes us, as we should take the colt, gently by the halter; and makes us simply smell at the new monster; till after a few trembling sniffs, we discover, like the colt, that it is not a monster, but a kettle.

*Health and Education*

Science (p. 284)

W. Isbister &amp; Company London, England. 1874

For science is, I verily believe, like virtue, its own exceeding great reward.

*Health and Education*

Science (p. 289)

W. Isbister &amp; Company. London, England. 1874

...it is the childlike, simple, patient, reverent heart, which science at once demands and cultivates. To prejudice or haste, to self-conceit or ambition, she proudly shuts her treasuries – to open them to men of humble heart, whom this world thinks simple dreamers – her Newtons, and Owens, and Faradays.

*Alton Locke, Taylor and Poet*

Chapter XVIII (p. 141)

Macmillan &amp; Company Ltd. London, England. 1911

Science...is like virtue, its own exceeding great reward.

*Scientific Lectures and Essays* (pp. 253–254)

Macmillan &amp; Company Ltd. London, England. 1893

**Kipling, Rudyard** 1865–1936

British writer and poet

There are times when Science does not satisfy.

*With the Night Mail* (p. 24)

Doubleday, Page &amp; Company. New York, New York, USA. 1909

**Kirby, William** 1759–1850

Clergyman and entomologist

Mankind in general, not excepting even philosophers, are prone to magnify, often beyond its just merit, the science or pursuit to which they have addicted themselves, and to depreciate any that seems to stand in competition with their favorite: like the redoubted champions of romance, each thinks himself bound to take the field against every-one that will not subscribe to the peerless beauty and accomplishments of his own Dulcinea.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Letter I (p. 1)

Longman, Green, Longman &amp; Roberts. London, England. 1860

**Kirkpatrick, Clifford** 1898–1970

American sociologist

Science recognizes no personal powers in the universe responsive to the prayers and needs of men.

*Religion in Human Affairs*

Chapter XVI (p. 470)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1929

**Köhler, Wolfgang** 1887–1967  
American psychologist

It would be interesting to inquire how many times essential advances in science have first been made possible by the fact that the boundaries of special disciplines are not respected. ...at the present time it is of course quite customary for physicists to trespass on chemical ground, for mathematicians to do excellent work in physics, and for physicists to develop new mathematical procedures... trespassing is one of the most successful techniques in science.

*Dynamics in Psychology*

Retention and Recall (pp. 115–116)

Liveright Publishing Corporation. New York, New York, USA. 1940

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

More often than not, the way science goes from point A to point B is by a random lurch through points X, Y, and Z. Even when great leaps of progress do occur, they only rarely come “out of the blue.” Advances are nearly always preceded by years, decades, or even centuries of patient accumulation of facts and data and ideas.

*Blind Watchers of the Sky*

Chapter Two (p. 25)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

Science does not proceed like a cookbook recipe in the making of a hypothesis, comparing its prediction with observations and either accepting or rejecting the hypothesis. There is always confusion at the leading edge of research, and there are always a few discrepant and contradictory pieces of information that can't be explained.

*Blind Watchers of the Sky*

Chapter Seven (pp. 193–194)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Koshland, Jr., Daniel E.** 1920–  
American biochemist

Science is not impressed with a conglomeration of data. It likes carefully constructed analysis of each problem.

Editorial

*Science*, Volume 263, Number 5144, January 14, 1994 (p. 155)

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

There are times, such as when the state school board in Kansas in 1999 removed evolution from its science curriculum, when I am reminded of Lavoisier, and shudder at the damage that can be done by ignorance combined with power. Even the magnificent modern edifice called science, built up over half a millennium of small increments toward the truth, is not safe from the vicissitudes of the political world. If, as Carl Sagan claimed, science is a “candle in the dark,” banishing demons that haunted

the benighted eras of mankind, it burns tenuously at best. One generation of ignorance, steeped in myth and mysticism, is all that may be needed to snuff it out.

*Atom: An Odyssey from the Big Bang to Life on Earth...and Beyond*

Chapter 13 (p. 172)

Little, Brown & Company. Boston, Massachusetts, USA. 2001

**Kroeber, Alfred Louis** 1876–1960  
American anthropologist

Science has always promised two things not necessarily related – an increase first in our powers, second in our happiness or wisdom, and we have come to realize that it is the first and less important of the two promises which it has kept most abundantly.

*The Modern Temper*

Chapter Three (p. 43)

Harcourt, Brace & Company. New York, New York, USA. 1929

...the most important part of our lives – our sensations, emotions, desires, and aspirations – takes place in a universe of illusions which science can attenuate or destroy, but which it is powerless to enrich.

*The Modern Temper*

Chapter Three (p. 50)

Harcourt, Brace & Company. New York, New York, USA. 1929

**Kuhn, Thomas S.** 1922–96  
American historian of science

...science...often suppresses fundamental novelties because they are necessarily subversive of its basic commitments.

*The Structure of Scientific Revolutions*

Chapter I (p. 5)

The University of Chicago Press. Chicago, Illinois, USA. 1970

To understand why science develops as it does, one need not unravel the details of biography and personality that lead each individual to a particular choice, though that topic has vast fascination. What one must understand, however, is the manner in which a particular set of shared values interacts with the particular experiences shared by a community of specialists to ensure that most members of the group will ultimately find one set of arguments rather than another decisive.

*The Structure of Scientific Revolutions*

Postscript–1969 (p. 200)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Kusch, Polykarp** 1911–93  
German-American physicist

Science is the greatest creative impulse of our time. It dominates the intellectual scene and forms our lives, not only in the material things which it has given us, but also in that it guides our spirit. Science shows us truth and beauty and fills each day with a fresh wonder of the exquisite order which governs our world.

Address to University Students

December 10, 1955

**Lamb, Charles** 1775–1834

English essayist and critic

Science has succeeded to poetry, no less in the little walks of children than with men. Is there no possibility of averting this sore evil?

In Thomas Noon Talfourd

*The Works of Charles Lamb: To which are Prefixed His Letters, and a Sketch of His Life* (Volume 1)

Letter to S.T. Coleridge, October 23, 1802 (p. 118)

Harper &amp; Brothers, Publishers. New York, New York, USA. 1838

In everything that relates to science, I am a whole Encyclopaedia behind the rest of the world.

*Essays of Elia*

The Old and the New Schoolmaster (p. 38)

Little, Brown &amp; Company. Boston, Massachusetts. USA. 1896

**Landsberg, Peter Theodore** 1922–

No biographical data available

Everybody who takes up science has the ambition to become a successful scientist and make some discoveries. Most of us are disappointed because we do not make the really big and interesting discoveries. Or, if we do make them, we do not realize they are interesting, because other discoveries seem more important.

*Mathematics Today*, October, 1902 (p. 135)**Lang, Andrew** 1844–1912

Scottish scholar and man of letters

But science, like the spear of Achilles, can cure the wounds which herself inflicts.

*The Disentanglers*

Adventure of the Canadian Heiress (p. 399)

Longmans, Green Publishers. New York, New York, USA. 1902

**Lankester, Edwin Ray** 1847–1929

English zoologist

Through it [science] we believe that man will be saved from misery and degradation, not merely acquiring new material powers, but learning to use and to guide his life with understanding. Through Science he will be freed from the fetters of superstition; through faith in Science he will acquire a new and enduring delight in the exercise of his capacities; he will gain a zest and interest in life such as the present phase of culture fails to supply.

*The Advancement of Science*

Chapter II (pp. 108–109)

Macmillan &amp; Company Ltd. London, England. 1890

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The sciences, on the contrary, without bounds like nature herself, increase infinitely by the labours of successive generations the most perfect work; by raising them to a height from which they can never again descend, gives birth to new discoveries which new works which efface the former from which they originated.

*The System of the World*

Book V, Chapter V (pp. 343–344)

Printed for Richard Phillips. London, England. 1809

**Lapp, Ralph E.** 1917–2004

American nuclear physicist

No one – not even the most brilliant scientist alive today – really knows where science is taking us. We are aboard a train which is gathering speed, racing down a track on which are an unknown number of switches leading to unknown destinations. No single scientist is in the cab, and there may be demons at the switch. Most of society is in the caboose looking backward. Some passengers, fearful that they have boarded an express train to hell, want to jump off before it is too late

*The New Priesthood: The Scientific Elite and the Uses of Power*

Chapter 2 (p. 29)

Harper &amp; Row, Publishers. New York, New York, USA. 1965

**Lavoisier, Antoine Laurent** 1743–94

French chemist

Science still has many chasms, which interrupt the series of facts and often render it extremely difficult to reconcile them with each other...

In *Great Books of the Western World* (Volume 45)*Elements of Chemistry*

Preface (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

Now all science starts gaily from the inland source of *I don't know*. Gaily it says: I don't know, but I'm going to know. It's like a little river bubbling up cheerfully in the determination to dissolve the whole world in its waves. And science, like the little river, winds wanderingly out again into the final *I don't know* of the ocean.

*Selected Critical Writings*

The Proper Study (p. 154)

Oxford University Press. Oxford, England. 1998

**Lebowitz, Fran** 1951–

American comedian

Science is not a pretty thing. It is unpleasantly proportioned, outlandishly attired and often over-eager. What then is the appeal of science? What accounts for its popularity? And who gives it its start?

*Metropolitan Life*

Science (p. 104)

Fawcett Crest. New York, New York, USA. 1978

**Leclerc, Georges-Louis, Comte de Buffon** 1707–88

French naturalist

The only good science is the knowledge of facts, and mathematical truths are only truths of definition, and completely arbitrary, quite unlike physical truths.

In L. Ducros  
*Les Encyclopedistes* (p. 326)  
 Publisher undetermined

**Leopold, Aldo** 1886–1948  
 American naturalist

If science cannot lead us to wisdom as well as power, it is surely no science at all.

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
 Ecology and Politics (p. 284)  
 The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**Lerner, Max** 1902–22  
 American educator and author

It is not science that has destroyed the world, despite all the gloomy forebodings of the earlier prophets. It is man who has destroyed man.

*Actions and Passions: Notes on the Multiple Revolution of Our Time*  
 The Human Heart and Human Will (p. 3)  
 Simon & Schuster. New York, New York, USA. 1949

**Lewis, Wyndham** 1882–1957  
 English author and painter

When we say “science” we can either mean any manipulation of the inventive and organizing power of the human intellect: or we can mean such an extremely different thing as the religion of science, the vulgarized derivative from this pure activity manipulated by a sort of priestcraft into a great religious and political weapon.

*The Art of Being Ruled*  
 Revolution and Progress, Chapter 1 (pp. 3–4)  
 Chatto & Windus. London, England. 1926

**Liebig, Justus** 1803–73  
 German organic chemist

It is not everyone who is called by his situation in life to assist in extending the bounds of science; but all mankind have a claim to the blessings and benefits which accrue from its earnest cultivation.

*Chemistry In Its Application to Agriculture and Physiology*  
 Preface (p. iii)  
 T.B. Peterson. Philadelphia, Pennsylvania, USA. 1847

**Lindley, David** 1956–  
 English astrophysicist and author

When scientists begin to wonder...how science is possible at all, which is ultimately what their questioning of the mathematical basis of science is about, they are searching for reassurance, for some proof that there really is a fundamental theory out there in the dark waiting to be hunted down.

*The End of Physics: The Myth of a Unified Theory*  
 Prologue (p. 4)  
 Basic Books, Inc. New York, New York, USA. 1993

**Locke, John** 1632–1704  
 English philosopher and political theorist

...as to a perfect *science* of natural bodies...we are, I think, so far from being capable of any such thing, that I conclude it lost labor to seek after it.

*An Essay Concerning the Human Understanding* Volume 2  
 Book IV, Chapter 4, Section 29 (p. 122)  
 Cummings & Hillard & J.T. Buckingham. Boston, Massachusetts, USA. 1813

## London Quarterly Review

The most obvious means of elevating the people, is to provide for them works on popular and practical science, freed from mathematical symbols and technical terms written in simple and perspicuous language, and illustrated by facts and experiments which are level to the capacity of ordinary minds.

*Popular Lectures on Science and Art*  
 Title page (p. 5)  
 Greeley & McElrath. New York, New York, USA. 1850

**Long, J. M.**  
 No biographical data available

Science analyzes nature into parts, in order that man may attain a point of attack by which to gain control over her laws and forces. On the other hand, philosophy aims to reduce the thought-world to unity, which has been destroyed by the analytic processes of science.

*The Synthetic Philosophy and Organon of the Sciences*  
*The Kansas City Review of Science and Industry*, Volume 4, Number 11, March, 1881 (p. 649)

**Lovecraft, H. P. (Howard Phillips)** 1890–1937  
 American writer of fantasy, horror, and science fiction

The sciences, each straining in its own direction, have hitherto harmed us little; but someday the piecing together of dissociated knowledge will open up such terrifying vistas of reality, and of our frightful position therein, that we shall either go mad from the revelation or flee from the light into the peace and safety of a new dark age.

In Joyce Carol Oates  
*Tales of H.P. Lovecraft: Major Works*  
*The Call of Cthulhu*  
 Chapter I (p. 52)  
 HarperCollins Books. New York, New York, USA. 1997

**Lowell, Percival** 1855–1916  
 American astronomer

Now in science there exists two classes of workers. There are men who spend their days in amassing material, in gathering facts. They are the collectors of specimens in natural history, the industrious takers of routine measurements in physics and astronomy or the mechanical accumulators of photographic plates. Very valuable such collections are. They may not require much brains to get, but they enable other brains to get a great deal out of them later.... The rarer they are the better. For the less mind

enters into them the more they are worth. When destitute altogether of informing intelligence, they become price-less, as they then convey nature's meaning unmeddled of man.... The second class of scientists are the architects of the profession. They are the men to whom the building up of science is due. In their hands, the acquired facts are put together to that synthesizing of knowledge from which new conceptions spring.... Though the gathering of material is good, without the informing mind to combine the facts they had forever remained barren of fruit.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 22)

University of Arizona Press, Tucson, Arizona, USA. 1976

### **Lubbock, John, First Baron Avebury** 1834–1919

English banker, politician, biologist, and archaeologist

Science, our Fairy Godmother, will, unless we perversely reject her help, and refuse her gifts, so richly endow us, that fewer hours of labour will serve to supply us with the material necessities of life, leaving us more time to ourselves, more leisure to enjoy all that makes life best worth living.

*The Beauties of Nature and the Wonders of the World We Live In*

Introduction (p. 37)

Macmillan & Company New York, New York, USA. 1893

### **Lucretius** ca. 99 BCE–55 BCE

Roman poet

Oh Science, lift aloud thy voice that stills The pulse of fear, and through the conscience thrills –

Thrills through the conscience with the news of peace –

How beautiful thy feet are on the hills!

In William Hurrell Mallock

*Lucretius on Life and Death*

Section III, XXII

John Lane, New York, New York, USA. 1900

### **Lundberg, G. A.**

No biographical data available

...no science tells us what to do with the knowledge that constitutes the science. Science only provides a car and a chauffeur for us. It does not directly, as science, tell us where to drive. The car and the chauffeur will take us into the ditch, over the precipice, against a stone wall, or into the highlands of age-long human aspirations with equal efficiency. If we agree as to where we want to go and tell the driver our goal, he should be able to take us thereby one of a number of possible routes the costs and conditions of each of which the scientist should be able to explain to us.

*Can Science Save Us?*

Social Problems (p. 31)

Longmans, Green & Company New York, New York, USA. 1947

### **Lyttleton, R. A.**

English astronomer

...many very serious-minded, solid, and knowledgeable people work hard in science all their lives and produce nothing of the smallest importance, while others, few by comparison and perhaps seemingly carefree and not highly erudite, exhibit a serendipity of mind that enables them to have valuable ideas in any subject they may choose to take up.

In R. Duncan and M. Weston-Smith (eds.)

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Nature of Knowledge (p. 10)

Pergamon Press, Oxford, England. 1977

### **MacArthur, Robert H.** 1930–72

American ecologist

[N]ot all naturalists want to do science; many take refuge in nature's complexity as a justification to oppose any search for patterns.... Doing science is not such a barrier to feeling or such a dehumanizing influence as is often made out. It does not take the beauty from nature.

*Geographical Ecology*

Introduction (p. 1)

Harper & Row, Publishers, New York, New York, USA. 1972

### **Macfie, Ronald Campbell** 1867–1931

Poet and physician

It is time that men knew that Science does not write with the cold finger of a starfish; it is time that men realized that true science is not a mere compilation of dead facts; it is time that men understood that Science is flamboyant and alive.

*Science, Matter and Immortality*

Chapter XXIII (p. 297)

William & Norgate, London, England. 1909

Conceived aright, science must always lead to belief in the unseen and to hope of immortality; but Science must learn to recognize her own limitations – must learn to recognize that her logic is not conclusive when her postulates are dubious – and that she can only become a ruler of men's souls and a brightener of men's lives if she takes Poetry and Philosophy by the hand, and dwells with them in the temple of Beauty and Reverence.

*Science, Matter and Immortality*

Chapter XXIII (p. 300)

William & Norgate, London, England. 1909

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

All science has its origin in the needs of life.

*The Science of Mechanics* (5th edition)

Chapter V, Part II, Section 1 (p. 610)

The Open Court Publishing Company, La Salle, Illinois, USA. 1942

Everyone who busies himself with science recognizes how unsettled and indefinite the notions are which he has



brought with him from common life, and how, on a minute examination of things, old differences are effaced and new ones introduced.

*Popular Scientific Lectures*

The Forms of Liquids (pp. 1–2)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Is science itself anything more than – a business? Is not its task to acquire with the least possible work, in the least possible time, with the least possible thoughts, the greatest possible part of eternal truth?

*Popular Scientific Lectures*

The Forms of Liquids (p. 16)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Science does not create facts from facts, but simply orders known facts.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physics (p. 211)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

The great results achieved by physical science in modern times – results not restricted to its own sphere but embracing that of other sciences which employ its help – have brought it about that physical ways of thinking and physical modes of procedure enjoy on all hands unwonted prominence, and that the greatest expectations are associated with their application.

*The Analysis of Sensations and the Relation of the Physical to the Psychological*  
Chapter I (p. 1)

The Open Court Publishing Company. Chicago, Illinois, USA. 1914

Science always has its origin in the adaptation of thought to some definite field of experience.

*The Analysis of Sensations and the Relation of the Physical to the Psychological*

Chapter I (p. 31)

The Open Court Publishing Company. Chicago, Illinois, USA. 1914

### **Mackay, Charles** 1814–89

Scottish poet, journalist, and song writer

Blessings on Science! When the earth seem'd old, When Faith grew dotting, and the Reason cold,  
'T was she discover'd that the world was young, And taught a language to its lisping tongue:  
'T was she disclosed a future to its view, And made old knowledge pale before the new.

*Voices from the Mountains and from the Crowd*

Railways

Ticknor, Reed & Fields. Boston, Massachusetts, USA. 1853

### **Maffei, Paolo** 1926–

Italian astronomer

We are now moving beyond those concepts and the knowledge familiar to us in the first half of this century, and we are entering a world in which science and fantasy intertwine...

Translated by D.J.K. O'Connell

*Beyond the Moon*

Chapter 10 (p. 301)

The MIT Press. Cambridge, Massachusetts, USA. 1978

### **Malthus, Thomas Robert** 1776–1834

English economist and sociologist

...if the science be manifestly incomplete, and yet of the highest importance, it would surely be most unwise to restrain inquiry, conducted upon just principles, even where the immediate practical utility of it was not visible. In mathematics, chemistry, and every branch of natural philosophy, how many are the inquiries necessary to their improvement and completion, which, taken separately, do not appear to lead to any specifically advantageous purpose! How many useful inventions, and how much valuable and improving knowledge would have been lost, if a rational curiosity and a mere love of information had not generally been allowed to be a sufficient motive for the search after truth!

*Principles of Political Economy Considered With a View to Their Practical Application*

Introduction (pp. 12–13)

William Pickering. London, England. 1836

### **Mantell, Gideon Algernon** 1780–1852

English obstetrician, geologist, and paleontologist

...it should ever be borne in mind that the primary object of every study ought to be an inward one that of enlarging and elevating the intellect; and the direct aim of science should be the discovery of the principles of unity, order, and connexion, which are everywhere manifest in the universal life of nature.

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Address to the Reader (p. xxiii)

G.H. Bohn. London, England. 1857–58

...whereby the useful is indissolubly linked with the true, the exalted, and the beautiful, science thus followed for its own sake will pour forth abundant overflowing streams to enrich and fertilize that industrial prosperity, which is the conquest of the intelligence of Man over matter.

*The Wonders of Geology; or, A Familiar Exposition of Geological Phenomena*

Address to the Reader (p. xiv)

G.H. Bohn. London, England. 1857–58

### **Mara Corday (Fictional character)**

Science is science, but a girl must get her hair done.

*Tarantula*

Film (1955)

### **Margenau, Henry** 1901–97

American physicist

It is in fact obvious that science should be pressed to say all it can about any problem which is at all susceptible to scientific treatment.



*The Nature of Physical Reality: A Philosophy of Modern Physics*  
Chapter 2 (p. 12)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

Science has no boundaries; it has an horizon which widens as science advances, placing in view more and more unknown terrain but never heaven.

*Open Vistas Philosophical Perspectives of Modern Science*  
Chapter 2 (p. 30)  
Yale University Press. New Haven, Connecticut, USA. 1961

The error of mistaking science for an exclusive catalogue of facts is symptomatic of a bias in other parts of our thinking, for it results in an underestimate and a disparagement of the power of theory to convince in the realm of international affairs; indeed, it may prove to be a tragic handicap in our struggle for supremacy in a world that probably no longer dares conduct military wars.

*Open Vistas Philosophical Perspectives of Modern Science*  
Chapter 2 (p. 33)  
Yale University Press. New Haven, Connecticut, USA. 1961

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist

**Sagan, Dorion** 1959–  
American science writer

Science has become a social method of inquiring into natural phenomena, making intuitive and systematic explorations of laws which are formulated by observing nature, and then rigorously testing their accuracy in the form of predictions. The results are then stored as written or mathematical records which are copied and disseminated to others, both within and beyond any given generation. As a sort of synergetic, rigorously regulated group perception, the collective enterprise of science far transcends the activity within an individual brain.

*Microcosmos*  
Chapter 12 (p. 233)  
Summit Books. New York, New York, USA. 1986

**Maritain, Jacques** 1882–1973  
French philosopher

Since science's competence extends to observable and measurable phenomena, not to the inner being of things, and to the means, not to the ends of human life, it would be nonsense to expect that the progress of science will provide men with a new type of metaphysics, ethics, or religion.

Science and Ontology  
*Bulletin of the Atomic Scientists*, Volume 5, 1944 (p. 200)

**Marshall, Alfred** 1842–1924  
English economist

...the mathematico-physical group of sciences...have this point in common, that their subject-matter is constant and unchanged in all countries and in all ages. ...if the subject-matter of a science passes through different

stages of development, the laws which apply to one stage will seldom apply without modification to others; the laws of science must have a development corresponding to that of the things of which they treat.

In A.C. Pigou (ed.)  
*Memorials of Alfred Marshall*  
Chapter VI (p. 154)  
Macmillan & Company Ltd. London, England. 1925

**Marshall, Arthur Milnes** 1852–93  
English zoologist

Science has been aptly compared to a globe, similar to our own earth a globe with a solid hard crust bounded by an irregular surface. The solid crust represents ascertained facts, facts that have been confirmed and stowed away in their proper places; the irregularity of its surface indicates the unequal accumulation of facts in the various branches of knowledge. The atmosphere by which the whole globe is invested represents the world of speculation, of theories an atmosphere heavily laden with germs and particles of truth, but germs as yet immature, particles whose position relative to the solid crust is not yet a fixed and determined one.

*Biological Lectures and Addresses, Delivered by the Late Arthur Milnes Marshall*  
Chapter I (pp. 1–2)  
Nutt. London, England. 1894

**Mason, James** 1909–84  
English actor

Don't you see what's at stake here? The ultimate aim of all science – to penetrate the unknown. Do you realize we know less about the earth we live on than about the stars and the galaxies of outer space? The greatest mystery is right here, right under our feet.

*A Journey to the Center of the Earth*  
Film (1959)

**Masters, William H.** 1915–2001  
American gynecologist

Science by itself has no moral dimension. But it does seek to establish truth. And upon this truth morality can be built.

*Life*, June 24, 1966

**Matsen, F. Albert**  
No biographical data available

Science is defined as a set of observations and theories about observations.

The Role of Theory in Chemistry  
*Journal of Chemical Education*, Volume 62, Number 5, May, 1985 (p. 365)

**Maxwell, James Clerk** 1831–79  
Scottish physicist

It was a great step in science when men became convinced that, in order to understand the nature of things,

they must begin by asking, not whether a thing is good or bad, noxious or beneficial, but of what kind is it? and how much is there of it? Quality and quantity were then first recognised as the primary features to be observed in scientific inquiry. As science has been developed, the domain of quantity has everywhere encroached on that of quality, till the process of scientific inquiry seems to have become simply the measurement and registration of quantities, combined with a mathematical discussion of the numbers thus obtained.

*Nature*, September 22, 1870 (p. 420)

Science appears to us with a very different aspect after we have found out that it is not in lecture-rooms only, and by means of the electric light projected on a screen, that we may witness physical phenomena, but that we may find illustrations of the highest doctrines of science in games and gymnastics, in travelling by land and by water, in storms of the air and of the sea, and wherever there is matter in motion.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell*

Chapter XII (p. 355)

Macmillan & Company Ltd. London, England. 1882

...we have been led, along a strictly scientific path, very near to the point at which science must stop; not that science is debarred from studying the internal mechanism of a molecule which she cannot take to pieces, anymore than from investigating an organism which she cannot put together. But in tracing back the history of matter, Science is arrested when she assures herself, on the one hand, that the molecule has been made, and on the other, that it has not been made by any of the processes we call natural.

Quoted in Frederick Soddy

*The Interpretation of Radium and the Structure of the Atom*

Chapter X (pp. 215–216)

J. Murray. London, England. 1909

### **McCarthy, Mary** 1912–89

American writer

Modern neurosis began with the discoveries of Copernicus. Science made man feel small by showing him that the earth was not the center of the universe.

*On the Contrary*

Tyranny of the Orgasm (p. 168)

Farrar, Straus & Cudahy, New York, New York, USA, 1961

### **McLuhan, Marshall** 1911–80

Canadian educator, philosopher, and scholar

Current illusion is that science has abolished all natural laws.

In Matie Molinaro, Corinne McLuhan, and William Toye (eds.)

*Letters of Marshall McLuhan*

Letter to Ezra Pound

January, 1951

Oxford University Press, Inc. New York, New York, USA. 1987

### **McMorris, Neville** 1934–

American academic

The “scientific nature of science” is not a paradox to be resolved but a truism to be pondered.

*The Nature of Science*

Chapter 9 (p. 199)

Fairfield Dickinson University Press. 1989

### **McMurry, Charles Alexander** 1857–1929

American educator

The intrusive and masterful way in which natural science has been coming into our houses, factories, and industries of all sorts, compels us to pay considerable attention to the applications of science to life.

*Special Method in Elementary Science for the Common School*

Chapter III (p. 21)

The Macmillan Co. New York, New York, USA. 1905

### **Mead, Margaret** 1901–78

American anthropologist

...the negative cautions of science are never popular. If the experimentalist would not commit himself, the social philosopher, the preacher and the pedagogue tried the harder to give a short-cut answer.

*Coming of Age in Samoa*

Chapter 1 (p. 3)

The Modern Library. New York, New York, USA. 1953

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Science is no more a classified inventory of factual information than history a chronology of dates. The equation of science with facts and of the humane arts with ideas is one of the shabby genteelisms that bolster up the humanist's self-esteem.

Two Conceptions of Science

*Encounter*, 143, August, 1965

...science is a great and glorious enterprise – the most successful, I argue, that human beings have ever engaged in. To reproach it for its inability to answer all the questions we should like to put to it is no more sensible than to reproach a railway locomotive for not flying or, in general, not performing any other operation for which it was not designed.

*The Limits of Science*

Preface (p. xiii)

Harper & Row, Publishers. New York, New York, USA. 1984

Science can only proceed on a basis of confidence, so that scientists do not suspect each other of dishonesty or sharp practice, and believe each other unless there is very good reason to do otherwise.

*The Limits of Science*

An Essay on Scians [Science] (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1984

Science will persevere just as long as we retain a faculty we show no signs of losing: the ability to conceive – in no

matter how imperfect or rudimentary a form – what the truth might be and retain also the inclination to ascertain whether our imaginings correspond to real life or not.

*The Limits of Science*

Chapter 4 (pp. 86–87)

Harper & Row, Publishers. New York, New York, USA. 1984

It is a layman's illusion that in science we caper from pinnacle to pinnacle of achievement and that we exercise a Method which preserves us from error. Indeed we do not; our way of going about things takes it for granted that we guess less often right than wrong, but at the same time ensures that we need not persist in error if we earnestly and honestly endeavor not to do so.

*The Limits of Science*

Notes, 3 (p. 101)

Harper & Row, Publishers. New York, New York, USA. 1984

...nowadays we all give too much thought to the material blessings or evils that science has brought with it, and too little to its power to liberate us from the confinements of ignorance and superstition. The greatest liberation of thought achieved by the scientific revolution was to have given human beings a sense of future in this world.

*The Art of the Soluble*

Introduction (p. 15)

Methuen & Company Ltd. London, England. 1967

If we accept, as I fear we must, that science cannot answer questions about first and last things or about purposes, there is yet no known or conceivable limit to its power to answer questions of the kind science can answer.... Science will dry up only if scientists lose or fail to exercise the power or incentive to imagine what the truth might be.

*Advice to a Young Scientist*

Chapter 11 (p. 90)

Basic Books, Inc. New York, New York, USA. 1979

One can envisage an end of science no more readily than one can envisage an end of imaginative literature or the fine arts.

*Advice to a Young Scientist*

Chapter 11 (p. 90)

Basic Books, Inc. New York, New York, USA. 1979

### **Mellor, Joseph William** 1863–1938

Chemist

...science aims at omniscience. The target, however, appears to recede with increasing knowledge.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 10)

Longman, Green, & Co. London, England. 1922

Science is not a mass of empirical knowledge gained by observation and experiment, but it is an organized body of facts which have been co-ordinated and generalized into a system. Science tacitly assumes that nature is a harmonious unity, and that rational order pervades the universe.

Science seeks a complete knowledge of the multitude of inter-related parts of the universe which act and react on one another producing endless variety. In fine, science aims at omniscience. The target, however, appears to recede with increasing knowledge. As man grows in wisdom and knowledge, he begins dimly to realize that the unknown multiplies into boundless proportions.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

(Volume 1)

Chapter I (p. 10)

Longman, Green, & Co. London, England. 1922

...science cannot enter into the dark territory beyond the scope of man's faculties, and where verification, direct or indirect, is not possible. A vivid imagination can people this region with phantasms and be deluded with the hallucination that these creatures of the imagination are real, substantial, objective facts.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*

Chapter I (p. 16)

Longman, Green & Co. London, England. 1922

### **Melville, Herman** 1819–91

American novelist

...however baby man may brag of his science and skill, and however much, in a flattering future, that science and skill may augment; yet forever and forever, to the crack of doom, the sea will insult and murder him, and pulverize the stateliest, stiffest frigate he can make; nevertheless, by the continual repetition of these very impressions, man has lost that sense of the full awfulness of the sea which aboriginally belongs to it.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 58 (p. 204)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

After science comes sentiment.

*Typee, Omoo, Mardi*

*Mardi*

Chapter 38 (p. 785)

The Library of America. New York, New York, USA. 1982

Thou canst not tell where one drop of water or one grain of sand will be tomorrow noon; and yet with thy impotence thou insultest the sun! Science! Curse thee, thou vain toy...

*Moby Dick, Or, The White Whale*

Chapter CXVIII (pp. 466–467)

L.C. Page & Co. Boston, Massachusetts, USA. 1892

### **Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

The notion that science does not concern itself with first causes – that it leaves the field to theology or metaphysics, and confines itself to mere effects – this notion has no support in the plain facts. If it could, science would explain the origin of life on earth at once – and there is

every reason to believe that it will do so on some not too remote tomorrow. To argue that gaps in knowledge which will confront the seeker must be filled, not by patient inquiry, but by intuition or revelation, is simply to give ignorance a gratuitous and preposterous dignity.

*Treatise on the Gods*

Chapter 5 (p. 239)

Vintage Books. New York, New York, USA. 1963

There is, in fact, no reason to believe that any given natural phenomenon, however marvelous it may seem today, will remain forever inexplicable. Soon or late the laws governing the production of life itself will be discovered in the laboratory, and man may set up business as a creator on his own account. The thing, indeed, is not only conceivable; it is even highly probable.

*Treatise on the Gods*

Chapter 5 (p. 241)

Vintage Books. New York, New York, USA. 1963

### **Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

What has been sown for the field of science will grow up for the people's welfare.

Translated by George Kamensky

*Principles of Chemistry* (Volume 1)

Introduction

Longmans, Green & Company. London, England. 1891

In comparing the science of the past, the present, and the future, in placing the particulars of its restricted experiments side by side with its aspirations for unbounded and infinite truth, and in restraining myself from yielding to a bias towards following the most attractive representation, I have endeavored to incite in the reader a spirit of inquiry, which, unsatisfied with speculative reasonings alone, should subject every idea to experiment, excite the habit of stubborn work, necessitate a knowledge of the past, and a search for fresh threads to complete the bridge over the bottomless unknown.

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. viii)

Longmans, Green & Co. London, England. 1891

Knowing how contented, free and joyful is life in the realms of science, one fervently wishes that many would enter their portals.

*Principles of Chemistry* (Volume 1)

Preface (p. ix, fn 1)

Longmans, Green & Company. London, England. 1891

Without the material, the plan alone is but a castle in the air, a mere possibility, whilst the material without a plan is but useless matter; all depends on the concordance of the materials with the plan and execution, and the general harmony thereby attained. In the work of science, the artisan, architect, and creator are very often one and the same individual, but sometimes, as in other walks of

life, there is a difference between them; sometimes the plan is preconceived, sometimes it follows the preparation and accumulation of the raw material. Free access to the edifice of science is not only allowed to those who devised the plan, worked out the detailed drawings, prepared the materials, or piled up the brickwork, but also to all those who are desirous of making a close acquaintance with the plan, and wish to avoid dwelling in the vaults or in the garrets where the useless lumber is stored.

Translated by George Kamensky

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. ix)

Longmans, Green & Co. London, England. 1891

Science, which deals with the infinite, is itself without bounds.

Translated by George Kamensky

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. x)

Longmans, Green & Co. London, England. 1891

The time has come to turn aside from visionary contemplation, from platonic aspirations, and from classical verbosity, and to enter the regions of actual labour for the common weal, and to prove that the study of science is not only an excellent education for youth, but that it instills the virtues of labour and truth, and creates solid national wealth, material and mental, which without it would be unattainable.

Translated by George Kamensky

*The Principles of Chemistry* (Volume 1)

Author's Preface to the Fifth Edition (p. x)

Longmans, Green & Co. London, England. 1891

Science is a universal heritage, and therefore it is only just to give the highest honour in science, not to those who first enunciate a certain truth, but to those who are first able to convince others of its authenticity and establish it for the general welfare.

Translated by George Kamensky

In Thomas Atkinson Lawson

*The Principles of Chemistry* (Volume 1)

Introduction (p. 17)

Longmans, Green & Co. London, England. 1891

While science is pursuing a steady onward movement, it is convenient from time to time to cast a glance back on the route already traversed, and especially to consider the new conceptions which aim at discovering the general meaning of the stock of facts accumulated from day to day in our laboratories.

The Periodic Law of the Chemical Elements

*Journal of the Chemical Society*, Volume 55, 1889 (p. 634)

Science plays an auxiliary part in our lives, for it is merely a means to the attainment of wellbeing.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Mendelsohn, Everett**

No biographical data available

**Elkana, Yehuda**

No biographical data available

...no cognitive area rests its case on an single source of knowledge.... And it is certainly wrong to say that... 'science rests its case on experience or experimental evidence'. Science does *not* rest its case on any one source of knowledge, but experience and experimental evidence, and clear and distinct ideas, aesthetic considerations, and analogy are all legitimate sources of knowledge.

*Sciences and Cultures: Anthropological and Historical Studies of the Sciences*

A Programmation Attempt at an Anthropology of Knowledge (p. 20)  
Reidel Publishing Co. Dordrecht, Holland. 1981

**Meredith, George** 1828–1909

English novelist and poet

Science is notoriously of slow movement.

*The Ordeal of Richard Feverel*

Chapter XLIV (p. 518)

The Modern Library. New York, New York, USA. 1927

**Meyer, Agnes** 1887–1970

American author and journalist

From the nineteenth century view of science as a god, the twentieth century has begun to see it as a devil. It behooves us now to understand that science is neither the one nor the other.

*Education for a New Morality*

Chapter 2 (p. 11)

The Macmillan Company. New York, New York, USA. 1957

**Mill, John Stuart** 1806–73

English political philosopher and economist

It is a common notion, or at least it is implied in many common modes of speech, that thoughts, feelings, and actions of sentient beings are not a subject of science.... This notion seems to involve some confusion of ideas, which it is necessary to begin by clearing up. Any facts are fitted, in themselves, to be a subject of science, which follows one another according to constant laws; although those laws may not have been discovered, nor even to be discoverable by our existing resources.

*A System of Logic, Rationative and Inductive* (Volume 2)

Book VI, Chapter 3, Section 1 (p. 426)

Longmans, Green, Reader & Dyer. London, England. 1868

It is unphilosophical to construct a science out of a few of the agencies by which the phenomena are determined, and leave the rest to the routine of practice or the sagacity of conjecture. We either ought not to pretend to scientific forms, or we ought to study all the determining agencies equally, and endeavor, so far as it can be done, to include all of them within the pale of the science; else we shall

infallibly bestow a disproportionate attention upon those which our theory takes into account, while we misestimate the rest, and probably underrate their importance.

*A System of Logic, Ratiocinative and Inductive*

Book VI, Chapter IX (p. 583)

Longmans, Green & Co. London, England. 1900

**Miller, Hugh** 1802–56

Scottish geologist and theologian

There is no science whose value can be adequately estimated by economists and utilitarians of the lower order. Its true quantities cannot be represented by arithmetical figures or monetary tables; for its effects on mind must be as surely taken into account as its operations on matter, and what it has accomplished for the human intellect, as certainly as what it has done for the comforts of society or the interests of commerce.

*The Old Red Sandstone*

Chapter IX (p. 177)

John B. Alden, Publisher. New York, New York, USA. 1892

**Millikan, Robert Andrews** 1868–1953

American physicist

We need science in education, and much more of it than we now have, not primarily to train technicians for the industries, which demand them, though that may be important, but much more to give everybody a little glimpse of the scientific mode of approach to life's problems, to give everyone some familiarity with at least one field in which the distinction between right and wrong is not always blurred and uncertain, to let him see that it is not true that "one opinion is as good as another"...

*The Relationship of Science to Industry*

*Science*, Volume 69, Number 1776, January 11, 1929 (p. 30)

The distinguishing feature of modern scientific thought lies in the fact that it begins by discarding all a priori conceptions about the nature of reality – or about the ultimate nature of the universe – such as had characterized practically all Greek philosophy and all medieval thinking as well, and takes instead, as its starting point, well-authenticated, carefully tested experimental facts, no matter whether these facts seen at the moment fit into any general philosophical scheme or not – that is, no matter whether they seem at the moment to be reasonable or not.

Professor Einstein at the California Institute of Technology

*Science*, Volume 73, Number 1893, April 10, 1931 (p. 376)

It is to lighten man's understanding, to illuminate his path through life, and not merely to make it easy, that science exists.

In Frederick Houk Law

*Science in Literature*

Modern Physics (p. 318)

Harper & Brothers. New York, New York, USA. 1929



...Science walks forward on two feet, namely theory and experiment...Sometimes it is one foot which is put forward first, sometimes the other, but continuous progress is only made by the use of both – by theorizing and then testing, or by finding new relations in the process of experimenting and then bringing the theoretical foot up and pushing it beyond, and so on in unending alternation.

*Nobel Lectures, Physics 1922–1941*

Nobel lecture for award received in 1923

The Electron and the Light-Quant from the Experimental Point of View (p. 55)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

A science grows in the main as does a planet by the process of infinitesimal accretion. Practically every experiment in physics is a modification of an experiment which has gone before.

The Significance of Radium

*Science (New Series)*, Volume 54, Number 1383, July 1, 1921 (p. 2)

**Minot, Charles Sedgwick** 1852–1914

American anatomist

The growth of science depends on three things: –

First. The unknown, which is discoverable. Second. Raw knowledge. Third. Assimilated knowledge.

*Biological Lectures Delivered at the Marine Biological Laboratory of Wood's Hole*

Tenth Lecture (p. 149)

Ginn & Co. Boston, Massachusetts, USA. 1896

**Mitchell, Maria** 1818–89

American astronomer and educator

The phrase “popular science” has in itself a touch of absurdity. That knowledge which is popular is not scientific.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter VII (p. 138)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Mivart, St. George Jackson** 1827–1900

English biologist

Every science is a definitely organised system of recognised relations between thoughts and objects, between thoughts and thoughts, and between objects and objects; and no science can be learned save by the aid of language, spoken, written, or both.

*The Groundwork of Science; A Study of Epistemology*

Chapter II (p. 16)

G.P. Putnam's Sons. New York, New York, USA. 1898

The difference between science and ordinary knowledge is no difference of kind but merely one of degree. Science is nothing more than plain reason and common sense used in a methodical manner and applied to the examination of various objects around us, with as much exactness as possible.

*An Introduction to the Elements of Science*

Chapter I (p. 2)

Little, Brown & Co. Boston, Massachusetts, USA. 1894

**Monod, Jacques** 1910–76

French biochemist

In science, self-satisfaction is death. Personal self-satisfaction is the death of the scientist. Collective self-satisfaction is the death of the research. It is restlessness, anxiety, dissatisfaction, agony of mind that nourish science.

Obituary

*News Science*, Volume 109, June 5, 1976 (p. 359)

**Montagu, Ashley** 1905–99

English-born American anthropologist

As the god of contemporary man's idolatry, science is a two-handed engine, and as such science is too important a human activity to leave to the scientist.

Advertisement of Jacques Barzun's "Science: The Glorious Entertainment"

*New York Times Book Review*, April 26, 1964

**More, Louis Trenchard** 1870–1944

English physicist and biographer of Isaac Newton

Science has so many dazzling achievements to its credit; we have done so many things which seemed to be impossible, that the popular mind is apt to conclude that, if an explanation is given in the name of science, it must be true whether it be understood or not.

*The Dogma of Evolution*

Chapter Seven (p. 241)

Princeton University Press. Princeton, New Jersey, USA. 1925

The goal of science is mathematics, and while mathematics may be said to be the only true science since it has the only true scientific method, mathematics is not a science because it deals with abstractions and ignores concrete phenomena.

*The Limitations of Science*

Chapter V (p. 151)

Henry Holt & Co. New York, New York, USA. 1915

**Morgan, Lloyd** 1870–1944

English psychologist

Science...deals exclusively with changes of configuration, and traces the accelerations which are observed to occur, leaving to metaphysics to deal with the underlying agency, if it exists.

*The Interpretation of Nature*

Chapter V (p. 62)

The Knickerbocher Press. New York, New York, USA. 1906

**Morrow, James** 1947–

American novelist

Everybody thinks he's being oh-so-deep when he says science doesn't have all the answers.... Science *does*



have all the answers.... The problem is that we don't have all the science.

*Only Begotten Daughter* (p. 90)

Harcourt Incorporated. Orlando, Florida, USA. 1990

**Moscovici, S.** 1925–

Romanian-born French psychologist

Science has become involved in this adventure, our adventure, in order to renew everything it touches and warm all that it penetrates – the earth on which we live and the truths which enable us to live. At each turn it is not the echo of a demise, a bell tolling for a passing away that is heard, but the voice of rebirth and beginning, ever afresh, of mankind and materiality, fixed for an instant in their ephemeral permanence. That is why the great discoveries are not revealed on a deathbed like that of Copernicus, but offered like Kepler's on the road of dreams and passion.

*Social Influence and Social Change* (pp. 297–298)

Academic Press. London, England. 1980

**Moser, E. S.**

No biographical data available

Science has no business to halt by the wayside and inquire whether or not the truths found in the book of Nature will horrify those who are nursing some creed or dogma.

Immaterial Science

*The Popular Science Monthly*, Volume 44, November, 1893 (p. 86)

**Motto**

Science Finds – Industry Applies – Man Conforms

Chicago World's Fair, 1933

**Moulton, Forest Ray** 1872–1952

American astronomer

In an age when the world is so largely run by the results of scientific effort it is almost superfluous to speak of the value of science. If the things which science has contributed to our everyday use and which make life at the present time pleasant for us were removed, we should speedily understand the immense debt we owe to it.

*Descriptive Astronomy: An Elementary Exposition of the Facts, Principles, and Theories of Astronomical Science*

Part I (p. 1)

American School of Correspondence. Chicago, Illinois, USA. 1912

**Mumford, Lewis** 1895–1990

American social philosopher

...however far modern science and techniques have fallen short of their inherent possibilities, they have taught mankind at least one lesson: Nothing is impossible.

*Technics and Civilization*

Chapter VIII, Section 13 (p. 435)

Routledge & Kegan Paul Ltd. London, England, 1934

**Munger, Theodore** 1830–1910

American clergyman

Science cannot determine origin, and so cannot determine destiny. As it presents only a sectional view of creation, it gives only a sectional view of everything in creation.

In Jefferson Hane Weaver

*The World of Physics* (Volume 3)

U. 1 (p. 212)

Simon & Schuster. New York, New York, USA. 1987

**Munroe, J.**

No biographical data available

Science has no longer a morbid hold on us. We are dragged from the shade of the Upas tree, and can survey it with impunity, finding in it a medicine instead of a poison. Without destroying the reverence, Science, when properly studied, only confirms the truth of the ancient saying, – “We are fearfully and wonderfully made.”

Science and the Sense of Beauty

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

Volume IV, (Third series), April, 1882 (p. 206)

So, after all our Science, we come to mystery in the end. Our reality lands us in ideality. All our Science can only stem back the unknown ocean of truth, mystic and awful, from the organism to the ultimate atom. We can only regard the universe, and man the microcosm, as a whole, whose wondrous construction we may gain some wise insight into, but whose material is an unfathomable mystery.

Science and the Sense of Beauty

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

Volume IV, (Third series), April, 1882 (p. 207)

**Needham, Joseph** 1900–95

English biochemist and sinologist

...our proper conclusion seems to me to be that the conceptual framework of Chinese associative or coordinative thinking was essentially something different from that of European causal and “legal” or nomothetic thinking. That it did not give rise to 17th-century theoretical science is no justification for calling it primitive.

*Science and Civilisation in China* (Volume 2) (p. 286)

At The University Press. Cambridge, England. 1954

**Nekrasov, Nikolai** 1821–78

Russian poet

There is no science for the sake of science, no art for the sake of art – they exist for the sake of society, for the ennoblement and exaltation of man, to enrich his knowledge and provide his material comforts.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

Its [science] animating spirit is love of truth. Its pride is to do the greatest good to the greatest number.

It embraces not only the whole human race but all nature in its scope.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*  
Chapter XVIII (p. 298)  
Harper & Brothers Publishers. New York, New York, USA. 1906

Science has its competition, as keen as that which is the life of commerce. But its rivalries are over the question who shall contribute the most and the best to the sum total of knowledge; who shall give the most, not who shall take the most.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*  
Chapter XVIII (p. 298)  
Harper & Brothers Publishers. New York, New York, USA. 1906

### **Newell, A.**

No biographical data available

Scientific fields emerge as the concerns of scientists congeal around various phenomena. Sciences are not defined, they are recognized.

In R.C. Shank and K.M. Colby (eds.)  
*Computer Models of Thought and Language*  
Artificial Intelligence and the Concept of Mind (p. 1)  
W.H. Freeman. San Francisco, California, USA. 1973

### **Newton, Roger G.**

Physics professor and author

Science is not holy scripture, nor do its practitioners consider themselves priests protecting a glittering grail, forever unchanging and pure. What drives scientists on is the thirst to understand more and to use nature, to build rather than to exploit a comprehensible universe.

*What Makes Nature Tick?*  
Epilogue (p. 234)  
Harvard University Press. Cambridge, Massachusetts, USA. 1993

### **Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

To the man who works and searches in it, science gives much pleasure; to the man who learns its results, very little.

Translated by Marion Faber  
*Human, All Too Human: A Book for Free Spirits*  
Section Five, Number 251  
Aphorism 205 (p. 153)  
University of Nebraska Press. Lincoln, Nebraska, USA. 1984

Oh, how much is today hidden by science! Oh, how much it is expected to hide!

Translated by William A. Haussmann  
*The Genealogy of Morals*  
What Do Ascetic Ideals Mean?  
Aphorism 23  
Macmillan Publishing Company. New York, New York, USA. 1907

Science offends the modesty of all real women. It makes them feel as though it were an attempt to peek under their skin – or, worse yet, under their dress and ornamentation!

*Beyond Good and Evil*  
Chapter IV, 127 (p. 83)  
The Modern Library. New York, New York, USA. 1917

Science rushes headlong, without selectivity, without “taste,” at whatever is knowable, in the blind desire to know all at any cost.

Translated by Marianne Cowan  
*Philosophy in the Tragic Age of the Greeks*  
Section 3 (p. 43)  
A Gateway Edition. Chicago, Illinois, USA. 1962

The old God was seized by mortal terror. Man himself had been his greatest blunder; he had created a rival to himself; science makes men godlike – it is all up with priests and gods when man becomes scientific – Moral: science is the forbidden per se; it alone is forbidden. Science is the first of sins, the germ of all sins, the original sin. This is all there is of morality. – “Thou shalt not know”: the rest follows from that.

Translated by H.L. Mencken  
*The Anti-Christ*  
Aphorism 48  
Macmillan Publishing Company. New York, New York, USA. 1911

### **Nobel Prize Medal**

*Inventas vitam iuvat excoluisse per artes.*  
Let us improve life through science and art.  
*Inscribed on Nobel Prize Medal*

### **Nordmann, Charles**

Astronomer

If love is, as Plato says, a soaring toward the infinite, where shall we find more love than in the impassioned curiosity which impels us, with bowed heads and beating hearts, against the wall of mystery that environs our material world? Behind that wall, we feel, there is something sublime. What is it? Science is the outcome of the search for that mysterious something.

Translated by Joseph McCabe  
*Einstein And The Universe: A Popular Exposition of The Famous Theory*  
Introduction (p. xiii)  
Henry Holt & Co. New York, New York, USA. 1922

...the very essence of the august and lofty grandeur of science that it is perpetually advancing. It is like a torch in the sombre forest of mystery.

Translated by Joseph McCabe  
*Einstein And The Universe: A Popular Exposition of The Famous Theory*  
Introduction (p. xvi)  
Henry Holt & Co. New York, New York, USA. 1922

### **Oberth, Hermann** 1894–1989

German mathematician and physicist

The present state of science and of technological knowledge permits the building of machines that can rise beyond the limits of the atmosphere of the earth.

After further development these machines will be capable of attaining such velocities that they – left undisturbed in the void of ether space – will not fall back to earth; furthermore, they will even be able to leave the zone of terrestrial attraction.

*The Rocket to the Interplanetary Spaces*  
 Publisher undetermined

**O'Neill, Eugene** 1888–1953  
 American playwright

DARRELL: Happiness hates the timid! So does Science!

*Strange Interlude*  
 Act Four (p. 152)  
 Boni & Liveright. New York, New York, USA. 1928

**Oppenheimer, James Robert** 1904–67  
 American theoretical physicist

Science has changed the conditions of man's life. It has changed its material conditions; by changing them it has altered our labor and our rest, our power, and the limits of that power, as men and as communities of men, the means and instruments as well as the substance of our learning, the terms and the forms in which decisions of right and wrong come before us.

*Science and the Common Understanding*  
 Chapter I (p. 3)  
 Simon & Schuster. New York, New York, USA. 1966

We live today in a world in which poets and historians and men of affairs are proud that they wouldn't even begin to consider thinking about learning anything of science, regarding it as the far end of a tunnel too long for any wise man to put his head into.

*The Open Mind*  
 Chapter VII (p. 128)  
 Simon & Schuster. New York, New York, USA. 1955

A subject is much harder to understand when no one understands it. The world is really an open place, but we start with such crude and limited experience, and our minds are so determined by that experience, that when science carries us into new domains we are not always prepared for what we encounter, and we are floored by it.

In Edward Lueders  
*Writing on Life: Sixteen Close-Ups*  
 Physicist Oppenheimer (p. 358)  
 William Sloane Associates, Publishers. New York, New York, USA. 1951

One thing science can do, and rarely does: it can correct the inherited views that it has by accident at another stage given to common sense, and which turn out to be not true.

The Growth of Science and the Structure of Culture  
*Daedalus*, Winter 1958 (pp. 71–72)

A change in science, whether novelty or discovery, when properly understood, when the linguistic problem is

adequately solved, will even then provide only a hunch, a starting point for looking at an area of experience other than the science in which it was nourished and born.

The Growth of Science and the Structure of Culture  
*Daedalus*, Winter 1958 (pp. 74–75)

The day is long past – if indeed it ever existed except in legend – when the whole of science was the expert province of any one man.

The Age of Science – 1900–1950  
*Scientific American*, Volume 183, Number 3, September, 1950 (p. 21)

Science, for all the brilliance of its contemporary development, for all the ingenuity of its technical invention, is still continuous with man's long history of rational life, of which it is a part; it is still the inheritor of the hope, so deeply founded in both Eastern and Western cultures, that, by reason and by open-minded efforts at understanding, man could not only enrich his life but better cope with the decisions that it fell to him to make.

The Age of Science – 1900–1950  
*Scientific American*, Volume 183, Number 3, September, 1950 (p. 21)

**O'Rourke, P. J.** 1947–  
 American political satirist

...to mistrust science and deny the validity of the scientific method is to resign your job as a human. You'd better go look for work as a plant or wild animal.

*Parliament of Whores: A Lone Humorist Attempts to Explain the Entire US Government*  
 Dirt of the Earth (p. 197)  
 Vintage Books. New York, New York, USA. 1992

**Orr, Louis**  
 American Medical Association president

Science will never be able to reduce the value of a sunset to arithmetic. Nor can it reduce friendship or statesmanship to a formula. Laughter and love, pain and loneliness, the challenge of accomplishment in living, and the depth of insight into beauty and truth; these will always surpass the scientific mastery of nature.

Commencement Address, Emory University, June 6, 1960

**Osler, Sir William** 1849–1919  
 Canadian physician and professor of medicine

To the physician particularly, a scientific discipline is an incalculable gift, which leavens his whole life, giving exactness to habits of thought and tempering the mind with that judicious faculty of distrust which can alone, amid the uncertainties of practice, make him wise unto salvation. For perdition inevitably awaits the mind of the practitioner who has never had the full inoculation with the leaven, who has never grasped clearly the relations of science to his art, and who knows nothing and perhaps cares less, for the limitations of either.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
The Leaven of Science (p. 92)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The future belongs to science. More and more she will control the destinies of the nations. Already she has them in her crucible and on her balances.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 2) (p. 262)  
Clarendon Press. Oxford, England. 1925

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932  
Latvian-born German chemist

Science is not like a chain which snaps when only a single link proves to be weak. It is like a tree, or, better still, like a forest, in which all sorts of changes or ravages go on without causing the whole to pass out of existence or cease to be active.

Translated by Thomas Seltzer

*Natural Philosophy*

Introduction (p. 6)

Henry Holt & Company. New York, New York, USA. 1910

...that is just what science is for, – to make practical things easier by letting us know what is important and what unimportant.

Translated by Harry Wheeler Morse

*Letters to a Painter on the Theory and Practice of Painting*

Letter I (p. 2)

Ginn & Co. Boston, Massachusetts, USA. 1907

**Ostwald, Friedrich Wilhelm** 1853–1932  
Latvian-born German chemist

The more perfect the theoretical evolution of the sciences becomes, the greater will be the scope of their explanations and at the same time the greater their practical importance.

On Chemical Energy

*The Journal of the American Chemical Society*, Volume 15, Number 8, August, 1893 (p. 430)

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

This sense of the unfathomable beautiful ocean of existence drew me into science. I am awed by the universe, puzzled by it and sometimes angry at a natural order that brings such pain and suffering. Yet an emotion or feeling I have toward the cosmos seems to be reciprocated by neither benevolence nor hostility but just by silence. The universe appears to be a perfectly neutral screen unto which I can project any passion or attitude, and it supports them all.

*Perfect Symmetry: The Search for the Beginning of Time*

Part Four, Chapter 2 (p. 370)

Simon & Schuster. New York, New York, USA. 1985

Science is not the enemy of humanity but one of the deepest expressions of the human desire to realize that vision of infinite knowledge.

*The Cosmic Code: Quantum Physics as the Language of Nature*  
Part III, Chapter 2 (p. 348)  
Simon & Schuster. New York, New York, USA. 1982

**Paglia, Camille** 1947–  
American social critic, intellectual, and writer

Modern bodybuilding is ritual, religion, sport, art, and science, awash in Western chemistry and mathematics.

Defying nature, it surpasses it.

*Sex, Art, and American Culture*

Alice in Muscle Land (p. 82)

Vintage Books. New York, New York, USA. 1992

**Pallister, William Hales** 1877–1946  
Canadian physician

You are the sum of what we know,

You are our might and main;

You are the whole of what is so,

The little we retain:

Our fond beliefs all come and go,

And you alone remain.

*Poems of Science*

Science (p. 39)

Playford Press. New York, New York, USA. 1931

Science works by the slow method of the classification of data, arranging the detail patiently in a periodic system into groups of facts, in series like the strata of the rocks. For each series there must be a vocabulary of special words which do not always make good sense when used in another series. But the laws of periodicity seem to hold throughout, among the elements and in every sphere of thought, and we must learn to co-ordinate the whole through our new conception of the reign of relativity.

*Poems of Science*

Men and the Stars (p. 88)

Playford Press. New York, New York, USA. 1931

**Panunzio, Constantine** 1884–1964  
Italian sociologist

Science...involves active, purposeful search; it discovers, accumulates, sifts, orders, and tests data; it is a slow, painstaking, laborious activity; it is a search after bodies of knowledge sufficiently comprehensive to lead to the discovery of uniformities, sequential orders or so-called "laws"; it may be carried on by an individual, but it gains relevance only as it produces data which can be added to and tested by the findings of others.

*Major Social Institutions*

Chapter 20 (p. 322)

The Macmillan Company. New York, New York, USA. 1945

If science is to subserve human needs, it will continue to discover and catalogue "all the islands of the universe 300,000,000 or more light years distant," but it will not fiddle while Rome burns...

*Major Social Institutions*

Chapter 21 (p. 338)

The Macmillan Company. New York, New York, USA. 1945

**Parin, V. V.**

No biographical data available

Science breathes but one air – the oxygen of facts. New methods of research are the trees that clear its atmosphere of the carbon dioxide of inaccurate conclusions and saturate it with the oxygen of first discovered, seen and apprehended phenomena.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierman

Progress Publishers. Moscow, Russia. 1979

**Parkhurst, Charles Henry** 1842–1933

American clergyman and reformer

Science is busy with the hither-end of things, not the thither-end.

*The Pattern in the Mount*

Sermon IV (p. 49)

Anson D.F. Randolph & Co. New York, New York, USA. 1885

**Parks USAF Meteor Chaser  
(Fictional character)**

You're not dealing with science fiction. You're dealing with science fact!

*Mosquito*

Film (1995)

**Pasteur, Louis** 1822–95

French chemist

I am imbued with two deep impressions; the first, that science knows no country; the second, which seems to contradict the first, although it is in reality a direct consequence of it, that science is the highest personification of the nation. Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation because that nation will remain the first which carries the furthest the works of thought and intelligence.

In Rene Dubos

*Pasteur and Modern Science*

Chapter 15. A Dedicated Life (p. 146)

Science Tech Publishers. Madison, Wisconsin, USA. 1988

You bring me the deepest joy that can be felt by a man whose invincible belief is that Science and Peace will triumph over Ignorance and War, that nations will unite, not to destroy, but to build, and that the future will belong to those who will have done most for suffering humanity.

In Rene Vallery-Radot

*The Life of Pasteur*

Chapter XIV (pp. 450–451)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1928

I could never work for money, but I would always work for science.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 6)

Macmillan & Company Ltd. London, England. 1918

Science should not concern itself in any way with the philosophical consequences of its discoveries.

In Emile Duclaux

*Pasteur: The History of a Mind*

Aphorisms and Ideals of Pasteur (p. 343)

W.B. Saunders Co. Philadelphia, Pennsylvania, USA. 1920

Science begets wonders every day.

In Frederick Morris Warren

*Ten Frenchmen of the Nineteenth Century*

Selections (p. 245)

The Chautauqua Press. Chautauqua, New York, USA. 1904

**Paterson, Hugh Sinclair**

...if science can tell us nothing about it, science should be silent. I do not ask more, and I will not take less.

*Studies in Life*

Chapter III (p. 66)

Hodder & Stoughton. London, England. 1880

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Only science, exact science about human nature itself, and the most sincere approach to it by the aid of the omnipotent scientific method, will deliver man from his present gloom, and will purge him from his contemporary shame in the sphere of interhuman relations.

Translated by Stephen G. Brush

*Lectures on Conditioned Reflexes*

Preface to the First Russian Edition (p. 41)

University of California Press. Berkeley, California, USA. 1964

Science moves in fits and starts, depending on the progress in methods of research. Every step forward in method takes us a step higher, affording a broader view of the horizon and of objects that were invisible before.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierman

Progress Publishers. Moscow, Russia. 1979

Remember that science demands from a man all his life. If you had two lives that would be not enough for you. Be passionate in your work and your searchings.

Bequest of Pavlov to the Academic Youth of his Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis.

Bequest of Pavlov to the Academic Youth of His Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)



Here I now simply uphold and assert the absolute and incontestable right of natural science to operate wherever and whenever it is able to display its power. And who knows the limits to this!

*Experimental Psychology and Other Essays*

Natural Science and the Brain (p. 218)

Philosophical Library, New York, New York, USA. 1957

It is often said, and not without truth, that science advances by stages dependent upon the results accruing from particular methods. With each advance in technique we reach a higher level from which a wider field of view is open to us, and in which we see events previously out of range.

Translated by William Henry Thompson

*The Work of the Digestive Glands*

Lecture I (p. 4)

Charles Griffin & Co., Ltd. London, England. 1902

### **Payne, Roger**

Biologist

In my own experience I have found that at their best the revelations of science are as inspiring as art.... I feel that science has a role to play just in conservation (in my view the most important human activity) but also in the more spiritual parts of our lives.

*Among Whales*

Chapter 9 (p. 343)

Charles Scribner's Sons. New York, New York, USA. 1995

### **Peacock, Thomas Love** 1785–1866

English writer

Science is one thing and wisdom is another. Science is an edged tool with which men play like children and cut their own fingers. If you look at the results which science has brought in its train, you will find them to consist almost wholly in elements of mischief.... The day would fail if I should attempt to enumerate the evils which science has inflicted on mankind.

*Gryll Grange*

Chapter 19 (p. 127)

Penguin Books. Harmondsworth, England. 1949

I almost think it is the ultimate destiny of science to exterminate the human race.

*Gryll Grange*

Chapter 19 (p. 127)

Penguin Books. Harmondsworth, England. 1949

### **Pearson, Karl** 1857–1936

English mathematician

The science of the future, while agnostic as to the super-sensuous, will replace knowledge by belief in the perceptual sphere, and reserve the term knowledge for the conceptual sphere – the region of their own concepts and ideas – of ether, atom, organic corpuscle, and Loading...Loading...vital force – of physical and plasmic mechanics.

*The Grammar of Science* (2nd edition)

Preface to the Second Edition (pp. vii–viii)

Adam & Charles Black. London, England. 1900

Modern Science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship.

*The Grammar of Science* (2nd edition)

Chapter 1 (p. 9)

Adam & Charles Black. London, England. 1900

Good science will always be intelligible to the logically trained mind, if that mind can read and translate the language in which science is written.

*The Grammar of Science* (2nd edition)

Chapter 1 (p. 10)

Adam & Charles Black. London, England. 1900

Modern Science, as training the mind to an exact and impartial analysis of facts, is an education specifically fitted to promote sound citizenship.

*The Grammar of Science*

Introductory, Section 3 (p. 11)

Charles Scribner's Sons. London, England. 1892

When every fact, every present or past phenomenon of that universe, every phase or present or past life therein, has been examined, classified, and co-ordinated with the rest, then the mission of science will be completed. What is this but saying that the task of science can never end till man ceases to be, till history is no longer made, and development itself ceases?

*The Grammar of Science*

Introductory, Section 5 (p. 15)

Charles Scribner's Sons. London, England. 1892

Every great advance of science opens our eyes to facts which we have failed before to observe, and makes new demands on our powers of interpretation. This extension of the material of science into regions where our great-grandfathers could see nothing at all, or where they would have declared human knowledge impossible, is one of the most remarkable features of modern progress. Where they interpreted the motion of the planets of our own system, we discuss the chemical constitution of stars, many of which did not exist for them, for the telescopes could not reach them. Where they discovered the circulation of the blood, we see the physical conflict of living poisons within the blood, whose battles would have been absurdities for them.

*The Grammar of Science*

Introductory, Section 5 (p. 17)

Charles Scribner's Sons. London, England. 1892

Science in no case can demonstrate any inherent necessity in a sequence, nor prove, with absolute certainty that it must be repeated. Science for the past is a description, for the future a belief; it is not, and has never been, an explanation, if by this word is meant that science shows the “necessity” of any sequence of perceptions.



*The Grammar of Science* (2nd edition)  
Chapter IV (p. 113)  
Adam & Charles Black. London, England. 1900

Does science leave no mystery? On the contrary it proclaims mystery where others profess knowledge. There is mystery enough in the universe of sensation and in its capacity for containing those little corners of consciousness which project their own products, or order and law and reason, into an unknown and unknowable world. There is mystery enough here, only let us clearly distinguish it from ignorance within the field of possible knowledge. The one is impenetrable, the other we are daily subduing.

*The Grammar of Science*  
Chapter III, Conclusion (p. 134)  
Charles Scribner's Sons. London, England. 1892

Science for the past is a description, for the future a belief...

*The Grammar of Science*  
Chapter IV, Section 1 (p. 136)  
Charles Scribner's Sons. London, England. 1892

...science claims for its heritage the whole domain to which the word knowledge can be legitimately applied; that it refuses to admit any co-heirs to its possessions, and asserts that its own slow and laborious processes of research are the sole profitable modes of cultivation, the only tillage from which we can reach a harvest of truth unchoked by dogmatic tares.

*The Grammar of Science* (2nd edition)  
Chapter XII (p. 504)  
Adam & Charles Black. London, England. 1900

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

It is not for all men actively to practice a science and advance it. But its gifts are gratuitous, and there is no one who need go in want of them, nor anyone, I think, who may scorn them wholly and call himself a modern. For it speaks the universal language, and prevails upon the mysteries by friendship. It is the taste of dragon's blood upon the lips that makes us understand the speech of birds. Where it turns its gaze, it puts a new dimension in the scene, deepening it with marvelous perspectives. And though so marvelous, they are real – more real than the evidence of the unaided senses.

*Flowering Earth*  
Chapter 2 (p. 12)  
G.P. Putnam's Sons. New York, New York, USA. 1939

Of our windows on the universe, science is set with the clearest pane; it is not warped or waved to make the images appear to support any dogma; the glass is not rose-tinted, neither is it leaded with a picture that shuts out the sun and, coming between the light of day and you, enforces the credence of the past upon the young present.

*Flowering Earth*  
Chapter 18 (p. 244)  
G.P. Putnam's Sons. New York, New York, USA. 1939

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

Science, when it comes to understand itself, regards facts as merely the vehicle of eternal truth, while for Practice they remain the obstacles which it has to turn, the enemy of which it is determined to get the better.

*The Essential Peirce: Selected Philosophical Writings* (Volume 2)  
The First Rule of Logic (p. 55)  
Indiana University Press. Bloomington, Indiana, USA. 1998

It is a common observation that a science first begins to be exact when it is quantitatively treated. What are called the exact sciences are no other than the mathematical ones.

*Chance, Love and Logic: Philosophical Essays*  
The Doctrine of Chances (p. 61)  
Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

[Science] advances by leaps; and the impulse for each leap is either some new observational resource, or some novel way of reasoning about the observations. Such novel way of reasoning might, perhaps, be considered as a new observation means, since it draws attention to reactions between facts which would previously have been passed by unperceived.

*Philosophical Writings of Peirce*  
Chapter 4 (p. 51)  
Dover Publications. New York, New York, USA. 1955

**Perl, Martin L.** 1927  
American physicist

I was following an old idea in science: "If you can't understand a phenomenon, look for more examples of that phenomenon..."

Electron, Muon, and Tau Heavy Lepton – Are These the Truly Elementary Particles?  
*The Science Teacher*, Volume 47, Number 9, December 1980  
(pp. 18–19)

**Perutz, Max F.** 1914–2002  
Austrian-born English biochemist

It seems to me that, just as the Church did in former times, science offers a safe niche where you can spend a quiet life classifying spiders, away from what E.M. Forster called the world of telegrams and anger.

*Is Science Necessary?*  
How to Become a Scientist (p. 193)  
E.P. Dutton & Company. New York, New York, USA. 1989

**Phelps, Almira Hart Lincoln** 1793–1884  
American educator and writer

If we had no sciences, nature would present exactly the same phenomena as at present. The heavenly bodies would move with equal regularity, and preserve the same relative situations, although no system of Astronomy had been formed. The laws of gravity and of motion, would operate in the same manner as at present, if we had no such science as Natural Philosophy.

The affinities of substances for each other were the same, before the science of Chemistry existed, as they are now. It is an important truth, and one which cannot be too much impressed upon the mind in all scientific investigations, that no systems of man can change the laws and operations of Nature; though by systems, we are enabled to gain a knowledge of these laws and relations.

*Familiar Lectures on Botany, Practical, Elementary and Physiological*  
Lecture I (p. 13)  
F.J. Huntington & Co. New York, New York, USA. 1837

**Pirsig, Robert M.** 1928–

American writer

Science values static patterns.

*Lila: An Inquiry Into Morals*  
Chapter 11 (p. 142)  
Bantam Books. New York, New York, USA. 1991

**Planck, Max** 1858–1947

German physicist

No doctrinal system in physical science, or indeed perhaps in any science, will alter its content of its own accord. Here we always need the pressure of outer circumstances. Indeed the more intelligible and comprehensive a theoretical system is the more obstinately it will resist all attempts at reconstruction or expansion.

Translated by James Murphy  
*Where is Science Going?*  
Chapter I (p. 40)  
George Allen & Unwin. London, England. 1933

No science can rest its foundation on the dependability of single human individuals.

Translated by James Murphy  
*Where is Science Going?* (p. 81)  
George Allen & Unwin. London, England. 1933

Science enhances the moral values of life because it furthers a love of truth and reverence – love of truth displaying itself in the constant endeavor to arrive at a more exact knowledge of the world of mind and matter around us, and reverence, because every advance in knowledge brings us face to face with the mystery of our own being.

Translated by James Murphy  
*Where is Science Going?*  
Chapter V (p. 169)  
George Allen & Unwin. London, England. 1933

That we do not construct the external world to suit our own ends in the pursuit of science, but that vice versa the external world forces itself upon our recognition with its own elemental power, is a point which ought to be categorically asserted again and again in these positivistic times. From the fact that in studying the happenings of nature we strive to eliminate the contingent and accidental and to come finally to what is essential and necessary,

it is clear that we always look for the basic thing behind the dependent thing, for what is absolute behind what is relative, for the reality behind the appearance and for what abides behind what is transitory. In my opinion, this is characteristic not only of physical science but all of science.

*Where Is Science Going?*  
Chapter VI (pp. 198–199)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery that we are trying to solve.

*Where Is Science Going?*  
Epilogue (p. 217)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

Science does not mean an idle resting upon a body of certain knowledge; it means unrelenting endeavor and continually progressing development towards an aim, which the poetic intuition may apprehend, but which the intellect can never fully grasp.

Translated by W. H. Johnston  
*The Philosophy of Physics*  
Chapter II (p. 83)  
W.W. Norton & Company, Inc. New York, New York, USA. 1936

...I had always looked upon the search for the absolute as the noblest and most worthwhile task of science.

*Scientific Autobiography and Other Papers*  
A Scientific Autobiography (p. 46)  
Philosophical Library. New York, New York, USA. 1949

...science is not contemplative repose amidst knowledge already gained, but is indefatigable work and an ever progressive development.

*Scientific Autobiography and Other Papers*  
The Concept of Causality in Physics (p. 150)  
Philosophical Library. New York, New York, USA. 1949

**Plato** 428 BCE–347 BCE

Greek philosopher

As being is to becoming, so is pure intellect to opinion. And as intellect is to opinion, so is science to belief...

In *Great Books of the Western World* (Volume 7)  
*The Republic*  
Book VII, Section 534 (p. 398)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Playfair, Lyon** 1818–98

Scottish scientist and Parliamentarian

Science may see an horizon bounding her view; but as she proceeds onward the horizon constantly recedes, and shows the limit to be altogether illusory. In one time and generation a nation may, like Newton, pick up a few pebbles on the seashore, while the boundless ocean of science lies beyond, with all its vast and unexplored treasures.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I  
The Study of Abstract Science (p. 30)  
Longman, Brown, Green & Longmans. London, England. 1852

Science is truly catholic, and is bounded only by the universe.

Inaugural Address  
*Nature*, Volume 32, September 10, 1885 (p. 438)

Science is too lofty for measurement by the yard of utility; – too inestimable for expression by a money standard. These grovelling ideas of the objects of science, which constantly jar it in its intercourse with the world, ought to find no response in the breast of any devotee who would draw inspiration from its shrine.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I  
The Study of Abstract Science (p. 27)  
Longman, Brown, Green & Longmans. London, England. 1852

There is no vein of science too abstract for future industrial application; none yet thoroughly mined out and exhausted.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I  
The Study of Abstract Science (p. 32)  
Longman, Brown, Green & Longmans. London, England. 1852

**Poe, Edgar Allan** 1809–49  
American short story writer

Science! true daughter of old Time thou art  
Who alterest all things with thy peering eyes!  
Why prey'st thou thus upon the poet's heart,  
Vulture! whose wings are dull realities!

*The Raven and Other Poems*  
Sonnet – To Science  
Columbia University Press. New York, New York, USA. 1942

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Man, then, cannot be happy through science, but today he can be much less be happy without it.

*The Foundations of Science*  
*The Value of Science*, Introduction (p. 206)  
The Science Press. New York, New York, USA. 1913

...science is a rule of action which is successful...

*The Foundations of Science*  
*The Value of Science*, Part III, Chapter X (p. 324)  
The Science Press. New York, New York, USA. 1913

...if science is feared, it is above all because it cannot give us happiness.

Translated by George Bruce Halsted  
*The Value of Science*  
Introduction (p. 12)  
The Science Press. New York, New York, USA. 1907

There is no science other than disinterested science.

In Stefan Amsterdamski  
*Between History and Method*  
Chapter V Crisis of the Modern Ideal (p. 94)  
Kluwer Academic Publishers. Dordrecht, Netherlands. 1992

As science progress, it becomes more and more difficult to fit in the new facts when they will not fit in spontaneously. The older theories depend upon the coincidences of so many numerical results which cannot be attributed to chance. We should not separate what has been joined together.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1912*  
The Ether and Matter (pp. 209–210)  
Government Printing Office. Washington, D.C. 1913

...a science produced with a view single to its applications is impossible; truths are fruitful only if they are concatenated; if we cleave to those only of which we expect an immediate result, the connecting links will be lacking, and there will be no longer a chain.

The Relations of Analysis and Mathematical Physics  
*Bulletin of the American Mathematical Society*, Volume IV, Number 6, March, 1898 (p. 247)

**Polanyi, Michael** 1891–1976  
Hungarian-born English scientist, philosopher, and social scientist

This coherence of valuation throughout the whole range of science underlies the unity of science. It means that any statement recognized as valid in one part of science can, in general, be considered as underwritten by all scientists. It also results in a general homogeneity of and a mutual respect between all kinds of scientists, by virtue of which science forms an organic unity.

*Science, Faith and Society*  
Authority and Conscience (p. 49)  
The University of Chicago Press. Chicago, Illinois. 1964

**Pope, Alexander** 1688–1744  
English poet

Trace Science then, with Modesty thy guide;  
First strip off all her equipage of Pride.

*The Complete Poetical Works* (Volume 2)  
An Essay on Man  
Epistle II, l. 43–44  
Houghton Mifflin Company. New York, New York, USA. 1903

One science only will one genius fit,  
So vast is art, so narrow human wit...

*The Complete Poetical Works* (Volume 2)  
Essay on Criticism, Part I, l. 60–61  
Houghton Mifflin Company. New York, New York, USA. 1903

Far eastward cast thine eye, from whence the Sun  
And orient Science their brite course begun.

*The Complete Poetical Works* (Volume 4)  
Duncaid, Book III, l. 73–74  
Houghton Mifflin Company. New York, New York, USA. 1903

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

The empirical basis of objective science has thus nothing “absolute” about it. Science does not rest upon solid bedrock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or “given” base; and when we cease our attempts to drive our piles into a deeper layer, it is not because we have reached firm ground. We simply stop when we are satisfied that they are firm enough to carry the structure, at least for the time being.

*The Logic of Scientific Discovery*

Part II, Chapter V, Section 30 (p. 111)

Basic Books, Inc. New York, New York, USA. 1959

Science is not a system of certain, or well-established statements, nor is it a system which steadily advances towards a state of finality.... Like Bacon we might describe our own contemporary science...as consisting of “anticipations, rash and premature,” and as “prejudices.”

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 278)

Basic Books, Inc. New York, New York, USA. 1959

I think that we shall have to get accustomed to the idea that we must not look upon science as a ‘body of knowledge’, but rather as a system of hypotheses; that is to say, as a system of guesses or anticipations which in principle cannot be justified, but with which we work as long as they stand up to tests, and of which we are never justified in saying that we know that they are ‘true’ or ‘more or less certain’ or even ‘probable’.

*The Logic of Scientific Discovery*

Appendix I (p. 317)

Basic Books, Inc. New York, New York, USA. 1959

Science does not aim, primarily, at high probabilities. It aims at a high informative content, well backed by experience. But a hypothesis may be very probable simply because it tells us nothing, or very little.

*The Logic of Scientific Discovery*

Appendix ix (p. 399)

Basic Books, Inc. New York, New York, USA. 1959

Science may be described as the art of systematic oversimplification.

*The Observer*, London, 1 August, 1982

...science is most significant as one of the greatest spiritual adventures that man has yet known...

*The Poverty of Historicism*

Chapter III, Section 19 (p. 56)

The Beacon Press. Boston, Massachusetts, USA. 1957

**Porter, Nash** 1811–92

American educator and philosopher

What science is, is not so easily stated as would seem likely from the freedom with which the term is used, or the readiness, not to say the flippancy, with which its authority is enforced.

*The Sciences of Nature Versus the Science of Man* (p. 21)

Dodd & Mead. New York, New York, USA. 1871

Science has penetrated the constitution of nature, and unrolled the mysterious pages of its history, and started again many, as yet, unanswered questions in respect to the mutual relations of matter and spirit, of nature and of God.

*Fifteen Years in the Chapel of Yale College*

Chapter XI (p. 241)

Charles Scribner’s Sons. New York, New York, USA. 1888

**Poteat, William Louis** 1856–1938

American educator

Science confers power, not purpose. It is a blessing, therefore, if the purpose which it serves is good; it is a curse, if the purpose is bad.

*Can a Man Be a Christian Today?*

Part I, Section 2 (p. 27)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1925

**Pouchet, Félix Archimède** 1800–72

French biologist

...when man begins the study of the sciences, it is with profound astonishment that he recognizes that the marvels which they reveal to him far surpass the most audacious fictions of antiquity.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book I, Chapter I (p. 731)

Blackie & Son. London, England. 1892

**Powers, Richard** 1957–

American novelist

Science is not about control. It is about cultivating a perpetual condition of wonder in the face of something that forever grows one step richer and subtler than our latest theory about it. It is about reverence, not mastery.

*The Gold Bug Variations*

Dialog (p. 411)

William Morrow & Company, Inc. New York, New York, USA. 1991

**Praed, Winthrop** 1802–39

English poet

Of science and logic he chatters,  
As fine and as fast as he can;  
Though I am no judge of such matters,  
I’m sure he’s a talented man.

*The Poems of Winthrop Mackworth Praed*

The Talented Man

Houghton Mifflin Company. Boston, Massachusetts, USA. 1909

**Pribram, Karl** 1919–  
Austrian neurosurgeon

For the first time in three hundred years science is admitting spiritual values into its explorations.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Holographic Brain (p. 133)

Ticknor & Fields. New York, New York, USA. 1984

**Price, Don Krasher** 1910–95  
American political scientist

Only if a nation can induce scientists to play an active role in government, and politicians to take a sympathetic interest in science (or at least in scientific institutions) can it [the nation] enlarge its range of positive freedom, and renew its confidence that science can contribute progressively to the welfare of mankind.

*The Scientific Estate*

Science and Freedom (p. 278)

Harvard University Press. Cambridge, Massachusetts, USA. 1965

**Prior, Matthew** 1664–1721  
English poet and diplomat

Forc'd by reflective Reason I confess,  
That human Science is uncertain guess.

In John Aikin

*Select Works of the British Poets*

Solomon, Book 1, l. 740

Longman, Hurst, Reese, Orme & Brown. London, England. 1820

### **Professor Alvah Jesper(Frictional character)**

God have mercy on us if we ever thought we could really keep science secret – or wanted to. God have mercy on us if we haven't the sense to keep the world in peace.

*Cloak and Dagger*

Film (1946)

**Quinet, Edgar** 1803–75  
French historian

Science is Christian, not when it condemns itself to the letter of things, but when, in the infinitely little, it discovers as many mysteries and as much depth and power as in the infinitely great.

*Ultramontaniam, or the Roman Church and Modern Society*

The Roman Church and Science-Galileo

Lecture, May 7, 1844

**Rabelais, François** ca. 1490–1553  
French writer and physician

...knowledge [i.e., science] without conscience is but the ruin of the soul.

*Gargantua and Pantagruel*

Book II, VIII (p. 152)

G.P. Putnam's Sons. New York, New York, USA. 1905

**Ramsay, Sir William** 1852–1916  
English chemist

No process is so perfect that there is not plenty of room for improvement. There is no finality in science. And that which today is a scientific toy may be tomorrow the essential part of an important industry.

*Essays Biological and Chemical*

The Great London Chemists

Section I (p. 19)

Archibald Constable & Company Ltd. London, England. 1908

### **Randall, J. H.**

No biographical data available

[Science] swept man out of his proud position as the central figure and end of the universe, and made him a tiny speck on a third-rate planet revolving about a tenth-rate sun drifting in an endless cosmic ocean.

*The Making of the Modern Mind: A Survey of the Intellectual Background of the Present Age*

Chapter X (p. 226)

The Riverside Press. Cambridge, Massachusetts, USA. 1940

Science was born of a faith in the mathematical interpretation of Nature, held long before it had been empirically verified.

*Making of the Modern Mind*

Book III, Chapter XI (p. 235)

Columbia University Press. New York, New York, USA. 1976

**Raup, David Malcolm** 1933–  
American paleontologist

Perhaps the only thing that saves science from invalid conventional wisdom that becomes effectively permanent is the presence of mavericks in every generation – people who keep challenging convention and thinking up new ideas for the sheer hell of it or from an innate contrariness.

*The Nemesis Affair: A Story of the Death of Dinosaurs and the Ways of Science*

Chapter 12 (p. 196)

W.W. Norton & Co. New York, New York, USA. 1999

**Raymo, Chet** 1936–  
American physicist and science writer

Science cannot be a repository of ultimate faith: It is a fulcrum upon which we can hope to balance the treasure of our knowledge against the claims of ignorance.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 21 (p. 199)

The Viking Press. New York, New York, USA. 1991

Science, like the play of children, satisfies a deep-seated need for escape from the boredom of fixity and the trauma of chaos.

Focal Point

*Sky and Telescope*, Volume 81, Number 5, May, 1991 (p. 460)

**Renan, Ernest** 1823–92  
French philosopher and Orientalist

Science and science alone is capable of restoring to humanity that without which it cannot live; a creed and a law.



Translated by Albert D. Vandam and C.B. Pitman  
*The Future of Science* (p. 24)  
 Chapman & Hall, Ltd. London, England. 1891

...science must pursue its road without minding with whom it comes in collision. Let the others get out of the way. If it appears to raise objections against received dogmas, it is not for science but the received dogmas to be on the defensive and to reply to the objections. Science should behave as if the world were free from preconceived opinions, and not heed the difficulties it starts.

*The Future of Science*  
 Chapter V (p. 83)  
 Roberts Brothers. Boston, Massachusetts, USA. 1893

...man's happiness and noble aims have rested before now on false foundations. The wisest thing to do, then, is to go on enjoying the supreme gifts vouchsafed to us, life and the faculty of seeing the reality. Science will always remain the gratification of the noblest craving of our nature; curiosity will always supply man with the sole means of improving his lot. It protects him against error, though it may not reveal the truth to him, but there is an advantage in being certain of not being duped.

In William Chatterton Coupland  
*Thoughts and Aspirations of the Ages*  
 Chapter XX (p. 617)  
 Swan Sonnenschein & Co. London, England. 1895

**Reynolds, William C.** 1933–2004  
 American mechanical engineer

**Perkins, Harry C.**  
 No biographical data available

Concepts form the basis for any science. These are ideas, usually somewhat vague (especially when first encountered), which often defy really adequate definition. The meaning of a new concept can seldom be grasped from reading a one-paragraph discussion. There must be time to become accustomed to the concept, to investigate it with prior knowledge, and to associate it with personal experience. Inability to work with details of a new subject can often be traced to inadequate understanding of its basic concepts.

*Engineering Thermodynamics*  
 Chapter 1 (p. 4)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1977

**Richards, Ivor Armstrong** 1893–1979  
 English literary critic

For science, which is simply our most elaborate way of pointing to things systematically, tells us and can tell us nothing about the nature of things in any ultimate sense. It can never answer any question of the form: What is so and so? [I]t can only tell us how so and so behaves. And it does not attempt to do more than this.

*Science and Poetry*  
 Chapter V (pp. 52–53)  
 Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1926

**Richet, Charles** 1850–1935  
 French physiologist

All...believe in the sovereignty of science; which like the grammar of Martine, rules even over kings, and imperiously subjects them to its laws.

*The Natural History of a Savant*  
 Chapter II (p. 13)  
 J.M. Dent & Sons Ltd. London, England. 1927

No one has the right to encumber science with premature assertions.

*The Natural History of a Savant*  
 Chapter X (p. 122)  
 J.M. Dent & Sons Ltd. London, England. 1927

To neglect science is to exclude fair hope, to condemn ourselves to live in a uniform monotonous existence.

*The Natural History of a Savant*  
 Chapter XIII (p. 147)  
 J.M. Dent & Sons Ltd. London, England. 1927

The future and the happiness of humanity depend on science.

*The Natural History of a Savant*  
 Chapter XIII (p. 155)  
 J.M. Dent & Sons Ltd. London, England. 1927

**Ridley, Matt** 1958–  
 English science writer

The fuel on which science runs is ignorance. Science is like a hungry furnace that must be fed logs from the forests of ignorance that surround us. In the process, the clearing we call knowledge expands, but the more it expands, the longer its perimeter and the more ignorance comes into view.... A true scientist is bored by knowledge; it is the assault on ignorance that motivates him – the mysteries that previous discoveries have revealed. The forest is more interesting than the clearing.

*Genome: The Autobiography of a Species in 23 Chapters*  
 Chapter 20 (p. 271)  
 HarperCollins Publishers. New York, New York, USA. 2000

**Roberts, Nora** 1950–  
 American author

She dealt in facts, and would stick with facts, no matter how tempting it was to leap to the next level. Instincts couldn't always be trusted. Science could.

*Homeport*  
 Chapter Three (p. 32)  
 G.P. Putnam's Sons. New York, New York, USA. 1998

Most people think of science as a series of steps forged in concrete, but it's not. It's a puzzle, and not all of the pieces will ever be firmly in place. When you're able to fit some of the together, to see an answer, it's thrilling.

*Homeport*  
 Chapter Thirteen (p. 171)  
 G.P. Putnam's Sons. New York, New York, USA. 1998



**Robinson, Sir Robert** 1886–1975  
English chemist

Science cannot be based on dogma or authority of any kind, nor on any institution or revelation, unless indeed it be of the Book of Nature that lies open before our eyes. We need not dwell on the processes of acquiring knowledge by observation, experiment, and inductive and deductive reasoning. The study of scientific method both in theory and practice is of great importance. It is inherent in the philosophy that the record may be imperfect and the conceptions erroneous; the potential fallibility of our science is not only acknowledged but also insisted upon.

Science and the Scientist  
*Nature*, Volume 176, Number 4479, September 3, 1955 (p. 434)

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

Science is advanced by husbands, but wives are often behind them.

*Encyclopedia of Thoughts*  
Aphorisms 91  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

Into the life of a cultured man enter science, art, and poetic philosophy.

*Encyclopedia of Thoughts*  
Aphorisms 1220  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

Pure science has no part in politics.

*Encyclopedia of Thoughts*  
Aphorisms 1281  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

Dedication to pure science or fine arts often is incompatible with a desire for economic gain.

*Encyclopedia of Thoughts*  
Aphorism 1457  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

Religions offer unbounded faith; science, logical preciseness; and the arts, creative imagination.

*Encyclopedia of Thoughts*  
Aphorisms 1471  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

Science and technology may lead to self-destruction; humanities to sensible social recovery.

*Encyclopedia of Thoughts*  
Aphorisms 2937  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Ross, Sir Ronald** 1857–1932  
English bacteriologist

We must not accept any speculations merely because they now appear pleasant, flattering, or ennobling to us. We must be content to creep upwards step by step, planting each foot on the firmest finding of the moment, using the compass and such other instruments as we many have,

observing without either despair or contempt the clouds and precipices above and beneath us. Especially our duty at present is to better our present foothold; to investigate; to comprehend the forces of nature, to set our State rationally in order; to stamp down disease in body, mind, and government; to lighten the monstrous misery of our fellows, not by windy dogmas, but by calm science.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter VIII (p. 233)  
Macmillan & Company Ltd. London, England. 1918

**Rostand, Jean** 1894–1977  
French biologist

Science has made gods of us before we were ever worthy of being men.

In Loren Eiseley  
*The Indivisible Pyramid*  
Charles Scribner's Sons. New York, New York, USA. 1970

**Roszak, Theodore** 1933–  
American social critic

Science *uses* the senses but does not *enjoy* them; finally buries them under theory, abstraction, mathematical generalization

*Where the Wasteland Ends*  
Chapter 9 (p. 280)  
Doubleday & Company. Garden City, New York, USA. 1973

**Rothman, Tony** 1953–  
American cosmologist

Principle of Literary Oversight: Textbooks may be straightforward and succinct, but the path of science is crooked and tortuous.

*Instant Physics: From Aristotle to Einstein, and Beyond*  
Introduction (p. xi)  
Ballentine Books. New York, New York, USA. 1995

**Roux, Joseph** 1725–93  
French hydrographer

Science is for those who learn; poetry, for those who know.

*Meditations of a Parish Priest*  
Part I, Number 71 (p. 43)  
Thomas Y. Crowell & Company New York, New York, USA. 1886

**Rubin, Harry**  
No biographical data available

...one of the great pitfalls of science is the fallacy of misplaced concreteness. Scientists seem to prefer questionable explanations to no explanation at all.

Does Somatic Mutation Cause Most Cancers?  
*Journal of the National Cancer Institute*, Volume 64, Number 5, May 1980 (p. 999)

**Ruse, Michael** 1940–  
English historian and philosopher of science

Science, like most human cultural phenomena, has evolved. What was allowable in the early nineteenth

century is not necessarily allowable in the late twentieth century. Specifically, science today does not break with law. And this is what counts for us. We want criteria of science for today, not for yesterday.

Response to the Commentary: Pro Justice

*Science, Technology and Human Values*, Volume 7, Number 41, Fall 1982 (p. 21)

### **Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Science does its duty, not in telling us the causes of spots in the sun, but in explaining to us the laws of our own life, and the consequences of their violation.

In Henry Attwell

*Thoughts from Ruskin*

33 (p. 29)

Longmans, Green & Company, New York, New York, USA; 1901

Science deals exclusively with things as they are in themselves; and art exclusively with things as they affect the human senses and human soul.

*The Stones of Venice*

Chapter II (p. 39)

John R. Alden, Publisher. New York, New York, USA. 1885

Science lives only in quiet places, and with odd people, mostly poor.

*Essays and Letters*

Fors Clavigera, Letter IV (p. 222)

Ginn & Co. Boston, Massachusetts, USA. 1894

...the step between practical and theoretic science is the step between the miner and the geologist, the apothecary and the chemist...

*Modern Painters* (Volume 1)

Chapter I (p. 17)

Charles E. Merrill & Co. New York, New York, USA. 1891

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Science, ever since the time of the Arabs, has had two functions: (1) to enable us to know things, and (2) to enable us to do things.

*The Impact of Science on Society*

Chapter II (p. 18)

Simon & Schuster. New York, New York, USA. 1938

Science has always prided itself on being empirical and believing only what could be verified.

In Robert E. Egner and Lester E. Denonn (eds.)

*The Basic Writings of Bertrand Russell*

Limitations on the Scientific Method (pp. 623–624)

Simon & Schuster. New York, New York, USA. 1961

In science men have discovered an activity of the very highest value in which they are no longer, as in art, dependent for progress upon the appearance of continually greater genius, for in science the successors stand upon the shoulders of their predecessors; where one man

of supreme genius has invented a method, a thousand lesser men can apply it.

*A Free Man's Worship and Other Essays*

Chapter 3 (first published as "The Free Man's Worship" in December, 1903)

George Allen & Unwin Ltd. London, England. 1917

A life devoted to science is therefore a happy life, and its happiness is derived from the very best sources that are open to dwellers on this troubled and passionate planet.

*Mysticism and Logic and Other Essays*

Chapter II, Section II (p. 45)

Longmans, Green & Company London, England. 1925

...the aspect of science as knowledge is being thrust into the background by the aspect of science as the power of manipulating nature.

*The Scientific Outlook*

Introduction (p. 10)

George Allen & Unwin. London, England. 1931

Science tells us what we can know, but what we can know is little, and if we forget how much we cannot know we become insensitive to many things of very great importance.

*A History of Western Philosophy* (p. xii)

Simon & Schuster. New York, New York, USA. 1945

Almost everything that distinguishes the modern world from earlier centuries is attributable to science...

*History of Western Philosophy*

Chapter 6 (p. 484)

Mathematics and Physics

Routledge. New York, New York, USA. 2004

We are on the threshold of utter disaster or unprecedented glorious achievement. No previous age has been fraught with problems so momentous; and it is to science that we must look for a happy issue.

In James R. Newmann

*What is Science?*

Science and Human Life (p. 17)

Simon & Schuster. New York, New York, USA. 1955

Science, whatever unpleasant consequences it may have by the way, is in its very nature a liberator, a liberator from the weight of destructive passions.

In James R. Newmann

*What is Science?*

Science and Human Life (p. 17)

Simon & Schuster. New York, New York, USA. 1955

In science men have discovered an activity of the very highest value in which they are no longer, as in art, dependent for progress upon the appearance of continually greater genius, for in science the successors stand upon the shoulders of their predecessors; where one man of supreme genius has invented a method, a thousand lesser men can apply it.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 41)

Longmans, Green & Co. London, England. 1919

A life devoted to science is...a happy life, and its happiness is derived from the very best sources that are open to dwellers on this troubled and passionate planet.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 45)

Longmans, Green & Co. London, England. 1919

It is...from science, rather than from ethics and religion, that philosophy should draw its inspiration.

*Mysticism and Logic: And Other Essays*

Chapter VI (p. 98)

Longmans, Green & Co. London, England. 1919

### **Sagan, Carl** 1934–96

American astronomer and author

There is no other species on Earth that does science. It is, so far, entirely a human invention, evolved by natural selection in the cerebral cortex for one simple reason: it works. It is not perfect. It can be misused. It is only a tool. But it is by far the best tool we have, self-correcting, ongoing, applicable to everything.

*Cosmos*

Chapter XIII (p. 333)

Random House, Inc. New York, New York, USA. 1980

Science may be hard to understand. It may challenge cherished beliefs. When its products are placed at the disposal of politicians or industrialists, it may lead to weapons of mass destruction and grave threats to the environment. But one thing you have to say about it. It delivers the goods.

*Demon-Haunted World: Science As a Candle in the Dark*

Chapter 2

Random House, Inc. New York, New York, USA. 1995

Cutting off fundamental, curiosity-driven science is like eating the seed corn. We may have a little more to eat next winter, but what will we plant so we and our children will have enough to get through the winters to come?

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 23 (p. 400)

Random House, Inc. New York, New York, USA. 1995

[Science is not popular] is...the fault of the educational system. We do not teach how to think. This is a very serious failure that may even, in a world rigged with 60,000 nuclear weapons, compromise the human future.

The Burden of Skepticism

*Skeptical Inquirer*, Fall 1987

Science involves a seemingly self-contradictory mix of attitudes: On the one hand, it requires an almost complete openness to all ideas, no matter how bizarre and weird they sound, a propensity to wonder.... But at the same time, science requires the most vigorous and uncompromising skepticism, because the vast majority of ideas are simply wrong, and the only way you can distinguish

the right from the wrong, the wheat from the chaff, is by critical experiment and analysis.

Wonder and Skepticism

*Skeptical Inquirer*, Jan/Feb 1995 (p. 24)

Science demands a tolerance for ambiguity. Where we are ignorant, we withhold belief. Whatever annoyance the uncertainty engenders serves a higher purpose: It drives us to accumulate better data. This attitude is the difference between science and so much else. Science offers little in the way of cheap thrills. The standards of evidence are strict. But when followed they allow us to see far, illuminating even a great darkness.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 20 (p. 365)

Random House, Inc. New York, New York, USA. 1994

### **Sarnoff, David** 1891–1971

Russian-born American broadcasting executive

At their best, at their most creative, science and engineering are attributes of liberty – noble expressions of man's God-given right to investigate and explore the universe without fear of social or political or religious reprisals.

In Emily Davie (ed.)

*Profile of America: An Autobiography of the USA*

Electronics – Today and Tomorrow

Crowell. New York, New York, USA. 1954

### **Sarton, George** 1884–1956

Belgian-born American scholar and writer

Science, like art and religion – neither more nor less – is a form of man's reaction against nature. It is an attempt to explain nature in its own terms, that is, to evidence its unity, wholeness, and congruency.

*The History of Science and the New Humanism*

Chapter I (p. 38)

H. Holt & Co. New York, New York, USA. 1931

Science tends to destroy the darkness where evil and injustice breed, but there is also some element of beauty and poetry in that darkness.

*The History of Science and the New Humanism*

Chapter I (p. 59)

H. Holt & Co. New York, New York, USA. 1931

Science like religion implies disinterestedness, earnestness, austerity.

*The History of Science and the New Humanism*

Chapter III (p. 132)

H. Holt & Co. New York, New York, USA. 1931

### **Scatchard, George** 1892–1973

American physical chemist

Since science progresses by building block upon block, it is important to examine the structure from time to time to make sure that there are no badly fitted blocks, none

which are being made to carry more than their proper capacity and none which might be made more useful.

Equilibrium Thermodynamics and Biological Chemistry  
*Science*, Volume 95, Number 2454, January 9, 1942 (p. 27)

**Schiebinger, Londa** 1952–  
Science historian

Only recently have we begun to appreciate that who does science affects the kind of science that gets done. How, then, has our knowledge of nature been influenced by struggles determining who is included in science and who is excluded, which projects are pursued and which ignored, whose experiences are validated and whose are not, and who stands to gain in terms of wealth or well-being and who does not?

*Nature's Body: Gender in the Making of Modern Science*  
Introduction (p. 3)  
Beacon Press. Boston, Massachusetts, USA. 1993

**Schiller, Ferdinand Canning Scott** 1864–1937  
English philosopher

To Archimedes once came a youth, who for knowledge was thirsting,

Saying, "Initiate me into the science divine,  
Which for my country has borne forth fruit of such wonderful value,

And which the walls of the town 'gainst the Sambuca protects.

"Calls't thou the science divine? It is so," the wise man responded;

"But it was so, my son, ere it avail'd for the town.

Wouldst thou have fruit from her only, e'en mortals wit that can provide thee;

Wouldst thou the goddess obtain, seek not the woman in Her!"

In Edgar Alfred Bower  
*The Poems of Schiller*  
Archimedes and the Student (p. 262)  
John W. Parker & Son. London, England. 1851

Science: To one, she is the exalted and heavenly Goddess; to another she is a capable cow which keeps him supplied with butter.

In Folke Dovring  
*Knowledge and Ignorance: Essays on Lights and Shadows*  
Chapter Ten (p. 141)  
Praeger. Westport, Connecticut, USA. 1998

**Schleiden, Matthias Jacob** 1804–81  
German botanist

Youthful fancy lends to the rock, the tree, the flower, an animating genius, and in the thunder hears the voice of God. Then comes earnest science stripping Nature of that inspiring charm, and substituting the unvarying law of blind necessity.

*Poetry of the Vegetable World*  
Chapter III (p. 70)  
Moore, Anderson, Wilstach & Keys. Cincinnati, Ohio, USA. 1853

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

...there is a tendency to forget that all science is bound up with human culture in general, and that scientific findings, even those which at the moment appear the most advanced and esoteric and difficult to grasp, are meaningless outside their cultural context.

Are There Quantum Jumps?  
*The British Journal for the Philosophy of Science*, Volume 3, 1952 (p. 109)

**Seifriz, William**  
No biographical data available

Let me give full credit to the young and enthusiastic research workers, full of high-energy phosphate bonds. What I deplore is their attitude of mind. Science has become tough and students learn to accept it that way.

A New University  
*Science*, Volume 120, Number 3107, July 16, 1954 (p. 89)

**Seymour Skinner (Fictional character)**

Ah, there's nothing more exciting than science! You get all the fun of sitting still, being quiet, writing down numbers, paying attention – Science has it all!

*The Simpsons*  
The Simpsons: Bart's Comet  
Television program (1995)

**Shapiro, Harry L.** 1902–90  
American physical anthropologist

Science, like organic life, has ramified by expanding into unoccupied areas and then adapting itself to the special requirements encountered there.

Symposium on the History of Anthropology, the History and Development of Physical Anthropology  
*American Anthropologist*, Volume 61, Number 3, 1959 (p. 371)

...as the diversified forms of animals, plants, and insects make evident by their morphology and their function the characteristics of ecological niches whose very existence might otherwise escape notice, so the diversity of techniques and concepts of scientific specialties by their very formulation reveal aspects of nature we would not have suspected. Anthropology, like other branches of science, has also embodied in its structure whole new worlds rich in insights into the development and nature of man.

Symposium on the History of Anthropology, the History and Development of Physical Anthropology  
*American Anthropologist*, Volume 61, Number 3, 1959 (p. 371)

**Shapiro, Robert** 1935–  
American DNA researcher and author

Science is not a given set of answers but a system for obtaining answers. The method by which the search is conducted is more important than the nature of the

solution. Questions need not be answered at all, or answers may be provided and then changed. It does not matter how often or how profoundly our view of the universe alters, as long as these changes take place in a way appropriate to science. For the practice of science, like the game of baseball, is covered by definite rules.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*  
Chapter One (p. 33)  
Summit Books. New York, New York, USA. 1986

Science is not the place for those who want certainty, who wish the truths they learned in childhood to reassure them in their old age. Surprises occur, and alter our perception of reality – for example, the discovery of radioactivity or the genetic role of DNA.... When we treat each new observation and theory with skepticism, retaining our doubt until it has passed the test of experience, and then place it alongside our other acquisitions with the care of a collector who has acquired a valued object after a long search, then we can experience the joy of science. It is this joy, rather than an insistence on an immediate answer, that is likely to be our reward as we continue to search for the origin of life. But even in this conclusion, let us exercise some caution. We may be closer to the answer than we think.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*  
Chapter Thirteen (p. 312)  
Summit Books. New York, New York, USA. 1986

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Science becomes dangerous only when it imagines that it has reached its goal.

*The Doctor's Dilemma*  
Preface on Doctors  
The Latest Theories (p. xc)  
Brentano's. New York, New York, USA. 1920

**Sheehan, Patrick Augustine** 1852–1913  
Catholic priest and author

I hate science, not because it is false; but because it is but a half-truth. And, as 'a lie that is half the truth is ever the worst of lies;' so the truth, which is only half-truth, becomes in one sense wholly false. That there are truths, or perhaps I should say facts, beyond the ken of intellect is an admitted doctrine, – never so much admitted as now, when the deeper we penetrate into the abyss of life, the closer and the more recondite does Nature keep its awful secrets. She retreats, as we advance, and gathers up her skirts, lest the very swish of them should reveal her hiding place.

*The Intellectuals; an Experiment in Irish Club-life*  
Session Seventeenth (p. 160)  
Longmans, Green & Co. London, England. 1911

**Shelley, Mary Wollstonecraft** 1797–1851  
English Romantic writer

You seek for knowledge and wisdom, as I once did; and I ardently hope that the gratification of your wishes may not be a serpent to sting you, as mine has been.

*Frankenstein*  
Letter 4 (p. 27)  
Running Press. Philadelphia, Pennsylvania, USA. 1990

The ambition of the enquirer seemed to limit itself to the annihilation of those visions on which my interest in science was chiefly founded. I was required to exchange chimeras of boundless grandeur for realities of little worth.

*Frankenstein*  
Chapter 3 (p. 38)  
Running Press. Philadelphia, Pennsylvania, USA. 1990

Life and death appeared to me ideal bounds, which I should first break through, and pour a torrent of light into our dark world.

*Frankenstein*  
Chapter 4 (p. 43)  
Running Press. Philadelphia, Pennsylvania, USA. 1990

"Man," I cried, "how ignorant art thou in thy pride of wisdom!"

*Frankenstein*  
Chapter 23 (p. 141)  
Running Press. Philadelphia, Pennsylvania, USA. 1990

**Shelley, Percy Bysshe** 1792–1822  
English poet

The cultivation of those sciences which have enlarged the limits of the empire of man over the external world, has, for want of the poetical faculty, proportionally circumscribed those of the internal world; and man, having enslaved the elements, remains himself a slave.

In Fanny Delisle  
*A Study of Shelley's "A Defence of Poetry"* (Volume 1)  
Line 1223 (p. 138)  
Institute für Englische Sprache und Literatur. Salzburg, Austria. 1974

**Shermer, Michael** 1954–  
American science writer

What separates science from all other human activities (and morality has never been successfully placed on a scientific basis) is its commitment to the tentative nature of all its conclusions. There are no final answers in science, only varying degrees of probability. Even scientific "facts" are just conclusions confirmed to such an extent that it would be reasonable to offer temporary agreement, but that assent is never final.

*Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*  
Part 2, Chapter 8 (p. 124)  
Henry H. Holt. New York, New York, USA. 2002

Science is not the affirmation of a set of beliefs but a process of inquiry aimed at building a testable body of knowledge constantly open to rejection or confirmation.



In science, knowledge is fluid and certainty fleeting. That is at the heart of its limitations. It is also its greatest strength.

*Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*

Part 2, Chapter 8 (p. 124)

Henry H. Holt. New York, New York, USA. 2002

### **Shu, Frank H.**

American theoretical astrophysicist

Science has a beauty and uplifting spirit which rivals any of the other cultural attainments of humanity. This aesthetic response arose in a recent congressional hearing. When asked how particle physics contributes to the defense of our country, Robert Wilson replied that it makes the country worth defending.

*The Physical Universe: An Introduction to Astronomy* (p. 101)

University Science Books. Mill Valley, California, USA. 1982

### **Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Science comes from the knowing that you want to know.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #298 (p. 68)

Definition Press. New York, New York, USA. 1972

### **Silver, Brian L.**

Israeli professor of physical chemistry

Science, man's greatest intellectual adventure, has rocked his faith and engendered dreams of a material Utopia. At its most abstract, science shades into philosophy; at its most practical, it cures disease. It has eased our lives and threatened our existence. It aspires, but in some very basic ways fails, to understand the ant and the Creation, the infinitesimal atom and the mind-bludgeoning immensity of the cosmos. It has laid its hand on the shoulders of poets and politicians, philosophers and charlatans. Its beauty is often apparent only to the initiated, its perils are generally misunderstood, its importance has been both over- and underestimated, and its fallibility, and that of those who create it, is often glossed over or malevolently exaggerated.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

Science is not a harmless intellectual pastime. In the last two centuries we have moved from being simply observers of nature to being, in a modest but growing way, its controller. Concomitantly, we have occasionally disturbed the balance of nature in ways that we did not always understand. Science has to be watched. The layman can no longer afford to stand to one side, ignorant of the meaning of advances that will determine the kind of world that his children will inhabit – and the kind of children that he will have. Science has become part of

the human race's way of conceiving of and manipulating its future. The manipulation of the future is not a question to be left to philosophers. The answers can affect the national budget, the health of your next child, and the long-term prospects for life on this planet.

*The Ascent of Science*

Preface (p. xiv)

Solomon Press Book. New York, New York, USA. 1998

### **Simpson, George Gaylord** 1902–84

American paleontologist

The important distinction between science and those other systematizations [i.e., art, philosophy, and theology] is that science is self-testing and self-correcting. Here the essential point of science is respect for objective fact. What is correctly observed must be believed...the competent scientist does quite the opposite of the popular stereotype of setting out to prove a theory; he seeks to disprove it.

*Notes on the Nature of Science*

Notes on the Nature of Science by a Biologist (p. 9)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

### **Slichter, Charles S.**

Mathematician

...science is not sacrificing any of its strength nor compromising its ideals. It is *technology* that is changing – that is becoming less empirical, more systematic, more quantitative, more scientific.

The Teaching of Mathematics to Students of Engineering

*Science*, New Series, Volume 28, Number 713, August 28, 1908 (p. 262)

### **Slosson, Edwin E.** 1865–1929

American chemist and journalist

Science consists in learning from nature how to surpass nature.

Spun Logs

*The Scientific Monthly*, December, 1925

Most people think of science as a serious and solemn thing, a strain upon the strongest intellect.

So it is for the pioneers of scientific progress, but not for those who merely follow along behind.

*Chats on Science*

Introduction (p. 1)

G. Bell & Sons Ltd. London, England. 1924

One cannot, of course, become a scientist by merely reading science, however diligently and long. For a scientist is one who makes science, not one who learns science. A novelist is one who writes novels, not one who reads them. A contortionist is one who makes contortions, not one who watches them.

Science from the Side-Lines

*The Century: A Popular Quarterly*, Volume 103, November 1921 to April 1922 (p. 473)



**Smith, Goldwin** 1823–1910  
British-Canadian historian and journalist

Science finds no law for the thoughts which, with her aid, are ministered to man by the starry skies. Science can explain the hues of sunset, but she cannot tell from what urns of pain and pleasure its pensiveness is poured.

*The World's Best Orations: From the Earliest Period to the Present Time*

The Secret Beyond Science (p. 3476)

Ferd. P. Keiser. St. Louis, Missouri, USA. 1899

**Smith, Henry Preserved** 1847–1927  
American Biblical scholar

More and more, science has become not only increasingly necessary as a foundation for professional skill, but has come to be regarded as the most valuable instrument of culture.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 28 (p. 395)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

...whether as the new salvation or the new superstition, science has modeled the whole life of the modern world.... All modern production of wealth, all contemporary life, depend on the knowledge of nature acquired by science. But more than that, religion, politics, philosophy, art and literature have capitulated to science, or at least receded before her. There is no department of human activity today untouched with the spirit of experiment and of mathematics.

*A History of Modern Culture* (Volume 1)

Epilogue (p. 606)

Peter Smith. Gloucester, Massachusetts, USA. 1957

**Smith, Sydney** 1771–1845  
English clergyman, writer, and wit

Science is his forte, and omniscience his foible.

In Isaac Todhunter

*William Whewell* (Volume 1)

Conclusion (p. 410)

Macmillan & Company Ltd. London, England. 1876

**Smyth, Nathan A.**

No biographical data available

To recognize with science that beyond our horizon lies impenetrable mystery will serve but to increase our reverence for the glory of the whole.

*Through Science to God*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1936

**Snow, Charles Percy** 1905–80  
English novelist and scientist

But after the idyllic years of science, we passed into a tempest of history; and by an unfortunate coincidence, we passed into a technological tempest, too.

In Paul C. Opler and Herman A. Estrin (eds.)

*The New Scientist: Essays on the Methods and Value of Modern Science*

The Moral Un-Neutrality of Science (p. 135)

**Soddy, Frederick** 1877–1956  
English chemist

As science advances and most of the more accessible fields of knowledge have been gleaned of their harvest, the need for more and more powerful and elaborate appliances and more and more costly materials ever grows.

*Science and Life: Aberdeen Addresses*

Science and the State (p. 60)

E.P. Dutton & Company, Inc. New York, New York, USA. 1920

**Somerville, Mary** 1780–1872  
English mathematician

Science, regarded as the pursuit of truth, which can only be attained by patient and unprejudiced investigation, wherein nothing is too great to be attempted, nothing so minute as to be justly disregarded, must ever afford occupation of consummate interest and subject of elevated meditation.

*On the Connexion of the Physical Sciences*

Section I (p. 2)

John Murray. London, England. 1834

**Sonneberg, Walter**  
No biographical data available

Science can move mountains, but it cannot move mole-hills.

*Social Eccentricities*

Social Eccentricities (p. 1)

Broadway Publishing Co. New York, New York, USA. 1906

**Sorokin, Pitirim A.** 1889–1968  
Russian-born American sociologist

Any science, at any moment of its historical existence, contains not only truth but also much that is half-truth, sham-truth, and plain error.

*Fads and Foibles in Modern Sociology*

Preface (p. v)

Henry Regnery. Chicago, Illinois, USA. 1956

**Spark, Muriel** 1918–2006  
Scottish novelist

Art and religion first; then philosophy; lastly science. That is the order of the great subjects of life, that's their order of importance.

*The Prime of Miss Jean Brodie*

Chapter 2 (p. 39)

Macmillan & Company Ltd. London, England. 1961

**Spencer, Herbert** 1820–1903  
English social philosopher

Only when Genius is married to Science, can the highest results be produced.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 70)

A.L. Fowle. New York, New York, USA. 1860

...the highest Art of every kind is based upon Science – that without Science there can be neither perfect production nor full appreciation.... Only when Genius is married to Science can the highest results be produced.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 75, 81)

D. Appleton & Co. New York, New York, USA. 1891

...it [science] alone can give us true conceptions of ourselves and our relation to the mysteries of existence. At the same time that it shows us all which can be known, it shows us the limits beyond which we can know nothing.... It realizes to us in a way which nothing else can, the littleness of human intelligence in the face of that which transcends human intelligence.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 78)

Willard Small. Boston, Massachusetts, USA. 1890

What knowledge is of most worth? – the uniform reply is – Science. This is the verdict on all counts. For direct self-preservation, or the maintenance of life and health, the all-important knowledge is – Science. For that indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is – Science. For the due discharge of parental functions, the proper guidance is to be found only in – Science. For that interpretation of national life, past and present, without which the citizen cannot rightly regulate his conduct, the indispensable key is – Science. Alike for the most perfect production and present enjoyment of art in all its forms, the needful preparation is still – Science, and for purposes of discipline – intellectual, moral, religious – the most efficient study is, once more – Science.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 79–80)

Willard Small. Boston, Massachusetts, USA. 1890

So far from science being irreligious, as many think, it is the neglect of science that is irreligious – it is the refusal to study the surrounding creation that is irreligious.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 81)

D. Appleton & Co. New York, New York, USA. 1860

What knowledge is of most worth? – the uniform reply is – Science. This is the verdict on all counts.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 84)

A.L. Fowle. New York, New York, USA. 1860

For direct self-preservation, or the maintenance of life and health, the all-important knowledge is – Science. For the indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is – Science. For that interpretation of national life, past and present, without which the citizen cannot rightly regulate his conduct, the indispensable key is – Science. Alike for the most perfect production and highest enjoy-

ment of art in all its forms, the needful preparation is still – Science. And for the purposes of discipline – intellectual, moral, religious – the most efficient study is, once more – Science.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 84–85)

A.L. Fowle. New York, New York, USA. 1860

But for science we should be still worshipping fetishes; or, with hecatombs of victims, propitiating diabolical deities.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 87)

D. Appleton & Co. New York, New York, USA. 1860

...it (science) alone can give us true conceptions of ourselves and our relation to the mysteries of existence. At the same time that it shows us all which can be known, it shows us the limits beyond which we can know nothing.... It realizes to us in a way which, nothing else can, the littleness of human intelligence in the face of that which transcends human intelligence.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 92, 93)

D. Appleton & Co. New York, New York, USA. 1891

We conclude, then, that for discipline, as well as for guidance, science is of chiefest value. In all its effects, learning the meanings of things, is better than learning the meanings of words. Whether for intellectual, moral, or religious training, the study of surrounding phenomena is immensely superior to the study of grammars and lexicons.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 93)

D. Appleton & Co. New York, New York, USA. 1891

Thus to the question with which we set out – What knowledge is of most worth? – the uniform reply is – Science.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 93)

D. Appleton & Co. New York, New York, USA. 1891

Necessary and eternal as are its truths, all Science concerns all mankind for all time. Equally at present, and in the remotest future, must it be of incalculable importance for the regulation of their conduct, that men should understand the science of life, physical, mental, and social; and that they should understand all other science as a key to the science of life.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 94–95)

D. Appleton & Co. New York, New York, USA. 1891

To the slowly growing acquaintance with the uniform co-existences and sequences of phenomena – to the establishment of invariable laws, we owe our emancipation from the grossest superstitions. But for science we should be still worshipping fetishes; or, with hecatombs of victims, propitiating diabolical deities.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 95)

D. Appleton & Co. New York, New York, USA. 1891

The more science familiarizes us with the constitution of things the more do we see in them an inherent self-sufficingness. A higher knowledge tends continually to limit our interference with the processes of life.

*Education: Intellectual, Moral, and Physical*

Chapter II (p. 111)

D. Appleton & Co. New York, New York, USA. 1891

Be there be or be there not any other revelation, we have a veritable revelation in Science – a continuous disclosure, through the intelligence with which we are endowed, of the established order of the Universe.

*First Principles of a New System of Philosophy*

Part I, Chapter I, section 5 (p. 20)

D. Appleton & Co. New York, New York, USA. 1892

From generation to generation Science has been proving uniformities of relation among phenomena which were before thought either fortuitous or supernatural in their origin – has been showing an established order and a constant causation where ignorance had assumed irregularity and arbitrariness.

*Essays, Scientific, Political, and Speculative* (Volume 1)

The Nebular Hypothesis (p. 109)

D. Appleton & Co. New York, New York, USA. 1898

Without further argument it will, we think, be admitted that the sciences are none of them separately evolved – are none of them independent either logically or historically; but that all of them have, in a greater or less degree, required aid and reciprocated it. Indeed, it needs but to throw aside hypotheses, and contemplate the mixed character of surrounding phenomena, to see at once that these notions of division and succession in the kinds of knowledge are simply scientific fictions: good, if regarded merely as aids to study; bad, if regarded as representing realities in Nature. No facts whatever are presented to our senses uncombined with other facts – no facts whatever but are in some degree disguised by accompanying facts: disguised in such a manner that all must be partially understood before anyone can be understood.

*Essays, Scientific, Political, and Speculative* (Volume 2)

The Genesis of Science (p. 65)

D. Appleton & Co. New York, New York, USA. 1907

The conceptions which developing science gives of the grandeur of creation, as well as the constancy and irresistibility of its Omnipresent Cause, make all feel the comparative littleness of human power...

*Essays, Scientific, Political, and Speculative* (Volume 3)

Representative Government – What Good is It For? (p. 313)

D. Appleton & Co. New York, New York, USA. 1892

The dull world outside thinks of Science as nothing but a matter of chemical analyses, calculations of distances and times, labelings of species, physiological experiments,

and the like; but among the initiated, those of higher type, while seeking scientific knowledge for its proximate value, have an ever-increasing consciousness of its ultimate value as a transfiguration of things, which, marvellous enough within the limits of the knowable, suggests a profounder marvel that cannot be known.

*An Autobiography* (Volume 1)

Chapter XXIV (p. 486)

D. Appleton & Co. New York, New York, USA. 1904

So vast is the accumulation of facts which men of science have before them, that only by dividing and subdividing their labors can they deal with it. To a complete knowledge of his own division, each adds but a general knowledge of the rest. Surely, then, science, cultivated even to a very moderate extent, affords adequate exercise for memory. To say the very least, it involves quite as good a training for this faculty as language does.

*The Greatest Works of the Greatest Authors, Ancient and Modern*

What Knowledge is of the Most Worth? (p. 252)

The H.W. Hagemann Publishing Co. New York, New York, USA. 1894

What is Science? To see the absurdity of the prejudice against it, we need only remark that Science is simply a higher development of common knowledge; and that if Science is repudiated, all knowledge must be repudiated along with it.

*First Principles of a New System of Philosophy*

Part I, Chapter I, Section 5 (p. 18)

D. Appleton & Co. New York, New York, USA. 1892

### **Stanislaus, Leszczynski (Stanislaus I)** 1677–1766

King of Poland

Science when well digested is nothing but good sense and reason.

*Maxims*

No. 43

Publisher undetermined

### **Stansfield, A.**

No biographical data available

Science is not like a house that is finished and complete, but resembles a tree that is constantly growing and renewing itself!

Samuel Gibson, *The Naturalist*

*City News Notes and Queries*, December 23, 1882 (p. 361)

### **Stansfield, William D.** 1930–

American biologist

Most scientific theories, however, are ephemeral. Exceptions will likely be found that invalidate a theory in one or more of its tenets. These can then stimulate a new round of research leading either to a more comprehensive theory or perhaps to a more restrictive (i.e., more precisely defined) theory. Nothing is ever completely finished in science; the search for better theories is endless. The interpretation of a scientific experiment should not be

extended beyond the limits of the available data. In the building of theories, however, scientists propose general principles by extrapolation beyond available data. When former theories have been shown to be inadequate, scientists should be prepared to relinquish the old and embrace the new in their never-ending search for better solutions. It is unscientific, therefore, to claim to have “proof of the truth” when all that scientific methodology can provide is evidence in support of a theory.

*The Science of Evolution*

Introduction (p. 8)

Macmillan Publishing Company, New York, New York, USA. 1977

**Stedman, Edmund Clarence** 1833–1908

American poet, critic, and essayist

Science has but one fashion – to lose nothing once gained...

*Poets of America*

Chapter VIII (p. 275)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1885

**Stenger, Victor J.** 1935–

American physicist

No one ever said science was easy, and nobody, scientist or not, should be expected to fall over and play dead when a challenge to existing knowledge is made. If a new idea has sufficient merit, it should ultimately overcome any resistance, no matter how strong.... Resistance to new ideas is part of the process of science. A worthy new idea must overcome barriers of doubt and skepticism, and even occasional irrational objections. But if an idea has merit, it will eventually climb over these barriers.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 3 (p. 65)

Prometheus Books, Buffalo, New York, USA. 1990

**Sterne, Laurence** 1713–68

English novelist and humorist

Sciences may be learned by rote, but Wisdom not.

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 1)

Book V, Chapter XXXII (p. 356)

Macmillan & Company Ltd. London, England. 1900

Vain science! Thou assisted us in no case of this kind, and thou puzzlest us in everyone.

*Life & Opinions of Tristram Shandy, Gentleman*

Chapter XXVII (p. 365)

Derby & Jackson, New York, New York, USA. 1857

I met with distinction, somewhere, once, comparing science to wit, and art to humor; but it has more of fancy than philosophy in it.

*The Works of Laurence Sterne*

84 (p. 127)

Printed for J. Mozley, London, England. 1745

Science is intelligent curiosity, an organized thinking replacing a primitive wonder.

*Man and the Stars*

Chapter I (p. 4)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1930

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

Science writes of the world as if with the cold finger of a starfish; it is all true; but what is it when compared to the reality of which it discourses, where hearts beat high in April, and death strikes, and hills totter in the earthquake, and there is a glamour over all the objects of sight, and a thrill in all noises for the ear, and Romance herself has made her dwelling among men? So we come back to the old myth, and hear the goat-footed piper making the music which is itself the charm and terror of things; and when a glen invites our visiting footsteps, fancy that Pan leads us thither with a gracious tremolo; or when our hearts quail at the thunder of the cataract, tell ourselves that he has stamped his hoof in the high thicket.

*Virginibus Puerisque and Familiar Studies of Men and Books*

Pan's Pipe (p. 108)

J.M. Dent & Sons Ltd. London, England. No date

**Stillman, J. D. B.**

American physician

...can science do something to check the wild revels of the imagination, confine it within the bounds of probability, and deduce such laws as will best serve to protect us from the destructive effects of offerees that we cannot control.

Concerning the Late Earthquake

*The Overland Monthly*, Volume 1, November, 1868 (p. 475)

**Stoker, Bram** 1847–1912

English writer

There are mysteries which men can only guess at, which age by age they may solve only in part.

*Dracula*

Chapter XV (p. 217)

Ameron House, Mattituck, New York, USA. No date

**Sullivan, John William Navin** 1886–1937

Irish mathematician

Science, like everything else that man has created, exists, of course, to gratify certain human needs and desires. The fact that it has been steadily pursued for so many centuries, that it has attracted an ever-wider extent of attention, and that it is now the dominant intellectual interest of mankind, shows that it appeals to a very powerful and persistent group of appetites.

*The Limitations of Science*

Introduction (p. 7)

New American Library, New York, New York, USA. 1956

...science deals with but a partial aspect of reality, and there is no faintest reason for supposing that everything science ignores is less real than what it accepts... Why is

it that science forms a closed system? Why is it that the elements of reality it ignores never come in to disturb it? The reason is that all the terms of physics are defined in terms of one another. The abstractions with which physics begins are all it ever has to do with.

*The Limitations of Science*

Chapter 6, Section IV (p. 147)

New American Library. New York, New York, USA. 1956

### Swenson, Jr., Lloyd S.

No biographical data available

The interplay of thought and action, theory and experiment, individuals and institutions in science is both comic and tragic, despite the actors' common belief that their lines are delivered as if for a triumphal pageant rather than a tragicomic play.

*Genesis of Relativity: Einstein in Context*

Preface (p. xiii)

Burt Franklin & Company, Inc. New York, New York, USA. 1979

### Swift, Jonathan 1667–1745

Irish-born English writer

The sciences are found, like Hercules's oxen, by tracing them backward; and old sciences are unravelled like old stockings, by beginning at the foot,

*The Works* (Volume 24)

General Index (p. 388)

Printed for J. Johnson. London, England. 1803

### Tait, Peter Guthrie 1831–1901

Scottish physicist and mathematician

Descriptive botany, natural history, volumes of astronomical observations, etc., are collections of statements, often facts, from which scientific truth may ultimately be extracted, but they are not science. Science begins to dawn, but only to dawn, when a Copernicus, and after him a Kepler or a Galilei, sets to work on these raw materials, and sifts from them their essence. She bursts into full daylight only when a Newton extracts the quintessence. There has been, as yet, but one Newton; there have not been very many Keplers.

In Cargill Gilston Knott

*Life and Scientific Work of Peter Guthrie Tait*

Chapter VII (p. 294)

University Press. Cambridge, England. 1911

### Teller, Edward 1908–2003

Hungarian-born American nuclear physicist

Science, like music or art, is not something that can or should be practiced by everybody. But we want all children to be able to enjoy music, to be able to tell good music from poor music, so we teach them to appreciate music in a discriminating manner. That should be the aim in science education for the nonscientist.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 28 (p. 208)

The Free Press. New York, New York, USA. 1987

Science introduces consistency and simplicity into a world that without them appears confused and random.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 29 (p. 215)

The Free Press. New York, New York, USA. 1987

### Tennyson, Alfred (Lord) 1809–92

English poet

...nourishing a youth sublime

With the fairy tales of science, and the long result of time.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 6

Oxford University Press, Inc. London, England. 1953

Science moves, but slowly, slowly, creeping on from point to point.

*Alfred Tennyson's Poetical Works*

Locksey Hall, Stanza 60

Oxford University Press, Inc. London, England. 1953

... When Science reaches forth her arms

To feel from world to world, and charms

Her secret from the latest moon?

*The Poetic and Dramatic Works of Alfred, Lord Tennyson*

In Memoriam

Houghton Mifflin Co. Boston, Massachusetts, USA. 1898

### Thom, René 1923–2002

French mathematician

If we admit a priori that science is just acquisition of knowledge, that is, building an inventory of all observable phenomena in a given disciplinary domain – then, obviously, any science is empirical.

In J. Casti and A. Karlqvist (eds.)

*Newton to Aristotle: Toward a Theory of Models for Living Systems*

Causality and Finality in Theoretical Biology

### Thomas, Lewis 1913–93

American physician and biologist

You either have science or you don't, and if you have it you are obliged to accept the surprising and disturbing pieces of information, even the overwhelming and upheaving ones, along with the neat and promptly useful bits. It is like that.

*The Medusa and the Snail: More Notes of a Biology Watcher*

The Hazard of Science (p. 73)

The Viking Press. New York, New York, USA. 1979

Science began by fumbling. It works because the people involved in it work, and work together. They become excited and exasperated, they exchange their bits of information at a full shout, and, the most wonderful thing of all, they keep at one another.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*

Alchemy

The Viking Press. New York, New York, USA. 1983

The essential wildness of science as a manifestation of human behavior is not generally perceived. As we extract



new things of value from it, we also keep discovering parts of the activity that seem in need of better control, more efficiency, less unpredictability.

*The Lives of a Cell: Notes of a Biology Watcher*

Natural Science (p. 100)

The Viking Press. New York, New York, USA. 1974

### Thompson, A. R.

No biographical data available

...science has not only helped to destroy popular traditions that might have nourished a modern spirit of admiration, but has fostered a wintry skepticism, making man appear not an imperfect angel, but a super-educated monkey.

In R. Foerster (ed.)

*Humanism and America: Essays on the Outlook of Modern Civilization*

The Dilemma of Modern Tragedy (p. 129)

Farrar & Rinehart Inc. New York, New York, USA. 1930

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

The study of Nature is as preoccupying as are the everyday interests of our life, yet in both fields we are still continuously pulling ourselves up and asking what it all means. At every corner there stands the great mark of interrogation, the Riddle of the Sphinx. Science has its own questions and answers: Whither, and How – but beyond science is the not less inevitable questions: WHY.

In Francis Mason (ed.)

*The Great Design*

Introduction (p. 12)

The Macmillan Co. New York, New York, USA. 1934

When science makes minor mysteries disappear, greater mysteries stand confessed. For one object of delight whose emotional value science has inevitably lessened – as Newton damaged the rainbow for Keats – science gives back double.

*The Outline of Science* (Volume 4 )

Chapter XXXVIII (p. 1176)

G.P. Putnam's Sons. New York, New York, USA. 1937

To the grand primary impression of the world power, the immensities, the pervading order, and the universal flux, with which the man of feeling has been nurtured from the old, modern science has added thrilling impressions of manifoldedness, intricacy, uniformity, inter-relatedness, and evolution. Science widens and clears the emotional window. There are great vistas to which science alone can lead, and they make for elevation of mind.

*The Outline of Science* (Volume 4 )

Chapter XXXVIII (pp. 1176–1177)

G.P. Putnam's Sons. New York, New York, USA. 1937

The opposition between science and feeling is largely a misunderstanding. As one of our philosophers has remarked, Science is in a true sense “one of the humanities.”

*The Outline of Science* (Volume 4 )

Chapter XXXVIII (p. 1177)

G.P. Putnam's Sons. New York, New York, USA. 1937

Great stores of wealth are awaiting the scientific “Open Sesame”; a great heightening of the standard of health will be attainable in a few generation if men of good-will take science as their torch.

*The Outline of Science* (Volume 4 )

Chapter XXXVIII (p. 1180)

G.P. Putnam's Sons. New York, New York, USA. 1937

Science expresses a quite specific endeavor to get phenomena under intellectual control, so that we can think of them economically and clearly in relation to the rest of our science, and so that we can use them as a basis for secure prediction and effective action.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 8)

William & Norgate. London, England. 1920

Science makes so many permanent discoveries, which are never contradicted though often transcended, that she acquires an assured confidence which has only been equaled by that of Theology.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 13)

William & Norgate. London, England. 1920

Science as science never asks the question Why? That is to say, it never inquires into the meaning, or significance, or purpose of this manifold Being, Becoming, and Having Been.... Thus science does not pretend to be a bedrock of truth.

In Bertrand Russell

*Religion and Science*

Mysticism (p. 175)

Henry Holt & Company. New York, New York, USA. 1935

...science aims at description in terms of the lowest common denominators available; while religion and philosophy aim at interpretation in terms of the greatest common measure.

The New World of Science

*The Atlantic Monthly*, June, 1930

Science is not wrapped up with any particular body of facts; it is characterized as an intellectual attitude. It is not tied down to any peculiar methods of inquiry; it is simply sincere critical thought, which admits conclusions only when these are based on evidence.

*Introduction to Science*

Chapter I (p. 27)

Williams & Norgate Ltd. London, England. 1916

What science knows it must know definitely; what it sees must be in focus.

*Introduction to Science*

Chapter I (p. 29)

Henry Holt & Co. New York, New York, USA. 1911

Science is not wrapped up with any particular body of facts; it is characterized as an intellectual attitude. It is not tied down to any peculiar methods of inquiry; it is simply sincere critical thought, which admits conclusions only when these are based on evidence.



*Introduction to Science*

Chapter III (p. 57)

Henry Holt &amp; Co. New York, New York, USA. 1911

It is part of “man’s chief end” not only to know Nature – which is Science, but to enjoy her forever. We are men of feeling, and Nature speaks to our heart, though we are not fond, unless we are poets, of saying much about it. But we listen with gladness, with awe, sometimes, perhaps, with fear, surely always with wonder.

*Introduction to Science*

Chapter VI (pp. 169–170)

Henry Holt &amp; Co. New York, New York, USA. 1911

Science never destroys wonder, but only shifts it, higher and deeper.

*Introduction to Science*

Chapter VI (p. 189)

Henry Holt &amp; Co. New York, New York, USA. 1911

Science always begins – not at the beginning, for that is impossible, but from something “given” which it does not explain.

*Introduction to Science*

Chapter VII (p. 205)

Henry Holt &amp; Co. New York, New York, USA. 1911

Is it science that satisfies man’s soul, or is it the attendant feeling and imagining which the study of Nature evokes?

*The System of Animate Nature* (Volume 1)

Lecture I (p. 27)

William &amp; Norgate. London, England. 1920

...science gives Man from time to time a greatly increased mastery over Nature; science, with its analytical triumphs, ever tends to diminish, in the shallow minded, the saving grace of wonder; and science is ever dispelling the darkness that oppresses the mind.

*The System of Animate Nature* (Volume 1)

Lecture I (pp. 41–42)

William &amp; Norgate. London, England. 1920

Science is not any particular body of facts: it is essentially the expression of an intellectual attitude or mood in relation to any order of phenomena. The distinctive feature is in the method, making sure of facts, classifying them, analysing them into their simplest adequate expression, observing their inter-relations, grouping them according to their likenesses of co-existence and sequence, and inventing descriptive formulae which sum them up in terms of our perceptual experience.

In James Edward Hand

*Ideals of Science & Faith*

A Biological Approach (p. 52)

Longmans, Green &amp; Co. New York, New York, USA. 1904

Although science is not in itself practical, anymore than artistic or emotional, there is a practical note in its ideal. Knowledge for knowledge’s sake is not a humanly satisfying motive, though the idea often fills the horizon for

an hour, or a day, a year, or a life-time, according to the nature of the man.

In James Edward Hand

*Ideals of Science & Faith*

A Biological Approach (p. 77)

Longmans, Green &amp; Co. New York, New York, USA. 1904

It may be granted, too, that science, like a child pulling a flower to bits, is apt and biology is one of the worst of the offenders to dissect more than it constructs, and to lose in its analysis the vision of unity and harmony which the artist has ever before his eyes.

In James Edward Hand

*Ideals of Science & Faith*

A Biological Approach (p. 77)

Longmans, Green &amp; Co. New York, New York, USA. 1904

Science reads the secret of the distant star and anatomises the atom; foretells the date of the comet’s return and predicts the kinds of chickens that will hatch from a dozen eggs; discovers the laws of the wind that bloweth where it listeth and reduces to order the disorder of disease. Science is always setting forth on Columbus voyages, discovering new worlds and conquering them by understanding. For Knowledge means Foresight and Foresight means Power.

In John Arthur Thomson

*The Outline of Science: A Plain Story Simply Told*

Introduction (p. 3)

G.P. Putnam’s Sons. New York, New York, USA. 1922

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

From age to age science has given mankind a new world, and the latest newness – which will not be the last – is perhaps the strangest of all.

In Franz Montgomery and Luther N. Becklund

*Essays in Science and Engineering*

The New World of Science (p. 3)

Farrar &amp; Rinehart. New York, New York, USA. 1938

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Science with its retorts would have put me to sleep; it was the opportunity to be ignorant that I improved. It suggested to me that there was something to be seen if one had eyes. It made a believer of me more than before. I believed that the woods were not tenantless, but choke-full of honest spirits as good as myself any day, – not an empty chamber, in which chemistry was left to work alone, but an inhabited house, – and for a few moments I enjoyed fellowship with them.

*The Writings of Henry David Thoreau* (Volume 3)*The Maine Woods, the Allegash and East Branch* (pp. 247–248)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Let us consider under what disadvantages Science has hitherto labored before we pronounce thus confidently on her progress.

*The Writings of Henry David Thoreau* (Volume 4)  
*Paradise (to Be) Regained* (p. 301)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Already nature is serving all those uses which science slowly derives on a much higher and grander scale to him that will be served by her. When the sunshine falls on the path of the poet, he enjoys all those pure benefits and pleasures which the arts slowly and partially realize from age to age. The winds which fan his cheek waft him the sum of that profit and happiness which their lagging inventions supply.

*The Writings of Henry David Thoreau* (Volume 4)  
*Paradise (to Be) Regained* (p. 302)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

What an admirable training is science for the more active warfare of life! Indeed, the unchallenged bravery which these studies imply, is far more impressive than the trumpeted valor of the warrior.

*The Writings of Henry David Thoreau* (Volume 9)  
*Natural History of Massachusetts* (p. 131)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Thurber, James** 1894–1961  
 American writer and cartoonist

Science has zipped the atom open in a dozen places, it can read the scrawling on the Rosetta stone as glibly as a literary critic explains Hart Crane, but it doesn't know anything about playwrights.

*Collecting Himself: James Thurber on Writing and Writers, Humor and Himself*  
 Roaming in the Gloaming (p. 194)  
 Harper & Row, Publishers. New York, New York, USA. 1989

**Thwing, Charles Franklin** 1853–1937  
 American educator and writer

Every enlargement of the field of knowledge has resulted in the enrichment of the academic curriculum. Great is the difference, moreover, between knowledge as knowledge and knowledge as a tool of intellectual training. Time is required for the transmutation of pure science into a practical agency or condition of discipline.

*A History of Higher Education in America*  
 Chapter I (p. 25)  
 D. Appleton & Co. New York, New York, USA. 1906

**Tolstoy, Leo** 1828–1910  
 Russian writer

What is called science today consists of a haphazard heap of information, united by nothing, often utterly unnecessary, and not only failing to present one unquestionable truth, but as often as not containing the grossest errors, today put forward as truths, and tomorrow overthrown.

*What Is Religion?*  
 Chapter I (p. 3)  
 T.Y. Crowell. New York, New York, USA. 1899

The highest wisdom has but one science – the science

of the whole – the science explaining the whole creation and man's place in it.

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
 Book Five, Chapter II (p. 197)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tucker, Wilson** 1914–2006  
 American mystery and science fiction writer

...Science tends to frighten those who are infrequently exposed to it, while the practitioners of science are often the most misunderstood people in the world....

*The Year of the Quiet Sun* (p. 78)  
 Ace. New York, New York, USA. 1970

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
 American author and humorist

[W]hat we most admire is the vast capacity of that intellect which, without effort, takes in at once all the domains of science – all the past, the present and the future, all the errors of two thousand years, all the encouraging signs of the passing times, all the bright hopes of the coming age.

*Is Shakespeare Dead?*  
 Chapter X (p. 124)  
 Oxford University Press, Inc. London, England. 1996

**Tyndall, John** 1820–93  
 Irish-born English physicist

Science must grow. Its development is as necessary and as irresistible as the motion of the tides, or the flowing of the Gulf-Stream.

*Heat a Mode of Motion* (6th edition)  
 Preface to the First Edition (p. xiv)  
 Longmans, Green & Co. London, England. 1875

Thus, having exhausted science and reached its very rim, the real mystery of existence still looms around us. And thus it will ever loom – ever beyond the bourne of man's intellect – giving the poets of successive ages just occasion to declare that,

We are such stuff  
 As dreams are made of, and our little life  
 Is rounded by a sleep.

*Heat a Mode of Motion* (6th edition)  
 Lecture XVII (p. 535)  
 D. Appleton & Co. New York, New York, USA. 1915

**Union Carbide and Carbon**

More Jobs Through Science  
 Advertising slogan

**Valéry, Paul** 1871–1945  
 French poet and critic

Science is feasible when the variables are few and can be enumerated; when their combinations are distinct and clear. We are tending toward the condition of science and

aspiring to do it. The artist works out his own formulas; the interests of science lies in the art of making science.

In Jackson Mathews (ed.)

*Analects* (p. 191)

Princeton University Press. Princeton, New Jersey, USA. 1971

Science means simply the aggregate of all the recipes that are always successful. All the rest is literature.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

*Analects*

Princeton University Press. Princeton, New Jersey, USA. 1971

### Vash (Fictional character)

Well, when it comes to choosing between science and profit, I'll choose profit every time.

*Star Trek: Deep Space Nine*

Q-Less

Television program

Season 1, 1993

### Verne, Jules 1828–1905

French novelist

[I]n the cause of science men are expected to suffer.

*A Journey to the Center of the Earth*

Chapter 6 (p. 33)

The Limited Editions Club. New York, New York, USA. 1966

When science has sent forth her fiat – it is only to hear and obey.

*A Journey to the Center of the Earth*

Chapter 11 (p. 73)

The Limited Editions Club. New York, New York, USA. 1966

Science, great, mighty and in the end unerring...science has fallen into many errors – errors which have been fortunate and useful rather than otherwise, for they have been the stepping stones to truth.

*A Journey to the Center of the Earth*

Chapter 28 (p. 182)

The Limited Editions Club. New York, New York, USA. 1966

We may brave human laws, but we cannot resist natural ones.

Translated by Mercier Lewis

*Twenty Thousand Leagues Under the Sea*

Part Two, Chapter 15 (p. 249)

Nelson Doubleday, Inc. Garden City, New York, USA. 1900

### Virchow, Rudolf Ludwig Karl 1821–1902

German pathologist and archaeologist

Science in itself is nothing, for it exists only in the human beings who are its bearers.

Translated by Lelland J. Rather

*Disease, Life, and Man. Selected Essays*

Standpoints in Scientific Medicine (1847) (pp. 29–30)

Stanford University Press. Stanford, California, USA. 1958

Has not science the noble privilege of carrying on its controversies without personal quarrels.

In F.H. Garrison

*Bulletin of the New York Academy of Medicine*, Volume 4, 1928 (p. 995)

### Voltaire (François-Marie Arouet) 1694–1778

French writer

True science necessarily carries tolerance with it.

Letter to Madame d'Épinay

*Correspondance de Voltaire*, 1881 edition, Volume 12, July 6, 1766 (p. 329)

### von Frisch, Karl 1886–1982

Austrian ethnologist

Science advances but slowly, with halting steps. But does not therein lie her eternal fascination? And would we not soon tire of her if she were to reveal her ultimate truths too easily?

*A Biologist Remembers*

To Munich for the Fifth Time (p. 178)

Pergamon Press. Oxford, England. 1967

Science is eternal in its out-gushing stream, bounded by neither time nor space, immeasurable in its activity, endless in its scope, its final goal ever unreachd.

Quoted in Martin Gumpert

*Trail Blazers of Science* (p. 1)

Funk & Wagnalls. New York, New York, USA. 1936

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

Four epochs of science:

childlike,

poetic, superstitious;

empirical,

searching, curious;

dogmatic,

didactic, pedantic;

ideal,

methodical, mystical.

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 304–305)

Suhrkamp. New York, New York, USA. 1988

Sciences destroy themselves in two ways: by the breadth they reach and by the depth they plumb.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 305)

Suhrkamp. New York, New York, USA. 1988

A crisis must necessarily arise when a field of knowledge matures enough to become a science, for those who focus on details and treat them as separate will be set against those who have their eye on the universal and try to fit the particular into it.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 305)

Suhrkamp. New York, New York, USA. 1988

Germans – and they are not alone in this – have a knack of making the sciences unapproachable.

*Scientific Studies* (Volume 12)  
Chapter VIII (p. 306)  
Suhrkamp. New York, New York, USA. 1988

In general the sciences put some distance between themselves and life, and make their way back to it only by a roundabout path.

*Scientific Studies* (Volume 12)  
Chapter VIII (p. 306)  
Suhrkamp. New York, New York, USA. 1988

A science, like every human creation and institution, is a Titanic structure of mingled false and true, of arbitrary and necessary. The common observations on nature and its procedure which we make from day to day, in whatever terms expressed, are really, after all, only symptoms which, if any real wisdom is to result from our studies, must be traced back to the physiological and pathological principles of which they are the exponents.

In John Stuart Blackie  
*The Wisdom of Goethe*  
Nature – Natural History (p. 185)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

Science helps us before all things in this, that it somewhat lightens the feeling of wonder with which Nature fills us; then, however, as life becomes more and more complex, it creates new facilities for the avoidance of what would do us harm and the promotion of what will do us good.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
#589 (p. 202)  
The Macmillan Co. New York, New York, USA. 1906

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

All that science can achieve is a perfect knowledge and a perfect understanding of the action of natural and moral forces.

Translated by E. Atkinson  
*Popular Lectures on Scientific Subjects*  
First Series  
On the Relation of Natural Science to General Science (p. 29)  
D. Appleton & Co. New York, New York, USA. 1897

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Science only begins for man from the moment his mind lays hold of matter, – when he strives to subject the mass accumulated by experience to rational combinations...

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 64)  
Longman, Brown, Green & Longmans. London, England. 1849

Science does not present itself to man until mind conquers matter in striving to subject the result of experimental investigation to rational combinations.

Translated by E. C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 76)  
Harper & Brothers Publishers. New York, New York, USA. 1858

The great and solemn spirit that pervades the intellectual labor [of science] arises from the sublime consciousness of striving toward the infinite, and of grasping all that is revealed to us amid the boundless and inexhaustible fullness of creation, development, and being.

Translated by E.C. Otte  
*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 3)  
Introduction (p. 8)  
D. Appleton & Co. New York, New York, USA. 1850

**von Liebig, Justus** 1803–73  
German organic chemist

It has been said that every science must pass through three periods of development. The first is that of presentiment, or of faith; the second is that of sophistry; and the third is that of sober research.

*Familiar Letters on Chemistry*  
Letter III (p. 60)  
Walton & Maberly. London, England. 1859

Through Nature herself, whose kingdom forms a united and compact whole, the natural sciences stand in a necessary mutual connection, so that no one of them can entirely dispense with all the others for its development. The extension of the individual branches of science by researches, has the inevitable result, that in a certain stage, or at a certain period, two of them, for example, come into contact at their boundaries. As a general rule, a new science arises on the debatable land between them, which combines in itself the objects and the modes of viewing the phenomena of both.

*Familiar Letters on Chemistry*  
Chapter XXII (p. 270)  
Walton & Maberly. London, England. 1859

Science confers power, not money; and power is the source of riches and of poverty, – of riches when it produces, and of poverty when it destroys...

In John Blyth  
*Letters on Modern Agriculture*  
Letter I (p. 7)  
Walton & Maberly. London, England. 1859

Science as a whole certainly cannot allow its judgment about facts to be distorted by ideas of what ought to be true, or what one may hope to be true.

*The Scientific Attitude*  
Science Is Not Neutral (p. 25)  
Penguin Books, Middlesex, England. 1941

**Wald, George** 1906–97  
American biologist and biochemist

Science goes from question to question; big questions, and little, tentative answers. The questions as they age grow ever broader, the answers are seen to be more limited.

*Les Prix Nobel. the Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967  
Nobel Foundation. Stockholm, Sweden. 1968

The trouble with most of the things that people want is that they get them. No scientist needs to worry on that score. For him there is always the further horizon. Science goes from question to question; big questions, and little, tentative answers. The questions as they age grow ever broader, the answers are seen to be more limited.

*Les Prix Nobel. the Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967  
Nobel Foundation. Stockholm, Sweden. 1968

**Waterman, Alan T.** 1892–1967

American physicist

Science, in its pure form, is not concerned with where discoveries may lead; its disciples are interested only in discovering the truth.

*Imagination of Science and Society*

*American Behavioral Scientist*, Volume VI, Number 4, December, 1962 (p. 3)

**Watson, David Lindsay** 1901–73

No biographical data available

Science sprawls over all the horizons of the modern mind like some vast cloudbank. The outlook and method of science penetrate relentlessly the strata of daily custom into the caverns of the unconscious mind itself. Science is by far the most powerful intellectual phenomenon of modern times, inexorably laying down the law in regions far from the laboratory, and subtly governing, by its techniques and devices, our modes of life and ways of thinking.

*Scientists Are Human*

Chapter I (p. 1)

Watts. London, England. 1938

**Weaver, Warren** 1894–1978

American mathematician

The desirable adjuncts of modern living, although in many instances made possible by science, certainly do not constitute science.

*Science and Imagination: Selected Papers*

Chapter 1

Basic Books, Inc. New York, New York, USA. 1967

Science is not technology, it is not gadgetry, it is not some mysterious cult, it is not a great mechanical monster! Science is an adventure of the human spirit. It is essentially an artistic enterprise, stimulated largely by the universe, served largely by disciplined imagination, and based largely on faith in the reasonableness, order, and beauty of the universe of which man is part.

In Walter Orr Robek

Science, a Well Spring of our Discontent

*American Scientist*, Volume 55, Number 1, March, 1957 (p. 3)

It is hardly necessary to argue, these days, that science is essential to the public. It is becoming equally true, as the support of science moves more and more to state and national sources, that the public is essential to science. The lack of general comprehension of science is thus dangerous both to science and the public, these being interlocked aspects of the common danger that scientists will not be given the freedom, the understanding, and the support that are necessary for vigorous and imaginative development.

In Hilary J. Deason

*A Guide to Science Reading*

Science and People (p. 38)

The New American Library. New York, New York, USA. 1966

**Weber, Max** 1864–1920

German founder of modern sociology and economic thinker

Science today is a “vocation” organized in special disciplines in the service of self-clarification and knowledge of interrelated facts. It is not the gift of grace of seers and prophets dispensing sacred values and revelations, nor does it partake of the contemplation of sages and philosophers about the meaning of the Universe.

In H.H. Gerth and C. Wright Mills (eds.)

*From Max Weber: Essays in Sociology*

Science as a Vocation (p. 152)

Oxford University Press, Inc. New York, New York, USA. 1970

**Weil, Simone** 1909–43

French philosopher and mystic

To us, men of the West, a very strange thing happened at the turn of the century; without noticing it, we lost science, or at least the thing that had been called by that name for the last four centuries. What we now have in place of it is something different, radically different, and we don't know what it is. Nobody knows what it is.

Translated by Richard Rees

*On Science, Necessity, and the Love of God*

Classical Science and After, Chapter I (p. 3)

Oxford University Press, Inc. London, England. 1968

Science today will either have to seek a source of inspiration higher than itself or perish.

*Gravity and Grace*

Intelligence and Grace (p. 119)

Routledge & Kegan Paul. London, England. 1952

Science only offers three kinds of interest: (1) Technical applications. (2) A game of chess. (3) A road to God. (Attractions are added to the game of chess in the shape of competitions, prizes, and medals.)

*Gravity and Grace*

Intelligence and Grace (p. 119)

Routledge & Kegan Paul. London, England. 1952

**Weinberg, Steven** 1933–

American nuclear physicist

...there is an essential element in science that is cold, objective, and nonhuman...the laws of nature are as



impersonal and free of human values as the rules of arithmetic.... Nowhere do we see human value or human meaning.

Reflections of a Working Scientist  
*Daedalus*, Volume 103, 1974 (p. 3)

**Weiss, Paul A.** 1898–1985  
Chemist

Science, to some, is Lady Bountiful, to others is the Villain of the Century. Some years ago, a book called it our “Sacred Cow,” and certainly to many it has at least the glitter of the “Golden Calf.” Glorification at one extreme, vituperation at the other...

*Within the Gates of Science and Beyond*

Science Looks at Itself (p. 25)

Hafner Publishing Company. New York, New York, USA. 1971

Science is usually understood to depict a universe of strict order and lawfulness, of rigorous economy – one whose currency is energy, convertible against a service charge into a growing common pool called entropy.

Organic Form: Scientific and Aesthetic Aspects

*Daedalus*, (p. 177)

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science cannot develop unless it is pursued for the sake of pure knowledge and insight. It will not survive unless it is used intensely and wisely for the betterment of humanity and not as an instrument of domination by one group over another.

*Physics in the Twentieth Century: Selected Essays*

The Significance of Science (p. 364)

The MIT Press. Cambridge, Massachusetts, USA. 1972

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

The science hangs like a gathering fog in a valley, a fog which begins nowhere and goes nowhere, an incidental, unmeaning inconvenience to passers-by.

*The Works of H.G. Wells* (Volume 9)

A Modern Utopia

Chapter 3, Section 3

Charles Scribner's Sons. London, England. 1924–27

**Weyl, Hermann** 1885–1955  
German mathematician

We must await the further development of science, perhaps for centuries, before we can design a true and detailed picture of the interwoven texture of Matter, Life and Soul. But the old classical determinism of Hobbes, and Laplace need not oppress us any longer.

*The Open World: Three Lectures in the Metaphysical Implications of Science*

Lecture II (p. 55)

Yale University Press. New Haven, Connecticut, USA. 1932

...science would perish without the continuous interplay between its facts and constructions on the one hand and the imagery of ideas on the other.

*Philosophy of Mathematics and Natural Science*

Preface (p. vi)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Wheeler, John Archibald** 1911–  
American physicist and educator

...the human activity that we call science is not science unless it is the uncovering or discovery of something new.

*At Home in the Universe*

Be the Best to Give the Most (p. 76)

The American Institute of Physics. Woodbury, New York, USA. 1994

**Whetham, Sir William Cecil Dampier** 1867–1952  
English scientific writer

But beyond the bright searchlights of science,

Out of sight of the windows of sense,

Old riddles still bid us defiance,

Old questions of Why and of Whence.

*Recent Development of Physical Science* (p. 10)

John Murray. London, England. 1927

**Whewell, William** 1794–1866  
English philosopher and historian

Science begins with common observation of facts; but even at this stage, requires that the observations be precise. Hence the sciences which depend upon space and number were the earliest formed. After common observation, comes Scientific Observation and Experiment.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, VII (p. 467)

John W. Parker. London, England. 1847

The tendency of the sciences has long been an increasing proclivity of separation and dismemberment. The mathematician turns away from the chemist; the chemist from the naturalist; between the mathematician and the chemist is to be interpolated a “physician” (we have no English name for him), who studies heat, moisture and the like.

*Quarterly Review*, Volume 51, 1834 (p. 59)

The principles which constituted the triumph of preceding stages of science may appear to be subverted and ejected by later discoveries, but in fact they are (so far as they are true) taken up into the subsequent doctrines and included in them. They continue to be an essential part of the science. The earlier truths are not expelled but absorbed, not contradicted but extended; and the history of each science which may thus appear like a succession of revolutions is, in reality, a series of developments.

*History of the Inductive Sciences, from the Earliest to the Present Time*

(Volume the First)

Introduction (p. 10)

John W. Parker. London, England. 1837

...two things are requisite to science – facts and ideas...

*History of the Inductive Sciences, from the Earliest to the Present Time*

(Volume 1)

Book I, Chapter III, Section 2 (p. 79)

John W. Parker. London, England. 1837



Man is the interpreter of Nature, Science is the right interpretation.

*The Philosophy of the Inductive Sciences Founded upon Their History*  
(Volume 2)

Aphorisms Concerning Ideas, Aphorism I (p. 443)  
John W. Parker. London, England. 1847

Deductive reasoners, those who cultivate science, of whatever kind, by means of mathematical and logical processes alone, may acquire an exaggerated feeling of the amount and value of their labours.

*Astronomy and General Physics*

Chapter V (p. 252)

Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

A science which hesitates to forget its founders is lost.

*The Organisation of Thought*

Chapter VI (p. 115)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Science has always suffered from the vice of overstatement. In this way conclusions true within strict limitations have been generalized dogmatically into a fallacious universality.

*The Function of Reason*

Chapter I (p. 22)

Beacon Press. Boston, Massachusetts, USA. 1929

Aristotle discovered all the half-truths which were necessary to the creation of science.

In Lucien Price

*Dialogues of Alfred North Whitehead*

Dialogue XLII, September 11, 1945 (p. 344)

Little Brown. Boston, Massachusetts, USA. 1954

To see what is general in what is particular and what is permanent in what is transitory is the aim of scientific thought.

*An Introduction to Mathematics*

Chapter I (p. 11)

Henry Holt & Co. New York, New York, USA. 1911

We may conceive humanity as engaged in an internecine conflict between youth and age. Youth is not defined by years, but by the creative impulse to make something. The aged are those who, before all things, desire not to make a mistake. Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

*The Organization of Thought*

*Science*, Volume 44, Number 1134, September 29, 1916 (p. 419)

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Science, testing absolutely all thoughts, all works, has already burst well upon the world – a sun, mounting, most illuminating, most glorious – surely never again to set.

*Democratic Vistas*

Democratic Vistas (p. 61)

Walter Scott. London, England. 1888

**Whyte, Lancelot Law** 1896–1972

Scottish physicist

Science starts with an assumption which is always present, though it may be unconscious, may be forgotten, and may sometimes even be denied.

*Accent on Form: An Anticipation of the Science of Tomorrow*

Chapter IV (p. 59)

Harper & Brothers. New York, New York, USA. 1954

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

There is no natural phenomenon that is comparable with the sudden and apparently accidentally timed development of science, except perhaps the condensation of a super-saturated gas or the explosion of some unpredictable explosives. Will the fate of science show some similarity to one of these phenomena?

*Proceedings of the American Philosophical Society*, Volume 94, Number 5, 1950

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

The advantage of the emotions is that they lead us astray, and the advantage of science is that it is not emotional.

*The Picture of Dorian Gray*

Chapter III (p. 59)

Charterhouse Press. New York, New York, USA. 1904

Science can never grapple with the irrational. That is why there is no future before it, in this world.

*The Plays of Oscar Wilde*

*An Ideal Husband*

Act I (p. 9)

The Modern Library. New York, New York, USA. No date

Romance should never begin with sentiment. It should begin with science and end with a settlement.

*An Ideal Husband* (p. 81)

Boni & Liveright. New York, New York, USA. 1919

**Williams, Henry Smith** 1863–1943

No biographical data available

**Williams, Edward Huntington**

...science, as the word is commonly used, implies these things: first, the gathering of knowledge through observation; second, the classification of such knowledge, and through this classification, the elaboration of general ideas or principles.

*A History of Science* (Volume 1)

Chapter I (p. 3)

Harper & Brothers Publishers. New York, New York, USA. 1901

**Wilson, Andrew** 1852–1912

No biographical data available

...science has also its warm, living aspect. The dry facts form, like the skeleton, the mere framework which gives support to the active, pulsating, life-retaining parts of the scientific organism.

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

Science-Culture for the Masses (p. 32)  
Chatto & Windus. London, England. 1879

When, therefore, you think of science, do not picture it to yourself as composed of nothing save the dry-as-dust technicalities of popular notions.... Think of true science as a living reality; as a faithful expounder of all that is worth knowing and that can be known; as an existing power, ever anxious in its unwearied march for the good and welfare of mankind; and best of all, perhaps, as an ever-willing instructor of all who will come to be taught.

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

Science-Culture for the Masses (pp. 34–35)  
Chatto & Windus. London, England. 1879

**Wilson, Edward O.** 1929–

American biologist and author

To a considerable degree science consists in originating the maximum amount of information with the minimum expenditure of energy. Beauty is the cleanness of line in such formulations along with symmetry, surprise, and congruence with other prevailing beliefs.

*Biophilia*

The Poetic Species (p. 60)  
Harvard University Press. Cambridge, Massachusetts. 1984

**Wolpert, Lewis** 1929–

British embryologist

When we come to face the problems before us – poverty, pollution, overpopulation, illness – it is to science that we must turn, not to gurus. The arrogance of scientists is not nearly as dangerous as the arrogance that comes from ignorance.

In Mary Midgley

Can Science Save Its Soul?

*New Scientist*, Volume 135, Number 1832, August 1, 1992 (p. 24)

**Wordsworth, William** 1770–1850

English poet

Science appears but what in truth she is,  
Not as our glory and our absolute boast,  
But as a succedaneum and a prop  
To our infirmity. No officious slave  
Art thou of that false secondary power  
By which we multiply distinctions, then  
Deem that our puny boundaries are things  
That we perceive, and not that we have made.

*The Complete Poetical Works of William Wordsworth*

The Prelude, Book II, l. 212–219

Crowell. New York, New York, USA. 1888

**Wright, Frank Lloyd** 1869–1959

American architect

I have seemed to belittle the nature of our time and the great achievements of science, but I have intended to do neither because I believe human nature still sound, and recognize that science has done a grand job as well; but well I know that Science cannot save us.

An Organic Architecture, Speech

London, England, May, 1939

**Yates, Frances** 1899–1981

English historian

Is not all science a gnosis, an insight into the nature of the All, which proceeds by successive revelations?

*Giordano Bruno and the Hermetic Tradition*

Chapter XXII (p. 452)

The University of Chicago Press. Chicago, Illinois, USA. 1964

**Ziman, John M.** 1925–2005

British physicist

Penicillin is not Science, anymore than a cathedral is Religion or a witness box is Law.

In E.D. Klemke, Robert Hollinger and A. David Kline

*Introductory Readings in the Philosophy of Science*

What Is Science? (p. 36)

Prometheus Books. Buffalo, New York, USA. 1980

In science, to echo Beethoven's dictum about music, "Everything should be both surprising and expected."

*Reliable Knowledge*

Chapter 3 (fn 17, p. 71)

Cambridge University Press. Cambridge, England. 1978

**Zinkernagel, Rolf M.** 1944–

Swiss immunologist and pathologist

...in science there are collectors, classifiers, compulsory tidiers-up and permanent contesters, detectives, some artists and many artisans, there are poet-scientists and philosophers and even a few mystics.

*Les Prix Nobel. The Nobel Prizes in 1996*

Nobel banquet speech for award received in 1996

Nobel Foundation. Stockholm, Sweden. 1997

**Zirkel, Ferdinand** 1838–1912

German geologist

No science can exist wholly for itself alone, exerting neither a passive nor an active influence. Each science must make some use of the results acquired by allied branches of knowledge for the furthering of its own advancement, and again each must contribute from its own results toward the advancement of other sciences.

Translated by Cleveland Abbey, Jr.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*

The Relations Existing Between Petrography and Its Related Sciences (p. 591)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**SCIENCE, ABC OF**

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

**SCIENCE, ABRACADABRA OF**

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

The abracadabra of Science accordingly, like the incantations and jargon of the astrologers and necromancers of the middle ages, fills the uninitiated with reverence and fosters this insensate idolatry.

*The Idolatry of Science*  
Chapter XII (pp. 92–93)  
John Lane Co. London, England. 1920

**SCIENCE, ACADEMY OF**

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

What members of an academy of science have in common is a certain form of semi-parasitic living.

*Voices in the Labyrinth: Nature, Man and Science* (p. 41)  
The Seabury Press. New York, New York, USA. 1977

**SCIENCE, ACCIDENTAL CAUSES OF**

**Wright, Chauncey** 1830–75  
American philosopher of science

The accidental causes of science are only “accidents” relatively to the intelligence of a man.

*The Philosophical Writings of Chauncey Wright*  
The Genesis of Species (p. 37)  
The Liberal Arts Press. New York, New York, USA. 1958

**SCIENCE, ACHIEVEMENT OF**

**Kubie, L. S.**  
No biographical data available

The primary achievement of science is the humility and honesty with which it constantly corrects its own errors. It is this that makes science the greatest of the humanities.

The Fostering of Creative Scientific Productivity  
*Daedalus*, Volume 91, 1962 (p. 305)

**Roosevelt, Franklin Delano** 1882–1945  
32nd president of the USA

The great achievement of science and even of art can be used in one way or another to destroy as well as create; they are only instruments by which men try to do the things they most want to do. If death is desired, science can do that. If a full, rich, and useful life is sought, science can do that also.

Address before the Eighth Pan American Scientific Conference  
Washington, D.C. May 10, 1948

**SCIENCE, ADVANCE OF**

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The greatest advances of science have always consisted in some successful formulation, in clear, abstract, and communicable terms, of what was instinctively known long before and of thus making it the permanent possession of humanity.

Translated by Thomas J. McCormack  
*Popular Scientific Lectures* (2nd edition)  
The Economical Nature of Physics (p. 191)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Pearson, Karl** 1857–1936  
English mathematician

Every great advance of science opens our eyes to facts which we had failed before to observe, and makes new demands on our powers of interpretation.

*The Grammar of Science* (2nd edition)  
Chapter I (p. 14)  
Adam & Charles Black. London, England. 1900

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

The advance of science is not comparable to the changes of a city, where old edifices are pitilessly torn down to give place to new, but to the continuous evolution of zoologic types which develop ceaselessly and end by becoming unrecognizable to the common sight, but where an expert eye finds always traces of the prior work of the centuries past. One must not think then that the old-fashioned theories have been sterile or vain.

Translated by George Bruce Halsted  
*The Value of Science*  
Introduction (p. 14)  
The Science Press. New York, New York, USA. 1907

**Schuster, Sir Arthur** 1851–1934  
English physicist

The advance of science takes place through many channels, and each generation has its own part to play. Particular ideas, particular faculties are wanted at particular times, and no one can foretell where success will be.

The Influence of Mathematics on the Progress of Physics  
*van Nostrand's Engineering Magazine*, Volume XXVI, Number CLX,  
 April, 1882 (p. 318)

**Weld, Charles Richard** 1813–69  
 Historian

The advancement of science ought ever to be the aim of  
 philosophers, independent of all petty jealousies.

*A History of the Royal Society, With Memoirs of the Presidents* Volume 2  
 Chapter VIII (p. 235)  
 John Parker. London, England. 1848

## SCIENCE, ADVANCES IN

**Tait, Peter Guthrie** 1831–1901  
 Scottish physicist and mathematician

In considering what may be designated as ‘Recent  
 Advances in Physical Science,’ it is well to remember  
 that many things which have become almost popularly Si  
 known within the last twenty-five years are much older in  
 the minds and writings of the foremost scientific men.

*Lectures on Some Recent Advances in Physical Science, With a Special  
 Lecture on Force* (3rd edition)  
 Lecture I (p. 1)  
 Macmillan & Co Ltd. London, England. 1885

## SCIENCE, ADVANCEMENT OF

**Conant, James Bryant** 1893–1978  
 American educator and scientist

There is only one proved method of assisting the  
 advancement of pure science – that of picking men of  
 genius, backing them heavily, and leaving them to direct  
 themselves.

Letter  
*New York Times*, August 13, 1945

## SCIENCE, AESTHETICS OF

**Holton, Gerald James** 1922–  
 Research professor of physics and science history

Hence it will be useful to develop a field that can fairly be  
 called the aesthetics of science.

*Thematic Origins of Scientific Thought: Kepler to Einstein*  
 Einstein, Michelson, and the “Crucil” Experiment (p. 326)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1979

## SCIENCE, AGE OF

**Compton, Karl Taylor** 1887–1954  
 American educator and physicist

We live in an age of science. I do not say “an age of  
 technology” for every age has been an age of technology.  
 We recognize this when we describe past civilizations as

the Stone Age, the Bronze Age, and the Age of Steam or  
 of Steel, thus implicitly admitting that the stage of civi-  
 lization is determined by the tools at man’s disposal – in  
 other words, by his technology....

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*  
*During the Years 1930–1949* (p. 1)  
 Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Kronenberger, Louis** 1904–80  
 American author and critic

Nominally a great age of scientific inquiry, ours has actu-  
 ally become an age of superstition about the infallibility  
 of science; of almost mystical faith in its nonmystical  
 methods; above all...of external verities; of traffic-cop  
 morality and rabbit-test truth.

*Company Manners: A Cultural Inquiry into American Life*  
 Chapter 4 (p. 94)  
 The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1954

**Langer, Susanne Katherina Knauth** 1895–1985  
 American philosopher

...it becomes apparent that the age of science has begot-  
 ten a new philosophical issue, inestimably more pro-  
 found than its original empiricism: for in all quietness,  
 along purely rational lines, mathematics has developed  
 just as brilliantly and vitally as any experimental tech-  
 nique, and, step by step, has kept abreast of discovery  
 and observation; and ail at ‘once, the edifice of human  
 knowledge stands before us, not as a vast collection of  
 sense reports, but as a structure of *facts that are symbols*  
*and laws that are their meanings*.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite,  
 and Art*  
 Chapter I (p. 21)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1942

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

To say that we live in an age of science is a common  
 place, but like most common places, it is only partially  
 true. From the point of view of our predecessors, if they  
 could view our society, we should, no doubt, appear to be  
 very scientific, but from the point of view of our succes-  
 sors, it is probable that the exactly opposite would seem  
 to be the cause.

*The Scientific Outlook*  
 Introduction (p. 9)  
 George Allen & Unwin Ltd. London, England. 1931

[T]heoretical science...is an attempt to *understand* the  
 world. Practical science, which is an attempt to *change*  
 the world, has been important from the first, and has  
 continually increased in importance, until it has almost  
 ousted theoretical science from men’s thoughts....

*A History of Western Philosophy*  
 Book Three, Part I, Chapter I (pp. 492–493)  
 Simon & Schuster. New York, New York, USA. 1945

The triumph of science has been mainly due to its practical utility, and there has been an attempt to divorce this aspect from that of theory, thus making science more and more a technique, and less and less a doctrine as to the nature of the world. The penetration of this point of view to philosophers is very recent.

*A History of Western Philosophy*

Book Three, Part I, Chapter I (pp. 492–493)

Simon & Schuster. New York, New York, USA. 1945

## SCIENCE, AIM OF

### Hall, A. D.

No biographical data available

The true aim of science is the enrichment of life.

*Nature*, Volume 138, 1936 (p. 576)

### James, William 1842–1910

American philosopher and psychologist

The aim of “science” is to attain conceptions so adequate and exact that we shall never need to change them.

*The Principles of Psychology*

The Perception of Things (p. 109)

Dover Publications, Inc. New York, New York, USA. 1950

### Laudan, Larry 1945–

American philosopher of science

The aim of science is merely to secure theories with a high problem-solving effectiveness.

*New Scientist*, 1 August, 1892 (p. 26)

### Mellor, Joseph William 1863–1938

Chemist

It is a popular belief that the aim of science is to explain things: as a matter of fact, the so-called explanations of science do not usually get much beyond describing the observed facts in the simplest possible terms so as to make their relations with one another clear and intelligible.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry* (Volume 1)

Chapter I (p. 13)

Longman, Green, & Co. London, England. 1922

### Milne, Edward Arthur 1896–1950

English astrophysicist and cosmologist

The Christmas message – which is also the Christian message – is “*Gloria in excelsis Deo*”...Glory to God in the highest and on earth peace among men of goodwill.... This is not a bad definition of the aim of all true science: the aim of rejoicing in the splendid mysteries of the world and universe we live in, and of attempting so to understand those mysteries that we can improve our command over nature, improve our conditions of life and so ensure peace...

*Modern Cosmology and the Christian Idea of God*

Chapter I (p. 1)

At The Clarendon Press. Oxford, England. 1952

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

...it is the aim of science to find satisfactory explanations, of whatever strikes us as being in need of explanation.

*Objective Knowledge: An Evolutionary Approach*

Chapter 5 (p. 191)

Clarendon Press. Oxford, England. 1972

## SCIENCE, ANTAGONISM OF

### Huxley, Thomas Henry 1825–95

English biologist

Scholarly and pious persons, worthy of all respect, favour us with allocutions upon the sadness of the antagonism of science to their mediaeval way of thinking, which betray an ignorance of the first principles of scientific investigation, an incapacity for understanding what a man of science means by veracity, and an unconsciousness of the weight of established scientific truths, which is almost comical.

*Science and Culture: and Other Essays*

Chapter I (p. 16)

Macmillan & Company Ltd. London, England. 1881

## SCIENCE, APPLICATIONS OF

### Playfair, Lyon 1818–98

Scottish scientist and Parliamentarian

The applications of science are not difficult, but without the science there are no applications.

*Records of the School of Mines and of Science Applied to the Arts*

(Volume 1), Part I

The Study of Abstract Science (p. 29)

Longman, Brown, Green & Longmans. London, England. 1852

## SCIENCE, APPLIED

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

Even when men build any science and theory upon experiment, yet they almost always turn with premature and hasty zeal to practise, not merely on account of the advantage and benefit to be derived from it, but in order to seize upon some security in a new undertaking of their not employing the remainder of their labor unprofitably, and by making themselves conspicuous, to acquire a greater name for their pursuit.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 70 (p. 116)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**Compton, Karl Taylor** 1887–1954  
American educator and physicist

Applied science is not an end in itself, but it is the most powerful means ever discovered for supplying the opportunity to secure the finest things of life.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 9)  
Undergraduate Association, MIT, Cambridge, Massachusetts, USA. 1955

**Einstein, Albert** 1879–1955  
German-born physicist

Why does this magnificent applied science which saves work and makes life easier bring us so little happiness? The simple answer runs: Because we have not yet learned to make sensible use of it.

Einstein Seeks Lack in Applying Science  
*The New York Times*, February 17, 1931 (p. 6)

It is not enough that you should understand about applied science in order that your work may increase man's blessings. Concern for the man himself and his fate must always form the chief interest of all technical endeavors; concern for the great unsolved problems of the organization of labor and the distribution of our mind shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations.

Einstein Seeks Lack in Applying Science  
*The New York Times*, February 17, 1931 (p. 6)

**Huxley, Aldous** 1894–1963  
English writer and critic

Applied Science is a conjurer, whose bottomless hat yields impartially the softest of Angora rabbits and the most petrifying of Medusas.

*Tomorrow and Tomorrow and Tomorrow and Other Essays*  
The Desert (p. 82)  
Harper & Brothers, New York, New York, USA. 1956

**Huxley, Thomas Henry** 1825–95  
English biologist

What people call applied science is nothing but the application of pure science to particular classes of problems.

*Science and Education*  
Chapter VI (p. 137)  
American Home Library Co. New York, New York, USA. 1902

I often wish that this phrase “applied science,” had never been invented. For it suggests that there is a sort of scientific knowledge of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed “pure science.” But there is no more complete fallacy than this.

*Collected Essays* (Volume 3)  
*Science and Education*  
Science and Culture (p. 137)  
Macmillan & Company Ltd. London, England. 1904

**Jevons, Frank Byron** 1858–1936  
No biographical data available

...an applied science does not sit in judgment upon the pure science on which it is based; it accepts the truths which the pure science presents to all the world, and bases itself upon them.

*An Introduction to the Study of Comparative Religion*  
Introduction (p. 2)  
The Macmillan Co. New York, New York, USA. 1908

## National Academy of Sciences (USA)

Applied science is a working bee who builds cells of utility, and in them rears to maturity the larvae hatched from her sister's eggs.

*Biographical Memoirs*  
Biographical Memoir of George Hammell Cook (p. 138)  
National Academy of Sciences (USA). Washington, D.C. 1902

**Pasteur, Louis** 1822–95  
French chemist

There does not exist a category of science to which one can give the name applied science. There are science and the applications of science, bound together as the fruit of the tree which bears it.

*Revue Scientifique*  
Pourquoi la France n'a pas trouvé hommes supérieurs au mont du péril (1871)

**Porter, George** 1920–2002  
English chemist

To feed applied science by starving basic science is like economising on the foundations of a building so that it may be built higher.

Let the Edifice of Science Crumble  
*New Scientist*, Volume 111, Number 1524, September, 1986 (p. 16)

**Ritchie, Arthur David** 1891–1967  
Scottish philosopher and science history writer

The fact that the regions of nature actually covered by known laws are few and fragmentary is concealed by the natural tendency to crowd our experience into those particular regions and to leave the others to themselves. We seek out those parts that are known and familiar and avoid those that are unknown and unfamiliar. This is simply what is called “Applied Science.”

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*  
Chapter VII (p. 201)  
Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

**Wheeler, Edgar C.**  
No biographical data available

...[researchers] cannot remain indefinitely in any field of pure research. For every time they come upon a new bit of knowledge, almost instantly they discover some practical



application. Thus the dividing line between pure science and applied science becomes thin.

Makers of Lightning

*The World's Work*, January, 1927 (p. 271)

## SCIENCE, ARCHES OF

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

There is a chasm between knowledge and ignorance which the arches of science can never span.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimack Rivers*

Sunday (p. 125)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

## SCIENCE, ARMY OF

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Thus along many battle fronts, the army of science advances on the strongholds of ignorance in the heart of earth. Speculations bristle like bayonets and collapse like papier-mâché. But though mistakes retard and darkness confuses, the army presses on.

*Autobiography of Earth*

Chapter VIII (p. 247)

Coward-McCann, Inc. New York, New York, USA. 1935

## SCIENCE, ASPECT OF

**Preston, Thomas** 1860–1900

Irish scientist

In the struggle for place it is not surprising that the nobler aspect of science, as an instrument of education and culture, should be lost sight of in the popular desire for a mere acquaintance with the facts demanded by the exigencies of the moment.

*The Theory of Heat* (2nd edition)

Preface to the First Edition (p. v)

Macmillan & Co Ltd. London, England. 1904

## SCIENCE, AVENUE OF

**Hume, David** 1711–76

Scottish philosopher and historian

The sweetest and most inoffensive path of life leads through the avenues of science and learning; and whoever can either remove any obstructions in this way, or open up any new prospect, ought so far to be esteemed a benefactor to mankind.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Enquiries Concerning the Human Understanding and Concerning the Principles of Morals

Section 1

Of the Different Species of Philosophy (p. 453)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## SCIENCE, AVERSION OF

**Eusebius of Caesarea** ca. 263–ca. 339

Bishop of Caesarea Palaestina

It is not through ignorance of the things admired by them, but through contempt of their useless labour, that we think little of these matters, turning our souls to the exercise of better things.

Quoted in John Tyndall

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)

Lecture I (p. 13)

D. Appleton & Co. New York, New York, USA. 1901

**Lactantius** ca. 240–ca. 320

Christian author

To search for the causes of things; to inquire whether the sun be as large as he seems; whether the moon is convex or concave; whether the stars are fixed in the sky, or float freely in the air; of what size and of what material are the heavens; whether they be at rest or in motion; what is the magnitude of the earth; on what foundations is it suspended or balanced; – to dispute and conjecture upon such matters is just as if we chose to discuss what we think of a city in a remote country, of which we never heard but the name.

Quoted in John Tyndall

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)

Lecture I (p. 13)

D. Appleton & Co. New York, New York, USA. 1901

## SCIENCE, AXIOMS OF

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Science, being the wonder of the ignorant and unskillful, may be not absurdly called a monster. In figure and aspect it is represented as many-shaped, in allusion to the immense variety of matter with which it deals. It is said to have the face and voice of a woman, in respect of its beauty and facility of utterance. Wings are added because the sciences and the discoveries of science appeared and fly-aboard in an instant; the communication of knowledge being like that of one candle with another, which lights up at once. Claws, sharp and hooked, are ascribed to it with great elegance, because the axioms and arguments of science penetrate and hold fast the mind, so that it has no means of evasion or escape.

In Hugh Dick (ed.)

*Selected Writings of Francis Bacon*

Sphinx on Science (pp. 418–419)

Random House, Inc. New York, New York, USA. 1955

**SCIENCE, BEAUTY OF****Gruber, Howard E.** 1922–2005

American psychology scholar and professor

The power and the beauty of science do not rest upon infallibility, which it has not, but on corrigibility, without which it is nothing.

The Origin of “The Origin of Species”

*The New York Times Book Review*, 22 July, 1979 (p. 7)**SCIENCE, BEST****Lynch, Gary**

No biographical data available

What you really need to do the best science is a tremendous tolerance for ambiguity. You have to be able to tolerate ambiguity. Because we as creatures are set up for some reason to see cause-and-effect. And what you really wind up doing is tolerating the fact that you have all these assumptions and all these uncertainties, and living with them. And when you really go into a novel area, what do you have to guide you? The more novel it is, the fewer the constraints. For a human being that is a very uncomfortable feeling.

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*

Mucking Around in the Wetware (pp. 91–92)

Alfred A. Knopf. New York, New York, USA. 1991

**SCIENCE, BIG****Butrica, Andrew J.**

No biographical data available

Defining Big Science is the intellectual equivalent of trying to nail Jell-O to the wall.

*To See the Unseen: A History of Planetary Radar Astronomy*

1996

**SCIENCE, BOUNDARIES OF****Polehampton, Edward**

No biographical data available

As the boundaries of Science extend, the Discoveries and Curiosities it develops extend also...

*The Gallery of Nature and Art; Or, a Tour Through Creation and Science* (Volume 1)

Preface (p. iii)

R. Wilks. London, England. 1815

**SCIENCE, BRANCH OF****Kemp, James Furman** 1859–1926

American geologist

...who will say that any branch of science stands alone, or that one is distinct from all the rest, when year by year the force of the old-time philosophical dictum “all is one” becomes the more apparent.

*Lectures on Science, Philosophy and Art, 1907–1908*

Geology (p. 17)

The Columbia University Press. New York, New York, USA. 1908

**SCIENCE, BUSINESS OF****von Liebig, Justus** 1803–73

German organic chemist

The business of science is to seek for causes, and like a light, to illuminate the surrounding darkness.

In John Blyth

*Letters on Modern Agriculture*

Letter 1 (p. 7)

Walton &amp; Maberly. London, England. 1859

**SCIENCE, CENTRAL TASK OF****Thomas, Lewis** 1913–93

American physician and biologist

The central task of science is to arrive, stage by stage, at a clearer comprehension of nature, but this does not mean, as it is sometimes claimed to mean, a search for mastery over nature.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*

Humanities and Science (p. 153)

Viking Press. New York, New York, USA. 1983

**SCIENCE, CHARACTERISTIC OF****Dublin, Max**

No biographical data available

It is characteristic of science, in its quest for objectivity, to exclude and avoid ethical considerations.

*Futurehype: The Tyranny of Prophecy* (p. 10)

The Viking Press. New York, New York, USA. 1989

**Prescott, William Hickling** 1796–1859

American historian

It is the characteristic of true science, to discern the impassable, but not very obvious, limits which divide the province of reason from that of speculation. Such knowledge comes tardily. How many ages have rolled away in which powers, that, rightly directed, might have revealed the great laws of nature, have been wasted in brilliant, but barren reveries on alchemy and astrology.

*History of the Conquest of Mexico* (Volume 1)

Book I, Chapter IV (p. 102)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1891

## SCIENCE, COMMANDMENTS OF

**Sagan, Carl** 1934–96  
American astronomer and author

One of the great commandments of science is, “Mistrust arguments from authority.”

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 28)  
Random House, Inc. New York, New York, USA. 1995

## SCIENCE, COMMUNICATION OF

**Casimir, Hendrik B. G.** 1909–2000  
Dutch physicist

There exists today a universal language that is spoken and understood almost everywhere: it is Broken English. [It] is used by the waiters in Hawaii, prostitutes in Paris and ambassadors in Washington, by businessmen from Buenos Aires, by scientists at international meetings and by dirty-postcard peddlers in Greece – in short, by honorable people like myself all over the world.

*Haphazard Reality: Half a Century of Science*  
Chapter 4 (p. 122)  
Harper & Row, Publishers. New York, New York, USA. 1983

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

There is no real popularization [of science] possible, only vulgarization that in most instances distorts the discoveries beyond recognition.

Bitter Fruits from the Tree of Knowledge  
*Perspectives in Biology and Medicine*, Volume 16, Summer, 1973 (p. 491)

...Scientists, like little fishes, swim in schools. When we open one of our scientific journals these days, we find a very uneven distribution of topics. Some important fields are almost entirely neglected, others seem to explode into bursts of unbelievable mediocrity. Really valuable contributions in the fields most in vogue at present probably are just as scarce as those dealing with the stepchildren of present-day biochemistry. But not all disciplines make it so easy to call each mush a “homogenate”, each soup a “partially purified extract”, and so to speak – when you have nothing whatever – of a “system.” There is a real danger that our science may suffocate in its own excrements.

*Essays on Nucleic Acids*  
Chapter 10 (p. 162)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1963

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Scientific phrases are used like scientific wheels and piston-rods to make swifter and smoother yet the path of the comfortable.

*Orthodoxy*  
Chapter VIII (p. 230)  
John Lane Company. New York, New York, USA. 1918

**Dancoff, S. M.**  
American physicist

When you set out in a new field and choose a terminology you have the choice of using old, familiar words in new meanings or else you can make up new words for the new meanings. If you use old words you make the theory look homey and inviting, but you run the risk of confusing the issue every time the old word is used. If you use new words you make the thing look excessively highbrow and frighten off any who might be interested.

Does the Neutrino Really Exist?  
*Bulletin of the Atomic Scientists*, Volume 8, Number 5, June, 1952  
(p. 139)

**Dornan, Christopher** 1957–  
American journalism professor

Science is seen as an avenue of access to assured findings, and scientists – in the dissemination of these findings – as the initial sources. The members of the laity are understood purely as recipients of this information. Journalists and public relations personnel are viewed as intermediaries through which the scientific findings filter. The task for science communication is to transmit as much information as possible with maximum fidelity.

Some Problems of Conceptualizing the Issues of “Science and the Media”  
*Critical Studies in Mass Communication*, Volume 7, Number 1, March, 1990 (p. 51)

**Feynman, Richard P.** 1918–88  
American theoretical physicist

We have a habit in writing articles published in scientific journals to make the work as finished as possible, to cover all the tracks, to not worry about the blind alleys or describe how you had the wrong idea first, and so on. So there isn’t any place to publish, in a dignified manner what you actually did in order to do the work....

*Nobel Lectures, Physics 1963–1970*  
Nobel lecture for award received in 1965  
The Development of the Space-Time View of Quantum Electrodynamics (p. 155)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Fischer, Martin H.** 1879–1962  
German-American physician

You must learn to talk clearly. The jargon of scientific terminology which rolls off your tongues is mental garbage.

In Howard Fabing and Ray Marr  
*Fischerisms*  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Gibbs, J. Willard** 1839–1903

American mathematician

...science is, above all, communication.

In H.N. Parton

*Science Is Human*

Science and the Liberal Arts (p. 11)

University of Otago Press. Dunedin, New Zealand. 1972

**Huxley, Thomas Henry** 1825–95

English biologist

...there is assuredly no more effectual method of clearing up one's own mind on any subject than by talking it over so to speak, with men of real power and grasp, who have considered it from a totally different point of view.

*Collected Essays* (Volume 1)*Method and Result*

Animal Automatism (p. 202)

Macmillan &amp; Company Ltd. London, England. 1904

**Large, E. C.**

American author

[I]t was contended that...compartments labeled Chemistry, Mycology, Bacteriology...were never really fish-tanks for myopic specialists to swim about in, but merely convenient departments in one splendid and sunlit edifice of science, separated at the most by glass walls, decorated with the flags of all nations, and provided with innumerable intercommunicating doors. If so many stacks of old scientific papers got piled up on each side of the glass partitions that in the end no one could see through them, that was certainly regrettable; and if some of the doors were locked for periods ranging from a decade to a century, well, that also was a pity – but who wanted to work in a draught?

*The Advance of the Fungi*

Chapter XXIII (p. 317)

Henry Holt &amp; Company. New York, New York, USA. 1940

**Lemke, J.**

No biographical data available

True Dialogue occurs when teachers ask questions to which they do not presume to already know the “correct answer.”

*Talking Science: Language, Learning and Values*

Chapter 3 (p. 55)

Ablex Publishing Corporation. Norwood, New Jersey, USA. 1990

**Loomis, Frederic Brewster** 1873–1937

American geologist

Everyone, who is alert as he wanders about this world, wants to know what he is seeing and what it is all about. Here and there with the aid of capable guides a few have been introduced into the sphere that wide and fascinating knowledge of Nature which has been so rapidly accumulated during this and the latter part of the last century. It is a full treasure house constantly being enriched,

but unfortunately the few who have been initiated have soon acquired technical language and habit, so that their knowledge and new acquisitions are communicated to but a few.

*Field Book of Common Rocks and Minerals*

Preface (p. vii)

**MacDonald, Sharon**

No biographical data available

...science communication involves selection and definition, not just of which “facts” are presented to the public, but of what is to count as science and of what kind of entity or enterprise science is to be. That is, science communicators act as authors of science for the public. They may also, however, by dint of their own institutional status, give implicit stamps of approval or disapproval to particular visions or versions of science. That is, they may act as authors with special authority on science – as authorisers of science.

In Alan Irwin and Brian Wynne (eds.)

*Misunderstanding Science? The Public Reconstruction of Science and Technology*

Authorizing Science: Public Understanding of Science in Museums

(p. 152)

Cambridge University Press. Cambridge, England. 1996

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Science is communicated by instruction, in order that one man may profit by the experience of another and be spared the trouble of accumulating it for himself; and thus, to spare posterity, the experiences of whole generations are stored up in libraries.

*The Science of Mechanics* (5th edition)

Chapter IV, Part IV, Section 1 (p. 578)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Economy of communication and of apprehension is of the very essence of science. Herein lies its pacificatory, its enlightening, its refining element.

*The Science of Mechanics* (5th edition)

Introduction (p. 7)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Michelson, Albert Abraham** 1852–1931

German-American physicist

Science, when it has to communicate the results of its labor, is under the disadvantage that its language is but little understood. Hence it is that circumlocution is inevitable and repetitions are difficult to avoid.

*Light Waves and Their Uses*

Lecture I (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1903

**Moore, John A.**

American writer and professor of genetics and biology

...recall some of the lectures you may have heard recently. Did you always know why the research had been done?

Was it clear what problem was being illuminated by the data presented?

Science as a Way of Knowing  
*American Zoologist*, Volume 24, Number 2, 1984 (p. 471)

### Moravcsik, M. J.

No biographical data available

New theories, when first proposed, may appear on the first page of the *New York Times*, but their demise, a few years later, never makes even page 68.

*Research Policy*, Volume 17, 1988 (p. 293)

### Neal, Patricia 1926–

American actress

Gort, *Klaatu berada niko!*

*The Day the Earth Stood Still*

Film (1951)

### Oppenheimer, James Robert 1904–67

American theoretical physicist

The true responsibility of a scientist, as we all know, is to the integrity and vigor of his science. And because most scientists, like all men of learning, tend in part also to be teachers, they have a responsibility for the communication of the truths they have found. This is at least a collective, if not an individual responsibility. That we should see in this any insurance that the fruits of science will be used for man's benefit, or denied to man when they make for his distress or destruction, would be a tragic naiveté.

*The Open Mind*

Chapter V (p. 91)

Simon & Schuster. New York, New York, USA. 1955

Often the very fact that the words of science are the same as those of our common life and tongues can be more misleading than enlightening, more frustrating to understanding than recognizably technical jargon.

*Science and the Common Understanding*

Chapter 1 (p. 5)

Simon & Schuster. New York, New York, USA. 1954

It is proper to the role of the scientist that he not merely find new truth and communicate it to his fellows, but that he teach, that he try to bring the most honest and intelligible account of new knowledge to all who will try to learn.

*The Open Mind: Lectures*

Prospects in the Arts and Sciences (p. 138)

Simon & Schuster. New York, New York, USA. 1955

### Parton, H. N.

No biographical data available

Scientists have the duty to communicate, firstly with each other, that is with those who are interested in the same or allied problems, and secondly with laymen: by layman I mean anyone not familiar with their special science, for specialization has raised the level of scientific

achievement so much, that chemists, for example, are usually laymen in say, biology; we may hope, intelligent laymen.

*Science Is Human*

Science and the Liberal Arts (p. 12)

University of Otago Press. Dunedin. 1972

Aldous Huxley, in a lecture on his grandfather, said that all communication is literature, and even in scientific writing there is wide room for the exercise of art.

*Science Is Human*

Science and the Liberal Arts (p. 14)

University of Otago Press. Dunedin. 1972

### Pool, Ithiel de Sola 1917–84

No biographical data available

Computing and communication are becoming one...

*Technologies Without Boundaries: On Telecommunications in a Global Age*

Part I, Chapter I (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1990

### Priestley, Joseph 1733–1804

English theologian and scientist

When for the sake of a little more reputation, men can keep brooding over a new fact, in the discovery of which they might, possibly, have very little real merit, till they think they can astonish the world with a system as complete as it is new, and give mankind a high idea of their judgment and penetration; they are justly punished for their ingratitude to the fountain of all knowledge, and for their want of a genuine love of science and of mankind, in finding their boasted discoveries anticipated, and the field of honest fame pre-occupied, by men, who, from a natural ardour of mind engage in philosophical pursuits, with an ingenious simplicity immediately communicate to others whatever occurs to them in their inquiries.

*Experiment and Observations on Different Kinds of Air* (Volume 1)

The Preface (pp. xvii–cviii)

Printed by Thomas Pearson. Birmingham, England. 1740

### Roe, Anne 1904–1991

American psychologist

Nothing in science has any value to society if it is not communicated....

*The Making of a Scientist*

Chapter I (p. 17)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1973

### Schrödinger, Erwin 1887–1961

Austrian theoretical physicist

Bohr's...approach to atomic problems...is really remarkable. He is completely convinced that any understanding in the usual sense of the word is impossible. Therefore the conversation is almost immediately driven into philosophical questions, and soon you no longer know whether



you really take the position he is attacking, or whether you really must attack the position that he is defending.

In W. Moore

*Schrodinger: Life and Thoughts*

Chapter 6, Letter to W. Wein, 1926 (p. 228)

Cambridge University Press. Cambridge, England. 1989

If you cannot – in the long run – tell everyone what you have been doing, your doing has been worthless.

*Science and Humanism: Physics in Our Time*

The Spiritual Bearing of Science on Life (pp. 8–9)

At The University Press. Cambridge, England. 1952

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The present age has a bad habit of being abstruse in the sciences. We remove ourselves from common sense without opening up a higher one; we become transcendent, fantastic, fearful of intuitive perception in the real world, and when we wish to enter the practical realm, or need to, we suddenly turn atomistic and mechanical.

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 308–309)

Suhrkamp. New York, New York, USA. 1988

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Nobody has a right to speak more clearly than he thinks.

*Washingtonian*, Volume 15, Number 143, November, 1979

### **Wiener, Norbert** 1894–1964

American mathematician

[T]he more probable the message, the less information it gives. Clichés, for example, are less illuminating than great poems.

*The Human Use of Human Beings*

Chapter 1 (p. 21)

da Capo Press. New York, New York, USA. 1988

### **Ziman, John M.** 1925–2005

British physicist

The cliché of scientific prose betrays itself “Hence we arrive at the conclusion that....” The audience to which scientific publications are addressed is not passive; by its cheering or booing, its bouquets or brickbats, it actively controls the substance of the communications that it receives.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 1 (p. 9)

Cambridge University Press. Cambridge, England. 1968

It is not enough to observe, experiment, theorize, calculate and communicate; we must also argue, criticize, debate, expound, summarize, and otherwise transform the information that we have obtained individually into reliable, well established, public knowledge.

Information, Communication, Knowledge

*Nature*, Volume 224, Number 5217, October 25, 1969 (p. 324)

## SCIENCE, CONCEPT OF

### **Temple, George Frederick James** 1901–92

English mathematician

...any serious examination of the basic concepts of any science is far more difficult than the elaboration of their ultimate consequences.

*Turning Points in Physics: A Series of Lectures Given at Oxford University in Trinity Term, 1958* (p. 68)

Interscience Publishers. New York, New York, USA. 1959

## SCIENCE, CONDUCT OF

### **Fox, Robin** 1934–

English anthropologist, poet, and essayist

The conduct of science can lead to boring triviality. Even great results can be used to evil ends.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 329)

New York Academy of Sciences. New York, New York, USA. 1996

## SCIENCE, CREATIVE

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Creative science is always a mixture of facts and ideas. Great thinkers are not those who can free their minds from cultural baggage and think or observe objectively (for such a thing is impossible), but people who use their milieu creatively rather than as a constraint.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 6 (p. 103)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

## SCIENCE, CREED

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Science corrects the old creeds....

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

*Letters and Social Aims*

Chapter VII (p. 228)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Hall, Asaph** 1829–1907

American astronomer

The scientific creed is constantly growing and expanding, and we have no fears, but rejoice at its growth. We need no consistency of bishops, no synod of ministers, to tell us what to believe. Everything is open to investigation and criticism.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (pp. 30–31)

Macmillan & Company Ltd. London, England. 1918



**Huxley, Thomas Henry** 1825–95  
English biologist

...science...commits suicide when it adopts a creed.

*Collected Essays* (Volume 2)

*Darwiniana*

The Darwin Memorial (p. 252)

Macmillan & Company Ltd. London, England. 1904

**LeShan, Lawrence**  
No biographical data available

**Margenau, Henry** 1901–97  
American physicist

1. We believe that the search for truth is a never-ending quest; yet we pledge ourselves to seek it.
2. We will not recognize or accept any kind of truth that pretends to be ultimate or absolute. We will consider and weigh all claims as provisional conclusions. If examination shows them to be stop signs on the road of inquiry, we will ignore them; if they are signposts, we will note them and move on.
3. We recognize no subjects and no facts that are alleged to be forever closed to inquiry or understanding; for science, every mystery is but a challenge.
4. We believe that new principles of understanding are constantly created through the efforts of man, and that a philosophy which sees the answers to all questions already implied in what is now called science is presumptuous and contrary to the spirit of science.
5. We are confident that scientific illumination can be made to penetrate not only the realms now affirmed as scientific, but also the shadowy regions that surround human consciousness, the essence of the mind, including features that are still obscure or occult and mysterious.

*Einstein's Space and van Gogh's Sky*

Chapter 4 (pp. 70–71)

The Macmillan Company. New York, New York, USA. 1982

## SCIENCE, DEFENDERS OF

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

The most heated defenders of a science, who cannot endure the slightest sneer at it, are commonly those who have not made very much progress in it and are secretly aware of this defect.

Translated by R.J. Hollingdale

*Aphorisms*

Notebook F, aphorism 8

Penguin Classics. New York, New York, USA. 1990

## SCIENCE, DEFINITION OF

**Weil, Simone** 1909–43  
French philosopher and mystic

The true definition of science is this: the study of the beauty of the world.

Translated by Arthur Wills

*The Need for Roots: Prelude to a Declaration of Duties Toward Mankind* Part III (p. 261)

The Beacon Press. Boston, Massachusetts, USA. 1952

## SCIENCE, DEVELOPMENT OF

**Feynman, Richard P.** 1918–88  
American theoretical physicist

The rate of the development of science is not the rate at which you make observations alone but, much more important, the rate at which you create new things to test.

*The Meaning of It All*

Chapter I (p. 27)

Perseus Books. Reading, Massachusetts, USA. 1998

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

They that know the entire course of the development of science, will, as a matter of course, judge more freely and more correctly of the significance of any present scientific movement than they, who limited in their views to the age in which their own lives have been spent, contemplate merely the momentary trend that the course of intellectual events takes at the present moment.

Translated by Thomas J. McCormack

*The Science of Mechanics: A Critical and Historical Account of Its Development*

Introduction (p. 7)

The Open Court Publishing Co. Chicago, Illinois, USA. 1919

...the entire course of the development of science will, as a matter of course, judge more freely and more correctly of the significance of any present scientific movement than they who, limited in their views to the age in which their own lives have been spent, contemplate merely the momentary trend that the course of intellectual events takes at the present moment.

*The Science of Mechanics* (5th edition)

Introduction (p. 8)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

There is no natural phenomenon that is comparable with the sudden and apparently accidentally timed development of science, except perhaps the condensation of a super-saturated gas or the explosion of some unpredictable explosives.

The Limits of Science  
*Proceedings, American Philosophical Society*, Volume 94, Number 5,  
 October 19, 1950 (p. 422)

## SCIENCE, DEVOTION TO

**Spencer, Herbert** 1820–1903  
 English social philosopher

Devotion to science is a tacit worship – a tacit recognition of worth in the things one studies; and by implication in their cause. It is not a mere lip-homage, but a homage expressed in actions – not a mere professed respect, but a respect proved by the sacrifice of time, thought, and labour.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
 Chapter III (p. 41)  
 Macmillan & Company Ltd. London, England. 1918

## SCIENCE, DISCOVERIES OF

**Gould, Stephen Jay** 1941–2002  
 American paleontologist and evolutionary biologist

No factual discovery of science (statements about how nature “is”) can, in principle, lead us to ethical conclusions (how we “ought” to behave) or to convictions about intrinsic meaning (the “purpose” of our lives).

Dorothy, It’s Really Oz  
*Time*, August 23, 1999 (p. 59)

**Bronowski, Jacob** 1908–74  
 Polish-born British mathematician and polymath

The discoveries of Science, the works of art are explorations – more, are explosions, of a hidden likeness.

*Science and Human Values*  
 The Creative Mind (p. 19)  
 Harper & Row, Publishers. New York, New York, USA. 1965

## SCIENCE, DIVISION OF

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

The divisions of the sciences are not like different lines that meet in one angle, but rather like the branches of trees that join in one trunk.

In J.A. Thomson  
*Introduction to Science*  
 Chapter IV (p. 92)  
 Williams & Norgate Ltd. London, England. 1916

## SCIENCE, DOMAIN OF

**Marsh, Othniel Charles** 1831–99  
 American paleontologist

It is certainly within the domain of science to determine when the earth was first fitted to receive life, and in what form the earliest life began. To trace that life in its manifold changes through past ages to the present is a more difficult task, but one from which modern science does not shrink.

*Introduction and Succession of Vertebrate Life in America*  
 Introduction (p. 3)  
 Tuttle, Morehouse & Taylor, Printers. New Haven, Connecticut, USA. 1877

## SCIENCE, DUTY OF

**Lapworth, Charles** 1842–1920  
 English Geologist

It is true that the first duty of every science is to move incessantly forward from discovery to discovery along the straight path of unremitting investigation and research, following truth whithersoever it may lead, wholly unbiased by the question as to whether that discovery bears any relation whatever to the material wants of mankind.

The Relations of Geology  
*Scottish Geographical Magazine*, Volume XIX, Number 8, August,  
 1902 (p. 406)

## SCIENCE, EDIFICE OF

**Mendeleyev, Dmitry Ivanovich** 1834–1907  
 Russian chemist

The edifice of science not only requires material, but also a plan, and necessitates the work of preparing the materials, putting them together, working out the plans and the symmetrical proportions of the various parts. To conceive, understand, and grasp the whole symmetry of the scientific edifice, including its unfinished portions, is equivalent to tasting that enjoyment only conveyed by the highest forms of beauty and truth. Without the material, the plan alone is but a castle in the air – a mere possibility; whilst the material without a plan is but useless matter.

Translated by George Kamensky  
 In Thomas Atkinson Lawson  
*The Principles of Chemistry* (Volume 1)  
 Author’s Preface (p. ix)  
 Longmans, Green & Co. London, England. 1891

Free access to the edifice of science is not only allowed to those who devised the plan, worked out the detailed drawings, prepared the materials, or piled up the brickwork, but also to all those who are desirous of making a close acquaintance with the plan, and wish to avoid dwelling in the vaults or in the garrets where the useless lumber is stored.

Translated by George Kamensky  
 In Thomas Atkinson Lawson  
*The Principles of Chemistry* (Volume 1)  
 Author’s Preface (p. ix)  
 Longmans, Green & Co. London, England. 1891

**SCIENCE, EEL OF**

**Pope, Alexander** 1688–1744  
English poet

How Index-learning turns no student pale,

Yet holds the eel of science by the tail...

*The Complete Poetical Works* (Volume 4)

Duncaid, Book 1, l. 279–80

Houghton Mifflin Company. New York, New York, USA. 1903

**SCIENCE, ENEMY OF**

**Gladstone, William Ewart** 1809–98  
British Liberal Party statesman

To treat a man as the enemy of Science is to treat him as the enemy of Truth.

*Correspondence on Church and Religion of William Ewart Gladstone* (Volume 2)

Letter 274 (p. 98)

The Macmillan Co. New York, New York, USA. 1910

**Morley, John** 1838–1923  
British Liberal statesman

The worst enemy of science is also the bitterest enemy of democracy, *cest le clericalisme*. The interests of science and the interests of democracy are one.

Sir H. Maine on Popular Government

*The Eclectic Magazine of Foreign Literature, Science, and Art*, Volume 43, April, 1886 (p. 567)

**SCIENCE, ENGLISH**

**King, Thomas Starr** 1824–64  
American Unitarian clergyman

The triumphs of English science over nature, the hiss of her engines, the whirl of her wheels, the roar of her factory drums, the crackle of her furnaces, the beat of her hammers, the vast and chronic toil that mines her treasures, affect him with no wonder and arouse no exultant thrill of partnership.

*Substance and Show, and Other Lectures*

On the Privilege and Duties of Patriotism (p. 395)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1879

**SCIENCE, ESSENCE OF**

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

[This] is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer.

*The Ascent of Man*

Chapter 4 (p. 153)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**SCIENCE, EVOLUTION OF**

**Roberts, Sir William**

The evolution of science differs fundamentally from that of literature and the fine arts. Science advances by a succession of discoveries. Each discovery constitutes a permanent addition to natural knowledge – and furnishes a post of vantage for, and a suggestion to, further discoveries. This mode of advance has no assignable limits; for the phenomena of nature – the material upon which science works – are practically infinite in extent and complexity.

*Science An Modern Civilization*

*Nature*, Volume 56, Number 1461, October 28, 1897

**SCIENCE, EXACT**

**Planck, Max** 1858–1947  
German physicist

Exact science – what wealth of connotation these two words have! They conjure up a vision of a lofty structure, of imperishable slabs of stone firmly joined together, treasure-house of all wisdom, symbol and promise of the coveted goal for a human race thirsting for knowledge, longing for the final revelation of truth.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science (p. 80)

Philosophical Library. New York, New York, USA. 1949

The roots of exact science feed in the soil of human life.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part IV (p. 112)

Philosophical Library. New York, New York, USA. 1949

**Teller, Edward** 1908–2003  
Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

If there ever was a misnomer, it is “exact science.” Science has always been full of mistakes. The present day is no exception. And our mistakes are good mistakes; they require a genius to correct them. Of course, we do not see our own mistakes.

*Conversations on the Dark Secrets of Physics*

Chapter 3 (p. 37)

Plenum Press. New York, New York, USA. 1991

**SCIENCE, FACTUAL BURDEN OF**

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

...the factual burden of a science varies inversely with its degree of maturity. As a science advances, particular facts are comprehended within, and therefore in a sense

annihilated by, general statements of steadily increasing explanatory powers and compass. In all sciences we are being progressively relieved of the burden of singular instances, the tyranny of the particular. We need no longer record the fall of every apple.

*The Art of the Soluble*

Two Conceptions of Science (p. 114)

Methuen & Company Ltd. London, England. 1967

## SCIENCE, FIELD OF

**Carus, Paul** 1852–1919

American philosopher

The field of science, however, is large, for it is nothing less than the whole world, the infinite universe in which we live; and the experiences which we make by studying the various phenomena of our surroundings are illimitable and inexhaustible.

Is All Science One?

*The Chautauquan: Organ of the Chautauqua Literary and Scientific Circle*, Volume XIX, Number 3, June, 1894 (p. 279)

**Dalton, John** 1766–1844

English chemist and physicist

The field of science is large; it is, therefore, impossible for any individual to cultivate the whole.

*John Dalton and the Rise of Modern Chemistry*

Chapter VIII (p. 167)

Macmillan & Co. New York, New York, USA. 1895

**Pearson, Karl** 1857–1936

English mathematician

The field of science is unlimited; its material is endless, every group of natural phenomena, every phase of social life, every stage of past or present development is material for science.

*The Grammar of Science* (2nd edition)

Chapter I (p. 12)

Adam & Charles Black. London, England. 1900

**Richardson, Samuel** 1689–1761

English novelist

Vast is the field of Science. The more a man knows, the more he will find he has to know.

*Sir Charles Grandison* (Volume 1)

Letter 11

Oxford University Press, Inc. Oxford, England. 1972

**Whately, Richard** 1787–1863

English theologian

The field of science may be compared to an American forest, in which the more trees a man cuts down, the greater is the expanse of wood he sees around him.

*Thoughts and Apothegms*

Section VI (p. 166)

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1856

## SCIENCE, FIRE OF

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

In the fires of science, burning with increasing heat every year, all the most dearly loved conventions are being melted down; and this is a process which is going continually to spread. In view of the inventions and discoveries which are being made for us, one might almost say every month, a unified direction of the war efforts of the three services would be highly beneficial.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Speech, Commons, March 21, 1934 (p. 327)

George Allen & Unwin Ltd. London, England. 1956

## SCIENCE, FIRST POSTULATE OF

**Temple, Frederick** 1821–1902

Anglican prelate and archbishop of Canterbury

The regularity of nature is the first postulate of Science; but it requires the very slightest observation to show us that, along with this regularity, there exists a vast irregularity which Science can only deal with by exclusion from its province.

*The Relations Between Religion and Science* (p. 99)

Macmillan & Company. New York, New York, USA. 1884

## SCIENCE, FOUNDATION OF

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

Thinking men are profoundly interested in the question whether critical inspection today shows that the foundation stones of the intellectual structures thus far built are solid in substance and essence – though quite certainly affected by infelicities in selection, cutting, trimming and fitting – or whether such inspection shows that flaws and fissures seriously weaken the foundation stones and require their replacement before any higher superstructures are built upon them.

In Charles Lane Poor

*Gravitation Versus Relativity: A Non-technical Explanation of the Fundamental Principles of Gravitational Astronomy and a Critical Examination of the Astronomical Evidence Cited as Proof of the Generalized Theory of Relativity*

A Preliminary Essay (p. x)

Putnam's Sons. New York, New York, USA. 1922

## SCIENCE, FRAGMENTATION OF

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

**Hoyle, Geoffrey** 1942–  
English science fiction writer

The fragmentation of science is a source of difficulty to all teachers and to all students – the connection of one research area to another is not always apparent. This is because science is rather like a vast and subtle jig-saw puzzle, and the usual way to attack a jig-saw puzzle is to work simultaneously on several parts of it. Only at the end do we seek to fit the different parts of it together into a coherent whole.

In Eugene H. Kone and Helene J. Jordan (eds.)  
*The Greatest Adventure: Basic Research that Shapes Our Lives*  
Cosmology and Its Relation to the Earth (p. 22)  
Rockefeller University Press. New York, New York, USA. 1974

## SCIENCE, FREEDOM OF

**Ravetz, J. R.**  
No biographical data available

The obsolescence of the conception of science as the pursuit of truth results from several changes in the social activity of science. First, the heavy warfare with “theology and metaphysics” is over. Although a few sharp skirmishes still occur, the attacks on the freedom of science from this quarter are no longer significant. This is not so much because of the undoubted victory of science over its ancient contenders as for the deeper reason that the conclusions of natural science are no longer ideologically sensitive. What people, either the masses or the educated, believe about the inanimate universe or the biological aspects of humanity is not relevant to the stability of society as it was once thought to be.

*Scientific Knowledge and Its Social Problems*  
Chapter I (pp. 200–201)  
Clarendon Press. Oxford, England. 1971

## SCIENCE, FRONTIER OF

**Gray, George W.**  
Freelance science writer

The frontiers of science are man’s frontiers. They are his hard-won outposts against the darkness. And that darkness, the ignorance of the mysterious universe of things which surrounds us and of the equally mysterious universe of consciousness which pervades us, is the enemy, the only ultimate enemy.

*The Advancing Front of Science*  
Prologue (p. 6)  
McGraw-Hill Book Co., Inc. New York, New York, USA. 1937

## SCIENCE, FUNCTION OF

**Cossons, Sir Neil** 1939–  
Chairman of English Heritage

Science’s function is to describe how things work, not what they mean. That is a role for philosophers, artists, and writers.

*Lancet*, Volume 339, 1992

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The function of science, as we take it, is to replace experience. Thus, on the one hand, science must remain in the province of experience, but, on the other, must hasten beyond it, constantly expecting confirmation, constantly expecting the reverse. Where neither confirmation nor refutation is possible, science is not concerned...

*The Science of Mechanics* (5th edition)  
Chapter IV, Part IV, Section 7 (p. 587)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Tyndall, John** 1820–93  
Irish-born English physicist

It is the function of science, not as some think to divest this universe of its wonder and its mystery, but, as in the case here before us, to point out the wonder and the mystery of common things.

*Fragments of Science for Unscientific People*  
Chapter IV (p. 84)  
D. Appleton & Co. New York, New York, USA. 1875

## SCIENCE, GLORY OF

**Teall, J. J. Harris** 1849–1924  
British geologist

The chief glory of science is, not that it produces an amelioration of the conditions under which we live, but that it continually enlarges our view, introduces new ideas, new ways of looking at things, and thus contributes in no small degree to the intellectual development of the human race.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*  
The Evolution of Petrological Ideas (p. 288)  
Government Printing Office. Washington, D.C. 1903

## SCIENCE, GOAL OF

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...the real and legitimate goal of the sciences is the endowment of human life with new inventions and riches.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 81 (p. 120)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearson, Karl** 1857–1936  
English mathematician

Great as the advance of scientific knowledge has been, it has not been greater than the growth of the material to

be dealt with. The goal of science is clear – it is nothing short of the complete interpretation of the universe. But the goal is an ideal one – it marks the direction in which we move and strive, but never a stage we shall actually reach.

*The Grammar of Science* (2nd edition)

Chapter I (p. 14)

Adam & Charles Black. London, England. 1900

**Ziman, John M.** 1925–2005

English physicist

...he goal of science is a consensus of rational opinion over the widest possible field.

*Reliable Knowledge: An Exploration of the Grounds for Belief in Science*

Chapter 1 (p. 3)

Canto. 1991

## SCIENCE, GOD OF

**King, Jr., Martin Luther** 1929–68

American civil rights leader and clergyman

We have genuflected before the god of science only to find that it has given us the atomic bomb, producing fears and anxieties that science can never mitigate.

*Strength to Love*

Chapter XIII (p. 106)

Harper & Row, Publishers. New York, New York, USA. 1963

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

The God of Science speaks in the thunder and smiles in the sunshine. He is so great that the stars eddy round his feet not ankle-high, yet so loving that He makes roses and sunsets for the human heart.

*Science, Matter and Immortality*

Chapter XVII (p. 207)

William & Norgate. London, England. 1909

## SCIENCE, GOLDEN AGE OF

**Iles, George**

No biographical data available

This is the golden age of science, a time of creative energy, broadening horizons, new revolutionary truth – an age which the race for centuries to come will esteem great and memorable as the epochs of Pericles, Augustus or Elizabeth.

In Richard Anthony Proctor

*The Skies and the Earth*

General Introduction (p. v)

Doubleday, Page & Co. New York, New York, USA. 1902

## SCIENCE, GOOD

**Watson, James D.** 1928–

American geneticist and biophysicist

...good science as a way of life is sometimes difficult. It often is hard to have confidence that you really know where the future lies. We must thus believe strongly in our ideas, often to point where they may seem tiresome and bothersome and even arrogant to our colleagues.

*Les Prix Nobel. The Nobel Prizes in 1962*

Nobel banquet speech for award received in 1962

Nobel Foundation. Stockholm, Sweden. 1963

## SCIENCE, GROWTH OF

**Pearson, Karl** 1857–1936

English mathematician

There are periods in the growth of science when it is well to turn our attention from its imposing superstructure and to carefully examine its foundations.

*The Grammar of Science* (2nd edition)

Preface to the First Edition (p. ix)

Adam & Charles Black. London, England. 1900

**Tatishchev, Vasilii Nikitich** 1686–1750

Russian historian and geographer

Freedom is not an essential and basic condition for the growth of science; the care and diligence of government authorities are the most important conditions for this development.

USA

*OMNI Magazine*, Volume 3, Number 1, October, 1980 (p. 41)

**Young, Charles Augustus** 1834–1908

American astronomer

...the growth of science is, on the whole, an orderly evolution. The germs of the future are now present in various stages of development, and many of them so far advanced that we can already form some idea of what the product is to be.

In George Isles

*The Skies and the Earth*

The Astronomical Outlook (p. 53)

Doubleday, Page & Co. New York, New York, USA. 1902

## SCIENCE, HALL OF

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Look in [ the hall of science] with me, then, while I attempt to throw some rays into its interior, which shall illuminate a few of its pillars and cornices, and show at the same time how many niches and alcoves remain in darkness.

*The Writings of Oliver Wendell Holmes* (Volume 9)

*Medical Essays: 1842–1882*

Chapter IV (p. 211)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911



## SCIENCE, HEALTHY

**Keller, Evelyn Fox** 1936–  
American scientist

A healthy science is one that allows for the productive survival of diverse conceptions of mind and nature and correspondingly diverse strategies.

*Reflections on Gender and Science*

Epilogue (p. 178)

Yale University Press. New Haven, Connecticut, USA. 1985

## SCIENCE, HEART OF

**Sagan, Carl** 1934–96  
American astronomer and author

At the heart of science is an essential tension between two seemingly contradictory attitudes – an openness to new ideas, no matter how bizarre or counterintuitive they may be, and the most ruthless skeptical scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense.

*The Demon-haunted World*

Chapter 17 (p. 304)

## SCIENCE, HEIGHT OF

**Young, Charles Augustus** 1834–1908  
American astronomer

...the heights of science are not, like earthly mountaintops, barren and icy, but clothed with verdure and bathed in the light of heaven, where one breathes untainted air and enjoys most glorious prospects.

In Richard Anthony Proctor

*The Skies and the Earth*

The Astronomical Outlook (p. 55)

Doubleday, Page & Co. New York, New York, USA. 1902

## SCIENCE, HISTORY OF

**Appleton, Sir Edward** 1892–1965  
English physicist

...the history of science has proved that fundamental research is the lifeblood of individual progress and that the ideas which lead to spectacular advances spring from it.

In J. Edwin Holmstrom

*Records and Research in Engineering and Industrial Science*

Chapter One (p. 7)

Chapman & Hall. London, England. 1956

**Asimov, Isaac** 1920–92  
American author and biochemist

A number of years ago, when I was a freshly-appointed instructor, I met, for the first time, a certain eminent historian of science. At the time I could only regard him with tolerant condescension. I was sorry for a man who,

it seemed to me, was forced to hover about the edges of science.... In a lifetime of being wrong at many a point, I was never more wrong. It was I, not he, who was wandering in the periphery. It was he, not I, who lived in the blaze. I had fallen victim to the fallacy of the “growing edge”; the belief that only the very frontier of scientific advance counted; that everything that had been left behind by that advance was faded and dead.

*Adding a Dimension*

Introduction (p. 7)

Lancer Books. New York, New York, USA. 1969

## Author undetermined

As science advances we are rather apt to forget that what to us are mere elementary, and apparently self-evident truths, were at one time original and great discoveries. So the services of our predecessors are not unfrequently too much underrated, and the truth of the old maxim that “familiarity breeds contempt” is proved in a new way. It seems, therefore, a good thing now and then to consider how large a debt we really do owe to those who have gone before us; often men who with imperfect aids have indicated the clue to some of nature’s mysteries, which a more perfect knowledge of natural laws now enables us firmly to grasp.

Sir Charles Lyell and *Modern Geology*

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

*Industrial Arts, Manufactures, and Technology*, Volume 4, Number 13, January, 1867 (p. 7)

**Bernal, John Desmond** 1901–71  
Irish-born physicist and X-ray crystallographer

The whole history of modern science, has been that of a struggle between ideas derived from observation and practice, and pre-conceptions derived from religious training. It was not...that Science had to fight an external enemy, the Church; it was that the Church itself – its dogmas, its whole way of conceiving the universe – was within the scientists themselves.... After Newton, God ruled the visible world by means of Immutable Laws of Nature, set in action by one creative impulse, but He ruled the moral world by means of absolute intimations of moral sanctions, implanted in each individual soul, reinforced and illuminated by Revelation and the Church....

In W.H. Waddington

*Science and Ethics*

A Marxist Critique (pp. 115–116)

George Allen & Unwin Ltd. London, England. 1942

The role of God in the material world has been reduced stage by stage with the advance of Science, so much so that He only survives in the vaguest mathematical form in the minds of older physicists and biologists.

In W.H. Waddington

*Science and Ethics*

A Marxist Critique (pp. 115–116)

George Allen & Unwin Ltd. London, England. 1942

**Boutroux, Émile** 1845–1921  
French philosopher

The history of science proves that we are right in affirming a continuity between what we know and what we do not know. That is why the expression “scientifically inexplicable,” is, henceforward, devoid of meaning. A mysterious force, a miraculous fact, when we admit that the fact exists, is nothing else than a phenomenon which we do not succeed in explaining by the aid of laws that we know. If this impossibility is averred, science will be rid of it in order to seek other laws.

Translated by Jonathan Nield

*Science & Religion in Contemporary Philosophy*

Part II, chapter III (pp. 358–359)

The Macmillan Co. New York, New York, USA. 1911

**Butterfield, Herbert** 1900–79  
English historian and philosopher of history

The greatest obstacle to the understanding of the history of science is our inability to unload our minds of modern views about the nature of the universe.

*The History of Science, Origins and Results of the Scientific Revolution: A Symposium*

Dante's View of the Universe (p. 15)

Free Press. Glencoe, Illinois, USA. 1953

One of the safest speculations that we could make...[is] that very soon the history of science is going to acquire an importance...incommensurate with anything that it has hitherto possessed. It...is no longer merely an account of one of many human activities like the history of music or...of cricket.... Because it deals with one of the main constituents of the modern world and the modern mind, we cannot construct a respectable history of Europe or a tolerable survey of western civilization without it. It is going to be as important for us for the understanding of ourselves as Graeco-Roman antiquity was for Europe during a period of over a thousand years.

The History of Science and the Study of History

*Harvard Library Bulletin*, Volume 13, 1959 (pp. 330–331)

Free Press. Glencoe, Illinois, USA. 1953

[The scientific revolution] outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to the ranks of mere episodes, mere internal displacements, within the system of medieval Christendom...it looms so large as the real origin of the modern world and the modern mentality that our customary periodization of European history has become an anachronism and an encumbrance.

*The Origins of Modern Science*

Introduction (pp. vii–viii)

The Macmillan Company. New York, New York, USA. 1961

**Calder, Ritchie** 1906–82  
Scottish author, journalist, and academic

The history of science is not a spoil heap of accidental discoveries and random ideas. Rather it is like an archae-

ological dig in which a potsherd is meaningful in terms of the chronological layer in which it is found; i.e., of the culture in which it has its origins.

*Man and the Cosmos: The Nature of Science Today*

Chapter II (p. 17)

Frederick A. Praeger, Publishers. New York, New York, USA. 1968

**Chamberlain, Owen** 1920–2006  
American physicist

The most that any scientist can ask is that he help to lay a few stones of a partially-built edifice that we call scientific knowledge. To him this edifice is a beautiful structure, although it will never be finished.

*Les Prix Nobel. the Nobel Prizes in 1959*

Nobel banquet speech for award received in 1959

Nobel Foundation. Stockholm, Sweden. 1960

**Cohen, I. Bernard** 1914–2003  
American physicist and science historian

History with the history of science, to alter slightly an apothegm of Lord Bacon, resembles a statue of Polyphemus without his eye – that very feature being left out which most marks the spirit and life of the person. My own thesis is complementary: science taught...without a sense of history is robbed of those very qualities that make it worth teaching to the student of the humanities and the social sciences.

In I. Bernard Cohen and Fletcher G. Watson (eds.)

*General Education in Science* (p. 71)

The History of Science and the Teaching of Science (p. 71)

Harvard University Press. Cambridge, Massachusetts, USA. 1952

**Comte, Auguste** 1798–1857  
French philosopher

...no science can be really understood apart from its special history, which again cannot be separated from the general history of Humanity.

Translated by John Henry Bridges, Frederic Harrison, Richard Congreve and Henry Dix Hutton

*System of Positive Polity*

General Introduction (p. 1)

Longmans, Green & Co. London, England. 1876

**Conant, James Bryant** 1893–1978  
American educator and scientist

We can put it down as one of the principles learned from the history of science that a theory is only overthrown by a better theory, never merely by contradictory facts.

*On Understanding Science*

Chapter II (p. 36)

Yale University Press. New Haven, Connecticut, USA. 1947

The history of science demonstrates beyond doubt that the really revolutionary and significant advances come not from empiricism but from new theories.

*Modern Science and Modern Man*

Science and Technology (p. 30)

Columbia University Press. New York, New York, USA. 1952

**Creighton, James Edwin** 1861–1924  
Canadian philosopher

The history of science shows that great discoveries are made by means of imaginative insight, but it also teaches that mere imagination without dependence upon known facts is frequently a source of much mischief.

*An Introductory Logic*

Part II, Chapter XVIII (p. 236)

The Macmillan Co. New York, New York, USA. 1902

**Darwin, Charles Robert** 1809–82  
English naturalist

Great is the power of steady misrepresentation – but the history of science shows how, fortunately, this power does not long endure.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XV (p. 239)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Draper, John William** 1811–82  
American scientist, philosopher, and historian

The history of science is not a mere record of isolated discoveries; it is a narrative of the conflict of two contending powers, the expansive force of the human intellect on one side, and the compression arising from traditionary faith and human interest on the other.

*History of the Conflict Between Religion and Science*

Preface (p. vi)

D. Appleton and Company. New York, New York, USA. 1898

**Duhem, Pierre-Maurice-Marie** 1861–1916  
French physicist and mathematician

...the history of science alone can keep the physicist from the mad ambitions of dogmatism as well as the despair of Pyrrhonian skepticism.

*The Aim and Structure of Physical Theory*

Part II, Chapter VII (p. 270)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

The history of science, after all, does not just consist of facts and conclusions drawn from facts. It also contains ideas, interpretations of facts, problems created by conflicting interpretations, mistakes, and so on. On closer analysis we even find that science knows no “bare facts” at all but that the “facts” that enter our knowledge are already viewed in a certain way and are, therefore, essentially ideational.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Introduction (p. 19)

Verso. London, England. 1978

...the history of science will be as complex, chaotic, full of mistakes, and entertaining as the ideas it contains, and these ideas in turn will be as complex, chaotic, full of mistakes, and entertaining as are the minds of those who invented them.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Introduction (p. 19)

Verso. London, England. 1978

**Fink, Karl** 1851–98  
Mathematician

If the history of a science possesses value for everyone whom calling or inclination brings into closer relations to it, – if the knowledge of this history is imperative for all who have influence in the further development of scientific principles or the methods of employing them to advantage, then acquaintance with the rise and growth of a branch of science is especially important to the man who wishes to teach the elements of this science or to penetrate as a student into its higher realms.

Translated by David Eugene Smith

*A Brief History of Mathematics* (2nd edition)

Preface (p. v)

The Open Court Publishing Co. Chicago, Illinois, USA. 1903

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

More attention to the History of Science is needed, as much by scientists as by historians, and especially by biologists, and this should mean a deliberate attempt to understand the thoughts of the great masters of the past, to see in what circumstances or intellectual milieu their ideas were formed, where they took the wrong turning or stopped short on the right track.

Natural Selection from the Genetical Standpoint

*Australian Journal of Science*, Volume 22, 1959

**Foster, Sir Michael** 1836–1907  
English physiologist and educator

When we look into the past of science and trace our the first buddings of what afterwards grow to be umbrageous branches, it sometimes seems as if every time, and almost every year, marked an epoch.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1898

Recent Advances in Science, and Their Bearing on Medicine and Surgery (p. 345)

Government Printing Office. Washington, D.C. 1899

It is one of the lessons of the history of science that each age steps on the shoulders of the ages which have gone before.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 5 (p. 51)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Geikie, Sir Archibald** 1835–1924  
English geologist

In science, as in all other departments of inquiry, no thorough grasp of a subject can be gained, unless the history of its development is clearly appreciated. Nevertheless, students of Nature, While eagerly pressing forward in the search after her secrets, are apt to keep the eye to constantly fixed on the way that has to be travelled, and to lose sight and remembrance of the paths already trodden.

*The Founders of Geology* (2nd edition)  
Chapter I (p. 1)  
Macmillan & Co Ltd. London, England. 1905

...by enabling them [researchers] to comprehend how, foot by foot, the realms of science have been painfully conquered, it [history] furnishes suggestive lessons as to tracks that should be avoided, and fields that may hopefully be entered.

*The Founders of Geology* (2nd edition)  
Chapter I (p. 2)  
Macmillan & Co Ltd. London, England. 1905

**Gray, George W.**  
Freelance science writer

In the history of science, as in that of nations, are epochs and cycles. There are periods of plodding, periods of meteoric advance, periods of pause and consolidation. Today we are in the current of a very rapid advance. And although no mind is wise enough and no imagination penetrating enough to stake out the limits of discovery, we are capable of glimpses of our borderlands. The present seems a propitious time for a glance backward, to see by what trails we have come, and for a general survey of existing frontiers, to see where we stand in relation to the great unknowns of nature.

*The Advancing Front of Science*  
Chapter I (p. 11)  
McGraw-Hill Book Co., Inc. New York, New York, USA. 1937

**Hall, Alfred Rupert** 1920–  
English historian of science

The difficulty [in understanding science history] is the greater because the history of science is not, and cannot be, a tight unity. The different branches of science are themselves unlike in complexity, in techniques, and in their philosophy. They are not all affected equally, or at the same time, by the same historical factors, whether internal or external. It is not even possible to trace the development of a single scientific method, some formulation of principles and rules of operating which might be imagined as applicable to every scientific inquiry, for there is no such thing.

*The Scientific Revolution, 1500–1800*  
Introduction (p. xiv)  
Longmans, Green & Company. London, England. 1954

**Hall, Marie Boas** 1919–  
English historian of science

For the...student whose chief interest does lie in science, for whom history as a course of study so often seems to deal solely with subjects remote from his intellectual turn of mind, the history of science provides a valid and useful point of contact with history, through which he may learn to develop wider humanistic interests. For the non-scientist, bored and baffled by the technical problems of science, the history of science may provide some insight into the scientific point of view and prevent the feeling of isolation which too often makes the scientist and the humanist appear to move in separate worlds.

*History of Science* (p. 1)  
American Historical Association. Washington, D.C. 1958

**Hobbs, William Herbert** 1864–1952  
American geologist

If we are to gauge the generally accepted hypotheses of any science and arrive at individual conclusions respecting their value, we must be prepared to inquire into the ancestry of each – we must trace out the route by which each has come to its present position of eminence.

*Characteristics of Existing Glaciers*  
Introduction (p. 1)  
The Macmillan Co. New York, New York, USA. 1911

**Holton, Gerald** 1922–  
Research professor of physics and science history

And yet, on looking into the history of science, one is overwhelmed by evidence that all too often there is no regular procedure, no logical system of discovery, no simple, continuous development. The process of discovery has been as varied as the temperament of the scientist.

*Thematic Origins of Scientific Thought: Kepler to Einstein*  
Chapter 11 (pp. 384–385)  
Harvard University Press. Cambridge, Massachusetts, USA. 1973

**Hunter, Joseph**  
No biographical data available

I see not how the history of any science is to be conducted through the middle age period, but by the assistance of the works of science of the middle age writers, though the contents of them, as works of science, may have now become of little value.

*English Monastic Libraries*  
Preface (p. xi)  
Printed for J.B. Nichols & Son. London, England. 1831

**Huxley, Thomas Henry** 1825–95  
English biologist

Next to undue precipitation in anticipating the results of pending investigations, the intellectual sin which is commonest and most hurtful to those who devote themselves

to the increase of knowledge is the omission to profit by the experience of their predecessors recorded in the history of science and philosophy.

*Collected Essays*

Scientific and Pseudo-Scientific Realism (p. 59)

D. Appleton & Co. New York, New York, USA. 1898

...anyone acquainted with the history of science will admit that its progress has meant, in all ages and now more than ever, the extension of the province of matter and causation, and the gradual banishment from human thought of what we call spirit and spontaneity.

*Collected Essays* (Volume 1)

*Method and Result*

On the Physical Basis of Life (p. 159)

Macmillan & Company Ltd. London, England. 1904

**Keller, Evelyn Fox** 1936–

American physicist, author, and feminist

To know the history of science is to recognize the mortality of any claim to universal truth.

*Reflections on Gender and Science*

Epilogue (pp. 178–179)

Yale University Press. New Haven, Connecticut, USA. 1995

**Knickerbocker, William Skinkle** 1892–1972

American professor of English and author

...the history of science is as inspiring in its human values as are the legends of the saints. Contemplate the heroism of a Galileo, the patience of a Darwin, the humility of a Pasteur; a modern eleventh chapter of Hebrews might be written listing the names of all those men of faith who by quiet work, unremitting in their zeal, one by one discovered facts which made man's lot easier and happier in what was otherwise to him a hostile and unhappy universe.

*Classics of Modern Science*

Preface

Alfred A Knopf. New York, New York, USA. 1927

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Koestler, Arthur** 1905–83

Hungarian-born English writer

We are in the habit of visualizing man's political and social history as a wild zig-zag which alternates between progress and disaster, but the history of science as a steady, cumulative process, represented by a continuously rising curve, where each epoch adds some new item of knowledge to the legacy of the past, making the temple of science grow brick by brick to ever greater height.

*The Sleep Walkers: A History of Man's Changing Vision of the Universe*

Epilogue (p. 513)

The Macmillan Co. New York, New York, USA. 1959

**Kuhn, Thomas S.** 1922–96

American historian of science

Though the gap seems small, there is no chasm that more

needs bridging than that between the historian of ideas and the historian of science.

*International Encyclopedia of the Social Sciences* (Volume 14)

History of Science (p. 78)

The Macmillan Company. New York, New York, USA. 1968

**Lakatos, Imre** 1922–74

Hungarian-born philosopher

Philosophy of science without history of science is empty; history of science without philosophy of science is blind.

In R. Buck and R. Cohen (eds.)

*Boston Studies in the Philosophy of Science* (Volume 8)

History of Science and Rational Reconstructions (p. 91)

D. Reidel Publishing Company. Dordrecht, Netherlands.

**Lardner, Dionysius** 1793–1859

British physicist and astronomer

For the civil and political historian the past alone has existence – he present he rarely apprehends, the future never. To the historian of science it is permitted, however, to penetrate the depths of past and future with equal clearness and certainty; facts to come are to him as present, and not unfrequently more assured than facts which are passed.

*Popular Lectures on Science and Art* (Volume 1)

12th Halley's Comet (p. 171)

Greeley & McElrath. New York, New York, USA. 1850

**Lavoisier, Antoine Laurent** 1743–94

French chemist

...if I had allowed myself to enter into long dissertations on the history of the science, and the works of those who have studied it, I must have lost sight of the true object I had in view, and produced a work, the reading of which must have been extremely tiresome to beginners. It is not to the history of the science, or of the human mind, that we are to attend in an elementary treatise: Our only aim ought to be ease and perspicuity, and with the utmost care to keep everything out of view which might draw aside the attention of the student; it is a road which we should be continually rendering more smooth, and from which we should endeavor to remove every obstacle which can occasion delay.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (pp. xxxii–xxxiii)

Printed for William Creech. Edinburgh, Scotland. 1790

**Lévi-Strauss, Claude** 1908–

French social anthropologist and structuralist

...scientific knowledge advances haltingly and is stimulated by contention and doubt.

Translated by John and Doreen Weightman

*The Raw and the Cooked*

Overture (p. 7)

Harper & Row, Publishers. New York, New York, USA. 1975



**Libby, Walter** 1867–1955  
American science historian

The history of science is an aid in scientific research. It places the student in the current of scientific thought, and gives him a clue to the purpose and necessity of the theories he is required to master. It presents science as the constant pursuit of truth rather than the formulation of truth long since revealed; it shows science as progressive rather than fixed; dynamic rather than static, a growth to which each may contribute.

*An Introduction to the History of Science*

Preface (p. v)

Houghton Mifflin & Co. New York, New York, USA. 1917

The history of science has something to offer to the humblest intelligence. It is a means of imparting a knowledge of scientific facts and principles to unschooled minds.

*An Introduction to the History of Science*

Preface (p. v)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1917

The history of science studies the past for the sake of the future. It is a story of continuous progress. It is rich in biographical material. It shows the sciences in their interrelations, and saves the student from narrowness and premature specialization.

*An Introduction to the History of Science*

Preface (p. vi)

Houghton Mifflin & Co. New York, New York, USA. 1917

The history of science is hostile to the spirit of caste. It shows the sciences rising from daily needs and occupations, formulated by philosophy, enriching philosophy, giving rise to new industries, which react in turn upon the sciences.

*An Introduction to the History of Science*

Preface (p. vi)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1917

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The knowledge of the development of a science rests on the study of writings in their historical sequence and in their historical connection.

*The Science of Mechanics* (5th edition)

Chapter I, Part V, Section 9 (p. 97)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

[N]ot only a knowledge of the ideas that have been accepted and cultivated by subsequent teachers is necessary for the historical understanding of a science, but also that the rejected and transient thoughts of the inquirers, nay even apparently erroneous notions, may be very important and very instructive. The historical investigation of the development of a science is most needful, lest the principles treasured up in it become a system of half-understood prescripts, or worse, a system of prejudices.

*The Science of Mechanics* (5th edition)

Chapter II, Part VIII, Section 7 (p. 316)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Historical investigation not only promotes the understanding of that which now is, but also brings new possibilities before us, by showing that which exists to be in great measure conventional and accidental. From the higher point of view at which different paths of thought converge we may look about us with freer vision and discover routes before unknown.

*The Science of Mechanics* (5th edition)

Chapter II, Part VIII, Section 7 (p. 316)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Macquer, Pierre Joseph** 1718–84  
French chemist

As the History of any Science ought to relate the labours, the discoveries, and the errors of the cultivators of that Science; and to shew the obstacles which they have been obliged to surmount, and the mistaken paths into which they have sometimes been misled; it cannot therefore fail of being very useful to persons engaged in the same pursuits.

*A Dictionary of Chemistry* (Volume 1)

A Preliminary Discourse Concerning the Origin and Progress of Chemistry (p. 1)

Printed for T. Caldwell & R.F. Elmsly. London, England. 1771

**Marmery, J. Villin**

No biographical data available

The history of science is a sealed book, generally speaking. To the multitude of readers, including in it scientific students, an historical thread conducting them through the bewildering field of science cannot fail to prove a welcome gain.

*Progress of Science: Its Origin, Course, Promoters, and Results*

Preface (p. vii)

Chapman & Hall, Ltd. London, England. 1895

**Maxwell, James Clerk** 1831–79  
Scottish physicist

The history of science shows that even during that phase of her progress in which she devotes herself to improving the accuracy of the numerical measurement of quantities with which she has long been familiar, she is preparing the materials for the subjugation of new regions, which would have remained unknown if she had been contented with the rough methods of her early pioneers.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell*

Chapter XII (p. 356)

Macmillan & Company Ltd. London, England. 1882

**Miller, George Abram** 1863–1951  
American mathematician

While the role of the history of science as an error exterminator is much more significant than its role as an error



breeder, it is necessary to consider it in both of these lights in order to understand its bearings completely.

The History of Science as an Error Breeder

*The Scientific Monthly*, Volume XII, Number 5, May, 1921 (p. 439)

### More, Louis Trenchard

American educator

If it be true that the permanent advances made in science have been the result of observing phenomena and of classifying them in laws which are as often as possible to be expressed by mathematical formulae; and if it be also true that we have persisted in the effort to explain the causes of phenomena without really advancing knowledge; then it will be most useful to compare our present state with that of an earlier time.

*The Limitations of Science*

Chapter III (p. 68)

Henry Holt & Co. New York, New York, USA. 1915

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

The history of science, like the history of all human ideas, is a history of irresponsible dreams, of obstinacy, and of error.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10, Section I (p. 216)

Harper & Row, Publishers. New York, New York, USA. 1963

### Richet, Charles 1850–1935

French physiologist

In the history of science, nobody has left his mark on the world unless he has been, in this sense, an innovator.

*The Natural History of a Savant*

Chapter VI (p. 38)

J.M. Dent & Sons Ltd. London, England. 1927

### Rostand, Jean 1894–1972

French biologist and philosopher

If there is one notion that clearly emerges from the history of science, and from which we can learn something, it is, I believe, the extreme diversity of the personal qualities and abilities that have contributed to the advancement of our knowledge.

*Humanly Possible: A Biologist's Note on the Future of Mankind*

On the History of Science (p. 180)

Saturday Review Press. New York, New York, USA. 1970

By showing us the extreme diversity of the factors involved in scientific creativity, the history of science teaches us that we should open the doors of our laboratories more widely. If we put that lesson into practice, our reflection on the past will have had a beneficial effect on the future.

*Humanly Possible: A Biologist's Note on the Future of Mankind*

On the History of Science (p. 182)

Saturday Review Press. New York, New York, USA. 1970

### Sarton, George 1884–1956

Belgian-born American scholar and writer

Between the old humanist and the scientist, there is but one bridge, the history of science, and the construction of that bridge is the main cultural need of our time. An immense task to be sure but one worth every pain it may cost. I do not know who is the poorer: the old humanist without understanding of science, or the scientist without appreciation of beauty, without urbanity, without reverence. I do not know which is worse: idealism without knowledge, or knowledge without idealism.

*The History of Science and the New Humanism*

Chapter I (p. 72)

H. Holt & Co. New York, New York, USA. 1931

The study of history, and especially of the history of science, may thus be regarded, not only as a source of wisdom and humanism, but also as a regulator for our consciences: it helps us not to be complacent, arrogant, too sanguine of success, and yet remain grateful and hopeful, and never to cease working quietly for the accomplishment of our own task.

*The History of Science and the New Humanism*

Chapter IV (p. 191)

Indiana University Press. Bloomington, Indiana, USA. 1962

The more science enters into our lives, the more it must be “humanized,” and there is no better way to humanize it than to study its history.

An Institute for the History of Science and Civilization

*Science*, N.S. Volume 40, Number 1100, January–June, 1917 (p. 284)

From the point of view of the history of science, transmission is as essential as discovery.

*Introduction to the History of Science (Volume 2)*

Introductory Chapter (p. 15)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

### Schlesinger, George N.

No biographical data available

The majority of thinkers agree that one of the important lessons of history is that in science there are no absolute guarantees. No matter how well founded a given belief may be, its truth cannot be established with ultimate certainty.

*The Range of Epistemic Logic* (p. 22)

Humanities Press. Atlantic Highlands, New Jersey, USA. 1985

### Schweizer, Karl W.

American professor of history

One of the obstructions to a genuine appreciation of history is the existence of a vague unformulated assumption that historical research merely seeks to disinter a fossilized past – merely digs into the memory to recover things which the human race once knew before. On the basis of such an assumption it is possible for people to have the

feeling that history can never produce anything which is fundamentally novel, but merely fills our minds with the lumber of bygone ages.

*Herbert Butterfield: Essays on the History of Science*

Chapter II (p. 19)

Edwin Mellon Press. Lewiston, New York, USA. 1998

### Silver, Brian L.

Israeli professor of physical chemistry

The essence of scientific history has been conflict.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

...the history of science may be a trail littered with broken theories and discarded concepts, science is also a triumph of reason, luck, and above all imagination. There are few more successful, exciting, or strange journeys.

*The Ascent of Science*

Preface (p. xiv)

Solomon Press Book. New York, New York, USA. 1998

### Stewart, Ian 1945–

English mathematician and science writer

### Cohen, Jack

Reproductive biologist

The history of science, broadly speaking, is the tale of a lengthy battle to dig out the secret simplicities of a complicated world. It is an astonishing story of insignificant humanity's triumph over huge mysteries.

*The Collapse of Chaos: Discovering Simplicity in a Complex World*

Chapter 1 (p. 28)

Viking Press. New York, New York, USA. 1994

### Tannery, Paul 1843–1904

French mathematician and historian of science

The scientist in so far as he is a scientist is only drawn to the history of the particular science that he studies himself; he will demand that this history be written with every possible technical detail, for it is only thus that it can supply him with materials of any possible utility. But what he will particularly require is the study of the thread of ideas and the linking together of discoveries. His chief object is to rediscover in its original form the expression of his predecessors' actual thoughts, in order to compare them with his own; and to unravel the methods that served in the construction of current theories, in order to discover at what point and towards what goal an effort towards innovation may be made.

In A. Rupert Hall

Can the History of Science Be History?

*The British Journal for the History of Science*, Volume 4, Part III, Number 15, June, 1969 (p. 212)

### Turner, H. H. (Herbert Hall) 1861–1930

English astronomer

It is a familiar fact that there are epochs in the history of a science when it acquires new vigor; when new branches are put forth and old branches bud afresh or blossom more plenteously. The vivifying cause is generally to be found either in the majestic form of the discovery of a new law of nature, or in the humbler guise of the invention of a new instrument of research.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904* (Volume 4)

The Relations of Photography to Astrophysics (p. 431)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

In the history of science and throughout the whole course of its progress we see certain epochs following one another more or less rapidly. Some important view is expressed, it may be original or only revived; sooner or later it receives recognition; fellow-workers spring up; the outcome of it finds its way into the schools; it is taught and handed down; and we observe, unhappily, that it does not in the least matter whether the view be true or false. In either case its course is the same; in either case it comes in the end to be a mere phrase, a lifeless word stamped on the memory.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#519 (p. 184)

The Macmillan Co. New York, New York, USA. 1906

### von Humboldt, Alexander 1769–1859

German naturalist and explorer

The history of science teaches us the difficulties that have opposed the progress of this active spirit of inquiry. Inaccurate and imperfect observations have led, by false inductions, to the great number of physical views that have been perpetuated as popular prejudices among all classes of society. Thus by the side of a solid and scientific knowledge of natural phenomena there has been preserved a system of the pretended results of observation, which is so much the more difficult to shake, as it denies the validity of the facts by which it may be refuted.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Introduction (p. 38)

D. Appleton & Co. New York, New York, USA. 1850

### Weisskopf, Victor Frederick 1908–2002

Austrian-American physicist

It was a heroic period [about 1922–1930] without any parallel in the history of science, the most fruitful and interesting one of modern physics.... In this great period of physics, Bohr and his associates touched the nerve of the universe. The intellectual eye of man was opened to the inner workings of nature.

In A.P. French and P.J. Kennedy (eds.)  
*Niels Bohr: A Centenary Volume*  
 Niels Bohr, the Quantum, and the World (p. 22)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1985

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

History is no exception amongst the sciences; as the gaps fill in, the outline simplifies; as the outlook broadens, the clustering multitude of details dissolve into general laws.

*The Outline of History*  
 Introduction (p. vi)  
 The Macmillan Company. New York, New York, USA. 1921

**Whewell, William** 1794–1866  
 English philosopher and historian

In an advanced Science, the history of the Language of the Science is the history of the Science itself.

*Novum Organon Renovatum*  
 Book IV (p. 355)  
 John W. Parker. London, England. 1858

The historian of science, from early periods to the present times, may hope for favour on the score of the mere subject of his narrative, and in virtue of the curiosity which the men of the present day may naturally feel respecting the events and persons of his story.

*History of the Inductive Sciences from the Earliest to the Present Time*  
 (Volume 1) (3rd edition)  
 Introduction (p. 4)  
 John W. Parker & Son. London, England. 1857

It will be universally expected that a history of Inductive Science should...afford us some indication of the most promising mode of directing our future efforts to add to its extent and completeness.

*History of the Inductive Sciences, from the Earliest to the Present Time*  
 (Volume the First)  
 Introduction (p. 5)  
 John W. Parker. London, England. 1837

We may best hope to understand the nature and conditions of real knowledge by studying the nature and conditions of the most certain and stable portions of knowledge which we already possess: and we are most likely to learn the best methods of discovering truth by examining how truths, now universally recognized, have really been discovered.

*The Philosophy of the Inductive Sciences Founded upon Their History*  
 (Volume 1)  
 Book I, Chapter I (p. 1)  
 John W. Parker. London, England. 1847

[T]here do exist among us doctrines of solid and acknowledged certainty, and truths of which the discovery has been received with universal applause. These constitute what we commonly term Sciences; and of these bodies of exact and enduring knowledge, we have

within our reach so large and varied a collection, that we may examine them, and the history of their formation, with good prospect of deriving from the study such instruction as we seek.

*The Philosophy of the Inductive Sciences Founded upon Their History*  
 (Volume 1)  
 Book I, Chapter I (p. 2)  
 John W. Parker. London, England. 1847

**White, Henry S.**

No biographical data available

The accepted truths of today, even the commonplace truths of any science, were the doubtful or the novel theories of yesterday. Some indeed of prime importance were long esteemed of slight importance and almost forgotten. The first effect of reading in the history of science is a naive astonishment at the darkness of past centuries, but the ultimate effect is a fervent admiration for the progress achieved by former generations, for the triumphs of persistence and of genius.

*Bulletin of the American Mathematical Society*, Volume 15, 1909 (p. 325)

**Williams, L. Pearce**

American historian of science

...the history of science is a professional and rigorous discipline demanding the same level of skills and scholarship as any other scholarly field. It is time for the scientists to realize that he studies nature and others study him. He is no more nor no less competent to comment on his own activities and the activities of his fellow scientist than is the politician. Critical political history is rarely written by the politician and the same is true of the history of science.

Letter to the Editor  
*Scientific American*, Volume 214, Number 6, June, 1966 (p. 8)

## SCIENCE, HOLY TRINITY OF

**Ingersoll, Robert Green** 1833–99

American lawyer, public official, and orator

Reason, Observation, and Experience – the Holy Trinity of Science.

*On the Gods and Other Essays*  
 The Gods (p. 54)  
 Prometheus Books. Buffalo, New York, USA. 1990

## SCIENCE, HOUSE OF

**Tyndall, John** 1820–93

Irish-born English physicist

In the house of science are many mansions, occupied by tenants of diverse kinds. Some of them execute with painstaking fidelity the useful work of observation, recording from day to day the aspects of Nature, or the

indications of instruments devised to reveal her ways. Others there are who add to this capacity for observation a power over the language of experiment, by means of which they put questions to Nature, and receive from her intelligible replies. There is, again, a third class of minds, that cannot rest content with observation and experiment, whose love of causal unity tempts them perpetually to break through the limitations of the senses, and to seek beyond them the roots and reasons of the phenomena which the observer and experimenter record. To such spirits adventurous and firm we are indebted for our deeper knowledge of the methods by which the physical universe is ordered and ruled.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 1)  
Chapter 5 (p. 131)  
D. Appleton & Co. New York, New York, USA. 1897

## SCIENCE, HUMAN

**MacDonald, George** 1824–1905  
Scottish novelist and poet

... human science is but the backward undoing of the tapestry-web of God's science...

*Unspoken Sermons*  
Third The Truth (p. 62)  
Longmans, Green & Co. London, England. 1889

## SCIENCE, IGNORANCE OF

**Coggan, Frederick Donald** 1909–2000  
1st Archbishop of Canterbury

My ignorance of science is such that if anyone mentioned copper nitrate I should think he was talking about policemen's overtime.

*NY Journal-American*, September 20, 1961

**Pearson, Karl** 1857–1936  
English mathematician

The ignorance of science means the enforced ignorance of mankind.

*The Grammar of Science* (2nd edition)  
Chapter 1 (p. 21)  
Adam & Charles Black. London, England. 1900

## SCIENCE, IMPORTANCE OF

**Schneer, Cecil J.** 1923–  
American science historian and mineralogist

The primary importance of science and the characteristic that distinguished it from other philosophies and arts is its usefulness. The remarkable thing about science is the extent to which nature and the world appear to adhere to the rules and constructions of science.

*The Evolution of Physical Science*  
Grove Press, Inc. New York, New York, USA. 1960

## SCIENCE, IMPORTANT

**Wilson, Edward O.** 1929–  
American biologist and author

Important science is not just any similarity glimpsed for the first time. It offers analogues that map the gateways to unexplored terrain.

*Biophilia*  
The Poetic Species (p. 67)  
Harvard University Press. Cambridge, Massachusetts. 1984

## SCIENCE, IMPURE

**Calvin, Melvin** 1911–97  
American biochemist

There is not a "pure" science. By this I mean that physics impinges on astronomy, on the one hand, and chemistry and biology on the other. And not only does each support neighbors, but derives sustenance from them. The same can be said of chemistry. Biology is, perhaps, the example par excellence today of an "impure" Science.

In Shirley Thomas  
*Men of Space. Profiles of the Scientists Who Probe for Life in Space* (Volume 6)  
Melvin Calvin (p. 35)  
Chilton Books. Philadelphia, Pennsylvania, USA. 1963

## SCIENCE, INFANCY OF

**Richards, William Carey** 1818–92  
American magazine editor

Those were thine infant days, Philosophy;  
Ere thou had'st dared with eagle flight to soar,  
To pluck bright mystery from the silent sky,  
Or boldly sweep the wide Empyrean o'er –  
In kingly quest of Nature's precious lore.  
Thine altar was no Inquisition then –  
To drag the priests of Mystery before –  
And put them to the torture there, as men  
Search, with the merciless rack, for truths beyond their ken.

*Electron, or, The Pranks of the Modern Puck*  
The Infancy of Science (p. 10)  
D. Appleton & Co. New York, New York, USA. 1858

## SCIENCE, INFLUENCE OF

**Thomson, Sir George Paget** 1892–1975  
English physicist

The influence of science on men's lives comes in two rather different ways – one through the ideas themselves, and the other through their material consequences.

The New Industrial Revolution  
*Bulletin of the Atomic Scientists*, Volume 13, Number 1, January, 1957 (p. 9)

**SCIENCE, INSIDIOUSNESS OF**

**Gerould, Katherine Fullerton** 1879–1944  
American writer

The insidiousness of science lies in its claim to be not a subject, but a method. You could ignore a subject; no subject is all-inclusive. But a method can plausibly be applied to anything within the field of consciousness.

*Modes and Morals*

The Extirpation of Culture (p. 86)

Charles Scribner's Sons. New York, New York, USA. 1920

**SCIENCE, KINGDOM OF**

**Wright, Henrietta Christian** 1854–99  
American children's story writer

The kingdom of science may be likened to a meadow full of children at play. One child plucks flowers, another gathers the pebbles that lie on the shores of the little brook, a third watches the waves bearing away the bits of moss from the woods beyond, and a fourth listens to the songs of the birds, or gazes at the clouds floating in the blue sky far above him.

*Children's Stories of the Great Scientists*

Chapter VIII (p. 154)

Charles Scribner's Sons. New York, New York, USA. 1888

**SCIENCE, KNOWLEDGE OF**

**McMurry, Charles Alexander** 1857–1929  
American educator

The child who draws his knowledge of science directly from life, under usual conditions, will not have much difficulty in finding it again in life and applying it to life.

*Special Method in Elementary Science for the Common School*

Chapter III (p. 31)

The Macmillan Co. New York, New York, USA. 1905

**SCIENCE, LANTERN OF**

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The lantern of science, throwing its light down the long corridors of time, enables us to trace out the gradual evolution of terrestrial life.

*Science and Music*

Chapter I (p. 1)

Dover Publications. New York, New York, USA. 1968

**SCIENCE, LAWS OF****Author undetermined**

The supreme law of science is not freedom, but truth.

In Charles George Herbermann

*The Catholic Encyclopedia*

Ethics (p. 557)

The Encyclopedia Press, Inc. New York, New York, USA. 1913

**Pearson, Karl** 1857–1936  
English mathematician

...the laws of science are products of the human mind rather than factors of the external world. Science endeavors to provide a mental *resume* of the universe, and its last great claim to our support is the capacity it has for satisfying our cravings for a brief description of the history of the world.

*The Grammar of Science* (2nd edition)

Chapter I (p. 36)

Adam & Charles Black. London, England. 1900

**SCIENCE, LESSON OF**

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The lessons of science should be experimental also. The sight of the planet through a telescope is worth all the course on astronomy: the shock of the electric spark in the elbow outvalues all the theories; the taste of the nitrous oxide, the firing of an artificial volcano, are better than volumes of chemistry.

*Essays: Second Series*

New England Reformers (p. 223)

Henry Altamus. Philadelphia, Pennsylvania, USA. 1894

**SCIENCE, LIFE-BLOOD OF**

**Sagan, Carl** 1934–96  
American astronomer and author

Reasoned disputation is the lifeblood of science – as is, sadly, infrequently the case in the intellectually more anemic arena of politics.

*The Cosmic Connection: An Extraterrestrial Perspective*

Preface (p. ix)

Dell Publishing, Inc. New York, New York, USA. 1975

**SCIENCE, LIGHT OF****Editor**

If God ever spoke to man, science is the fiery bush; and if there is any light by which man can hope to illumine his path so as to make firm steps, it is the light of science.

The Late Professor Romanes's Thoughts on Religion

*The Monist*, Volume V, Number 3, April, 1895 (p. 400)

**Gore, George** 1826–1909  
English electrochemist

Science is systematic knowledge; without the light of science, all is vague.



*The Scientific Basis of Morality*

The Scope and Claims of Science (p. 3)

Swan Sonnenschein & Co. London, England. 1899

## SCIENCE, LIMIT OF

### Black, Hugh

No biographical data available

The limits of science are not limits of its methods, but limits of its spheres.

Our Made-Over World

*Everybody's Magazine*, November, 1914 (p. 710)

## SCIENCE, LOT OF

### Steward, J. H.

No biographical data available

It is the unhappy lot of science that it must clear the ground of flimsy and fanciful structures built upon false premises and errors of fact before it can build anew.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1936

Petroglyphs of the United States (p. 407)

Government Printing Office. Washington, D.C. 1937

## SCIENCE, LOVE OF

### Mitchell, Maria 1818–89

American astronomer and educator

There will come with the greater love of science greater love to one another. Living more nearly to Nature is living farther from the world and from its follies, but nearer to the world's people; it is to be of them, with them, and for them, and especially for their improvement.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 186)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

## SCIENCE, MAN OF

### A. C. B.

The man of science does not always know what the business man wants, and the business man often does not understand what the man of science tells him.

Obituary of Lyon Playfair

*Proceedings of the Royal Society of London*, Volume LXIV, Number 411, March 9, 1899 (p. xi)

### Acton, John Emerich Edward Dalberg 1834–1902

English historian

It is they [men of science] who hold the secret of the mysterious property of the mind by which error minis-

ters to truth, and truth slowly but irrevocably prevails. Theirs is the logic of discovery, the demonstration of the advance of knowledge and the development of ideas, which as the earthly wants and passions of men remain almost unchanged, are the charter of progress, and the vital spark in history.

*Lectures on Modern History*

Inaugural Lecture on the Study of History (p. 21)

Macmillan & Company Ltd. London, England. 1906

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

The application of science to the useful arts requires other abilities, other qualities, other tools than his; and therefore I say that the man of science who follows his studies into their practical application is false to his calling. The practical man stands ever ready to take up the work where the scientific man leaves it, and to adapt it to the material wants and uses of daily life.

*Methods of Study in Natural History*

Chapter II (p. 23)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

### Armstrong, Henry Edward 1848–1937

English organic chemist

After all, we scientific workers...like women, are the victims of fashion: at one time we wear dissociated ions, at another electrons; and we are always loath to don rational clothing; some fixed belief we must have manufactured for us: we are high or low church, of this or that degree of nonconformity, according to the school in which we are brought up – but the agnostic is always rare of us and of late years the critic has been taboo.

'The Thirst of Salted Water or the Ions Overboard

*Science Progress*, Volume 3, 1909 (p. 643)

### Barrie, Sir James M. 1860–1937

Scottish journalist, writer, and dramatist

The man of science appears to be the only man who has something to say, just now – and the only man who does not know how to say it.

Quoted in Editorial

The Young Engineer and His English

*Engineering and Contracting*, Volume 55, Number 14, October 5, 1921

### Berkeley, George 1685–1753

Irish prelate and metaphysical philosopher

Query: Whether the difference between a mere computer and a man of science be not, that the one computes on principles clearly conceived, and by rules evidently demonstrated, whereas the other doth not?

In A. Luce and T. Jessop (eds.)

*The Works of George Berkeley, Bishop of Cloyne* (Volume 4)

The Analyst

Nelson. London, England. 1948



**Bernard, Claude** 1813–78  
French physiologist

The doubter is a true man of science; he doubts not only himself and his interpretations, but he believes in science.

Translated by Henry Copley Green  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter 2 (p. 52)  
Henry Schuman, Inc. New York, New York, USA. 1949

Men of science, then, do not seek for the pleasure of seeking; they seek the truth to possess it, and they possess it already within the limits expressed in the present state of science.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter IV, Section IV (p. 222)  
Henry Schuman, Inc. New York, New York, USA. 1927

...men of science must not halt on the road; they must climb ever higher and strive toward perfection; they must always seek as long as they see anything to be found.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter IV, Section IV (p. 222)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

A closer look at the course followed by developing theory reveals for a start that it is by no means as continuous as one might expect, but full of breaks and at least apparently not along the shortest logical path. Certain methods often afforded the most handsome results only the other day, and many might well have thought that the development of science to infinity would consist in no more than their constant application. Instead, on the contrary, they suddenly reveal themselves as exhausted and the attempt is made to find other quite disparate methods. In that event there may develop a struggle between the followers of the old methods and those of the newer ones. The former's point of view will be termed by their opponents as out-dated and outworn, while its holders in turn belittle the innovators as corrupters of true classical science.

*Ludwig Boltzmann: Theoretical Physics and Philosophical Problems, Selected Writings*  
On the Development of the Methods of Theoretical Physics in Recent Times (p. 79)

**Bonney, Thomas George** 1833–1923  
English geologist

Perfect concordance among reformers is not to be expected; and men who are honestly struggling towards the light cannot hope to attain at one bound to the complete truth. There is always a danger lest the fascination of a new discovery should lead us too far. Men of science, being human, are apt, like lovers, to exaggerate the

perfections and be a little blind to the faults of the object of their choice.

The Anniversary Address of the President  
*The Quarterly Journal of the Geological Society of London*, Volume 41, 1885 (p. 55)

**Bradley, Omar** 1893–1981  
American Army general

With the monstrous weapons man already has, humanity is in danger of being trapped in this world by its moral adolescents. Our knowledge of science has already outstripped our capacity to control it. We have many men of science, too few men of God.

Address  
Boston, November 10, 1948

**Brooks, William Keith** 1848–1908  
American zoologist

...men of science repudiate the opinion that natural laws are rulers and governors over nature; looking with suspicion on all "necessary" or "universal" laws.

*The Foundations of Zoology*  
Lecture III (p. 77)  
Macmillan & Company Ltd. London, England. 1899

The man of science quarrels with no man's opinions; but he will not be held responsible for perplexities which are none of his making.

*The Foundations of Zoology*  
Lecture VI (p. 134)  
The Macmillan Co. New York, New York, USA. 1899

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

I do not know whether my distrust of men of science is congenital or acquired, but I think I should have transmitted it to descendants.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
Myself and Distrust of Men of Science (p. 32)  
Jonathan Cape. London, England. 1951

If [men of science] are worthy of the name, [they] are indeed about God's path and about his bed and spy out all his ways.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
Men of Science (p. 204)  
Jonathan Cape. London, England. 1951

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Far away in some strange constellation in skies infinitely remote, there is a small star, which astronomers may someday discover. At least, I could never observe in the faces or demeanor of most astronomers or men of science any evidence that they had discovered it; though as a matter of fact they were walking about on it all the

time. It is a star that brings forth out of itself very strange plants and very strange animals; and none stranger than the men of science.

*The Everlasting Man*

Chapter I (p. 1)

Dodd, Mead & Company. New York, New York, USA. 1925

...the ordinary scientific man is strictly a sentimentalist. He is a sentimentalist in this essential sense, that he is soaked and swept away by mere associations.

*Orthodoxy*

Chapter IV (pp. 94–95)

John Lane Company. New York, New York, USA. 1918

...the deputation of distinguished geologists and mineralogists from Paris and Berlin were there in the most magnificent and appropriate dress, for there are no men who like wearing their decorations so much as the men of science – as anybody knows who has ever been to a soiree of the Royal Society.

*The Wisdom of Father Brown*

The Fairy Tale of Father Brown (p. 309)

John Lane Co. New York, New York, USA. 1921

**Clarke, Frank Wigglesworth** 1847–1931

American chemist

The man of science deals with questions which commonly lie outside of the range of ordinary experience, which often have no immediately discernible relation to the affairs of everyday life, and which concentrate the mind upon apparent abstractions to an extraordinary degree.

The Man of Science in Practical Affairs

*Appletons' Popular Science Monthly*, Volume XLV, February, 1900 (p. 487)

The man of science may be grave or gay, moral or immoral, social or unsocial, keen or visionary – in short, he may exemplify any trait of human nature, except the traits of ignorance and stupidity.

The Man of Science in Practical Affairs

*Appletons' Popular Science Monthly*, Volume XLV, February, 1900 (pp. 487–488)

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

A man of science...explains as much as ever he can, and then he says, "This is all I can do; for the rest you must ask the next man."

In Leslie Stephen and Frederick Pollock (eds.)

*Lectures and Essays* (Volume 2)

Body and Mind (p. 32)

Macmillan & Company. London, England. 1879

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

The first man of science was he who looked into a thing, not to learn whether it could furnish him with food, or

shelter, or weapons, or tools, or ornaments, or *playwiths*, but who sought to know it for the gratification of knowing...

In Ernest Hartley Coleridge

*Anima Poetæ from the Unpublished Note-books of Samuel Taylor*

*Coleridge*

Chapter IX (p. 221)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1895

**Coleridge, Stephen** 1854–1936

English author, barrister, and opponent of vivisection

The man of letters whose mind is stored with all that the wise and eloquent and witty and inspired have written about the actions, aspirations and thoughts of men, unless he is dumb, must inevitably be the most agreeable of companions; whereas the man of Science with his mind stuffed with the changeless laws of physics and the dead phenomena of matter must ever be a dull companion; and man being a social creature, not the least desirable object of education must be to fit him for pleasant association with his fellows.

*The Idolatry of Science*

Chapter IV (p. 22)

John Lane Co. London, England. 1920

**Dantzig, Tobias** 1884–1956

Russian mathematician

The man of science will act as if this world were an absolute whole controlled by laws independent of his own thoughts or acts; but whenever he discovers a law of striking simplicity or one of sweeping universality or one which points to a perfect harmony in the cosmos, he will be wise to wonder what role his mind has played in the discovery, and whether the beautiful image he sees in the pool of eternity reveals the nature of this eternity, or is but a reaction of his own mind.

*Number: The Language of Science*

Chapter Eleven (p. 233)

Macmillan & Co Ltd. New York, New York, USA. 1954

**Darwin, Charles Robert** 1809–82

English naturalist

Children are one's greatest happiness, but often and often a still greater misery. A man of science ought to have none – perhaps not a wife; for then there would be nothing in this wide world worth caring for, and a man might (whether he could is another question) work away like a Trojan.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 139, Darwin Asa Gray, July 11, 1862 (p. 202)

D. Appleton & Company. New York, New York, USA. 1903

...my success as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these, the most important have been – the

love of science, unbounded patience in long reflecting over any subject, industry in observing and collecting facts, and a fair share of invention as well as of common-sense. With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 85)

D. Appleton & Company. New York, New York, USA. 1896

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

The recollection of an already long life has permitted me to become acquainted with a great variety of personages. And if I call on memory to picture to me how the type of true happiness is realized on earth I do not see it under the form of the powerful man clothed in high authority, nor under that of the rich man to whom the splendors of luxury and the delicacies of well-being are granted, but under that of the man of science, who consecrates his life to penetrating the secrets of Nature and to the discovery of new truths.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 18)

Macmillan & Company Ltd. London, England. 1918

**Duncan, Robert Kennedy** 1919–88

American poet

...the man of science cannot hesitate. He cannot believe that there was actually a break between the inorganic and the organic evolutions bridged over by the direct action of the finger of God. He must believe that there has been no break whatever – that waving palm-trees and toddling children and wave-beaten rocks are alike the present natural outcome of an absolute sequence of cause and effect passing back to the blazing star that formed the elements that comprise them.

*Some Chemical Problems of Today*

Chapter V (p. 103)

Harper & Brothers Publishers. New York, New York, USA. 1911

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Verily, it is easier for a camel to pass through the eye of a needle than for a scientific man to pass through a door. And whether the door be barn door or church door it might be wiser that he should consent to be an ordinary man and walk in rather than wait till all the difficulties involved in a really scientific ingress are resolved.

*The Nature of the Physical World*

Chapter XV (p. 342)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

It has often been said, and certainly not without justification, that the man of science is a poor philosopher. Why then should it not be the right thing for the physicist to let the philosopher do the philosophizing? ...At a time like the present, when experience forces us to seek a newer and more solid foundation, the physicist cannot simply surrender to the philosopher the critical contemplation of the theoretical foundations; for, he himself knows best, and feels more surely where the shoe pinches. In looking for a new foundation, he must try to make clear in his own mind just how far the concepts which he uses are justified, and are necessities.

Physik and Realität

*Journal of the Franklin Institute*, Volume 221, 1936

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

We hearken to the man of science, because we anticipate the sequence in natural phenomena which he uncovers.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

*Representative Men*

Chapter IV (p. 170)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Foster, Sir Michael** 1836–1907

English physiologist

It is not so much the men of science who make science, as some spirit which, born of the truths already won, drives the man of science onward and uses him to win new truths in turn.

*Report of the Sixty-ninth Meeting of the British Association for the Advancement of Science*

President's Address (p. 14)

John Murray. London, England. 1900

The man of science cannot sit by himself in his own cave weaving out results by his own efforts, unaided by others, heedless of what others have done and are doing. He is but a bit of a great system, a joint in a great machine, and he can only work aright when he is in due touch with his fellow-workers.

The President's Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 131)

...there is written clearly on each page of the history of science, in characters which cannot be overlooked, the lesson that no scientific truth is born anew, coming by itself and of itself. Each new truth is always the offspring of something which has gone before, becoming in turn the parent of something coming after. In this aspect the man of science is unlike, or seems to be unlike, the poet and the artist. The poet is born, not made; he rises up, no man knowing his beginnings; when he goes away,

though men after him may sing his songs for centuries, he himself goes away wholly, having taken with him his mantle, for this he can give to none other. The man of science is not thus creative; he is created. His work, however great it be, is not wholly his own; it is in part the outcome of the work of men who have gone before.

Address by the President of the British Association for the Advancement of Science

*Science*, N.S. Volume 10, Number 249, October 6, 1899 (p. 474)

**Froude, James Anthony** 1818–94

English historian and biographer

The secrets of nature have been opened out to us on a thousand lines; and men of science of all creeds can pursue side by side their common investigations.

*Short Studies on Great Subjects* (Volume 1)

Times of Erasmus, Desiderius and Luther, Lecture I (p. 41)

Longmans, Green & Company. London, England. 1879

**Gregory, Sir Richard Arman** 1864–1952

English scientific writer and journalist

To the man of science discoveries signify extensions of the field of work, and he usually leaves their exploitation to prospectors who follow him.

The Message of Science

*Science*, Volume LIV, Number 1402, November, 1921 (p. 448)

To the popular mind, a man of science is a callous necromancer who has cut himself off from communion with his fellows, and has thereby lost the throbbing and compassionate heart of a full life: he is a Faust who has not yet made a bargain with Mephistopheles, and is therefore without human interest.

*Discovery; or, The Spirit and Service of Science*

Preface (p. v)

Macmillan & Company Ltd. London, England. 1918

Most men of science are neither suppliants at the feet of Nature nor fiery advocates of truth wrested from her. But by critical inquiry into the origin of her strength and weakness they hope to discover the means of subduing her.

*Discovery, Or, The Spirit and Service of Science*

Chapter I (p. 4)

Macmillan & Co Ltd. London, England. 1918

The scientific man has to work for truth so far as her ways can be comprehended by him, but he is never more than a trustee for posterity, and has no authority to define the functions or limit the freedom of those who follow him.

*Discovery; or The Spirit and Service of Science*

Chapter II (p. 30)

Macmillan & Company Ltd. London, England. 1918

The man of science, by virtue of his training, is alone capable of realising the difficulties – often enormous – of obtaining accurate data upon which just judgment may be based.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 40)

Macmillan & Company Ltd. London, England. 1918

**Hall, Asaph** 1829–1907

American astronomer

When men are striving for the discovery of truth in its various manifestations, they learn that it is by correcting the mistakes of preceding investigators that progress is made, and they have charity for criticism. Hence persecution for difference of opinion becomes an absurdity. The labours of scientific men are forming a great body of doctrine that can be appealed to with confidence in all countries. Such labours bring people together, and tend to break down national barriers and restrictions.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (pp. 30–31)

Macmillan & Company Ltd. London, England. 1918

**Hamerton, Philip Gilbert** 1834–94

English artist and art critic

The men of science are like the coral insects in the sea; they build on the work of their predecessors and rise ever higher and higher...

*Thoughts about Art*

Chapter VII (p. 100)

Roberts Brothers. Boston, Massachusetts, USA. 1888

**Holland, Josiah Gilbert** 1819–81

American novelist and poet

God pity the man of science who believes in nothing but what he can prove by scientific methods! We cannot imagine a sadder or more unfortunate man in the world. God pity him, we say, for if ever a human being needed divine pity, he does.

*Every-day Topics*, 2nd Series

Religion and the Churches (p. 5)

Charles Scribner's Sons. New York, New York, USA. 1882

**Huggins, Sir William** 1824–1910

English astronomer

In direct opposition to the narrowness of thought, which views all subjects through the distorting mirage of party prejudice, stands the absolute freedom of mind of the man of science, who knows, or ought to know, nothing of party, and stands with open arms to welcome truth in however strange or unexpected guise she may present herself. In his writings the man of science has no lower aim than the diffusion of truth so far as it is known, and no desire to make converts to any opinion or party. As opposed to the finality of party opinions, he proclaims that truth is but very partially attained by man on any subject, for we can see truth only imperfectly, as she appears altered by the perspective of our own standpoint.

Quoted in Richard Arman Gregory  
*Discovery, Or, The Spirit and Service of Science*  
Chapter II (p. 32)  
Macmillan & Co Ltd. London, England. 1916

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

...the man of scientific observation, who looks into the chain of physical events connected with the present state of things, sees great changes that have been made, and foresees a different state that must follow in time, from the continued operation of that which actually is in nature.

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)  
Chapter VIII (p. 238)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

When men of science reason upon subjects where the ideas are distinct and definite, with terms appropriated to the ideas, they come to conclusions in which there is no difference of opinion.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter III (p. 286)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95  
English biologist

The man of science, in fact, simply uses with scrupulous exactness the methods which we all, habitually and at every moment, use carelessly...

*Science and Education: Essays*  
Of the Educational Value of the Natural History of Science (p. 46)  
D. Appleton & Co. New York, New York, USA. 1896

...the man of science, who, forgetting the limits of philosophical inquiry, slides from these formulae and symbols into what is commonly understood by materialism, seems to me to place himself on a level with the mathematician, who should mistake the x's and y's with which he works his problems, for real entities – and with this further disadvantage, as compared with the mathematician, that the blunders of the latter are of no practical consequence, while the errors of systematic materialism may paralyze the energies and destroy the beauty of a life.

*Method and Results: Essays*  
On the Physical Basis of Life (p. 165)  
D. Appleton & Co. New York, New York, USA. 1898

The man of science has learned to believe in justification, not by faith, but by verification.

*Collected Essays* (Volume 1)  
*Method and Result*  
On Improving Natural Knowledge (p. 41)  
Macmillan & Company Ltd. London, England. 1904

What men of science want is only a fair day's wages for more than a fair day's work...

*Collected Essays* (Volume 1)  
*Method and Result*  
Administrative Nihilism (p. 287)  
Macmillan & Company Ltd. London, England. 1904

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

The scientific man sees and feels beauty as much as any mere observer – as much as any artist or painter. But he also sees something underlying that beauty; he wishes to learn something of the actions and forces producing those beautiful results.

*Popular Lectures and Addresses*  
Address delivered on the occasion of the opening of the (p. 477)  
Physical and Chemical Laboratories in University College, Bangor, North Wales  
Macmillan & Co Ltd. London, England. 1894

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

The isolated man of science can dedicate himself without fear to dogmatism; he hears only from afar contradictions of his ideas. But in a scientific society the impact of dogmatic ideas soon results in their destruction, and the desire to win one another over to their point of view establishes necessarily among members the convention of admitting only the results of observations and calculation.

In Maurice Crosland  
*Gay-Lussac: Scientist and Bourgeois*  
Chapter 2 (p. 34)  
Cambridge University Press. Cambridge, England. 1978

**Lee, Frederic Schiller** 1878–1939  
American psychologist

The man of science who is not a doubter has no claim to honorable standing. He who doubts not is dead to science.

*Scientific Features of Modern Medicine*  
Chapter I (p. 2)  
The Columbia University Press. New York, New York, USA. 1911

**Lodge, Sir Oliver** 1851–1940  
English physicist

Take a scientific man who is not something more than a scientific man, one who is not a poet, or a philosopher, or a saint, and place him in the atmosphere habitual to the churches, and he must starve. He requires solid food, and he finds himself in air. He requires something to touch and define and know; but there everything is ethereal, indefinable, illimitable, incomprehensible, beautiful, and vague. He dies of inanition.

In James Edward Hand  
*Ideals of Science & Faith*  
A Physicist's Approach (p. 12)  
Longmans, Green & Co. New York, New York, USA. 1904

**Mather, Kirtley F.** 1888–1978  
American geologist

To the man of science every event in the history of the universe is a miracle. It is both awe-inspiring and significant, a "sign and wonder."



In Edward H. Cotton  
*Has Science Discovered God?*  
 Sermons from Stones (p. 3)  
 Thomas Y. Crowell Company, Publishers. New York, New York, USA.  
 1931

**Maxwell, James Clerk** 1831–79  
 Scottish physicist

But who will lead me into that still more hidden and dimmer region where Thought weds Fact; where the mental operation of the mathematician and the physical action of the molecules are Seen in their true relation? Does not the way to it pass through the very den of the metaphysician, strewn with the remains of former explorers, and abhorred by every man of Science?

Presidential address  
*Nature*, Volume 2, September 22, 1870 (p. 419)

**Melville, Herman** 1819–91  
 American novelist

...a man of true science...uses but few hard words, and those only when none other will answer his purpose; whereas the smatterer in science...thinks, that by mouthing hard words, he proves that he understands hard things.

*White Jacket*  
 Chapter LXIII (p. 277)  
 Northwestern University Press. Evanston, Illinois, USA. 1970

**Mivart, St. George Jackson** 1827–1900  
 English biologist

It is not enough for the true man of science to be acquainted with many sciences, and to reflect on the knowledge he so possesses. The rational mind sooner or later seeks to know what is the basis of his own knowledge and the ultimate groundwork of all science.

*The Groundwork of Science; A Study of Epistemology*  
 Chapter I (p. 2)  
 G.P. Putnam's Sons. New York, New York, USA. 1898

**More, Louis Trenchard**  
 American educator

Men of science have two principal functions to perform: first to observe the phenomena of the world; and when certain connections and differences are found in these phenomena, to classify them under laws.

*The Limitations of Science*  
 Chapter VI (p. 186)  
 Henry Holt & Co. New York, New York, USA. 1915

**Muller, Herbert Joseph** 1905–80  
 American historian and educator

...men of science, men given to "realism," are likely to make a clean sweep of old interests and sentiments as so much rubbish. They regard religion as superstition, metaphysics as moonshine, art as primitive pastime, and all ritual as monkey-business.

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*  
 Chapter I (p. 6)  
 G. Braziller. New York, New York, USA. 1943

**Newcomb, Simon** 1835–1909  
 Canadian-American astronomer

The true man of science has no such expression in his vocabulary as *useful knowledge*. His domain is as wide as nature itself, and he best fulfills his mission when he leaves to others the task of applying the knowledge he gives to the world.

*Annual Report of the Board of Regents of the Smithsonian Institution (1904)*

Evolution of the Scientific Investigator (p. 233)  
 Government Printing Office. Washington, D.C. 1905

**Newell, Lyman C.**  
 Chemist

A man of science who ignores evidence from any source whatever is himself ignored.

*The Spirit of Science*  
*Mind*, Volume 7, Number 1, October, 1900 (p. 5)

**Pasteur, Louis** 1822–95  
 French chemist

A man of science should think of what will be said of him in the following century, not of the insults or the compliments of one day.

Translated by Erwin Frink Smith and Florence Hodges  
 In Emile Duclaux  
*Pasteur: The History of a Mind*  
 Aphorisms and Ideals of Pasteur (p. 343)  
 W.B. Saunders Co. Philadelphia, Pennsylvania, USA. 1920

**Pearson, Karl** 1857–1936  
 English mathematician

The scientific man has above all things to strive at self-elimination in his judgments, to provide an argument which is as true for each individual mind as for his own.

*The Grammar of Science* (2nd edition)  
 Chapter I (p. 6)  
 Adam & Charles Black. London, England. 1900

The man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the scientific method and is a man of science.

*The Grammar of Science* (2nd edition)  
 Chapter I (p. 12)  
 Adam & Charles Black. London, England. 1900

**Pierce, Charles Sanders** 1839–1914  
 American logician, mathematician, philosopher, and scientist

It is the man of science, eager to have his every opinion regenerated, his every idea rationalized, by drinking at the fountain of fact, and devoting all the energies of his life to the cult of truth, not as he understands it, but as



he does not yet understand it, that ought properly to be called a philosopher.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
The Century's Great Men in Science (p. 699)  
US Government Printing Office. Washington, D.C. 1901

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The true man of science has no such expression in his vocabulary as useful science...if there can be no science for science's sake there can be no science.

In James Kip Finch  
Engineering and Science  
*Technology and Culture*, Fall 1961 (p. 330)

**Pope John Paul II** 1920–2005

Bishop of Rome

We are well aware...that the future of man and mankind is threatened, radically threatened, despite very noble intentions, by men of science. And it is menaced because the tremendous results of their discoveries, especially regarding the natural sciences, have been and continue to be exploited – for ends which have nothing to do with the prerequisites of science, but with the ends of destruction and death.

Speech  
Fiftieth Anniversary of the Pontifical Academy of Sciences  
Rome, October 28, 1968

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...it is not his possession of knowledge, of irrefutable truth, that makes the man of science, but his persistent and recklessly critical quest for truth.

*The Logic of Scientific Discovery*  
Part II, Chapter X, Section 85 (p. 281)  
Basic Books, Inc. New York, New York, USA. 1959

**Renan, Ernest** 1823–92

French philosopher and Orientalist

With the saints, the heroes, the great men of all ages we may fearlessly compare our men of scientific minds, given solely to the research of truth, indifferent to fortune, often proud of their poverty, smiling at the honors they are offered, as careless of flattery as of obloquy, sure of the worth of that they are doing, and happy because they possess truth.

The Nobility of Science  
*Scientific American*, Volume 40, Number 20, New Series, May 17, 1879 (p. 310)

**Robinson, James Harvey** 1863–1936

American historian

**Beard, Charles A.** 1874–1948

American historian

It may well be that men of science, not kings, or warriors, or even statesmen are to be the heroes of the future.

*The Development of Modern Europe: An Introduction to the Study of Current History* (Volume 2)  
Chapter XXXI (p. 421)  
Ginn & Company. Boston, Massachusetts, USA. 1908

**Ross, Sir Ronald** 1857–1932

English bacteriologist

A witty friend of mine once remarked that the world thinks of the man of science as one who pulls out his watch and exclaims, "Ha! half an hour to spare before dinner: I will just step down to my laboratory and make a discovery." Who but men of science themselves are to blame for such a misconception? Out of the many memoirs...[o]ur books of science are records of results rather than of that sacred passion for discovery which leads to them. Yet many discoveries have really been the climax of an intense drama...in which the protagonists are man and nature, and the issue a decision for all the ages.

*Memoirs*  
Preface (pp. v–vi)  
Publisher undetermined

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The man of science looks for facts that are significant, in the sense of leading to general laws; and such facts are frequently quite devoid of any intrinsic interest.

*The Scientific Outlook*  
Chapter I (p. 49)  
George Allen & Unwin. London, England. 1931

The man of science, whatever his hopes may be, must lay them aside while he studies nature...

*Mysticism and Logic: And Other Essays*  
Chapter I (p. 7)  
Longmans, Green & Co. London, England. 1919

The prudent man of science acquires a certain instinct as to the kind of uses which may be made of present scientific beliefs without incurring the danger of complete and utter refutation from the modifications likely to be introduced by subsequent discoveries.

*Mysticism and Logic: And Other Essays*  
Chapter VI (p. 103)  
Longmans, Green & Co. London, England. 1919

All the conditions of happiness are realized in the life of the man of science.

*The Conquest of Happiness*  
Chapter X (p. 146)  
Liverwright Publishing Corporation. New York, New York, USA. 1930

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

If your wish is to become really a man of science, and not merely a petty experimentalist, I should advise you to apply to every branch of natural philosophy, including mathematics.

*Frankenstein: Or, The Modern Prometheus*  
Chapter III (p. 66)  
George Routledge & Sons. London, England. 1888

**Sowerby, William** 1827–1906  
Artist and botanist

The man of science may be likened to an artist or sculptor who spends a lifetime in producing one or two masterpieces of his art, which few are able to see or appreciate, while his statuettes or sketches please or satisfy the multitude who are his daily customers.

Article V  
*Transactions of the Bombay Geographical Society*, Volume XIX, 1894 (p. 122)

**Spencer, Herbert** 1829–1903  
English social philosopher

By accumulated experiences the man of science acquires a thorough belief in the unchanging relations of phenomena – in the invariable connection of cause and consequence – in the necessity of good or evil results.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 82)  
D. Appleton & Co. New York, New York, USA. 1860

Only the sincere man of science (and by this title we do not mean the mere calculator of distances, or analyser of compounds, or labeler of species; but him who through lower truths seeks higher, and eventually the highest) – only the genuine man of science, we say, can truly know how utterly beyond, not only human knowledge, but human conception, is the Universal Power of which Nature, and Life, and Thought are manifestations.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 93)  
D. Appleton & Co. New York, New York, USA. 1891

At present the most powerful and most instructed mind has neither the knowledge nor the capacity required for symbolizing in thought the totality of things. Occupied with one or other division of Nature, the man of science usually does not know enough of the other divisions even rudely to conceive the extent and complexity of their phenomena; and supposing him to have adequate knowledge of each, yet he is unable to think of them as a whole. Wider and stronger intellect may hereafter help him to form a vague consciousness of them in their totality.

*The Principles of Sociology* (Volume 3)  
Part VI, Chapter XVI (p. 174)  
D. Appleton & Co. New York, New York, USA. 1909

...the genuine man of science, we say, can truly know how utterly beyond, not only human knowledge, but human conception, is the Universal Power of which Nature, and Life, and Thought are manifestations.

Education  
*The Greatest Works of the Greatest Authors, Ancient and Modern*  
Intellectual Education (p. 254)  
The H.W. Hagemann Publishing Co. New York, New York, USA. 1894

**Strutt, John William (Lord Rayleigh)** 1842–1919  
English physicist

There are some great men of science whose charm consists in having said the first word on a subject, in having introduced some new idea which has proved fruitful; there are others whose charm consists perhaps in having said the last word on the subject, and who have reduced the subject to logical consistency and clearness.

*Life of John William Strutt: Third Baron Rayleigh*  
Chapter XVII (p. 310)  
University of Wisconsin Press. Madison, Wisconsin, USA. 1968

**Suits, C. G.**  
American physicist

I've never met that "coldly calculating man of science" whom the novelists extol.... I doubt that he exists; and if he did exist I greatly fear that he would never make a startling discovery or invention.

In Frederic Brownell  
Heed that Hunch  
*The American Magazine*, December, 1945 (p. 142)

**Sullivan, John William Navin** 1886–1937  
Irish mathematician

...outside their views on purely scientific matters there is nothing characteristic of men of science.

*Aspects of Science*  
Scientific Citizen (p. 120)  
J. Cape & H. Smith. New York, New York, USA. 1927

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The man of science, who is not seeking for expression but for a fact to be expressed merely, studies nature as a dead language. I pray for such inward experience as will make nature significant.

*The Writings of Henry David Thoreau* (Volume 5)  
Chapter III (p. 135)  
Houghton Mifflin & Co. New York, New York, USA. 1906

He is not a true man of science who does not bring some sympathy to his studies, and expect to learn something by behavior as well as by application. It is childish to rest in the discovery of mere coincidences, or of partial and extraneous laws. The study of geometry is a petty and idle exercise of the mind if it is applied to no larger system than the starry one.

*The Writings of Henry David Thoreau* (Volume 1)  
*A Week on the Concord and Merrimack Rivers*  
Friday (p. 477)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

The true man of science will know nature better by his finer organization; he will smell, taste, see, hear, feel, better than other men. His will be a deeper and finer experience. We do not learn by inference and deduction and the application of mathematics to philosophy, but

by direct intercourse and sympathy. It is with science as with ethics, – we cannot know truth by contrivance and method; the Baconian is as false as any other, and with all the help of machinery and the arts, the most scientific will still be the healthiest and friendliest man, and possess a more perfect Indian wisdom.

*The Writings of Henry David Thoreau* (Volume 9)

*Natural History of Massachusetts* (pp. 161–162)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Thurston, Robert H.

No biographical data available

The man of science, – the philosopher whose task it is to create and to advance all human knowledge of the great kingdom of nature, – is, therefore, a discoverer of facts, an observer of phenomena, a student of nature's laws. He is a systematic recorder of fact and a codifier of laws. He gathers the pearls of truth and collects the silken threads that we term principles, spins them into the cords, and works them into the chains upon which he strings his pearls...

*Proceedings of the American Association for the Advancement of Science*  
Address (p. 44)

Published by the Permanent Secretary

Salam, Massachusetts, USA. 1879

### Tomlinson, C.

No biographical data available

The man of science is, in his day, the minister and interpreter of nature, and he delivers his message according to his light; his successor in the same department has a fuller message to reveal, and in its fullness the first man is more or less forgotten.

Poetry versus Science

*Notes and Queries*, Eighth Series, Volume II, Number 33, August 13, 1892 (p. 132)

### Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910

American author and humorist

The surest way for a nation's scientific men to prove that they were proud and ignorant was to claim to have found out something fresh in the course of a thousand years or so. Evidently the peoples of this book's day regarded themselves as children, and their remote ancestors as the only grown-up people that had existed. Consider the contrast: ...our own scientific men may and do regard themselves as grown people and their grandfathers as children. The change...is probably the most sweeping that has ever come over mankind in the history of the race. It is the utter reversal, in a couple of generations, of an attitude which had been maintained without challenge or interruption from the earliest antiquity.... The change from reptile to bird was not more tremendous, and it took longer.

*The Complete Humorous Sketches and Tales of Mark Twain*

A Majestic Literary Fossil (p. 534)

Hanover House. Garden City, New York, USA. 1961

### von Goethe, Johann Wolfgang

1749–1832

German poet, novelist, playwright, and natural philosopher

Scientific man is supposed to limit himself to his immediate surroundings. However if he should occasionally want to step forth as a poet, he certainly should not be prevented from doing so.

In Karl J. Fink

*Goethe's History of Science*

Chapter 9 (p. 125)

Cambridge University Press. Cambridge, England. 1991

### von Helmholtz, Hermann

1821–94

German scientist and philosopher

In fact, men of science form, as it were, an organised army, labouring on behalf of the whole nation, and generally under its direction and at its expense, to augment the stock of such knowledge as may serve to promote industrial enterprises, to increase wealth, to adorn life, to improve political and social relations, and to further the moral development of individual citizens.

*Popular Lectures on Scientific Subjects*

Lecture I

Volume 2, 1846 (p. 28)

D. Appleton & Company. New York, New York, USA. 1885

### von Lommel, Eugen

1837–99

German physicist

The deeds of a man of science are his scientific investigations. Truth once discovered does not remain shut up in the study or the laboratory. When the moment comes, it bursts its narrow bonds and joins the quick pulse of life. That which has been discovered in solitude, in the unselfish struggle for knowledge, his pure love of science, is often fated to be the mighty lever to advance the culture of our race.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter VII (p. 184)

Macmillan & Co Ltd. London, England. 1916

### Wells, H. G. (Herbert George)

1866–1946

English novelist, historian, and sociologist

The training of a scientific man is a training in what an illiterate lout would despise as a weakness, it is a training in blabbing, in blurting things out, in telling just as plainly as possible and as soon as possible what it is he has found.

*New Worlds for Old*

Chapter II (p. 23)

The Macmillan Company. New York, New York, USA. 1918

### Whitehead, Alfred North

1861–1947

English mathematician and philosopher

No man of science wants merely to know. He acquires knowledge to appease his passion for discovery. He does

not discover in order to know, he knows in order to discover.

*The Organisation of Thought*

Chapter II (p. 37)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

For the engineer “safety first” is a good slogan, but “safety last” is better for the man of research.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry

*Science*, Volume 65, Number 1862, March 25, 1927 (p. 289)

**Williamson, William Crawford** 1816–95

English naturalist

...the man of science is not like the tunnel-constructing engineer. The latter can measure the lengths and heights of the otherwise unknown masses which he designs to penetrate; and he can define the exact point at which he will emerge into daylight, fully assured that the results will accord with his pre-conceived plan; but the scientific explorer, having no such definite guides as the theodolite and the measuring-chain, must fall back upon the more uncertain aid of hypothesis to direct his efforts to penetrate the unknown.

*Essays and Addresses*

Chapter VII (p. 200)

Macmillan & Co Ltd. London, England. 1874

**Willmott, Robert Eldridge Aris** 1809–63

English writer and poet

The history of men of science has one peculiar advantage, as it shows the importance of little things in producing great results.

*Pleasures, Objects, and Advantages, of Literature* (4th edition)

Chapter XXI (p. 129)

G. Routledge & Co. London, England. 1855

**Wordsworth, William** 1770–1850

English poet

We have no knowledge, that is, no general principles drawn from the contemplation of particular facts, but what has been built up by pleasure, and exists in us by pleasure alone. The Man of science, the Chemist and Mathematician, whatever difficulties and disgusts they may have had to struggle with, know and feel this.

*The Poems of William Wordsworth* (Volume 3)

Preface to the Second Edition of *Lyrical Ballads* (p. 491)

Methuen & Co. London, England. 1908

The Man of science seeks truth as a remote and unknown benefactor; he cherishes and loves it in his solitude...

In Nowell Charles Smith

*The Poems of William Wordsworth* (Volume 3)

Preface to the Second Edition of *Lyrical Ballads* (p. 492)

Methuen & Co. London, England. 1908

If the labours of men of Science should ever create any material revolution, direct or indirect, in our condition, and in the impressions which we habitually receive, the Poet will sleep then no more than at present, but he will be ready to follow the steps of the Man of Science, not only in those general indirect effects, but he will be at his side, carrying sensation into the midst of the objects of the Science itself. The remotest discoveries of the Chemist, the Botanist, or Mineralogist will be as proper objects of the Poet’s art as any upon which I can be employed, if the time should ever come when these things shall be familiar to us...

In R.L. Brett and A.R. Jones (eds.)

*Lyrical Ballads*

Preface (pp. 259–260)

Methuen & Company Ltd. London, England. 1963

**Wright, George Frederick** 1838–1921

American geologist

...men of science properly deal only with secondary causes, from observation of which they draw conclusions of more or less probability with reference to conditions both past and future. Their investigations never lead them to ultimate facts. It is still as true as ever that, however much you may lengthen the chain of natural causes, you cannot reach the ultimate link that fastens it to its permanent support.

In Levi Franklin Gruber

*Creation Ex Nihilo*

Foreword (p. 1)

The Gorham Press. Boston, Massachusetts, USA. 1918

## SCIENCE, MANIFESTATIONS OF

**Branford, Victor**

No biographical data available

There are two dominant moods or manifestations of science: the cosmic, the naturalistic or geographical mood, on the one hand; and on the other, the humanist, the historical, the idealist mood.

*Science and Citizenship*

Section III (p. 6)

George Allen. London, England. 1906

## SCIENCE, MARCH OF

**Lamb, Charles** 1775–1834

English essayist and critic

Can we unlearn the arts that pretend to civilize, and then burn the world? There is a march of science; but who shall beat the drums for its retreat?

In Thomas Noon Talfourd

*The Works of Charles Lamb: To which are Prefixed His Letters, and a Sketch of His Life* (Volume 1)

Letter to George Dyer, December 20, 1830 (p. 292)

Harper & Brothers, Publishers. New York, New York, USA. 1838

**Swann, William Francis Gray** 1884–1962  
Anglo-American physicist

The forerunners in the march of science do not often come heralded by much ceremony suggestive of the power that lies behind them. Often in apparent trivialities do they reveal themselves – trivialities so void of spectacular content that but few can be found who deem it worthwhile to listen to their story.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

Three Centuries of Natural Philosophy (p. 237)  
Government Printing Office. Washington, D.C. 1929

## SCIENCE, MATERIAL OF

**Carson, Rachel** 1907–64  
American marine biologist and author

We live in a scientific age, yet we assume that knowledge of science is the prerogative of only a small number of human beings, isolated and priest-like in their laboratories. This is not true. The materials of science are the materials of life itself. Science is part of the reality of living; It is the what, the how and the why of everything in our experience.

In Paul Brooks

*The House of Life: Rachel Carson at Work*  
Fame (p. 128)

Houghton Mifflin. Boston, Massachusetts, USA. 1972

**Pearson, Karl** 1857–1936  
English mathematician

The material of science is coextensive with the whole physical universe, not only that universe as it now exists, but with its past history and the past history of all life therein.

*The Grammar of Science* (2nd edition)

Chapter I (p. 12)

Adam & Charles Black. London, England. 1900

## SCIENCE, MEANING OF

**Pesic, Peter**  
Musician

To seek the meaning of science is to seek its human significance.

The Bell & the Buzzer: On the Meaning of Science

*Daedalus*, Fall, 2003 (p. 35)

## SCIENCE, METHOD OF

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

Because we are human beings and not mere animals, we try to discover as much as we can about the world in which our lives are cast. We have seen that there is only one method of gaining such knowledge – the method of science, which consists in a direct questioning of nature by observation and experiment.

*Physics and Philosophy*

Chapter VII (p. 174)

The University Press. Cambridge, England. 1943

**Slosson, Edwin E.** 1865–1929  
American chemist and journalist

The method of science is economy of thought. The aim of science is control of the future.

Science from the Side-Lines

*The Century: A Popular Quarterly*, Volume 103, November 1921 to April 1922 (p. 473)

## SCIENCE, MISSION OF

**Balard, Antoine-Jérôme** 1802–76  
French chemist

Science appears to have as its mission not merely the satisfaction of man's need of learning and understanding everything, which characterizes the noblest of our faculties; it has another aim, doubtless less brilliant but perhaps more moral, I would almost say more sacred, which consists in coordinating the forces of nature to increase production and make men more nearly equal by the univ-ersality of comfort.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 438)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

The mission of Science is to study and sound every-thing.

Translated by Melville Best Anderson

*William Shakespeare*

Part I, Book I, Chapter V (p. 38)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

**Pearson, Karl** 1857–1936  
English mathematician

When every fact, every present or past phenomenon of that universe, every phase of present or past life therein, has been examined, classified, and co-ordinated with the rest, then the mission of science will be completed. What is this but saying that the task of science can never end till man ceases to be, till history is no longer made, and development itself ceases?

*The Grammar of Science* (2nd edition)

Chapter I (pp. 12–13)

Adam & Charles Black. London, England. 1900



**SCIENCE, MODERN**

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

...modern science cares far less for pure logic than a dancing Dervish.

*Orthodoxy*

Chapter II (p. 36)

John Lane Company. New York, New York, USA. 1918

[Modern science moves] toward the supernatural with the rapidity of a railway train.

*Orthodoxy*

Chapter IX (p. 277)

John Lane Company. New York, New York, USA. 1918

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

I believe that the advent of modern science is the most important social event in all history.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 2)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Modern science has vindicated the natural equality of man.

*Sybil; Or, The Two Nations*

Chapter V (p. 263)

Longmans, Green & Co. London, England. 1907

**Elliot, Hugh Samuel Roger** 1881–1930  
No biographical data available

Modern science, taking it as it stands without inquiring into the gradual steps by which it was cleared of traditional superstitions, baseless assumptions, and ignorant fancies, has arrived at a systematic interpretation of the phenomena which we call 'Nature' as a vast and orderly mechanism, the working of which we can to a large extent perceive, foresee and manipulate so as to bring about certain results and avoid others.

*Modern Science and the Illusions of Professor Bergson*

Preface (pp. ix–x)

Longmans, Green & Co. New York, New York, USA. 1912

**Gardner, Martin** 1914–  
American writer and mathematics games editor

...modern science should indeed arouse in all of us a humility before the immensity of the explored and a tolerance for crazy hypotheses.

*Science: Good, Bad and Bogus*

Chapter 22 (p. 246)

Prometheus Books. Buffalo, New York, USA. 1981

**Hayward, Jeremy**  
American physicist

Like Christianity, modern science teaches that these things of the world of senses are not really real, but that there is a more real reality, in Nature, behind these appearances, a permanent, unchanging reality in comparison to which the world of appearance is ever changing and is an accidental product of our sense organs. Unlike the "other world" of Christianity, which is world of spirit or mind, altogether without body, this "other world" of science is a world of matter, altogether without spirit, life, or mind. This ultimately real world is the world of particles (little bits of dead stuff), of space and time and of forces (gravitational, electromagnetic, and more recently the strong and weak nuclear forces).

*Shifting Worlds, Changing Minds: Where the Sciences and Buddhism Meet*

Chapter 1 (p. 14)

New Science Library Shambhala Publications, Inc. Boston, Massachusetts, USA. 1987

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

The attitude of modern Science is erect, her aspect serene, her determination inexorable, her onward movement unflinching...

*The Writings of Oliver Wendell Holmes*

*Pages from an Old Volume of Life*

Chapter VIII (p. 310)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1891

**Kennedy, John F.** 1917–63  
35th president of the USA

In the years since man unlocked the power stored up within the atom, the world has made progress, halting but effective, toward bringing that power under human control. The challenge may be our salvation. As we begin to master the destructive potentialities of modern science, we move toward a new era in which science can fulfill its creative promise and help bring into existence the happiest society the world has ever known.

Address

National Academy of Sciences

Washington, D.C., October 22, 1963

**Lebowitz, Fran** 1951–  
American comedian

...modern science was largely conceived of as an answer to the servant problem and...is generally practiced by those who lack the flair for conversation.

*Metropolitan Life*

Science (p. 104)

Fawcett Crest. New York, New York, USA. 1978

**Lippmann, Walter** 1889–1974  
American journalist and author

The radical novelty of modern science lies precisely in the rejection of the belief, which is at the heart of all



popular religion, that the forces which move the stars and atoms are contingent upon the preferences of the human heart.

*A Preface to Morals*

Chapter VII (p. 127)

Transaction Publishers. New Brunswick, New Jersey, USA. 1982

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The story of the triumphs of modern science is one of which Man may well be proud. Science reads the secret of the distant star and anatomises the atom; foretells the date of the comet's return and predicts the kinds of chickens that will hatch from a dozen eggs; discovers the laws of the wind that bloweth where it listeth and reduces to order the disorder of disease.

*The Outline of Science: A Plain Story Simply Told*

Introduction (p. 3)

G.P. Putnam's Sons. New York, New York, USA. 1922

**Thomson, Sir George Paget** 1892–1975

English physicist

[The method of science is] a collection of pieces of advice, some general, some rather special, which may help to guide the explorer in his passage through the jungle of apparently arbitrary facts.... In fact, the sciences differ so greatly that it is not easy to find any sort of rule which applies to all without exception.

*The Inspiration of Science*

Chapter II (p. 7)

Oxford University Press, Inc. London, England. 1961

**Weyl, Hermann** 1885–1955

German mathematician

Modern science, insofar as I am familiar with it through my own scientific work, mathematics and physics make the world appear more and more an open one.... Science finds itself compelled, at once by the epistemological, the physical and the constructive-mathematical aspect of its own methods and results, to recognize this situation. It remains to be added that science can do no more than show us this open horizon; we must not by including the transcendental sphere attempt to establish anew a closed (though more comprehensive) world.

*The Open World: Three Lectures in the Metaphysical Implications of Science*

Preface (p. v)

Yale University Press. New Haven, Connecticut, USA. 1932

**SCIENCE, MORSEL OF**

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

The morsels of science which [the young scientist] picks up – even though often dry or else speciously varnished

– instill in him the intimation of intellectual treasures and creative joys far beyond his ken. His intuitive realization of a great system of valid thought and of an endless path of discovery sustain him in laboriously accumulating knowledge and urge him on to penetrate into intricate brain-racking theories. Sometimes he will also find a master whose work he admires and whose manner and outlook he accepts for his guidance. Thus his mind will become assimilated to the premise of science. The scientific institution of reality henceforth shapes his perception. He learns the methods of scientific investigation and accepts the standards of scientific value.

*Science, Faith and Society*

Authority and Conscience (p. 44)

The University of Chicago Press. Chicago, Illinois. 1964

**SCIENCE, MOTIVE OF**

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The motive of science was the extension of man, on all sides, into Nature, till his hands should touch the stars, his eyes see through the earth, his ears understand the language of beast and bird, and the sense of the wind; and, through his sympathy, heaven and earth should talk with him.

*The Conduct of Life*

Beauty (p. 223)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1894

**SCIENCE, MOVEMENT OF**

**Martin, Geoffrey**

Chemist

Science, aided by thousands of busy brains, is striding onwards so swiftly that no single man can keep pace with her or prophesy into what unknown regions of fact and thought she will next launch us.

*Modern Chemistry and Its Wonders*

Chapter I (p. 21)

D. van Nostrand Co. New York, New York, USA. 1915

**SCIENCE, MYSTERY OF**

**Scoffern, John** 1814–82

Science writer

[S]cience teems with mysteries, but is devoid of mysticisms. None know so well as men of science how slow the march of induction; how limited the grasp of human reason. But the mysteries of science are of this sort: often beyond reason, but never opposed to reason.

*Stray Leaves of Science and Folk-lore*

Modern Mysticism and Modern Science (p. 286)

Tinsley Brothers. London, England. 1870

**Serviss, Garrett Putman** 1851–1921

American science fiction writer

To most minds mystery is more fascinating than science. But when science itself leads straight up to the ‘borders of mystery and there comes to a dead stop, saying, “At present I can no longer see my way,” the force of the charm is redoubled.

*Curiosities of the Sky*

Chapter I (p. 1)

Harper &amp; Brothers Publishers. New York, New York, USA. 1909

**SCIENCE, NAKED****Brown, Samuel** 1817–56

Chemist

...naked science is cold and repulsive, except to the initiated and the predestined votary; but, clothed with its own biography, it becomes instinct with the warmth of life for all.

*Lectures on the Atomic Theory and Essays Scientific and Literary*

(Volume 1)

The History of Science (p. 300)

Thomas Constable &amp; Co. Edinburgh, Scotland. 1858

**SCIENCE, NATURAL****Ardrey, Robert** 1908–80

American anthropologist

The contemporary revolution in the natural sciences has proceeded in something more striking than silence. It has proceeded in secret. Like our tiny, furry, squirrel-like, earliest primate ancestors, seventy million years ago, the revolution has found obscurity its best defence and modesty the key to its survival. For it has challenged larger orthodoxies than just those of science, and its enemies exist beyond counting. From seashore and jungle, from ant-heap and travertine cave have been collected the inflammable materials that must someday explode our most precious intellectual movement seeking light under darkest cover.

*African Genesis*

Chapter 1, Section 2 (p. 13)

Athenaeum. New York, New York, USA. 1968

**Author undetermined**

In every enlightened country, men illustrious for talent, worth, and knowledge, are ardently engaged in enlarging the boundaries of natural science; and the history of their labours and discoveries is communicated to the world chiefly through the medium of Scientific Journals.

Introductory Remarks

*The American Journal of Science*, Volume 1, Number 1, 1819 (p. 1)**Carpenter, William Benjamin** 1813–85

English physiologist and naturalist

As a means of intellectual discipline, the study of Natural Science is perhaps second to none. Habits of accurate, discriminating, unprejudiced observation; of cautious reasoning, and of sound judgment; together with a fearless love of Truth, are cultivated by it.

*Popular Cyclopaedia of Natural Science* (p. ii)

William S. Orr &amp; Co. London, England. 1843

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The natural sciences are furiously writing on second volumes of which there exist neither the first nor the last.

*Voices in the Labyrinth: Nature, Man and Science* (p. 26)

The Seabury Press. New York, New York, USA. 1977

**Freund, Ida** 1863–1914

Austrian-born chemist

The object of all the Natural Sciences is the acquisition of knowledge concerning the natural objects surrounding us, as we apprehend them by our senses; of the changes occurring in these objects, together with the laws governing these changes; and of the more proximate or more ultimate causes to the operation of which are due the individual phenomena and the general laws comprising these.

*The Study of Chemical Composition*

Introduction (p. 1)

At The University Press. Cambridge, England. 1904

**Gorky, Maxim** 1868–1938

Russian writer

For us natural science is the Archimedes’ screw that alone can turn the world to face the sun of reason.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Natural science does not simply describe and explain nature; it is part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter V (p. 81)

Harper &amp; Row, Publishers. New York, New York, USA. 1958

**Herrick, Charles Judson** 1868–1960

American neurologist

The operations of natural science are limited by definition to the domain of nature. We cannot talk rationally about the supernatural without first explaining what we mean by nature. All science is a human construction based on human experience, and it can go no further than the range of possible experience. This sets a logical and an actual

operational limit to nature as envisaged scientifically and practically.

*The Evolution of Human Nature*

Epilogue: The Unknown God (p. 462)

University of Texas Press. Austin, Texas, USA. 1956

**Jourdain, Philip E. B.** 1879–1919

English logician

Natural science is occupied very largely with the prevention of waste of the labour of thought and muscle when we want to call up, for some purpose or other, certain facts of experience.

*The Nature of Mathematics* (Revised edition)

Introduction (p. 11)

T.C. & E.C. Jack. London, England. 1919

**Kingsley, Charles** 1819–75

English clergyman and author

...Natural Science is a subject which a man cannot learn by paying for teachers. He must teach it himself, by patient observation, by patient common sense.

*Scientific Lectures and Essays*

Preface (p. 16)

Macmillan & Co Ltd. London, England. 1893

**Marsh, George Perkins** 1801–82

American diplomat, scholar, and conservationist

Natural science has become so vastly extended, its recorded facts and its unanswered questions so immensely multiplied, that every strictly scientific man must be a specialist, and confine the researches of a whole life within

*Man and Nature: Or, Physical Geography as Modified by Human Action*

Chapter I (p. 12)

Charles Scribner's Sons. New York, New York, USA. 1865

**Müller, Paul** 1899–1965

Swiss chemist

In the field of natural science only persistence and sustained hard work will produce results...

*Nobel Lectures, Physiology or Medicine 1942–1962*

Dichloro-Diphenyl-Trichloroethane and Newer Insecticides

Elsevier Publishing Co. Amsterdam, The Netherlands. 1964

**Nichols, Ernest Fox** 1869–1924

American physicist

...in the natural sciences as in more practical affairs, *how* we have arrived is as important as *where* we have arrived.

*Lectures on Science, Philosophy and Art, 1907–1908*

Physics (p. 6)

The Columbia University Press. New York, New York, USA. 1908

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

The foundation of every natural science is now at last firmly laid, not a day passing without some addition of

buttress and pinnacle to their already magnificent fabric.

*The Stones of Venice*

Chapter IV (p. 169)

John R. Alden, Publisher. New York, New York, USA. 1885

**Simon, Herbert Alexander** 1916–2001

American social scientist

The central task of a natural science is to make the wonderful commonplace: to show that complexity, correctly viewed, is only a mask for simplicity; to find pattern hidden in apparent chaos.

*The Sciences of the Artificial*

Chapter I (p. 1)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Wright, Julia McNair** 1840–1903

Writer

Natural science is so placed in the fore-front of the studies of the present age that no apology is needed for pressing it upon the schools. To object to this pursuit is simply to write oneself a laggard behind the times. We can do little that is better for our children than to teach them that the world is lawful to the core.

*Nature Readers: Sea-side and Way-side* Number 4

Note

D.C. Heath & Co. Boston, Massachusetts, USA. 1896

## SCIENCE, NATURE OF

**Bain, Alexander** 1818–1903

Scottish philosopher and psychologist

It is the nature of science to be more or less dry; until its commanding power is felt the path of the learner is thorny.

In Lamar Taney Beman

*Selected Articles on the Study of Latin and Greek*

Negative Discussion (p. 143)

The H.W. Wilson Co. New York, New York, USA. 1921

**Beck, Stanley D.**

No biographical data available

If we are to live in an age of science, and indeed we must, it is very important that we understand the nature of science itself.

*The Simplicity of Science*

Chapter I (p. 13)

Doubleday & Company, Inc. Garden City, New York, USA. 1959

## SCIENCE, NET OF

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The net of science covers the empirical universe: What is it made of (fact) and why does it work this way (theory).

Non Overlapping Magisteria

*Natural History*, Volume 106, Number 2, March, 1997 (p. 61)

## SCIENCE, NORMAL

**Kuhn, Thomas S.** 1922–96

American historian of science

The practice of normal science depends on the ability, acquired from exemplars, to group objects and situations into similarity sets which are primitive in the sense that the grouping is done without an answer to the question, “similar with respect to what?”

*The Structure of Scientific Revolutions*

Postscript–1969 (p. 200)

The University of Chicago Press. Chicago, Illinois, USA. 1970

Normal science...is predicated on the assumption that the scientific community knows what the world is like. Much of the success of the enterprise derives from the community’s willingness to defend that assumption, if necessary at considerable cost.

*The Structure of Scientific Revolutions*

Chapter I (p. 5)

The University of Chicago Press. Chicago, Illinois, USA. 1970

## SCIENCE, OBJECT OF

**Lowe, Robert**

No biographical data available

The object of science is not to please or to conciliate. It has no policy. It knows no compromise. If false, no popularity can redeem it; if true, no unpopularity can hurt it.

Recent Attacks on Political Economy

*The Nineteenth Century*, Volume 4, November, 1878 (p. 862)

**Lyman, Theodore**

No biographical data available

The sole object of science thus becomes, to find out all the  $x$ ’s in the universe and all the  $y$ ’s, and to give to each  $x$  its proper  $y$ .

Force

*American Journal of Science*, Volume XXIX, Number 66, March, 1860

## SCIENCE, OSCARS OF

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The Oscars of science do not set trends, but follow them.

*Voices in the Labyrinth: Nature, Man and Science* (p. 86)

The Seabury Press. New York, New York, USA. 1977

## SCIENCE, PACE OF

**Fromm, Erich** 1900–80

German psychoanalyst

The pace of science forces the pace of the technique. Theoretical physics forces atomic energy on us; the successful production of the fission bomb forces upon us the

manufacture of the hydrogen bomb. We do not choose our problems, we do not choose our products; we are pushed, we are forced – by what? By a system which has no purpose and goal transcending it, and which makes man its appendix.

*The Sane Society*

Chapter Five, Nineteenth-Century Capitalism (p. 83)

Fawcett Publications. Greenwich, Connecticut, USA. 1955

## SCIENCE, PARTS OF

**Holliday, Francis**

No biographical data available

Many...parts of science are founded only on probable conjectures, in the midst of which the mind not knowing where to fix, and wanting sufficient principles to direct its searches, wanders in the dark, and at length gives them over as useless and unsatisfactory.

In Francis Holliday

*Miscellanea Curiosa Mathematica* (Volume 1)

Preface (p. viii)

Printed for Edward Cave. London, England. 1749

## SCIENCE, PATH OF

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

...the path of science and of letters is not the way into nature. The idiot, the Indian, the child, and unschooled farmer’s boy, stand nearer to the light by which nature is to be read, than the dissector or the antiquary.

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: First Series*

History (p. 256)

The Library of America. New York, New York, USA. 1983

**Guyot, Arnold** 1807–84

Swiss-born American geologist, geographer, and educator

Be pleased always to remember...that the path of science is often difficult and beset with rugged cliffs. The traveler doubtless gathers many flowers on the way. But the tree of Science, which bears the noblest fruits, is placed high up on precipitous rocks. It holds out to our view these precious fruits from afar. Happy he who by his efforts may pluck one of them, even were it the humblest. He values it, then, by what it has cost him.

*The Earth and Man*

Lecture I (p. 35)

Gould & Lincoln. Boston, Massachusetts, USA. 1860

## SCIENCE, PHILOSOPHY OF

**Carus, Paul** 1852–1919

American philosopher

Mankind has become more and more convinced of the efficiency of science, and in this sense the philosophy of

science prevails even now as a still latent but nevertheless potent factor in the life of mankind, manifesting itself in innumerable subconscious tendencies of the age.

*Philosophy as a Science: A Synopsis of Writings of Dr. Paul Carus*

Introduction (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1909

## SCIENCE, PHYSICAL

**Brooks, William Keith** 1848–1908

American zoologist

The physical sciences deal with the external world, and in the laboratory we study the structure and activities of organisms by very similar methods; but if we stop here, neglecting the relation of the living being to its environment, our study is not biology or the science of life.

*The Foundations of Zoology*

Lecture III (p. 54)

The Macmillan Company. New York, New York, USA. 1899

**Chambers, George Frederick** 1841–1915

English amateur astronomer

It may, I fear, be taken as a truism that “the man in the street” (collectively, “the general public”) knows little and cares less for what is called physical science. Now and again when something remarkable happens, such as a great thunderstorm, or an earthquake, or a volcanic eruption, or a brilliant comet, or a total eclipse, something in fact which has become the talk of the town, our friend will condescend to give the matter the barest amount of attention, while he is filling his pipe or mixing a whisky and soda...

*The Story of Eclipses*

Chapter I (p. 9)

S.S. McClure Co. New York, New York, USA. 1909

**Condorcet, Marie Jean** 1749–1827

French mathematician, astronomer, and physicist

This adventure of the physical sciences...could not be observed without enlightened men seeking to follow it up in the other sciences; at each step it held out to them the model to be followed.

In K.M. Baker

*Condorcet: From Natural Philosophy to Social Mathematics*

Chapter 2 (p. 85)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Cooke, Josiah Parsons** 1827–94

American chemist

Physical science is noble because it does deal with thought, and with the very noblest of all thought. Nature at once manifests and conceals an Infinite Presence: Her methods and orderly successions are the manifestations of Omnipotent Will; Her contrivances and laws the embodiment of Omniscient Thought.

*Scientific Culture*

The Baconian Method

Henry S. King & Co. London, England. 1876

**d’Abro, Abraham**

No biographical data available

Practically the whole of physical science is thus one mass of inference based ultimately, but not immediately, on direct knowledge.

*The Rise of the New Physics* (Volume 1)

Chapter II (p. 15)

Dover Publications, Inc. New York, New York, USA. 1951

**Disraeli, Benjamin, First Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

The world is devoted to physical science, because it believes these discoveries will increase its capacity of luxury and self-indulgence.

*Lothair*

Chapter XVII (p. 70)

Longmans, Green & Co. London, England. 1879

**Huxley, Thomas Henry** 1825–95

English biologist

Physical science, its methods, its problems, and its difficulties, will meet the poorest boy at every turn, and yet we educate him in such a manner that he shall enter the world as ignorant of the existence of the methods and facts of science as the day he was born. The modern world is full of artillery; and we turn out our children to do battle in it, equipped with the shield and sword of an ancient gladiator.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

Physical science is one and indivisible. Although, for practical purposes, it is convenient to mark it out into the primary regions of Physics, Chemistry, and Biology, and to subdivide these into subordinate provinces, yet the method of investigation and the ultimate object of the physical inquirer are everywhere the same.

*Method and Results: Essays*

The Progress of Science (p. 60)

D. Appleton & Co. New York, New York, USA. 1898

Physical science therefore rests on verified or uncontradicted hypotheses; and, such being the case, it is not surprising that a great condition of its progress has been the invention of verifiable hypotheses.

*Method and Results: Essays*

The Progress of Science (pp. 61–62)

D. Appleton & Co. New York, New York, USA. 1898

**Keeler, James E.** 1847–1900

American astrophysicist

The domains of the physical sciences are not, like the political divisions represented on a map, capable of being defined by boundary lines traced with mathematical precision. They pass into one another by imperceptible



gradations, the unity of nature opposing itself to rigid systems of classification. Thus there often exists between two allied sciences a broad ground, belonging to each, yet exclusively the property of neither, which may be so extensive and fertile as to justify the development of a new science for its special cultivation. And such a science not only subserves the purpose for which it was created, but it has the further special importance that, by promoting an exchange of knowledge between its previously established neighbors, by investigating the cause of disagreements between them, by comparing their methods, and possibly by detecting errors in their results, it tends to bring them into more perfect coordination.

The Importance of Astrophysical Research and Their Relation of Astrophysics to Other Physical Sciences  
*The Astrophysical Journal*, Volume 6, Number 4, November, 1897 (p. 271)

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Physical science does not pretend to be a *complete* view of the world; it simply claims that it is working toward such a complete view in the future. The highest philosophy of the scientific investigator is precisely this *toleration* of an incomplete conception of the world and the preference for it rather than an apparently perfect, but inadequate conception.

Translated by Thomas J. McCormack  
*The Science of Mechanics: A Critical and Historical Exposition of Its Principles*  
Chapter IV (p. 464)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1893

Physical science makes no investigation at all into things that are absolutely inaccessible to exact investigation, or as yet inaccessible to it.

Translated by Thomas J. Macormack  
*The Science of Mechanics: A Critical and Historical Account of Its Development*  
Chapter IV (p. 465)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1893

**Newman, John Henry** 1801–90  
Catholic Cardinal

...if Physical Science be dangerous, as I have said, it is dangerous, because it necessarily ignores the idea of moral evil...

*The Idea of a University Defined and Illustrated*  
Introductory (p. 7)  
Longmans, Green & Co. London, England. 1891

**O'Malley, Austin** 1858–1932  
American physician and humorist

Physical science reads through its sense of touch like a blind man, and the supply of books in braille type on the spiritual life is very small.

*Keystones of Thought* (p. 10)  
The Devin-Adair Co. New York, New York, USA. 1915

**Smith, Goldwin** 1823–1910  
British-Canadian historian and journalist

What is the sum of physical science? Compared with the comprehensible universe and with conceivable time, not to speak of infinity and eternity, it is the observation of a mere point, the experience of an instant.

*The World's Best Orations: From the Earliest Period to the Present Time* (Volume 9)  
The Secret Beyond Science (p. 3476)  
Ferd. P. Keiser. St. Louis, Missouri, USA. 1899

**Wells, David Ames** 1828–98  
American economist

The principles of physical science are so intimately connected with the arts and occupations of every-day life, with our very existence and continuance as sentient beings, that public opinion, at the present time, imperatively demands that the course of instruction on this subject should be as full, thorough, and complete as opportunity and time will permit. With this view, the author has endeavored to render the work, in all its arrangements and details, eminently practical, and, at the same time, interesting to the student. The illustrations and examples have been multiplied to a greater extent than is usual in works of like character, and have been derived, in most cases, from familiar and common objects.

*Well's Natural Philosophy*  
Preface (p. iii)  
Iverson, Blakeman, Taylor, & Co. New York, New York, USA. 1873

## SCIENCE, POPULAR

**Mitchell, Maria** 1818–89  
American astronomer and educator

The phrase 'popular science' has in itself a touch of absurdity. That knowledge which is popular is not scientific.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter IX (p. 185)  
Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

## SCIENCE, POPULARIZER OF

**Sagan, Carl** 1934–96  
American astronomer and author

It is a supreme challenge for the popularizer of science to make clear the actual, tortuous history of its great discoveries and the misapprehensions and occasional stubborn refusal by its practitioners to change course.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 1 (p. 22)  
Random House, Inc. New York, New York, USA. 1995



**SCIENCE, PORT OF**

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

The port of science – whether pure or applied – is free, and a modest yawl can find a berth in it as readily as a splendid merchantman, provided that it has a cargo to discharge.

The Message of Science  
*Science*, Volume LIV, Number 1402, November, 1921 (p. 447)

**SCIENCE, POSITION OF**

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

The positions of science must be tried in the jeweller's scales, not like the mixed commodities of the market, on the weigh-bridge of common opinion and vulgar usage.

*Hints Towards the Formation of a More Comprehensive Theory of Life*  
The Nature of Life (p. 21)

John Churchill. London, England. 1847

**SCIENCE, POTENTIALITIES OF**

**Lewis, Wyndham** 1882–1957  
English author and painter

The puritanic potentialities of science have never been forecast. If it evolves a body of organized rites, and is established as a religion, hierarchically organized, things more than anything else will be done in the name of “decency.” The coarse fumes of tobacco and liquors, the consequent tainting of the breath and staining of white fingers and teeth, which is so offensive to many women, will be the first things attended to.

*The Art of Being Ruled*

Chapter 7 (p. 210)

Chatto & Windus. London, England. 1926

**SCIENCE, POWER OF**

**Podolsky, Boris** 1896–1966  
American physicist

In recent years the power of Science has received such popular recognition that the adjective scientific attached to merchandise or statement is known to give to such merchandise or to a statement prestige having definite advertising value. As a consequence the words science and scientific are frequently abused by those who find it profitable to borrow reputation instead of earning it.

What Is Science?

*The Physics Teacher*, Volume 3, Number 2, February, 1965 (p. 71)

**SCIENCE, PRACTICAL**

**Aquinas, St. Thomas** 1227?–74  
Dominican philosopher and theologian

Practical sciences proceed by building up; theoretical sciences by resolving into components.

Translated by Thomas Gilby

*Philosophical Texts* (p. 4)

1982

**Playfair, Lyon** 1818–98

Scottish scientist and Parliamentarian

Practical, like abstract science, has no limits.

*Records of the School of Mines and of Science Applied to the Arts*  
(Volume 1), Part I

The Study of Abstract Science (p. 30)

Longman, Brown, Green & Longmans. London, England. 1852

**National Academy of Sciences (USA)**

Practical science may...be compared to intelligent parentage, which not only conceives and bears, but nourishes and rears its progeny, foreseeing the end from the beginning.

*Biographical Memoirs*

Biographical Memoir of George Hammell Cook (p. 138)

National Academy of Sciences (USA). Washington, D.C. 1902

**SCIENCE, PRACTITIONER OF**

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

The practitioner of a science must know much more than he can know. Ignorance is no handicap in the arts – Renoir did not have to have seen all the nudes that were painted before him.

*Voices in the Labyrinth: Nature, Man and Science* (p. 149)

The Seabury Press. New York, New York, USA. 1977

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

In the end, science as we know it has two basic types of practitioners. One is the educated man who still has a controlled sense of wonder before the universal mystery, whether it hides in a snail's eye or within the light that impinges on that delicate organ. The second kind of observer is the extreme reductionist who is so busy stripping things apart that the tremendous mystery has been reduced to a trifle, to intangibles not worth troubling one's head about.

*The Star Thrower*

Science and the Sense of the Holy (p. 190)

Times Books. New York, New York, USA. 1978

**SCIENCE, PRINCIPLES OF**

**McMurry, Charles Alexander** 1857–1929  
American educator

A child does not want the alphabet (that is, the simple principles) of science anymore than he wants the names of the letters of the alphabet when learning to read.

*Special Method in Elementary Science for the Common School*  
Chapter III (p. 30)  
The Macmillan Co. New York, New York, USA. 1905

**SCIENCE, PROCESS OF**

**Asimov, Isaac** 1920–92  
American author and biochemist

The process of science... involves a slow forward movement through the reachable portions of the Universe – a gradual unfolding of parts of the mystery.

*"X" Stands for Unknown*  
Introduction (p. 10)  
Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

The process of science involves heroic ideas as well as its share of stupidity.

*Blind Watchers of the Sky*  
Preface (p. x)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**SCIENCE, PROGRESS OF**

**Abernethy, John** 1680–1740  
Irish Presbyterian minister, theologian, and dissenter

Although knowledge has at times appeared to exhibit something of uniformity in its advances, yet it cannot have escaped the least observant that, as a whole, the Progress of Science has been marked by very variable activity. At once time marvelously rapid; at another, indefinitely slow; now merged in darkness or obscurity, and not blazing forth with meridian splendor.

*Memoirs of John Abernethy*  
Chapter I (p. 1)  
Harper & Brothers. New York, New York, USA. 1853

**Bernard, Claude** 1813–78  
French physiologist

The progress of experimental method consists in this, – that the sum of truths grows larger in proportion as the sum of errors grows less. But each one of these particular truths is added to the rest to establish more general truths. In this fusion, the names of promoters of science disappear little by little, and the further science advances,

the more it takes an impersonal form and detaches itself from the past.

*An Introduction to the Study of Experimental Medicine*  
Part I, Chapter II, Section iv (p. 42)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

The progress of science is the discovery at each step of a new order which gives unity to what had long seemed unlike.

*Science and Human Value*  
The Creative Mind (p. 26)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Brown, Samuel** 1817–56  
Chemist

The progress of science is as orderly and determinate as the movements of the planets, the solar systems, and the celestial firmaments. It is regulated by laws as exact and irresistible as those of astronomy, optics, or chemistry...

*Lectures on the Atomic Theory, and Essays Scientific and Literary*  
(Volume 1)  
The Atomic Theory before Christ and Since (p. 81)  
Thomas Constable & Co. Edinburgh, Scotland. 1858

**Cohen, Morris Raphael** 1880–1947  
American philosopher

...the progress of science always depends upon our questioning the plausible, the respectably accepted, and the seemingly self-evident.

*Reason and Nature*  
Book III  
Chapter One, Section II (p. 348)  
Free Press. Glencoe, Georgia, USA. 1953

**Coles, Abraham** 1813–91  
American physician, hymnist, and poet

Believing needless ignorance a crime,  
You strive to reach the summit of your time;  
To old age learning up from early youth  
Your life one long apprenticeship to truth.  
Wisely suspicious sometimes of the new,  
Ye give alert acceptance to the true:  
Even though it make old science obsolete,  
It with a thousand welcomes still you greet...  
Each Year adds something – many things ye know  
Your sires knew not a Hundred Years ago.

*The Microcosm and Other Poems*  
The Microcosm  
Physician's Character and Aims – Science Progressive  
D. Appleton & Company. New York, New York, USA. 1881

**Constitution of the USA**

The Congress shall have the Power...to promote the Progress of Science and useful Arts...

*United States Constitution*  
Article I, Section 8

**Daly, Reginald Aldworth** 1871–1957  
Canadian-American geologist

Inasmuch as cosmogony and geology are both young sciences, consensus of opinions about the earth's origin and history is still reserved for the future. Meantime these sciences are advancing through the erection and testing of competing hypotheses; in other words, through speculation, controlled by all the available facts. Science progresses through systematic guessing in the good sense of the world.

*Our Mobile Earth*

Introduction (p. xx)

Charles Scribner's Sons. New York, New York, USA. 1926

**de La Beche, Henry Thomas** 1796–1855  
English geologist

It surely can be no offence to state, that the progress of science has led to new views, and that the consequences that can be deduced from the knowledge of a hundred facts may be very different from those deducible from five. It is also possible that the facts first known may be the exceptions to a rule, and not the rule itself, and generalizations from these first-known facts, though useful at the time, may be highly mischievous, and impede the progress of the science if retained when it has made some advance.

*Sections & Views, Illustrative of Geological Phenomena*

Preface (p. viii)

Treuttel & Wurtz. London, England. 1830

**Dewar, James** 1842–1923  
English physicist and chemist

In a legitimate sense all genuine scientific workers feel that they are "inheritors of unfulfilled renown." The battlefields of science are the centers of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of nature.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

History of Cold and the Absolute Zero (p. 240)

Government Printing Office. Washington, D.C. 1903

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

Is it not evident, in these last hundred years (when the Study of Philosophy has been the business of all the Virtuosi in Christendom) that almost a new Nature has been reveal'd to us? that more errors of the School have been detected, more useful Experiments in Philosophy have been made, more Noble Secrets in Opticks, Medicine, Anatomy, Astronomy, discover'd, than in all those credulous and doting Ages from Aristotle to us? so true it is that nothing spreads more fast than Science, when rightly and generally cultivated.

*Of Dramatick Poesie: An Essay* (Volume 1) (p. 12)  
Printed for Henry Herringman. London, England. 1684

**Duclaux, Pierre Émile** 1840–1904  
French biochemist

It is because science is sure of nothing that it is always advancing.

In William Osler

*Evolution of Modern Medicine*

Chapter VI (p. 219)

Yale University Press. New Haven, Connecticut, USA. 1921

A series of judgments, revised without ceasing, goes to make up the incontestable progress of science.

In W. Mansfield Clark

*The Determination of Hydrogen Ions*

Chapter VIII (p. 177)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1928

## Editorial

The progress of science, but even more the spread and development of the scientific spirit, are constantly forcing upon religion new and difficult questions and constantly raising anew the question whether faith and the scientific mind can live together. If not it will soon come to pass that between the intellectual forces of the world and the religion of the world there will be a great gulf fixed over which none will pass from either side. On the one hand, from the attitude of mind which science has created there will be no retreat but only advance; and on the other, the human heart's need of religion makes it certain that however it may change its form religion will never die. The only question is whether religion and science will live together or dwell apart in separate and hostile camps.

Faith and the Scientific Mind

*The Biblical World*, Volume XXXVIII, Number 1, July, 1911

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

Science forces us to create new ideas, new theories. Their aim is to break down the wall of contradictions which frequently blocks the way of scientific progress. All the essential ideas in science were born in a dramatic conflict between reality and our attempts at understanding.

*The Evolution of Physics*

Quanta (p. 280)

Simon & Schuster. New York, New York, USA. 1936

**Enriques, Federico** 1871–1946  
Italian mathematician

[T]he progress of science is dependent upon science itself, it is an extension and not a creation.

*Problems of Science*

Chapter 3, Section 37 (p. 165)

The Open Court Publishing Company. Chicago, Illinois, USA. 1914

**Fiske, John** 1842–1901  
American philosopher and historian

When we look at the stupendous edifice of science that has been reared upon this basis, when we consider the almost limitless sweep of inorganic and organic chemistry, the myriad applications to the arts, the depth to which we have been enabled to penetrate into the innermost proclivities of matter, it seems almost incredible that a single century can have witnessed so much achievement.

*A Century of Science and Other Essays*

Chapter I (p. 4)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1900

**Foster, Sir Michael** 1836–1907  
English physiologist

Though much of the progress of science seems to take on the form of a series of great steps, each made by some great man, the distinction in science between the great discoverer and the humble worker is one of degree only, not of kind.

Address by the President of the British Association for the Advancement of Science

*Science*, N.S. Volume X, Number 249, October 6, 1899 (p. 476)

The path [of progress in science] may not always be in a straight line; there may be swerving to this side and to that; ideas may seem to return again and again to the same point of the intellectual compass; but it will always be found that they have reached a higher level.... Moreover, science is not fashioned as is a house, by putting brick to brick, that which is once put remaining as it was put to the end. The growth of science is that of a living being. As is the embryo, phases follows phase, and each member or body puts on in succession different appearances, though all the while the same member, so a scientific conception of one age seems to differ from that of a following age...

*Annual Report of the Smithsonian Institution For 1899*

The Growth of Science in the Nineteenth Century

Government Printing Office. Washington, D.C. 1900

In science there is only progress. The path may not be always a straight line, there may be swerving to this side and to that, ideas may seem to return again and again to the same point of the intellectual compass; but it will always be found that they have reached a higher level – they have moved, not in a circle, but in a spiral.

*Report of the Sixty-ninth Meeting of the British Association for the Advancement of Science*

President's Address (p. 15)

John Murray. London, England. 1900

**France, Anatole (Jean Jacques Brousson)** 1844–1924  
French writer

The progress of science renders useless the very books which have been the greatest aid to that progress. As those works are no longer useful, modern youth is naturally

inclined to believe they never had any value; it despises them, and ridicules them if they happen to contain any superannuated opinion whatever.

Translated by Lafcadio Hern

*The Crime of Sylvester Bonnard*

June 4 (p. 168)

Harper & Brothers. New York, New York, USA. 1890

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

The rapid progress true Science now makes occasions my regretting sometimes that I was born so soon. It is impossible to imagine the heights to which may be carried, in a thousand years, the power of man over matter. O that moral Science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity.

In Linus Pauling

*College Chemistry*

Letter to Joseph Priestley, 8 February, 1780

Chapter 1 (p. 3)

W.H. Freeman & Company. San Francisco, California, USA. 1964

**Free, E. E.**

No biographical data available

Like a man on a bicycle science cannot stop; [science] must progress or collapse.

The Electric Brains in the Telephone

*The World's Work*, Volume LIII, Number 4, February, 1927 (p. 429)

**Garrod, Archibald** 1857–1936  
English physician

In these days of rapid scientific progress there is a tendency to accept the facts of nature, as at present known, without glancing back at the slow and difficult stages by which the knowledge of these facts has been arrived at. Yet such a retrospect is by no means unprofitable, since it warns us that hasty generalizations upon insufficient data retard rather than advance the progress of knowledge, and that the theories of the day must not be accepted as necessarily expressing absolute truths.

In Alexander G. Bearn

*Archibald Garrod and the Individuality of Man*

Chapter 3 (p. 25)

Clarendon Press. Oxford, England. 1993

**Greene, Brian** 1963–  
American physicist

Progress in science proceeds in fits and starts. Some periods are filled with great breakthroughs, in other times researchers experience dry spells. Scientists put forward results, both theoretical and experimental. The results are debated by the community, sometimes they are discarded, sometimes they are modified, and sometimes they provide inspirational jumping-off points for new and more accurate ways of understanding the physical

universe. In other words, science proceeds along a zigzag path toward what we hope will be ultimate truth, a path that began with humanity's earliest attempts to fathom the cosmos and whose end we cannot predict.

*The Elegant Universe*

Chapter 1 (p. 20)

W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Science progresses not only because it helps to explain newly discovered facts, but also because it teaches us over and over again what the word “understanding” may mean.

*Physics and Beyond*

Chapter 10 (p. 124)

Harper & Row, Publishers. New York, New York, USA. 1971

**Kingzett, Charles Thomas** 1852–1935

Chemist

Boast is made of the rapid progress of science. Bah! it is untrue. Science never did, does not, and never can make rapid strides. Relatively, progress may be rapid, but it is only relative to times when progress was much slower.

*Animal Chemistry; Or, The Relations of Chemistry to Physiology and Pathology*

Part I, Chapter I (p. 17)

Longmans, Green & Co. London, England. 1878

**Koestler, Arthur** 1905–83

Hungarian-born English writer

The progress of science is strewn, like an ancient desert trail, with the bleached skeletons of discarded theories which once seemed to possess eternal life.

*The Ghost in the Machine* (p. 178)

The Macmillan Co. New York, New York, USA. 1968

**Kuhn, Thomas S.** 1922–96

American historian of science

...we must explain why science – our surest example of sound knowledge – progresses as it does, and we first must find out how, in fact, it does progress.

In Imre Lakatos and Alan Musgrave (eds.)

*Criticism and the Growth of Knowledge*

Logic of Discovery or Psychology of Research (p. 20)

Cambridge University Press. Cambridge, England. 1970

Does a field make progress because it is a science, or is it a science because it makes progress?

*The Structure of Scientific Revolutions* (2nd edition)

Chapter XIII (p. 162)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Langley, Samuel Pierpoint** 1834–1906

American astronomer and aviation pioneer

I would almost prefer to ask you to think rather of a moving crowd [for the progress of science], where the

direction of the whole comes somehow from the independent impulses of its individual members, not wholly unlike a pack of hounds, which, in the long run, perhaps catches its game, but where, nevertheless, when at fault, each individual goes his own way by scent, not by sight, some running back and some forward; where the louder-voiced bring many to follow them, nearly as often in a wrong path as in a right one; where the entire pack even has been known to move off bodily on a false scent...

The History of a Doctrine

*The Popular Science Monthly*, Volume 34, Number 2, December, 1888

(p. 213)

**Lee, Tsung Dao** 1926–

Chinese-born American nuclear physicist

The progress of science has always been the result of a close interplay between our concepts of the universe and our observations on nature. The former can only evolve out of the latter and yet the latter is also conditioned greatly by the former. Thus, in our exploration of nature, the interplay between our concepts and our observations may sometimes lead to totally unexpected aspects among already familiar phenomena.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1957

Weak Interactions and Nonconservation of Parity (p. 417)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Lewis, Exum Percival**

No biographical data available

...the progress of science is greatly aided by the judicious use of the imagination, constantly checked by a comparison with facts.

*Notes on the Properties of Matter and Heat*

Introductory (p. 3)

Percival Lewis. Berkeley, California, USA. 1903

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

There is no greater impediment to progress in the sciences than the desire to see it take place too quickly.

Translated by R.J. Hollingdale

*Aphorisms*

Notebook K, Aphorism 72

Penguin Classics. New York, New York, USA. 1990

**Lindley, David** 1956–

English astrophysicist and author

Progress in science is a matter of jumping to conclusions. The trick is to jump to useful and interesting conclusions. Generalizing from small scraps of evidence may lead one astray, but sticking strictly to what limited evidence one has, and refusing to countenance anything that is not directly provable, leads nowhere at all. The scientist has to generate new ideas and hypotheses, then act upon them.



*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*  
An Engineer, a Physicist, and a Philosopher... (p. 157)  
Basic Books, Inc. New York, New York, USA. 1996

### Loey, William Albert

No biographical data available

In the progress of science there is an army of observers and experimenters each contributing his share, but the rank and file supply mainly isolated facts, while the ideas take birth in the minds of a few gifted leaders, either endowed with unusual insight, or so favored by circumstances that they reach general conclusions of importance.

*Biology and Its Makers: With Portraits and Other Illustrations* (3rd edition)

Part I, Chapter I (p. 7)

Henry Holt & Co. New York, New York, USA. 1908

### Lowie, Robert H. 1883–1957

Austrian-born American anthropologist

The clarification of concepts...directly gauges scientific progress.

*The History of Ethnological Theory*

Chapter XIV (p. 281)

Rinehart & Company, Inc. New York, New York, USA. 1937

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

Science has almost made greater progress through that which she has known how to ignore than by that which she has taken into account.

Translated by the Bhikkhau Silacara

In Paul Dahlke

*Buddhism & Science*

Chapter 6 (p. 100)

Macmillan & Co Ltd. London, England. 1913

As a fact, every enlightening progress made in science is accompanied with a certain feeling of disillusionment. We discover that that which appeared wonderful to us is no more wonderful than other things which we know instinctively and regard as self-evident; nay, that the contrary would be much more wonderful; that everywhere the same fact expresses itself. Our puzzle turns out then to be a puzzle no more; it vanishes into nothingness, and takes its place among the shadows of history.

Translated by Thomas McCormack

*The Science of Mechanics: A Critical and Historical Account of Its Development* (4th edition)

Chapter I (p. 31)

The Open Court Publishing Co. Chicago, Illinois, USA. 1902

### Mayr, Ernst 1904–2005

German-born American biologist

Any scientific revolution has to accept all sorts of black boxes, for if one had to wait until all black boxes are opened, one would never have any conceptual advances.

*One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought*

Chapter Ten (p. 146)

Harvard University Press. Cambridge, Massachusetts, USA. 1991

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

It can be said that Science progresses only by peeling away, one after another, all the covering of apparent stability in the world; disclosing beneath the immobility of the infinitely small, movement of extra rapidity, and beneath the immobility of the Immense, movement of extra slowness.

*The Future of Man*

Some Reflections on Progress (p. 62)

Methuen & Company Ltd. London, England. 1960

### Planck, Max 1858–1947

German physicist

It is a rather zigzag pattern than the curve of scientific progress follows; indeed I might say that the forward movement is of an explosive type, where the rebound is an attendant characteristic of the advance. Every applied hypothesis which succeeds in throwing the searchlight of a new vision across the field of physical science represents a plunge into the darkness; because we cannot at first reduce the vision to a logical statement. Then follows the birth-struggle of a new theory. Once this has seen the light of day it has to go forward willy-nilly until the stamp of its destiny is put on it when the test of the research measurements is applied.

*Where Is Science Going?*

Nature's Image in Science (pp. 90–91)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning...

*The Philosophy of Physics*

Chapter III (p. 97)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

In science it would be a tremendous loss if we were to say: "We are not making very much progress. Let us sweep away all science and start afresh." The rational procedure is to correct it and to revolutionize it, but not to sweep it away. You may create a new theory, but the new theory is created in order to solve those problems which the old theory did not solve.

*Conjectures and Refutations*

Chapter 4 (p. 132)

Harper & Row, Publishers. New York, New York, USA. 1963



...in order that a new theory should constitute a discovery or a step forward it should conflict with its predecessor... it should contradict its predecessor; it should overthrow it. In this sense, progress in science – or at least a striking progress – is always revolutionary.

In Rom Harré

*Problems of Scientific Revolution*

The Rationality of Scientific Revolutions (pp. 82–83)

The Clarendon Press. Oxford, England. 1975

**Price, Don Krasher** 1910–95

American political scientist

...most scientists are prepared to work most of the time within the framework of ideas developed by their acknowledged leaders. In that sense...science is ruled by oligarchs who hold influence as long as their concepts and systems are accepted as the most successful strategy.... Once in a great while, a rival system is proposed; then there can usually be no settlement of the issue by majority opinion. The metaphor of “scientific revolution” suggests the way in which the losing party is displaced from authority, discredited and its doctrines eliminated from textbooks.

*The Scientific Estate*

Chapter 6 (p. 172)

Harvard University Press. Cambridge, Massachusetts, USA. 1965

**Priestley, Joseph** 1733–1804

English theologian and scientist

If the progress continues the same in another period, of equal length, what a glorious science shall we see unfold, what a fund of entertainment is there in store for us, and what important benefits must derive mankind.

Quoted by John G. McEvoy

Electricity, Knowledge, and the Nature of Progress in Priestley’s Thought

*The British Journal for the History of Science*, Volume 12, Number 40, 1979 (p. 76)

**Quetelet, Adolphe** 1794–1874

Belgian mathematician, astronomer, and statistician

The more progress physical sciences makes, the more they tend to enter the domain of mathematics, which is a kind of center to which they all converge. We may even judge of the degree of perfection to which a science has arrived by the facility with which it may be submitted to calculation.

In E. Mailly

*Annual Report of the Board of Regents of the Smithsonian Institution, 1874*

Eulogy of Quetelet (p. 173)

Government Printing Office. Washington, D.C. 1875

**Richet, Charles** 1850–1935

French physiologist

One can only progress in the sciences – with the exception of Mathematics – at the price of great pecuniary sacrifice.

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter II (p. 21)

J.M. Dent & Sons Ltd. London, England. 1927

All progress in science is progress in civilization, and consequently contributes to the welfare of man.

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter XIII (p. 145)

J.M. Dent & Sons Ltd. London, England. 1927

**Rindos, David** 1947–96

American educator

Progress in science depends not only upon new data but also upon the careful elaboration of new approaches to old data as well as new.

In Michael B. Schiffer (ed.)

*Archaeological Method and Theory* (Volume 1)

Chapter I (p. 1)

University of Arizona Press. Tucson, Arizona, USA. 1989

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Science is the key to the progress of the world.

*Encyclopedia of Thoughts*

Aphorism 20

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Men sometimes speak as though the progress of science must necessarily be a boon to mankind, but that, I fear, is one of the comfortable nineteenth century delusions which our more disillusioned age must discard.

*Icarus; or, The Future of Science* (p. 57)

**Russell, Lord John** 1792–1878

English Whig and Liberal politician

Those who make these [scientific] discoveries sometimes commit great errors. They fall into many absurd mistakes...but these blunders and these errors disappear – the discoveries alone remain; other men afterwards make these discoveries the elements and groundwork of new investigations, and thus the progress of science is continual; but truth remains, the methods of investigations even are shortened, and the progress continually goes on.

*The World’s Best Orations: From the Earliest Period to the Present*

*Time* (Volume 9)

Science and Literature as Modes of Progress (p. 3365)

Ferd. P. Keiser. St. Louis, Missouri, USA. 1899

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

When we say that science is essentially progressive this does not mean that in his quest of truth man follows always the shortest path. Far from it, he beats about

the bush, does not find what he is looking for but finds something else, retraces his steps, loses himself in various detours, and finally after many wanderings touches the goal.

*The History of Science and the New Humanism*

Chapter I (pp. 45–46)

H. Holt & Co. New York, New York, USA. 1931

**Smith, Alexander** 1865–1922

American chemist and author

The progress of science would be almost completely arrested, if, every time we succeeded in formulating a seemingly satisfactory statement of truth in regard to some set of phenomena, the exhibition by nature of any behavior which was in conflict with our statement became forthwith “impossible.”

*Introduction to General Inorganic Chemistry*

Chapter I (p. 8)

The Century Co. New York, New York, USA. 1907

**Stewart, Alfred Walter** 1880–1947

British chemist

Speaking exclusively of observational and experimental sciences, it is obvious that progress can be accomplished only at the cost of destroying or modifying current theories; for if a theory suffices to explain facts discovered after its promulgation, knowledge may be increased; but there is no true progress unless our general outlook is altered.

*Recent Advances in Organic Chemistry*

Chapter I (p. 1)

Longmans, Green & Co. London, England. 1908

**Thomson, Sir George Paget** 1892–1975

English physicist

...the progress of science is a little like making a jig-saw puzzle. One makes collections of pieces which certainly fit together, though at first it is not clear where each group should come in the picture as a whole, and if at first one makes a mistake in placing it, this can be corrected later without dismantling the whole group.

*The Inspiration of Science*

Introduction (pp. 5–6)

Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

You can hardly convince a man of an error in a life-time, but must content yourself with the reflection that the progress of science is slow.

*A Week on the Concord and Merrimack Rivers*

Sunday (p. 43)

Charles Scribner's Sons. New York, New York, USA. 1921

**Umbgrove, J. H. F.**

No biographical data available

Science progresses with steady strides. New facts come to light and new ideas are born every day, and

our conception of the structure of the universe changes accordingly. Our views have constantly to be revised and readjusted, but occasionally new aspects of far-reaching consequence shed such an unexpectedly different light on existing problems that its effects might be compared to those of a revolution. All that had hitherto been sacrosanct crumbles to the ground; hardly anything is left untouched.

*The Pulse of the Earth*

Chapter I (p. 2)

M. Nijhoff. The Hague, Netherlands. 1947

**von Bertalanffy, Ludwig** 1901–72

Austrian biologist

The evolution of science is not a movement in an intellectual vacuum; rather it is both an expression and a driving force of the historical process.

*Problems of Life: An Evaluation of Modern Biological Thought*

Chapter Six (p. 202)

Watts & Company. London, England. 1952

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...we might well mention from our perspective, that there are advantages to entering a field of science which is in a state of crisis, and in which we also find an active, extraordinary person. We are young with young methods, our beginnings reach into a new epoch.

In Karl J. Fink

*Goethe's History of Science*

Chapter 6 (p. 88)

Cambridge University Press. Cambridge, England. 1991

**von Liebig, Justus** 1803–73

German organic chemist

...the progress of science is, like the development of Nature's works, gradual and expansive. After the buds and branches spring forth the leaves and blossoms, after the blossoms the fruit.

*Familiar Letters on Chemistry*

Letter IX (p. 128)

Walton & Maberly. London, England. 1859

## SCIENCE, PROMOTION OF

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

If a man devotes himself to the promotion of science, he is firstly opposed, and then he is informed that his ground is already occupied. At first men will allow no value to what we tell them, and then they behave as if they knew it all themselves.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#571 (p. 199)

The Macmillan Co. New York, New York, USA. 1906

**von Neumann, John** 1903–57  
Hungarian-American mathematician

**Morgenstern, Oskar** 1902–77  
German-born American economist

The great progress in every science came when, in the study of problems which were modern as compared with ultimate aims, methods were developed which could be extended further and further. The free fall is a very trivial physical phenomenon, but it was the study of this exceedingly simple fact and its comparison with the astronomical material, which brought forth mechanics.

*Theory of Games and Economic Behavior*  
Chapter 1.3.2 (p. 6)  
Princeton University Press. Princeton, New Jersey, USA. 1947

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The progress of Science consists in observing interconnections and in showing with a patient ingenuity that the events of this ever-shifting world are but examples of a few general relations, called laws. To see what is general in what is particular, and what is permanent in what is transitory, is the aim of scientific thought.

*An Introduction to Mathematics*  
Chapter 1 (p. 4)  
Oxford University Press, Inc. New York, New York, USA. 1958

[S]cience started its modern career by taking over ideas derived from the weakest side of the philosophies of Aristotle's successors. In some respects it was a happy choice. It enabled the knowledge of the seventeenth century to be formulated so far as physics and chemistry were concerned, with a completeness which lasted to the present time. But the progress of biology and psychology has probably been checked by the uncritical assumption of half-truths.

*Science and the Modern World*  
Chapter I (pp. 16–17)  
The Macmillan Company. New York, New York, USA. 1929

In the conditions of modern life the rule is absolute, the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated.

*The Organisation of Thought*  
Chapter I (p. 28)  
Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## SCIENCE, PURE

**Barnett, Lincoln Kinnear** 1909–79  
American science writer

...the aims of pure basic science, unlike those of applied science, are neither fast-flowing nor pragmatic. The quick harvest of applied science is the useable process, the medicine, the machine. The shy fruit of pure science is understanding.

The Meaning of Einstein's New Theory  
*Life*, January 9, 1950 (p. 22)

**Coulter, John Merle** 1851–1928  
American botanist and educator

To neglect pure science and support only applied science would be like wanting children and eliminating parents. The Social, Educational, and Scientific Value of Botanic Gardens  
*Science*, N.S. Volume 45, Number 1174, June 29, 1917 (p. 645)

**Jevons, Frank Byron** 1858–1936  
No biographical data available

The business of pure science is to discover facts; that of the applied science is to use them.

*An Introduction to the Study of Comparative Religion*  
Introduction (p. 2)  
The Macmillan Co. New York, New York, USA. 1908

**Munroe, J.**  
No biographical data available

The study of pure Science tends in a measure not only to lessen our sense of the beauty of external Nature, but to dispel that reverent spirit in which we should regard each other and the wonderful universe in which we dwell.

*Science and the Sense of Beauty*  
*The Journal of Science, and Annals of Astronomy, Biology, Geology*,  
Volume IV, (Third series), April, 1882 (p. 201)

## National Academy of Sciences (USA)

...pure science is the blind instinct of civilization. It delights to lay eggs – the more, the better – but gives no thought nor care to their hatching.

*Biographical Memoirs* (Volume 4)  
Biographical Memoir of George Hammell Cook (p. 138)  
National Academy of Sciences (USA). Washington, D.C. 1902

**Sagan, Carl** 1934–96  
American astronomer and author

Science – pure science, science not for any practical application but for its own sake – is a deeply emotional matter for those who practice it, as well as for those non-scientists who every now and then dip in to see what's been discovered lately.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 19 (p. 330)  
Random House, Inc. New York, New York, USA. 1995

## SCIENCE, PURSUIT OF

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

The pursuit of science has often been compared to the scaling of mountains, high and not so high. But who amongst us can hope, even in imagination, to scale the Everest and reach its summit when the sky is blue and the air is still, and in the stillness of the air survey the entire Himalayan range in the dazzling white of the snow stretching to infinity? None of us can hope for a comparable vision of nature and of the universe around us. But there is nothing mean or lowly in standing in the valley below and awaiting the sun to rise over Kinchinjunga.

*Truth and Beauty: Aesthetics and Motivation in Science*  
Chapter 2, Section X (pp. 26–27)  
The University of Chicago Press. Chicago, Illinois, USA. 1987

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We all know that there are regions of the human spirit untrammelled by the world of physics. In the mystic sense of the creation around us, in the expression of art, in a yearning towards God, the soul grows upward and finds the fulfillment of something implanted in its nature. The sanction for this development is within us, a striving born with our consciousness or an Inner Light proceeding from a greater power than ours. Science can scarcely question this sanction, for the pursuit of science springs from a striving which the mind is impelled to follow, a questioning that will not be suppressed.

*The Nature of the Physical World*  
Chapter XV (pp. 327–328)  
The University Press. New York, New York, USA. 1929

**Priestley, Joseph** 1733–1804  
English theologian and scientist

A successful pursuit of science makes a man the benefactor of all mankind and of every age.

*Experiments and Observations on Different Kinds of Air* (Volume 1)  
The Preface (p. xxvii)  
Thomas Pearson. Birmingham, England. 1790

**Wheeler, John Archibald** 1911–  
American physicist and educator

...the pursuit of science is more than the pursuit of understanding. It is driven by the creative urge, the urge to construct a vision, a map, a picture of the world that gives the world a little more beauty and coherence than it had before.

*Geons, Black Holes, and Quantum Foam: A Life in Physics*  
Chapter 3 (p. 84)  
W.W. Norton & Company, Inc. New York, New York, USA. 1998

## SCIENCE, REALITY OF

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

...the realities of Science have proved far more varied and surprising than the dreams of fiction.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter III (p. 96)  
Macmillan & Company Ltd. London, England. 1903

## SCIENCE, REFINEMENT OF

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

The latest refinements of science are linked with the cruelties of the Stone Age.

Speech  
26 March, 1942

## SCIENCE, REPUBLIC OF

**Clifford, William Kingdon** 1845–79  
English mathematician

...the republic of science, which allows no masters, but proved comrades only...

In Robert Tucker  
*Mathematical Papers*  
Review of *A Budget of Paradoxes* (p. 561)  
Macmillan & Company Ltd. London, England. 1882

## SCIENCE, REWARD OF

**Slosson, Edwin E.** 1865–1929  
American chemist and journalist

The highest reward of science, the secret satisfaction of standing where no mortal man has ever stood before, is rightly reserved to those who contribute most to its advance.

Science from the Side-Lines  
*The Century: A Popular Quarterly*, Volume 103, November 1921 to April 1922 (p. 473)

## SCIENCE, RIGOR OF

**Hertz, Heinrich** 1857–94  
German physicist

The rigor of science requires, that we distinguish well the un-draped figure of nature itself from the gay-coloured

vesture with which we clothe it at our pleasure.

Quoted in Ludwig Boltzmann

Certain Questions of the Theory of Gasses

*Nature*, Volume 51, Number 1322, February 28, 1895 (p. 413)

## SCIENCE, ROLE OF

### Colin, Trudge

No biographical data available

The true role of science is not to change the universe but more fully to appreciate it.

*The Engineer in the Garden: Genes and Genetics* (p. 361)

Hill & Wang. New York, New York, USA. 1993

### Tudge, Colin 1943–

English science writer

The true role of science is not to change the universe but more fully to appreciate it.

*The Engineer in the Garden: Genes and Genetics* (p. 361)

Hill & Wang. New York, New York, USA. 1993

## SCIENCE, RUSH OF

### Darwin, Sir Francis 1848–1925

English botanist

How grand is the onward rush of science; it is enough to console us for the many errors which we have committed, and for our efforts being overlaid and forgotten in the mass of new facts and new views which are daily turning up.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Wallace, August 28, 1872 (p. 348)

D. Appleton & Company. New York, New York, USA. 1896

## SCIENCE, SCAVENGER OF

### Magendie, Francois 1783–1855

French physiologist

I am a mere street scavenger of science. With hook in hand and basket on my back, I go about the streets of science collecting whatever I find.

In Rene Dubos

*Louis Pasteur: Free Lance of Science*

Chapter XIII (p. 363)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

## SCIENCE, SCOPE OF

### Simpson, George Gaylord 1902–84

American paleontologist

As for the scope of science, it includes everything known to exist or to happen in the material universe. Since the arts, philosophy, and theology do exist in the material universe, they too are within the scope of science and can

properly be studied as psychological, anthropological, and biological phenomena.

*Notes on the Nature of Science*

Notes on the Nature of Science by a Biologist (pp. 11–12)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

## SCIENCE, SCRUTINIZING EYE OF

### Dana, James Dwight 1813–95

American geologist, mineralogist, and naturalist

The scrutinizing eye of science penetrates with far-reaching sight the system of things about us, and in the dim limits of vision reads everywhere the word mystery.

*On Coral Reefs and Islands*

Chapter II (p. 47)

G.P. Putnam & Co. 1853

## SCIENCE, SEARCH-LIGHT OF

### Dampier, Sir William Cecil 1867–1952

English scientific writer

But beyond the bright search-lights of science, Out of sight of the windows of sense, Old riddles still bid us defiance, Old questions of Why and of Whence.

*The Recent Development of Physical Science*

Introduction (p. 10)

P. Blakiston's Son & Co. Philadelphia, Pennsylvania, USA. 1904

## SCIENCE, SECRETS OF

### Quintilian ca. 35–ca. 100

Roman rhetorician

There is nothing more detestable than a man who, because he has learned a little more than the alphabet, thinks that he has been initiated into the deepest secrets of science.

*De Institutione Oratoria*

I, 1, 8

Publisher undetermined. London, England. 1822

The lofty serenity of science becomes possible only on the condition of impartial criticism, which without regard for the beliefs of a certain portion of humanity, handles its imperturbable instrument with the inflexibility of the geometrician, without anger and without pity. The critic never insults.

*The Future of Science*

Chapter XV (p. 257)

Roberts Brothers. Boston, Massachusetts, USA. 1893

## SCIENCE, SERENITY OF

### Renan, Ernest 1823–92

French philosopher and Orientalist

The lofty serenity of science becomes possible only on the condition of impartial criticism, which without regard

for the beliefs of a certain portion of humanity, handles its imperturbable instrument with the inflexibility of the geometriician, without anger and without pity. The critic never insults.

*The Future of Science*

Chapter XV (p. 257)

Roberts Brothers. Boston, Massachusetts, USA. 1893

## SCIENCE, SHIP OF

**Gregory, Sir Richard Arman** 1864–1952

English scientific writer and journalist

Explorers on the ship of science go out to discover new lands; and their spirit is not the same as that which actuates the prospectors who follow them with the intention of making the lands profitable to themselves and others.

*Discovery, Or, The Spirit and Service of Science*

Chapter IX (pp. 234–235)

Macmillan & Co Ltd. London, England. 1916

## SCIENCE, SIGNS OF

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

The signs of science are, some certain and infallible; some, uncertain. Certain, when he that pretendeth the science of anything, can teach the same; that is to say, demonstrate the truth thereof perspicuously to another; uncertain, when only some particular events answer to his pretence, and upon many occasions prove so as he says they must.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth,*

*Ecclesiastical and Civil* (2nd edition)

Chapter V (p. 30)

George Routledge & Sons. London, England. 1886

## SCIENCE, SOUL OF

**Darwin, Sir Francis** 1848–1925

English botanist

Forgive me for suggesting one caution; as Demosthenes said, “Action, action, action,” was the soul of eloquence, so is caution almost the soul of science.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

To Dohrn, January 4, 1870 (p. 444)

D. Appleton & Company. New York, New York, USA. 1903

**Lowenberg, J.**

No biographical data available

The soul of science is a restless soul. Its temper is a temper aglow with defiance of all that limits and arrests inquiry, analysis, and experiment. Ceaseless incursion into the unknown is its endless task. It lives on questions and it feeds on problems. No scientific answer

which in its turn is not the beginning of new questions. No scientific solution without its peculiar train of fresh problems. It is in this sense that the word finality is utterly incongruous with the critical and mobile spirit of science.

Philosophy and Humanism

*University of California Chronicle*, Volume XXIII, Number 3, July, 1921 (p. 311)

## SCIENCE, STAGE OF

**Whewell, William** 1794–1866

English philosopher and historian

Every stage of science has its train of practical applications and systematic inferences, arising both from the demands of convenience and curiosity, and from the pleasure which, as we have already said, ingenious and active-minded men feel in exercising the process of deduction.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book III, Chapter I (p. 121)

John W. Parker & Son. London, England. 1857

## SCIENCE, STORY OF

**Anthony, H. D.**

No biographical data available

The story of science and its background reveals another aspect of human progress, measured not so much in terms of time as of achievement.

*Science and Its Background*

Chapter I (p. 6)

Macmillan & Co Ltd. London, England. 1948

## SCIENCE, STRENGTH OF

**Abelson, Philip Hauge** 1913–2004

American physicist

Part of the strength of science is that it has tended to attract individuals who love knowledge and the creation of it. Just as important to the integrity of science have been the unwritten rules of the game. These provide recognition and approbation for work which is imaginative and accurate, and apathy or criticism for the trivial or inaccurate.... Thus, it is the communication process which is at the core of the vitality and integrity of science...

The Roots of Scientific Integrity

*Science*, Volume 139, 1963

**Hauge, Philip** 1913–2004

American scientist, editor, and administrator

Part of the strength of science is that it has tended to attract individuals who love knowledge and the creation of it.



Just as important to the integrity of science have been the unwritten rules of the game. These provide recognition and approbation for work which is imaginative and accurate, and apathy or criticism for the trivial or inaccurate.... Thus, it is the communication process which is at the core of the vitality and integrity of science.... The system of rewards and punishments tends to make honest, vigorous, conscientious, hardworking scholars out of people who have human tendencies of slothfulness and no more rectitude than the law requires.

The Roots of Scientific Integrity  
*Science*, Volume 139, 1963 (p. 3561)

**Lewis, Gilbert Newton** 1875–1946  
American chemist

The strength of science lies in its naïveté. Science is like life itself; if we could foresee all the obstacles that lie in our path we would not attack even the first, but would settle down to self-centered contemplation.

*The Anatomy of Science*  
Chapter I (p. 1)  
Yale University Press. New Haven, Connecticut, USA. 1926

## SCIENCE, STUDENT OF

**Hill, Alexander**  
No biographical data available

The aim Of science is to know Nature. As a merchant takes stock of his goods before he makes plans for placing them on the market, so the student of science must make himself acquainted with the phenomena which Nature exhibits, in the province which he has pledged himself to explore, before he attempts to assign to them their several uses.

*Introduction to Science*  
Chapter I (p. 5)  
The Macmillan Co. New York, New York, USA. 1900

**Kingsley, Charles** 1819–75  
English clergyman and author

Good men, honest men, accurate men, righteous men, patient men, self-restraining men, fair men, modest men. Men who are aware of their own vast ignorance compared with the vast amount that there is to be learned in such a universe as this. Men who are accustomed to look at both sides of a question; who, instead of making up their minds in haste like bigots and fanatics, wait like wise men, for more facts, and more thought about the facts. In one word, men who had acquired just the habit of mind which the study of Natural Science can give, and must give; for without it there is no use studying Natural Science; and the man who has not got that habit of mind, if he meddles with science, will merely become a quack and a charlatan, only fit to get his bread as a spirit-rapper, or an inventor of infallible pills.

*Scientific Lectures and Essays*  
Preface (pp. 19–20)  
Macmillan & Co Ltd. London, England. 1893

**Munroe, J.**  
No biographical data available

The student of modern Science is led by patient observation and experiment into the details of Nature. He is no longer viewing the great masses of the heavens and endeavoring to solve the riddle of their mysterious motions. He is busy investigating the component particles of their large masses.

Science and the Sense of Beauty  
*The Journal of Science, and Annals of Astronomy, Biology, Geology*,  
Volume IV, (Third series), April, 1882 (p. 202)

**Richards, Theodore William** 1868–1928  
American chemist

Every student of Science, even if he cannot start his journey where his predecessors left off, can at least travel their beaten track more quickly than they could while they were clearing the way: and so before his race is run he comes to virgin forest and becomes himself a pioneer.

*Nobel Lectures, Chemistry 1901–1921*  
Nobel lecture for award received in 1914  
Atomic Weights (p. 280)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1966

## SCIENCE, STUDY OF

**Boole, George** 1815–64  
English mathematician

The study of every department of physical science begins with observation, it advances by the collation of facts to a presumptive acquaintance with their connecting law, the validity of such presumption it tests by new experiments so devised as to augment, if the presumption be well founded, its probability indefinitely; and finally, the law of the phenomenon having been with sufficient confidence determined, the investigation of causes, conducted by the due mixture of hypothesis and deduction, crowns the inquiry.

*An Investigation of the Laws of Thought*  
Chapter XXII (p. 402)  
Walton & Maberly. London, England. 1854

**Clarke, Frank Wigglesworth** 1847–1931  
American chemist

The study of science is a continual discouragement of obscurity or vagueness; it is a discipline in the statement and solution of definite problems, and it trains one to see things as they are, apart from all irrelevancies.

The Man of Science in Practical Affairs  
*Appletons' Popular Science Monthly*, Volume XLV, February, 1900  
(p. 488)

**Lavoisier, Antoine Laurent** 1743–94

French chemist

When we begin the study of any science, we are in a situation, respecting that science, similar to that of children; and the course by which we have to advance is precisely the same which Nature follows in the formation of their ideas. In a child, the idea is merely an effect produced by a sensation; and, in the same manner, in commencing the study of a physical science, we ought to form no idea but what is a necessary consequence, and immediate effect, of an experiment or observation. Besides, he that enters upon the career of science, is in a less advantageous situation than a child who is acquiring his first ideas.

*Elements of Chemistry*

Preface (p. xv)

Publisher undetermined

Edinburgh, Scotland. 1799

**Prout, Curtis**

No biographical data available

The study of science suggests the need for humility.

*Demand and Get the Best Health Care for You: An Eminent Doctor's Practical Advice* (p. 148)

Faber &amp; Faber. Boston, Massachusetts, USA. 1997

**SCIENCE, SUBJECTS OF****Cole, K. C.**

Science writer

The subjects of science are not only often unseeable; they are also untouchable, unmeasurable, and sometimes even unimaginable.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Part I, Chapter I (p. 17)

Harcourt Brace &amp; Co. Orlando, Florida, USA. 1999

**SCIENCE, SUCCEED IN****Singer, Charles** 1876–1960

Historian of science and medicine

To succeed in science it is necessary to receive the tradition of those who have gone before us. In science, more perhaps than in any other study, the dead and the living are one.

In Lloyd William Taylor

*Physics: the Pioneer Science* (Volume 1)

Chapter 15 (p. 182)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**SCIENCE, SUPERIORITY OF****Born, Max** 1882–1970

German-born English physicist

I now regard my former belief in the superiority of science over other forms of human thought and behavior

as a self-deception due to youthful enthusiasm over the clarity of scientific thinking as compared with the vagueness of metaphysical systems.

Still, change of fundamental concepts and the failure to improve the moral standards of human society are no demonstration of the uselessness of science in the search for truth and for a better life.

*Physics in My Generation*

Preface (p. v)

Springer-Verlag New York, Inc. New York, New York, USA. 1969

**SCIENCE, TECHNICALITIES OF****Clarke, Frank Wigglesworth** 1847–1931

American chemist

The technicalities of science, so bewildering to the layman, are merely aids to exactness, avoidances of circumlocution – in short, they are practical devices whereby labor is saved.

The Man of Science in Practical Affairs

*Appletons' Popular Science Monthly*, Volume XLV, February, 1900 (p. 488)**SCIENCE, TEMPLE OF****Brewster, David** 1781–1868

Scottish scientist, inventor, and writer

If the God of Love is most appropriately worshiped in the Christian Temple, the God of Nature may be equally honoured in the Temple of science.

*Report of the Twentieth Meeting of the British Association for the Advancement of Science*

Address of the President (p. xli)

John Murray. London, England. 1851

**Einstein, Albert** 1879–1955

German-born physicist

Many kinds of men devote themselves to Science, and not all for the sake of Science herself. There are some who come into her temple because it offers them the opportunity to display their particular talents. To this class of men science is a kind of sport in the practice of which they exult, just as an athlete exults in the exercise of his muscular prowess. There is another class of men who come into the temple to make an offering of their brain pulp in the hope of securing a profitable return. The men are scientists only by the chance of some circumstance which offered itself when making a choice of career...it is clear that if the men who have devoted themselves to science consisted only of the two categories I have mentioned, the edifice could never have grown to its present proud dimensions....

In Max Planck

*Where Is Science Going?*

Prologue (p. 7)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1932

I am inclined to agree with Schopenhauer in thinking that one of the strongest motives that lead people to give their lives to art and science is the urge to flee from everyday life, with its drab and deadly dullness, and thus to unshackle the chains of one's own transient desires, which supplant one another in interminable succession so long as the mind is fixed on the horizon of daily environment.

In Max Planck

*Where Is Science Going?*

Prologue (p. 7)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

In the temple of science are many mansions, and various indeed are they that dwell therein and the motives that have led them thither. Many take to science out of a joyful sense of superior intellectual power; science is their own special sport to which they look for vivid experience and the satisfaction of ambition; many others are to be found in the temple who have offered the products of their brains on this altar for purely utilitarian purposes. Were an angel of the Lord to come and drive all the people belonging to these two categories out of the temple, the assemblage would be seriously depleted, but there would still be some men, of both present and past times, left inside.

*Ideas and Opinions*

Principles of Research (p. 224)

Crown Publishers, Inc. New York, New York, USA. 1954

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

To qualify for admission into the temple of science it is necessary to offer sacrifices at the altar of knowledge; and only those with sincere regard for truth will find their gifts acceptable.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 54)

Macmillan & Company Ltd. London, England. 1918

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Admission to its [temple of science] sanctuary, and to the privileges and feelings of a votary, is only to be gained by one means – sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.

*Outlines of Astronomy: By Sir John F. W. Herschel*

Introduction (p. 26)

American Home Library Co. New York, New York, USA. 1902

**Pasteur, Louis** 1822–95

French chemist

Preconceived ideas are like searchlights which illuminate the path of the experimenter and serve him as a guide to interrogate nature. They become a danger only if he transforms them into fixed ideas – this is why I should like to see these profound words inscribed on the threshold of all the temples of science: “The greatest derangement of the mind is to believe in something because one wishes it to be so”...

In René Dubos

*Louis Pasteur: Free Lance of Science*

Speech to the French Academy of Medicine, July 18, 1876, Chapter XIII (p. 376)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Peet, C. C.**

No biographical data available

The temple of science is the temple of sense; Its foundation is logic, and right its defense; Knowledge and wisdom, its beams of support; Truth its great tower, and reason its court.

*Whispers and Echoes*

The Temple of Science (p. 48)

Published by the Author. Boston, Massachusetts, USA. 1882

**Pierce, Benjamin** 1809–80

American mathematician

...it is not to be forgotten that the Temple of Science, by whomsoever built, belongs to no country or clime. It is the World's Temple, and all men are free of its communion. Let us not mar its beauty by 'writing our names upon its walls. The stone which we have inserted, is not ours, it is not thine, it is not mine, but it is part of the Temple.

Opening Address

*The Annals of Science*, Volume I, Number 18, August, 1853 (p. 207)

**Planck, Max** 1858–1947

German physicist

Anybody who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: *Ye must have faith*. It is a quality which the scientist cannot dispense with.

*Where Is Science Going?*

Epilogue (p. 214)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Polyphilus**

One evening as I slept, methought I beheld a beautiful temple in a beautiful place; I stood and gazed on this wonderful work with admiration and astonishment, many of its high towers appeared to touch the sky, but one in particular met my observation; it seemed to rise above all the others and lose its summit in the deep blue sky, which it would have done but for a stream of vivid gold which displayed its wondrous termination. What does

this mean? I enquired of an old man at the gate of the temple. He answered, son! This is the temple of science!

*The Oriental Rambler, or, The Papers of Polyphilus*

Part I

Number 25 (p. 109)

J.B. Pharoah. 1844

**Richards, William Carey** 1818–92

American magazine editor

And lo! a temple builded to her praise,  
Whose grand proportions mortals may not know!  
Geology its deep foundation lays,  
In massive rocks, that with the ages grow,  
Slow as their solemn lapse, and strong as slow:  
No marble walls on these foundations rise,  
Nor mortal-fashioned columns stand arrow;  
For walls and dome, Astronomy supplies  
The infinite profound, of wonder-veiling skies.

*Electron, or, The Pranks of the Modern Puck*

The Temple of Science (pp. 17–18)

D. Appleton & Co. New York, New York, USA. 1858

## SCIENCE, THEOREM OF

**Harris, James** 1709–80

English grammarian

...every Exercise of the Mind upon Theorems of Science, like generous and manly Exercise of the Body, tends to call forth and strengthen Nature's original Vigour. Be the Subject itself immediately lucrative or not, the Nerves of Reason are braced by the mere Employ, and we become abler Actors in the Drama of Life, whether our Part be of the busier, or of the sedater kind.

*Hermes: Or, A Philosophical Inquiry Concerning Universal Grammar*

(7th edition)

Book II, Chapter V (p. 295)

Printed for J. Collingwood. London, England. 1825

## SCIENCE THEORETICAL

**Kline, Morris** 1908–92

American mathematics professor and writer

Theoretical Science is a game of mathematical make-believe.

*Mathematics: The Loss of Certainty*

Chapter XIV (p. 325)

Oxford University Press, Inc. New York, New York, USA. 1980

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

A theoretical science unaware that those of its constructs considered relevant and momentous are destined eventually to be framed in concepts and words that have a grip on the educated community and become part and parcel of the general world picture – a theoretical science, I say,

where this is forgotten, and where the initiated continue musing to each other in terms that are, at best, understood by a small group of close fellow travelers, will necessarily be cut off from the rest of cultural mankind; in the long run it is bound to atrophy and ossify however virulently esoteric chat may continue within its joyfully isolated groups of experts.

Are There Quantum Jumps?

*The British Journal for the Philosophy of Science*, Volume 3, 1952 (p. 110)

## SCIENCE, THINK OF

**Wilson, Andrew** 1852–1912

No biographical data available

When, therefore, you think of science, do not picture it to yourself as composed of nothing save the dry-as-dust technicalities of popular notions.... Think of true science as a living reality; as a faithful expounder of all that is worth knowing and that can be known; as an existing power, ever anxious in its unwearied march for the good and welfare of mankind; and best of all, perhaps, as an ever-willing instructor of all who will come to be taught.

*Leisure-time Studies: Chiefly Biological. A Series of Essays and Lectures*

Science-Culture for the Masses (pp. 34–35)

Chatto & Windus. London, England. 1879

## SCIENCE, TORCH OF

**Poteat, William Louis** 1856–1938

American educator

It is true that the torch of science grows brighter with each passing year, and shoots its rays deeper into the enveloping darkness, but mystery is ever with it. Science proposes more questions than it solves.

Science and Culture

*The South Atlantic Quarterly*, Volume 2, Number 1, January, 1903 (p. 72)

## SCIENCE, TOUCH OF

**Balfour, Arthur James** 1848–1930

English prime minister

The material world, howsoever it may have gained in sublimity, has, under the touch of science, lost (so to speak) in domestic charm. Except where it affects the immediate needs of organic life, it may seem so remote from the concerns of men that in the majority it will rouse no curiosity, while of those who are fascinated by its marvels, not a few will be chilled by its impersonal and indifferent immensity.

In Wilfrid M. Short

*The Mind of Arthur James Balfour*

Decadence (p. 97)

George H. Doran Co. New York, New York, USA. 1918

**Pritchett, V. S.** 1900–97  
English writer

A touch of science, even bogus science, gives an edge to the superstitious tale.

*The Living Novel and Later Appreciations*  
An Irish Ghost (p. 123)  
Random House, Inc. New York, New York, USA. 1964

## SCIENCE, TOUCHSTONE OF

**Pearson, Karl** 1857–1936  
English mathematician

The touchstone of science is the universal validity of its results for all normally constituted and duly instructed minds.

*The Grammar of Science* (2nd edition)  
Chapter I (p. 24)  
Adam & Charles Black. London, England. 1900

## SCIENCE, TRACES OF

**Venable, Francis Preston** 1856–1934  
American chemist

In attempting to discover traces of a science in earliest historic times, one must first disabuse his mind of the idea that he will find it in anything like the elaborated modern form in which he knows it. These natural sciences are the result of a long process of evolution, and the primal form will probably prove a very much disguised one.

*A Short History of Chemistry*  
Part First (p. 1)  
D.C. Heath & Co. Boston, Massachusetts, USA. 1894

## SCIENCE, TRASH CANS OF

**Mandelbrot, Benoit B.** 1924–  
French mathematician

I started looking in the trash cans of science...because I suspected that what I was observing was...perhaps very widespread. I attended lectures and looked in unfashionable periodicals...once in a while finding some interesting things. In a way it was a naturalist's approach, not a theoretician's approach. But my gamble paid off.

In James Gleick  
*Chaos: Making a New Science*  
A Geometry of Nature (p. 110)  
The Viking Press. New York, New York, USA. 1987

## SCIENCE, TREASURES OF

**Webster, Daniel** 1782–1852  
American statesman

We welcome you to the treasures of science and the delights of learning.

*The Great Speeches and Orations of Daniel Webster*  
First Settlement of New England (p. 52)  
Little, Brown & Co. Boston, Massachusetts, USA. 1914

## SCIENCE, TRUE

**Harvey, Moses** 1820–1901  
Irish clergyman, essayist, and naturalist

True science being thus the interpretation of nature, must of necessity be imperfect, though progressive; and from feeble beginnings, and through many mistakes arising from an imperfect acquaintance with facts, she has to correct her stammering utterances, as she attempts to read the hieroglyphics of the universe.

Science and Religion  
*The Maritime Monthly*, Volume II, November, 1873 (p. 479)

...true Science is always modest and humble; always cherishes a deep reverence for facts, and is always ready to correct her own interpretations as a clearer light is reached. As she conquers one realm after another, she recognizes that these are but fringes of the great realms of the unknown which lie beyond.

Science and Religion  
*The Maritime Monthly*, Volume II, November, 1873 (p. 479)

**Renan, Ernest** 1823–92  
French philosopher and Orientalist

A little true science is better than a great deal of bad science. One is less liable to error by confessing one's ignorance than by fancying that one knows a great many things one does not.

*The Future of Science*  
Preface (p. xix)  
Roberts Brothers. Boston, Massachusetts, USA. 1893

## SCIENCE, TRUTH OF

**Silver, Brian L.**  
Israeli professor of physical chemistry

One point is incontestable: the "truth" of science must always remain open to critical scrutiny and will sometimes have the status of a beauty queen: looks good today, but next year she'll be dethroned. That is because the real test of a scientific theory is not whether it is "true." The real test is whether it works.

*The Ascent of Science*  
Part I, Chapter 2 (p. 24)  
Solomon Press Book. New York, New York, USA. 1998

## SCIENCE, TYPES OF

**Harris, Errol E.**  
No biographical data available

Accordingly there are two main types of science, exact science...and empirical science...seeking laws which are



generalizations from particular experiences and are verifiable (or, more strictly, “probabilities”) only by observation and experiment.

*Hypothesis and Perception: The Roots of Scientific Method*  
Prevalent Views of Science (p. 25)  
George Allen & Unwin Ltd. London, England. 1970

## SCIENCE, UNITY OF

**Pearson, Karl** 1857–1936  
English mathematician

The unity of all science consists alone in its method, not in its material.

*The Grammar of Science* (2nd edition)  
Chapter I (p. 12)  
Adam & Charles Black. London, England. 1900

## SCIENCE, UTILITY OF

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

To see things and happenings clearly, both in themselves and in their relations to other things and happenings, is the aim of science. And no one who enjoys scientific work – whether at the humble level of accurate description, or at the high level of discovering a formula – cares to hear much about the “utility of science.”

*Introduction to Science*  
Chapter VIII (p. 224)  
Henry Holt & Co. New York, New York, USA. 1911

## SCIENCE, VALUE OF

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

The values of science derive neither from the virtues of its members, nor from the finger-wagging codes of conduct by which every profession reminds itself to be good. They have grown out of the practice of science, because they are the inescapable conditions for its practice.

*Science and Human Values*  
The Sense of Human Dignity (p. 60)  
Harper & Row, Publishers. New York, New York, USA. 1965

## SCIENCE, VEHICLE OF

**Watson, David Lindsay** 1901–73  
No biographical data available

The main vehicle of science is not the published formulations of laws and experiments in books and periodicals. This vehicle is, first and foremost, men who are worthy of them, who can understand and use the laws. But more than this: the vehicle is also the pattern of the society that can produce such men.

*Scientists Are Human*  
Chapter I (p. 3)  
Watts. London, England. 1938

## SCIENCE, WATCH-TOWERS OF

**Mitchel, Ormsby MacKnight** 1805–62  
American astronomer

The watch-towers of science now cover the whole earth, and the sentinels never sleep.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Lecture I (p. 39)  
Baker & Scribner. New York, New York, USA. 1848

## SCIENCE, WELLS OF

**Hunt, Robert**

No biographical data available

...the world has too long been accustomed to look upon the results of scientific labor as mere dry details of facts. The day is rapidly approaching when Truth in her own severe simplicity will be found to possess charms to attract the lover of the beautiful far more potent than the half-formed and incongruous creations of untutored Fancy – when the poet and the child of genius will make pilgrimages to the wells of Science and drink inspiration from waters purer than those of Castalia.

*The Poetry of Science*  
*The Mercersburg Review*, Volume 3, Number 1, January, 1851 (p. 96)

## SCIENCE, WILDERNESS OF

**Thomas, Lewis** 1913–93  
American physician and biologist

The essential wildness of science as a manifestation of human behavior is not generally perceived. As we extract new things of value from it, we also keep discovering parts of the activity that seem in need of better control, more efficiency, less unpredictability.

*The Lives of a Cell: Notes of a Biology Watcher*  
Natural Science (p. 100)  
The Viking Press. New York, New York, USA. 1974

## SCIENCE, WINDOWS OF

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Even if the open windows of science at first make us shiver after the cozy indoor warmth of traditional humanizing myths, in the end the fresh air brings vigor, and the great spaces have a splendor of their own.

*What I Believe*  
Chapter I (p. 14)  
E.P. Dutton & Company. New York, New York, USA. 1925



**SCIENCE, WONDER OF**

**Kennedy, John F.** 1917–63  
35th president of the USA

Let both sides seek to invoke the wonders of science instead of its terrors. Together let us explore the stars, conquer the deserts, eradicate disease, tap the ocean depths and encourage the arts and commerce.

Inaugural Address, January 20, 1961

**SCIENCE, WORK OF**

**Bachelard, Gaston** 1884–1962  
French philosopher

Any work of science, no matter what its point of departure, cannot become fully convincing until it crosses the boundary between the theoretical and the experimental: *Experimentation must give way to argument, and argument must have recourse to experimentation.*

Translated by A. Goldhammer

*The New Scientific Spirit*

Introduction (pp. 3–4)

Beacon Press. Boston, Massachusetts, USA. 1984

**Kroeber, Alfred Louis** 1876–1960  
American anthropologist

...it appears that the total work of science must be done on a series of levels which the experience of science gradually discovers.

*The Nature of Culture* (p. 121)

The University of Chicago Press. Chicago, Illinois, USA. 1952

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

The work of science is to substitute facts for appearances, and demonstrations for impressions.

*The Works of John Ruskin* (Volume 2)

*The Stones of Venice*

Chapter II (p. 36)

John Wiley & Sons. New York, New York, USA. 1887

**Wilson, Edward O.** 1929–  
American biologist and author

The work of real science is hard and often for long intervals frustrating. You have to be a bit compulsive to be a productive scientist. Keep in mind that new ideas are commonplace, and almost always wrong. Most flashes of insight lead nowhere; statistically, they have a half-life of hours or maybe days. Most experiments to follow up the surviving insights are tedious and consume large amounts of time, only to yield negative or (worse!) ambiguous results.

Scientists, Scholars, Knaves and Fools

*American Scientist*, Volume 86 January-February, 1998 (p. 6)

**SCIENCE, WORLD OF****National Research Council (USA)**

In a viable democracy it is essential that each participating citizen appreciate the scientific and technological bases of his society. Unless the general public can understand something of the world of science and appreciate the nature and goals of scientific activity, it will not be able to fit science and technology properly into its perspective of life.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 27)

National Academy of Sciences

Washington, D.C. 1972

**Spencer-Brown, George** 1923–  
English mathematician and polymath

Left to itself, the world of science slowly diminishes as each result classed as scientific has to be reclassified as anecdotal or historical...Science is a continuous living process; it is made up of activities rather than records; and if the activities cease it dies.

*Probability and Scientific Inference*

Chapter XV (p. 107)

Longmans, Green & Company. London, England. 1957

**SCIENCE AND ART**

**Asimov, Isaac** 1920–92  
American author and biochemist

How often people speak of art and science as though they were two entirely different things, with no interconnection. An artist is emotional, they think, and uses only his intuition; he sees all at once and has no need of reason. A scientist is cold, they think, and uses only his reason; he argues carefully step by step, and needs no imagination. That is all wrong. The true artist is quite rational as well as imaginative and knows what he is doing; if he does not, his art suffers. The true scientist is quite imaginative as well as rational, and sometimes leaps to solutions where reason can follow only slowly; if he does not, his science suffers.

*The Roving Mind*

Chapter 25

Prometheus Books. Buffalo, New York, USA. 1983

**Author undetermined**

Science and art mutually assist each other; the arts furnish facts and materials to science, and science illuminates the path of the arts.

Introductory Remarks

*The American Journal of Science*, Volume 1, Number 1, 1819 (p. 8)

Art is personal and science is universal.

In Lecomte du Nouy

*The Road to Reason*

Chapter 1 (p. 31)

Longmans, Green & Company. London, England. 1949

**Blake, William** 1757–1827

English poet, painter, and engraver

He who would do good to another must  
do it in Minute Particulars:

General Good is the plea of the scoundrel,  
hypocrite and flatterer;

For art and science cannot exist but in  
minutely organized Particulars.

*The Complete Poetry and Prose of William Blake*

Jerusalem

The Holiness of Minute Particulars, 3, Section 55 (p. 399)

University of California Press. Berkeley, California, USA. 1982

**Brecht, Bertolt** 1898–1956

German writer

But science and art meet on this ground, that both are  
there to make man's life easier, the one setting out to  
maintain, the other to entertain us. In the age to come  
art will create entertainment from that new productivity  
which can so greatly improve our maintenance, and in  
itself, if only it is left unshackled, may prove to be the  
greatest pleasure of all.

Translated by John Willett

*Brecht on Theatre: The Development of an Aesthetic*

A Short Organon for the Theater, 20 (p. 185)

Hill & Wang. New York, New York, USA. 1964

**Campbell, Norman R.** 1880–1949

English physicist and philosopher

Science is the noblest of the arts and men of science the  
most artistic of all artists.

*Physics: The Elements*

Chapter VIII (pp. 227–228)

At The University Press. Cambridge, England. 1920

Science, like art, should not be something extraneous,  
added as a decoration to other activities of existence; it  
should be part of them, inspiring our most trivial actions  
as well as our noblest thoughts.

*What Is Science?*

Chapter VIII (p. 183)

Dover Publications. New York, New York, USA. 1952

**Cassidy, Harold Gomes**

No biographical data available

A balanced response to science and art can come only  
from people who do not fear science, but understand its  
power and its limitations people who have such faith in  
the ultimate power of truth, wherever it may be found,  
that they are not afraid to look for it; people who believe  
that what is true in art or science remains true always,  
even though it may be continually reinterpreted.

*The Sciences and the Arts: A New Alliance* (p. 3)

Harper & Brothers Publishers. New York, New York, USA. 1962

If humans understood science and would effectively  
make their voices heard, they could, with the aid of scien-  
tists, control the forces of cultural change in the process  
of their actual generation, directing them in the ways that  
lead toward the morally and ethically just ends that arise  
from the union of art and science. This union, when it  
is a union of whole science and whole art, supports and  
illuminates anew a noble image of man.

*The Sciences and the Arts: A New Alliance*

Chapter 11 (p. 165)

Harper & Brothers. New York, New York, USA. 1962

**Cassirer, Ernst** 1874–1945

German philosopher

Since art and science move in entirely different planes,  
they cannot contradict or thwart one another.

*An Essay on Man: An Introduction to a Philosophy of Human Culture*

Chapter IX (p. 170)

Yale University Press. New Haven, Connecticut, USA. 1944

**Cohen, I. Bernard** 1914–2003

American physicist and science historian

Great creations whether of science or art – can never be  
viewed dispassionately.

In the 1952 printing

*Optics*

Preface (p. ix)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Comte, Auguste** 1798–1857

French philosopher

If science springs from art, it can only be matured when  
it has left art behind.

*The Positive Philosophy of Auguste Comte* (Volume 2)

Book V, Chapter I (p. 4)

George Bell & Sons. London, England. 1896

**Connolly, Cyril** 1903–74

English critic and editor

Today the function of the artist is to bring imagination  
to science and science to imagination, where they meet,  
in the myth.

*The Unquiet Grave*

Part III (p. 86)

Hamish Hamilton. London, England. 1945

**Crick, Francis Harry Compton** 1916–2004

English biochemist

People with training in the arts still feel that in spite of  
the alterations made in their life by technology – by the  
internal combustion engine, by penicillin, by the Bomb –  
modern science has little to do with what concerns them  
most deeply. As far as today's science is concerned this  
is partly true, but tomorrow's science is going to knock  
their culture right out from under them.

*Of Molecules and Men*

The Prospect Before Us (p. 95)

University of Washington Press. Seattle, Washington, USA. 1966

**Davy, Sir Humphry** 1778–1829  
English chemist

It is needless for us again to say that in *science* and the *arts* there is a dependence which is the source of their progression and importance. In a well organized country, power is always compound: Archimedes could not have made machines which terrified the Roman soldiers without the assistance of good carpenters and good workers in metal.

In John Davy

*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*

Chapter III (p. 116)

John Churchill. London, England. 1858

**de Gourmont, Rémy** 1858–1915  
French critic and novelist

Art includes everything that stimulates the desire to live; science, everything that sharpens the desire to know. Art, even the most disinterested, the most disembodied, is the auxiliary of life. Born of the sensibility, it sows and creates it in its turn. It is the flower of life and, as seed, it gives back life. Science, or to use a broader term, knowledge, has its end in itself, apart from any idea of life and propagation of the species.

Translated by Glenn S. Burne

*Selected Writings*

Art and Science (p. 170)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1966

**de Montaigne, Michel Eyquem** 1533–92  
French Renaissance writer

...Sciences and Arts are not cast in a mold, but rather by little and little formed and shaped by often handling and polishing them over; even as bears fashion their young whelps by often licking them...

*Essays of Montaigne*

Book II, Chapter 12 (p. 278)

David Nutt. London, England. 1895

**Delbrück, Max** 1906–81  
German-born American biologist

The books of the great scientists are gathering dust on the shelves of learned libraries. And rightly so. The scientist addresses an infinitesimal audience of fellow composers. His message is not devoid of universality but its universality is disembodied and anonymous. While the artist's communication is linked forever with its original form, that of the scientist is modified, amplified, fused with the ideas and results of others, and melts into the stream of knowledge and ideas which forms our culture.

A Physicist's Renewed Look at Biology: Twenty Years Later

*Science*, Volume 168, Number 3937, June 12, 1970 (p. 1314)

The scientist has in common with the artist only this: that he can find no better retreat from the world than his work and also no stronger link with the world than his work.

A Physicist's Renewed Look at Biology: Twenty Years Later  
*Science*, Volume 168, Number 3937, June 12, 1970 (p. 1314)

**Dickens, Charles** 1812–70  
English novelist

What art was to the ancient world, science is to the modern...

*Coningsby; or, The New Generation*

Book IV, Chapter I (p. 142)

The Century Co. New York, New York, USA. 1907

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Directly or indirectly, the various forms of art reflect the strivings, the struggles, and the sufferings of mankind. The state of health and the ills of a society are recorded not only in the writings of its physicians and scholars but also in the themes and moods of its artists and poets.

*Mirage of Health*

Chapter VII (p. 215)

Harper & Brothers Publishers. New York, New York, USA. 1959

**Durant, William James** 1885–1981

American historian and essayist

Every science begins as philosophy and ends as art; it arises in hypothesis and flows into achievement.

*The Story of Philosophy*

Introduction (p. 2)

Simon & Schuster. New York, New York, USA. 1953

**Einstein, Albert** 1879–1955

German-born physicist

Science exists for Science's sake, like Art for Art's sake, and does not go in for special pleading or for the demonstration of absurdities.

*Cosmic Religion, with Other Opinions and Aphorisms*

On Science (p. 100)

Covici-Fiede. New York, New York, USA. 1931

...one of the strongest motives that lead men to art and science is escape from everyday life with its painful crudity and hopeless dreariness, from the fetters of one's own ever shifting desires. A finely tempered nature longs to escape from personal life into the world of objective perception and thought... Man tries to make for himself in the fashion that suits him best a simplified and intelligible picture of the world; he then tries to some extent to substitute this cosmos of his for the world of experience, and thus to overcome it. This is what the painter, the poet, the speculative philosopher, and the natural scientist do, each in his own way.

*The World as I See It*

Principles of Research (pp. 20–21)

Philosophical Library. New York, New York, USA. 1949

After a certain high level of technical skill is achieved, science and art tend to coalesce in esthetics, plasticity,

and form. The greatest scientists are always artists as well.

In Alice Calaprice (ed.)  
*The Quotable Einstein* (p. 171)  
Princeton University Press. Princeton, New Jersey, USA. 1996

**Escher, M. C.** 1898–1972  
Dutch graphic artist

...science and art sometimes can touch one another, like two pieces of the jigsaw puzzle which is our human life, and that contact may be made across the borderline between the two respective domains.

In Doris Schattschneider  
*Visions of Symmetry: Notebooks, Periodic Drawings, and Related Works of M.C. Escher*  
Chapter 2 (p. 104)  
W.H. Freeman & Company. New York, New York, USA. 1990

**Feynman, Richard P.** 1918–88  
American theoretical physicist

I've always been very one-sided about science and when I was younger I concentrated almost all my effort on it. I didn't have time to learn and I didn't have much patience with what's called the humanities, even though in the university there were humanities that you had to take. I tried my best to avoid somehow learning anything and working at it. It was only afterwards, when I got older, that I got more relaxed, that I've spread out a little bit. I've learned to draw and I read a little bit, but I'm really still a very one-sided person and I don't know a great deal. I have a limited intelligence and I use it in a particular direction.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 1 (p. 2)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Hanotaux, Gabriel** 1853–1944  
French statesman

Art imitates and interprets Nature; Science studies it and applies it to the needs of Humanity. Art and Science are united through technique.

*Contemporary France* (Volume 2)  
Chapter XII, Section III (p. 640)  
Archibald Constable & Co. London, England. 1905

**Harvey, William** 1578–1657  
English physician

On the same terms, therefore, as art is attained to, is all knowledge and science acquired; for as art is a habit with reference to things to be done, so is science a habit in respect to things to be known; as that proceeds from the imitation of types or forms so this proceeds from the knowledge of natural things.

In *Great Books of the Western World* (Volume 28)  
*Anatomical Exercises on the Generation of Animals*

Of the Manner and Order of acquiring Knowledge (p. 333)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Both science and art form in the course of the centuries a human language by which we can speak about the more remote parts of reality, and the coherent sets of concepts as well as the different styles of art are different words or groups of words in this language.

*Physics and Philosophy: The Revolution in Modern Science*  
Chapter VI (p. 109)  
Harper & Row, Publishers. New York, New York, USA. 1958

**Huxley, Aldous** 1894–1963  
English writer and critic

Unlike art, science is genuinely progressive. Achievement in the fields of research and technology is cumulative; each generation begins at the point where its predecessor left off.

*Science, Liberty and Peace*  
Chapter I (p. 30)  
William Morrow & Company, Inc. New York, New York, USA. 1967

Science and art are only too often a superior kind of dope, possessing this advantage over booze and morphia: that they can be indulged in with a good conscience and with the conviction that, in the process of indulging, one is leading the "higher life."

*Ends and Means*  
Chapter XIV (p. 276)  
Chatto & Windus. London, England. 1938

**Karanikas, Alexander** 1916–2006  
Greek-American professor of English

...science pierces reality like a dagger in search of fact and truth while art caresses reality looking for pleasure, grace and beauty.

*Tillers of a Myth*  
Science, the False Messiah (p. 127)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1969

**Kepes, Gyorgy** 1906–2001  
Hungarian-born American artist and theorist

The essential vision of reality presents us not with fugitive appearances but with felt patterns of order which have coherence and meaning for the eye and for the mind. Symmetry, balance and rhythmic sequences express characteristics of natural phenomena: the connectedness of nature – the order, the logic, the living process. Here art and science meet on common ground.

*The New Landscape*  
In *Art and Science*  
Chapter I (p. 24)  
Paul Theobald & Company Chicago, Illinois, USA. 1956

Mathematicians who build new spaces and physicists who find them in the universe can profit from the study

of pictorial and architectural spaces conceived and built by men of art.

*The New Landscape*

In *Art and Science*

Chapter I (p. 28)

Paul Theobald & Company Chicago, Illinois, USA. 1956

**Klee, Paul** 1879–1940

Swiss expressionist painter

...the worst state of affairs is when science begins to concern itself with art.

*The Diaries of Paul Klee 1898–1918*

Diary III, Number 747 (p. 194)

University of California Press. Berkeley, California, USA. 1964

**Knuth, Donald E.** 1938–

Creator of TeX

The difference between art and science is that science is what people understand well enough to explain to a computer. All else is art.

In Robert Slater

*Portraits in Silicon*

Chapter 31 (p. 351)

The MIT Press. Cambridge, Massachusetts, USA. 1987

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Einstein's space is no closer to reality than van Gogh's sky. The glory of science is not in a truth more absolute than the truth of Bach or Tolstoy, but in the act of creation itself. The scientist's discoveries impose his own order on chaos, as the composer or painter imposes his; an order that always refers to limited aspects of reality, and is based on the observer's frame of reference, which differs from period to period as a Rembrandt nude differs from a nude by Manet.

*The Act of Creation*

Book One, Part Two, Chapter X (p. 252)

The Macmillan Company. New York, New York, USA. 1964

**Kraus, Karl** 1874–1936

Austrian essayist and poet

Science is spectrum analysis. Art is photosynthesis.

In John D. Barrow

*The Artful Universe* (p. 114)

Clarendon Press. Oxford, England. 1995

**M'Cosh, James** 1811–94

Scottish philosopher

There were bleaching, dyeing, and tanning, and artificers in copper and iron, before there was chemistry to explain the processes used. Men made wine before there was any theory of fermentation; and glass and porcelain were manufactured before the nature of alkalis and earths had been determined. The pyramids of Nubia and Egypt, the palaces and sculptured slabs of Nineveh, the cyclopean walls of Italy and Greece, the obelisks and temples of

India, the cromlechs and druidical circles of countries formerly Celtic, all preceded the sciences of mechanics and architecture. There was music before there was a science of acoustics; and painting, while yet there was no theory of colours or perspective.

*The Method of the Divine Government, Physical and Moral* (p. 140)

Robert Carter & Brothers. New York, New York, USA. 1865

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

There is no spiritual copyright in scientific discoveries, unless they should happen to be quite mistaken. Only in making a blunder does a scientist do something which, conceivably, no one else might ever do again. Artists are not troubled by matters of priority, but Wagner would certainly not have spent twenty years on *The Ring* if he had thought it at all possible for someone else to nip in ahead of him with *Götterdämmerung*.

*The Act of Creation*

*New Statesman*, 19 June, 1964

**Melville, Herman** 1819–91

American novelist

One can envisage an end of science no more readily than one can envisage an end of imaginative literature or the fine arts.

*Advice to a Young Scientist*

Chapter 11 (p. 90)

Basic Books, Inc. New York, New York, USA. 1979

**Moulton, Forest Ray** 1872–1952

American astronomer

It is a mistake to regard science in itself as the opposite of art. There are in all branches of science harmonies and beauties which appeal strongly to those who fully understand them.

*Descriptive Astronomy; An Elementary Exposition of the Facts, Principles, and Theories of Astronomical Science*

Part I (p. 2)

American School of Correspondence. Chicago, Illinois, USA. 1912

**Munroe, J.**

No biographical data available

Science eradicates superstition. Art teaches us to enjoy Nature without analysis, and Science to investigate her. The artistic interpretation of Nature is one-sided and passive; it is the impression which Nature makes on our sensibility. But the scientific interpretation is active, and engages our reason.

*Science and the Sense of Beauty*

*The Journal of Science, and Annals of Astronomy, Biology, Geology*, Volume IV, (Third series), April, 1882 (p. 205)

**Musil, Robert** 1880–1942

Austrian author

What is done for science must also be done for art: accepting undesirable side effects for the sake of the main goal,



and moreover diminishing their importance by making this main goal more magnificent. For one should reform forward, not backward: social illnesses, revolutions, are evolutions inhibited by a conserving stupidity.

Translated by Burton Pike and David S. Luft

*Precision and Soul: Essays and Addresses*

Novellas (p. 9)

University of Chicago Press, Chicago, Illinois, USA. 1990

**Nabokov, Vladimir Vladimirovich** 1899–1977

Russian-born American novelist

Attainment and science, retainment and art – the two couples keep to themselves, but when they do meet, nothing else in the world matters.

*The Stories of Vladimir Nabokov*

Time and Ebb (p. 586)

Vintage Books, New York, New York, USA. 1997

**Page, David**

No biographical data available

There can, indeed, be no antagonism between science and art, between theoretical knowledge and its economic applications. The practical expression of a truth can never be divorced from its theoretic conception.

*Economic Geology; Or, Geology in Its Relations to the Arts and Manufactures*

Introduction (p. 1)

William Blackwood & Sons, Edinburgh, Scotland. 1874

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

Both the man of science and the man of art live always at the edge of mystery, surrounded by it; both always, as to the measure of their creation, have had to do with the harmonization of what is new with what is familiar, with the balance between novelty and synthesis, with the struggle to make partial order in total chaos.

Prospects in the Arts and Sciences

Speech, 26 December, 1954, Columbia University Bicentennial

The frontiers of science are separated now by long years of study, by specialized vocabularies, arts, techniques, and knowledge from the common heritage even of a most civilized society; and anyone working at the frontier of such science is in that sense a very long way from home, a long way too from the practical arts that were its matrix and origin, as indeed they were of what we today call art.

Prospects in the Arts and Sciences

Speech, 26 December, 1954, Columbia University Bicentennial

**Pearson, Karl** 1857–1936

English mathematician

Our aesthetic judgment demands harmony between the representation and the represented, and in this sense science is often more artistic than modern art.

*The Grammar of Science*

Chapter I (p. 17)

Adam & Charles Black, London, England. 1900

**Reynolds, Osborne** 1842–1912

English fluid dynamics engineer

I have to deal with facts, and I shall try to deal with nothing but facts. Many of these facts, or the conclusions to be immediately drawn from them, may appear to bear on the possibilities – or, rather, the impossibilities – of art. But in the Society of Arts I need not point out that art knows no limit; where one way is found to be closed, it is the function of art to find another. Science teaches us the results that will follow from a known condition of things; but there is always the unknown condition, the future effect of which no science can predict.

*Papers on Mechanical and Physical Subjects* (Volume 2)

Lecture to the Society of Arts

At The University Press, Cambridge, England. 1900=03

**Rubbia, Carlo** 1934–

Italian physicist

...science for me is very close to art. Many people think that scientific discovery is a very rational process –

mathematics and equations and so on make it look extremely formal and extremely strict – but in my view, scientific discovery is an irrational act. It's an intuition which turns out to be reality at the end of it – and I see no difference between a scientist developing a marvelous discovery and an artist making a painting, or music or something.

In Lewis Wolpert and Alison Richards

*Passionate Minds*

Asking Nature (p. 197)

Oxford University Press, Oxford, England. 1997

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Science and art are commonly distinguished by the nature of their actions; the one as knowing, the other as changing, producing, or creating.

*The Works of John Ruskin*

*The Stones of Venice*

Chapter II (p. 36)

John Wiley & Sons, New York, New York, USA. 1887

...science has to do with facts, art with phenomena. To science, phenomena are of use only as they lead to facts; and to art facts are of use only as they lead to phenomena.

*The Stones of Venice*

Chapter II (p. 39)

John R. Alden, Publisher, New York, New York, USA. 1885

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In art nothing worth doing can be done without genius; in science even a very moderate capacity can contribute to a supreme achievement.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 41)

Longmans, Green & Co, London, England. 1919



**Sagan, Carl** 1934–96  
American astronomer and author

It is sometimes said that scientists are unromantic, that their passion to figure out robs the world of beauty and mystery. But is it not stirring to understand how the world actually works – that white light is made of colors, that color is the way we perceive the wavelengths of light, that transparent air reflects light, that in so doing it discriminates among the waves, and that the sky is blue for the same reason that the sunset is red? It does no harm to the romance of the sunset to know a little bit about it.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 10 (pp. 159–160)  
Random House, Inc. New York, New York, USA. 1994

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952  
Spanish-born American philosopher

Science is the response to the demand for information, and in it we ask for the whole truth and nothing but the truth. Art is the response to the demand for entertainment, for the stimulation of our senses and imagination, and truth enters into it only as it subserves these ends.

*The Sense of Beauty: Being the Outlines of Aesthetic Theory*  
The Nature of Beauty (p. 22)  
Charles Scribner's Sons. New York, New York, USA. 1896

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

When one reads the history of science one has the exhilarating feeling of climbing a big mountain. The history of art gives one an altogether different impression. It is not at all like the ascension of a mountain, always upward whichever the direction of one's path; it is rather like a leisurely journey across a hilly country.

*The History of Science and the New Humanism*  
Chapter I (p. 25)  
H. Holt & Co. New York, New York, USA. 1931

**Shlain, Leonard**  
American surgeon and author

Both art and physics are unique forms of language. Each has a specialized lexicon of symbols that is used in a distinctive syntax. Their very different and specific contexts obscure their connection to everyday language as well as to each other. Nevertheless, it is noteworthy just how often the terms of one can be applied to the concepts of the other. "Volume," "space," "mass," "force," "light," "color," "tension," "relationship," and "density" are descriptive words that are heard repeatedly if you trail along with a museum docent. They also appear on the blackboards of freshman college physics lectures.

Quoted by Gerald Nolton  
*Art and Physics: Parallel Visions in Space, Time and Light*  
Chapter 1  
William Morrow & Company, Inc. New York, New York, USA. 1991

The proponents of these two diverse endeavors [art and physics] wax poetic about elegance, symmetry, beauty, and aesthetics. While physicists demonstrate that  $A$  equals  $B$  or that  $X$  is the same as  $Y$ , artists often choose signs, symbols, and allegories to equate a painterly image with a feature of experience. Both of these techniques reveal previously hidden relationships.

Quoted by Gerald Nolton  
*Art and Physics: Parallel Visions in Space, Time and Light*  
Chapter 1  
William Morrow & Company, Inc. New York, New York, USA. 1991

**Silver, Brian L.**  
Israeli professor of physical chemistry

Whatever the Sun may be, said D. H. Lawrence, it is certainly not a ball of flaming gas. Helios, the sun god, has more sex appeal than a cloud of gas, however hot.

*The Ascent of Science*  
Part IX, Chapter 36 (p. 485)  
Solomon Press Book. New York, New York, USA. 1998

[D. H.] Lawrence [saw] science systematically chipping away at the mysterious, but generally benign, unknown and arrogantly replacing it with the dull, prosaic, down-to-earth known. . . . The scientist's rainbow is the result of the different refractive indices of the various frequencies of light that make up solar radiation. But man evidently prefers mystery to math, and the intrusion of science into the movements of the planets and the stars, into the living cell and into that final sanctuary of the spirit, the mind, has undoubtedly cast a chill over that warm, blurred garden, the theocentric universe. The scientist, ruthlessly buying up desirable property, appears to many people to be building an automated factory in the middle of the garden.

*The Ascent of Science*  
Part IX, Chapter 36 (p. 485)  
Solomon Press Book. New York, New York, USA. 1998

**Smyth, H. D.**  
No biographical data available

We have a paradox in the method of science. The research man may often think and work like an artist, but he has to talk like a bookkeeper in terms of facts, figures and logical sequence of thought.

Quoted by Gerald Nolton  
On the Duality and Growth of Physical Science  
*American Scientist*, Volume 41, 1953 (p. 93)

**Spencer, Herbert** 1820–1903  
English social philosopher

...Science is necessary not only for the most successful production, but also for the full appreciation of the fine arts.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 70)  
A.L. Fowle. New York, New York, USA. 1860

**Sterne, Laurence** 1713–68  
English novelist and humorist

Art and science are words frequently made use of, but the precision of which is so rarely understood, that they are often mistaken for one another.

*The Works of Laurence Sterne: With a Life of the Author* (Volume 6)  
The Koran (p. 347)  
William Durell & Co. New York, New York, USA. 1814

I think that science may be styled the knowledge of universals, or abstract wisdom; and art is science reduced to practice – or science is reason, and art the mechanism of it – and may be called practical science. Science, in fine, is the theorem, and art the problem.

*The Works of Laurence Sterne: With a Life of the Author* (Volume 6)  
The Koran (p. 348)  
William Durell & Co. New York, New York, USA. 1814

Science is the theorem...and art is the problem.

*The Works of Laurence Sterne*  
84 (p. 127)

Printed for J. Mozley. London, England. 1745

**Sullivan, John William Navin** 1886–1937  
Irish science writer

...it is certain that the real function of art is to increase our self-consciousness; to make us more aware of what we are, and therefore of what the universe in which we live really is. And since mathematics, in its own way, also performs this function, it is not only aesthetically charming but profoundly significant. It is an art, and a great art.

In James Roy Newman  
*The World of Mathematics* (Volume 3)  
Part XVII (p. 2021)  
Simon & Schuster. New York, New York, USA. 1956

The measure in which science falls short of art is the measure in which it is incomplete as science.

The Justification of the Scientific Method  
*The Athenaeum*, May, 1919 (p. 275)

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

...it is certain, though rarely realized, that Science has precious gifts to place in the hands of Art that she may fashion them magically into beauty.

*Introduction to Science*  
Chapter VI (p. 167)  
Henry Holt & Co. New York, New York, USA. 1911

I [the scientist] also am an artist, he says, or words to that effect, meaning (1) that a scientific investigation is, like a picture, an endeavor to get at the setting and significance of things or events; (2) that there is a delight and an endeavor in scientific workmanship that is its own reward; and (3) that in the higher reaches of science, the discovery of a formula, a general law, a pedigree, a

homology, an interrelation – whatever it may be – is in some measure a personal achievement.

*Introduction to Science*  
Chapter VIII (pp. 224–225)  
Henry Holt & Co. New York, New York, USA. 1911

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Art can never match the luxury and superfluity of Nature. In the former all is seen; it cannot afford concealed wealth, and is niggardly in comparison; but Nature, even when she is scant and thin outwardly, satisfies us still by the assurance of a certain generosity at the roots.

*A Week on the Concord and Merrimack Rivers*  
Thursday (p. 236)  
Charles Scribner's Sons. New York, New York, USA. 1921

**Tolstoy, Leo** 1828–1910  
Russian writer

True science investigates and brings to human perception such truths and such knowledge as the people of a given time and society consider most important. Art transmits these truths from the region of perception to the region of emotion.

*What Is Art?*  
Chapter Twenty (p. 181)  
Hackett Publishing Co. Indianapolis, Indiana, USA. 1996

Science and art are as closely bound together as the lungs and heart, so that if one organ is vitiated the other cannot act rightly.

*What Is Art?*  
Chapter Twenty (p. 181)  
Hackett Publishing Co. Indianapolis, Indiana, USA. 1996

**Trousseau, Armand** 1801–67  
French internist

Every science touches art at some points – every art has its scientific side; the worst man of science is he who is never an artist, and the worst artist is he who is never a man of science.

*Lectures on Clinical Medicine, Delivered at the Hotel-Dieu* (Volume 2)  
Introduction (p. 40)  
Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1869

**Valéry, Paul** 1871–1945  
French poet and critic

There is a science of simple things, an art of complicated ones. Science is feasible when the variables are few and can be enumerated; when their combinations are distinct and clear. We are tending toward the condition of science and aspiring to it. The artist works out his own formulas; the interest of science lies in the art of making science.

In Jackson Mathews (ed.)  
*The Collected Works of Paul Valéry* (Volume 14)  
*Moralités*  
Analects (p. 64)  
Princeton University Press. Princeton, New Jersey, USA. 1971

**Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

The best of modern art is compatible only with true science, and the bogus science requires a fake art to keep it company.

*The Scientific Attitude*

Science Is Not Neutral (p. 27)

Penguin Books, Middlesex, England. 1941

**Watson, William**

When will you learn your place and rank in Mind? Art can create; Science can only find.

*The Muse in Exile*

Science and Nature

John Lane Co. New York, New York, USA. 1913

**Waugh, John Hugh W.**

No biographical data available

Science and Art, truly twin offspring of the intellect, are every way meet companions – impotent when disjoined; in union, irresistible, – the very powers of nature “becoming plastic” and rendering a ready allegiance to their sway.

*Mathematical Essays*

Essay I (p. 14)

Johnstone &amp; Hunter. Edinburgh, Scotland. 1854

**Whewell, William** 1794–1866

English philosopher and historian

Art and Science differ. The object of Science is Knowledge; the objects of Art are Works. In Art, truth is a means to an end; in Science, it is the only end. Hence the Practical Arts are not to be classed among the Sciences.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms Concerning Science, Aphorism XXV (p. 471)

John W. Parker. London, England. 1847

**Willmott, Robert Eldridge Aris** 1809–63

English writer and poet

Some gifted adventurer is always sailing round the world of art and science, to bring home costly merchandise from every port.

*Pleasures, Objects, and Advantages, of Literature* (4th edition)

Chapter XII (p. 53)

G. Routledge &amp; Co. London, England. 1855

**Wordsworth, William** 1770–1850

English poet

Enough of Science and of Art;  
Close up these barren leaves;  
Come forth, and bring with you a heart  
That watches and receives.

*The Complete Poetical Works of William Wordsworth*

The Tables Turned, Stanza 8

Crowell. New York, New York, USA. 1888

**SCIENCE AND CAPRICIOUS FAIRY****Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Science throws her treasures, not like a capricious fairy into the laps of a favored few, but into the laps of all humanity, with a lavish extravagance that no legend ever dreamt of!

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

The Economical Nature of Physical Inquiry (p. 189)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**SCIENCE AND CIVILIZATION****Ackerman, Diane** 1948–

American writer

When we think of science, we often picture arcane quests after minutiae, or efforts to explain underlying principles. But it’s amazing that in a civilization as complex as ours, we are still engaged in Adam’s task, the naming of animals.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Insect Love (p. 160)

Vintage Books. New York, New York, USA. 1997

**Compton, Arthur H.** 1892–1962

American physicist

I verily believe that in the advancement of science lies the hope of our civilization.

*Les Prix Nobel. The Nobel Prizes in 1927*

Nobel banquet speech for award received in 1927

Nobel Foundation. Stockholm, Sweden. 1928

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Science has two main functions in civilization. One is to give man a picture of the world phenomena, the most accurate and complete picture possible. The other is to provide him with the means of controlling his environment and his destiny.

*What Dare I Think?: The Challenge of Modern Science to Human Action and Belief, Including the Henry La Barre Jayne Foundation Lectures*

Chapter IV (pp. 127–128)

Harper &amp; Brothers. New York, New York, USA. 1931

Without the impersonal guidance and the efficient control provided by science civilization will either stagnate or collapse, and human nature cannot make progress towards realizing its possible evolutionary destiny.

*What Dare I Think?: The Challenge of Modern Science to Human Action and Belief, Including the Henry La Barre Jayne Foundation Lectures*

Chapter V (p. 177)

Harper &amp; Brothers. New York, New York, USA. 1931

Modern civilisation rests upon physical science; take away her gifts to our own country, and our position among the leading nations of the world is gone tomorrow; for it is physical science only that makes intelligence and moral energy stronger than brute force.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

### **Lovell, Sir Alfred Charles Bernard** 1913–

English physicist, radio astronomer, and author

The pursuit of the good and evil are now linked in astronomy as in almost all science.... The fate of human civilization will depend on whether the rockets of the future carry the astronomer's telescope or a hydrogen bomb.

*The Individual and the Universe* (p. 72)

Oxford University Press. London, England. 1959

### **Metropolis, Nicholas C.** 1915–99

Mathematician

Science is the locomotive that drives our civilization.

In Sigfried S. Hecker and Gian-Carlo Rota (eds.)

*Essays on the Future: In Honor of Nick Metropolis*

Belated Thoughts (p. xv)

Birkhäuser. Boston, Massachusetts, USA. 2000

### **Ortega y Gasset, José** 1883–1955

Spanish philosopher

...experimental science has progressed thanks in great part to the work of men astoundingly mediocre, and even less than mediocre. That is to say, modern science, the root and symbol of our actual civilisation, finds a place for the intellectually commonplace man and allows him to work therein with success.... A fair amount of the things that have to be done in physics or in biology is mechanical work of the mind which can be done by anyone or almost anyone. For the purpose of innumerable investigations it is possible to divide science into small sections, to enclose oneself in one of these, and leave out of consideration all the rest.

*The Revolt of the Masses*

Chapter 12 (pp. 110, 111)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

### **Parton, H. N.**

No biographical data available

A successful blending of the sciences and the humanities is necessary for the health of our civilization.

*Science Is Human*

Science Is Human (p. 31)

University of Otago Press. Dunedin, New Zealand. 1972

### **Sagan, Carl** 1934–96

American astronomer and science writer

The very method of mathematical reasoning that Isaac Newton introduced to explain the motion of the planets

around the Sun has led to most of the technology of our modern world. The Industrial Revolution, for all its shortcomings, is still the global model of how an agricultural nation can emerge from poverty. These debates have bread-and-butter consequences.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 4 (p. 56)

Random House, Inc. New York, New York, USA. 1994

## SCIENCE AND CRIME

### **Wilson, Andrew** 1852–1912

No biographical data available

The scientific study of criminals, and the philosophic study of crimes, form not merely an interesting, but a highly warrantable exercise of intellect. Only through some such investigation into these subjects can a knowledge of the nature, cause, and cure of crime be attained – if, indeed, such knowledge in its perfect phases be ever reached in human history.

*Leaves from a Naturalist's Note-book*

Science and Crime (p. 1)

Chatto & Windus. London, England. 1882

## SCIENCE AND ETHICS

### **Margenau, Henry** 1901–97

American physicist

To be sure, there is no agreement among philosophers or even among practicing educators as to the disciplines that are truly sciences. Few will argue that the study of literature is a science or that physics is not a science, but disputes arise when this question is raised with regard to sociology or history. Such disputes may rise above the fruitless quarrels over terminology and attain considerable importance, as in the question whether ethics is, ought to be, or cannot be a science.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 2 (p. 16)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1950

## SCIENCE AND FAME

### **da Costa, J. Chalmers** 1863–1933

American physician

Men come and men go, but science lives and advances. Individual discoveries are glorious and worthy, but we must give due meed of praise to the hard-working, obscure practitioners who, regardless of fame and wealth, apply them. Too often in this modern world even the scientist has been touched by the love of notoriety or the joy of gain, emotions which will mar his usefulness, will cloud the agar in his test-tube and blur the glass of his microscope.

Then And Now

*Transactions of the Philadelphia County Medical Society*, Volume XX,  
Number 5, May, 1899 (p. 159)

## SCIENCE AND FREEDOM

**Baltimore, David** 1938–  
American biologist

Freedom is the range of opportunities available to an individual – the more he has to choose from, the freer his choices. Science creates freedom by widening our range of understanding and therefore the possibilities from which we can choose.

In Gerald Holton and Robert S. Morison (eds.)

*Limits of Scientific Inquiry*

Limiting Science: A Biologist's Perspective (p. 42)

W.W. Norton & Co. New York, New York, USA. 1979

## SCIENCE AND GOD

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

...I will frankly tell you that my experience in prolonged scientific investigations convinces me that a belief in God – a God who is behind and within the chaos of ungeneralized facts beyond the present vanishing-points of human knowledge – adds a wonderful stimulus to the man who attempts to penetrate into the region of the unknown.

In Edwin Percy Whipple

*Recollections of Eminent Men: With Other Papers*

Recollections of Agassiz (p. 96)

Ticknor & Co. Boston, Massachusetts, USA. 1886

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

All the visible Works of God Almighty are made in *Number, Weight and Measure*: Therefore, to consider them, we ought to understand *Arithmetic, Geometry, and Statics*...  
*An Essay on the Usefulness of Mathematical Learning* (3rd edition) (p. 8)  
Printed for J. Barrett  
London, England. 1745

**Chittenden, Newton W.**  
Mineral surveyor

Thus, the diligent student of science, the earnest seeker of truth, as through the courts of a sacred Temple, wherein, at each step, new wonders meet the eye, till, as a crowning grace, they stand before a Holy of Holies, and learn that all science and all truth are one which hath its beginning and its end in the knowledge of Him whose glory the heavens declare, and whose handiwork the firmament showeth forth.

Translated by Andrew Motte

In Isaac Newton

*Newton's Principia: The Mathematical Principles of Natural Philosophy*

Life of Sir Isaac Newton

Daniel Adee. New York, New York, USA. 1848

**Herrick, Charles Judson** 1868–1960  
American neurologist

We may render to God the things that are God's and to science only the things that are nature's.

*The Evolution of Human Nature*

Epilogue: The Unknown God (p. 465)

University of Texas Press. Austin, Texas, USA. 1956

**von Braun, Wernher** 1912–77  
German-American rocket scientist

I find it as difficult to understand a scientist who does not acknowledge the presence of a superior rationality behind the existence of the universe as it is to comprehend a theologian who would deny the advances of science. And there is certainly no scientific reason why God cannot retain the same relevance in our modern world that He held before we began probing His creation with telescope, cyclotron, and space vehicles.

In Richard H. Utt

*Creation: Nature's Designs and Designer*

Foreword (p. 6)

Pacific Press. Mountain View, California, USA. 1971

## SCIENCE AND GOVERNMENT

**Babbage, Charles** 1792–1871  
English mathematician

...scientific knowledge scarcely exists amongst the higher classes of society. The discussion in the Houses of Lords or of Commons, which arise on the occurrence of any subjects connected with science, sufficiently prove this fact...  
*Reflections on the Decline of Science in England. And on Some of Its Causes*

Introductory Remarks (p. 8)

Printed for B. Fellowes. London, England. 1830

## SCIENCE AND KNOWLEDGE

**Locke, John** 1632–1704  
English philosopher and political theorist

Nobody is under an obligation to know everything. Knowledge and science in general is the business only of those who are at ease and leisure.

*An Essay Concerning Human Understanding and a Treatise on the Conduct of the Understanding*

A Treatise on the Conduct of the Understanding

Section 7 (p. 494)

James Kay, June & Company. Philadelphia, Pennsylvania, USA. ca. 1850

## SCIENCE AND LITERATURE

**Burroughs, John** 1837–1921  
American naturalist and essayist

Until science is mixed with emotion, and appeals to the heart and imagination, it is like dead inorganic matter;



and when it becomes so mixed and so transformed, it is literature.

*Indoor Studies*

Chapter II (p. 53)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1904

Science and literature in their aims and methods have but little in common. Demonstrable fact is the province of the one; sentiment is the province of the other.

*Indoor Studies*

Chapter II (p. 58)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

Science is probably unfavorable to the growth of literature because it does not throw man back upon himself and concentrate him as the old belief did; it takes him away from himself, away from human relations and emotions, and leads him on and on.

*Indoor Studies*

Science and Literature (p. 58)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1904

Literature interprets life and nature in terms of our sentiments and emotions; science interprets them in terms of our understanding.

*Under The Apple Tree*

Literature and Science (p. 177)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

Science reveals things as they are in and of themselves; literature, as they stand related to our mental and emotional condition and edification. One is not true and the other false; both are true in their own sphere, true as fact, and true as emotion and idea. Science explains the rainbow, but literature sees it as a symbol and a promise. So with the sunset or the sunrise. Science knows all about the diamond, but knows not why it is so prized by us. It explains the pearl, but not the pearl necklace.

*Under the Apple-Trees*

Chapter XI (p. 179)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

**Newman, John Henry** 1801–90

Catholic Cardinal

Literature stands related to Man, as Science stands to Nature; it is his history.

*The Scope and Nature of University Education*

Discourse VIII (p. 333)

Longman, Green, Longman & Roberts. London, England. 1859

## SCIENCE AND MORALS

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

It is not the business of science to inherit the earth, but to inherit the moral imagination; because without that man and beliefs and science will perish together.

*The Ascent of Man*

Chapter 13 (p. 432)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

...when any part of the general public is drawn into a debate on physical science, we may be certain that it has already become a debate on moral science.

*All Is Grist: A Book of Essays*

On Gossip about Heredity (p. 96)

Methuen & Company Ltd. London, England. 1931

**Compton, Karl Taylor** 1887–1954

American educator and physicist

I would emphasize the fact that scientific discovery is, per se, neither good nor bad. It simply produces knowledge and with knowledge, opportunity and responsibility. I think it fair to say that the advance of science carries with it powerful demands on morality if the results are to be beneficial rather than harmful.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

During the Years 1930–1949 (p. 5)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Dewey, John** 1859–1952

American philosopher and educator

Science through its physical technological consequences is now determining the relations which human beings, severally and in groups, sustain to one another. If it is incapable of developing moral techniques which will also determine these relations, the split in modern culture goes so deep that not only democracy but all civilized values are doomed.

*Freedom and Culture*

Chapter Six (p. 118)

Prometheus Books. Buffalo, New York, USA. 1989

**Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

The moral universe is so closely linked to the physical universe that it is scarcely likely that they are not one and the same machine.

*Eléments de Physiologie* (pp. xiii–xiv)

Librairie M. Didier. Paris, France. 1964

**Ferré, Nels F. S.** 1908–71

Swedish-American theologian

Science can be and is being made into an escapist philosophy – into a dodge of moral disciplines and spiritual responsibilities.

*Faith and Reason*

Chapter II (p. 83)

Harper & Brothers. New York, New York, USA. 1946

**Friedenberg, Edgar Z.** 1921–2001

Educator, education critic, and sociologist

...only science can hope to keep technology in some sort of moral order.

*The Vanishing Adolescent*

The Impact of the School, the Clarification of Experience (p. 50)

Beacon Press. Boston, Massachusetts. 1964



**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

I do not know when the technical and popular prose of science became separated, although I accept the inevitability of such a division as knowledge became increasingly more precise, detailed, and specialized. We have now reached the point where most technical literature not only falls outside the possibility of public comprehension but also (as we would all admit in honest moments) outside our own competence in scientific disciplines far removed from our personal expertise. I trust that we all regard this situation as saddening, even though we accept its necessity.

Take Another Look

*Science*, Volume 286, Number 5441, October 29, 1999 (p. 899)

**Jefferson, Thomas** 1743–1826

3rd president of the USA

...if science produces no better fruits than tyranny, murder, rapine and destitution of national morality, I would rather wish our country to be ignorant, honest and estimable, as our neighboring savages are.

*The Writings of Thomas Jefferson* (Volume 6)

Letter to John Adams, 1812 (p. 37)

Deby & Jackson. New York, New York, USA. 1859

**Kruyt, Hugo Rudolph** 1882–1959

Dutch colloid chemist

Clearer than ever we understand that knowledge is not all, that we need morals and brotherhood to avoid science becoming a curse.

In John P. Dickinson

*International Council of Scientific Unions*

First General Assembly Following the Second World War, Science and Scientific Researchers in Modern Society (p. 165)

**Lerner, Max** 1902–92

American educator and author

Science itself is a humanist in the sense that it doesn't discriminate between human beings, but it is also morally neutral. It is no better or worse than the ethos with and for which it is used.

Manipulating Life

*New York Post*, January 24, 1968

**Masters, William H.** 1915–2001

American gynecologist and researcher

Science by itself has no moral dimension. But it does seek to establish truth. And upon this truth morality can be built.

Two Sex Researchers on the Firing Line

*Life*, 24 June, 1966 (p. 49)

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

Scientists aren't responsible for the facts that are in nature. It's their job to find the facts. There's no sin connected with it – no morals. If anyone should have a sense of sin, it's God. He put the facts there.

In Lincoln Barnett

J. Robert Oppenheimer

*Life*, October 10, 1949 (p. 133)

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

There can no more be immoral science than there can be scientific morals.

*The Foundations of Science*

*The Values of Science*, Introduction (p. 206)

The Science Press. New York, New York, USA. 1913

**Snow, Charles Percy** 1905–80

English novelist and scientist

...there is a moral component right in the grain of science itself...

*The Two Cultures: And a Second Look*

Chapter I (p. 13)

At The University Press. Cambridge, England. 1964

**Toynbee, Arnold J.** 1882–83

English historian

Our western science is a child of moral virtues; and it must now become the father of further moral virtues if its extraordinary material triumphs in our time are not to bring human history to an abrupt, unpleasant and discreditable end.

A Turning Point in Man's Destiny

*The New York Times Magazine*, December 26, 1954 (p. 5)

**Wallace, Henry A.** 1888–1935

33rd vice-president of the USA

I can understand the impulse which prompts scientists to defend science against the attacks of the uninformed. Science has achieved so many miracles for society, saved so many lives, made possible so extraordinary an advance in material living standards for so many millions of people, that it is disquieting to think that all the consequences of science can ever be other than good. Yet I don't see what basis we have for assuming that science can and does have only beneficial consequences. Is the product of man's curiosity inevitably good?...It may be disturbing to realize it, but the truth seems to be that science proceeds without moral obligations; it is neither moral nor immoral, but in essence amoral.

Scientists in an Unscientific Society

*Scientific Monthly*, Volume 150, 1934 (p. 285)

## SCIENCE AND PHILOSOPHY

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The great and radical difference of capacities, as to philosophy and the sciences, lies here: that some are stronger and fitter to observe the differences of things; others their correspondencies: for a steady and sharp genius can fix it's contemplations, and dwell and fasten upon all the subtlety of differences, while a sublime and ready genius perceives and compares the smallest and most general agreements of things; but both kinds easily fall into excess, by grasping either at the dividing scale, or shadows of things. The former is so taken up with the particles of things, as almost to neglect their structure, whilst the other views their fabrication with such astonishment, as not to enter into the simplicity of nature.

In George Adams  
*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture IV (p. 127)  
Printed by R. Hindmarsh. London, England. 1794

**Burroughs, John** 1837–1921  
American naturalist and writer

Science displeases literature when it dehumanizes nature and shows us irrefragable laws when we had looked for humanistic divinities.

*The Breath of Life*  
Chapter X (p. 243)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

To mix science up with philosophy is only to produce a philosophy that has lost all its ideal value and a science that has lost all its practical value.

*All Things Considered*  
Science and Religion (p. 187)  
John Lane Co. New York, New York, USA. 1910

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

Science is not a technique or a body of knowledge, though it uses both. It is rather an attitude of inquiry, or observation and reasoning, with respect to the world. It can be developed, not by memorizing facts or juggling formulas to get an answer, but only by actual practice of scientific observation and reasoning.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 44)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**de Casseres, Benjamin** 1873–1945  
American journalist and author

My studies in speculative philosophy, metaphysics, and science are all summed up in the image of a mouse called

man, running in and out of every hole in the cosmos hunting for the absolute cheese.  
*Harper's Weekly*, Volume 19, Number 3164, June 28, 1976

**Durant, William James** 1885–1981  
American historian and essayist

Philosophy...is the front trench in the siege of truth. Science is the captured territory.

*The Story of Philosophy*  
Introduction (p. 2)  
Simon & Schuster. New York, New York, USA. 1953

Science is analytical description, philosophy is synthetic interpretation. Science wishes to resolve the whole into the known.

*The Story of Philosophy*  
Introduction (p. 2)  
Simon & Schuster. New York, New York, USA. 1953

Science without philosophy, facts without perspective and valuation, cannot save us from havoc and despair. Science gives us knowledge, but only philosophy can give us wisdom.

*The Story of Philosophy*  
Introduction (p. 3)  
Simon & Schuster. New York, New York, USA. 1953

**Eddy, Mary Baker** 1821–1910  
American religious writer

Jesus of Nazareth was the most scientific man that ever trod the globe. He plunged beneath the material surface of things, and found the spiritual cause.

*Science and Health with Key to the Scriptures*  
Chapter X (p. 313)  
Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Fischer, Martin H.** 1879–1962  
German-American physician

Not fact-finding, but attainment to philosophy, is the aim of science.

*Fischerisms* (p. 7)  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Gornick, Vivian**  
American essayist

Science – like art, religion, political theory, or psychoanalysis – is work that holds out the promise of philosophical understanding, excites in us the belief that we can “make sense of it all.”

*Women in Science: Portraits from a World in Transition*  
Part One (p. 66)  
Simon & Schuster. New York, New York, USA. 1983

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

The attempt to understand this universe, including the nature of man, is the task of science; and as she makes progress with this task, so will she become more and

more an indispensable part of philosophy and religion – imagination’s touchstone, thought’s background, action’s base.

Searching for the Elixir of Life  
*The Century Illustrated Monthly Magazine*, Volume 103, Number 4,  
February, 1922

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The philosophy of any period is always largely interwoven with the science of the period, so that any fundamental change in science must produce reactions in philosophy.

*Physics and Philosophy*  
Chapter I (p. 2)  
Dover Publications, Inc. New York, New York, USA. 1981

In whatever ways we define science and philosophy their territories are contiguous; wherever science leaves off – and in many places its boundary is ill-defined – there philosophy begins.

*Physics and Philosophy*  
Chapter I (p. 17)  
Dover Publications, Inc. New York, New York, USA. 1981

**Jones, Steve** 1944–

English genetics professor

...philosophy is to science as pornography is to sex.

In Mary Midgley  
Can Science Save Its Soul?  
*New Scientist*, 1 August, 1992 (p. 25)

**Keats, John** 1795–1821

English Romantic lyric poet

Do not all charms fly  
At the mere touch of cold philosophy?  
There was an awful rainbow once in heaven:  
We know her woof, her texture; she is given  
In the dull catalogue of common things.  
Philosophy will clip an Angel’s wings,  
Conquer all mysteries by rule and line,  
Empty the haunted air, and gnom’ed mine –  
Unweave a rainbow...

*The Complete Poetical Works and Letters of John Keats*  
Lamia, Part II, l. 229–237  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Mercier, André** 1913–99

Swiss physicist

Philosophy does not “solve problems”, whereas science does. Philosophy, in its relations to science, gathers up the problems of science, which are no longer problems since they have found solutions, and seeks to order them in such a way that the structure of knowledge does, in fact, appear.

Fifty Years of the Theory of Relativity  
*Nature*, Volume 175, Number 4465, May 28, 1955 (p. 919)

**Pope Pius XII** 1876–1958

Bishop of Rome

Science descends ever more deeply into the hidden recesses of things, but it must halt at a certain point when questions arise which cannot be settled by means of sense observations. At that point the scientist needs a light which is capable of revealing to him truth which entirely escapes his senses. This light is philosophy.

In Philip G. Fothergill  
*Life and Its Origin*  
Pontifical Academy of Science, Meeting 1955 (p. 12)

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

All science and all philosophy are enlightened common sense.

*Objective Knowledge: An Evolutionary Approach*  
Chapter 2 (p. 34)  
Clarendon Press. Oxford, England. 1972

**Renan, Ernest** 1823–92

French philosopher and Orientalist

Socrates founded philosophy, and Aristotle science. There was philosophy before Socrates, and science before Aristotle; and since Socrates and since Aristotle, philosophy and science have made immense progress: but all has all been built upon the foundations they laid.

*The Life of Jesus*  
Chapter 28 (p. 383)  
Modern Library. New York, New York, USA. 1955

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

It is only in modern times that science has taken the advanced step, and led philosophy into the beautiful avenues of Nature; where, amid the infinite, she gazes at the universe, listens to the music of the spheres, and beholds the golden wealth of the infinite displayed on every side.

*Nature and Culture*  
Chapter 1 (p. 10)  
Lee & Shepard. Boston, Massachusetts, USA. 1875

**Ritchie, Arthur David** 1891–1967

Scottish philosopher and science history writer

Philosophers who write about Science and scientists who write about Philosophy are too often preoccupied with the scientific theories and discoveries of the moment to the detriment of both their Science and their Philosophy.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*  
Preface (p. v)  
Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The man who has no tincture of philosophy goes through life imprisoned in the prejudices.... To such a man the

world tends to become definite, finite, obvious; common objects rouse no questions, and unfamiliar possibilities are contemptuously rejected.

*The Problems of Philosophy*

Chapter XV (pp. 156–157)

Oxford University Press, Inc. London, England. 1959

It seems to me that science has a much greater likelihood of being true in the main than any philosophy hitherto advanced (I do not, of course, except my own). In science there are many matters about which people are agreed; in philosophy there are none. Therefore, although each proposition in a science may be false, and it is practically certain that there are some that are false, yet we shall be wise to build our philosophy upon science, because the risk of error in philosophy is pretty sure to be greater than in science. If we could hope for certainty in philosophy, the matter would be otherwise, but so far as I can see such a hope would be a chimerical.

*The Philosophy of Logical Atomism*

Logical Atomism

University of Minnesota Press. Minneapolis, Minnesota, USA. 1959

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Science brings in great wealth of raw material, but the architectural genius must be sought in Philosophy.

*Introduction to Science*

Chapter V (p. 132)

Henry Holt & Co. New York, New York, USA. 1911

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

In our science and philosophy, even, there is commonly no true and absolute account of things. The spirit of sect and bigotry has planted its hoof amid the stars. You have only to discuss the problem, whether the stars are inhabited or not, in order to discover it.

*The Writings of Henry David Thoreau* (Volume 4)

*Life Without Principle* (p. 469)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Weyl, Hermann** 1885–1955

German mathematician

A scientist who writes on philosophy faces conflicts of conscience from which he will seldom extricate himself whole and unscathed; the open horizon and depth of philosophical thoughts are not easily reconciled with that objective clarity and determinacy for which he has been trained in the school of science.

*Philosophy of Mathematics and Natural Science*

Preface (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1949

## SCIENCE AND POETRY

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

True poetry is truer than science, because it is synthetic, and seizes at once what the combination of all the sciences is able at most to attain as a final result.

Translated by Humphry Ward

*Amiel's Journal: The Journal Intime of Henri-Frédéric Amiel*

31st October, 1852 (p. 30)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1893

The soul of nature is divined by the poet; the man of science only serves to accumulate materials for its demonstration.

Translated by Humphry Ward

*Amiel's Journal: The Journal Intime of Henri-Frédéric Amiel*

31st October, 1852

McGraw-Hill Book Co., Inc. New York, New York, USA. 1893

**Arnold, Matther** 1822–88

English poet and social critic

...the highest reach of science is, one may say, an inventive power, a faculty of divination, akin to the highest power exercised in poetry...

*Essays in Criticism*

The Literary Influence of Academies (p. 47)

Macmillan & Company Ltd. London, England. 1869

The interpretations of science do not give us this intimate sense of objects as the interpretations of poetry give it; they appeal to a limited faculty, and not to the whole man.

*Essays in Criticism* (2nd edition)

Maurice de Guerin (p. 76)

Macmillan & Company Ltd. London, England. 1869

## Author undetermined

Science dissects the universe; it is a dead thing to the dissector: poetry apprehends the universe; it is alive to the poet.

Brief Practical Reading in the Book of Revelation

*Evangelical Magazine and Missionary Chronicle*, N.S. Volume IX, 1867 (pp. 258–259)

**Berdoe, Edward** 1836–1919

Physician

The more thoroughly the lover of Nature is skilled in the knowledge of her laws, the greater will be the intellectual pleasure with which he will contemplate them; and the poet who can follow Nature into her secret chambers, and commune with her on her deepest phenomena, will be the poet who has the noblest things to say to the human soul.

In the Browning Society

*The Browning Society's Papers*

Chapter XXX (p. 36)

N. Trübner & C. London, England. 1885–1886

**Beston, Henry** 1888–1968

American writer

Poetry is as necessary to comprehension as science. It is as impossible to live without reverence as it is without joy.

*The Outermost House*  
Chapter X (p. 221)  
Rinehart & Company. New York, New York, USA. 1928

**Burroughs, John** 1837–1921  
American naturalist and essayist

The true poet and the true scientist are not estranged. They go forth into nature like two friends. Behold them strolling through the summer fields and woods. The younger of the two is much the more active and inquiring; he is ever and anon stepping aside to examine some object more minutely, plucking a flower, treasuring a shell, pursuing a bird, watching a butterfly; now he turns over a stone, peers into the marshes, chips off a fragment of a rock, and everywhere seems intent on some special and particular knowledge of the things about him. The elder man has more an air of leisurely contemplation and enjoyment, – is less curious about special objects and features, and more desirous of putting himself in harmony with the spirit of the whole. But when his younger companion has any fresh and characteristic bit of information to impart to him, how attentively he listens, how sure and discriminating is his appreciation! The interests of the two in the universe are widely different, yet in no true sense are they hostile or mutually destructive.

*Indoor Studies* (Volume 8)  
Chapter II (p. 74)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

To clothe science with flesh and blood, to breathe into it the breath of life, is a creative work which only the Poet can do.

*Indoor Studies*  
Chapter III (p. 77)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Carus, Paul** 1852–1919  
American philosopher

Why a mathematical or otherwise scientific poetry has not yet developed, is due simply to the fact that there are not enough mathematicians in the world to form an audience sufficiently large to make the man of poetical sentiments a real poet as the word is commonly understood; for the poet is made by the people, and public recognition is the true laurel wreath of any real poet laureate.

*Friedrich Schiller: A Sketch of His Life and an Appreciation of His Poetry*  
Schiller, A Philosophical Poet (p. 33)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1905

**Clifford, William Kingdon** 1845–79  
English philosopher and mathematician

It is an open secret to the few who know it, but a mystery and a stumbling-block to the many, that Science and Poetry are own sisters; insomuch that in those branches of scientific inquiry which are most abstract, most formal, and most remote from the grasp of the ordinary

sensible imagination, a higher power of imagination akin to the creative insight of the poet is most needed and most fruitful of lasting work.

In Leslie Stephen and Frederick Pollock (eds.)  
*Lectures and Essays* (Volume 1)  
Introduction (p. 1)  
Macmillan & Company. London, England. 1886

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Poetry is not the proper antithesis to prose, but to science. Poetry is opposed to science, and prose to metre.

In Henry Nelson Coleridge  
*The Literary Remains of Samuel Taylor Coleridge* (Volume 2)  
Definition of Poetry (p. 7)  
William Pickering. London, England. 1836

The proper and immediate object of science is the acquirement, or communication, of truth; the proper and immediate object of poetry is the communication of immediate pleasure.

In Henry Nelson Coleridge  
*The Literary Remains of Samuel Taylor Coleridge* (Volume 2)  
Definition of Poetry (p. 7)  
William Pickering. London, England. 1836

**Cooke, George Willis** 1848–1923  
American Unitarian minister, writer, editor, and lecturer

Science can dissect the human body, but it can do little towards an explanation of the subtler meaning of life and mind. Its methods are analytical; it has reached no truly synthetic results in the regions where knowledge is most to be desired. Its effects on literature are destructive. Science destroys poetry, dries up the poetic sense, closes the doors of imagination.

*George Eliot: A Critical Study of Her Life, Writings, and Philosophy*  
Chapter XIX (pp. 410–411)  
Houghton Mifflin & Co. New York, New York, USA. 1883

**Davis, Joel** 1948–  
No biographical data available

Poetry and science are closer than most people realize. Many poets and scientists already know this, of course. Most of the rest of us are still trapped in dismal stereotypes about both fields of human endeavor. The deep link between the two is vision.

*Alternate Realities*  
In a Grain of Sand (p. 3)  
Plenum Trade. New York, New York, USA. 1997

**Day-Lewis, Cecil** 1904–72  
Irish poet

Science is concerned with finding out and stating the facts: poetry's task is to give you the look, the smell, the taste, the "feel" of those facts.

*Poetry for You*  
Chapter I (p. 10)  
Basil Blackwell & Mott Ltd. Oxford, England. 1959



Every good poem, in fact, is a bridge built from the known, familiar side of life over into the unknown. Science, too, is always making expeditions into the unknown. But this does not mean that science can supersede poetry. For poetry enlightens us in a different way from science: it speaks directly to our feelings or imagination. The findings of poetry are no more and no less true than science.

*Poetry for You*

Chapter VIII (p. 92)

Basil Blackwell & Mott Ltd. Oxford, England. 1959

**Gray, David** 1838–61

Scottish poet

It is certain that the clear, dry sky of scientific knowledge is utterly unlike that vague atmosphere of dream and phantasy in which the Muse has been wont to move and have her being.

*Letters, Poems and Selected Prose Writings of David Gray*

Science and Poetry (p. 323)

The Courier Co. Buffalo, New York, USA. 1888

Science and poetry will continue to co-exist, and may even become good friends. The dauntless and tireless scientist will not cease to question nature and push outward the lines of physical knowledge; but, on the other hand, he can scarcely make any serious invasion of Poetry's spiritual domain.

*Letters, Poems and Selected Prose Writings of David Gray*

Science and Poetry (p. 330)

The Courier Co. Buffalo, New York, USA. 1888

**Grierson, Francis** 1848–1927

English-born American musician, composer, and pianist

There is such a thing as poetic science, but no such thing as scientific poetry.

*The Humour of the Underman, and Other Essays* (p. 9)

John Lane Co. London, England. 1913

**Hare, Julius Charles** 1795–1855

English theological writer

**Hare, Augustus William** 1834–1903

Science sees signs; Poetry the thing signified.

*Guesses at Truth* (p. 354)

Macmillan & Co Ltd. London, England. 1876

**Holton, Gerald** 1922–

Research professor of physics and science history

Poets rush in where scientists fear to tread.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part One, Chapter 6 (p. 132)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Irving, David**

No biographical data available

The principal object indeed of poetry is not profit but pleasure: if however a scientific poem be intended for solid

instruction, the endless progression of human knowledge will speedily abridge the importance of almost every precept which it may contain; and when the scientific part is completely obsolete, the poetry will no longer be found attractive.

*Memoirs of the Life and Writings of George Buchanan* (p. 242)

Printed for Bell & Bradfute. Edinburgh, Scotland. 1907

**Jones, Frederick Wood** 1879–1954

Physician

Whoever wins to a great scientific truth will find a poet before him in the quest.

*Medical Journal of Australia*, 29 August, 1931

**Kingsley, Charles** 1819–75

English clergyman and author

Science has made vast strides, and introduced entirely new modes of looking at nature, and poets must live up to the age.

*Alton Locke*

Chapter XV (p. 133)

Macmillan & Co Ltd. London, England. 1862

**Lowell, James Russell** 1819–91

American poet, critic, essayist, editor, and diplomat

In the earliest ages science was poetry, as in the later poetry has become science.

*The Writings of James Russell Lowell* (p. 359)

The Riverside Press. Cambridge, England. 1890

**Lysaght, Sidney Royse** 1860–1941

Irish writer

Science in the first place looks for information, poetry for beauty; and, taking different paths, they meet on the borderland of discovery.

*A Reading of Life*

Chapter II (p. 35)

Macmillan & Company Ltd. London, England. 1936

**Macaulay, Thomas Babington** 1800–50

English historian and writer

...as men know more, and think more, they look less at individuals, and more at classes. They therefore make better theories, and worse poems.

*Critical and Miscellaneous Essays*

Milton (p. 21)

Carey & Heart. Philadelphia, Pennsylvania, USA. 1843

In an enlightened age there will be much intelligence, much science, much philosophy, abundance of just classification and subtle analysis, abundance of wit and eloquence, abundance of verses, and even of good ones – but little poetry.

*Critical and Miscellaneous Essays*

Milton (p. 23)

Carey & Heart. Philadelphia, Pennsylvania, USA. 1843



...poetry effects its purpose most completely in a dark age. As the light of knowledge breaks in upon its exhibitions, as the outlines of certainty become more and more definite, and the shades of probability more and more distinct, the hues and lineaments of the phantoms which it calls up grow fainter and fainter.

*Critical and Miscellaneous Essays*

Milton (pp. 23–24)

Carey & Heart. Philadelphia, Pennsylvania, USA. 1843

### **Maudsley, Henry** 1835–1918

English physician

The mountains are not less imposing in their grandeur because the Oreads have deserted them, nor the groves less attractive, nor the streams more desolate, because science has banished the Dryads and the Naiads. No, science has not destroyed poetry, nor expelled the divine from Nature, but has furnished the materials, and given the presages, of a higher poetry and a mightier philosophy than the world has yet seen.

*Body and Mind*

Lecture III (p. 96)

D. Appleton & Co. New York, New York, USA. 1872

### **Melandri, E.**

No biographical data available

The existence of poetics of science is undeniable.... Barring poetics from science is the same as barring use of the hypothesis.

In Fernand Hallyn

*The Poetic Structure of the World: Copernicus and Kepler*

Introduction (p. 7)

Zone Books. New York, New York, USA. 1990

### **Miller, Hugh** 1802–56

Scottish geologist and theologian

Because science flourishes, must poesy decline? The complaint serves but to betray the weakness of the class who urge it.

*Sketch-book of Popular Geology* (3rd edition)

Lecture Second (p. 80)

William P. Nimmo. Edinburgh, Scotland. 1869

### **Moore, Thomas** 1779–1852

Irish poet

Lady Bab. Yes, my dear, a poem upon *sol ammoniac* – in which, under the name of the *Loves of Ammonia*, I have personified this interesting *alkali*, and described very tenderly all the various *experiments* that have been tried on her.

Miss S. This is what has been called ‘enlisting Poetry under the banners of Science,’

*The Works of Thomas Moore*

The Blue Stocking (p. 295)

Printed for E. Fleischer. Leipzig, Germany 1833

### **Munroe, J.**

No biographical data available

There is a lofty poetry in the wonderful revelations of Science, – poetry felt by Newton, Herschel, Faraday, and perhaps by all great discoverers. It is still sometimes felt by the student as he pursues his studies into fresh fields. If, then, we have lost a reverent sense for the marvels we are familiar with, we should rather attribute it to the triteness of our knowledge than to the character of that knowledge in itself.

Science and the Sense of Beauty

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

Volume IV, (Third series), April, 1882 (p. 203)

### **Pellissier, Georges**

No biographical data available

The pitfall of scientific poetry lies in a perfection which the prose writer masters without effort, but which the poet can only attain through miracles of patient, laborious art. To tax one’s ingenuity to set in verse a law, an axiom, or a definition more naturally expressed in prose, is a mental exercise quite as sterile as difficult.

*The Literary Movement in France During the Nineteenth Century*

Part III, Chapter II (p. 372)

G. Putnam’s Sons. New York, New York, USA. 1897

### **Pollock, Sir Frederick** 1845–1937

English jurist

It is an open secret to the few who know it, but a mystery and a stumbling-block to the many, that Science and Poetry are own sisters; insomuch that in those branches of scientific inquiry which are most abstract, most formal, and most remote from the grasp of the ordinary sensible imagination, a higher power of imagination akin to the creative insight of the poet is most needed and most fruitful of lasting work.

In Leslie Stephen and Frederick Pollock

*Lectures and Essays, by the Late William Kingdon Clifford* (2nd edition)

Introduction, Part I (p. 1)

Macmillan & Company Ltd. London, England. 1886

### **Proctor, Richard Anthony** 1837–88

English astronomer

Many think that science cannot truly be called science if clothed in poetic garb, and, on the other hand, others seem to fear that a glory must depart from the face of nature if science scrutinise her mysteries too closely.

*The Poetry of Astronomy*

Preface

Smith, Elder & Co. London, England. 1881

### **Robertson, Frederick W.** 1816–53

English divine

Science destroys poetry until the heart bursts into mysticism, and out of science brings poetry again, asserting a

wonder and a vague mystery of life and feeling, beneath and beyond all science, and proclaiming the wonderfulness and mystery of that which we seem most familiarly to understand.

*The World's Best Orations: From the Earliest Period to the Present Time* (Volume 9)

The Highest Form of Expression (pp. 3319–3320)  
Ferd. P. Keiser. St. Louis, Missouri, USA. 1899

**Poetry creates life; Science dissects death.**

*Lectures and Addresses on Literary and Social Topics*  
Lecture I (p. 123)

Ticknor & Fields. Boston, Massachusetts, USA. 1859

**Roux, Joseph** 1725–93

French hydrographer

Science is for those who learn; poetry, for those who know.

Translated by Isabel Hapgood

*Meditations of a Parish Priest: Thoughts*  
LXXI (p. 43)

Thomas Y. Crowell & Co. New York, New York, USA. 1886

**Spencer, Herbert** 1829–1903

English social philosopher

...science opens up realms of poetry where to the unscientific all is a blank. Those engaged in scientific researches constantly show us that they realize not less vividly, but more vividly, than others, the poetry of their subjects. Whoever will dip into Hugh Miller's works on geology, or read Mr. Lewes's "Seaside Studies," will perceive that science excites poetry rather than extinguishes it.

*Education*

Chapter I (p. 68)

Willard Small. Boston, Massachusetts, USA. 1890

...those who have never entered upon scientific pursuits know not a tithe of the poetry by which they are surrounded. Whoever has not in youth collected plants and insects, knows not half the halo of interest which lanes and hedgerows can assume. Whoever has not sought for fossils, has little idea of the poetical associations that surround the places where imbedded treasures were found. Whoever at the seaside has not had a microscope and aquarium, has yet to learn what the highest pleasures of the seaside are.

*Education*

Chapter I (p. 69)

Willard Small. Boston, Massachusetts, USA. 1890

...it is not true that the facts of science are unpoetical; or that the cultivation of science is necessarily unfriendly to the exercise of imagination or the love of the beautiful. On the contrary science opens up realms of poetry where to the unscientific all is a blank.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 82)

D. Appleton & Co. New York, New York, USA. 1891

**Stedman, Edmund Clarence** 1833–1908

American poet, critic, and essayist

...our school-girls and spinsters wander down the lanes with Darwin, Huxley, and Spencer under their arms; or if they carry Tennyson, Longfellow, and Morris, read them in the light of spectrum analysis, or test them by the economics of Mill and Bain.

*Victorian Poets* (p. 13)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1915

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Science has enormous treasure-caves full of what we cannot but describe as the raw materials of poetry.

*Introduction to Science*

Chapter VI (p. 167)

Henry Holt & Co. New York, New York, USA. 1911

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The poet uses the results of science and philosophy, and generalizes their wisest deductions.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimack Rivers*

Friday (p. 478)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Tillyard, E. M. W.** 1889–1962

English classical scholar

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Only science can tell you where and when you are likely to meet an elm: only poetry can tell you what meeting an elm is like.

*The Personal Heresy: A Controversy*

Chapter V (p. 110)

Oxford University Press, Inc. London, England. 1939

**Tomlinson, C.**

No biographical data available

The single object of science is the discovery of truth as it is in nature, and I cannot imagine greater mistake than to suppose that science is the enemy of poetry. There are higher flights in science than were ever reached by poetry, and if the poetry of the future is to be something more than repetition of the past, it must borrow wings from science.

Poetry versus Science

*Notes and Queries*, Eighth Series, Volume II, Number 33, August 13, 1892 (p. 133)

**von Schlegel, Friedrich** 1772–1829

German philosopher, critic, and writer

Strictly speaking, the idea of a scientific poem is probably as nonsensical as that of a poetic science.

*Dialogue on Poetry and Literary Aphorisms*

Selected Aphorisms from the Lyceum

Aphorism 61 (p. 127)

The Pennsylvania State University Press, University Park, Pennsylvania, USA. 1968

**Wheelock, John Hall** 1886–1978

American poet

The statements of science are hearsay, reports from a world outside the world we know. What the poet tells us has long been known to us all, and forgotten. His knowledge is of our world, the world we are both doomed and privileged to live in, and it is a knowledge of ourselves, of the human condition, the human predicament.

*What Is Poetry?*

Chapter 6

Charles Scribner's Sons, New York, New York, USA. 1963

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Exact science and its practical movements are no checks on the greatest poet but always his encouragement and support. ...there the arms that lifted him first and brace him best...there he returns after all his goings and comings. The sailor and traveller...the anatomist chemist astronomer geologist phrenologist spiritualist mathematician historian and lexicographer are not poets, but they are the lawgivers of poets and their construction underlies the structure of every perfect poem.

*Leaves of Grass*

Preface to the 1855 edition of "*Leaves of Grass*" (p. 304)

Doubleday, Doran & Company, Inc. New York, New York, USA. 1940

If there shall be love and content between the father and the son and if the greatness of the son is the exuding of the greatness of the father, there shall be love between the poet and the man of demonstrable science. In the beauty of poems are the tuft and final applause of science.

*Leaves of Grass*

Preface to the 1855 edition of "*Leaves of Grass*" (p. 304)

Doubleday, Doran & Company, Inc. New York, New York, USA. 1940

**Wordsworth, William** 1770–1850

English poet

If the time should ever come when what is now called science, thus familiarised to men, shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the Being thus produced, as a dear and genuine inmate of the household of man.

*The Prose Works of William Wordsworth* (Volume 2)

Chapter III (p. 92)

Edward Moxon, Son, & Co. London, England. 1876

Poetry is the breath and finer spirit of all knowledge; it is the impassioned expression which is in the countenance of all Science.

*Lyrical Ballads* (Volume 1)

Preface (p. xxxvii)

Printed for T.N Longman & O. Rees. London, England. 1802

The knowledge both of the Poet and the Man of science is pleasure; but the knowledge of the one cleaves to us as a necessary part of our existence, our natural and unalienable inheritance; the other is a personal and individual acquisition, slow to come to us, and by no habitual and direct sympathy connecting us with our fellow-beings.

In Andrew Jackson George

*The Complete Poetical Works of William Wordsworth*

Preface to the Lyrical Ballads (p. 795)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1904

**Zee, Anthony**

American physicist

In science, one tries to say what no one else has ever said before. In poetry, one tries to say what everyone else has already said, but better. This explains, in essence, why good poetry is as rare as good science.

*Fearful Symmetry*

Chapter 7 (p. 103)

Macmillan Publishing Company, New York, New York, USA. 1986

## SCIENCE AND POLITICS

**Bernal, John Desmond** 1901–71

Irish-born physicist and X-ray crystallographer

The greater the man the more he is soaked in the [political] atmosphere of his time; only thus can he get a wide enough grasp of it to be able to change substantially the pattern of knowledge and action.

*Science in History* (p. 22)

C.A. Watts & Co. London, England.

**Born, Max** 1882–1970

German-born English physicist

...the subordination of fundamental research to political and military authorities is detrimental. The scientists themselves have learned by now that the period of unrestricted individualism in research has come to an end. They know that even the most abstract and remote ideas may one day become of great practical importance – like Einstein's law of equivalence of mass and energy. They have begun to organize themselves and to discuss the problem of their responsibility to human society. It should be left to these organizations to find a way to harmonize the security of the nations with the freedom of research and publication without which science must stagnate.

*The Restless Universe*

Postscript (p. 308)

Dover Publications, Inc. New York, New York, USA. 1951

**Budworth, D.**

No biographical data available

Science policy is essentially about the allocation of scarce resources, and is therefore a part of politics.... The scarce resource with which science policy should concern itself in the short term is not money, but that portion of the scientific population which is capable of initiating and leading significant work. Such people are always in short supply, even when the total population itself is greater than the available jobs.

Science Policy Should Be About People

*New Scientist*, Volume 69, Number 993, 25 March, 1976 (pp. 684–685)**Clarke, Arthur C.** 1917–

English science and science fiction writer

The menace of interplanetary imperialism can be overcome only by world-wide technical and political agreements well in advance of the actual event, and these will require continual pressure and guidance from the organizations which have studied the subject.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 8)

Harper &amp; Brothers. New York, New York, USA. 1959

**de Maupertuis, Pierre-Louis Moreau** 1698–1759

French mathematician and astronomer

There are sciences over which the will of kings has no immediate influence; it can procure advancement there only in so far as the advantages which it attaches to their study can multiply the number and the efforts of those who apply themselves to them. But there are other sciences which for their progress urgently need the power of sovereigns; they are all those which require greater expenditure than individuals can make or experiments which would not ordinarily be practicable.

*Lettres su le progrès des sciences, Oeuvres de Maupertuis*

Dresden (pp. 6–7)

Publisher undetermined

**Johnson, Harry G.** 1923–1979

American economist

Basic science, per se, contributes to culture; it contributes to our social well-being, including national defence and public health; to our economic well-being; and it is an essential element of the education not only of scientists but also of the population as a whole. In deciding how much science the society needs, one must decide how the support of science bears on these other, politically defined, goals of the society.

In National Academy of Sciences

*Basic Research and National Goals: A Report to the Committee on Science and Astronautics*

Federal Support of Basic Research: Some Economic Issues, Summary (p. 5)

US Government Printing Office. Washington, D.C. 1965

**Koestler, Arthur** 1905–83

Hungarian-born English writer

No scientist is admired for failing in the attempt to solve problems that lie beyond his competence. The most he can hope for is the kindly contempt earned by the Utopian politician. If politics is the art of the possible, research is surely the art of the soluble. Both are immensely practical-minded affairs.

The Act of Creation

*New Statesman*, Volume 19, June, 1964**Price, Don Krasher** 1910–95

American political scientist

...all sciences are considered by their professors as equally significant; by the politicians, as equally incomprehensible; and by the military as equally expensive.

*The Scientific Estate*

Chapter 1 (p. 12)

Harvard University Press. Cambridge, Massachusetts, USA. 1965

...it has begun to seem evident to a great many administrators and politicians that science had become something very close to an establishment, in the old and proper sense of that word: a set of institutions supported by tax funds but largely on faith and without direct responsibility to political control.

*The Scientific Estate*

Chapter 1 (p. 12)

Harvard University Press. Cambridge, Massachusetts, USA. 1965

**Rabinowitch, Eugene** 1901–73

Russian-born American biophysicist

Science has assumed such an important role in determining the parameters of national and international life, that participation in national decisions by people whose world picture has been affected by the study and practice of science (even if this picture has its own bias), is indispensable for many major political decisions – to correct the bias of the more traditional molders of national decisions, such as men with legal training.

Open Season on Scientists

*The New Republic*, January 1, 1966 (p. 21)**SCIENCE AND PRACTICE****de La Beche, Henry Thomas** 1796–1855

English geologist

Science and practice are not antagonistic, they are mutual aids.

*Records of the School of Mines and of Science Applied to the Arts* (Volume 1), Part I

Inaugural Discourse (p. 21)

Longman, Brown, Green &amp; Longmans. London, England. 1852

## SCIENCE AND RELIGION

**Adams, George** 1750–95  
English instrument maker

The two kingdoms of nature and grace, as two parallel lines, correspond to each other, follow a like course, but can never be made to touch. An adequate understanding of this distinction in all its branches, would be the consummation of human knowledge.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture VI (p. 242)  
Printed by R. Hindmarsh. London, England. 1794

**Adams, Henry Brooks** 1838–1918  
American man of letters

The preacher then went on to criticise the attitude of religion towards science. “If there is still a feeling of hostility between them...it is no longer the fault of religion. There have been times when the church seemed afraid, but she is so no longer. Analyze, dissect, use your microscope or your spectrum till the last atom of matter is reached; reflect and refine till the last element of thought is made clear; the church now knows with the certainty of science what she once knew only by the certainty of faith, that you will find enthroned behind all thought and matter only one central idea, – that idea which the church has never ceased to embody, – I AM!

*Democracy, and Esther: Two Novels by Henry Adams*  
Esther (p. 212)  
Peter Smith. Gloucester, Massachusetts, USA. 1965

**Atkinson, Henry George**  
No biographical data available

**Martineau, Harriet**

There is no theory of a God, of an author of Nature, of an origin of the universe, which is not utterly repugnant to my faculties; which is not (to my feelings) so irreverent as to make me blush; so misleading as to make me mourn.

*Letters on the Laws of Man's Nature and Development*  
Chapter 19 (p. 217)  
John Chapman. London, England. 1851

**Allport, Gordon** 1897–1967  
American psychologist

A narrowly conceived science can never do business with a narrowly conceived religion.

*The Individual and His Religion: A Psychological Interpretation*  
Preface (p. vi)  
The Macmillan Company. New York, New York, USA. 1956

**Alpher, Ralph Asher** 1921–  
American physicist

I...reject the argument put forth by many fundamentalists that science has nothing to do with religion because

God is not among the things making up the universe in which we live. Surely if a necessity for a god-concept in the universe ever turns up, that necessity will become evident to the scientist.

Theology of the Big Bang  
*Religious Humanism*, Volume 17, Number 1, Winter, 1983 (p. 12)

**Appleyard, Bryan** 1951–  
English author and journalist

Science was the lethally dispassionate search for truth in the world whatever its meaning might be; religion was the passionate search for meaning whatever the truth might be. Science can lay a claim to a meaning in the sense of establishing causality, and religion could claim truth in the sense of a transcendent order. But science's meaning does not answer the question Why? And religion's truth had no scientific relevance.

*Understanding the Present: Science and the Soul of Modern Man*  
Chapter 4 (p. 79)  
Doubleday. New York, New York, USA. 1992

**Bakunin, Mikhail Alexandrovich** 1814–76  
Russian revolutionary

In our church – if I may be permitted to use for a moment an expression which I so detest – ...we have a chief, an invisible Christ, science.

*God and the State*  
Chapter I (p. 20)  
McGraw-Hill Book Co., Inc. New York, New York, USA. 1916

**Berger, Peter L.** 1929–  
American sociologist

Protestant theologians have been increasingly engaged in playing a game whose rules have been dictated by their cognitive antagonists.

*A Rumor of Angels: Modern Society and the Rediscovery of the Supernatural*  
Chapter 1 (p. 10)  
Doubleday & Company, Inc. Garden City, New York, USA. 1970

**Berman, Louis**  
No biographical data available

Science also as a religion, as a faith to bind men together, as a substitute for the moribund old mythologies and theologies which kept them sundered, is commencing to be talked of in a more serious tone.

*The Glands Regulating Personality*  
Introduction (pp. 16–17)  
The Macmillan Co. New York, New York, USA. 1921

...the religion of science will play the great part of the Liberator of mankind from the whole system of torments that have made the way of all flesh a path of rocks along which a manacled prisoner crawls to his doom.

*The Glands Regulating Personality*  
Introduction (p. 17)  
The Macmillan Co. New York, New York, USA. 1921



**Bernal, John Desmond** 1901–71  
Irish-born physicist and X-ray crystallographer

Now the history of scientific advance has shown us clearly that any appeal to Divine Purpose or any supernatural agency, to explain any phenomenon, is in fact only a concealed confession of ignorance, and a bar to genuine research.

*Science and Ethics*

A Marxist Critique (p. 116)

George Allen & Unwin Ltd. London, England. 1942

The role of God in the material world has been reduced stage by stage with the advance of science, so much so that He only survives in the vaguest mathematical form in the minds of older physicists and biologists.

In C.H. Waddington (ed.)

*Science and Ethics*

A Marxist Critique (p. 116)

George Allen & Unwin Ltd. London, England. 1942

**Boutroux, Émile** 1845–1921  
French philosopher

In spite of their relations, science and religion remain, and must remain, distinct. If there were no other way of establishing a rational order between things than that of reducing the many to the one, either by assimilation or by elimination, the destiny of religion would appear doubtful.

Translated by Jonathan Nield

*Science and Religion in Contemporary Philosophy*

Conclusion (pp. 399–400)

Duckworth & Company. London, England. 1912

**Brewster, David** 1781–1868  
Scottish scientist, inventor and writer

...identified with astronomy, in proclaiming truths supposed to be hostile to Scripture, Geology has been denounced as the enemy of religion. The twin sisters of terrestrial and celestial physics have thus been joint-heirs of intolerance and persecution – unresisting victims in the crusade which ignorance and fanaticism are ever waging against science.

*More Worlds Than One: The Creed of the Philosopher and the Hope of the Christian*

Chapter III (p. 47)

Chatto & Windus. London, England. 1876

**Buchner, Ludwig** 1824–99  
German physician and philosopher

[How can we conceive] a supreme legislator, who allows himself to be moved by prayers and sobs, to reverse the immutable order which he himself has created, to violate his own laws, and with his own hand to destroy the action of the natural forces!

*Force and Matter*

Chapter VI (p. 38)

Trübner & Co. London, England. 1864

What this or that man may understand by a governing reason, an absolute power, a universal soul, a personal God, etc., is his own affair. The theologians, with their articles of faith, must be left to themselves; so the naturalists with their science: they both proceed by different routes.

*Force and Matter*

Chapter VI (p. 43)

Trübner & Co. London, England. 1864

It is now known that there can be no discussion about those periodic creations of the earth of which so much was said, and which to this day an erroneous conception of nature tries to identify with the so-called days of creation of the Bible; but that the whole past of the earth is nothing but an unfolded *present*.

*Force and Matter*

Chapter IX (p. 57)

Trübner & Co. London, England. 1864

How curious and whimsical is not the conception of a creative power, which conducts the earth and its inhabitants through various transitions and immense periods of time to a more developed form, in order to make it finally a fit dwelling-place for the most organised animal – man.

*Force and Matter*

Chapter IX (p. 60)

Trübner & Co. London, England. 1864

An enlightened intellect no longer requires the aid of that powerful hand which, acting from without, excites the burning spirits of the interior of the earth to a sudden rebellion, which pours the waters as a deluge over the earth, and shapes for its designs the whole structure like soft clay.

*Force and Matter*

Chapter IX (p. 60)

Trübner & Co. London, England. 1864

**Buck, Pearl S.** 1892–1973  
American author

Science and religion, religion and science, put it as I may they are two sides of the same glass, through which we see darkly until these two, focusing together, reveal the truth.

*A Bridge for Passing*

Chapter III (p. 255)

John Day Company. New York, New York, USA. 1962

**Bultmann, R.**

No biographical data available

...the New Testament provides a world picture which belongs entirely to Jewish or Gnostic mythology and is incredible or even meaningless in a scientific age.

In H.J. Paton

*The Modern Predicament: A Study in the Philosophy of Religion*

Chapter XV, Section 3 (p. 228)

Collier Books. New York, New York, USA. 1962



**Burroughs, John** 1837–1921  
American naturalist and essayist

The scientific faith of mankind – faith in the universality of natural causation – is greatly on the increase; it is waxing in proportion as theological faith is waning; and if love of truth is to be our form of love of God, and if the conservation of human life and the amelioration of its conditions are to be our form of brotherly love, then the religion of a scientific age certainly has some redeeming features.

*The Writings of John Burroughs* (Volume 19)  
Chapter X (p. 175)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

The mysteries of religion are of a different order from those of science; they are parts of an arbitrary system of man's own creation; they contradict our reason and our experience, while the mysteries of science are revealed by our reason, and transcend our experience.

Scientific Faith

*The Atlantic Monthly*, July 1915 (p. 33)

The miracles of religion are to be discredited, not because we cannot conceive of them, but because they run counter to all the rest of our knowledge; while the mysteries of science, such as chemical affinity, the conservation of energy, the indivisibility of the atom, the change of the non-living into the living...extend the boundaries of our knowledge, though the modus operandi of the changes remains hidden.

Scientific Faith

*The Atlantic Monthly*, July 1915 (p. 33)

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

To pursue science is not to disparage the things of the spirit. In fact, to pursue science rightly is to furnish a framework on which the spirit may rise.

Speech, MIT, October 5, 1953

**Bushnell, Horace** 1802–76  
American Congregational minister

As the science of nature goes toward completion, religion, having all the while been watching for it in close company, will have gotten immense breadth and solidity, from the ideas and facts unfolded in its discoveries, and will be as much enlarged in its confidence and the sentiment of worship, as beholding God's deep system in the world signifies more than looking on its surfaces.

Science and Religion

*Putnam's Magazine*, Volume 1, 1868 (p. 267)

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Science and religion are reconciled in amiable and sensible people but nowhere else.

*The Note-Books of Samuel Butler* (Volume 1)  
1874–1883 (p. 118)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Carpenter, William Benjamin** 1813–85  
English physiologist and naturalist

...when Science, passing beyond its own limits, assumes to take the place of Theology, and sets up its own conception of the Order of Nature as a sufficient account of its Cause, it is invading a province of Thought to which it has no claim, and not unreasonably provokes the hostility of those who ought to be its best friends.

*Report of the Forty-second Meeting of the British Association for the Advancement of Science*

Address (p. lxxxiv)

**Chadwick, Owen** 1916–  
English historian and Christian scholar

Science versus Religion – the antithesis conjures two hypostatized entities of the later nineteenth century: Huxley St. George slaying Samuel smoothest of dragons; a mysterious undefined ghost called Science against a mysterious indefinable ghost called Religion; until by 1900 schoolboys decided not to have faith because Science, whatever that was, disproved Religion, whatever that was.

*The Secularisation of the European Mind in the Nineteenth Century*  
Part II, Chapter 7 (p. 161)

Cambridge University Press. Cambridge, England. 1990

**Chapin, Edwin Hubbell** 1840–80  
Universalist minister, author, lecturer, and social reformer

Revelation and science are continually interpreting one another, while every day the material universe is unfolding a more spiritual significance, and indicating its subservience to a spiritual end.

*Living Words* (p. 45)

Universalist Publishing House. Boston, Massachusetts, USA. 1883

Let us not fear that the issues of natural science shall be scepticism or anarchy. Through all God's works there runs a beautiful harmony. The remotest truth in his universe is linked to that which lies nearest the throne.

*Living Words* (p. 117)

Universalist Publishing House. Boston, Massachusetts, USA. 1883

**Clark, W. C.**  
No biographical data available

**Majone, G.**  
No biographical data available

The social uses of science have always had something in common with the social uses of religion. And in the two decades following the Second World War, modern science took on a most religious-looking numinous legitimacy as an unquestioned source of authority on all manner of policy problems.

*Report of the International Institute of Applied Systems Analysis*  
The Critical Appraisal of Scientific Inquiries with Policy Implications,  
Luxemburg, Austria, 1984 (p. 35)

**Cobbe, Frances Power** 1822–1904  
Irish writer

Science... is but a mere heap of facts, not a golden chain of truths, if we refuse to link it to the throne of God.

*The Peak in Darien: An Octave of Essays*  
Magnanimous Atheism (pp. 50–51)  
George H. Ellis. Boston, Massachusetts, USA. 1882

**Coleridge, Stephen** 1854–1936  
English author, barrister, and opponent of vivisection

The Church by no mental contortions or intellectual gymnastics can ever reconcile the dull negative assertions of Science with the spiritual aspirations of Religion, the noble altruisms of Christianity, or the divine visions of the philosophers.

*The Idolatry of Science*  
Chapter II (p. 9)  
John Lane Co. London, England. 1920

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

Science has contributed to the making of religion into a developing dynamic spiritual force.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*  
During the Years 1930–1949 (p. 19)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Conklin, Edwin Grant** 1863–1952  
American zoologist

Science cannot solve the great mysteries of our existence, – why we are, whither we are bound, and what it all means. Faith alone assures us that there is definite purpose in all experience. This knowledge makes life worth living and service a privilege.

In Edward H. Cotton  
*Has Science Discovered God?*  
A Biologist's Religion (p. 89)  
Thomas Y. Crowell Company. New York, New York, USA. 1931

The faith, ideals, and ethics of science constitute a form of natural religion.

*Science*, December 31, 1837

**Coulson, Charles Alfred** 1910–74  
English theoretical chemist

...science is one aspect of God's presence, and scientists therefore part of the company of His heralds.

*Science and Christian Belief*  
Scientific Method (p. 30)  
The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1955

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

If the Church is largely ignored today it is not because science has finally won its age-old battle with religion, but because it has so radically reoriented our society that the biblical perspective of the world now seems largely irrelevant. As one television cynic recently remarked, few of our neighbors possess an ass for us to covet.

*God and the New Physics*  
Chapter 1 (p. 2)  
Simon & Schuster. New York, New York, USA. 1983

Those who invoke God as an explanation of cosmic organization usually have in mind a supernatural agency, acting on the world in defiance of natural laws. But it is perfectly possible for much, if not all of what we encounter in the universe to be the product of intelligent manipulation of a purely natural kind: within the laws of physics. For example, our galaxy could have been made by a powerful mind who rearranged the primeval gases using carefully placed gravitating bodies, controlled explosions and all the other paraphernalia of a space age astro-engineer.

*God and the New Physics*  
Chapter 15 (p. 208)  
Simon & Schuster. New York, New York, USA. 1983

In spite of the fact that religion looks backward to revealed truth while science looks forward to new vistas and discoveries, both activities produce a sense of awe and a curious mixture of humility and arrogance in their practitioners. All great scientists are inspired by the subtlety and beauty of the natural world that they are seeking to understand. Each new subatomic particle, every unexpected object, produces delight and wonderment. In constructing their theories, physicists are frequently guided by arcane concepts of elegance in the belief that the universe is intrinsically beautiful.

*God and the New Physics*  
Chapter 17 (p. 220)  
Simon & Schuster. New York, New York, USA. 1983

**Davis, Andrew Jackson**  
No biographical data available

The world has many needs; the greatest of all is, a philosophy, which unfolds in a systematic and orderly form the stupendous truths of Nature; which points the soul of man, through Nature, to the Eternal Mind... The soft silvery sunbeams of heaven do not more naturally flow over the fields than did the loving, intuitive soul of Jesus spread its elixir over his solemn utterances. Every Bible student feels its mysterious beauty; realizes its spiritual presence, as he reads those sacred evangels of the Testaments. Every civilized mind feels the goodness of his teachings, and admires the expurgated history of the man, bequeathed to us by the early fathers of the Church; nevertheless, the world needs today a 'philosophy' which Jesus did not furnish, needs a 'revelation' to the faculty of reason, which the Bible does not explain.

*The Present Age and Inner Life* (3rd edition)  
A Survey of Human Needs (pp. 17, 24)  
W. White & Co. Boston, Massachusetts, USA. 1873

**Dembski, William A.** 1960–  
Mathematician and philosopher

Any view of the sciences that leaves Christ out of the picture must be seen as fundamentally deficient.

*Intelligent Design: The Bridge Between Science and Theology*  
Part 3, Chapter 7, Section 7.6 (p. 206)  
InterVarsity Press. Downers Grove, Illinois, USA. 1999

**Disraeli, Benjamin, First Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

It [the revelation of chaos] is treated scientifically; everything is explained by geology and astronomy, and in that way. It shows you exactly how a star is formed; nothing can be so pretty! A cluster of vapour, the cream of the milky way, a sort of celestial cheese, churned into light,

*Novels and Tales by the Earl of Beaconsfield* (Volume 9)  
*Tancred, Or The New Crusade*  
Chapter IX (p. 109)  
Longmans, Green & Co. London, England. 1900

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

There are still many people who are happy and comfortable adhering to fundamentalist creeds. This should cause no surprise, since a large majority of these believers are as unfamiliar with scientific findings as were people who lived centuries ago.

*The Biology of Ultimate Concern*  
Chapter 5 (p. 95)  
The New American Library, Inc. New York, New York, USA. 1967

Science and religion deal with different aspects of existence...[T]hese are the aspect of facts and the aspect of meaning. But there is one stupendous fact...the meaning of which they have ceaselessly tried to discover. This fact is Man.

*The Biology of Ultimate Concern*  
Chapter 5 (p. 96)  
The New American Library, Inc. New York, New York, USA. 1967

...nothing gives more pleasure to a rather common type of religious person than to point out that science cannot explain this or cannot account for that!

*The Biology of Ultimate Concern*  
Chapter 5 (p. 97)  
The New American Library, Inc. New York, New York, USA. 1967

**Draper, John William** 1811–82  
English scientist

As to Science, she has never sought to ally herself to civil power. She has never attempted to throw odium or inflict social ruin on any human being. She has never subjected anyone to mental torment, physical torture, least of all

to death, for the purpose of upholding or promoting her ideas. She presents herself unstained by cruelties and crimes. But in the Vatican – we have only to recall the Inquisition – the hands that are now raised in appeals to the Most Merciful are crimsoned.

*History of the Conflict between Religion and Science*  
Preface (p. xi)  
D. Appleton and Company. New York, New York, USA. 1898

The time approaches when men must take their choice between quiescent, immobile faith and ever-advancing Science – faith, with its medieval consolations, Science, which is incessantly scattering its material blessings in the pathway of life, elevating the lot of man in this world, and unifying the human race.

*History of the Conflict between Religion and Science* (pp. 364–365)  
D. Appleton & Co. New York, New York, USA. 1897

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

Any man who believes in God must realize that no scientific fact, as long as it is true, can contradict God. Otherwise, it would not be true. Therefore, any man who is afraid of science does not possess a strong faith.

*Human Destiny*  
Chapter 16 (p. 243)  
Longmans, Green & Company. London, England. 1947

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

Religion and science...constitute deep-rooted and ancient efforts to find richer experience and deeper meaning than are found in the ordinary biological and social satisfactions. As pointed out by Whitehead, religion and science have similar origins and are evolving toward similar goals.

*A God Within*  
Chapter 12. On Being Human (p. 255)  
Charles Scribner's Sons. New York, New York, USA. 1972

Both [religion and science] started from crude observations and fanciful concepts, meaningful only within a narrow range of conditions for the people who formulated them of their limited tribal experience. But progressively, continuously, and almost simultaneously, religious and scientific concepts are ridding themselves of their coarse and local components, reaching higher and higher levels of abstraction and purity.

*A God Within*  
Chapter 12. On Being Human (p. 255)  
Charles Scribner's Sons. New York, New York, USA. 1972

Both the myths of religion and the laws of science, it is now becoming apparent, are not so much descriptions of facts as symbolic expressions of cosmic truths.

*A God Within*  
Chapter 12. On Being Human (p. 255)  
Charles Scribner's Sons. New York, New York, USA. 1972

**Durant, William James** 1885–1981

American historian and essayist

Those of you who specialize in science will find it hard to understand religion, unless you feel, as Voltaire did, that the harmony of the spheres reveals a cosmic mind, and unless you realize, as Rousseau did, that man does not live by intellect alone.

Commencement Address

Webb School of Claremont, California, June 7, 1958

We are such microscopic particles in so immense a universe that none of us is in a position to understand the world, much less to dogmatize about it. Pascal trembled at the thought of man's bewildered minuteness between the immensity of the whole and the complexity of each part; "these infinite spaces," he said, "frighten me!" Let us be careful how we pit our pitiful generalizations against the infinite variety, scope, and subtlety of the world.

Commencement Address

Webb School of Claremont, California, June 7, 1958

**Dyson, Freeman J.** 1923–

American physicist and educator

Professional scientists today live under a taboo against mixing science and religion.

*Disturbing the Universe*

Chapter 23 (p. 245)

Basic Books, Inc. New York, New York, USA. 1979

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Probably most astronomers, if they were to speak frankly, would confess to some chafing when they are reminded of the psalm "The heavens declare the glory of God." It is so often rubbed into us with implications far beyond the simple poetic thought awakened by the splendour of the star-clad sky. There is another passage from the Old Testament that comes nearer to my own sympathies –

And behold the Lord passed by, and a great and strong wind rent the mountains, and brake in pieces the rocks before the Lord; but the Lord was not in the wind: and after the wind an earthquake; but the Lord was not in the earthquake: and after the earthquake a fire; but the Lord was not in the fire: and after the fire a still small voice.... And behold there came a voice unto him, and said, "What doest thou here, Elijah?"

Wind, earthquake, fire – meteorology, seismology, physics – pass in review, as we have been reviewing the natural forces of evolution; the Lord was not in them. Afterwards, a stirring, an awakening in the organ of the brain, a voice which asks "What doest thou here?"

*Science and the Unseen World*

Lecture II (pp. 25–26)

The Macmillan Co. New York, New York, USA. 1929

It is probably true that the recent changes of scientific thought remove some of the obstacles to a reconciliation of religion with science; but this must be carefully distinguished from any proposal to base religion on scientific discovery. For my own part I am wholly opposed to any such attempt.

*Science and the Unseen World*

Chapter VII (pp. 72–73)

The Macmillan Company. New York, New York, USA. 1929

The starting-point of belief in mystical religion is a conviction of significance or, as I have called it earlier, the sanction of a striving in the consciousness. This must be emphasized because appeal to intuitive conviction of this kind has been the foundation of religion through all ages, and I do not wish to give the impression that we have now found something new and more scientific to substitute. I repudiate the idea of proving the distinctive beliefs of religion either from the data of physical science or by the methods of physical science.

*The Nature of the Physical World*

Chapter XV (p. 333)

The Macmillan Company. New York, New York, USA. 1930

It is curious that the doctrine of the running down of the physical universe is so often looked upon as pessimistic and contrary to the aspirations of religion. Since when has the teaching that "heaven and earth shall pass away" become ecclesiastically unorthodox?

*New Pathways in Science*

Chapter III, Section III (p. 59)

The Macmillan Company. New York, New York, USA. 1935

**Einstein, Albert** 1879–1955

German-born physicist

All religions, arts and sciences are branches of the same tree.

*Out of My Later Years* (p. 7)

Thames &amp; Hudson. London, England. 1950

Scientific research is based on the idea that everything that takes place is determined by laws of nature, and therefore this holds for the actions of people. For this reason, a research scientist will hardly be inclined to believe that events could be influenced by a prayer, i.e., by a wish addressed to a supernatural Being.

However, it must be admitted that our actual knowledge of these laws is only imperfect and fragmentary, so that, actually, the belief in the existence of basic all-embracing laws in Nature also rests on a sort of faith. [Belief in basic laws of Nature] has been largely justified so far by the success of scientific research.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 24 January, 1936 (pp. 32–33)

Princeton University Press. Princeton, New Jersey, USA. 1979

Everyone who is seriously involved in the pursuit of science becomes convinced that a spirit is manifest in the

laws of the Universe – a spirit vastly superior to that of man, and one in the face of which we with our modest powers must feel humble. In this way the pursuit of science leads to a religious feeling of a special sort, which is indeed quite different of the religiosity of someone more naïve.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side – New Glimpses from His Archives*  
Letter dated 20 December, 1935 (p. 33)  
Princeton University Press, Princeton, New Jersey, USA. 1979

The basis of all scientific work is the conviction that the world is an ordered and comprehensive entity, which is a religious sentiment. My religious feeling is a humble amazement at the order revealed in the small patch of reality to which our feeble intelligence is equal.

*Cosmic Religion, With Other Opinions and Aphorisms*  
On Science (p. 98)  
Covici-Fiede. New York, New York, USA. 1931

[T]he cosmic religious experience is the strongest and the noblest driving force behind scientific research. No one who does not appreciate the terrific assertions, and, above all, the devotion without which pioneer creations in scientific thought cannot come into being, can judge the strength of the feeling out of which alone such work, turned away as it is from immediate practical life, can grow. What a deep faith in the rationality of the structure of the world and what a longing to understand even a small glimpse of the reason revealed in the world there must have been in Kepler and Newton to enable them to unravel the mechanism of the heavens in long years of lonely study.

*The New York Times Magazine*, 9 November, 1930

Certain it is that a conviction, akin to religious feeling, of the rationality or intelligibility of the world lies behind all scientific work of a higher order.... This firm belief, a belief bound up with deep feeling, in a superior mind that reveals itself in the world of experience, represents my conception of God.

*Ideas and Opinions*  
On Scientific Truth (p. 261)  
Crown Publishers, Inc. New York, New York, USA. 1954

I have never found a better expression than “religious” for this trust in the rational nature of reality and of its peculiar accessibility to the human mind. Where this trust is lacking science degenerates into an uninspired procedure. Let the devil care if the priests make capital out of this. There is no remedy for that.

*Lettres a Maurice Solovine* (pp. 102–103)  
Gauthier-Villars. Paris, France. 1956

I am of the opinion that all the finer speculations in the realm of science spring from a deep religious feeling, and that without such feeling they would not be fruitful.

*Science and God: A Dialog*  
*Forum*, Volume 83, June, 1930 (p. 373)

Science without religion is lame, religion without science is blind.

*Out of My Later Years*  
Science and Religion, II (p. 26)  
Thames & Hudson. London, England. 1950

...science not only purifies the religious impulse of the dross of its anthropomorphism but also contributes to a religious spiritualization of our understanding of life.

*Out of My Later Years*  
Science and Religion, II (p. 29)  
Thames & Hudson. London, England. 1950

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

Century after century, humanity studies itself in the mirror of fashion, and ever the mirror gives back distortions, which for the moment impose themselves upon man’s real image. In one period we believe ourselves governed by immutable laws; in the next, by chance. In one period angels hover over our birth; in the following time we are planetary waifs, the product of a meaningless and ever altering chemistry. We exchange halos in one era for fangs in another. Our religious and philosophical conceptions change so rapidly that the theological and moral exhortations of one decade become the wastepaper of the next epoch. The ideas for which millions yielded up their lives produce only bored yawns in a later generation.

*The Unexpected Universe*  
Chapter Eight, Section 2 (p. 179)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The Religion that is afraid of science dishonors God and commits suicide.

*The Journals and Miscellaneous Notebooks of Ralph Waldo Emerson*  
(Volume 2)  
1826–1832, 4 March, 1831 (p. 239)  
Harvard University Press. Cambridge, Massachusetts, USA. 1970

**Flaubert, Gustave** 1821–90  
French novelist

A little science takes your religion from you; a great deal brings you back to it.

*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

**Fosdick, Harry Emerson** 1878–1969  
American clergyman and educator

What modern science is doing for multitudes of people, as anybody who watches American life can see, is not to disprove God’s theoretical existence, but to make him “progressively less essential.”

*Adventurous Religion*  
Will Science Displace God? (p. 136)  
Harper & Brothers. New York, New York, USA. 1926



**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

The scientific spirit brings about a particular attitude towards worldly matters; before religious matters it pauses for a little, hesitates, and finally there too crosses the threshold. In this process there is no stopping; the greater the number of men to whom the treasures of knowledge become accessible, the more widespread is the falling-away from religious belief...

*The Future of an Illusion*

Chapter VII (p. 38)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1961

**Frothingham, Octavius Brooks** 1822–95

American clergyman and author

[There are] a host of minds of profoundest thought, who find nothing in the disclosures of science to shake their faith in the eternal verities of reason and religion.

*George Ripley*

Chapter VI (p. 231)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA. 1883

**Froude, James Anthony** 1818–94

English historian and biographer

The superstitions of science scoff at the superstitions of faith.

*The Lives of the Saints**Eclectic Review*, February, 1852**Garman, Charles E.** 1862–1932

No biographical data available

Science is thinking God's thoughts after Him just as truly as when we read the scriptures.

*Letters, Lectures, Addresses of Charles Edward Garman; A Memorial Volume, Prepared with the Cooperation of the Class of 1884, Amherst Science and Theism* (p. 231)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1909

**Gilkey, Langdon** 1919–2004

Protestant theologian

It is because science is limited to a certain level of explanation that scientific and religious theories can exist side by side without excluding one another, that one person can hold both to the scientific accounts of origins and to a religious account, to the creation of all things by God...

*Creationism on Trial: Evolution and God at Little Rock*

Chapter 5 (p. 117)

Winston Press. Minneapolis, Minnesota, USA. 1985

**Gillispie, Charles Coulston** 1918–

French writer and editor of philosophy and history of science

If one be clear about the nature of science as a description of the world, declarative but never normative, may not the choice between science and religion be refused? Is

it not simply a false problem, arising from a confusion – an ancient confusion going back to the beginning of science – between objects and persona? Science is about nature, after all, not about duties. It is about objects. Christianity is about persons, the relation of the persons of men to the person of God.

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*

Chapter VIII (pp. 350–351)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Gladstone, William Ewart** 1809–98

British Liberal Party statesman

To characterize Science as having gone to war with Providence would be, for a man with my convictions, both altogether irrational and very nearly blasphemous. There is, indeed, a practice which seems to me to be widely spread among many persons in the present day, of first unduly narrowing the definition of Science, and then as unduly extending it to all the opinions which those persons think fit to hold, and all the theories they erect on the subjects they term scientific.

*Correspondence on Church and Religion of William Ewart Gladstone* (Volume 2)

Letter 274 (p. 98)

The Macmillan Co. New York, New York, USA. 1910

**Goodspeed, Edgar J.** 1871–1962

American scholar

Science sees meaning in every part; religion sees meaning in the whole.

*Four Pillars of Democracy*

Chapter V (p. 106)

Harper &amp; Brothers. New York, New York, USA. 1940

...religion needs science, to protect it from religion's greatest danger, superstition.

*Four Pillars of Democracy*

Chapter V (p. 115)

Harper &amp; Brothers. New York, New York, USA. 1940

Science needs religion, to prevent it from becoming a curse to mankind instead of a blessing.

*The Four Pillars of Democracy*

Chapter VI (p. 134)

Harper &amp; Brothers. New York, New York, US. 1940

**Grinnell, Frederick** 1945–

American cell biologist

...modern science constitutes a method for understanding and modifying the world but has no inherent direction, whereas modern religion describes a messianic world view but lacks a useful method to bring about this state of affairs.

*Complementarity: An Approach to Understanding the Relationship Between Science and Religion**Perspectives in Biology and Medicine*, Volume 29, Number 2, Winter 1986 (p. 293)



**Gull, Sir William Withey** 1816–90

English physician

Realize, if you can, what a paralyzing influence on all scientific inquiry the ancient belief must have had which attributed the operations of nature to the caprice not of one divinity only, but of many. There still remains vestiges of this in most of our minds, and the more distinct in proportion to our weakness and ignorance.

*British Medical Journal*, Volume 2, 1874 (p. 425)

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

The wise man regulates his conduct by the theories both of religion and science. But he regards these theories not as statements of ultimate fact but as art-forms.

*Possible Worlds and Other Papers*

Chapter XXXI (p. 252)

Harper & Brothers. New York, New York, USA. 1928

**Hardin, Garrett** 1915–2003

American ecologist and microbiologist

We are terribly clever people, we moderns: we bend Nature to our will in countless ways. We move mountains, we make caves, fly at speeds no other organism can achieve and tap the power of the atom. We are terribly clever. The essentially religious feeling of subserviency to a power greater than ourselves comes hard to us clever people. But by our intelligence we are now beginning to make out the limits of our cleverness, the impotence principles that say what can and cannot be. In an operational sense, we are experiencing a return to a religious orientation toward the world.

*Nature and Man's Fate*

The Search for Truth

The New American Library. New York, New York, USA. 1961

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

In the history of science, ever since the famous trial of Galileo, it has repeatedly been claimed that scientific truth cannot be reconciled with the religious interpretation of the world. Although I am now convinced that scientific truth is unassailable in its own field, I have never found it possible to dismiss the content of religious thinking as simply part of an outmoded phase in the consciousness of mankind, a part we shall have to give up from now on. Thus in the course of my life I have repeatedly been compelled to ponder on the relationship of these two regions of thought, for I have never been able to doubt the reality of that to which they point.

*Across the Frontiers*

Chapter XVI (p. 213)

Harper & Row, Publishers. New York, New York, USA. 1974

If we are honest – and scientists have to be – we must admit that religion is a jumble of false assertions, with

no basis in reality. The very idea of God is a product of human imagination.

*Physics and Beyond: Encounters and Conversations*

Chapter 7 (p. 85)

Harper & Row, Publishers. New York, New York, USA. 1972

**Hertz, Rabbi Richard**

No biographical data available

I find no conflict between science and religion. Science teaches what is. Religion teaches what ought to be. Science describes. Religion prescribes. Science analyzes what we can see. Religion deals with what is unseen. Each can help the other.

*The American Jew in Search of Himself*

Chapter 4 (p. 42)

Bloch Publishing Company. New York, New York, USA. 1962

**Hillis, W. Daniel** 1956–

American engineer, inventor, and author

...I remain convinced that neither religion nor science has everything figured out.

*The Pattern on the Stone: The Simple Ideas that Make Computers Work*

(p. 152)

Basic Books, Inc. New York, New York, USA. 1998

**Hitchcock, Edward** 1793–1864

American geologist

Twin sister of natural and revealed religion, and of heavenly birth, she will never belie her celestial origin, nor cease to sympathize with all that emanates from the same pure home. Human ignorance and prejudice may for a time seem to have divorced what God has joined together. But human ignorance and prejudice shall at length pass away, and then science and religion shall be seen blending their particolored rays into one beautiful bow of light, linking heaven to earth and earth to heaven.

*The Religion of Geology and Its Connected Sciences*

Lecture V (p. 178)

Phillips Sampson & Co. Boston, Massachusetts, USA. 1854

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Science, for instance, – in other words, knowledge, – is not the enemy of religion; for, if so, then religion would mean ignorance. But it is often the antagonist of school-divinity.

*The Professor at the Breakfast-table*

Chapter V (p. 162)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

**Hooykaas, Reijer**

Dutch historian of science

Metaphorically speaking, whereas the bodily ingredients of science may have been Greek, its vitamins and hormones were biblical.

*Religion and the Rise of Modern Science*

Epilogue (p. 162)

William B. Eerdmans Publishing Company, Grand Rapids, Michigan, USA. 1972

**Howerth, I. W.**

No biographical data available

...the relation of intelligent man to the world of nature, and the social possibilities that grow out of such a relation, are the elements which might be made the basis of "a new religion," the religion of science, and the religion of humanity.

*Science Monthly*, Volume XVII, November, 1923**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

...it is no longer possible to maintain that science and religion must operate in thought-tight compartments or concern separate sectors of life; they are both relevant to the whole of human existence.

In Teilhard de Chardin

*The Phenomenon of Man*

Introduction (p. 26)

Harper &amp; Row, Publishers. New York, New York, USA. 1959

Like the meridians as they approach the poles, science, philosophy and religion are bound to converge as they draw nearer to the whole. I say "converge" advisedly, but without merging, and without ceasing, to the very end, to assail the real from different angles and on different planes.

In Teilhard de Chardin

*The Phenomenon of Man*

Introduction (p. 30)

Harper &amp; Row, Publishers. New York, New York, USA. 1959

**Huxley, Thomas Henry** 1825–95

English biologist

...the materialistic position that there is nothing in the world but matter, force, and necessity, is as utterly devoid of justification as the most baseless of theological dogmas.

*Collected Essays* (Volume 1)

On the Physical Basis of Life (p. 162)

Macmillan &amp; Company Ltd. London, England. 1904

Elijah's great question, "Will you serve God or Baal? Choose ye," is uttered audibly enough in the ears of everyone of us as we come to manhood. Let every man who tries to answer it seriously ask himself whether he can be satisfied with the Baal of authority, and with all the good things his worshippers are promised in this world and the next. If he can, let him, if he be so inclined, amuse himself with such scientific implements as authority tells him are safe and will not cut his fingers; but let him not imagine he is, or can be, both a true son of the Church and a loyal soldier of science.

*Collected Essays* (Volume 2)*Darwiniana*

Mr. Darwin's Critics (p. 149)

Macmillan &amp; Company Ltd. London, England. 1904

Extinguished theologians lie about the cradle of every science as the strangled snakes beside that of Hercules; and history records that whenever science and orthodoxy have been fairly opposed, the latter has been forced to retire from the lists, bleeding and crushed if not annihilated; scotched, if not slain.

*Collected Essays**Darwinia*

Chapter II (p. 52)

D. Appleton &amp; Co. New York, New York, USA. 1897

True science and true religion...are twin-sisters, and the separation of either from the other is sure to prove the death of both. Science prospers exactly in proportion as it is religious; and religion flourishes in exact proportion to the scientific depth and firmness of its basis. The great deeds of philosophers have been less the fruit of their intellect than of the direction of that intellect by an eminently religious tone of mind. Truth has yielded herself rather to their patience, their love, their single-heartedness, and their self-denial, than to their logical acumen.

Quoted in Herbert Spencer

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 81)

D. Appleton &amp; Co. New York, New York, USA. 1860

**Inge, William Ralph** 1860–1954

English religious leader and author

No scientific discovery is without its religious and moral implications.

*Outspoken Essays* (Second Series)

Confessio Fidei (p. 56)

Longmans, Green &amp; Company. London, England. 1922

**Jastrow, Robert** 1925–

American space scientist

For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance; he is about to conquer the highest peak; as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries.

*God and the Astronomers*

Chapter 6 (p. 116)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1978

**Joint Statement of Religious Leaders**

The purpose of science is to develop, without prejudice or preconception of any kind, a knowledge of the facts, the laws, and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals, and the aspirations of mankind.

In Robert Andrews Millikan

*Science and Life*

A Joint Statement upon the Relations of Science and Religion (p. 86)

The Pilgrim Press. Boston, Massachusetts, USA. 1924

**Jones, John**

No biographical data available

When a scientist is confronted with the facts of Spiritualism, and is satisfied that they are genuine, he is pretty sure to conclude that he has come upon the discovery of a “new force;” when the same facts are brought home to a clergyman or Congregationalist Minister, he in general is equally confident that it must all be the work of the devil or of evil spirits; and as the one naturally has recourse to levers, spring balances, and other mechanical apparatus to prove his theory, so the other as instinctively resorts to Church doctrines, Scripture texts, and other theological apparatus to establish his.

A Congregationalist Minister on Spiritualism as “The Work of Demons” *The Spiritual Magazine*, February, 1872 (p. 49)

**Kaempffert, Waldemar** 1877–1956

American science editor and museum director

Religion may preach the brotherhood of man; science practices it.

In Edward R. Murrow

*This I Believe*

2, Michael Faraday (p. 196)

Simon & Schuster. New York, New York, USA. 1952

**Kidd, Benjamin** 1858–1916

English social philosopher

A rational religion is a scientific impossibility...

*Social Evolution*

Chapter V (p. 101)

The Macmillan Co. New York, New York, USA. 1894

**King, Jr., Martin Luther** 1929–68

American civil rights leader and clergyman

Science investigates; religion interprets. Science gives man knowledge which is power; religion gives man wisdom which is control.

*Strength to Love*

Chapter I (p. 3)

Harper & Row, Publishers. New York, New York, USA. 1963

**Laing, Samuel** 1810–97

English writer

In the meantime, it behooves those who see more clearly than others the absolute certainty of the conclusions of science, and the inevitably fatal results to religion of staking its existence on literal interpretations which have become flatly incredible, to do their best to assist the transformation of the old dogmatic theology into a new “Christianity without miracles,” which shall retain the essential spirit, the pure morality, the consoling beliefs, and as far as possible the venerable forms and sacred associations of the old faith, while placing them in thorough accordance with freedom of thought, and with the whole body of other truths, discovered and to be discovered,

*Modern Science and Modern Thought*

Part II, Chapter IX (p. 297)

Chapman & Hall, Ltd. London, England. 1891

**Lankester, Edwin Ray** 1847–1929

English zoologist

...no sane man has ever pretended, since science became a definite body of doctrine, that we know or ever can hope to know or conceive of the possibility of knowing, whence this mechanism has come, why it is there, whither it is going, and what there may or may not be beyond and beside it which our senses are incapable of appreciating. These things are not ‘explained’ by science and never can be.

*Science from an Easy Chair (Second Series)*

Chapter XXXI (p. 389)

Henry Holt & Co. New York, New York, USA. 1913

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Keep pressing home on him the ordinarieness of things. Above all, do not attempt to use science (I mean, the real sciences) as a defense against Christianity. They will positively encourage him to think about realities he can’t touch and see. There have been sad cases among the modern physicists.

*The Screwtape Letters: Letters from a Senior to a Junior Devil* (p. 4)

Harper & Row, Publishers. New York, New York, USA. 2001

**Lewis, Gilbert Newton** 1875–1946

American chemist

...in the struggle of life with the facts of existence, Science is a bringer of aid; in the struggle of the soul with the mystery of existence, Science is the bringer of light.

On the Dread and Dislike of Science

*Fortnightly Review*, Volume 29, 1878

**Lodge, Sir Oliver** 1851–1940

English physicist

It is widely recognised at the present day that the modern spirit of scientific inquiry has in the main exerted a wholesome influence upon Theology, clearing it of much encumbrance of doubtful doctrine, freeing it from slavery to the literal accuracy of historical records, and reducing the region of the miraculous or the incredible, with which it used to be almost conterminous, to a comparatively small area.

*Man and the Universe* (2nd edition)

Section 1, Chapter I (p. 1)

Methuen & Co. London, England. 1908

Now it must, I think, be admitted that the modern scientific atmosphere, in spite of much that is wholesome and nutritious, exercises some sort of blighting influence upon religious ardour, and that the great saints or seers have as a rule not been eminent for their acquaintance

with exact scientific knowledge, but, on the contrary, have felt a distrust and a dislike of that uncompromising quest for cold hard truth in which the leaders of science are engaged; and on the other hand, that the leaders of science have shown an aloofness from, if not a hostility for, the theoretical aspects of religion.

In James Edward Hand

*Ideals of Science & Faith*

A Physicist's Approach (p. 5)

Longmans, Green & Co. New York, New York, USA. 1904

Science aims at a vigorous adult, intelligent, serpent-like wisdom, and active interference with the course of nature; religion aims at a meek, receptive, child-hearted attitude of dovelike resignation to the Divine will.

In James Edward Hand

*Ideals of Science & Faith*

A Physicist's Approach (p. 12)

Longmans, Green & Co. New York, New York, USA. 1904

### Lonchamp, Jean-Pierre

No biographical data available

A desirable dialogue between science and religion presupposes, primarily, vigour of language and a clarification of terms used. In the scientific area, there needs to be a clear distinction made between theory and application; in the area of religion between belief, faith and theology.

Translated by Dame Mary Groves

*Science and Belief*

Chapter 16 (p. 157)

St. Pauls. Middlegreen, England 1992

### Lynch, Gary

No biographical data available

What you're really seeking are constraints.... You're seeking things that box you in. That's what separates science from most other human endeavors. Religion is not something where people sit down and say, "Well, if there were a god then".... But science is a constant search for that, for those things that hem you in.

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*

Mucking Around in the Wetware (p. 91)

Alfred A. Knopf. New York, New York, USA. 1991

### Maimonides, Moses 1135–1204

Spanish-born philosopher, jurist, and physician

...as long as you are occupied with the mathematical sciences and the technique of logic, you belong to those who walk around the palace in search of the gate.... When you complete your study of the natural sciences and get a grasp of the metaphysics, you enter into the inner courtyard and are in the same house as [God] he.

*The Guide of the Perplexed*

Book III, Chapter LI (p. 186)

Hackett, Publishing Co. Indianapolis, Indiana, USA. 1995

### Marguerite of Valois 1553–1615

Queen of France and Navarre

Science conducts us, step by step, through the whole range of creation, until we arrive, at length, at God.

*Memoirs of Marguerite de Valois*

Letter XII, 1628 (p. 80)

P.F. Collier & Son, Company. New York, New York, USA. 1910

### Mather, Kirtley F. 1888–1978

American geologist

The faith by which a man lives must be in accord with the facts which men know. Only that religion, which is in harmony with the current scientific description of man and the universe, can maintain itself effectively in any age.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (p. 6)

Thomas Y. Crowell Company, Publishers. New York, New York, USA.

1931

### McCabe, Joseph 1867–1955

English rationalist writer and ex-Franciscan priest

The theist and the scientist are rival interpreters of nature, The one retreats as the other advances.

*The Existence of God*

Chapter V (p. 80)

Watts & Company. London, England. 1933

### McKenzie, John L. d. 1991

American Jesuit theologian and Catholic cardinal

Happily, we have survived into a day when science and theology no longer speak to each other in the language of fishmongers.

*The Two-Edged Sword: An Interpretation of the Old Testament*

Chapter V. Cosmic Origins (p. 74)

The Bruce Publishing Company. Milwaukee, Minnesota, USA. 1968

### Mencken, H. L. (Henry Louis) 1880–1956

American journalist and literary critic

To me the scientific point of view is completely satisfying, and it has been so as long as I can remember. Not once in this life have I ever been inclined to seek a rock and a refuge elsewhere. It leaves a good many dark spots in the universe, to be sure, but not a hundredth time as many as theology. We may trust it, soon or late, to throw light upon many of them, and those that remain dark will be beyond illumination by any other agency. It also fails on occasion to console, but so does theology...

In Charles A. Fecher

*Mencken: A Study of His Thought* (p. 84)

Alfred A. Knopf. New York, New York, USA. 1978

The notion that science does not concern itself with first causes – that it leaves the field to theology or metaphysics, and confines itself to mere effects – this notion has

no support in the plain facts. If it could, science would explain the origin of life on earth at once – and there is every reason to believe that it will do so on some not too remote tomorrow. To argue that gaps in knowledge which will confront the seeker must be filled, not by patient inquiry, but by intuition or revelation, is simply to give ignorance a gratuitous and preposterous dignity.

*Treatise on the Gods*

Chapter 5 (p. 239)

Vintage Books. New York, New York, USA. 1963

The essence of science is that it is always willing to abandon a given idea, however fundamental it may seem to be, for a better one; the essence of theology is that it holds its truths to be eternal and immutable. To be sure, theology is always yielding a little to the progress of knowledge, and only a Holy Roller in the mountains of Tennessee would dare to preach today what the popes preached in the Thirteenth Century, but this yielding is always done grudgingly, and thus lingers a good while behind the event.

*Minority Report: H.L. Mencken's Notebooks*

No. 232 (p. 166)

Alfred A. Knopf. New York, New York, USA. 1956

The effort to reconcile science and religion is almost always made, not by theologians, but by scientists unable to shake off altogether the piety absorbed with their mother's milk.

*Minority Report: H.L. Mencken's Notebooks*

No. 232 (p. 166)

Alfred A. Knopf. New York, New York, USA. 1956

### **Mernissi, Fatima** 1940–

Moroccan writer, feminist, and sociologist

Awareness of the stars and their light pervades the Koran, which reflects the brightness of the heavenly bodies in many verses. The blossoming of mathematics and astronomy was a natural consequence of this awareness. Understanding the cosmos and the movements of the stars means understanding the marvels created by Allah. There would be no persecuted Galileo in Islam, because Islam, unlike Christianity, did not force people to believe in a “fixed” heaven.

Translated by Mary Jo Lakeland

*Islam and Democracy: Fear of the Modern World*

Chapter 9 (p. 133)

Perseus Publishing. New York, New York, USA. 1992

### **Methodist New Connexion**

Science ceases to scoff at religion. Religion ceases to frown on science. Through a happy conjuncture of events they have met together, and are kissing each other. The hour of mockery by the one, and of reproof by the other are past. Henceforth, they will dwell together in amity and good will. They will mutually illustrate the wisdom, power and grace of God. Science will adorn and enrich

religion and religion will ennoble and sanctify science.

*The Jubilee of the Methodist New Connexion*

Chapter VI (p. 386)

John Bakewell. London, England. 1848

### **Miller, Kenneth R.** 1948–

American biology professor and author

To a believer, God's great gift was to provide us with a means to understand, to master, and to do good using both the strengths and weaknesses of human nature.

Where does science sit with all of this? I would argue that any scientist who believes in God possesses the faith that we are given our unique imaginative powers not only to find God, but also to discover as much of His universe as we could. In other words, to a religious person, science can be a pathway towards God, not away from Him, an additional and sometimes even an amazing grace!

*Finding Darwin's God*

Chapter 9 (pp. 280–281)

HarperCollins Publishers, Inc. New York, New York, USA. 1999

### **Millikan, Robert Andrews** 1868–1953

American physicist

If the beauty, the meaning and the purposes of this life as revealed by both science and religion are all a dream, then let me dream on forever!

*Science and Life*

Science and Religion (p. 64)

The Pilgrim Press. Boston, Massachusetts, USA. 1924

Modern science, of the real sort, is slowly learning to walk humbly with its God, and in learning that lesson it is contributing something to religion.

*Evolution in Science and Religion*

Chapter III (pp. 94–95)

Yale University Press. New Haven, Connecticut, USA. 1927

The purpose of science is to develop, without prejudice or preconception of any kind, a knowledge of the facts, the laws and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals and the aspirations of mankind. Each of these two activities represents a deep and vital function of the soul of man, and both are necessary for the life, the progress and the happiness of the human race.

Science Serves God

*Time*, June 4, 1923

It is a sublime conception of God which is furnished by science, and one wholly consonant with the highest ideals of religion, when it represents Him as revealing Himself through countless ages in the development of the earth as an abode for man and in the age long inbreathing of life into its constituent matter, culminating in man with his spiritual nature and all his Godlike powers.

Science Serves God

*Time*, June 4, 1923



**Moore, Benjamin** 1745–1816  
Episcopal writer and professor of rhetoric

...the eternal truths of science and religion were the same one hundred years ago as they are today and as they will be one hundred years hence, both realms of knowledge, as well as our inborn desires to penetrate their mysteries, are a part of the great plan of creation, and in their intrinsic laws remain the same “yesterday, today and forever.”

*The Origin and Nature of Life*

Chapter I

Henry Holt & Co. New York, New York, USA.

Science can readily strip away from any earlier system of religion, mythological accounts of creation which represent the state of natural knowledge when the system was growing, and can disprove or reject accounts of natural phenomena which are now known clearly to be errors, but when this has all been done the real kernel still remains in any religious system worthy of the name.

*The Origin and Nature of Life*

Chapter I

Henry Holt & Co. New York, New York, USA.

When new scientific facts are suddenly thrown in amongst old pre-conceived ideas of divinity, there may at first appear discords, and zealous champions of natural science and of religious knowledge fly to arms and indulge in acrimonious polemics; but as time advances and things that are crude and adventitious are thrown away one each side, it is discovered that science has added a new beauty to religion, or rather revealed a beauty that was there all the while, but concealed by misconceptions, or by lack of knowledge.

*The Origin and Nature of Life*

Chapter I (p. 8)

Henry Holt & Company. New York, New York, USA. No date

### **Moore, John A.**

American writer and professor of genetics and biology

A fundamental difference between religious and scientific thought is that the received beliefs in religion are ultimately based on revelations or pronouncements, usually by some long dead prophet or priest.... Dogma is interpreted by a caste of priests and is accepted by the multitude on faith or under duress. In contrast, the statements of science are derived from the data of observations and experiment, and from the manipulation of these data according to logical and often mathematical procedures.

*Science as a Way of Knowing: The Foundations of Modern Biology*

Chapter 4 (p. 59)

Harvard University Press. Cambridge, Massachusetts, USA. 1993

### **Morehouse, George Wilkinson** 1840–?

American naturalist

Religion is emotion without true knowledge of Nature, and where it begins Science ends.

*The Wilderness of Worlds*

Chapter XVII (p. 228)

Peter Eckler, Publisher. New York, New York, USA. 1898

### **Morris, Robert Tuttle** 1857–1945

American surgeon

The churchman who believes that an astronomer or a physicist is less moral than he is a careless observer. The churchman who believes that an astronomer or a physicist has less spiritual inspiration than he is unintentionally impertinent.

*A Surgeon's Philosophy*

Chapter I (p. 11)

Doubleday, Page & Co. Garden City, New York, USA. 1916

### **Morrow, Lance** 1942–

American writer and professor of journalism

Sometime after the Enlightenment, science and religion came to a gentleman's agreement. Science was for the real world: machines, manufactured things, medicines, guns, moon rockets. Religion was for everything else, the immeasurable: morals, sacraments, poetry, insanity, death, and some residual forms of politics and statesmanship. Religion became, in both senses of the word, immaterial.

*Fishing in the Tiber: Essays*

God and Science (p. 195)

Henry Holt & Company. New York, New York, USA. 1988

Science and religion were apples and oranges. So the pact said: render unto apples the things that are Caesar's, and unto oranges the things that are God's. Just as the Maya kept two calendars, one profane and one priestly, so Western science and religion fell into two different conceptions of the universe, two different vocabularies.

*Fishing in the Tiber: Essays*

God and Science (p. 195)

Henry Holt & Company. New York, New York, USA. 1988

### **Moser, E. S.**

No biographical data available

If the truths of science have terrors for a man's religion there must be something wrong and untrue in connection with his religion.

Immaterial Science

*The Popular Science Monthly*, Volume 44 November, 1893 (p. 86)

### **Moss, Lemural**

No biographical data available

Our abiding belief is, that just as the workmen in the tunnel of St. Gothard, working from either end, met at last, to shake hands, in the very central root of the mountain, so the students of nature and the students of Christianity will yet join hands in the unity of reason, and faith, in the heart of their deepest mysteries.

Present Relation of Scientific Thought to Christianity

*The Baptist Quarterly Review*, Volume IV, January-February-March, 1882 (p. 14)



**Nemerov, Howard** 1920–91  
American poet, novelist, and critic

Religion and science both profess peace (and the sincerity of the professors is not being doubted), but each always turns out to have a dominant part in any war that is going or contemplated.

*Figures of Thought: Speculations on the Meaning of Poetry and Other Essays*  
On the Resemblances Between Science and Religion  
David R. Godine. Boston Massachusetts, USA. 1979

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932  
Latvian-born German chemist

...research workers were, at one time, obliged to endeavor to ensure that their theories did not contradict those of the Church, nowadays, in contrast, the Church is at pains to prove that its teachings are compatible with those of Science. In other words, the Church acknowledges Science as the higher authority.

*Nobel Lectures, Chemistry 1901–1921*  
On Catalysis  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Paley, William** 1743–1805  
English theologian

There cannot be design without a designer; contrivance without a contriver; order without choice; arrangement, without anything capable of arranging; subserviency and relation to a purpose, without that which could intend a purpose; means suitable to an end, without the end ever having been contemplated, or the means accommodated to it. Arrangement, disposition of parts, subserviency of means to an end, relation of instruments to an use, imply the presence of intelligence and mind.

*The Works of William Paley, D.D.*  
*Natural Theology*  
Chapter II, Section III (p. 22)  
Ward, Lock & Company. London, England. No date

**Parker, J. W.**

God forbid we should live to see the day which proclaimed war between Christianity and Science – a civil war, a war between brothers! *Nature is one book of God, the Bible is another*: its claims as such resting on grounds independent of Science, and unassailable by the evidence of Science. *They cannot be at variance.*

Immutability of Nature  
*The Living Age*, Number 913, November 30, 1861 (p. 388)

**Parker, Theodore** 1810–60  
American Transcendentalist

Science is the natural ally of religion. Shall we try and separate what God has joined? We injure both by the attempt.

*Ten Sermons of Religion* (2nd edition)  
Sermon II (p. 47)  
Ticknor & Fields. Boston, Massachusetts, USA. 1861

**Pearson, Karl** 1857–1936  
English mathematician

...the day I believe will come when its [science's] evangelists will spread through the country, be heard in every house, and be seen on every street preaching and teaching the only faith which is consonant with the reason, with the dignity of man.

*The Ethic of Freethought* (2nd edition)  
The Ethic of Freethought (p. 13)  
Adam & Charles Black. London, England. 1901

**Peirce, Benjamin** 1809–80  
American mathematician

Of the many difficult questions with which science is disturbed, none are so serious as those which are connected with religion. There are men, and pious men too, who seem honestly to think that science and religion are naturally opposed to each other; than which I cannot conceive a more monstrous absurdity. How can there be a more faithless species of infidelity, than to believe that the Deity has written his word upon the material universe and a contradiction of it in the Gospel?

*Address of Professor Benjamin Peirce, President of the American Association for the Year 1853, on Retiring from the Duties of President* (p. 11)  
Unknown publisher. 1853

Science and religion are born of the same house, and that house is not divided against itself. There will at all times be an apparent conflict between them, arising from defects of human nature; but all this conflict is of human origin, and it originates in the deficiency of our knowledge, not in the greatness of it.

The Conflict between Religion and Science  
*Dickinson's Theological Quarterly*, Volume 3, Number 4, October, 1877 (p. 101)

**Planck, Max** 1858–1947  
German physicist

There can never be any real opposition between religion and science; for the one is the compliment of the other.

*Where Is Science Going?*  
Chapter V (p. 168)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

Religion belongs to that realm that is inviolable before the law of causation and therefore closed to science.

*Where Is Science Going?*  
Chapter V (p. 168)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

Religion and natural science...are in agreement, first of all, on the point that there exists a rational world order independent from man, and secondly, on the view that the character of this world order can never be directly known but can only be indirectly recognized or suspected. Religion employs in this connection its own

characteristic symbols, while natural science uses measurements founded on sense experiences.

*Scientific Autobiography and Other Papers*

Religion and Natural Science, Part IV (pp. 182–183)

Philosophical Library. New York, New York, USA. 1949

Religion and natural science are fighting a joint battle in an incessant, never relaxing crusade against skepticism and against dogmatism, against disbelief and against superstition, and the rallying cry in this crusade has always been, and always will be, “On to God.”

*Scientific Autobiography and Other Papers*

Religion and Natural Science, Part IV (p. 187)

Philosophical Library. New York, New York, USA. 1949

### Poeco, Carolyn

No biographical data available

Let’s teach our children from a very young age about the story of the universe and its incredible richness and beauty. It is already so much more glorious and awesome – and even comforting–than anything offered by any scripture or God concept I know.

Quoted in Dinesh D’Souza

*What’s So Great About Christianity* (p. 35)

### Polanyi, Michael 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

Admittedly, religious conversion commits our whole person and changes our whole being in a way that an expansion of natural knowledge does not do. But once the dynamics of knowing are recognized as the dominant principle of knowledge, the difference appears only as one of degree...it establishe[s] a continuous ascent from our less personal knowing of inanimate matter to our convivial knowing of living beings and beyond this to knowing our responsible fellow men. Such I believe is the true transition from the sciences to the humanities and also from our knowing the laws of nature to our knowing the person of God.

Faith and Reason

*Journal of Religion*, Volume 41, Number 4, October, 1961 (pp. 244, 245)

### Polkinghorne, John 1930–

British physicist, Episcopal priest, and writer

Only in the media, and in the popular and polemical scientific writing, does there persist the myth of the light of pure scientific truth confronting the darkness of obscurantist religious error. Indeed, when one reads writers like Richard Dawkins or Daniel Dennett, one sees that nowadays the danger of a facile triumphalism is very much a problem for the secular academy rather than the Christian Church.

*Quarks, Chaos, and Christianity* (p. 5)

Abingdon Press. Nashville, Tennessee, USA. 2005

### Pope John Paul II 1920–2005

Bishop of Rome

Science can purify religion from error and superstition. Religion can purify science from idolatry and false absolutes.

In James Reston

*Galileo, a Life* (p. 461)

HarperCollins Publishers, Inc. New York, New York, USA. 1994

Science goes astray if it ceases to pursue its ultimate end, which is the service of culture and hence of man; it experiences crisis when it is reduced to a purely utilitarian model; it is corrupted when it becomes a technical instrument of domination or manipulation for economic or political goals. There is then what one can call a crisis of the legitimation of science, and it is therefore urgent to defend authentic science that is open to the question of the meaning of man and to the search for the whole truth, *a free science that is dependent only on the truth*. From the point of view of the Church, it would be impossible to separate science and culture.

Speech

Fiftieth Anniversary of the Pontifical Academy of Sciences

Rome, 28 October, 1968

### Pope Pius XII 1876–1958

Bishop of Rome

The more true science advances, the more it discovers God, almost, as though he were standing, vigilant behind every door which science opens.

Address, November 22, 1951

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

Science is most significant as one of the greatest spiritual adventures that man has yet known.

In John Oulton Wisdom

*Foundations of Inference in Natural Science* (p. v)

Methuen & Company Ltd. London, England. 1952

### Raven, Charles E. 1885–1964

English writer of theology and science

To mention Science and Religion in the same sentence is...to affirm an antithesis and suggest a conflict.

*Science, Religion and the Future*

Chapter I (p. 1)

At The University Press. Cambridge, England. 1943

### Raymo, Chet 1936–

American physicist and science writer

Everything we have learned in science since the time of Galileo suggests that the nebulas and galaxies are oblivious to our fates. Everything we have learned suggests that our souls and bodies are inseparable. Everything we have learned suggests that the grave is our destiny. Therefore, if the promise of eternal life is to have maximum drawing power, it is essential for Church and guru to undermine the legitimacy of science.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*  
Chapter Four (pp. 66–67)  
Walker & Company. New York, New York, USA. 1998

**Reichenbach, Hans** 1891–1953  
German philosopher of science

The belief in science has replaced in large measure, the belief in God. Even where religion was regarded as compatible with science, it was modified by the mentality of the believer in scientific truth.

*The Rise of Scientific Philosophy*  
Chapter 3 (p. 44)  
University of California Press. Berkeley, California, USA. 1951

**Reynolds, Joseph William**  
No biographical data available

Our theologians are becoming more intelligent, as to nature; and those who give themselves to research, finding God everywhere, grow more sacred.

*The Natural History of Immortality*  
Chapter I (p. 2)  
Longmans, Green & Co. London, England. 1891

**Rice, Laban Lacy** 1870–1973  
American educator

Science does not regard its currently established truths as final: religion everywhere and in all centuries has followed the trend toward crystallization of belief.

*The Universe: Its Origin, Nature and Destiny*  
Chapter I (p. 15)  
Exposition Press. New York, New York, USA. 1951

**Robertson, John Mackinnon** 1856–1933  
English journalist

Religion and Science are to be finally reconciled...when Religion has abandoned every dogma and every positive belief, and takes the shape of a final negative proposition that Science never rejected [that its explanations are proximate and relative], and has long affirmed.

*Modern Humanists*  
Herbert Spencer (p. 223)  
Swan Sonnenschein & Co. London, England. 1891

...the “reconciliation” of Religion and Science consists in Religion, as such, disappearing...

*Modern Humanists*  
Herbert Spencer (p. 226)  
Swan Sonnenschein & Co. London, England. 1891

**Roelofs, Howard Dykema** 1893–1974  
Professor of philosophy

Religion can produce on occasion what science never does, namely, saints. Today we have science and scientists aplenty. We lack saints.

In Herbert J. Muller  
*Science and Criticism: The Humanistic Tradition in Contemporary Thought*  
Chapter III (p. 59)  
G. Braziller. New York, New York, USA. 1943

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

The most essential characteristic of scientific technique is that it proceeds from experiment, not from tradition. The experimental habit of mind is a difficult one for most people to maintain; indeed the science of one generation has already become the tradition of the next, and there are still wide fields, notably that of religion, into which the experimental spirit has hardly penetrated at all.

*The Scientific Outlook*  
Chapter VI (p. 149)  
George Allen & Unwin. London, England. 1931

**Sagan, Carl** 1934–96  
American astronomer and author

How is it that hardly any major religion has looked at science and concluded, “This is better than we thought! The Universe is much bigger than our prophets said, grander, more subtle, more elegant?”

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 4 (p. 52)  
Random House, Inc. New York, New York, USA. 1994

If you lived two or three millennia ago, there was no shame in holding that the Universe was made for us. It was an appealing thesis consistent with everything we knew; it was what the most learned among us taught without qualification. But we have found out much since then. Defending such a position today amounts to willful disregard of the evidence, and a flight from self-knowledge.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 4 (p. 52)  
Random House, Inc. New York, New York, USA. 1994

If you want to know when the next eclipse of the Sun will be, you might try magicians or mystics, but you’ll do much better with scientists.

*The Demon-Haunted World: Science as a Candle in the Dark* (p. 30)  
Random House, Inc. New York, New York, USA. 1995

Think of how many religions attempt to validate themselves with prophecy. Think of how many people rely on these prophecies, however vague, however unfulfilled, to support or prop up their beliefs. Yet has there ever been a religion with the prophetic accuracy and reliability of science?

*Demon-Haunted World: Science As a Candle in the Dark*  
Chapter 2 (p. 30)  
Random House, Inc. New York, New York, USA. 1995

Heroes who try to explain the world in terms of matter and energy may have arisen many times in many cultures, only to be obliterated by the priests and philosophers in charge of the conventional wisdom....

*The Demon-Haunted World: Science as a Candle in the Dark* (p. 310)  
Random House, Inc. New York, New York, USA. 1995

**Seeley, John Robert** 1834–95  
English essayist and historian

Religion says, “Let man be silent, and listen when God speaks.” Science says, “Let us interrogate Nature, and let us be sure that the answer we get is really Nature’s, and not a mere echo of our own voice.”

*Natural Religion, by the Author of ‘Ecce homo’*  
Chapter I (p. 11)  
Macmillan & Co Ltd. London, England. 1882

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Let the Churches ask themselves why there is no revolt against the dogmas of mathematics though there is one against the dogmas of religions. It is not that the mathematical dogmas are more comprehensible.... It is not that science is free from legends, witchcraft, miracles, biographic boostings of quacks as heroes and saints, and of barren scoundrels as explorers and discoverers.... But no student of science has yet been taught that specific gravity consists in the belief that Archimedes jumped out of the bath and ran naked through the streets of Syracuse shouting Eureka, Eureka, or that the law of inverse squares must be discarded if anyone can prove that Newton was never in an orchard in his life.

*Back to Methuselah*  
Preface (pp. lxxvii–lxxviii)  
Constable & Company Ltd. London, England. 1921

**Spencer, Herbert** 1829–1903  
English social philosopher

As, to the religious, it will seem absurd to set forth any justification for Religion; so, to the scientific, will it seem absurd to defend Science.

*First Principles of a New System of Philosophy*  
Part I, Chapter I, section 5 (p. 17)  
D. Appleton & Co. New York, New York, USA. 1892

Of all antagonisms of belief, the oldest, the widest, the most profound and the most important, is that between Religion and Science. It commenced when the recognition of the simplest uniformities in surrounding things, set a limit to the once universal superstition.

*First Principles of a New System of Philosophy*  
Part I, Chapter I, section 3 (p. 11)  
D. Appleton & Co. New York, New York, USA. 1892

...Religion, everywhere present as a weft running through the warp of human history, expresses some eternal fact; while it is almost a truism to say of Science that it is an organised mass of facts, ever growing, and ever being more completely purified from errors. And if both have bases in the reality of things, then between them there must be a fundamental harmony.

*First Principles of a New System of Philosophy*  
Part I, Chapter I, section 6 (p. 20)  
D. Appleton & Co. New York, New York, USA. 1892

He who contemplates the Universe from the religious point of view, must learn to see that this which we call Science is one constituent of the great whole; and as such ought to be regarded with a sentiment like that which the remainder excites.

*First Principles of a New System of Philosophy*  
Part I, Chapter I, section 6 (p. 21)  
D. Appleton & Co. New York, New York, USA. 1892

...in much of the science that is current, there is a pervading spirit of irreligion; but not in that true science which has passed beyond the superficial into the profound.... So far from science being irreligious, as many think, it is the neglect of science that is irreligious – it is the refusal to study the surrounding creation that is irreligious.

*Education: Intellectual, Moral, and Physical*  
Chapter I (pp. 89–90)  
D. Appleton & Co. New York, New York, USA. 1891

**Sperry, Roger Wolcott** 1913–94  
Neuropsychologist

Probably the widest, deepest rift in contemporary culture and the source of its most profound conflict is that separating the two major opposing views of existence upheld by science and by orthodox religions, respectively. Together they represent two totally different kinds of “truth”, the former asking us to accept impersonal mass-energy accounts of the cosmos, the latter requiring faith in varied spiritual explanations.

The New Mentalist Paradigm and Ultimate Concern  
*Perspectives in Biology and Medicine*, Volume 29, Number 3, Part I, Spring 1986 (p. 415)

**Stace, Walter Terence** 1886–1967  
English philosopher and educator

...no scientific argument – by which I mean an argument drawn from the phenomena of nature – can ever have the slightest tendency either to prove or disprove the existence of God...science is irrelevant to religion.

*Religion and the Modern Mind*  
Chapter 5 (p. 76)  
J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1952

**Stanley, Arthur Penrhyn** 1815–81  
English clergyman and author

There were, there are perhaps still, two modes of reconciliation of Scripture and science, which have been each in their day attempted, and have each totally and deservedly failed. One is the endeavor to wrest the words of the Bible from their natural meaning, and force them to speak the language of science.... [T]here is another reconciliation an acknowledgment of the affinity, the identity which exists between the *spirit* of Science and the *spirit* of the Bible.

*Sermons on Special Occasions Preached in Westminster Abbey*  
The Religious Aspects of Geology (pp. 201, 202–203)  
John Murray. London, England. 1882

**Stapledon, Olaf** 1886–1950

English author

Within the chapel, the great Bible was decorously removed and the windows thrown open, to dispel somewhat the odour of sanctity. For though the early and spiritistic interpretations of relativity and quantum theory had by now accustomed men of science to pay their respects to the religions, many of them were still liable to a certain asphyxia when they were actually within the precincts of sanctity.

*Last and First Men*

Chapter II (p. 29)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1988

When the scientists had settled themselves upon the archaic and unyielding benches, the President explained that the chapel authorities had kindly permitted this meeting because they realized that, since men of science had gradually discovered the spiritual foundation of physics, science and religion must henceforth be close allies. Moreover the purpose of this meeting was to discuss one of those supreme mysteries which it was the glory of science to discover and religion to transfigure.

*Last and First Men*

Chapter II (p. 29)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1988

**Streeter, B. H. (Burnett Hillman)** 1874–1937

English theologian and New Testament scholar

Science is the great cleanser of the human thinking; it makes impossible any religion but the highest.

*Reality*

Chapter IX (p. 272)

Publisher undetermined

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

Religion and science are the two conjugated faces of phases of one and the same act of complete knowledge – the only one which can embrace the past and future of evolution so as to contemplate, measure and fulfill them.

*The Phenomenon of Man*

Chapter Three, Chapter III, Section 2 (pp. 284–285)

Harper &amp; Brothers. New York, New York, USA. 1959

**Temple, Frederick** 1821–1902

Anglican prelate and archbishop of Canterbury

Science and Religion seem very often to be the most determined foes to each other that can be found. The scientific man often asserts that he cannot find God in Science; and the religious man often asserts that he cannot find Science in God.

*The Relations Between Religion and Science* (p. 4)

Macmillan &amp; Company. New York, New York, USA. 1884

Science postulates uniformity; Religion postulates liberty.

*The Relations Between Religion and Science* (p. 70)

Macmillan &amp; Company. New York, New York, USA. 1884

**Thompson, Joseph Parrish**

No biographical data available

The strife over science and religion would be greatly restricted by a rigorous and binding definition of the terms in dispute. Scientific theory and theological dogma would go on contending; but that which is true in science and that which is true in religion can never come in collision, and the demarcation of each would make their harmony apparent almost without discussion.

*American Comments on European Questions, International and Religious*

Chapter IX (p. 186)

Houghton Mifflin &amp; Co. New York, New York, USA. 1884

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Although there has never been much love lost between Biology and Theology, we cannot say that there is any unanimity in the attitude which biologists have assumed, or assume, in regard to theological doctrines. Some are or have been aggressively hostile, such as Haeckel and Huxley; others assume or really feel a nonchalant indifference, having no use for theology; others affect a superficial acquiescence, either by keeping idea-tight compartments in their cerebral machinery, or by condescending to verbal devices. And there are others, who feel the opposition to be real and deep, but who try to effect friendly contact and mutual appreciation, of an emotional sort at least.

In James Edward Hand

*Ideals of Science & Faith*

A Biological Approach (p. 50)

Longmans, Green &amp; Co. New York, New York, USA. 1904

When we are thrilled with the wonder of the world, the heights and depths of things, the beauty of it all, we approach the door of natural religion. And when the Nature-feeling is not superficial but informed with knowledge, with no gain of the hard-won analysis unused, we may reach the threshold. And when we feel that our scientific cosmology leaves Isis still veiled, and when our attempts at philosophical interpretation give us a reasoned conviction of a meaning behind the process, we may perhaps enter in.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 42)

William &amp; Norgate. London, England. 1920

Religious interpretation and scientific description must not be inconsistent, but they are incommensurable.

*The Outline of Science* (Volume 4)

Chapter XXXVIII (p. 1177)

G.P. Putnam's Sons. New York, New York, USA. 1937

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

There is more religion in men's science than there is science in their religion.



*A Week on the Concord and Merrimack Rivers*  
 Sunday (p. 54)  
 Charles Scribner's Sons. New York, New York, USA. 1921

**Tillich, Paul** 1886–1965  
 German-born American theologian

The distinction between the truth of faith and the truth of science leads to a warning, directed to theologians, not to use recent scientific discoveries to confirm the truth of faith. Microphysics have undercut some scientific hypotheses concerning the calculability of the universe. The theory of quantum and the principle of indeterminacy have had this effect. Immediately religious writers use these insights for the confirmation of their own ideas of human freedom, divine creativity, and miracles. But there is no justification for such a procedure at all, neither from the point of view of physics nor from the point of view of religion. The physical theories referred to have no direct relation to the infinitely complex phenomenon of human freedom, and the emission of power in quantum has no direct relation to the meaning of miracles.... The truth of faith cannot be confirmed by latest physical or biological or psychological discoveries – as it cannot be denied by them.

*Dynamics of Faith*  
 Chapter V, Section 2 (p. 85)  
 Harper & Brothers. New York, New York, USA. 1957

...theology cannot rest on scientific theory. But it must relate its understanding of man to an understanding of universal nature, for man is a part of nature and statements about nature underlie every statement about him. In Theodosius Dobzhansky  
*The Biology of Ultimate Concern*  
 Chapter 6 (pp. 109–110)  
 The New American Library, Inc. New York, New York, USA. 1967

**Tipler, Frank J.** 1947–  
 American physicist

When I began my career as a cosmologist some twenty years ago, I was a convinced atheist. I never in my wildest dreams imagined that one day I would be writing a book purporting to show that the central claims of Judeo-Christian theology are in fact true, that these claims are straightforward deductions of the laws of physics as we now understand them. I have been forced into these conclusions by the inexorable logic of my own special branch of physics.

*The Physics of Immortality*

**Toynbee, Arnold J.** 1852–83  
 English historian

Theology, not religion, is the antithesis to science.  
*Toynbee's Industrial Revolution*  
 Notes and Jottings (p. 243)  
 A.M. Kelley. New York, New York, USA. 1969

Before the close of the seventeenth century our forefathers consciously took their treasure out of religion and reinvested it in natural science...

A Turning Point in Man's Destiny  
*The New York Times Magazine*, December 26, 1954 (p. 5)

**Tyndall, John** 1820–93  
 Irish-born English physicist

We claim, and we shall wrest from theology, the entire domain of cosmological theory.

The Belfast Address  
 The Position of Science

**Valéry, Paul** 1871–1945  
 French poet and critic

Without religions the sciences would never have existed. For the human brain would not have trained itself to range beyond the immediate, ever – present “facts” of appearance which, for it, constitute reality.

In Jackson Mathews (ed.)  
*The Collected Works of Paul Valéry* (Volume 14)  
*Analects*, XLVIII (p. 285)  
 Princeton University Press. Princeton, New Jersey, USA. 1971

**Virchow, Rudolf Ludwig Karl** 1821–1902  
 German pathologist and archaeologist

There can be no scientific dispute with respect to faith, for science and faith exclude one another.

Translated by Lelland J. Rather  
*Disease, Life, and Man, Selected Essays*  
 On Man (p. 68)  
 Stanford University Press. Stanford, California, USA. 1958

The task of science...is not to attack the objects of faith, but to establish the limits beyond which knowledge cannot go and to found a unified self-consciousness within these limits.

Translated by Lelland J. Rather  
*Disease, Life, and Man, Selected Essays*  
 On Man (p. 69)  
 Stanford University Press. Stanford, California, USA. 1958

...belief has no place as far as science reaches, and may be first permitted to take root where science stops.

Translated by Lelland J. Rather  
*Disease, Life, and Man, Selected Essays*  
 On Man (p. 69)  
 Stanford University Press. Stanford, California, USA. 1958

**Whaling, Thornton** 1858–1938  
 American Presbyterian writer

There can be no real conflict between natural science and true religion because their spheres are entirely distinct and separate. ...Conflicts between these two are always the result of misinterpretation and misrepresentation of one or the other or both, and history abounds with illustrations of all these forms of confusing contradictions. Science and religion, while thus separate,



have various relationships which make each the servant of the other.

*Science and Religion Today* (pp. 51–52)  
The University of North Carolina Press. Chapel Hill, North Carolina. 1929

Dean Inge [English religious leader] remarks, “We may hope for a time when the science of a religious man will be scientific and religion of a scientific man religious.”

*Science and Religion Today* (pp. 51–52)  
The University of North Carolina Press. Chapel Hill, North Carolina. 1929

**Whewell, William** 1794–1866  
English philosopher and historian

All speculations on subjects in which Science and Religion bear upon each other are liable to one of the two opposite charges[:] that the speculator sets Philosophy and Religion at variance; or that he warps Philosophy into a conformity with Religion.

*Of the Plurality of Worlds*  
Preface (p. iv)  
John W. Parker & Son. London, England. 1853

**White, Andrew Dickson** 1832–1918  
American diplomat, historian, and educator

In all modern history, interference with science in the supposed interest of religion, no matter how conscientious such interference may have been, has resulted in the direst evils both to religion and to science, and invariably; and, on the other hand, all untrammelled scientific investigation, no matter how dangerous to religion some of its stages may have seemed . . . , has invariably resulted in the highest good both of religion and of science.

*A History of the Warfare of Science With Theology in Christendom*  
(Volume 1)  
Introduction (p. viii)  
D. Appleton & Co. New York, New York, USA. 1922

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

When we consider what religion is for mankind, and what science is, it is no exaggeration to say that the future course of history depends upon the decision of this generation as to the relations between them.

*Science and the Modern World*  
Chapter XII (p. 181)  
The Macmillan Company. New York, New York, USA. 1929

Religion will not gain its old power until it can face change in the same spirit as does science. Its principles may be eternal, but the expression of these principles requires continual development.

*Science and the Modern World*  
Chapter XII (p. 189)  
The Macmillan Company. New York, New York, USA. 1929

Science suggests a cosmology; and whatever suggests a cosmology suggests a religion.

*Religion in the Making*  
Truth and Criticism (p. 136)  
New American Library. New York, New York, USA. 1960

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Science is the record of dead religions.  
*Phrases and Philosophies for the Use of the Young*  
L. Smithers. London, England. 1903  
Press. Minneapolis, Minnesota, USA. 1996

**Winchell, Alexander** 1824–91  
American geologist

The din of a great controversy sounds in our ears. Men of thought have been summoned to choose their banner, and range themselves upon one side or the other of the line of battle. It is the “conflict” between Religion and Science which has thrown the world into commotion.

*Reconciliation of Science and Religion*  
Chapter I (p. 17)  
Harper & Brothers Publishers. New York, New York, USA. 1877

**Wood, William Hamilton**  
No biographical data available

...he who has science and art has religion also.  
*The Religion of Science*  
Chapter I (p. 8)  
The Macmillan Co. New York, New York, USA. 1922

Science is general, universal, unbiased, rational, while theology is local, limited, narrow and practical.  
*The Religion of Science*  
Chapter I (p. 9)  
The Macmillan Co. New York, New York, USA. 1922

Science is reason, religion is emotion, therefore they do not move in the same plane or speak the same language.  
*The Religion of Science*  
Chapter II (p. 19)  
The Macmillan Co. New York, New York, USA. 1922

All religions of advanced standing have a Sacred Book or Literature. This Book, unlike all others is a special revelation and it is authority. The religion of science declares that nature itself is the source of authority and revelation, but the revelation will be given only to him who seeks with open and properly prepared mind.

*The Religion of Science*  
Chapter IV (p. 69)  
The Macmillan Co. New York, New York, USA. 1922

**Wright, George Frederick** 1838–1921  
American geologist

If the men of science could distinguish between their legitimate scientific conclusions and their metaphysical speculations, and if Christian apologists were less ready than some of them are to set limits to the realm of secondary causes, Science and Religion would have

no difficulty in lying down together without either being incorporated in the other.

In Levi Franklin Gruber

*Creation Ex Nihilo*

Foreword (p. 1)

The Gorham Press. Boston, Massachusetts, USA. 1918

## SCIENCE AND SOCIETY

**Asimov, Isaac** 1920–92

American author and biochemist

Science with all its faults has brought education and the arts to more people – a larger percentage – than has ever existed before science. In that respect it is science that is the great humanizer. And, if we are going to solve the problems that science has brought us, it will be done by science and in no other way.

Essay 400 – A Way of Thinking

*The Magazine of Fantasy and Science Fiction*, December, 1994

...science must not be viewed as a mysterious black box out of which came toys and goodies, for that way laymen would view scientists as a kind of lab-coated priesthood – and, eventually, fear and hate them.

Essay 400 – A Way of Thinking

*The Magazine of Fantasy and Science Fiction*, December, 1994

**Balfour, Arthur James** 1848–1930

English prime minister

...science is the great instrument of social change, all the greater because its object is not change but knowledge;

*Decadence: Henry Sidgwick Memorial Lecture* (pp. 55–56)

At The University Press. Cambridge, England. 1908

**Barry, Dave** 1947–

American humor columnist

...a recent survey, conducted by the National Science Foundation...showed that the average American does not understand basic scientific principles. Naturally, the news media reported this finding as though it was shocking, which is silly. This is, after all, a nation that has produced tournament bass fishing and the Home Shopping Channel; we should be shocked that the average American still knows how to walk erect.

In a World of Scientists, No One Really Knows Much of Anything

*Dave's World*, July 8, 1996

**Bauer, Henry H.** 1931–

American chemist

The point is that no amount of knowledge of or about science in itself causes individuals or groups to make good decisions about the many quandaries of life: humans readily subjugate their knowledge to their wishes, believing and doing what they want, all scientific facts and knowledge notwithstanding.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 1 (p. 13)

University of Illinois Press. Urbana, Illinois, USA. 1992

What is the social value of science? Why should we support it with taxes? Answer: It can keep people honest. Emperors and popes used to insist that people subscribe to lies about the Earth, about the relationships among different sorts of people, and about a lot of other things. They cannot lie to that extent anymore. Science can put and keep politicians and prophets in their proper place, at least over some things.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 146)

University of Illinois Press. Urbana, Illinois, USA. 1992

Scientific research is an investment in the future; trying to make it pay off quickly is as counterproductive as is, in the economic sphere, skimming wealth from corporations through leveraged buy-outs instead of investing for the long haul. Science is part of humanity's cultural heritage. Being educated in science is as important as being educated in philosophy, or psychology, or foreign languages because without it one is ignorant, a primitive savage rather than a civilized human being. And to be scientifically literate is to understand that.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 147)

University of Illinois Press. Urbana, Illinois, USA. 1992

Studying science is excellent training for the mind, much better than the classically prescribed study of Latin. When you study science in the right way, you learn about reality therapy; and that is worth applying to other things than science.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 147)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

...the first reason for teaching science to non scientists is that many of these nonscientists have a genuine desire to learn about science, and this, after all, is the best reason for teaching anything to anyone.

*Cranks, Quarks, and the Cosmos: Writings on Science*

Chapter 16 (p. 196)

Basic Books, Inc. New York, New York, USA. 1993

We live in a complex, dangerous, and fascinating world. Science has played a role in creating the dangers, and one hopes that it will aid in creating ways of dealing with these dangers. But most of these problems cannot, and will not, be dealt with by scientists alone. We need all the help we can get, and this help has got to come from a scientifically literate general public. Ignorance of science and technology is becoming the ultimate self-indulgent luxury.

*Cranks, Quarks, and the Cosmos: Writings on Science*  
Chapter 16 (p. 202)  
Basic Books, Inc. New York, New York, USA. 1993

**Brin, David** 1950–  
American scientist and author

We Americans have refined self-righteousness to a high art, cherishing the romantic image of smart outsiders against the establishment. New Age types see themselves as brave truth-seekers, opposed by a rigid technological priesthood. No matter that this priesthood is dedicated to self-criticism, and to sharing whatever they learn. Science represents this era's "establishment," and is therefore automatically suspect.

*Otherness*

What to Say to a UFO  
Bantam Dell Doubleday Publishing Group. New York, New York, USA. 1994

**Burke, Edmund** 1729–97  
English statesman and philosopher

[Society] is a partnership in all science, a partnership in all art, a partnership in every virtue and in all perfection. As the ends of such a partnership cannot be obtained in many generations, it becomes a partnership not only between those who are living, but between those who are living, those who are dead, and those who are to be born.

*The Works of the Right Hon. Edmund Burke: With a Biographical and Critical Introduction* (Volume 1)  
Part V (p. 417)  
Holdsworth & Ball. London, England. 1834

**Calvin, William H.** 1939–  
Theoretical neurophysiologist

Science doesn't merely empower us, as in seeding better technologies; it also helps prevent trouble in the first place. Knowledge can be like a vaccine, immunizing you against false fears and bad moves.

*How Brains Think: Evolving Intelligence, Then and Now*  
Chapter 3 (p. 41)  
Basic Books, Inc. New York, New York, USA. 1996

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

One of the factors, ironically enough, which has contributed to popular willingness to accept the incredible is the success of modern science. Because so many technical marvels have been achieved, the public believes that the scientist is a magician who can make anything happen. It does not know where to draw the line between the possible, the plausible, the improbable and the frankly absurd. Admittedly this is often extremely difficult, and even the experts sometimes fall flat on their faces. But usually, all that is needed is a little common sense.

*Voices from the Sky: A Preview of the Coming Space Age*  
The Lunatic Fringe  
Harper & Row, Publishers. New York, New York, USA. 1965

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

There is "something new under the sun" in that modern science has given mankind, for the first time in the history of the human race, a way of securing a more abundant life which does not simply consist in taking it away from someone else. Science really creates wealth and opportunity where they did not exist before.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 2)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Cori, Carl** 1896–1984  
American biochemist

Art and science can best grow and develop in a society which cherishes freedom and which shows respect for the needs, the happiness and the dignity of human beings.

*Les Prix Nobel. The Nobel Prizes in 1947*  
Nobel banquet speech for award received in 1947  
Nobel Foundation. Stockholm, Sweden. 1948

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

The average adult can usually enjoy something only if it relates to what he knows already, and what he knows about science is in many cases pitifully inadequate.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 7 (p. 80)  
Basic Books, Inc. New York, New York, USA. 1988

**Dawkins, Richard** 1941–  
British ethologist, evolutionary biologist, and popular science writer

People certainly blame science for nuclear weapons and similar horrors. It's been said before but needs to be said again: if you want to do evil, science provides the most powerful weapons to do evil; but equally, if you want to do good, science puts into your hands the most powerful tools to do so. The trick is to want the right things, then science will provide you with the most effective methods of achieving them.

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12th, 1996

It has become almost a cliché to remark that nobody boasts of ignorance of literature, but it is socially acceptable to boast ignorance of science and proudly claim incompetence in mathematics.

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12th, 1996

Science provokes more hostility than ever, sometimes with good reason, often from people who know nothing about it and use their hostility as an excuse not to learn. Depressingly many people still fall for the discredited cliché that scientific explanation corrodes poetic sensibility.

*Science and Sensibility*  
Queen Elizabeth Hall Lecture, London, 24th March, 1998

## Editorial

The scientific illiteracy of politicians, their simple lack of “feel” for what science is and what it can do, prevents them from exploring the deeper questions, among the most important facing humankind: how can science be conducted so that, on the one hand, the thinkers have the freedom to think, for that is the *sine qua non*; and how, on the other hand, can the products of unfettered thought be harnessed for the needs of society?

Who Cares About Science?

*New Scientist*, 17 October, 1985 (p. 18)

## Eisenhower, Dwight David 1890–1969

34th president of the USA

Science, great as it is, remains always the servant and the handmaiden of freedom. And a free science will ever be one of the most effective tools through which man will eventually bring to realization his age-old aspiration for an abundant life, with peace and justice for all.

In Dael Wolfe (ed.)

*Symposium on Basic Research*

Casper Auditorium of the Rockefeller Institute, May, 1959

Science: Handmaiden of Freedom (p. 142)

American Association of the Advancement of Science. Washington, D.C. 1959

## Feyerabend, Paul K. 1924–94

Austrian-born American philosopher of science

[Because] there is trouble in the third world... [it is argued that] the attempt to judge cosmologies by their content may have to be given up. Such a development, far from being undesirable, changes science from a stern and demanding mistress into an attractive and yielding courtesan who tries to anticipate every wish of her lover. Of course, it is up to us to choose either a dragon or a pussy cat for our company. I do not think I need to explain my own preferences.

*Realism, Rationalism and Scientific Method*

Consolations for the Specialist (p. 161)

Cambridge University Press. Cambridge, England. 1985

## Feynman, Richard P. 1918–88

American theoretical physicist

...the things that appear in the newspaper and that seem to excite the adult imagination are always those things which they cannot possibly understand, because they haven't learned anything at all of the much more interesting well-known [to scientists] things that people have found out before. It's not the case with children, thank goodness, for a while – at least until they become adults.

In Jeffrey Robbins, ed.

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 4 (p. 102)

Perseus Books. Cambridge, Massachusetts, USA. 1999

Another value of science is the fun called intellectual enjoyment which some people get from reading and learning and thinking about it, and which others get from working in it. This is an important point, one which is not considered enough by those who tell us it is our social responsibility to reflect on the impact of science on society. Is this mere personal enjoyment of value to society as a whole? No! But it is also a responsibility to consider the aim of society itself. Is it to arrange matters so that people can enjoy things? If so, then the enjoyment of science is as important as anything else.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 6 (p. 143)

Perseus Books. Cambridge, Massachusetts, USA. 1999

I don't believe in the idea that there are a few peculiar people capable of understanding math, and the rest of the world is normal. Math is a human discovery, and it's no more complicated than humans can understand. I had a calculus book once that said, “What one fool can do, another can.” What we've been able to work out about nature may look abstract and threatening to someone who hasn't studied it, but it was fools who did it, and in the next generation, all the fools will understand it.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 9 (p. 144)

Perseus Books. Cambridge, Massachusetts, USA. 1999

When we read about this in the newspaper, it says “Scientists say this discovery may have importance in the search for a cure for cancer.” The paper is only interested in the use of the idea, not the idea itself. Hardly anyone can understand the importance of an idea, it is so remarkable. Except that, possibly, some children catch on. And when a child catches on to an idea like that, we have a scientist.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 6 (p. 145)

Perseus Books. Cambridge, Massachusetts, USA. 1999

[I]f a thing is not scientific, if it cannot be subjected to the test of observation, this does not mean that it is dead, or wrong, or stupid. We are not trying to argue that science is somehow good and other things are somehow not good. Scientists take all those things that can be analyzed by observation, and thus the things called science are found out. But there are some things left out, for which the method does not work. This does not mean that those things are unimportant. They are, in fact, in many ways the most important.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter 1 (p. 16)

Perseus Books. Reading, Massachusetts, USA. 1998

It is odd, but on the infrequent occasions when I have been called upon in a formal place to play the bongo drums, the introducer never seems to find it necessary to mention that I also do theoretical physics.

*The Character of Physical Law*

Chapter 1 (p. 13)

British Broadcasting Company. London, England. 1965

### **Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

There are the elements, which seem to mock at all human control: the earth, which quakes and is torn apart and buries all human life and its works; water, which deluges and drowns everything in a turmoil; storms, which blow everything before them; there are diseases, which we have only recently recognized as attacks by other organisms; and finally there is the painful riddle of death, against which no medicine has yet been found, nor probably will be. With these forces nature rises up against us, majestic, cruel and inexorable; she brings...to our mind once more our weakness and helplessness, which we thought to escape through the work of civilization.

*The Future of an Illusion*

Chapter III (pp. 15–16)

W.W. Norton & Company, Inc. New York, New York, USA. 1961

### **Gleick, James** 1954–

American author, journalist, and essayist

Einstein's relativity did not speak to human values. Those were, or were not, relative for reasons unrelated to the physics of objects moving at near-light speed. Borrowing metaphors from the technical sciences could be a dangerous practice.

*Genius: The Life and Science of Richard Feynman*

Epilogue (p. 430)

Pantheon Books. New York, New York, USA. 1992

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

...I believe that science must be understood as a social phenomenon, a gutsy, human enterprise, not the work of robots programmed to collect pure information.... Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.

*The Mismeasure of Man*

Chapter One (p. 53)

W.W. Norton & Company, Inc. New York, New York, USA. 1996

Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.

*The Mismeasure of Man*

Chapter One (pp. 53–54)

W.W. Norton & Company, Inc. New York, New York, USA. 1996

Science is accessible to all thinking people because it applies universal tools of intellect to its distinctive material. The understanding of science – one need hardly repeat the litany – becomes ever more crucial in a world of biotechnology, computers, and bombs.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 7)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

### **Haskins, C. P.**

No biographical data available

Science provides a challenge to effort for the individual youth that is far greater than the challenge of militarism. It provides a unity of thought which is far wider, for it transcends all national boundaries. It provides a wider battleground, for the goal of militarism is the conquering of man, but that of science is the understanding and the subjugation of all the rest of our natural environment. And finally, it is an infinitely broader training than totalitarian training can possibly be, for it requires, in addition to great courage, stamina, and drive, the qualities of intellectualism and gentleness.

*Science Philosophy and Religion*

Scientific Thought and a Democratic Ideology (p. 235)

The Conference on Science, Philosophy and Religion in Their Relation to a Democratic Way of Life, Inc. New York, New York, USA. 1941

### **Hoffmann, Roald** 1937–

Polish-born American chemist

...the overall effect of science is inexorably democratizing, in the deepest sense of the word – by making available to a wider range of people the necessities and comforts that in a previous age were reserved for a privileged elite.

*The Same and Not the Same*

Part Eight, Chapter 40 (p. 212)

Columbia University Press. New York, New York, USA. 1995

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I am a little afraid that science is breeding us down too fast into coral-insects. A man like Newton or Leibnitz



or Haller used to paint a picture of outward or inward nature with a free hand, and stand back and look at it as a whole and feel like an archangel; but nowadays you have a Society, and they come together and make a great mosaic, each man bringing his little bit and sticking it in its place, but so taken up with his petty fragment that he never thinks of looking at the picture the little bits make when they are put together.

*The Poet at the Breakfast-Table*

Chapter III (p. 79)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

### **Holton, Gerald** 1922–

Research professor of physics and science history

Was not the universe of Dante and Milton so powerful and “gloriously romantic” precisely because it incorporated, and thereby rendered meaningful, the contemporary scientific cosmology alongside the moral and aesthetic conceptions? Leaving aside the question of whether Dante’s and Milton’s contemporaries by and large were living in a rich and fragrant world of gladness, love, and beauty, it is fair to speculate that if our new cosmos is felt to be cold, inglorious, and unromantic, it is not the new cosmology which may be at fault, but the absence of new Dantes and Miltons.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part One, Chapter 2 (p. 53)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

But making science again a part of every intelligent person’s educational resource is the minimum requirement – not because science is more important than other field, but because it is an integral part of a sound contemporary worldview.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part One, Chapter 2 (p. 53)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

### **King, Jr., Martin Luther** 1929–68

American civil rights leader and clergyman

The means by which we live have outdistanced the ends for which we live. Our scientific power has outrun our spiritual power. We have guided missiles and misguided men.

*Strength to Love*

Chapter VII (p. 57)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Lederman, Leon** 1922–

American high-energy physicist

In his “Defense of Poetry,” the English romantic poet Percy Bysshe Shelley contended that one of the sacred tasks of the artist is to “absorb the new knowledge of the sciences and assimilate it to human needs, color it with

human passions, transform it into the blood and bone of human nature.” Not many romantic poets rushed to accept Shelley’s challenge, which may explain the present sorry state of our nation and planet. If we had Byron and Keats and Shelley and their French, Italian, and Urdu equivalents explaining science, the science literacy of the general public would be far higher than it is now.

*The God Particle: If the Universe Is the Answer, What Is the Question*

Chapter 9 (p. 382)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Money can’t buy ideas, that’s for sure, but lack of it can prevent one having them.

*The Cost-Benefit Analysis of Pure Research*

*Hospital Practice*, Sept 1973

I am afraid we shall have to regard the funding of “pure” research as a tax levied upon society that is not dissimilar in kind from that which maintains art galleries and opera houses – a “civilization tax”, perhaps.

*The Cost-Benefit Analysis of Pure Research*

*Hospital Practice*, Sept 1973

It is the great glory and also the great threat of science that anything which is possible in principle – which does not flout a bedrock law of physics – can be done if the intention to do it is sufficiently resolute and long sustained.

*Four Score Years and Ten – And Still Counting*

*Guardian*, December 13, 1984

### **More, Louis Trenchard**

American educator

...science has other functions in addition to the attack and solution of problems by the creative power of the individual: phenomena and laws must be taught in detail to the specialist; general conclusions must be given to the world in order that they may become a part of the general intellectual life; and finally discoveries are to be applied to social and industrial needs.

*The Limitations of Science*

Chapter VI (p. 190)

Henry Holt & Co. New York, New York, USA. 1915

### **Oppenheimer, James Robert** 1904–67

American theoretical physicist

We live today in a world in which poets and historians and men of affairs are proud that they wouldn’t even begin to consider about learning anything of science, regarding it as the far end of a tunnel too long for any wise man to put his head into.

*The Open Mind*

*The Scientist in Society* (p. 128)

Simon & Schuster. New York, New York, USA. 1955



**Paulos, John Allen** 1945–  
American mathematician

In general, almost any mathematically expressed scientific fact can be transformed into a consumer caveat (or lure) that will terrify (or attract) people.

*A Mathematician Reads the Newspaper*  
Asbestos Removal Closes NYC Schools (p. 142)  
Basic Books, Inc. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Some men are so impressed by what science knows that they forget what it does not know; others are so much more interested in what it does not know than in what it does that they belittle its achievements.

*Unpopular Essays*  
Philosophy for Laymen (p. 40)  
George Allen & Unwin Ltd. London, England. 1950

Can a society in which thought and technique are scientific persist for a long period, as, for example, ancient Egypt persisted, or does it necessarily contain within itself forces which must bring either decay or explosion?

Lloyd Roberts lecture  
Can a Scientific Community be Stable, Royal Society of Medicine, London, November 29, 1949

**Sagan, Carl** 1934–96  
American astronomer and author

Many of the dangers we face indeed arise from science and technology – but, more fundamentally, because we have become powerful without becoming commensurately wise. The world-altering powers that technology has delivered into our hands now require a degree of consideration and foresight that has never before been asked of us.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 22 (p. 384)  
Random House, Inc. New York, New York, USA. 1994

Surely...any powerful tool, those in power will try to use...or even monopolize.... Surely scientists, being people, grow up in a society and reflect the prejudices of that society. How could it be otherwise? Some scientists have been nationalists; some have been racists; some have been sexists. But that doesn't undermine the validity of science. It's just a consequence of being human.

Wonder and Skepticism  
*Skeptical Inquirer*, January/February, 1995 (p. 24)

There is a reward structure in science that is very interesting: Our highest honors go to those who disprove the findings of the most revered among us.... [I]t's exactly the opposite [in economics, politics, or religion]: There we reward those who reassure us that what we've been told is right, that we need not concern ourselves about it.

This difference, I believe, is at least a basic reason why we've made so much progress in science, and so little in some other areas.

Wonder and Skepticism  
*Skeptical Inquirer*, January/February, 1995 (p. 24)

The scientific world view works so well, explains so much and resonates so harmoniously with the most advanced parts of our brains that in time, I think, virtually every culture on the Earth, left to its own devices, would have discovered science.

*Cosmos*  
Chapter VII (p. 176)  
Random House, Inc. New York, New York, USA. 1980

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

... – who are we? ... I consider this not only one of the tasks, but the task of science, the only one that really counts.

*Science and Humanism: Physics in Our Time*  
The Alleged Break-Down of the Barrier Between Subject and Object (p. 51)  
At The University Press. Cambridge, England. 1952

**Silver, Brian L.**  
Israeli professor of physical chemistry

Scientific ideas have affected the relationship of man to society, his ideas of God, and his image of himself. Science has influenced the way people write poetry and the way they paint pictures. In the hands of bigots, it has provided a theoretical justification for the sterilization of some human beings and the enslavement of others. Science, as a source of ideas, is a major character in the human drama.

*The Ascent of Science*  
Preface (p. xvi)  
Solomon Press Book. New York, New York, USA. 1998

**Snow, Charles Percy** 1905–80  
English novelist and scientist

Literary intellectuals at one pole – at the other scientists. – .... Between the two a gulf of mutual incomprehension.

*The Two Cultures and the Scientific Revolution*  
Chapter I (p. 4)  
Cambridge University Press. New York, New York, USA. 1961

**Stenger, Victor J.** 1935–  
American physicist

Most humans on this planet use the fruits of science in every phase of their lives. I become very irritated at those who decry science while accepting its every benefit. It is especially ironic how the antiscientists use modern communications to get their messages to the public.

*Physics and Psychics: The Search for a World Beyond the Senses*  
Chapter 14 (p. 297)  
Prometheus Books. Buffalo, New York, USA. 1990

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Science grows and Beauty dwindles.

*Alfred Tennyson's Poetical Works*  
Locksley Hall. Sixty Years After, Stanza 123  
Oxford University Press, Inc. London, England. 1953

**Thomas, Lewis** 1913–93  
American physician and biologist

The cloning of humans is on most of the lists of things to worry about from Science, along with behavior control, genetic engineering, transplanted heads, computer poetry and the unrestrained growth of plastic flowers.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
On Cloning Human Beings (pp. 51–52)  
The Viking Press. New York, New York, USA. 1979

**Timiriazeff, C. A.**  
Russian botanist

To develop and prosper, every science requires the moral and material support of society; but, on the other hand, society takes practical interest only in things which it considers useful.

Translated by Anna Sheremeteva  
*Die Sinne der Pflanzen*  
Chapter 1 (p. 7)  
Longmans, Green & Co. London, England. 1912

**Weinberg, Steven** 1933–  
American nuclear physicist

It is simply a logical fallacy to go from the observation that science is a social process to the conclusion that the final product, our scientific theories, is what it is because of the social and historical forces acting in this process. A party of mountain climbers may argue over the best path to the peak, and these arguments may be conditioned by the history and social structure of the expedition, but in the end either they find a good path to the peak or they do not, and when they get there they know it. (No one would give a book about mountain climbing the title Constructing Everest.)

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VI (p. 165)  
Pantheon Books. New York, New York, USA. 1992

It certainly feels to me that we are discovering something real in physics, something that is what it is without any regard to the social and historical conditions that allowed us to discover it.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VI (p. 165)  
Pantheon Books. New York, New York, USA. 1992

We may need to rely again on the influence of science to preserve a sane world. It is not the certainty of scientific knowledge that fits it for this role, but its uncertainty.

Seeing scientists change their minds again and again about matters that can be studied directly in laboratory experiments, how can one take seriously the claims of religious tradition or sacred writings to certain knowledge about matters beyond human experience?

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VII (p. 188)  
Pantheon Books. New York, New York, USA. 1992

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science cannot develop unless it is pursued for the sake of pure knowledge and insight. It will not survive unless it is used intensely and wisely for the betterment of humanity and not as an instrument of domination. Human existence depends upon compassion and curiosity. Curiosity without compassion is inhuman; compassion without curiosity is ineffectual.

*Science Yesterday, Today, and Tomorrow*  
Speech, 1993

**Wilson, Edward O.** 1929–  
American biologist and author

The love of complexity without reductionism makes art; the love of complexity with reductionism makes science.

*Consilience: The Unity of Knowledge*  
Chapter 4 (p. 54)  
Alfred A. Knopf. New York, New York, USA. 1998

**Wolpert, Lewis** 1929–  
British embryologist

Mary Shelley's *Dr. Frankenstein*, H. G. Wells's *Dr. Moreau* and Aldous Huxley's *Brave New World...* are evidence of a powerfully emotive anti-science movement. Science is dangerous, so the message goes – it dehumanizes; it takes away free will; it is materialistic and arrogant. It removes magic from the world and makes it prosaic. But note where these ideas come from – not from the evidence of history, but from creative artists who have molded science by their own imagination.

*The Unnatural Nature of Science*  
Introduction (p. x)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Zelinsky, Wilbur** 1921–  
American cultural geographer

Perhaps the greatest discovery of twentieth century science has to do with its own essential nature: That it is, first and always, a social activity, an organized band of human beings who obey the same fundamental rules of organized behavior as do any other complex group of people, not a disembodied flock of angels soaring unswervingly upward toward the elysian fields of truth. The Demigod's Dilemma

*Annals of the Association of American Geographers*, Volume 65, 1975 (p. 133)

## SCIENCE AND SORCERY

**Foster, Alan Dean** 1946–  
American author of fantasy and science fiction

Where lies the line between sorcery and science? It is only a matter of terminology, my friend.

*Cyber Way* (p. 320)  
Ace Books. New York, New York, USA. 1990

## SCIENCE AND SPIRITUALITY

**Sagan, Carl** 1934–96  
American astronomer and author

The notion that science and spirituality are mutually exclusive does a disservice to both.

*Demon-Haunted World: Science As a Candle in the Dark*  
Chapter 2 (pp. 29–30)  
Random House, Inc. New York, New York, USA. 1995

## SCIENCE AND STATE

**Duprée, Hunter** 1921–  
American historian of science and technology

The mighty edifice of government science dominated the scene in the middle and twentieth century as a Gothic cathedral dominated a thirteenth century landscape. The work of many hands over the years, it universally inspired admiration, wonder and fear.

*Science in the Federal Government*  
Chapter XIX (p. 375)  
Harvard University Press. Cambridge, Massachusetts. 1957

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

...the separation of state and church must be complemented by the separation of state and science, that most recent, most aggressive, and most dogmatic religious institution.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 18 (p. 295)  
Verso. London, England. 1978

**Mellanby, Kenneth** 1908–93  
English ecologist and entomologist

...the corridors of power have a strong attraction for even the most devoted investigator, and these corridors seldom lead back to the laboratory.

*Disorganisation of Scientific Research*  
*New Scientist*, Volume 59, Number 86023, August, 1973 (p. 436)

**Ramón y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

Today's statesmen undoubtedly have limitations, one of which is not realizing that the greatness and might

of nations are the products of science, and that justice, order, and good laws are important but secondary factors in prosperity.

*Advice for a Young Investigator*  
Chapter 6 (p. 91)  
The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rutherford, Ernest** 1871–1937  
English physicist

It is essential for men of science to take an interest in the administration of their own affairs or else the professional civil servant will step in – and then the Lord help you.

*Bulletin of the Institute of Physics*, 1950, 1, Number 1, cover

**Wiener, Norbert** 1894–1964  
American mathematician

Neither the public nor the big administrator [of science] has too good an understanding of the inner continuity of science, but they have both seen its world-shaking consequences, and they are afraid of it. Both of them wish to decerebrate the scientist, as the Byzantine State emasculated its civil servants. Moreover the great administrator who is not sure of his own intellectual level can aggrandize himself only by cutting his scientific employees down to size.

*I Am a Mathematician*  
Epilogue (p. 363)  
Doubleday. Garden City, NY 1956

## SCIENCE AND SUPERSTITION

**Einstein, Albert** 1879–1955  
German-born physicist

By furthering logical thought and a logical attitude, science can diminish the amount of superstition in the world. There is no doubt that all but the crudest scientific work is based on a firm belief – akin to religious feeling – in the rationality and comprehensibility of the world.

*Cosmic Religion, With Other Opinions and Aphorisms*  
On Science (p. 98)  
Covici-Fiede. New York, New York, USA. 1931

**Lovecraft, H. P. (Howard Phillips)** 1890–1937  
American writer of fantasy, horror, and science fiction

We were not...in any sense childishly superstitious, but scientific study and reflection had taught us that the known universe of three dimensions embraces the merest fraction of the whole cosmos of substance and energy.

*The Shunned House*  
Section IV  
The Recluse Press. Athol, Massachusetts, USA. 1928

To say that we actually believed in vampires or werewolves would be a carelessly inclusive statement. Rather must it be said that we were not prepared to deny the

possibility of certain unfamiliar and unclassified modifications of vital force and attenuated matter; existing very infrequently in three-dimensional space because of its more intimate connection with other spatial units, yet close enough to the boundary of our own to furnish us occasional manifestations which we, for lack of a proper vantage-point, may never hope to understand.

*The Shunned House*

Section IV

The Recluse Press. Athol, Massachusetts, USA. 1928

**Machen, Arthur** 1863–1947

Welsh author

I have told you that I was of skeptical habit; but though I understood little or nothing, I began to dread, vainly proposing to myself the iterated dogmas of science that all life is material, and that in the system of things there is no undiscovered land, even beyond the remotest stars, where the supernatural can find a footing. Yet there struck in on this the thought that matter is as really awful and unknown as spirit, that science itself but dallies on the threshold, scarcely gaining more than a glimpse of the wonders of the inner place.

*The Novel of the Black Seal* (p. 18)

Kessinger Publishing. Whitefish, Montana, USA.

**Pagels, Heinz R.** 1939–88

American physicist and science writer

I like to browse in occult bookshops if for no other reason than to refresh my commitment to science.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 11 (p. 242)

Simon & Schuster. New York, New York, USA. 1988

## SCIENCE AND TECHNOLOGY

**Adler, Alfred** 1870–1937

Austrian psychiatrist

The confusion of science with technology is understandable. Certainly the two often appear to be aspects of a single larger process, as when science proposes new laws of physics, which inspire the development of a technology for their exploration, which in turn exposes inaccuracies in the laws and forces science to seek a more profound level of theory. But in fact their divergence is great. It is in the divergence of engagement from fulfillment, of means from ends.... If truth is a path, then science explores it, and the brief stops along the way are where technologies begin (they build towns and pave a highway). Technology is results, science is process; though the two fuse and separate and then fuse once more, as ends and means must, their opposition is profound.

*The Atlantic Monthly*, February, 1972

## SCIENCE AND TRUTH

**Lorenz, Konrad** 1903–89

Austrian zoologist

Truth, in science, can be defined as the working hypothesis best fitted to open the way to the next better one.

Translated by Marjorie Kerr Wilson

*On Aggression*

Chapter Fourteen (p. 288)

Harcourt, Brace & World, Inc. New York, New York, USA. 1963

## SCIENCE AND WOMEN

### Agrippa (Fictional character)

Well versed in the natural sciences and mathematics. She speaks seven languages proficiently. Were she not a woman one would consider her to be an intellectual.

*Cleopatra*

Film (1963)

**Bolton, Henrietta**

No biographical data available

As a general rule the scientific woman must be strong enough to stand alone, able to bear the often unjust sarcasm and dislike of men who are jealous of seeing what they consider their own field invaded.

Women in Science

*Popular Science Monthly*, Volume 53, 1898 (p. 511)

**Buckley, Arabella B.** 1840–1929

English author

I have promised to introduce you today to the fairy-land of science, – a somewhat bold promise, seeing that most of you probably look upon science as a bundle of dry facts, while fairy-land is all that is beautiful, and full of poetry and imagination. But I thoroughly believe myself, and hope to prove to you, that science is full of beautiful pictures, of real poetry, and of wonder-working fairies...

*The Fairy-Land of Science*

Lecture I (p. 7)

D. Appleton & Company. New York, New York, USA. 1892

**Cannon, Annie Jump** 1863–1941

American astronomer

...a life spent in the routine of science need not destroy the attractive human element of a woman's nature.

Obituary of Williamina Paton Fleming

*Science*, Volume 33, June 30, 1911 (p. 988)

**de Lamennais, Félicité Robert** 1782–1854

French nobleman and ecclesiastic scholar

I have never met a woman who was competent to follow a course of reasoning the half of a quarter of an hour – *un demi quart d'heure*. She has qualities which are wanting in us, qualities of a particular, inexpressible charm; but,

in the matter of reason, logic, the power to connect ideas, to enchain principles of knowledge and perceive their relationships, woman, even the most highly gifted, rarely attains to the height of a man of mediocre capacity.

In H.J. Mozans

*Women in Science*

Chapter III (p. 136)

The MIT Press. Cambridge, Massachusetts, USA. 1974

**de Pizan, Christine** 1364–ca. 1430

Venetian Medieval writer and analyst

I'll give you some conclusive examples. I repeat – and don't doubt my word – that if it were the custom to send little girls to school and to teach them all sorts of different subjects there, as one does with little boys, they would grasp and learn the difficulties of all the arts and sciences just as easily as the boys do.

Translated by Rosalind Brown-Grant

*The Book of the City of Ladies*

Part I, 26 (p. 57)

Penguin Books. London, England. 1999

**Galbraith, John Kenneth** 1908–2006

Canadian-American economist

The real accomplishment of modern science and technology consists in taking ordinary men, informing them narrowly and deeply, and then, through appropriate organization, arranging to have their knowledge combined with that of other specialized but equally ordinary men. This dispenses with the need for genius. The resulting performance, though less inspiring, is far more predictable.

*The New Industrial State*

Chapter VI, Section 2 (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**Gildersleeve, Virginia Crocheron** 1877–1965

American educator

If we could produce one or two more Madame Curies, that would accomplish far more for the advancement of women than any amount of agitation, argument and legislation.

*Many a Good Crusade: Memoirs of Virginia Crocheron Gildersleeve*

Part I. The Advancement of Women, (p. 104)

The Macmillan Company. New York, New York, USA. 1954

**Johnston, William** 1861–1917

American typographer

Into what profound mystery of science shall man be permitted to enter where woman may not follow?

*Address on Female Education* (p. 16)

Printed by Chas. Scott & Co. Columbus, Ohio, USA. 1845

**Kant, Immanuel** 1724–1804

German philosopher

All abstract speculations, all knowledge which is dry, however useful it may be, must be abandoned to the laborious and solid mind of man.... For this reason women

will never learn geometry.

In H.J. Mozans

*Women in Science*

Chapter III (p. 136)

The MIT Press. Cambridge, Massachusetts, USA. 1974

**Kass-Simon, G.**

American neurobiologist

**Farnes, Patricia** 1931–85

American health care writer

For women in science to be remembered, not only must their work be thought right, but usually it must have such impact upon scientific thought that exclusion is impossible. If women scientists are wrong, or if they narrowly miss the mark, or if they propound ideas that are ultimately superseded, not only are their ideas quickly forgotten, but as often as not, the women are ostracized by their contemporaries or treated with derision.

*Women of Science: Righting the Record*

Introduction (p. xiii)

Indiana University Press. Bloomington, Indiana, USA. 1990

**Lamy, Étienne** 1845–1919

French essayist, politician, and lawyer

Women...group themselves at the center of human knowledge, whereas men disperse themselves toward its outer boundaries. While men are always pushing analysis to its utmost limits, women are seeking a synthesis. While men are becoming more technical, women are becoming more intellectual. They are better placed to observe the correlations of the different sciences, and to subordinate them to the common and unique source of truth from which they all descend. We seem, indeed, to be approaching a time when women will become the conservers of general ideas.

In H.J. Mozans

*Women in Science.*

Chapter XII (pp. 409–410)

The MIT Press. Cambridge, Massachusetts, USA. 1974

**Marcet, Mrs. (Jane Haldimand)** 1769–1858

English expository author in chemistry, botany, religion, and economics

In writing these pages, the author was more than once checked in her progress by the apprehension that such an attempt might be considered by some, either as unsuited to the ordinary pursuits of her sex, or ill justified by her own recent and imperfect knowledge of the subject. But, on the one hand, she felt encouraged by the establishment of those public institutions, open to both sexes, for the dissemination of philosophical knowledge, which clearly prove that the general opinion no longer excludes women from an acquaintance with the elements of science...

*Conversations on Chemistry, in Which the Elements of that Science Are*

*Familiarly Explained and Illustrated by Experiments*

Preface (p. iv)

Sidney's Press for Cooke. New Haven, Connecticut, USA. 1809



**Merchant, Carolyn** 1936? –  
American ecofeminist philosopher

While learned ladies had always been present among the educated of nobility, and women had contributed to science and mathematics from earliest times, the “scientific lady” was a product of the Scientific Revolution.

*The Death of Nature: Women, Ecology, and the Scientific Revolution*  
Chapter 11 (p. 269)  
Harper & Row, Publishers. San Francisco, California, USA. 1980

**Mitchell, Maria** 1818–89  
American astronomer and educator

Women, more than men, are bound by tradition and authority. What the father, the brother, the doctor, and the minister have said has been received undoubtingly. Until women throw off this reverence for authority, they will not develop. When they do this, when they come to truth through their investigations, when doubt leads them to discovery, the truth which they get will be theirs, and their minds will work on and on unfettered.

In Eve Merriam

*Growing Up Female in America*  
Maria Mitchell (p. 96)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Mozans, H. J. (John Augustine Zahm)** 1851–1921  
American priest, professor of physics, and science writer

Whilst men of science will be forced to continue as specialists as long as the love of fame, to consider no other motives of research, continue to be a potent influence in their investigations, it is probable that women will have less love for the long and tedious processes involved in the more difficult kinds of specialization. They will, it seems likely, be more inclined to acquire a general knowledge of the whole circle of the sciences – a knowledge that will enable them to take a comprehensive survey of nature. And it will be fortunate for themselves, as well as for the men who must perforce remain specialists, if they elect to do so. For nothing gives falsier views of nature as a whole, nothing more unfits the mind for a proper apprehension of higher and more important truths, nothing more incapacitates one for the enjoyment of the masterpieces of literature or the sweeter amenities of life, than the narrow occupation of a specialist who sees nothing in the universe but electrons, microbes and protozoa.

*Women in Science*

Chapter XII (pp. 408–409)

The MIT Press. Cambridge, Massachusetts, USA. 1974

**Myrdal, Sigrid**  
American scientist and inventor

There’s the question of how you react when your data do not turn out the way you want them to. One possibility is to think “Oh no, something went wrong, my experiment failed.” or “Did I ask the question wrong?” and put

the data in the drawer. I think the feminine approach is to ask “What’s this trying to tell me?” and consider that nature may be more interesting and complicated than... expected, but therefore probably a bit more elegant. By actually having to deal with the data, I’ve gone to totally different interpretations. If something turns out quite screwy, I give it a chance. It’s possible that it’s more feminine to give something a chance.

In Linda Jean Shepherd

*Lifting the Veil: The Feminine Face of Science*  
Receptivity (p. 86)

Shambhala. Boston, Massachusetts, USA. 1993

**Pepwell, Henry**  
English printer

I mervayle gretely of the opnyon of some men that say they wolde in no wyse that theyr daughters or wyves or kynneswomen sholde lerne scyences, and that it sholde apayre theyr codycyons. This thing is not to say ne to sustayne. That the woman apayreth by conyng it is not well to beleve. As the proverb saythe, ‘that nature gyveth may not be taken away.’

Quoted in H. J. Mozans

*Woman in Science*

Chapter II (p. 106)

D. Appleton & Company. New York, New York, USA. 1913

**Pidgeon, Walter** 1897–1984  
Canadian actor

Women and science are incompatible. No true scientist can have anything to do with a woman.

*Madame Curie*

Film (1943)

**Plato** 428 BCE–347 BCE  
Greek philosopher

Nothing can be more absurd than the practice, which prevails in our country, of men and women not following the same pursuits with all their strength and with one mind, for thus the state, instead of being a whole, is reduced to a half.

In H.J. Mozans

*Women and Science* (p. 2)

The MIT Press. Cambridge, Massachusetts, USA. 1974

**Poullain de la Barre, François** 1647–1723  
French feminist theorist and philosopher

*L’esprot n’a point de sexe.*

The mind has no sex.

*De l’éducation des dames pour la conduite de l’esprit dans les sciences et dans les moeurs*

Paris, France. 1674.

**Rich, Adrienne** 1929–  
American poet

The belief that established science and scholarship – which have so relentlessly excluded women from their



making – are “objective” and “value-free” and that feminist studies are “unscholarly,” “biased,” and “ideological” dies hard. Yet the fact is that all science, and all scholarship, and all art are ideological; there is no neutrality in culture!

*Blood, Bread and Poetry*

Chapter 1 (p. 3)

W.W. Norton & Company. New York, New York, USA. 1986

**Sharp, Katharine Dooris** 1846–1935

Irish botanist

...while the road to scientific attainment is for the man broad and well-paved through centuries of use, there is generally for woman, when she dares to walk therein, a look askance and a cold reception.

*Summer in a Bog*

The Woman Botanist (p. 93)

Stewart & Kidd Co. Cincinnati, Ohio, USA 1913

**Yentsch, Clarice M.**

No biographical data available

**Sindermann, Carl J.**

No biographical data available

Science, as a remarkably conservative human institution despite its relatively brief history, has typically cast women in supporting roles in which they were subservient to male professionals, usually dreadfully underpaid, and totally unrecognized.

*The Woman Scientist: Meeting the Challenges for a Successful Career*

Chapter 2 (p. 27)

Plenum Press. New York, New York, USA. 1992

## SCIENCE EDUCATION

**Bethe, Hans** 1906–2005

American physicist

We need science education to produce scientists, but we need it equally to create literacy in the public. Man has a fundamental urge to comprehend the world about him, and science gives today the only world picture which we can consider as valid. It gives an understanding of the inside of the atom and of the whole universe, or the peculiar properties of the chemical substances and of the manner in which genes duplicate in biology. An educated layman can, of course, not contribute to science, but can enjoy and participate in many scientific discoveries which as constantly made. Such participation was quite common in the 19th century, but has unhappily declined. Literacy in science will enrich a person's life.

Quote

*Popular Mechanics*, Volume 116, Number 3, September, 1961 (p. 256)

**von Liebig, Justus** 1803–73

German organic chemist

Without an acquaintance with the history of physics it is impossible to form any correct opinion of the effect which the study of nature has exercised upon the cultivation of the mind. In our schools mere children are now taught truths, the attainment of which has cost immense labour and indescribable efforts.

In John Gardner

*Familiar Letters on Chemistry*

Second Series

Letter I (p. 8)

Taylor & Walton. London, England. 1844

The great desideratum of the present age is practically manifested in the establishment of schools in which the natural sciences occupy the most prominent place in the course of instruction. From these schools a generation will spring up, vigorous in understanding, qualified to accomplish all that is truly great, and to bring forth fruits of universal usefulness. Through them the resources, strength, and wealth of empires will be incalculably increased...

In John Gardner

*Familiar Letters on Chemistry*

Second Series

Letter I (p. 33)

Taylor & Walton. London, England. 1844

## SCIENCE FICTION

**Asimov, Isaac** 1920–92

American author and biochemist

Individual science fiction stories may seem as trivial as ever to the blinder critics and philosophers of today – but the core of science fiction, its essence...has become crucial to our salvation if we are to be saved at all.

In Robert Holdstock (ed.)

*The Encyclopedia of Science Fiction*

Foreword (p. 7)

Octopus Books Ltd. London, England. 1978

**Ballard, James Graham** 1930–

English writer

Everything is becoming science fiction. From the margins of an almost invisible literature has sprung the intact reality of the 20th century.

Fictions of Every Kind

*Books and Bookmen*, February, 1971

**Hawking, Stephen William** 1942–

English theoretical physicist

We may not yet be able to boldly go where no man (or woman) has gone before, but at least we can do it in the mind.

In Lawrence M. Krauss

*The Physics of Star Trek*

Foreword (pp. xi–xii)

Harp Perennial Publishers. New York, New York, USA. 1995

There is a two-way trade between science fiction and science. Science fiction suggests ideas that scientists incorporate into their theories, but sometimes science turns up notions that are stranger than any science fiction.

In Lawrence M. Krauss  
*The Physics of Star Trek*

Forward (p. xii)

Harp Perennial Publishers. New York, New York, USA. 1995

Nevertheless, today's science fiction is often tomorrow's science fact. The physics that underlies Star Trek is surely worth investigating. To confine our attention to the terrestrial matters would be to limit the human spirit.

In Lawrence M. Krauss  
*The Physics of Star Trek*

Forward (p. xiii)

Harp Perennial Publishers. New York, New York, USA. 1995

## SCIENCE GEEK

**Willis, Connie** 1945–

American science fiction writer

The effect, especially with the Coke-bottle glasses, should have been science geek, but it wasn't... Science geeks wear black shoes and white socks. he wasn't even wearing a pocket protector, though he should have been.

*Bellwether* (p. 12)

Bantam Spectra. New York, New York, USA. 1997

## SCIENCE IS

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Science is the whore of industry and the handmaiden of war.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 10 (p. 93)

St. Martin's Press. New York, New York, USA. 1989

**Adams, Henry Brooks** 1838–1918

American man of letters

My belief is that science is to wreck us, and that we are like monkeys monkeying with a loaded shell; we don't in the least know or care where our practically infinite energies come from or will bring us to.

*Letters of Henry Adams* (Volume 2)

Letter, August 10, 1902, to Brooks Adams (p. 392)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

**Alves, Reuben**

No biographical data available

Science is what it is, not what scientists think they do.

*New York Times*, July 13, 1979, A8 (p. 128)

## Arabic Proverb

Science is a plant whose roots indeed are at Mecca, but its fruit ripens at Herat.

In Robert Christy

*Proverbs, Maxims and Phrases of All Ages* (p. 236)

G.P. Putnam's Sons. New York, New York, USA. 1888

**Asimov, Isaac** 1920–92

American author and biochemist

[Science is] a system for testing your thoughts against the universe and seeing whether they match.

In Carl Freedman

In Bill Moyer

*Conversations With Isaac Asimov*

*Isaac Asimov Speaks* (p. 143)

University Press of Mississippi. Jackson, Mississippi, USA. 2005

**Astbury, William Thomas** 1898–1961

English crystallographer and molecular biologist

...science is truly one of the highest expressions of human culture – dignified and intellectually honest, and withal a never-ending adventure. Personally, I feel much the same with regard to the more ecstatic moments in science as I do with regard to music. I see little difference between the thrill of scientific discovery and what one experiences when listening to the opening bars of the Ninth Symphony.

Science in Relation to the Community

*School Science Review*, Number 109, 1948 (p. 279)

## Author undetermined

Science is like an organism, it cannot be made great by the command of "hurry up." It must have its time to grow and develop.

*Ninth Annual Report of the Pathological Institute*

Relation of the Pathological Institute to the Official Organ of the Publication of State Hospitals (p. 226)

Wynkoop Hallenbeck Crawford Co. Albany, New York, USA. 1898

**Bain, Alexander** 1818–1903

Scottish philosopher and psychologist

[Science] is the most perfect embodiment of Truth, and of the ways of getting at Truth. More than anything else does it impress the mind with the nature of Evidence, with the labour and precautions necessary to prove a thing. It is the grand corrective of the laxness of the natural man in receiving unaccredited facts and conclusions. It exemplifies the devices for establishing a fact, or a law, under every variety of circumstances; it saps the credit of everything that is affirmed without being properly attested.

*Education as a Science*

Chapter V (pp. 146–147)

D. Appleton & Co. New York, New York, USA. 1898

**Bauer, Henry H.** 1931–

American chemist

That science is inescapably a human activity does not mean that it is only or just a human activity, essentially similar to all other human activities.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 7 (p. 141)  
University of Illinois Press. Urbana, Illinois, USA. 1992

**Bernal, John Desmond** 1901–71  
Irish-born physicist and X-ray crystallographer

Science is one of the most absorbing and satisfying pastimes, and as such it appeals in different ways to different types of personality. To some it is a game against the unknown where one wins and no one loses; to others, more humanly minded, it is a race between different investigators as to who should first wrest the prize from nature. It has all the qualities which make millions of people addicts of the crossword puzzle or the detective story, the only difference being that the problem has been set by nature or chance and not by man, that the answer cannot be got with certainty, and when they are found often raise far more questions than the original problem.  
*The Social Function of Science* (p. 97)  
The Macmillan Company. New York, New York, USA. 1939

**Bernard, Claude** 1813–78  
French physiologist

Science is like a rope that we hold by one end, which we see. The other end is in the water and is attached to the unknown.  
Translated by Hebbel H. Hoff, Lucienne Guillemin and Roger Guillemin  
*The Cahier Rouge of Claude Bernard* (p. 89)  
Schenkman Publishing Co. Cambridge, Massachusetts, USA. 1967

**Berthelot, Marcellin (or Marcelin) Pierre**

**Eugène** 1827–1907  
French chemist and politician

Science is essentially a collective work, pursued during the course of time by the efforts of a multitude of workers of every age and of every nation, succeeding themselves and associating by virtue of a tacit understanding for the search for pure truth and for the applications of that truth to the continuous betterment of the condition of all mankind.  
In Camille Matignon  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*  
Marcellin Berthelot (p. 684)  
Government Printing Office. Washington, D.C. 1908

**Boas, George** 1891–1980  
American philosophy professor

Science is the art of understanding nature.  
In Laurence M. Gould  
*Science and the Culture of Our Times*  
*UNESCO Courier*, February, 1968 (p. 6)

**Bohm, David** 1917–92  
American physicist

**Peat, F. David** 1938–  
English holistic physicist and author

Science is an attempt to understand the universe and humanity's relationship to nature.  
*Science, Order, and Creativity*  
Chapter One (p. 16)  
Bantam Books. New York, New York, USA. 1987

Science is essentially a public and social activity.  
*Science, Order, and Creativity*  
Chapter Two (p. 67)  
Bantam Books. New York, New York, USA. 1987

Science is, however, at least in principle, dedicated to seeing any fact as it is, and to being open to free communication with regard not only to the fact itself, but also to the point of view from which it is interpreted.  
*Science, Order, and Creativity*  
Chapter Six (pp. 241–242)  
Bantam Books. New York, New York, USA. 1987

**Born, Max** 1882–1970  
German-born English physicist

The satisfaction of the noble curiosity of the scholar is only one aspect of research. Science is also – and many say predominantly – a collective effort to obtain power over the forces of nature in the interest of human life.  
*The Restless Universe*  
Postscript (p. 297)  
Dover Publications, Inc. New York, New York, USA. 1951

**Bouty, Edmond** 1846–1922  
French physicist

Science is a product of the human mind, a product that conforms to both the laws of thought and the outside world. Hence it has two aspects, one subjective, the other objective; and both are equally necessary, for it is impossible to alter the laws of the mind as it is to change the laws of the universe.  
In Gaston Bachelard  
*The New Scientific Spirit*  
Introduction (p. 2)  
Beacon Press. Boston, Massachusetts, USA. 1984

**Broad, William** 1951–  
Science writer

**Wade, Nicholas**  
British-born scientific writer

Science is not an abstract body of knowledge, but man's understanding of nature. It is not an idealized interrogation of nature by dedicated servants of truth, but a human process governed by the ordinary human passions of ambition, pride, and greed, as well as by all the well-hymned virtues attributed to men of science.  
*Betrayers of the Truth* (p. 223)  
Simon & Schuster. New York, New York, USA. 1982

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Science is a very human form of knowledge. We are always at the brink of the known, we always feel forward for what is to be hoped.

*The Ascent of Man*

Knowledge or Certainty (p. 374)

Little, Brown & Co. Boston, Massachusetts, USA. 1973

**Brown, Samuel** 1817–56  
Chemist

Science is an ideal of the method of nature, and the production of that ideal is a true creation.

*Lectures on the Atomic Theory and Essays Scientific and Literary*

(Volume 1)

The History of Science (p. 299)

Thomas Constable & Co. Edinburgh, Scotland. 1858

**Burroughs, John** 1837–1921  
American naturalist and writer

Science is the critic and doctor of life, but never its inspirer. It enlarges the field of literature, but its aims are unlitrary. The scientific explanation of the great problems – life, mind, consciousness -seems strangely inadequate; they are like the scientific definition of light as vibrations or electric oscillations in the ether of space, which would not give a blind man much idea of light.

*Under the Apple-Trees*

Chapter XI (p. 196)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1916

Science is a capital or fund perpetually reinvested; it accumulates, rolls up, is carried forward by every new man. Every man of science has all the science before him to go upon, to set himself up in business with. What an enormous sum Darwin availed himself of and reinvested! Not so in literature; to every poet, to every artist, it is still the first day of creation, so far as the essentials of his task are concerned. Literature is not so much a fund to be reinvested as it is a crop to be ever new-grown.

*The Writings of John Burroughs* (Volume 17)

The Summit of the Years

In the Noon of Science (p. 64)

Houghton Mifflin Company. New York, New York, USA. 1913

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Science is being daily more and more personified and anthropomorphized into a god. By and by they will say that science took our nature upon him, and sent down his only begotten son, Charles Darwin, or Huxley, into the world so that those who believe in him, etc.; and they will burn people for saying that science, after all, is only an expression for our ignorance of our own ignorance.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Science (p. 233)

Jonathan Cape. London, England. 1951

**Buzzati-Traverso, Adriano** 1913–83  
Italian genetic scientist

Science is a game: it can be exhilarating, it can be useful, it can be frightfully dangerous. It is a play prompted by man's irrepressible curiosity to discover the universe and himself, and to increase his awareness of the world in which he lives and operates.

*The Scientific Enterprise, Today and Tomorrow*

Part I, Chapter 1 (p. 3)

UNES Company. Paris, France. 1977

**Calder, Ritchie** 1906–82  
Scottish journalist

Science is a river which the explorer may encounter at any point along its course. He can follow it either to its source or to its delta or both.

*Profile of Science*

Introduction (p. 13)

George Allen & Unwin Ltd. London, England. 1951

Science is the everlasting interrogation of Nature by Man.

*Man and the Cosmos: The Nature of Science Today*

Chapter I (p. 3)

Frederick A. Praeger, Publishers. New York, New York, USA. 1968

**Carnap, Rudolf** 1891–1970  
American philosopher

Science is a system of statements based on direct experience, and controlled by experimental verification. Verification in science is not, however, of single statements but of the entire system or sub-system of such statements.

Translated by M. Black

*The Unity of Science* (p. 42)

Kegan Paul, Trench, Trubner & Co. London, England. 1934

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

Science is the most important, the most magnificent, and the most necessary element of life.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Chernyshevsky, Nikolai Gavrilovich** 1828–89  
Russian socialist reformer

Science is the repository of the experience and thinking of the human race. It is mainly through science that the ideas, and then the morals and life of people, are improved.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Conant, James Bryant** 1893–1978  
American educator and scientist

[Science is] the activity of people who work in laboratories and whose discoveries have made possible modern industry and medicine.

*Science and Common Sense*

Chapter Two (p. 23)

Yale University Press. New Haven, Connecticut, USA. 1951

Science is an interconnected series of concepts and schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation.

*Science and Common Sense*

Chapter Two (p. 25)

Yale University Press. New Haven, Connecticut, USA. 1951

Science is a dynamic undertaking directed to lowering the degree of the empiricism involved in solving problems.

*Modern Science and Modern Man*

Science and Human Conduct (p. 62)

Columbia University Press. New York, New York, USA. 1952

**Cromer, Alan** 1935–

American physicist and educator

Science is overwhelmingly cumulative, not revolutionary, in its structure. This means that most of its established results – even those established recently – will be around forever. A particular result may be found to be an instance of a more general result, but its factualness, as far as it goes, will never change.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 1 (p. 6)

Oxford University Press, Inc. New York, New York, USA. 1993

Science is the heretical belief that the truth about the real nature of things is to be found by studying the things themselves.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 1 (p. 18)

Oxford University Press, Inc. New York, New York, USA. 1993

Science is the search for a consensus of rational opinion among all competent researchers.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 8 (pp. 143–144)

Oxford University Press, Inc. New York, New York, USA. 1993

**Cromie, William J.** 1930–

American journalist and writer

Science is not a mere “lump” of knowledge. It is disciplined thought, it is curiosity, it is creativity, it is the scientists themselves and the methods they use. It is the hope – the religion – that there is order in the universe; that man shall find that order; that someday he will be able to control the environment to which he is now little more than a slave. All this and more make up the dynamic, ever-changing whole called “science.”

*Exploring the Secrets of the Sea*

Conclusion (p. 280)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Science is the captain, practice the soldiers.

*Leonardo da Vinci's Note Books* (p. 54)

Duckworth & Company. London, England. 1906

**Davis, Watson** 1896–1967

No biographical data available

Science is a grand procession through the ages. Blaring trumpets, waving flags, and pomp are not its accompaniment. It travels the quieter roads of the intellect.

*The Advance of Science*

Chapter 32 (p. 375)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1934

**de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

Science is a cemetery of dead ideas, even though life may issue from them.

Translated by J.E. Crawford Flitch

*The Tragic Sense of Life in Men and in Peoples*

Chapter V (p. 90)

Macmillan & Company Ltd. London, England. 1921

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Science is cumulative knowledge. Each generation of scientists works to add to the treasury assembled by its predecessors. A discovery made today may not be significant or even comprehensible by itself, but it will make sense in conjunction with what was known before. Indeed this will usually have been necessary to its achievement.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1974

Advancement and Obsolescence in Science (p. 52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1974

**Durant, William James** 1885–1981

American historian and essayist

Science is the captured territory; and behind it are those secure regions in which knowledge and art build our imperfect and marvelous world.

*The Story of Philosophy*

Introduction (p. 2)

Simon & Schuster Paperback. New York, New York, USA. 2005

**Edelman, Gerald M.** 1929–

American biochemist and neuroscientist

Science is imagination in the service of the verifiable truth and that service is indeed communal. It cannot be rigidly planned. Rather, it requires freedom and courage and the plural contributions of many different kinds of people who must maintain their individuality while giving to the group.



*Les Prix Nobel. The Nobel Prizes in 1972*

Nobel banquet speech for award received in 1972

Nobel Foundation. Stockholm, Sweden. 1973

**Elliot, Hugh Samuel Roger** 1881–1930

No biographical data available

Our science is like a small candle set in the midst of infinite and pitchy darkness. It helps not at all in seeing things that are a million miles away; and even if we succeed in multiplying its light a million-fold, we shall still be no wiser as to space a trillion miles away, and we shall have approached no nearer the solution of infinite distance or the boundaries of space.

*Modern Science and Materialism*

Chapter I (p. 19)

Longmans, Green & Co. London, England. 1919

**Egler, Frank E.** 1911–96

American botanist and ecologist

Science is a product of man, of his mind; and science creates the real world in its own image.

*The Way of Science*

Science Concepts (p. 22)

Hafner Publishing Company. New York, New York, USA. 1970

**Einstein, Albert** 1879–1955

German-born physicist

Science is a wonderful thing if one does not have to earn one's living at it.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter to a California student March 24, 1951 (p. 57)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Elmer-Dewitt, Philip** 1949–

American writer and editor

Science is like a flashlight; what it illuminates depends on where it is pointed.

Don't Tread on My Lab

*Time*, January 24, 1994

**Farrar, Frederic William** 1831–1903

English clergyman and author

Science is the best teacher of accurate, acute, and exhaustive observation of what is; it encourages the habit of mind which will rest on nothing but what is true; truth is the ultimate and only object, and there is the ever-recurring appeal to facts as the test of truth.

*Essays on a Liberal Education* (2nd edition)

Essay Six (p. 251)

Macmillan & Co Ltd. London, England. 1868

**Feynman, Richard P.** 1918–88

American theoretical physicist

Science is a way to teach how something gets to be known, what is not known, to what extent things are known (for nothing is known absolutely), how to handle doubt and uncertainty, what the rules of evidence are, how to think about things so that judgments can be made, how to distinguish truth from fraud, and from show.

*The Problem of Teaching Physics in Latin America*

*Engineering and Science*, November, 1963

**Gill, Eric** 1882–1940

English sculptor

Science is analytical, descriptive, informative. Man does not live by bread alone, but by science he attempts to do so. Hence the deadliness of all that is purely scientific.

*It All Goes Together: Selected Essays* (p. 117)

The Devin-Adair Company. New York, New York, USA. 1944

**Glass, H. Bentley** 1906–2005

American geneticist

Science is not only to know, it is to do, and in the doing it has found its soul.

*Science and Ethical Values*

Chapter 3 (p. 101)

University of North Carolina Press. Chapel Hill, North Carolina, USA. 1965

**Gluckman, Max** 1911–75

English anthropologist

Science is cumulative. The apprentice in this generation can outdo his master of the last.

*Politics, Law & Ritual*

Chapter VII (p. 303)

Aldine Publishing Company. Chicago, Illinois, USA. 1965

**Gore, George** 1826–1909

English electrochemist

Science is the interpretation of nature, and man is the interpreter.

*The Art of Scientific Discovery*

Part I, Chapter I (p. 2)

Longmans, Green & Co. London, England. 1878

**Gorky, Maxim** 1868–1938

Russian writer

Science is becoming the nervous system of our time.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

Science is humanity's superior reason, the sun which man has created of his own flesh and blood and has lit to illuminate the darkness of his hard life and to show the way to freedom, justice, and beauty.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979



**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

All science is intelligent inference; excessive literalism is a delusion, not a humble bowing to evidence.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 12 (p. 156)

Random House, Inc. New York, New York, USA. 1995

Science is an integral part of culture. It's not this foreign thing, done by an arcane priesthood. It's one of the glories of the human intellectual tradition.

*Independent (London)*, January 24, 1990

**Gray, George W.**

Freelance science writer

Science is not only for illumination, for the mastery of nature's resources and the improvement of man's estate, it is also for the satisfaction of the soul.

*New World Picture*

Preface (p. x)

Little, Brown & Co. Boston, Massachusetts, USA. 1935

...science supremely is the art of entertaining doubts of beliefs experimentally accepted. No truth is sacrosanct. No belief is too generally approved, too well established by experiment, to escape the challenge of doubt. And no doubt is too radical to receive a hearing if it is seriously proposed.

*The Advancing Front of Science*

Chapter IV (p. 70)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1937

**Goth, Alan** 1947–

American physicist

...science is not merely a collection of facts, but is instead an ongoing detective story, in which scientists passionately search for clues in the hope of unraveling the mysteries of the universe.

*The Inflationary Universe; the Quest for a New Theory of Cosmic Origins*

Chapter 3 (p. 34)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

**Harare, José V.**

No biographical data available

**Bell, David F.**

No biographical data available

Science is the totality of the world's legends. The world is the space of their inscription. To read and to journey are one and the same act.

In Michel Sires

*Hermes: Literature, Science, Philosophy*

Introduction (p. xxi)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1982

**Harman, Willis**

No biographical data available

Science is all about cause. That's why you have science; you're trying to find the explanation, the causes, for the phenomena. Now, if really everything is connected to everything, if there really is only a oneness, everything then affects everything, and everything is the cause of everything in a certain sense, so that the whole idea of causality has to be revised.

*Thinking Allowed: Conversations on the Leading Edge of Knowledge and Discovery*

Metaphysics and Modern Science, Part I: Consciousness and Science

Thinking Allowed Productions. Berkeley, California, USA.

**Harrington, John W.**

American geologist

Science is the progressive discovery of the nature of nature.

*Dance of the Continents*

The Lure of the Hunt (p. 30)

J.P. Archer. Los Angeles, California, USA. 1983

**Harvey, Moses** 1820–1901

Irish clergyman, essayist, and naturalist

In its largest sense, Science is the interpretation of the great volume of nature, whose author is God. To the finite mind of man that volume presents difficulties, perplexities, mysteries, partly because of the vastness of the plan on which it is projected, and partly because of the feebleness of that human intelligence which attempts to penetrate its secrets. It is a sealed volume: and only by patient study, and humble labour can the mystic seals be unloosed.

Science and Religion

*The Maritime Monthly*, Volume II, Number 5, November, 1873 (p. 478)

**Henry, Joseph** 1797–1878

Scottish-born American scientist

...science is the pursuit above all which impresses us with the capacity of man for intellectual and moral progress and awakens the human intellect to aspiration for a higher condition of humanity.

Inscription on the National Museum of American History, Washington, D.C.

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Science is the knowledge of many, orderly and methodically digested and arranged, so as to become attainable to one.

*The Cabinet of Natural Philosophy*

Part I, Chapter II, Section 13 (p. 18)

Longman, Rees, Orme, Brown & Green. London, England. 1831

Science is of no party. Under the government, whether of Whig or Tory, she has often had to complain of the difficulty of making herself heard in recommendation of her objects; but those objects once recognized by a British government, are taken up in a spirit and with a liberality which ensures success, if success be possible.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*  
 Terrestrial Magnetism (pp. 112–113)  
 Longman, Brown, Green, Longmans & Roberts. London, England. 1857

Science is the knowledge of many, orderly and methodically digested and arranged, so as to become attainable by one.

*A Preliminary Discourse on the Study of Natural Philosophy*  
 Chapter II (p. 18)  
 Longman, Rees, Orme, Brown & Green. London, England. 1831

**Herzen, Aleksandr** 1812–70

Russian political author

Science is a table abundantly laid for every man whose hunger is great enough, whose craving for spiritual nourishment has grown sufficiently insistent.

*Selected Philosophical Works*  
 Dilettantism in Science (p. 58)  
 Foreign Languages Publishing House. Moscow, Russia. 1956

Science is strength; it shows the relations of things, their laws and interactions.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
 Translated by Vic Schneiersson  
 Progress Publishers. Moscow, Russia. 1979

**Hill, Alexander**

No biographical data available

Science is a synonym of knowledge ...

*Introduction to Science*  
 Chapter I (p. 2)  
 The Macmillan Co. New York, New York, USA. 1900

Science is knowledge in perspective. It is knowledge viewed down the vista of time: not an aggregation of facts presented simultaneously to the intellect, but a sequence of facts successively ascertained and placed in proper relation with all that was previously known.

*Introduction to Science*  
 Chapter I (p. 2)  
 The Macmillan Co. New York, New York, USA. 1900

Science is learning with understanding.

*Introduction to Science*  
 Chapter I (pp. 2–3)  
 The Macmillan Co. New York, New York, USA. 1900

**Hitler, Adolf** 1889–1945

Chancellor of Germany

Science is a social phenomenon, and like every other social phenomenon is limited by the injury or benefit it confers on the community.... The idea of free and unfettered science... is absurd.

In Hermann Rauschning  
*Hitler Speaks: A Series of Political Conversations with Adolf Hitler on His Real Aims* (pp. 220–221)  
 Butterworth. London, England. 1939

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Science is the topography of ignorance. From a few elevated points we triangulate vast spaces, inclosing infinite unknown details.

*The Writings of Oliver Wendell Holmes* (Volume 9)  
*Border Lines in Medical Science* (p. 211)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1891–1906

**Holton, Gerald** 1922–

Research professor of physics and science history

**Roller, Duane H. D.** ?–1994

Science historian

Science is an ever-unfinished quest to discover facts and establish relationships between them.

*Foundations of Modern Physical Science*  
 Chapter 13 (p. 214)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Science is ignorant, and has no right to laugh: a *savant* who laughs at the possible, is very near being an idiot.

Translated by Melville Best Anderson  
*William Shakespeare*  
 Part I, Book I, Chapter V (p. 38)  
 A.C. McClurg & Co. Chicago, Illinois, USA. 1887

**Huizinga, Johan** 1872–1945

Dutch historian

...that all science is merely a game can be easily discarded as a piece of wisdom too easily come by. But it is legitimate to enquire whether science is not liable to indulge in play within the closed precincts of its own method. Thus, for instance, the scientist's continuous penchant for systems tends in the direction of play.

*Homo Ludens*  
 Chapter XI (p. 203)  
 Roy Publishers. New York, New York, USA. 1950

**Huxley, Aldous** 1894–1963

English writer and critic

Science is angling in the mud – angling for immortality and for anything else that may happen to turn up.

*After Many a Summer Dies the Swan*  
 Part II, Chapter 6 (p. 179)  
 Harper & Row Publishers. New York, New York, USA. 1965

**Jacks, L. P.** 1860–1955

English educator, philosopher, and Unitarian minister

Science is never static, never stagnant, never content with the boundary it has reached. It is always dynamic, always breaking bounds.... Science...abhors a limitation....

Is There a Foolproof Science?  
*The Atlantic Monthly*, February, 1924 (p. 231)

Science is the pursuer, life is the pursued....

Is There a Foolproof Science?

*The Atlantic Monthly*, February, 1924 (p. 238)

**Jeffers, Robinson** 1887–1962

American poet

Science is not to serve but to know. Science is for itself its own value, it is not for man...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 291)

Stanford University Press. Stanford, California. USA. 1988

Science is an adoration; a kind of worship.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 292)

Stanford University Press. Stanford, California. USA. 1988

**Kafka, Franz** 1883–1924

German-language novelist

All science is methodology with regard to the Absolute. Therefore, there need be no fear of the unequivocally methodological. It is a husk, but not more than everything except the One.

*Dearest Father: Stories and Other Writings*

The Blue Octavo Notebooks

The Third Notebook

October 18, 1917

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Science is bound by the everlasting law of honour, to face fearlessly every problem which can fairly be presented to it. If a probable solution, consistent with the ordinary course of nature, can be found, we must not involve the abnorm act of Creative Power.

*Popular Lectures and Addresses* (Volume 2)

Presidential Address to the British Association, Edinburgh, 1871

(pp. 199–200)

Macmillan & Company Ltd. London, England. 1894

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Science is destined to appear as the child and the parent of freedom blessing the earth without design. Not in the ground of need, not in bent and painful toil, but in the deep-centered play-instinct of the world, in the joyous mood of the eternal Being, her spirit, which is always young, Science has her origin and root; and her spirit, which is the spirit of genius in moments of elevation, is but a sublimated form of play, the austere and lofty analogue of the kitten playing with the entangled skein...

*Mathematics* (p. 44)

Columbia University Press. New York, New York, USA. 1907

**Kliuchevsky, V. O.** 1841–1911

Russian historian

Science is often identified with knowledge. This is a gross misunderstanding. Science is not merely knowledge, but also consciousness, that is, the skill of properly using knowledge.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierston

Progress Publishers. Moscow, Russia. 1979

**Knight, David**

No biographical data available

Most science is a very ordinary human activity not so very far removed from painting by numbers.

*Ideas in Chemistry: A History of the Science*

Introduction (p. 6)

Athlone. London, England. 1992

**Knuth, Donald E.** 1938–

Creator of TeX

Science is what we understand well enough to explain to a computer, Art is all the rest.

In Marko Petkovsek, Herbert S. Wilf and Doron Zeilberger

*A=B*

Foreword

A.K. Peters. Wellesley, Massachusetts, USA. 1996

**Kofahl, R. E.**

No biographical data available

Science is human experience systematically extended (by intent, methodology and instrumentation) for the purpose of learning more about the natural world and for the critical empirical testing and possible falsification of all ideas about the natural world. Scientific hypotheses may incorporate only elements of the natural empirical world, and thus may contain no element of the supernatural.

Correctly Redefining Distorted Science; A Most Essential Task

*Creation Research Society Quarterly*, Volume 23, 1986 (p. 112)

**Kosso, Peter**

No biographical data available

Science is like a microscope, and nature is the specimen.

*Appearance and Reality: An Introduction to the Philosophy of Physics*

Chapter 8 (p. 178)

Oxford University Press. Oxford, England. 1998

**Krauss, Lawrence M.** 1954–

American theoretical physicist

Science is based on limits: It proceeds by progressively finding out what is not possible, through experiment and theory, in order to determine how the universe might really function. It is worth recalling Sherlock Holmes's adage that when you have eliminated all other possibilities, whatever remains, no matter how improbable, is the truth. Because of this, the universe is a pretty remarkable place even without all the extras. The greatest gift science has bestowed upon humanity, in my opinion, is the

knowledge that whether we like it or not, the universe is the way it is.

*Beyond Star Trek: Physics from Alien Invasions to the End of Time*

Epilogue (p. 173)

Basic Books, Inc. New York, New York, USA. 1997

### **Larrabee, Eric** 1922–90

Historian

Science is a – what? a method, a faith, a body of facts, a structure of theories, an institution, a way of life, a finite number of duly qualified individuals, an infinity of relevance and possibility. For a large number of scientists, science is indescribable, but indisputably a thing: it is knowable, palpable, reliable, usable. They live with it and by it; it is simply and unequivocally there.

Commentary

*Science and the Common Reader*, June, 1966 (p. 43)

### **Leary, Timothy** 1920–96

American psychologist and educator

Science is all metaphor.

*Contemporary Authors*, Volume 107

### **Lewes, George Henry** 1817–78

English philosopher

Science is the systematic classification of Experience.

*The Physical Basis of Mind*

Problem I, Chapter I (p. 4)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1891

### **Lysaght, Sidney Royse** 1860–1941

Irish writer

Science is the lamp which man has himself kindled; it has built him light-houses on the dark shores of the unknown: but his dreams, his quests of truth lead him beyond the waters which his little lamp of knowledge illumines ...

*A Reading of Life*

Chapter II (p. 54)

Macmillan & Company Ltd. London, England. 1936

### **March, Robert H.** 1937–

American professor of physics

Science is more than a mere attempt to describe nature as accurately as possible. Frequently the real message is well hidden, and a law that gives a poor approximation to nature has more significance than one which works fairly well but is poisoned at the root.

*Physics for Poets*

Chapter I (p. 17)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1996

### **Muller, Herbert Joseph** 1905–80

American historian and educator

Although science is no doubt the Jehovah of the modern world, there is considerable doubt about the glory of its handiwork.

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*

Chapter III (p. 59)

G. Braziller. New York, New York, USA. 1943

### **Newton, Roger G.**

Physics professor and author

Science is, in fact, an intricate edifice erected from complex, imaginative designs in which esthetics is a more powerful incentive than utility. Beauty, finally, comprises its greatest intellectual appeal.

*What Makes Nature Tick?*

Epilogue (p. 236)

Harvard University Press. Cambridge, Massachusetts, USA. 1993

### **O'Malley, Austin** 1858–1932

American physician and humorist

Science is truth with her wings clipped.

*Thoughts of a Recluse*

God and Religion (p. 109)

D.H. McBride & Co. Chicago, Illinois, USA. 1898

### **O'Neill, John J.**

No biographical data available

Science is like the expanding universe in which, according to a tentative theory of the astronomers, all the stars and all of the galaxies, in all directions, are moving away from the earth. As each science becomes more complex, it moves further from the common understanding.... Like the stars, each science as it makes further progress into the unknown becomes further separated from its neighbors, and faces the danger of being isolated in a limited universe of its own.

*You and the Universe*

Foreword (p. 3)

Ives Washburn, Inc. New York, New York, USA. 1946

### **Pearson, Karl** 1857–1936

English mathematician

'That all science is description and not explanation, that the mystery of change in the inorganic world is just as great and just as omnipresent as in the organic world, are statements which will appear platitudes to the next generation.

*The Grammar of Science*

Preface to the Second Edition (p. vii)

Adam & Charles Black. London, England. 1900

### **Poincaré, Lucien** 1862–1920

French physicist

Science is in some sort a living organism, which gives birth to an indefinite series of new beings taking the places of the old, and which evolves according to the nature of its environment, adapting itself to external conditions, and healing at every step the wounds which contact with reality may have occasioned.

*The New Physics and Its Evolution*

Chapter I (p. 6)

D. Appleton & Co. New York, New York, USA. 1908

**Porterfield, Austin L.**

No biographical data available

Science, in the broadest sense, is the entire body of the most accurately tested, critically established, systematized knowledge available about that part of the universe which has come under human observation. For the most part this knowledge concerns the forces impinging upon human beings in the serious business of living and thus affecting man's adjustment to and of the physical and the social world.... Pure science is more interested in understanding, and applied science is more interested in control...

*Creative Factors in Scientific Research*

Chapter II (p. 11)

Duke University Press. Durham, North Carolina, USA. 1941

**Pratt, C. C.**

No biographical data available

Science is a vast and impressive tautology.

*The Logic of Modern Psychology*

Chapter VI (p. 154)

The Macmillan Company. New York, New York, USA. 1939

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

**Stengers, Isabelle** 1949–

Belgian philosopher

Science is part of the Darwinian struggle for life. It helps us to organize our experience. It leads us to economy of thought. Mathematical laws are nothing more than conventions useful for summarizing the results of possible experiments.

*Order Out of Chaos*

Chapter III Ignoramus, Ignoramibus (p. 97)

Bantam Books. New York, New York, USA. 1984

**Quine, Willard van Orman** 1908–2000

American logician and philosopher

Science is like a boat, which we rebuild plank by plank while staying afloat in it. The philosopher and the scientist are in the same boat.

In George Johnson

*In the Palaces of Memory: How We Build the World Inside Our Heads*

The End of Philosophy (p. 222)

Alfred A. Knopf. New York, New York, USA. 1991

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

Science is a great game. It is inspiring and refreshing. The playing field is the universe itself.

*New York Times*, October 28, 1964 (p. 38)

**Randi, James** 1928–

Canadian magician and scientific skeptic

I believe that science is best defined as a careful, disciplined, logical search for knowledge about any and

all aspects of the universe, obtained by examination of the best available evidence and always subject to correction and improvement upon the discovery of better evidence.

What's left is magic, and it doesn't work.

*The Mask of Nostradamus*

Chapter Five (p. 66)

Prometheus Books. Buffalo, New York, USA. 1993

**Raymo, Chet** 1936–

American physicist and science writer

...science is a spider's web. Confidence in any one strand of the web is maintained by the tension and resiliency of the entire web.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 16 (p. 144)

The Viking Press. New York, New York, USA. 1991

**Renan, Ernest** 1823–92

French philosopher and Orientalist

...science is a religion, science alone will henceforth make the creeds, science alone can solve for men the eternal problems, the solutions of which his nature imperatively demands.

*The Future of Science*

Chapter V (p. 97)

Roberts Brothers. Boston, Massachusetts, USA. 1893

**Russell, Bertrand Arthur William** 1872–1970

English philosopher

Science is in its essence nothing but the systematic pursuit of knowledge, and knowledge, whatever ill-uses bad men may make of it, is in its essence good. To lose faith in knowledge is to lose faith in the best of man's capacities; and there if repeat unhesitatingly that the unyielding rationalist has a better faith and a more unbending optimism than any other of the timid seekers after the childish comforts of a less adult age.

*The Scientific Outlook*

Chapter V (p. 138)

George Allen & Unwin. London, England. 1931

**Sagan, Carl** 1934–96

American astronomer and author

Science is an attempt, largely successful, to understand the world, to get a grip on things, to get hold of ourselves, to steer a safe course. Microbiology and meteorology now explain what only a few centuries ago was considered sufficient cause to burn women to death.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 26)

Random House, Inc. New York, New York, USA. 1995

Science is far from a perfect instrument of knowledge. It's just the best we have.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 27)

Random House, Inc. New York, New York, USA. 1995



Science is much more than a body of knowledge. It is a way of thinking. This is central to its success. Science invites us to let the facts in, even when they don't conform to our preconceptions. It counsels us to carry alternative hypotheses in our heads and see which best match the facts. It urges on us a fine balance between no-holds-barred openness to new ideas, however heretical, and the most rigorous skeptical scrutiny of everything – new ideas and established wisdom.

Why We Need to Understand Science  
*Parade Magazine*, September 10, 1989

**Sandage, Allan** 1926–  
American astronomer

Science is the only self-correcting human institution, but it also is a process that progresses only by showing itself to be wrong.

In Alan Lightman and Roberta Brawer  
*Origins: The Lives and Worlds of Modern Cosmologists*  
Allan Sandage (p. 82)  
Harvard University Press. Cambridge, Massachusetts, USA. 1990

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952  
Spanish-born American philosopher

Science is nothing but developed perception, interpreted intent, common sense rounded out and minutely articulated.

*The Life of Reason: Or, The Phases of Human Progress*  
Chapter XI (p. 307)  
Charles Scribner's Sons. New York, New York, USA. 1906

Science is a half-way house between private sensation and universal vision.

*The Life of Reason; or The Phases of Human Progress*  
Part V, Chapter I (p. 385)  
Charles Scribner's Sons. New York, New York, USA. 1953

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

Science is neither philosophy, nor religion, nor art; it is the totality of positive knowledge, as closely knit as possible; it is as different from its practical applications on the one hand, as it is from idle theorizing and blind faith on the other. It behooves us to make no extravagant claims for it, and to be as humble as we can.

*The History of Science and the New Humanism*  
Chapter III (p. 133)  
H. Holt & Co. New York, New York, USA. 1931

**Schwartz, John** 1941–  
American theoretical physicist

Science is a long movie, and the news media generally take mere snapshots.

If You Seek the Truth, Don't Trash the Science  
*Washington Post*, 21 February, 1999 (p. B-1)

**Sharma, Jaipuria**  
No biographical data available

**Sharma, Pt. Gopal**  
No biographical data available

**Rao, Poornachandra**  
No biographical data available

Science is an ocean and research is the exploration of that ocean to find out the hidden treasures of facts.

*Vaastu* (p. 28)  
Lotus Press. New Delhi, India. 2007

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Science is always simple and always profound. It is only the half-truths that are dangerous.

*The Doctor's Dilemma*  
Act I (p. 24)  
Brentano's. New York, New York, USA. 1920

**Smith, Adam** 1723–1790  
Scottish moral philosopher and founder of modern economic theory

Science is the great antidote to the poison of enthusiasm and superstition.

*An Inquiry into the Nature and Causes of the Wealth of Nations*  
Book V, Chapter I, part III, Section III (p. 748)  
The Modern Library. New York, New York, USA. 1937

**Smolin, Lee** 1955–  
American theoretical physicist

Science is, above everything else, a search for an understanding of our relationship with the rest of the universe.

*The Life of the Cosmos*  
Part One, Chapter One (p. 23)  
Oxford University Press, Inc. New York, New York, USA. 1997

**Soddy, Frederick** 1877–1956  
English chemist

Amid all the sneers at the impracticability and visionary character of communist schemes, let it not be forgotten that science is a communism, neither theoretical nor on paper, but actual and in practice. The results of those who labour in the fields of knowledge for its own sake are published freely and pooled in the general stock for the benefit of all. Common ownership of all its acquisitions is the breath of its life. Secrecy or individualism of any kind would destroy its fertility.

*Science and Life: Aberdeen Addresses*  
Science and Life (pp. 2–3)  
E.P. Dutton & Co. New York, New York, USA. 1920

**Spencer, Herbert** 1820–1903  
English social philosopher

Paraphrasing an Eastern fable, we may say that in the family of knowledges, Science is the household drudge, who, in obscurity, hides unrecognized perfections. To her



has been committed all the work; by her skill, intelligence and devotion, have all the conveniences and gratifications been obtained; and while ceaselessly occupied ministering to the rest, she has been kept in the background, that her haughty sisters might flaunt their fripperies in the eyes of the world. The parallel holds yet further. For we are fast coining to the *denouement*, when the positions will be changed; and while these haughty sisters sink into merited neglect, Science, proclaimed as highest alike in worth and beauty, will reign supreme.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 82)

Willard Small. Boston, Massachusetts, USA. 1890

Science is organized knowledge; and before knowledge can be organized, some of it must first be possessed. Every study, therefore, should have a purely experimental introduction; and only after an ample fund of observations has been accumulated, should reasoning begin.

*Education: Intellectual, Moral, and Physical*

Chapter II (p. 124)

D. Appleton & Co. New York, New York, USA. 1891

All Science is prevision; and all prevision ultimately aids us in greater or less degree to achieve the good and avoid the bad. As certainly as the perception of an object lying in our path warns us against stumbling over it; so certainly do those more complicated and subtle perceptions which constitute Science, warn us against stumbling over intervening obstacles in the pursuit of our distant ends.

*First Principles of a New System of Philosophy*

Chapter I (p. 19)

D. Appleton & Co. New York, New York, USA. 1865

### **Sterne, Laurence** 1713–68

English novelist and humorist

Science is intelligent curiosity, an organized thinking replacing a primitive wonder.

*Man and the Stars*

Chapter I (p. 4)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1930

### **Stewart, Ian** 1945–

English mathematician and science writer

Science is a collective activity, and the actions of each individual resonate and interact with those of the others in a pattern so gigantic that we can no more comprehend the whole than a blood cell can comprehend how its host feels when it mashes a finger in a car door.

*The Problems of Mathematics*

Chapter 20 (p. 234)

Oxford University Press, Inc. Oxford, England. 1987

### **Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Science is one of the pathways toward the truth, but there are other pathways.

The New World of Science

*The Atlantic Monthly*, June, 1930

Science is a particular way of looking at the world, but it is not the only way.

The New World of Science

*The Atlantic Monthly*, June, 1930

Science is a kind of knowledge which gives descriptions and laws reached by observation and experiment. It is not the only kind of knowledge, it is not the only pathway towards truth – but it is indispensable.

In Francis Mason (ed.)

*The Great Design*

Introduction (p. 13)

The Macmillan Co. New York, New York, USA. 1934

Science is always setting forth on Columbus voyages, discovering new worlds and conquering them by understanding. For Knowledge means Foresight and Foresight means Power.

*The Outline of Science: A Plain Story Simply Told*

Introduction (p. 3)

G.P. Putnam's Sons. New York, New York, USA. 1922

Science is frankly empirical in method and aim; it seeks to discover the laws of concrete being and becoming, and to formulate these in the simplest terms, which are either immediate data of experience or verifiably derived therefrom.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 39)

William & Norgate. London, England. 1920

### **Thorne, Kip S.** 1940–

American theoretical physicist

Science is a community enterprise. The insights that shape our view of the Universe come not from a single person or a small handful, but from the combined efforts of many.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 18)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

### **Titchener, Edward Bradford** 1867–1927

English-born American psychologist

If science is curiosity, therefore, it is the curiosity which pierces the overlay of interpretation to arrive at sheer existence; if it is love of truth, then truth is the face its objects wear to themselves and their kind and the man who identifies himself with them, and science seeks to know that face; if it is a passion for facts, then facts are the materials of a world scoured clean of belief and inference and all such evaluative accretion, and science aims to explore this world.

*Systematic Psychology: Prolegomena*

Chapter I (p. 32)

The Macmillan Co. New York, New York, USA. 1929

**Toynbee, Arnold J.** 1852–83  
English historian

There have been many definitions of the word “science.” Perhaps the most generally accepted one is that science is a form of study in which there can be an exact knowledge of the present and the past and, through this, an infallible prediction of the future. If this is what science means, then no study made by a human mind can be completely scientific.

*Occasional Paper, The Institute for the Study of Science in Human Affairs*

Science in Human Affairs: An Historian’s View

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Science is as sorry as you are that this year’s science is no more like last year’s science than last year’s was like the science of twenty years gone by. But science cannot help it. Science is full of change. Science is progressive and eternal. The scientists of twenty years ago laughed at the ignorant men who had groped in the intellectual darkness of twenty years before. We derive pleasure from laughing at them.

*Collected Tales, Sketches, Speeches, and Essays 1852–1890* (Volume 1)  
A Brace of Brief Lectures on Science (p. 538)

The Library of America. New York, New York, USA. 1992

**Urey, Harold Clayton** 1893–1981

American chemist

To those of us who spend our lives working on scientific problems, science is a great intellectual adventure of such interest that nothing else we ever do can compare with it. We are attempting to understand the order of a physical universe, vast in extent in space and time, and most complicated and beautiful in its details.

In Shirley Thomas

*Men of Space. Profiles of the Scientists Who Probe for Life in Space* (Volume 6)

Harold C. Urey (p. 212)

Chilton Books. Philadelphia, Pennsylvania, USA. 1963

**Vernadskii, Vladimir Ivanovich** 1863–1945

Russian mineralogist

Science is alone and the routes to its achievement are alone. They are independent from the ideas of man, from his aspirations and wishes, from the social tenor of his life, from his philosophical, social, and religious theories. They are independent from his will and from his world outlook – they are primordial.

In Loren R. Graham

*The Soviet Academy of Sciences and the Communist Party, 1927–1932*  
Chapter III (p. 80)

Princeton University Press. Princeton, New Jersey, USA. 1967

**von Baer, Carl Ernst** 1792–1876

Prussian-Estonian biologist

Science...is, in its source, eternal; in its operation, not limited by time and space; in its scope, immeasurable; in its problem, endless; in its goal, unattainable.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 53)

Macmillan & Company Ltd. London, England. 1918

**von Frisch, Karl** 1886–1982

Austrian ethnologist

Science is eternal in its out-gushing stream, bounded by neither time nor space, immeasurable in its activity, endless in its scope, its final goal ever unreachd.

Quoted in Martin Gumpert

*Trail Blazers of Science* (p. 1)

Funk & Wagnalls. New York, New York, USA. 1936

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Science is the labor of mind applied to nature...

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 76)

Harper & Brothers. New York, New York, USA. 1869

**von Liebig, Justus** 1803–73

German organic chemist

Science is conservative in her nature, not destructive. She does not reject the truths discovered by practice, but receives them; they are never disputed by her, but are examined and receive from her their proper import and further application. Science, therefore, can produce no revolution in practice; but she leads the way to a series of progressive developments, which are evolved in natural sequence from each other.

In John Blyth

*Letters on Modern Agriculture*

Letter XII (p. 233)

Walton & Maberly. London, England. 1859

Science is the organized attempt of mankind to discover how things work as causal systems.

*The Scientific Attitude*

Forward (p. 9)

Penguin Books. Middlesex, England. 1941

**Weil, Simone** 1909–43

French philosopher and mystic

Science is voiceless; it is the scientist who talks.

*On Science, Necessity, and the Love of God*

Reflections on Quantum Theory (p. 57)

Oxford University Press, Inc. London, England. 1968

Science is today regarded by some as a mere catalogue of technical recipes, and others as a body of pure intellectual speculations which are sufficient unto themselves; the former set too little value on the intellect, the latter on the world.

Translated by Arthur Wills and John Petrie

*Oppression and Liberty*

Theoretical Picture of a Free Society (pp. 104–105)

Routledge & Kegan Paul Ltd. London, England. 1958

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science is curiosity, discovering things and asking why.

*The Privilege of Being a Physicist*  
Chapter 4 (p. 31)

W.H. Freeman & Company, New York, New York, USA. 1989

Science is like a tree in which the basic sciences make up the trunk, the older ones at the base, the newer, more esoteric ones at the top where growth into new areas takes place. The branches represent the applied activities. The lower, larger ones correspond to the applied sciences that emerged from older basic sciences; the higher, smaller ones are the outgrowth of more recent basic research. The top of the trunk, the frontier of basic research, has not yet developed any branches.

The Significance of Science

*Science*, Volume 176 March, 1972 (p. 146)

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Science is a match that man has just got alight. He thought he was in a room – in moments of devotion, a temple – and that his light would be reflected from and display walls inscribed with wonderful secrets and pillars carved with philosophical systems wrought into harmony. It is a curious sensation, now that the preliminary splutter is over and the flame burns up clear, to see his hands and just a glimpse of himself and the patch he stands on visible, and around him, in place of all that human comfort and beauty he anticipated – darkness still.

The Rediscovery of the Unique

*The Fortnightly Review*, New Series 50, July 1891

**White, Leslie Alvin** 1900–75  
American anthropologist

Science is sciencing.

Science Is Sciencing

*Philosophy of Science*, Volume 5, 1938

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Science is simply setting out on a fishing expedition to see whether it cannot find some procedure which it can call the measurement of space and some procedure which it can call the measurement of time, and something which it can call a system of forces, and something which it can call masses, so that these formulae may be satisfied. The only reason – on this theory – why anyone should want to satisfy these formulae is a sentimental regard for Galileo, Newton, Euler and Lagrange. The theory, so far from founding science on a sound observational basis, forces everything to conform to a mere mathematical preference for certain simple formulae.

*The Concept of Nature*

Chapter VI (pp. 139–140)

Cambridge University Press, Cambridge, England. 1926

Science is in the minds of men, but men sleep and forget, and at their best in any one moment of insight entertain but scanty thoughts. Science therefore is nothing but a confident expectation that relevant thoughts will occasionally occur.

*An Enquiry Concerning the Principles of Natural Knowledge*

Part I, Chapter I (p. 10)

At The University Press, Cambridge, England. 1919

Science is either an important statement of systematic theory correlating observations of a common world or is the daydream of a solitary intelligence with a taste for the daydream of publication.

*Process and Reality: An Essay in Cosmology*

Part IV, Chapter V, Section IV (p. 502)

The Macmillan Company, New York, New York, USA. 1929

Science is even more changeable than theology.

*Science and the Modern World*

Chapter XII (p. 183)

The Macmillan Company, New York, New York, USA. 1929

Science is concerned with the facts of bygone transition. History relates the aim at ideals. And between Science and History, lies the operation of the Deistic impulse of energy. It is the religious impulse in the world which transforms the dead facts of Science into the living drama of History. For this reason Science can never foretell the perpetual novelty of History.

*Modes of Thought*

Chapter II, Lecture Five (p. 142)

The Macmillan Company, New York, New York, USA. 1938

Science is the organisation of thought.

*The Organisation of Thought*

Chapter VI (p. 106)

Greenwood Press Publishers, Westport, Connecticut, USA. 1974

Science is a river with two sources, the practical source and the theoretical source. The practical source is the desire to direct our actions to achieve predetermined ends.... The theoretical source is the desire to understand.

*The Organisation of Thought*

Chapter VI (p. 106)

Greenwood Press Publishers, Westport, Connecticut, USA. 1974

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Science is out of the reach of morals, for her eyes are fixed upon eternal truths.

*The Works of Oscar Wilde* (Volume 10)

*Intentions*

The Critic as Artist, Part 2 (p. 394)

AMS Press, New York, New York, USA. 1909

**Willmott, Robert Eldridge Aris** 1809–63

English writer and poet

Science is not embraced in the pleasures of literature.

*Pleasures, Objects, and Advantages, of Literature* (4th edition)

Chapter I (p. 2)

G. Routledge & Co. London, England. 1855

**Winchell, Alexander** 1824–91

American geologist

Science is an indefatigable reaper; but how many tares do we find bound up with the wheat! How many exploded theories have left their wrecks along the highway of time! How many abandoned explanations and beliefs lie scattered by the way-side!

*Reconciliation of Science and Religion*

Chapter I (pp. 29–30)

Harper & Brothers Publishers. New York, New York, USA. 1877

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Man has to awaken to wonder – and so perhaps do peoples. Science is a way of sending him to sleep again.

Translated by Peter Winch

*Culture and Value* (p. 5e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wood, Theodore**

No biographical data available

Science is no longer a mere accumulation of dry facts, complicated by pedantic and often meaningless phraseology, but has been proved capable of affording instruction and interest not only to the few, but to the many.

*Our Insect Allies*

Chapter II (p. 25)

Society for Promoting Christian Knowledge. London, England. 1884

**Zinsser, Hans** 1878–1940

American bacteriologist

Science is but a method. Whatever its material, an observation accurately made and free of compromise to bias and desire, and undeterred by consequence, is science.

Untheological Reflections

*The Atlantic Monthly*, July 1929 (p. 91)

**SCIENTIFIC****Author undetermined**

This semi-scientific balderdash is wonderfully like what one reads in the old recipes against witchcraft, or as an introduction to the remedies of quack doctors.

Spitiy Circles and How to Move in Them

*Chamber's Edinburgh Journal*, Number 487, April 26, 1873 (p. 259)

**Balfour, Arthur James** 1848–1930

English prime minister

Now whether the main outlines of the world-picture which I have just imperfectly presented to you be des-

tinued to survive, or whether in their turn they are to be obliterated by some new drawing on the scientific palimpsest, all will, I think, admit that so bold an attempt to unify physical nature excites feelings of the most acute intellectual gratification. The satisfaction it gives is almost esthetic in its intensity and quality. We feel the same sort of pleasurable shock as when from the crest of some melancholy pass we first see far below us the sudden glories of plain, river and mountain.

Reflections Suggested by the New Theory of Matter

*Popular Science Monthly*, Volume 65, Number 6, October, 1904 (p. 501)

**Buchner, Eduard** 1860–1917

German chemist

The work on which I have to report lies on the boundary between animate and inanimate nature. I therefore have reason to hope that I can interest not only the chemists but also the wide circles of all those who follow the advance of biological science with close attention. It is difficult, however, for a person to be comprehensible and at the same time remain scientific, so I must ask you to bear with me.

*Nobel Lectures, Chemistry 1901–1921*

Cell-Free Fermentation

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Calder, Ritchie** 1906–82

Scottish author, journalist, and academic

“Science” and “Scientific” have become overcharged terms because they have been given an arrogance (often by the scientists themselves) or a huckster quality (by mendacious modern advertising) or a magical quality (because the language has become an abracadabra to the layman).

*Man and the Cosmos: The Nature of Science Today*

Chapter I (p. 4)

Frederick A. Praeger, Publishers. New York, New York, USA. 1968

**Newell, Lyman C.**

Chemist

The word *scientific* is often applied to a doctrine, principle, or opinion as a compliment. The word has a good reputation, judging from its generous use. It must be admitted, however, that it is often used with a vague conception of its significance.

The Spirit of Science

*Mind*, Volume 7, Number 1, October, 1900 (p. 5)

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The kernel of the scientific outlook is a thing so simple, so obvious, so seemingly trivial, that the mention of it may almost excite derision. The kernel of the scientific outlook is the refusal to regard our own desires, tastes, and interests as affording a key to the understanding of the world.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 42)

Longmans, Green & Co. London, England. 1919

**Shaw, George Bernard** 1856–1950  
Irish playwright

The notion that therapeutics or hygiene or surgery is any more or less scientific than making or cleaning boots is entertained only by people to whom a man of science is still a magician who can cure diseases, transmute metals, and enable us to live forever.

*The Doctor's Dilemma*

Preface (p. 78)

Penguin Books. Baltimore, Maryland, USA. 1954

**Shelley, Mary Wollstonecraft** 1797–1851  
English Romantic writer

In other studies you go as far as others have gone before you, and there is nothing more to know; but in a scientific pursuit there is continual food for discovery and wonder. A mind of moderate capacity, which closely pursues one study, must infallibly arrive at great proficiency in that study...

*Frankenstein: Or, The Modern Prometheus*

Chapter III (p. 68)

George Routledge & Sons. London, England. 1891

**Spencer, Herbert** 1829–1903  
English social philosopher

...those who have never entered upon scientific pursuits know not a tithe of the poetry by which they are surrounded. "Whoever has not in youth collected plants and insects, knows not half the halo of interest which lanes and hedge-rows can assume. Whoever has not sought for fossils, has little idea of the poetical associations that surround the places where imbedded treasures were found. Whoever at the seaside has not had a microscope and aquarium, has yet to learn what the highest pleasures of the seaside are.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 83)

D. Appleton & Co. New York, New York, USA. 1891

## SCIENTIFIC ADVANCE

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

...as a general thing every scientific advance, every new problem elucidated, every extension or enrichment of our knowledge of facts, affords a better foundation for practical pursuits.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On Some Phenomena Attending the Flight of Projectiles (p. 327)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

## SCIENTIFIC AGE

**Sedgwick, William T.** 1855–1921  
American bacteriologist

One of the most fruitful sequels of the scientific age has been the new and higher valuation which it places upon ordinary human life.

*The Call to Public Health*

*Science*, New Series, Volume 28, Number 711, August 14, 1908 (p. 193)

## SCIENTIFIC ANALYSIS

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

...the habit of scientific analysis...exhausts the material offered to it...

Translated by Humphry Ward

*Amiel's Journal: The Journal Intime of Henri-Frédéric Amiel*

(Volume 2)

1 September, 1875 (p. 193)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1894

## SCIENTIFIC APPROACH

**Farber, Eduard** 1892–1969  
Galician chemist

The scientific approach to reality consists of separating our experiences into simple parts so as to see them more clearly, and of connecting these parts so as to knowingly reconstruct what impressed us. This seems to be a complicated kind of approach. We use two steps, analysis and synthesis, and we have to create intricate relationships between them because separately they are contradictory and sterile. Is it not better to use the direct method of understanding reality as one whole? The inspirational feeling which refuses both analysis and synthesis is strong but it is mute. The German poet Friedrich Schiller expressed our inability to communicate our deepest feelings with these words: "When the soul speaks, alas, it is no longer the soul that speaks!" Science is the effort to find the language of the soul.

*The Evolution of Chemistry: A History of Its Ideas, Methods, and Materials*

Introduction (p. 3)

Ronald Press. New York, New York, USA. 1952

## SCIENTIFIC ATTITUDE

**Bohm, David** 1917–92  
American physicist

**Peat, F. David** 1938–  
English holistic physicist and author

Although science literally means "knowledge," the scientific attitude is concerned much more with rational perception through the mind and with testing such perceptions against actual fact, in the form of experiments and observations.

*Science, Order, and Creativity*

Chapter Six (p. 260)

Bantam Books. New York, New York, USA. 1987



**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

The scientific attitude of mind involves a sweeping away of all other desires in the interests of the desire to know – it involves suppression of hopes and fears, loves and hates, and the whole subjective emotional life, until we become subdued to the material, able to see it frankly, without preconceptions, without bias, without any wish except to see it as it is, and without any belief that what it is must be determined by some relation, positive or negative, to what we should like it to be, or to what we can easily imagine it to be.

*Mysticism and Logic: And Other Essays*

Chapter II (p. 44)

Longmans, Green & Co. London, England. 1919

## SCIENTIFIC BELIEF

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

The mind of the most rational among us may be compared to a stormy ocean of passionate convictions based upon desire, upon which float perilously a few tiny boats carrying a cargo of scientifically treated beliefs.

*The Scientific Outlook*

Chapter I (p. 11)

George Allen & Unwin. London, England. 1931

## SCIENTIFIC CHILD

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

The scientific child in training should foreshadow the scientific man in creative work.

The Ethical Functions of Scientific Study

*The Journal of Geology*, Volume 2, Number 6, December, 1888 (p. 387)

## SCIENTIFIC COGNITION

**Naan, G. I.**  
Estonian academician

The path of scientific cognition is a race-track without a finish.

Translated by N. Kittell

In Victor N. Komarov

*This Fascinating Astronomy* (p. 299)

MIR Publishers. Moscow, Russia. 1985

## SCIENTIFIC COMMUNITY

**Latour, Bruno** 1947–  
French sociologist of science

**Woolgar, S.**

No biographical data available

...a body of practices widely regarded by outsiders as well organized, logical, and coherent, in fact consists of a disordered array of observations with which scientists struggle to produce order.... Despite participants' well-ordered reconstructions and rationalizations, actual scientific practice entails the confrontation and negotiation of utter confusion.

*Laboratory Life: The Social Construction of Scientific Facts*

Chapter 1 (p. 36)

Sage Publications. Beverly Hills, California, USA. 1979

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

In any science there is harmony between practitioners. A man may work as an individual, learning of what his colleagues do through reading or conversation; he may be working as a member of a group on problems whose technical equipment is too massive for individual effort. But whether he is part of a team or solitary in his own study, he, as a professional, is a member of a community. His colleagues in his own branch of science will be grateful to him for the inventive or creative thoughts he has, will welcome his criticism....

*The Open Mind*

Chapter VIII (pp. 137–138)

Simon & Schuster. New York, New York, USA. 1955

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

There isn't a scientific community. It is a culture. It is a very undisciplined organization.

In Daniel S. Greenberg

*The Politics of Pure Science*

Book One, Chapter I (p. 3)

New American Library. New York, New York, USA. 1967

## SCIENTIFIC CONCEPT

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Great scientific concepts often have an entirely noninductive, dream-like quality.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 164)

The Rockefeller University Press. New York, New York, USA. 1978

## SCIENTIFIC CONCEPTION

**Huxley, Thomas Henry** 1825–95  
English biologist

...the attempt to convey scientific conceptions, without the appeal to observation, which can alone give such conceptions firmness and reality, appears to me to be in direct antagonism to the fundamental principles of scientific education.

*Physiography: An Introduction to the Study of Nature*

Preface (p. vii)

Macmillan & Co Ltd. London, England. 1897



## SCIENTIFIC CONSCIENCE

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Alas! The scientific conscience has got into the debasing company of money obligation and selfish respects.

*Middlemarch* (Volume 2)

Book VIII, LXXIII (p. 473)

William Blackwood & Sons. Edinburgh, Scotland. 1907

## SCIENTIFIC CRITICISM

**Pearson, Karl** 1857–1936  
English mathematician

In an age like our own, which is essentially an age of scientific inquiry, the prevalence of doubt and criticism ought not to be regarded with despair or as a sign of decadence. It is one of the safeguards of progress; – *la critique est la vie de la science*, I must again repeat. One of the most fatal (and not so impossible) futures for science would be the institution of a scientific hierarchy which would brand as heretical all doubt as to its conclusions, all criticism of its results.

*The Grammar of Science*

Chapter II, Section 7 (p. 66)

Charles Scribner's Sons. London, England. 1892

**Tagore, Rabindranath** 1861–1941  
Indian poet and philosopher

Our scientific world is our world of reasoning. It has its greatness and uses and attractions. We are ready to pay homage due to it. But when it claims to have discovered the real world for us and laughs at the worlds of all simple-minded men, then we must say it is like a general grown intoxicated with his power, usurping the throne of his king.

*Personality*

The World of Personality (p. 70)

The Macmillan Company. New York, New York, USA. 1917

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

Our age is possessed by a strong surge towards the criticism of traditional customs and opinions. A new spirit is arising which is unwilling to accept anything on authority, which does not so much permit as demand independent, rational thought on every subject, and which refrains from hampering any attack based upon such thought, even though it be directed against things which formerly were considered to be as sacrosanct as you please. ...Its results can only be advantageous: no scientific structure falls entirely into ruin: what is worth preserving preserves itself and requires no protection.

*Science and the Human Temperament*

Chapter I (p. 38)

W.W. Norton & Company, Inc. New York, New York, USA. 1935

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

A scientific researcher must always think of himself as a member of a jury. His only concern should be the adequacy of the evidence and the clarity of the proofs which support it. Guided by this, he will form his opinion and cast his vote without regard for whether he shares the author's views.

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 306–307)

Suhrkamp. New York, New York, USA. 1988

**von Mises, Ludwig** 1881–1973  
Austrian economist

...scientific criticism has no nobler task than to shatter false beliefs.

*Socialism: An Economic and Sociological Analysis*

Preface to the Second German Edition (p. 19)

Yale University Press. New Haven, Connecticut, USA. 1951

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

If science is not to degenerate into a medley of ad hoc hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations.

*Science and the Modern World*

Chapter I (pp. 16–17)

The Macmillan Company. New York, New York, USA. 1929

**Ziman, John M.** 1925–2005  
British physicist

The community of those who are competent to contribute to, or criticize, scientific knowledge must not be closed; it must be larger, and more open, than the group of those who entirely accept a current consensus or orthodoxy. It is an essential element in the health of Science, or of a science, or of the sciences, that self-confirming, mutually validating circles be unable to close. Yet it is also essential that technical scientific discussion be not smothered in a cloud of ignorant prejudices and cranky speculations.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 4 (p. 64)

Cambridge University Press. Cambridge, England. 1968

## SCIENTIFIC DISCIPLINE

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

To the physician particularly, a scientific discipline is an incalculable gift, which leavens his whole life, giving exactness to habits of thought and tempering the mind with that judicious faculty of distrust which can alone, amid the uncertainties of practice, make him wise unto salvation. For perdition inevitably awaits the mind of the

practitioner who has never had the full inoculation with the leaven, who has never grasped clearly the relations of science to his art, and who knows nothing and perhaps cares less, for the limitations of either.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

The Leaven of Science (p. 97)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1910

## SCIENTIFIC DISCOVERY

**Chargaff, Erwin** 1905–2002

Austrian biochemist

It is true of every scientific discovery that the road means more than the goal.

*Voices in the Labyrinth: Nature, Man and Science* (p. 17)

The Seabury Press. New York, New York, USA. 1977

**Mellor, Joseph William** 1863–1938

Chemist

The secret charm of scientific discovery is not in the facts *per se*, but rather in the extrication of natural relations among the facts one with another.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry* (Volume 1)

Chapter I (p. 10)

Longman, Green, & Co. London, England. 1922

**Pasteur, Louis** 1822–95

French chemist

In our century, science is the soul of the prosperity of nations and the living source of progress. Undoubtedly, the tiring daily discussions of politics seem to be our guide. Empty appearances! – What really leads us forward are a few scientific discoveries and their applications.

In Leo Hendrik Baekeland

*Some Aspects of Industrial Chemistry* (p. 43)

Columbia University Press. New York, New York, USA. 1914

**Rubbia, Carlo** 1934–

Italian physicist

...scientific discovery is an irrational act. It's an intuition which turns out to be reality at the end of it – and I see no difference between a scientist developing a marvellous discovery and an artist making a painting, or music or something.

In Lewis Wolpert and Alison Richards

*Passionate Minds*

Asking Nature (p. 197)

Oxford University Press. Oxford, England. 1977

**Whewell, William** 1794–1866

English philosopher and historian

The process of scientific discovery is cautious and rigorous, not by abstaining from hypotheses, but by rigorously

comparing hypotheses with facts, and resolutely rejecting all which the comparison does not confirm.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (Volume 2) (2nd edition)

Aphorisms Concerning Science (p. 468)

John W. Parker. London, England. 1848

## SCIENTIFIC DOCTRINE

**Keyser, Cassius Jackson** 1862–1947

American mathematician

In the early part of the last century a philosophic French mathematician, addressing himself to the question of the perfectibility of scientific doctrines, expressed the opinion that one may not imagine the last word has been said of a given theory so long as it cannot by a brief explanation be made clear to the man of the street. Doubtless that conception of doctrinal perfectibility, taken literally, can never be realized. For doubtless, just as there exist now, so in the future there will abound, even in greater and greater variety and on a vaster and vaster scale, deep-laid and high-towering scientific doctrines that, in respect to their infinitude of detail and in their remote parts and more recondite structure, shall not be intelligible to any but such as concentrate their life upon them.

*Mathematics* (p. 5)

The Columbia University Press. New York, New York, USA. 1907

## SCIENTIFIC DOUBT

**Richet, Charles** 1850–1935

French physiologist

Scientific doubt is a first-class quality, but rather eliminates piquancy from controversy.

*The Natural History of a Savant*

Chapter III (p. 25)

J.M. Dent & Sons Ltd. London, England. 1927

## SCIENTIFIC EDUCATION

**Enriques, Federigo** 1871–1946

Italian mathematician

Our need is to perfect the organization of that work which ought to be accomplished, under free conditions, through a fitting scientific education. To this end it is necessary that all enlightened men, in whatever special branch of study they are respectively working, should be conscious of the unity of the aims of science.

Translated by Katharine Royce

*Problems of Science*

Introduction (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

The end for which we ought to strive today is a scientific education, which shall enable the workers in any field

whatsoever to understand better how the object of their own research is subordinated to more general problems.

Translated by Katharine Royce

*Problems of Science*

Introduction (p. 2)

The Open Court Publishing Co. Chicago, Illinois, USA. 1914

## SCIENTIFIC ENDEAVOR

### Baskerville, Charles

No biographical data available

I like to fancy scientific endeavor as the sea – calm and serene, supporting and mirroring that which is below it, bearing that which is upon it, reaching to and reflecting that which is above it, moving all the while; yet, torn and rent at times by conflict from without and contest within, it runs; it beats against the shores of the unknown, making rapid progress here, meeting stubborn resistance there, compassing it, to destroy but to rebuild elsewhere; and the existence of those within it!

The Elements: Verified and Unverified

*Science*, New Series, Volume 19, Number 472, 15 January, 1904 (p. 100)

### Hawkins, Michael

English astronomer

Scientific endeavor is no more a journey toward absolute truth than biology in all its diversity is a set of constantly improving stages toward some state of ultimate perfection.

*Hunting Down the Universe: The Missing Mass, Primordial Black Holes, and Other Dark Matters*

Chapter 1 (p. 5)

Perseus Books. Reading, Massachusetts, USA. 1998

## SCIENTIFIC ENQUIRY

### Roscoe, Henry E. 1833–1915

English chemist

On the ennobling nature of original scientific enquiry it is needless to enlarge, for although I should be the last to contend that men of science are free from the foibles and weaknesses common to all mankind, I think it stands to reason that the habits of mind which an investigator must cherish are such as must raise him above the petty struggles of ordinary existence, and must, for a time at least, lift him into an atmosphere free from the cloud and smoke which too often darken the usual current of men's lives.

*Essays and Addresses*

Lecture II (pp. 52–53)

Macmillan & Co Ltd. London, England. 1874

## SCIENTIFIC ETHICS

### Westermarck, Edward 1862–1939

Finnish sociologist, anthropologist, and philosopher

If there are no general moral truths, the object of I scientific ethics cannot be to fix rules for human conduct, the aim of all science being the discovery of some truth.

*The Origin and Development of the Moral Ideas* (Volume 1)

Chapter I (p. 18)

Macmillan & Co Ltd. London, England. 1905

## SCIENTIFIC EXPERIMENTER

### Gregory, Sir Richard Arman 1864–1952

English scientific writer and journalist

He [the scientific experimenter] looks at Nature's countenance, and as a sworn witness before the tribunal of reality, testifies to what is revealed to him. Upon him is the responsibility of recording exactly what he sees, and by his gaze alone can that knowledge be obtained which will subdue Nature to the rule of the human intellect. Much that he sees may not be understood, but unless he has the love of truth his vision will be distorted.

*Discovery, Or, The Spirit and Service of Science*

Chapter II (p. 26)

Macmillan & Co Ltd. London, England. 1916

## SCIENTIFIC EXPLORER

### Kingsley, Charles 1819–75

English clergyman and author

The scientific explorer is always like Saul of old, who set out simply to find his father's asses, and found them – and a kingdom besides.

Every Pebble in the Street

*Every Saturday*, Volume I, March 9, 1872 (p. 273)

## SCIENTIFIC FACT

### Tydings, Joseph Davies 1928–

American Senator

Apparently that is one of those scientific facts we are supposed to accept and not ask why.

*Atomic Energy: Hearings before the Special Committee on Atomic Energy United States Senate, seventy-ninth congress, first session pursuant to S. Res. 179* (p. 337)

US Government Printing Office. Washington, D.C. 1945

## SCIENTIFIC FAITH

### Burroughs, John 1837–1921

American naturalist and essayist

Scientific faith is no more smooth sailing than is theological faith. One involves about as many mysteries, as many unthinkable truths, as the other.

*Under The Apple Tree*

Scientific Faith Once More (p. 159)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

## SCIENTIFIC FASHION

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Scientific fashions last longer than women's fashions but not as long as men's.

*Voices in the Labyrinth: Nature, Man and Science* (p. 85)  
The Seabury Press. New York, New York, USA. 1977

## SCIENTIFIC IDEA

**Chrystal, George** 1851–1911  
Scottish mathematician

...few scientific ideas spring up suddenly without previous trace or history.... a close examination always shows that the sprite was in the air before the Prospero came to catch him. [There are] long periods in which great improvements were effected in the science, which cannot be traced to any individual, but seem to have been due merely to the working of the minds of scientific men generally upon the matter, one giving it this little turn, another that, in the main always for the better.

Opening Address

*Nature*, Volume XXXII, September 10, 1885 (p. 447)

**Ritchie, Arthur David** 1891–1967  
Scottish philosopher and science history writer

It is a grave difficulty in the analytical treatment of scientific ideas that the simple laws are so vaguely conceived that analysis is difficult and the theories that are precisely formulated are often put forward as dogma and the evidence in favor of them has sunk into oblivion or into the realm of myth.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter VI (p. 157)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

## SCIENTIFIC IGNORANCE

**Pearson, Karl** 1857–1936  
English mathematician

Scientific ignorance may...either arise from an insufficient classification of facts, or be due to the unreality of the facts with which science has been called upon to deal.

*The Grammar of Science* (2nd edition)

Chapter I (p. 22)

Adam & Charles Black. London, England. 1900

## SCIENTIFIC INQUIRY

**Dewey, John** 1859–1952  
American philosopher and educator

The routine of custom tends to deaden even scientific inquiry; it stands in the way of discovery and of the active scientific worker. For discovery and inquiry are synonymous as an occupation. Science is a pursuit, not a coming into possession of the immutable; new theories as points of view are more prized than discoveries that quantitatively increase the store on hand.

*Reconstruction in Philosophy*

Introduction (p. xvii)

Beacon Press. Boston, Massachusetts, USA. 1920

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

It is true that the whole scientific inquiry starts from the familiar world and in the end it must return to the familiar world; but the part of the journey over which the physicist has charge is in foreign territory.

*The Nature of the Physical World*

Introduction (p. xiii)

1928

...the whole scientific inquiry starts from the familiar world and in the end it must return to the familiar world; but the part of the journey over which the physicist has charge is in foreign territory.

*The Nature of the Physical World*

Introduction (p. xv)

The University Press. New York, New York, USA. 1929

**Foster, Sir Michael** 1836–1907  
English physiologist

What is gained by scientific inquiry is gained forever; it may be added to, it may seem to be covered up, but it can never be taken away.

*A Century's Progress in Science*

*Educational Review*, Volume XVIII, November, 1899 (p. 325)

...scientific inquiry, though it be pre-eminently an intellectual effort, has need of the moral quality of courage – not so much the courage which helps a man to face a sudden difficulty as the courage of steadfast endurance.

Presidential Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX,

Number 2077, September 15, 1899 (p. 130)

**Heinlein, Robert A.** 1907–88  
American science fiction writer

There ought not to be anything in the whole universe that man can't poke his nose into – that's the way we're built and I assume there's some reason for it.

*Methuseelah's Children*

Chapter 8 (p. 160)

Aeonian Press. Mattituck, New York, USA. 1976

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

A mind which has once imbibed a taste for scientific inquiry, and has learnt the habit of applying its principles

readily to the cases which occur, has within itself an inexhaustible source of pure and exciting contemplations...

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 11 (pp. 14–15)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

### Herwitz, Daniel

No biographical data available

Cosmological inquiry takes place in the space between mathematics, theory, experiment, simulation, observation, and philosophic speculation. It is where science lives.

In Heather Wax and Gerald Shaw

Master of His Universe

*Science & Spirit*, November–December, 2004

### Lasalle, Ferdinand 1825–64

German jurist and socialist political activist

Whoever obstructs scientific inquiry clamps down the safety valve of public opinion, and puts the State in train for an explosion.

Translated by Thorstein B. Veblan

In Kuno Francke and Isidore Singer

*The German Classics: Masterpieces of German Literature Translated Into English*

Science and the Workingmen (p. 436)

The German Publication Society. New York, New York, USA. 1914

### Maxwell, James Clerk 1831–79

Scottish physicist

Others, again, are not content unless they can project their whole physical energies into the scene, which they conjure up. They learn at what a rate the planets rush through space, and they experience a delightful feeling of exhilaration. They calculate the forces with which the heavenly bodies pull at one another, and they feel their own muscles straining with the effort. To such men momentum, energy, mass are not mere abstract expressions of the results of scientific inquiry. They are words of power, which stir their souls like the memories of childhood.

Address

*Nature.*, Volume II, September 22, 1870

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

If the purpose of scientific methodology is to prescribe or expound a system of enquiry or even a code of practice for scientific behavior, then scientists seem able to get on very well without it.

*Pluto's Republic*

Induction and Intuition in Scientific Thought (p. 78)

Oxford University Press, Inc. Oxford, England. 1982

The purpose of scientific enquiry is not to compile an inventory of factual information, nor to build up a totalitarian world picture of Natural Laws in which every event

that is not compulsory is forbidden. We should think of it rather as a logically articulated structure of justifiable beliefs about nature. It begins as a story about a Possible World – a story which we invent and criticize and modify as we go along, so that it winds by being, as nearly as we can make it, a story about real life.

*Pluto's Republic*

Mainly About Intuition, Section 4 (pp. 110–111)

Oxford University Press, Inc. Oxford, England. 1982

...it is high time that laymen abandoned the misleading belief that scientific enquiry is a cold dispassionate enterprise, bleached of imaginative qualities, and that a scientist is a man who turns the handle of discovery; for at every level of endeavor scientific research is a passionate undertaking and the Promotion of Natural Knowledge depends above all on a *sortée* into what can be imagined but is not yet known.

Imagination and Hypothesis

*The Times Literary Supplement* (London), October 25, 1963 (p. 850)

### Rothschild, Lord Nathaniel Mayer 1910–90

English banker

It is sometimes said in justification of basic research, that chance observations made during such work, and their subsequent study may be just as important as those made during applied R & D. While there is some truth in this contention, the country's needs are not so trivial as to be left to the mercies of a form of scientific roulette, with many more than the conventional 37 numbers on which the ball may land.

*A Framework for Government Research and Development* (p. 3)

Her Majesty's Stationery Office. London, England. 1971

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

Scientific inquiry may be likened to fishing in the sea of reality with a particular kind of tackle. The tackle has well-known excellences, but it has also recognized limitations; and there may be much in the sea that the net used will not catch, being of too wide a mesh.

The New World of Science

*The Atlantic Monthly*, June, 1930

## SCIENTIFIC INSIGHT

### Gore, George 1826–1909

English electrochemist

Our power of scientific insight is but feeble when compared with the profundity of nature, because deep truths require deep thought to enable us to understand and value them.

*The Art of Scientific Discovery*

Part III, Chapter XXXV (p. 328)

Longmans, Green & Co. London, England. 1878



## SCIENTIFIC INTERPRETATION

**Burroughs, John** 1837–1921

American naturalist and essayist

The scientific interpretation of the universe repels a great many minds because it lays the emphasis upon matter itself instead of upon something supermaterial. It hesitates to name a creative energy, but makes matter itself creative, and does not try to help it out with teleological conception.

*Under The Apple Tree*

Literature and Science (p. 180)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

## SCIENTIFIC INVESTIGATION

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Scientific investigation in our day should be inspired by a purpose as animating to the general sympathy, as was the religious zeal which built the Cathedral of Cologne or the Basilica of St. Peter's. The time is passed when men expressed their deepest convictions by these wonderful and beautiful religious edifices; but it is my hope to see, with the progress of intellectual culture, a structure arises among us which may be a temple of the revelations written in the material universe.

*Louis Agassiz: His Life and Correspondence* (Volume 2)

Dredging Expedition (pp. 670–671)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1885

**Bayliss, Sir William Maddock** 1860–1925

English physiologist

It is not going too far to say that the greatness of a scientific investigator does not rest on the fact of his having never made a mistake, but rather on his readiness to admit that he has done so, whenever the contrary evidence is cogent enough.

*Principles of General Physiology*

Preface (pp. xvi–xvii)

Longmans, Green & Company. London, England. 1920

**Born, Max** 1882–1970

German-born English physicist

The Scientist's urge to investigate, like the faith of the devout or the inspiration of the artist, is an expression of mankind's longing for something fixed, something at rest in the universal whirl: God, Beauty, Truth.

*The Restless Universe*

Chapter V (p. 278)

Dover Publications, Inc. New York, New York, USA. 1951

**Boycott, A. E.**

No biographical data available

The difficulty in most scientific work lies in framing the questions rather than in finding the answers.

The Transition from Live to Dead

*Nature*, Volume 123, January 19, 1929 (p. 93)

**Carryl, Charles Edward** 1841–1920

American writer

Then we gather as we travel,  
Bits of moss and dirty gravel,  
And we chip off little specimens of stone;  
And we carry home as prizes  
Funny bugs, of handy sizes,  
Just to give the day a scientific tone.

In Franklin P. Adams

*Innocent Merriment: An Anthology of Light Verse*

Robinson Crusoe's Story

McGraw-Hill Book Company, Inc. New York, New York, USA. 1942

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The scientific professions began to develop a momentum of their own, thereby creating a vested interest in always having more science, bigger science, better-endowed science. This is, incidentally, quite in contrast, for instance, to orchestra musicians whose influence on the number of orchestra pieces being written is minimal.

Voices in the Labyrinth

*Perspectives in Biology and Medicine*, Volume 18, Number 3, Spring, 1975 (p. 324)

**Crookes, Sir William** 1832–1919

English chemist and physicist

To stop short in any research that bids fair to widen the gates of knowledge, to recoil from fear of difficulty or adverse criticism, is to bring reproach on science. There is nothing for the investigator to do but to go straight on; to explore up and down, inch by inch, with the taper of his reason; to follow the light wherever it may lead, even should it at times resemble a will-o'-the-wisp.

Address

British Association for the Advancement of Science, Bristol, England (1898)

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Holmes is a little too scientific for my tastes – it approaches to cold-bloodedness. I could imagine his giving a friend a little pinch of the latest vegetable alkaloid, not out of malevolence, you understand, but simply out of a spirit of inquiry in order to have an accurate idea of the effects. To do him justice, I think that he would take it himself with the same readiness. He appears to have a passion for definite and exact knowledge.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

*A Study in Scarlet*, Chapter 1 (p. 149)

Wings Books. New York, New York, USA. 1967



**Farrington, Benjamin** 1891–1974  
Irish scholar

Just as all scientific investigation is fruitless which is not pursued in a spirit of truth, so the results of all scientific endeavor are wasted if the continuity of tradition cannot be assured. It is of the very essence of science to be a co-operation and that not only of the men of the same generation, but of the generations successively.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 2)

Chapter 35 (p. 503)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Hall, Alfred Rupert** 1920–  
English historian of science

The cumulative growth of science, arising from the employment of methods of investigation and reasoning which have been justified by their fruits and their resistance to the corrosion of criticism, cannot be reduced to any single themes. We cannot say...why some men can perceive the truth, or a technical trick, which has eluded others. From the bewildering variety of experience in its social, economic and psychological aspects it is possible to extract only a few factors, here and there, which have had a bearing on the development of science. At present at least, we can only describe, and begin to analyse, where we should like to understand.

*The Scientific Revolution, 1500–1800*

Introduction (p. xiv)

Longmans, Green & Company. London, England. 1954

**Hertz, Heinrich** 1857–94  
German physicist

I have never forgotten what I often used to say to myself, that I would rather be a great scientific investigator than a great engineer, but would rather be a second-rate engineer than a second-rate investigator.

*Miscellaneous Papers*

Introduction (p. x)

Macmillan & Company Ltd. London, England. 1896

**Huxley, Thomas Henry** 1825–95  
English biologist

The method of scientific investigation is nothing but the expression of the necessary mode of working of the human mind. It is simply the mode in which all phenomena are reasoned about, rendered precise and exact.

*Collected Essays* (Volume 2)

*Darwiniana*

Six Lectures to Working Men (p. 363)

Macmillan & Company London, England. 1904

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

The man of action has to believe, the inquirer has to doubt; the scientific investigator is both.

In J.B. Conant

*Modern Science and Modern Man*

Science and Spiritual Values (p. 103)

Columbia University Press. New York, New York, USA. 1952

**von Lommel, Eugen** 1837–99  
German physicist

The deeds of a man of science are his scientific investigations. Truth once discovered does not remain shut up in the study or the laboratory. When the moment comes, it bursts its narrow bonds and joins the quick pulse of life. That which has been discovered in solitude, in the unselfish struggle for knowledge, in pure love of science, is often fated to be the mighty lever to advance the culture of our race.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VII (p. 184)

Macmillan & Company Ltd. London, England. 1918

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

The popular idea of scientific investigation is a vehement, aimless collection of little facts, collected as a bower bird collects shells and pebbles, in methodical little rows, and out of this process, in some manner unknown to the popular mind, certain conjuring tricks – the celebrated “wonders of science” – in a sort of accidental way emerge.

*The Discovery of the Future*

The Discovery of the Future (p. 34)

B.W. Huebsch. New York, New York, USA. 1914

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

In the course of a scientific investigation we say all kinds of things; we make many utterances whose role in the investigation we do not understand. For it isn't as though everything we say has a conscious purpose; our tongues just keep going. Our thoughts run in established routines, we pass automatically from one thought to another according to the techniques we have learned. And now comes the time for us to survey what we have said. We have made a whole lot of movements that do not further our purpose, or that even impede it, and now we have to clarify our thought processes philosophically.

Translated by Peter Winch

*Culture and Value* (p. 64e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

## SCIENTIFIC KNOWLEDGE

**Collins, Wilkie** 1824–89  
English novelist

What is scientific knowledge now may be scientific ignorance in some years more.

*Heart and Science*

Chapter LIV (p. 171)

Chatto &amp; Windus. London, England. 1883

What we call scientific knowledge today is a body of statements of varying degrees of certainty.

*The Meaning of It All*

Chapter 1 (p. 27)

Addison-Wesley. Reading, Massachusetts, USA. 1998

**Glass, H. Bentley** 1906–2005

American geneticist

...the fruits [of scientific knowledge] are of undeniable importance, and before we eat, it might be well for us to see upon which side of the tree of good and evil they are borne.

*Annual Report of the Board of Regents of the Smithsonian Institution (1955)*

Genetics in the Service of Man (p. 299)

Government Printing Office. Washington, D.C. 1956

**Gore, George**

No biographical data available

New scientific knowledge is like a powerful light, it cannot be hidden.

*The Scientific Basis of National Progress*

Chapter IV (p. 181)

Williams &amp; Norgate. London, England. 1882

**Hogben, Lancelot** 1895–1975

English zoologist

...scientific knowledge is not a mere collection of facts. It is an organized repository of useful and fruitful facts.

*Science for the Citizen: A Self-Educator Based on the Social Background of Scientific Discovery*

Part I, Chapter VI (p. 337)

Alfred A. Knopf. New York, New York, USA. 1938

**Lincoln, Almira H.** 1793–1884

Botanist

The beginner in any branch of scientific knowledge, is not like one travelling a straight road, where every step is so much ground actually gained; but the views which he takes are like the faint sketches of a painter, which gradually brighten, and grow more definite as he advances.

*Familiar Lectures on Botany, Practical, Elementary and Physiological*

Part I, Lecture IV (p. 23)

F.J. Huntington &amp; Co. New York, New York, USA. 1837

**Munroe, J.**

No biographical data available

The chief reason why scientific knowledge conflicts with sentiment, and curtails imagination, is that it induces a scientific habit of thought instead of a passive yielding to the enjoyment of beauty and the pleasant reveries it would inspire.

*Science and the Sense of Beauty**The Journal of Science, and Annals of Astronomy, Biology, Geology*, Volume IV, (Third series), April, 1882 (p. 204)**Norton, Charles Eliot** 1827–1908

American scholar

The first stepping-stones towards scientific knowledge are wonder and curiosity ...

*The Work of the Archaeological Institute of America**American Journal of Archaeology*, Volume 4, 1900 (p. 5)

## SCIENTIFIC LANGUAGE

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

I can hardly hope, by the use of scientific language, to convey any sense of my meaning to those ineffectual people who gather their ideas from the columns of a daily newspaper.

*The Poison Belt*

Chapter I (p. 8)

Hodder &amp; Stroughton. London, England. 1913

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Exploded errors may survive partially among the uneducated, aided in some instances by an obscure and mystic phraseology: they have also left behind them many expressions by which our nomenclature is more or less disfigured; while a few of happier, though figurative origin, have gradually received more accurate definition, and have been found worthy of preservation in our scientific language.

*Cosmos: A Sketch of a Physical Description of the Universe*

Introduction (p. 5)

Longman, Brown, Green &amp; Longmans. London, England. 1849

## SCIENTIFIC LAW

**Moulton, Richard Green** 1849–1924

English-born American author and lawyer

In science...law has to do not with what ought to be, but with what is; scientific laws are facts reduced to formulae, statements of the habits of things, so to speak.

*Shakespeare as a Dramatic Artist* (3rd edition)

Introduction (p. 33)

At The Clarendon Press. Oxford, England. 1901

## National Research Council (USA)

Knowledge of fundamental scientific laws makes for economy of human thought. It is the great simplifier in a universe of otherwise bewildering complexity.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 64)

National Academy of Sciences

Washington, D.C. 1972

It is not necessary to analyze every cogwheel in an alleged perpetual motion machine to know that it will not

work or to keep tracking all the planets to be sure that they are not about to collide.

*Physics in Perspective* (Volume 1)  
Chapter 3 (p. 64)  
National Academy of Sciences  
Washington, D.C. 1972

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

...scientific laws are not artificial creations; we have no reason to regard them as accidental, though it be impossible to prove they are not.

Translated by George Bruce Halsted

*The Value of Science*

Introduction (p. 14)

The Science Press. New York, New York, USA. 1907

## SCIENTIFIC LITERACY

**Deason, Hilary J.** d. 1971

No biographical data available

Scientific literacy has become a real and urgent matter for the informed citizen. Many have allowed themselves to lapse into a coma of scientific illiteracy because of the misconception that science and mathematics are beyond their understanding, have no personal appeal, and can be rejected or ignored. For them a tocsin [alarm bell] has been sounded by hundreds of intelligent men and women whose personal crusade is the awakening of people everywhere to scientific awareness. They admonish, “read, mark, learn, and inwardly digest.”

*A Guide to Science Reading*

Foreword to the First Edition (p. ix)

The New American Library. New York, New York, USA. 1966

**Walberg, Herbert J.**

Educator

The scientific literacy of American youth, their mastery of the basic knowledge and skills of communication in science, is a problem of grave national concern.

Scientific Literacy and Economic Productivity in International Perspective  
*Daedalus*, Volume 112, Number 2, Spring, 1983 (p. 1)

## SCIENTIFIC LITERATURE

**Foster, Sir Michael** 1836–1907

English physiologist

We have only to read the scientific literature of the time to recognize that a truth which is now not only woven as a master-thread into all our scientific conceptions, but even enters largely into the every-day talk and thoughts of educated people, was a hundred years ago struggling into existence among the philosophers themselves.

*A Century's Progress in Science*

*Educational Review*, Volume XVIII, November, 1899 (p. 315)

## SCIENTIFIC MAN

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

...it must be for truth's sake, and not even for the sake of its usefulness to humanity, that the scientific man studies Nature.

*Methods of Study in Natural History*

Chapter II (p. 24)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

**Darwin, Charles Galton** 1809–82

English naturalist

...a scientific man ought to have no wishes, no affections – a mere heart of stone.

In Francis Darwin

*More Letters of Charles Darwin* (Volume I)

Letter 52 (p. 98)

John Murray. London, England. 1903

**Foster, Sir Michael** 1836–1907

English physiologist

[The scientific man] must be alert of mind. Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint, however small, to listen to her whisper, however low.

*Report of the Sixty-ninth Meeting of the British Association for the Advancement of Science*

President's Address (p. 16)

John Murray. London, England. 1900

**Kingsley, Charles** 1819–75

English clergyman and author

...a scientific man must expect his little disappointments and injustices. If you were behind the scenes in the scientific world, I can assure you, you would find as much party-spirit, and unfairness, and jealousy, and emulation there, as anywhere else. Human nature, human nature, everywhere!

*Alton Locke*

Chapter XV (p. 132)

Macmillan & Co Ltd. London, England. 1862

**Schuster, Sir Arthur** 1851–1934

English physicist

A scientific man, in so far as he influences the progress of science cannot be far ahead of his time, and though his writings may be read and admired centuries after his death, he will have written in vain if he has not been appreciated by his contemporaries or by those who immediately followed.

*The Influence of Mathematics on the Progress of Physics*

*van Nostrand's Engineering Magazine*, Volume XXVI, Number CLX, April, 1882 (p. 317)

**von Liebig, Justus** 1803–73  
German organic chemist

The discovery of the conditions of a phenomenon is the first and most important requisite for its explanation. They must be ascertained and established by observation. The mode of inquiry and observation depends on the art of the scientific man; the skilful putting of the questions displays the powers of his mind.

*Familiar Letters on Chemistry*

Letter II (p. 27)

Walton & Maberly. London, England. 1859

**Whewell, William** 1794–1866  
English philosopher and historian

...scientific Ideas and common Notions differ in this, that the former are precise and stable, the latter vague and variable; the former are possessed with clear insight, and employed in a sense rigorously limited, and always identically the same; the latter have grown up in the mind from a thousand dim and diverse suggestions, and the obscurity and incongruity which belong to their origin hang about all their applications.

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Introduction (p. 13)

John W. Parker & Son. London, England. 1857

## SCIENTIFIC MEN

**Bagehot, Walter** 1826–77  
English lawyer, statesman, and essayist

We think of Euclid as of fine ice; we admire Newton as we admire the Peak of Teneriffe. Even the intensest labours, the most remote triumphs of the abstract intellect, seem to carry us into a region different from our own – to be in a *terra incognita* of pure reasoning, to cast a chill on human glory.

In Richard Holt Hutton

*Literary Studies* (Volume 2)

Thomas Babington Macaulay (p. 222)

Longmans, Green & Co. London, England. 1879

## SCIENTIFIC METHOD

**Agre, Peter** 1949–  
American biologist

The field was essentially stuck, but following the well known scientific approach known as “sheer blind luck,” we stumbled upon the protein that is the answer to the question: do water channels exist?

*Les Prix Nobel. The Nobel Prizes in 2003*

Nobel lecture for award received in 2003

Nobel Foundation. Stockholm, Sweden. 2004

**Bauer, Henry H.** 1931–  
American chemist

There is no good reason to discard the scientific method as an ideal; rather, there is good reason to keep it so. Myths, after all, even if not literally true, are stories that embody moral truths.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 2 (p. 39)

University of Illinois Press. Urbana, Illinois, USA. 1992

One of the things wrong with the popular, classical definition of the scientific method is the implication that solitary people can successfully do good science, for example frame hypotheses and test them. In practice, however, the people who put forward the hypotheses are not usually the same people who apply the best test to them.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 3 (p. 52)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Becker, Carl Lotus** 1873–1945  
American historian

It is one of the engaging ironies of modern thought that the scientific method, which it was once fondly hoped would banish mystery from the world, leaves it every day more inexplicable.

*The Heavenly City of the Eighteenth Century Philosophers*

Chapter I (p. 24)

Yale University Press. New Haven, Connecticut, USA. 1932

**Bernard, Claude** 1813–78  
French physiologist

I believe, in a word, that the true scientific method confines the mind without suffocating it, leaves it as far as possible face to face with itself, and guides it, while respecting the creative originality and the spontaneity which are its most precious qualities.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 226)

Henry Schuman, Inc. New York, New York, USA. 1927

**Born, Max** 1882–1970  
German-born English physicist

There are two objectionable types of believers: those who believe the incredible and those who believe that “belief” must be discarded and replaced by “the scientific method.”

*Natural Philosophy of Cause and Chance*

Appendix One (p. 209)

At The Clarendon Press. Oxford, England. 1949

**Bridgman, Percy Williams** 1882–1961  
American physicist

It seems to me that there is a good deal of ballyhoo about scientific method. I venture to think that the people who talk most about it are the people who do least about it. Scientific method is what working scientists do, not what other people or even they themselves may say about it. . . . Scientific method is something talked about by people

standing on the outside and wondering how the scientist manages to do it...

*Reflections of a Physicist*

Chapter 5 (p. 81)

Philosophical Library. New York, New York, USA. 1955

[S]cience is what scientists do, and there are as many scientific methods as there are individual scientists.

*Reflections of a Physicist*

Chapter 5 (p. 81)

Philosophical Library. New York, New York, USA. 1955

The scientific method, as far as it is a method, is nothing more than doing one's damndest with one's mind, no holds barred.

*Reflections of a Physicist*

Chapter 21 (p. 351)

Philosophical Library. New York, New York, USA. 1950

**Butler, Nicholas Murray** 1862–1947

American educator and university administrator

The making of a few score of admirable specialists, and the annual production of a small army of youths with narrow, if minute, information useful in some particular vocation, is a sorry substitute for reaching the great mass of the population with the influence and ideals of scientific inquiry and the scientific method.

In Bernard Jaffe

*New World of Chemistry*

Preface (p. vii)

Silver, Burdett & Company. New York, New York, USA. 1935

**Campbell, Norman R.** 1880–1949

English physicist and philosopher

If the discovery of laws could be reduced to a set of formal rules, anyone who learnt the rules could discover laws. But there is no broad road to progress. Herein lies the most serious objection to much that has been written on the methods of science. There is no method, and it is because there is no method which can be expounded to all the world that science is a delight to those who possess the instincts which make methods unnecessary.

*Physics: The Elements*

Chapter IV (p. 112)

At The University Press. Cambridge, England. 1920

**Case, Thomas**

No biographical data available

Scientific method is simply the way in which inferences are arranged in any science.

In Thomas Banks Strong

*Lectures on the Method of Science*

Chapter I (p. 1)

At The Clarendon Press. Oxford, England. 1906

**Conant, James Bryant** 1893–1978

American educator and scientist

There is no such thing as the scientific method. If there were, surely an examination of the history of physics,

chemistry, and biology would reveal it. For as I have already pointed out, few would deny that it is the progress in physics, chemistry and experimental biology which gives everyone confidence in the procedures of the scientist. Yet, a careful examination of these subjects fails to reveal any one method by means of which the masters in these fields broke new ground.

*Science and Common Sense*

Chapter Three (p. 45)

Yale University Press. New Haven, Connecticut, USA. 1951

**Crick, Francis Harry Compton** 1916–2004

English biochemist

What, then, do Jim Watson and I deserve credit for? If we deserve any credit at all, it is for persistence and the willingness to discard ideas when they became untenable. One reviewer thought that we couldn't have been very clever because we went on so many false trails, but that is the way discoveries are usually made. Most attempts fail not because of lack of brains but because the investigator gets stuck in a cul-de-sac or gives up too soon.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 6 (p. 74)

Basic Books, Inc. New York, New York, USA. 1988

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

The success of the scientific method at unlocking the secrets of nature is so dazzling it can blind us to the greatest scientific miracle of all: science works.

*The Mind of God: The Scientific Basis for a Rational World*

Chapter 1 (p. 20)

Simon & Schuster. New York, New York, USA. 1992

...the heart of the scientific method is the problem-hypothesis-test process. And, necessarily, the scientific method involves predictions. And predictions, to be useful in scientific methodology, must be subject to test empirically.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 2 (p. 12)

Simon & Schuster. New York, New York, USA. 1988

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

...like its literary and artistic counterparts, the process of scientific creation is a completely personal experience for which no technique of observation has yet been devised. Moreover, out of false modesty, pride, lack of inclination or psychological insight, very few of the great discoverers have revealed their own mental processes; at the most they have described methods of work – but rarely their dreams, urges, struggles and visions.

*Louis Pasteur: Free Lance of Science*

Chapter XIII (p. 369)

Little, Brown & Company. Boston, Massachusetts, USA. 1950



**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

The idea that science can, and should, be run according to fixed and universal rules, is both unrealistic and pernicious.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 18 (p. 295)  
Verso. London, England. 1978

**Feynman, Richard P.** 1918–88  
American theoretical physicist

After we look for the evidence we have to judge the evidence. There are the usual rules about the judging the evidence; it's not right to pick only what you like, but to take all of the evidence, to try to maintain some objectivity about the thing – enough to keep the thing going – not to ultimately depend upon authority. Authority may be a hint as to what the truth is, but is not the source of information. As long as it's possible, we should disregard authority whenever the observations disagree with it.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 4 (p. 104)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Observation, reason, and experiment make up what we call the scientific method.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 2–1 (p. 2–1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Flexner, Abraham** 1866–1959  
American educator

So long as men strive to transcend their native powers, to rid themselves of prejudice and preconception, to observe phenomena in a dry light, the effort is scientific, whether at the moment it attains mathematical accuracy or not.

*Medical Education: A Comparative Study*  
Chapter I (p. 3)  
The Macmillan Company. New York, New York, USA. 1925

**France, Anatole (Jean Jacques Brosson)** 1844–1924  
French writer

...the scientific reasons for preferring one piece of evidence to another are sometimes very strong, but they are never strong enough to outweigh our passions, our prejudices,

our interests, or to overcome that levity of mind common to all grave men. It follows that we continually present the facts in a prejudiced or frivolous manner.

*Penguin Island*  
Preface (p. vi)  
Dodd, Mead & Company. New York, New York, USA. 1923

**Garrod, Archibald** 1857–1936  
English physician

[Scientific method] acts as a check, as well as a stimulus, sifting the value of the evidence, and rejecting that which is worthless, and restraining too eager flights of the imagination and too hasty conclusions.

In Alexander G. Bearn  
*Archibald Garrod and the Individuality of Man*  
Chapter 7 (p. 82)  
Clarendon Press. Oxford, England. 1993

**Gotch, Francis** 1853–1913  
English physiologist

The scientific method comprises all those modes of mental activity which are best adapted to attain this end. It is not a hard-and-fast system of thought; it is not a particular method of observation or of experiment; it is not any special technique. In itself, the method is meaningless; it acquires merit through its aim, and is significant because of its purpose. Its form may, and indeed must, be plastic, varying with the condition of man and of nature, but its end remains throughout the same – he revelation of the truth about things.

In Thomas Banks Strong  
*Lectures on the Method of Science*  
Chapter II (p. 27)  
At The Clarendon Press. Oxford, England. 1906

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

It is important that we, as working scientists, combat these myths of our profession as something superior and apart. The myths may serve us well in the short and narrow as rationale for a lobbying strategy – give us the funding and leave us alone, for we know what we're doing and you don't understand anyway. But science can only be harmed in the long run by its self-proclaimed separation as a priesthood guarding a sacred rite called the scientific method.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*  
Chapter 1 (p. 7)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

The Nobel prizes focus on quantitative nonhistorical, deductively oriented fields with their methodology of perturbation by experiment and establishment of repeatable chains of relatively simple cause and effect. An entire set of disciplines, different though equal in scope and status, but often subjected to ridicule because they



do not follow this pathway of “hard” science, is thereby ignored: the historical sciences, treating immensely complex and nonrepeatable events (and therefore eschewing prediction while seeking explanation for what has happened) and using the methods of observation and comparison.

Balzan Prize to Ernst Mayr

*Science*, Volume 223, Number 4633, January 20, 1984 (p. 255)

If justification required eyewitness testimony, we would have no sciences of deep time – no geology, no ancient human history either. (Should I believe Julius Caesar ever existed? The hard bony evidence for human evolution...surely exceeds our reliable documentation of Caesar’s life.)

Dorothy, It’s Really Oz

*Time Magazine*, August 23, 1999 (p. 59)

[O]ur ways of learning about the world are strongly influenced by the social preconceptions and biased modes of thinking that each scientist must apply to any problem. The stereotype of a fully rational and objective “scientific method,” with individual scientists as logical (and interchangeable) robots, is self-serving mythology.

This View of Life. In the Mind of the Beholder

*Natural History*, Volume 103, Number 2, February, 1994 (p. 14)

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The scientific method of analyzing, explaining and classifying has become conscious of its human limitations, which arise out of the fact that by its intervention science alters and refashions the object of its investigation. In other words, method and object can no longer be separated. The scientific world view has ceased to be a scientific view in the true sense of the word.

*The Physicist’s Conception of Nature*

### **Hoffman, Paul** 1934–

American writer

...sometimes serious scientific problems are solved by a scientific method that can be described only as playful.

Playing for Keeps

*Discover*, October, 1990 (p. 4)

### **Huxley, Thomas Henry** 1825–95

English biologist

I am not afraid of the priests in the long-run. Scientific method is the white ant which will slowly but surely destroy their fortifications. And the importance of scientific methods in modern practical life – always growing and increasing – is the guarantee for the gradual emancipation of the ignorant upper and lower classes, the former of whom especially are the strength of the priests.

*Collected Essays* (Volume 3)

*Science and Education*

Life and Letters (p. 330)

Macmillan & Company Ltd. London, England. 1904

### **Jevons, William Stanley** 1835–82

English economist and logician

Nothing is more certain in scientific method than that approximate coincidence alone can be expected. In the measurement of continuous quantity perfect correspondence must be accidental, and should give rise to suspicion rather than to satisfaction.

*The Principles of Science: A Treatise on Logic and Scientific Method* (2nd edition)

Book IV, Chapter XXI (p. 457)

Macmillan & Co Ltd. London, England. 1877

### **Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

He who has once in his life experienced this joy of scientific creation will never forget it; he will be longing to renew it; and he cannot but feel with pain that this sort of happiness is the lot of so few of us, while so many could also live through it, – on a small or on a grand scale, – if scientific methods and leisure were not limited to a handful of men.

*Memoirs of a Revolutionist*

Part IV, I (p. 6)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

### **Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

We are committed to the scientific method, and measurement is the foundation of that method; hence we are prone to assume that whatever is measurable must be significant and that whatever cannot be measured may as well be disregarded.

*Human Nature and the Human Condition*

Chapter V (p. 78)

Random House, Inc. New York, New York, USA. 1959

### **Maxwell, James Clerk** 1831–79

Scottish physicist

Nature is a journal of science, and one of the several tests of a scientific mind is to discern the limits of the legitimate application of scientific methods.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Paradoxical Philosophy (p. 759)

Dover Publications, Inc. New York, New York, USA. 1965

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The scientific method, as it is sometimes called, is a potentiation of common sense.

*Advice to a Young Scientist*

Chapter 11 (p. 93)

Basic Books, Inc., Publishers. New York, New York, USA. 1979

The accusation is sometimes directed against scientists that there is in reality no such thing as the scientific method, i.e., that there is no logically accountable and intellectually rigorous process by which we may proceed

directly to the solution of a given problem. Scientific method works only in retrospect. This accusation is perfectly just but it doesn't in practice amount to anything more than saying that there is no set of cut-and-dried rules for writing a poem or passage of music or conducting any other imaginative exercise.

The Cost-Benefit Analysis of Pure Research  
*Hospital Practice*, Sept 1973

Ask a scientist what he conceives the scientific method to be, and he will adopt an expression that is at once solemn and shifty-eyed; solemn because he feels he ought to declare an opinion; shifty-eyed, because he is wondering how to conceal the fact that he has no opinion to declare.

*Induction and Intuition in Scientific Thought*  
Chapter I, Section 2 (p. 11)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

One of the severest tests of the scientific mind is to know the limits of the legitimate application of the scientific method.

In W.D. Niven

*The Scientific Papers of James Clerk Maxwell* (Volume 2) (p. 759)  
Cambridge University Press. Cambridge, England. 1890

**Pearson, Karl** 1857–1936

English mathematician

Minds trained to scientific methods are less likely to be led by mere appeal to the passions or by blind emotional excitement to sanction acts which in the end may lead to social disaster.

*The Grammar of Science* (2nd edition)  
Chapter I (p. 9)

Adam & Charles Black. London, England. 1900

The man who has accustomed himself to marshal facts, to examine their complex mutual relations, and predict upon the result of this examination their inevitable sequences – sequences which we term natural laws and which are as valid for every normal mind as for that of the individual investigator – such a man, we may hope, will carry his scientific method into the field of social problems.

*The Grammar of Science* (2nd edition)  
Chapter I (p. 9)

Adam & Charles Black. London, England. 1900

I assert that the encouragement of scientific investigation and the spread of scientific knowledge by largely inculcating scientific habits of mind will lead to more efficient citizenship and so to increased social stability. Minds trained to scientific methods are less likely to be led by mere appeal to the passions or by blind emotional excitement to sanction acts which in the end may lead to social disaster.

*The Grammar of Science*

Introductory, Section 3 (pp. 10–11)

Charles Scribner's Sons. London, England. 1892

There is no short cut to truth, no way to gain a knowledge of the universe except through the gateway of scientific method.

*The Grammar of Science* (2nd edition)

Chapter I (p. 17)

Adam & Charles Black. London, England. 1900

**Pirsig, Robert M.** 1928–

American writer

When I think of formal scientific method an image sometimes comes to mind of an enormous juggernaut, a huge bulldozer – slow, tedious, lumbering, laborious, but invincible. It takes twice as long, five times as long, maybe a dozen times as long as informal mechanic's techniques, but you know in the end you're going to get it. There's no fault isolation problem in motorcycle maintenance that can stand up to it. When you've hit a really tough one, tried everything, racked your brain and nothing works, and you know that this time Nature has really decided to be difficult, you say, "Okay, Nature, that's the end of the nice guy," and you crank up the formal scientific method.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part II, Chapter 9 (p. 107)

William Morrow & Company, Inc. New York, New York, USA. 1974

The real purpose of scientific method is to make sure Nature hasn't misled you into thinking you know something you don't actually know. There's not a mechanic or scientist or technician alive who hasn't suffered from that one so much that he's not instinctively on guard.... If you get careless or go romanticizing scientific information, giving it a flourish here and there, Nature will soon make a complete fool out of you.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part II, Chapter 9 (p. 108)

William Morrow & Company, Inc. New York, New York, USA. 1974

Traditional scientific method has always been at the very best, 20–20 hindsight. It's good for seeing where you've been.

*Zen and the Art of Motorcycle Maintenance: An Inquiry Into Values*  
Part III, Chapter xxiv (p. 280)

William Morrow & Company, Inc. New York, New York, USA. 1974

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

Scientists who believe that the old, tried, and true is sufficient or who underestimate and fail to understand the need for change may soon be lost in a challenging and exciting period of history. But those who have the vision to see beyond the obvious, the wisdom to search for and recognize the truth, and the ability to apply basic knowledge for the good of mankind will find this period one of great reward and satisfaction.

Challenges to Editors of Scientific Journals

*Science*, Volume 141, Number 3585, September 13, 1963 (p. 1017)

**Raymo, Chet** 1936–

American physicist and science writer

How is it that astronomers can tell such stories, stories more fabulous than any myth of gods and nymphs, when the ink of night offers to the eye only pinpricks of light? The answer is both simple and complex. We look, we invent, we look again. We test our inventions against what we see, and we insist that our inventions be consistent with one another, that our stories of the stars be consistent with our stories of the earth, of life, and of matter and energy.... The story of the falling apple and the story of the stars must resonate together. Only then, when our stories of the world vibrate with a symphonic harmony, are we confident that our inventions partake of reality.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 19 (p. 175)

The Viking Press. New York, New York, USA. 1991

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Whatever knowledge is attainable, must be attained by scientific methods; and what science cannot discover, mankind cannot know.

*Religion and Science*

Science and Ethics (p. 243)

Henry Holt & Company. New York, New York, USA. 1935

Scientific method...consists mainly in eliminating those beliefs which there is reason to think a source of shocks, while retaining those against which no definite argument can be brought.

*Human Knowledge: Its Scope and Limits*

Part III, Chapter III (p. 185)

Simon & Schuster. New York, New York, USA. 1948

Scientific method...consists in observing such facts as will enable the observer to discover general laws governing facts of the kind in question.

*The Scientific Outlook*

Chapter I (p. 15)

George Allen & Unwin Ltd. London, England. 1931

In arriving at a scientific law there are three main stages: The first consists in observing the significant facts; the second in arriving at a hypothesis, which, if it is true, would account for these facts; the third is deducing from this hypothesis consequences which can be tested by observation. If the consequences are verified, the hypothesis is provisionally accepted as true, although it will usually require modification later on as a result of the discovery of further facts.

*The Scientific Outlook*

Chapter II (p. 58)

George Allen & Unwin Ltd. London, England. 1931

**Smith, Alexander** 1865–1922

American chemist and author

The chief object of useful thought, no matter whether the problem is one of language, history, business, or life, is to organize isolated facts into knowledge, and the means of successfully accomplishing this is the use of the scientific method.

*Introduction to General Inorganic Chemistry*

Chapter I (p. 4)

The Century Co. New York, New York, USA. 1907

**Stansfield, William D.** 1930–

American biologist

Most scientific theories, however, are ephemeral. Exceptions will likely be found that invalidate a theory in one or more of its tenets. These can then stimulate a new round of research leading either to a more comprehensive theory or perhaps to a more restrictive (i.e., more precisely defined) theory. Nothing is ever completely finished in science; the search for better theories is endless.

*The Science of Evolution*

Introduction (p. 8)

Macmillan Company. New York, New York, USA. 1977

The interpretation of a scientific experiment should not be extended beyond the limits of the available data. In the building of theories, however, scientists propose general principles by extrapolation beyond available data. When former theories have been shown to be inadequate, scientists should be prepared to relinquish the old and embrace the new in their never-ending search for better solutions. It is unscientific, therefore, to claim to have “proof of the truth” when all that scientific methodology can provide is evidence in support of a theory.

*The Science of Evolution*

Introduction (p. 8)

Macmillan Publishing Company. New York, New York, USA. 1977

**Skinner, Burrhus Frederic** 1904–90

American psychologist

Here was a first principle not formally recognized by scientific methodologists: When you run into something interesting, drop everything else and study it.

A Case History in Scientific Method

*The American Psychologist*, Volume 11, 1956 (p. 223)

**Skolimowski, Henryk** 1930–

Polish philosopher

We are the proud inheritors and perpetuators of the scientific tradition. But perhaps also the slaves of certain modes of thinking; subjects to a conceptual tyranny which we glorify, thus being perfect slaves – slaves who enjoy their imprisonment.

In A.J. Ayala (ed.)

*Studies in the Philosophy of Biology: Reduction and Related Problems*

Problems of Rationality in Biology (p. 213)

Macmillan & Company Ltd. London, England. 1974

**Sullivan, John William Navin** 1886–1937  
Irish mathematician

To judge from the history of science, the scientific method is excellent as a means of obtaining plausible conclusions which are always wrong, but hardly as a means of reaching the truth.

The Justification of the Scientific Method  
*The Athenaeum*, Number 4644, 2 May, 1919 (p. 275)

**Tate, Allen** 1899–1979  
American poet, teacher, and novelist

Scientific approaches, because each has its own partial conventions momentarily arrogating to themselves the authority of total explanation, must invariably fail to see all the experience latent in the work.

Critical Responsibility  
*The New Republic*, Volume 51, Number 663, August 17, 1927 (p. 340)

**Tennant, F. R.**  
No biographical data available

Half a century ago, it was taught that the scientific method is the sole means of approach to the whole realm of possible knowledge: that there were no reasonably propounded questions worth discussing to which its method was inapplicable. Such belief is less widely held today. Since many men of science became their own epistemologists, science has been more modest.

*Philosophical Theology* (Volume 1)  
Chapter XIII (p. 333)  
At The University Press. Cambridge, England. 1956

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

When our aim is to get a grip of scientific method, we are more likely to succeed by settling down to the thorough study of some one order of facts, than by indulging in an intellectual ramble through the universe.

*Introduction to Science*  
Chapter IV (p. 82)  
Henry Holt & Co. New York, New York, USA. 1911

**Thomson, Sir George Paget** 1892–1975  
English physicist

The scientific method is not a royal road leading to discoveries in research, as Bacon thought, but rather a collection of pieces of advice, some general, some rather special, which may help to guide the explorer in his passage through the jungle of apparently arbitrary facts.

*The Inspiration of Science*  
Chapter II (p. 7)  
Oxford University Press, Inc. London, England. 1961

**Weisz, Paul B.** 1919–  
German-born American chemical engineer and biomedical researcher

All science begins with observation, the first step of the scientific method. At once this delimits the scientific domain; something that cannot be observed cannot be investigated by science.

*Elements of Biology* (p. 40)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1965

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

For the true scientific method is this:  
To trust no statements without verification,  
to test all things as rigorously as possible,  
to keep no secrets, to attempt no monopolies,  
to give out one's best modestly and plainly,  
serving no other end but knowledge.

In William Beebe  
*Edge of the Jungle*  
Cover page (p. 1)  
Garden City Publishing Company, Inc. Garden City, New York, USA. 1925

**Wolpert, Lewis** 1929–  
British embryologist

Even distinguished philosophers of science... recognize the failure of philosophy to help understand the nature of science. They have not discovered a scientific method that provides a formula or prescriptions for how to make discoveries. But many famous scientists have given advice: try many things; do what makes your heart leap; think big; dare to explore where there is no light; challenge expectation; cherchez le paradox; be sloppy so that something unexpected happens, but not so sloppy that you can't tell what happened; turn it on its head; never try to solve a problem until you can guess the answer; precision encourages the imagination; seek simplicity; seek beauty.... One could do no better than to try them all.

*The Unnatural Nature of Science*  
Chapter 6 (p. 108)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

No one method, no paradigm, will capture the process of science. There is no such thing as the scientific method.

*The Unnatural Nature of Science*  
Chapter 6 (p. 108)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Zimmerman, Michael** 1946–  
American biologist

Having a scientific outlook means being willing to divest yourself of a pet hypothesis, whether it relates to easy self-help improvements, homeopathy, graphology, spontaneous generation, or any other concept, when the data produced by a carefully designed experiment contradict

that hypothesis. Retaining a belief in a hypothesis that cannot be supported by data is the hallmark of both the pseudoscientist and the fanatic. Often the more deeply held the hypothesis, the more reactionary is the response to nonsupportive data.

*Science, Nonscience, and Nonsense: Approaching Environmental Literacy*

Chapter Two (p. 37)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1995

## SCIENTIFIC MIND

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Any good poet, in our age at least, must begin with the scientific view of the world; and any scientist worth listening to must be something of a poet, must possess the ability to communicate to the rest of us his sense of love and wonder at what his work discovers.

*The Journey Home: Some Words in Defense of the American West*

Chapter 8 (p. 87)

E.P. Dutton & Company. New York, New York, USA. 1977

**Ackerman, Edward A.** 1911–73

American geographer

The mind of the scientist, no less than that of the poet or musician, must be structured by thought and experience before it reaches the creative stage.

Where Is a Research Frontier?

*Annals of the Association of American Geographers*, Volume 30, 1931 (p. 433)

**Bauer, Henry H.** 1931–

American chemist

Science progresses not because scientists as a whole are passionately open-minded but because different scientists are passionately closed-minded about different things.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 4 (p. 76)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

It is true that much time and effort is devoted to training and equipping the scientist's mind, but little attention is paid to the techniques of making the best use of it.

*The Art of Scientific Investigation*

Preface (p. viii)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Compton, Karl Taylor** 1887–1954

American educator and physicist

Science requires straight and independent thinking. Every hypothesis or idea is capable of definite proof or disproof. The habit of mind that subjects every idea to rigid test is of utmost value. Much of the loose think-

ing in social, educational, political, and economic affairs would be avoided if the workers in these fields could be given a real training in accurate scientific thinking.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 39)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Dewey, John** 1859–1952

American philosopher and educator

The future of our civilization depends on the widening spread and deepening hold of the scientific habit of mind.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 11 (p. 137)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

The true scientific mind is not to be tied down by its own conditions of time and space. It builds itself an observatory erected upon the border line of present, which separates the infinite past from the infinite future. From this sure post it makes its sallies even to the beginning and to the end of all things.

*The Poison Belt*

Chapter III (p. 108)

Hodder & Stroughton. London, England. 1913

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The scientific mind must have a faith which is science.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

*The Conduct of Life*

Chapter VI (p. 240)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

In scientific subjects, the natural remedy for dogmatism has been found in research. By temperament and training, the research worker is the antithesis of the pundit. What he is actively and constantly aware of is his ignorance, not his knowledge; the insufficiency of his concepts, of the terms and phrases in which he tries to excogitate his problems: not their final and exhaustive sufficiency. He is, therefore, usually only a good teacher for the few who wish to use their mind as a workshop, rather than to store it as a warehouse.

Eugenics, Academic and Practical

*Eugenics Review*, Volume 27, 1935

**Foster, Sir Michael** 1836–1907

English physiologist and educator

...the mind which has been already sharpened by the methods of one science takes a keener edge, and the more quickly, when it is put on the whetstone of another



science, than does a mind which knows nothing of no science.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*

Recent Advances in Science, and Their Bearing on Medicine and Surgery (p. 340)

Government Printing Office. Washington, D.C. 1899

### **Kingsley, Charles** 1819–75

English clergyman and author

In one word, [scientific] men [have] acquired just the habit of mind which the study of Natural Science can give, and must give; for without it there is no use studying Natural Science; and the man who has not got that habit of mind, if he meddles with science, will merely become a quack and a charlatan, only fit to get his bread as a spirit-rapper, or an inventor of infallible pills.

*Town Geology*

Preface

D. Appleton & Company. New York, New York, USA. 1873

### **Knickerbocker, William Skinkle** 1892–1972

American professor of English and author

...the scientific...mind produces many of the virtues which in old-fashioned courses of ethics were taught as objectively as a problem in geometry. Patience, endurance, humility, teachableness, honesty, accuracy – without these it is impossible for a scientist to work.

*Classics of Modern Science*

Preface

Alfred A Knopf. New York, New York, USA. 1927

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Kruger, Otto** 1885–1974

American actor

My mind is just as open as it ever was, professor. But it's a scientific mind, and there's no place in it for superstitions.

*Dracula's Daughter*

Film (1936)

### **Large, E. C.**

No biographical data available

There were two age-old tendencies toward stagnation in scientific thought which those of youthful spirit had always to resist. One was the human weakness of accepting the uncorroborated say-so of eminent authorities, and the other was the human stupidity of regarding natural science as something divisible into watertight compartments.

*The Advance of the Fungi*

Chapter XXIII (p. 317)

Henry Holt & Company. New York, New York, USA. 1940

### **Lévi-Strauss, Claude** 1908–

French social anthropologist and structuralist

The scientific mind does not so much provide the right answers as ask the right questions.

Translated by John and Doreen Weightman

*The Raw and the Cooked*

Overture (p. 7)

Harper & Row, Publishers. New York, New York, USA. 1975

### **Maxwell, James Clerk** 1831–79

Scottish physicist

...one of the severest tests of a scientific mind is to discern the limits of the legitimate application of the scientific method.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Paradoxical Philosophy (p. 759)

At The University Press. Cambridge, England. 1890

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

There is no such thing as a Scientific Mind. Scientists are people of very dissimilar temperaments doing different things in very different ways. Among scientists are collectors, classifiers and compulsive tidiers-up; many are detectives by temperament and many are explorers; some are artists and others artisans. There are poet-scientists and philosopher-scientists and even a few mystics. What sort of mind or temperament can all these people be supposed to have in common? Obligative scientists must be very rare, and most people who are in fact scientists could easily have been something else instead.

*The Art of the Soluble*

Hypothesis and Imagination (p. 132)

Methuen & Company Ltd. London, England. 1967

### **Menzel, Donald Howard** 1901–76

American astronomer

### **Boyd, Lyle B.**

No biographical data available

The creative scientist, eternally curious, keeps an open mind toward strange phenomena and novel ideas, knowing that we have only begun to understand the universe we live in. He remembers, too, that Biot's discovery that meteorites were "stones from the sky" was at first greeted with disbelief, and he hopes never to be guilty or similar obtuseness. But an open mind does not mean credulity or a suspension of the logical faculties that are man's most valuable asset.

*The World of Flying Saucers: A Scientific Examination of a Major Myth of the Space Age*

Chapter VIII (p. 289)

Doubleday & Company, Inc. Garden City, New York, USA. 1963

### **Pagels, Heinz R.** 1939–88

American physicist and science writer

I like to browse in occult bookshops if for no other reason than to refresh my commitment to science.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 11 (p. 242)

Simon & Schuster. New York, New York, USA. 1988



**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

The Talmud and the Tao are trainers of scientific minds. A variety of talents is required if the scientific community is to thrive. ...

*Indiscrete Thoughts*  
Chapter XX (p. 210)  
Birkhäuser. Boston, Massachusetts, USA. 1997

**Rowland, Henry Augustus** 1848–1901  
American physicist

...for myself, I value in a scientific mind most of all that love of truth, that care in its pursuit and that humility of mind which makes the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection which has laid one stone upon the other with such care that it offers to the world the most complete monument to human reason. is the mind which is destined to govern the world in the future and to solve problems pertaining to politics and humanity as well as to inanimate nature.

*The Physical Papers of Henry Augustus Rowland*  
The Physical Laboratory in Modern Education (p. 618)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...the scientific attitude is in some degree unnatural to man; the majority of our opinions are wish-fulfillments, like dreams in the Freudian theory.

*The Scientific Outlook*  
Chapter I (p. 16)  
George Allen & Unwin Ltd. London, England. 1931

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

The scientific mood is especially marked by a passion for facts, by cautiousness of statement, by clearness of vision, and by a sense of the inter-relatedness of things.

*Introduction to Science*  
Chapter I (p. 34)  
Williams & Norgate Ltd. London, England. 1916

**Trotter, Wilfred** 1872–1939  
British surgeon and sociologist

The truly scientific mind is altogether unafraid of the new, and while having no mercy for ideas which have served their turn or shown their uselessness, it will not grudge to any unfamiliar conception its moment of full and friendly attention, hoping to expand rather than to minimize what small core of usefulness it may happen to contain.

Observation and Experiment and Their Use in the Medical Sciences  
*British Medical Journal*, Volume 2, 1930

**Tyndall, John** 1820–93  
Irish-born English physicist

The scientific mind can find no repose in the mere registration of sequence in nature. The further question intrudes itself with resistless might, Whence comes the sequence?

*Fragments of Science* (Volume 2)  
Chapter II (p. 29)  
D. Appleton & Co. New York, New York, USA. 1915

**Valéry, Paul** 1871–1945  
French poet and critic

Each mind can regard itself as a laboratory in which processes peculiar to the individual are used for transforming a substance common to all.

The results obtained by certain individuals are a source of wonderment to others. Starting out with ordinary carbon, one man produces a diamond, by means of temperatures and pressures that others never dreamt of. "Why, it's only carbon!" they say, after analyzing it. But they don't know how to do what he did.

In Jackson Mathews (ed.)  
*The Collected Works of Paul Valéry* (Volume 14)  
*Analects* (p. 482)  
Princeton University Press. Princeton, New Jersey, USA. 1971

**Weidlein, Edward Ray**  
Chemical engineer

A true scientist never grows old in his way of thinking. His mind is constantly working to improve his surroundings and to better understand the laws of nature. He expects to live in a changing world.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1938*  
A World of Change (p. 199)  
Government Printing Office. Washington, D.C. 1939

**Weil, Simone** 1909–43  
French philosopher and mystic

A scientific conception of the world doesn't prevent one from observing what is socially fitting.

Translated by Arthur Wills  
*The Need for Roots: Prelude to a Declaration of Duties Toward Mankind*  
Part III (p. 248)  
The Beacon Press. Boston, Massachusetts, USA. 1952

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Some people maintain that scientific insight has eliminated the need for meaning. I do not agree. The scientific worldview established the notion that there is a sense and purpose in the development of the universe when it recognized the evolution from the primal explosion to

matter, life, and humanity. In humans, nature begins to recognize itself.

*The Joy of Insight: Passions of a Physicist*

Chapter Fourteen (pp. 317–318)

Basic Books, Inc. New York, New York, USA. 1991

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The aim of scientific thought are to see the general in the particular and the eternal in the transitory.

*OMNI Magazine*, Volume 2, Number 41, November, 1979

A man who only knows his own science, as a routine peculiar to that science, does not even know that. He has no fertility of thought, no power of quick seizing the bearing of alien ideas. He will discover nothing, and be stupid in practical applications.

*The Organisation of Thought*

Chapter II (p. 46)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## SCIENTIFIC MOVEMENT

**Sadler, Michael**

No biographical data available

What the classical renaissance was to men of the fifteenth and sixteenth centuries, the scientific movement is to us. It has given a new trend to education. It has changed the outlook of the mind. It has given a new intellectual background to life.

In Fred Hodson

*Broad Lines in Science Teaching*

Introduction (p. xvi)

The Macmillan Co. New York, New York, USA. 1910

## SCIENTIFIC OBSESSION

**Gerould, Katherine Fullerton** 1879–1944

American writer

The great danger of the scientific obsession is not the destruction of all things that are not science, but the slow infection of those things.

*Modes and Morals*

The Extirpation of Culture (p. 87)

Charles Scribner's Sons. New York, New York, USA. 1920

## SCIENTIFIC OPINION

**Brooks, William Keith** 1848–1908

American zoologist

In this course of lectures I shall give, on many questions, the Scotch verdict of “not proven,” and experience

warns us that this will be interpreted as an assertion that they are proved or disproved, although no one can, in justice, interpret an admission that a thesis may sometime be proved or disproved as belief that either of these things will come about, or as an admission of anything else except a suspension of judgment, for all must hold it the height of folly to found a scientific opinion on lack of evidence.

*The Foundations of Zoology*

Lecture I (p. 14)

Macmillan & Co Ltd. London, England. 1899

## SCIENTIFIC PAPER

**Crick, Francis Harry Compton** 1916–2004

English biochemist

There is no form of prose more difficult to understand and more tedious to read than the average scientific paper.

*The Astonishing Hypothesis: The Scientific Search For the Soul*

Preface (p. xiii)

Touchstone. New York, New York, USA. 1995

## SCIENTIFIC PHILOSOPHY

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The scientific philosophy, therefore, which aims only at understanding the world and not directly at any other improvement of human life, cannot take account of ethical notions without being turned aside from that submission to fact which is the essence of the scientific temper.

*Mysticism and Logic: And Other Essays*

Chapter VI (p. 109)

Longmans, Green & Co. London, England. 1919

## SCIENTIFIC PICTURE

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

...the scientific picture of the real world around me is very deficient. It gives a lot of factual information, puts all our experience in a magnificently consistent order, but it is ghastly silent about all and sundry that is really near to our heart, that really matters to us. It cannot tell us a word about red and blue, bitter and sweet, physical pain and physical delight; it knows nothing of beautiful and ugly, good or bad, God and eternity. Science sometimes pretends to answer questions in these domains, but the answers are very often so silly that we are not inclined to take them seriously.

*Nature and the Greeks*

Chapter VII (p. 93)

At The University Press. Cambridge, England. 1954

## SCIENTIFIC POLICY

### Branford, Victor

No biographical data available

If we assume that at present there is no science, but sciences – unclassified and therefore ungeneralised, it would seem to follow that there is no scientific ideal, but only scientific ideals – unharmonised; and no scientific policy, but only scientific policies – un-co-ordinated.

*Science and Citizenship*

Section IV (p. 11)

George Allen. London, England. 1906

## SCIENTIFIC PRACTICE

### Haraway, Donna 1944–

American educator

Scientific practice may be considered a kind of story-telling practice ...

*Primate Visions*

Introduction (p. 4)

Routledge, Chapman & Hall. New York, New York, USA. 1989

## SCIENTIFIC PRINCIPLES

### Dewey, John 1859–1952

American philosopher and educator

Scientific principles and laws do not lie on the surface of nature. They are hidden, and must be wrested from nature by an active and elaborate technique of inquiry.

*Reconstruction in Philosophy*

Chapter II (p. 32)

Henry Holt & Co. New York, New York, USA. 1920

## SCIENTIFIC PROBLEMS

### Mayr, Ernst 1904–2005

German-born American biologist

Actually most scientific problems are far better understood by studying their history than their logic.

*The Growth of Biological Thought: Diversity, Evolution, and Inheritance*

Chapter I (p. 6)

Harvard University Press. Cambridge, Massachusetts, USA. 1982

## SCIENTIFIC PROCESS

### Brown, Samuel 1817–56

Chemist

By the scientific process there is effected the elaboration of a beautiful orderliness from the midst of a chaos of sensations.

*Lectures on the Atomic Theory and Essays Scientific and Literary*

(Volume 1)

The History of Science (p. 299)

Thomas Constable & Co. Edinburgh, Scotland. 1858

## SCIENTIFIC PROGRESS

### Anthony, H. D.

No biographical data available

As a prelude to any scientific progress there must be a means of recording, a framework of time within which to record, and a system of measurement: an alphabet, a calendar and a system of counting.

*Science and Its Background*

Chapter III (p. 25)

Macmillan & Co Ltd. London, England. 1948

### Brooks, William Keith 1848–1908

American zoologist

The path of scientific progress is strewn with beliefs which have been abandoned for lack of evidence, as burst shells strew a battlefield, and it is our boast that they are abandoned, and not lugged along the line of march. As a shell which has failed to burst is, now and then, picked up on some old battlefield, by someone on whom experience is thrown away, and is exploded by him in the bosom of his approving family, with disastrous results, so one of these abandoned beliefs may be dug up by the head of some intellectual family, to the confusion of those who follow him as their leader.

*The Foundations of Zoology*

Lecture VI (p. 126)

The Macmillan Co. New York, New York, USA. 1899

### Bush, Vannevar 1890–1974

American electrical engineer and physicist

Scientific progress on a broad front results from free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for the exploration of the unknown.

*Science: The Endless Frontier*

Chapter 1 (p. 2)

US Government Printing Office. Washington, D.C. 1945

### Compton, Karl Taylor 1887–1954

American educator and physicist

The geographical pioneer is now supplanted by the scientific pioneer.... Without the scientific pioneer our civilization would stand still and our spirit would stagnate; with him mankind will continue to work toward his higher density. This being so, our problem is to make science as effective an element as possible in our American program for social progress.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

During the Years 1930–1949 (p. 2)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

The whole history of scientific progress illustrates the importance of free communication of ideas, of co-operative work at all levels, of adequate support and facilities, and above all, of high grade research workers and top-notch leadership.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 11)  
Undergraduate Association, MIT, Cambridge, Massachusetts, USA. 1955

**Crick, Francis Harry Compton** 1916–2004

English biochemist

It can be confidently stated that our present knowledge of the brain is so primitive – approximately at the stage of the four humours in medicine or of bleeding in therapy (what is psychoanalysis but mental bleeding?) – that when we do have fuller knowledge our whole picture of ourselves is bound to change radically. Much that is now culturally acceptable will then seem to be nonsense. People with training in the arts still feel that in spite of the alterations made in their life by technology – by the internal combustion engine, by penicillin, by the Bomb – modern science has little to do with what concerns them most deeply. As far as today's science is concerned this is partly true, but tomorrow's science is going to knock their culture right out from under them.

*Of Molecules and Men*

The Prospect Before Us (p. 94)

University of Washington Press, Seattle, Washington, USA. 1966

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The most important scientific revolutions all include, as their only common feature, the dethronement of human arrogance from one pedestal after another of previous convictions about our centrality in the cosmos.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 13 (p. 164)

Random House, Inc. New York, New York, USA. 1995

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The discovery of a law of Nature is always of great advantage to scientific progress. By the warp and woof of experiment, the man of science weaves a pattern from the threads of evidence, and presents the result to the world for anyone to improve.

*Discovery: Or the Spirit and Service of Science*

Chapter VII (p. 183)

Macmillan & Company Ltd. London, England. 1918

**Jacob, François** 1920–

French biologist

Contrary to what I once thought, scientific progress did not consist simply in observing, in accurately formulating experimental facts and drawing up a theory from them. It began with the invention of a possible world, or a fragment thereof, which was then compared by experimenta-

tion with the real world. And it was this constant dialogue between imagination and experiment that allowed one to form an increasingly fine-grained conception of what is called reality.

In William Calvin

*The Cerebral Symphony: Seashore Reflections on the Structure of Consciousness*

Chapter 10 (p. 206)

Bantam Books, New York, New York, USA. 1989

**Mather, Kirtley F.** 1888–1978

American geologist

The more we know about the world, the more mysterious and marvelous it becomes. The arrogance which characterized so many scientists of preceding generations has given place to a true humility, admirably displayed by most of the leaders in contemporary scientific progress.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (p. 3)

Thomas Y. Crowell Company, Publishers, New York, New York, USA. 1931

**Trimble, George S.** d. 1863

No biographical data available

Actually the biggest deterrent to scientific progress is a refusal of some people, including scientists, to believe that things that seem amazing can really happen.

In Charles Berlitz and William Moore

*The Philadelphia Experiment: Project Invisibility* (p. 8)

Souvenir Press Ltd. London, England. 1979

**Tyndall, John** 1820–93

Irish-born English physicist

One of the problems of science, on which scientific progress mainly depends, is to help the senses of man, by carrying them into regions which could never be attained without such help. Thus we arm the eye with the telescope when we want to sound the depths of space, and with the microscope when we want to explore motion and structure in their infinitesimal dimensions.

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)

Lecture I (p. 12)

D. Appleton & Co. New York, New York, USA. 1901

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

...if we would serve science, we must extend her limits, not only as far as our own knowledge is concerned, but in the estimation of others.

Translated by Frank Chase

*Cellular Pathology: As Based Upon Physiological and Pathological History*

Authors Preface (p. 7)

Dover Publications, Inc. New York, New York, USA. 1971

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

When science appears to be slowing down and, despite the efforts of many energetic individuals, comes to a

dead stop, the fault is often to be found in a certain basic concept that treats the subject too conventionally. Or the fault may lie in a terminology which, once introduced, is unconditionally approved and adopted by the great majority, and which is discarded with reluctance even by independent thinkers, and only as individuals in isolated cases.

*Goethe's Botanical Writings*

An Attempt to Evolve a General Comparative Theory (p. 81)  
University of Hawaii Press. Honolulu, Hawaii, USA. 1952

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...Who put up that big City and Guilds place at South Kensington? Enterprising business men! They fancy they'll have a bit of science going on, they want a handy Expert ever and again, and there you are! And what do you get for research when you've done it? Just a bare living and no outlook. They just keep you to make discoveries, and if they fancy they'll use 'em they do.

*Tono-Bungay*

Book the Second, Chapter the Second, II (p. 156)

Duffield & Company. New York, New York, USA. 1921

**Weinberg, Steven** 1933–  
American nuclear physicist

I do not believe that scientific progress is always best advanced by keeping an altogether open mind. It is often necessary to forget one's doubts and to follow the consequences of one's assumptions wherever they may lead – the great thing is not to be free of theoretical prejudices, but to have the right theoretical prejudices. And always, the test of any theoretical preconception is in where it leads.

*The First Three Minutes: A Modern View of the Origin of the Universe*  
Chapter V (p. 119)

Basic Books, Inc. New York, New York, USA. 1993

## SCIENTIFIC PUBLISHING

**Agnew, Neil McK.**

No biographical data available

**Pyke, Sandra W.**

No biographical data available

...perhaps the most deceptive myth of all is that the Ph.D. represents the last hurdle in some kind of knowledge race. A student who has just cleared the jump should enjoy this illusion while it lasts. The science game now shifts to a new ground with new rules. Your rating first depends on getting some articles out; then, once you've demonstrated that you can publish, your rating depends on whether you are publishing in respectable journals; then your rating depends on whether you have a good book out; and then...

*The Science Game*

Chapter 12 (p. 146)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1969

**Arber, Agnes Robertson** 1879–1960  
English botanist

A record of research should not resemble a casual pile of quarried stone; it should seem “not built, but born”, as Vasari said in praise of a building.

*The Mind and the Eye: A Study of the Biologist's Standpoint*  
Chapter V (p. 50)

At The University Press. Cambridge, England, USA. 1954

## Author undetermined

As this paper contains nothing which deserves the name either of experiment or discovery, and as it is, in fact, destitute of every species of merit, we should have allowed it to pass among the multitude of those articles which must always find their way into the collections of a society which is pledged to publish two or three volumes every year.... We wish to raise our feeble voice against innovations, that can have no other effect than to check the progress of science, and renew all those wild phantoms of the imagination which Bacon and Newton put to flight from her temple.

Review of Dr. Young's Bakerian Lecture

*Edinburgh Review*, January, 1803 (p. 450)

**Batchelor, G. K.** 1920–2000  
English applied mathematics professor and fluid mechanics engineer

Reading a paper is a voluntary and demanding task, and a reader needs to be enticed and helped and stimulated by the author.

Preoccupations of a Journal Editor

*Journal of Fluid Mechanics*, Volume 106, 1981 (p. 8)

**Buckle, Henry Thomas** 1821–62  
English historian

The publications of our scientific authors overflow with minute and countless details, which perplex the judgment, and which no memory can retain. In vain do we demand that they should be generalized, and reduced into order. Instead of that, the heap continues to swell. We want ideas, and get more facts. We hear constantly what nature is doing, but we rarely hear what man is thinking.

*History of Civilization in England* (Volume 2)

Chapter VI (p. 396)

D. Appleton & Company. New York, New York, USA. 1891

**Casimir, Hendrik B. G.** 1909–2000  
Dutch physicist

I should like to find a way of discouraging unnecessary publications, but I have not found a solution, save the radical one...that all scientific papers be published anonymously.

In Praise of Smallness – How Can We Return to Small Science

*Perspectives in Biology and Medicine*, Volume 23, Number 3, Spring 1980 (p. 383)



**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Scientific journals must remain the preserve of articles capable of affecting the consensus of the scientific public. Books are the place for opinions, speculations, and fanciful accounts of ricocheting planets. The publisher has only to convince enough buyers to cover their cost of publication. In a free society with a vigorous press, there is little danger that an important idea will not get a fair hearing.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 8 (pp. 149–150)

Oxford University Press, Inc. New York, New York, USA. 1993

**Comroe, Jr., Julius H.** 1911–84  
American physician

Almost every scientist working today can get his work published, somewhere, once he decides to “write it up”; maybe it will be in the Bulletin of the Podunk Medical Society rather than in a journal with international prestige or readership, or maybe it will be published only as an abstract. The main determinant of what is or is not published therefore seems to be the scientist, for it is he who decides to become or not to become an author.

Publish and/or Perish

*American Review of Respiratory Disease*, Volume 113, 1976

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

...a scientific paper should never try to make more than one point.

In B.D. Davis

Two Perspectives

*Perspectives in Biology and Medicine*, Volume 35, Number 1, Autumn

1991 (p. 38)

**Dyson, Freeman J.** 1923–  
American physicist and educator

Most of the papers which are submitted to the Physical Review are rejected, not because it is impossible to understand them, but because it is possible. Those which are impossible to understand are usually published.

Innovation in Physics

*Scientific American*, Volume 199, Number 3, September, 1958

**Elder, Joseph**  
No biographical data available

Publication is the end-product of research. Research without publication is sterile.

Jargon – Good and Bad

*Science*, Volume 119, Number 3095, 23 April, 1954 (p. 536)

**Gastel, Barbara**  
American medical science writing educator

Every master’s thesis or doctoral dissertation should be accompanied by a lay summary or press release written by the graduate student (with the guidance, if possible, of

a science writing instructor or public information officer at the student’s institution).

*Earth and Life Science Editing*, Volume 24, 1985 (p. 3)

**Gelernter, David** 1955–  
Computer scientist

Scientists nowadays rarely know how to read seriously. They are accustomed to strip-mining a paper to get the facts out and then moving on, not to mollycoddling the thing in search of nuances; there probably aren’t any.

In John Brokman and Katinka Matson (eds.)

*How Things Are: A Tool Kit For the Mind*

Study Talmud (p. 213)

William Morrow & Company, Inc. New York, New York, USA. 1995

**Glaisher, James Whitbread Lee** 1848–1928  
English mathematician

In other branches of science, where quick publication seems to be so much desired, there may possibly be some excuse for giving to the world slovenly or ill-digested work, but there is no excuse in mathematics. The form ought to be as perfect as the substance, and the demonstrations as rigorous as those of Euclid. The mathematician has to deal with the most exact facts of Nature, and he should spare no effort to render his interpretation worthy of his subject, and to give to his work its highest degree of perfection.

Presidential Address, British Association for the Advancement of Science

*Nature*, Section A (1890), Volume 42 (p. 467)

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

I do not know when the technical and popular prose of science became separated, although I accept the inevitability of such a division as knowledge became increasingly more precise, detailed, and specialized. We have now reached the point where most technical literature not only falls outside the possibility of public comprehension but also (as we would all admit in honest moments) outside our own competence in scientific disciplines far removed from our personal expertise. I trust that we all regard this situation as saddening, even though we accept its necessity.

Take Another Look

*Science*, Volume 286, Number 5441, October 29, 1999 (p. 899)

**Hagstrom, Warren O.**  
No biographical data available

Manuscripts submitted to scientific periodicals are often called “contributions,” and they are, in fact, gifts. Authors do not usually receive royalties or other payments, and their institutions may even be required to aid in the financial support of the periodical. On the other hand, manuscripts for which the scientific authors do receive financial payments, such as textbooks and popularizations, are, if not despised, certainly held in much lower esteem than articles containing original research results.

*The Scientific Community*

Basic Books, Inc. New York, New York, USA. 1965



**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

Four stages of acceptance: (a) this is worthless nonsense; (b) this is an interesting, but perverse, point of view; (c) this is true, but quite unimportant; (d) I always said so.  
*Journal of Genetics*, Volume 58 (p. 464)

**Hudson, Jeffrey**  
No biographical data available

There's this desert prison...with an old prisoner, resigned to his life, and a young one just arrived. The younger one talks constantly of escape, and, after a few months, he makes a break. He's gone a week, and then he's brought back by the guard. He's half dead, crazy with hunger and thirst. He describes how awful it was to the old prisoner. The endless stretches of sand, no oasis, no sign of life anywhere. The old prisoner listens for awhile, then says. "Yep. I know. I tried to escape myself, twenty years ago." The younger prisoner says "You did? Why didn't you tell me, all these months I was planning my escape? Why didn't you let me know it was impossible?" And the old prisoner shrugs, and says, "So who publishes negative results?"  
*A Case of Need*  
Tuesday, 11 October  
Nine (p. 121)  
The World Publishing Company. New York, New York, USA. 1968

**Huth, Edward Janavel** 1923–  
American physician

Why should the investigators confine themselves to one paper when they can slice up data and interpretations into two, three, five, or more papers that will better serve their needs when they face promotion or tenure committees? "Salami science" does not always equal baloney, but such divided publication is often an abuse of scientific publication.  
Irresponsible Authorship and Wasteful Publication  
*Annals of Internal Medicine*, Volume 104, 1986

**Ingle, Dwight J.** 1907–78  
Biologist and endocrinologist

Science cannot be equated to measurement, although many contemporary scientists behave as though it can. For example, the editorial policies of many scientific journals support the publication of data and exclude the communication of ideas.  
*Principles of Research in Biology and Medicine*  
Chapter 1 (p. 3)  
Lippincott. Philadelphia, Pennsylvania, USA. 1958

**Kennedy, Donald**  
No biographical data available

All the thinking, all the textual analysis, all the experiments and the data-gathering aren't anything until we

write them up. In the world of scholarship we are what we write.

*Academic Duty* (p. 186)  
Harvard University Press. Cambridge, Massachusetts, USA. 1997

**Maslow, A. H.** 1908–70  
American psychologist

I do not recall seeing in the literature with which I am familiar any paper that criticized another paper for being unimportant, trivial or inconsequential.

*Motivation and Personality*  
Chapter 2 (p. 14)  
Harper & Row, Publishers. New York, New York. 1970

**Mayo, William J.** 1861–1939  
American physician

Reading papers is not for the purpose of showing how much we know and what we are doing, but is an opportunity to learn.  
The Value of the Weekly General Staff Meeting  
*Proceedings of Staff Meetings, Mayo Clinic*, Volume 10, January 30, 1935

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

...it is no use looking to scientific "papers," for they not merely conceal but actively misrepresent the reasoning that goes into the work they describe.... Nor is it any use listening to accounts of what scientists say they do, for their opinions vary widely enough to accommodate almost any methodological hypothesis we may care to devise. Only unstudied evidence will do – and that means listening at a keyhole.

*The Art of the Soluble*  
Hypothesis and Imagination (p. 151)  
Methuen & Company Ltd. London, England. 1967

**Nelkin, Dorothy** 1933–2003  
American sociologist

...too often science in the press is more a subject for consumption than for public scrutiny, more a source of entertainment than of information. Too often science is presented as an arcane activity outside and above the sphere of normal human understanding, and therefore beyond our control. Too often the coverage is promotional and uncritical, encouraging apathy, a sense of impotence, and the ubiquitous tendency to defer to expertise.

*Selling Science: How the Press Covers Science and Technology*  
Chapter 10 (p. 173)  
W.H. Freeman & Company. New York, New York, USA. 1995

**Price, Derek John de Solla** 1922–83  
English science historian and information scientist

...scientists have a strong urge to write papers but only a relatively mild one to read them.

*Little Science, Big Science*  
Chapter 3 (pp. 69–70)  
Columbia University Press. New York, New York, USA. 1963

**Rowland, Henry Augustus** 1848–1901  
American physicist

A hermit philosopher we can imagine might make many useful discoveries. Yet, if he keeps them to himself, he can never claim to have benefited the world in any degree. His unpublished results are his private gain, but the world is not better off until he has made them known in language strong enough to call attention to them and to convince the world of their truth.

*The Physical Papers of Henry Augustus Rowland*  
The Highest Aim of the Physicist (p. 669)  
Johns Hopkins Press, Baltimore, Maryland, USA. 1902

**Schrödinger, Erwin** 1887–1961  
Australian theoretical physicist

...a typical scientific paper has never pretended to be more than another little piece in a larger jigsaw – not significant in itself but as an element in a grander scheme. This technique, of soliciting many modest contributions to the vast store of human knowledge, has been the secret of Western science since the seventeenth century, for it achieves a corporate, collective power that is far greater than any one individual can exert.

Information, Communication, Knowledge  
*Nature*, Volume 224, Number 5217, October 25, 1969 (p. 324)

Primary scientific papers are not meant to be final statement of indisputable truths; each is merely a tiny tentative step forward, through the jungle of ignorance.

Information, Communication, Knowledge  
*Nature*, Volume 224, Number 5217, October 25, 1969 (p. 324)

**Shrady, George**  
No biographical data available

The time is already past when any man can hope to rise to be an authority in any department of medical science through any royal road of social influence, political manipulations, or even personal charms. Those who are to be the leaders and guides of medical science for the coming generation must earn their position by persistent, original investigation, and by faithfully recording their experience in the permanent literature of the day.

Medical Authorship  
*Medical Record*, Volume 2, 1867

**Simpson, Michael A.**  
No biographical data available

We still consistently overvalue poor research and semi-literate publication; again, partly, because quantity, in number of publications, is easier to measure than quality.

A Mythology of Medical Education  
*Lancet*, Volume 3, 1974

**Wilson, Logan**  
No biographical data available

Results unpublished are little better than those never achieved.... One must write something and get it into

print. Situational imperatives dictate a “publish or perish” credo within the ranks.

*The Academic Man: A Study in the Sociology of a Profession* (p. 197)  
Oxford University Press, Inc. London, England. 1942

**Woolley, Sir Charles Leonard** 1880–1960  
English archaeologist

The prime duty of the field archaeologist is to collect and set in order material with not all of which he can himself deal at first hand. In no case will the last word be with him; and just because that is so his publication of the material must be minutely detailed, so that from it others may draw not only corroboration of his views but fresh conclusions and more light.

*Digging Up the Past*  
Chapter V (pp. 133–134)  
Charles Scribner's Sons, New York, New York, USA. 1931

**Ziman, John M.** 1925–2005  
British physicist

The moment of truth for many young scientists comes when they first act as a referee for a scientific paper; having striven for years to get their own work published against the criticism of anonymous referees, they find themselves, by psychological role-reversal, on the other side of the fence. Thus do we eventually internalize the “scientific attitude.”

*Reliable Knowledge*  
Chapter 6 (fn 13, p. 132)  
Cambridge University Press, Cambridge, England. 1978

## SCIENTIFIC PURSUIT

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

My life has been divided between the service of science and that of my country. I would rather have remained the servant of science alone; but, sprung from the obscure ranks of democracy, I have always thought that my country had done so much for me that no devotion on my part could be refused to it. If I have deceived myself, science itself will not hold me guilty. In limiting myself to scientific pursuits, I should have been happier, my life would have been a less anxious one, and perhaps I should have attained a larger view of truth.

Quoted in Thomas Edward Thorpe  
*Essays in Historical Chemistry*  
Chapter XI (p. 361)  
Macmillan & Co Ltd. London, England. 1902

**Shelley, Mary Wollstonecraft** 1797–1851  
English Romantic writer

None but those who have experienced them can conceive of the enticements of science. In other studies you go as far as others have gone before you, and there is nothing

more to know; but in a scientific pursuit there is continual food for discovery and wonder.

*Frankenstein: Or, The Modern Prometheus*

Chapter IV (p. 68)

George Routledge & Sons, London, England. 1888

## SCIENTIFIC RESEARCH

**Davy, Sir Humphry** 1778–1829

English chemist

When, by the unrivalled power of one great genius, and the industry and talent of his illustrious disciples, the laws of the motions of the great masses of matter composing the universe were discovered, and most of the physical phenomena connected with them solved, it appeared as if the field of scientific research were exhausted, as if the rich crops taken from the soil had rendered it sterile, and that little was left for the ingenuity and labour of future inquirers; time, however, has proved how unfounded was this opinion, and how nearly approaching to infinite, are the objects of natural philosophy.

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* Volume 7

Address of the President (pp. 7–8)

Smith, Elder & Co. London, England. 1840

**Gore, George** 1826–1909

English electrochemist

Scientific research deals fearlessly, not only with things that lie beyond our senses and observation, but also with those which altogether surpass even our conception or imagination; such as extremely minute and immensely great magnitudes, distances and velocities.

*The Art of Scientific Discovery*

Part I, Chapter I (p. 6)

Longmans, Green & Co. London, England. 1878

## SCIENTIFIC RESULTS

**Witt, Otto N.** 1875–1923

German chemist

...scientific results are like the grains of sand, the importance of which lies in their aggregation.

Evolution in Applied Chemistry

*Nature*, Volume 81, Number 2071, July 8, 1909

## SCIENTIFIC REVOLUTION

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The most important scientific revolutions all include, as their only common feature, the dethronement of human arrogance from one pedestal after another of previous convictions about our centrality in the cosmos.

*Dinosaur in a Haystack: Reflections in Natural History*

Jove's Thunderbolts (p. 164)

Three Rivers Press. New York, New York, USA. 1995

**Casimir, Hendrik B. G.** 1909–2000

Dutch physicist

Scientific revolutions are not made by scientists. They are declared post factum, often by philosophers and historians of science rather than by the scientists themselves.

*Haphazard Reality*

Chapter 2 (p. 33)

Harper & Row. New York, New York, USA. 1983

## SCIENTIFIC SOCIETY

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

To say that we live in an age of science is a commonplace, but like most commonplaces it is only partially true. From the point of view of our predecessors, if they could view our society, we should, no doubt, appear to be very scientific, but from the point of view of our successors it is probable that the exact opposite would seem to be the case.

*The Scientific Outlook*

Introduction (p. 9)

George Allen & Unwin. London, England. 1931

## SCIENTIFIC SPIRIT

**Bernard, Claude** 1813–78

French physiologist

In my opinion the true scientific spirit is that whose high aspiration fertilize the sciences and draw them on in search of truths which are still beyond them but which must not be suppressed, because they have been attacked by stronger and more delicate philosophic minds.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 223)

Henry Schuman, Inc. New York, New York, USA. 1927

**Burroughs, John** 1837–1921

American naturalist and essayist

The scientific spirit, when applied to historical research, is – like chemistry applied to agriculture – valuable, but good crops have been and can be grown without it.

Arnold on Emerson and Carlyle

*The Century*, Volume XXVII (p. 926)

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

There is no scientific discoverer, no poet, no painter, no musician, who will not tell you that he found ready made his discovery or poem or picture – that it came to him from outside, and that he did not consciously create it from within.

In Leslie Stephen and Frederick Pollock (eds.)  
*Lectures and Essays* (Volume 1)  
 Some of the Conditions of Mental Development (p. 99)  
 Macmillan & Company Ltd. London, England. 1879

The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.

In Leslie Stephen and Frederick Pollock (eds.)  
*Lectures and Essays* (Volume 1)  
 On the Aims and Instruments of Scientific Thought (p. 126)  
 Macmillan & Company Ltd. London, England. 1879

**Compton, Arthur H.** 1892–1962  
 American physicist

The spirit of science knows no national or religious boundaries, and it is thus a powerful force for the peace of the world.

*Les Prix Nobel. The Nobel Prizes in 1927*  
 Nobel banquet speech for award received in 1927  
 Nobel Foundation. Stockholm, Sweden. 1928

**Darwin, Sir George Howard** 1845–1912  
 English astronomer and mathematician

The problems involved in the origin and history of the solar and of other celestial systems have little bearing upon our life on the earth, yet these questions can hardly fail to be of interest to all those whose minds are in any degree permeated by the scientific spirit.

*The Tides and Kindred Phenomena in the Solar System*  
 Preface (p. vi)  
 Houghton Mifflin & Co. Boston, Massachusetts, USA. 1898

**Franklin, Benjamin** 1706–90  
 American printer, scientist, and diplomat

Furnished as all Europe now is with Academies of Science, with nice instruments and the spirit of experiment, the progress of human knowledge will be rapid and discoveries made of which we have at present no conception. I begin to be almost sorry I was born so soon, since I cannot have the happiness of knowing what will be known a hundred years hence.

*The Writings of Benjamin Franklin*  
 Letter, July 27, 1783, to naturalist Sir Joseph Banks (p. 74)  
 Macmillan & Company Ltd. London, England. 1906

**Garrod, Archibald** 1857–1936  
 English physician

...scientific method is not the same as the scientific spirit. The scientific spirit does not rest content with applying that which is already known, but is a restless spirit, ever pressing forward towards the regions of the unknown....

*Archibald Garrod and the Individuality of Man*  
 Chapter 7 (p. 82)  
 Clarendon Press. Oxford, England. 1993

**Hocking, W. E.** 1873–1966  
 American philosopher

We are scientific people and we want our students to feel the enthusiasm and promise of the scientific method. We

want them to feel the moral quality of exact technique, as exact as the subject matter permits. We want them to feel that science is a spiritual experience.

In Lloyd William Taylor  
*Physics: The Pioneer Science* (Volume 1)  
 Chapter 6 (p. 63)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Huxley, Thomas Henry** 1825–95  
 English biologist

...the scientific spirit is of more value than its products, and irrationally held truths may be more harmful than reasoned errors. Now the essence of the scientific spirit is criticism. It tells us that whenever a doctrine claims our assent we should reply, "Take it if you can compel it." The struggle for existence holds as much in the intellectual as in the physical world. A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

*Collected Essays* (Volume 2)  
*Darwiniana*  
 The Coming of Age of "The Origin of Species" (p. 229)  
 Macmillan & Company Ltd. London, England. 1904

**Millikan, Robert Andrews** 1868–1953  
 American physicist

The God of science is the Spirit of rational order, and of orderly development. Atheism as I understand it is the denial of the existence of the spirit. Nothing could therefore be more antagonistic to the whole spirit of science.

*Evolution in Science and Religion*  
 Chapter III (p. 88)  
 Yale University Press. New Haven, Connecticut, USA. 1927

**Mivart, St. George Jackson** 1827–1900  
 English biologist

The scientific spirit is, above all, an inquiring spirit. It can never rest satisfied with what has become known, but must ever press on in all directions into fields of truth yet unexplored, and even seek to ascend into regions commonly deemed inaccessible to human research.

*The Groundwork of Science; A Study of Epistemology*  
 Chapter I (p. 1)  
 G.P. Putnam's Sons. New York, New York, USA. 1898

**Peirce, Charles Sanders** 1839–1914  
 American scientist, logician, and philosopher

...the scientific spirit requires a man to be at all times ready to dump his whole cartload of beliefs, the moment experience is against them.

In Justus Buchler (ed.)  
*Philosophical Writings of Peirce*  
 Chapter 4 (pp. 46–47)  
 Dover Publications, Inc. New York, New York, USA. 1955

**Rabi, Isidor Isaac** 1898–1988  
 Austrian-born American physicist

The essence of the scientific spirit is to use the past only as a springboard to the future.

In A.A. Warner, Dean Morse, and T.E. Cooney (eds.)  
*The Environment of Change*  
 The Revolution in Science (p. 47)  
 Columbia University Press. New York, New York, USA. 1969

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

The scientific spirit is not an affair of quotation, of externally acquired information, anymore than manners are an affair of the etiquette-book.

*Mysticism and Logic: And Other Essays*  
 Chapter II (pp. 43–44)  
 Longmans, Green & Co. London, England. 1939

To say that we live in an age of science is a commonplace, but like most commonplaces it is only partially true. From the point of view of our predecessors, if they could view our society, we should, no doubt, appear to be very scientific, but from the point of view of our successors it is probable that the exact opposite would seem to be the case.

*The Scientific Outlook*  
 Introduction (p. 9)  
 George Allen & Unwin. London, England. 1931

**Swain, Joseph**  
 No biographical data available

A greater gain to the world perhaps than all the gain of scientific knowledge is the growth of the scientific spirit, with its courage and serenity, its discipline of conscience, its intellectual morality and its habitual response to any disclosure of the truth.

Moral Training Thru the Agency of the Public School  
*Addresses and Proceedings – National Education Association of the United States*  
 Discussion by Joseph Swain (p. 383)  
 National Education Association  
 1907

**Weisskopf, Victor Frederick** 1908–2002  
 Austrian-American physicist

Science, of course, is not the only way of giving sense to our lives. Art does it; so does religion. But when this sense is missing, that's when spiritual pollution is present, when people don't know why they are here. We can have leisure time diversions, of course. But until we learn to fill the vacuum in our minds with content – with meaning, with sense – we will never find solutions to our problems.

*The Privilege of Being a Physicist*  
 Chapter 13 (p. 107)  
 W.H. Freeman & Company. New York, New York, USA. 1989

**Whitman, Walt** 1819–92  
 American poet, journalist, and essayist

I like the scientific spirit – the holding off, the being sure but not too sure, the willingness to surrender ideas when the evidence is against them: this is ultimately fine – it always keeps the way beyond open – always gives life, thought, affection, the whole man, a chance to try over again after a mistake – after a wrong guess.

In Horace Traubel  
*Walt Whitman's Camden Conversations* (pp. 168–169)  
 Rutgers University Press. New Brunswick, New Jersey, USA. 1973

## SCIENTIFIC STUDY

**Chamberlin, Thomas Chrowder** 1843–1928  
 American geologist

The distinction between scientific study and the study of science is much the same as that between creative scholarship and acquisitive scholarship; between modern research and ancient erudition.

The Ethical Functions of Scientific Study  
*The Journal of Geology*, Volume 2, Number 6, December, 1888 (p. 382)

## SCIENTIFIC TEACHING

**Lasalle, Ferdinand** 1825–64  
 German jurist and socialist political activist

Unrestrained freedom of scientific teaching is...not only an inalienable right of the individual, but, what is more to the point, it is, primarily and most particularly, a necessity of life to the community; it involves the life of the State itself.

Translated by Thorstein B. Veblen  
 In Kuno Francke and Isidore Singer  
*The German Classics: Masterpieces of German Literature Translated Into English*  
 Science and the Workingmen (p. 436)  
 The German Publication Society. New York, New York, USA. 1914

## SCIENTIFIC TECHNIQUE

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

The essential characteristic of scientific technique is the utilization of natural forces in ways not evident to the totally uninstructed.

*The Scientific Outlook*  
 Chapter VI (p. 141)  
 George Allen & Unwin. London, England. 1931

The tendency of scientific technique is to cause everything to be regarded as not just a brute datum, but raw material for the carrying out of some human purpose.

*The Scientific Outlook*  
 Chapter IX (p. 177)  
 George Allen & Unwin. London, England. 1931



## SCIENTIFIC THEORY

**Frazer, Sir James** 1854–1941  
Scottish social anthropologist

...the history of thought should warn us against concluding that because the scientific theory of the world is the best that has yet been formulated, it is necessarily complete and final. We must remember that at bottom the generalizations of science or, in common parlance, the laws of nature are merely hypotheses devised to explain that ever-shifting phantasmagoria of thought which we dignify with the high-sounding names of the world and the universe. In the last analysis magic, religion, and science are nothing but theories of thought; and as science has supplanted its predecessors, so it may hereafter be itself superseded by some more perfect hypothesis

*The Golden Bough* Volume 2

Chapter XIII (p. 306)

Macmillan & Co Ltd. London, England. 1913

### Reich, Wilhelm

...scientific theory is a contrived foothold in the chaos of living phenomena.

*The Function of the Orgasm* (Volume 1)

Chapter II (pp. 39–40)

The Macmillan Company. New York, New York, USA. 1973

## SCIENTIFIC THINKERS

**Clifford, William Kingdon** 1845–79  
English mathematician

...the world in general, contains three classes of persons. In the first place, it contains scientific thinkers; that is to say, persons whose thoughts have very frequently the characters which I shall presently describe. Secondly, it contains persons who are engaged in work upon what are called scientific subjects, but who in general do not, and are not expected to, think about these subjects in a scientific manner. Lastly, it contains persons who suppose that their work and their thoughts are unscientific, but who would like to know something about the business of the other two classes aforesaid.

*Lectures and Essays, by the Late William Kingdon Clifford*

On the Aims and Instruments of Scientific Thought (p. 85)

Macmillan & Co Ltd. London, England. 1886

## SCIENTIFIC THOUGHT

### Advertisement

Scientific thought deeply influences over everyday life; it is important to our spiritual life, rational and aesthetic, and affords a more intimate insight into the source of all human thought and artistic creation.

Advertisement by The New School for Social Research

*Scientific American*, Volume 2, Number 2, February, 1961 (p. 85)

**Boone, Richard Gause** 1849–1923  
American educator

Scientific thought is no more the province of the physicist than of the philanthropist; it no more belongs to botany than to ethics; to diatoms, than to the Decalogue.

*Science of Education*

Part II, Chapter XIV (p. 186)

Charles Scribner's Sons. New York, New York, USA. 1904

**Clifford, William Kingdon** 1845–79  
English mathematician

...scientific thought does not mean thought about scientific subjects with long names. There are no scientific subjects. The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.

In Leslie Stephen and Frederick Pollock

*Lectures and Essays, by the Late William Kingdon Clifford* (2nd edition)

On the Aims and Instruments of Scientific Thought (p. 86)

Macmillan & Co Ltd. London, England. 1886

...scientific thought is not an accompaniment or condition of human progress, but human progress itself.

*Lectures and Essays, by the Late William Kingdon Clifford* (2nd edition)

On the Aims and Instruments of Scientific Thought (p. 109)

Macmillan & Co Ltd. London, England. 1886

**Einstein, Albert** 1879–1955  
German-born physicist

Scientific thought is a development of pre-scientific thought.

*Essays in Science*

The Problem of Space, Ether, and the Field in Physics (p. 61)

Philosophical Library. New York, New York, USA. 1934

### Hill, Alexander

No biographical data available

There is a limit beyond which scientific thought cannot penetrate; not because the outer realm does not appertain to science, but because experience which bears up thought with varying degrees of firmness – just as matter in its several conditions of aggregation, solid, liquid, gaseous, supports animals which stand, swim, fly – becomes too rarified a medium for human intelligence to mount in.

*Introduction to Science*

Chapter I (p. 12)

The Macmillan Co. New York, New York, USA. 1900

**Tyndall, John** 1820–93  
Irish-born English physicist

I have thus led you to the outer rim of speculative science, for beyond the nebulae scientific thought has never ventured hitherto, and have tried to state that which I considered ought, in fairness, to be outspoken.

*The World's Best Orations: From the Earliest Period to the Present Time* (Volume 9)

The Origin of Life (p. 3667)

Ferd. P. Keiser. St. Louis, Missouri, USA. 1899



**Timiriacheff, C. A.**

Russian botanist

Scientific thought, like every other form of mental activity, can work only under conditions of absolute liberty. Oppressed by the weight of utilitarian demands, science can produce but pitiable artificial work, after the same kind as any meagre and mechanical work of art fashioned under similar circumstances.

Translated by Anna Sheremeteva

*Die Sinne der Pflanzen*

Chapter I (p. 9)

Longmans, Green &amp; Co. London, England. 1912

**SCIENTIFIC THOUGHT: HISTORY OF****Jammer, Max** 1915–

Israeli physicist and philosopher

...the study of the history of scientific thought is most essential to a full understanding of the various aspects and achievements of modern culture. Such understanding is not to be reached by dealing with the problems of priority in the history of discoveries, the details of the chronology of inventions, or even the juxtaposition of all the histories of the particular sciences. It is the history of scientific thought in its broadest perspective against the cultural background of the period which has decisive importance for the modern mind.

*Concepts of Space* (2nd edition)

Preface to the First Edition (p. vii)

Harvard University Press. Cambridge, Massachusetts, USA. 1969

**SCIENTIFIC TRAINING****Huxley, Thomas Henry** 1825–95

English biologist

The introduction of scientific training into the general education of the country is a topic upon which I could not have spoken without some more or less apologetic introduction a few years ago. But upon this, as upon other matters, public opinion has of late undergone a rapid modification. Committees of both houses of the Legislature have agreed that something must be done in this direction, and have even thrown out timid and faltering suggestions as to what should be done; while at the opposite pole of society, committees of working-men have expressed their conviction that scientific training is the one thing needful for their advancement, whether as men or as workmen.

Scientific Education: Notes of an After-Dinner Speech

*The Eclectic Magazine*, New Series, Volume X, July-December, 1869

(p. 150)

...if scientific training is to yield its most eminent results,

it must, I repeat, be made practical. That is to say, in explaining to a child the general phenomena of nature, you must, as far as possible, give reality to your teaching by object-lessons ...

Scientific Education: Notes of an After-Dinner Speech

*The Eclectic Magazine*, New Series, Volume X, July-December, 1869

(p. 155)

**SCIENTIFIC TRENDS****Cooper, Leon** 1930–

American physicist

I like to say sometimes that scientific fashion is like fashion in men's and women's clothes.... One year the ties are wide; the next year they're narrow. One year the skirts are high; the next year they're low. And if everyone is wearing a short skirt, you're just hopelessly out of fashion if you're wearing a long skirt. That's the way it sometimes seems with science. You want to be in the middle of what everyone is talking about; you want to be in the mainstream. And the next year it might be something completely different.

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*

A Model of Memory (p. 149)

Alfred A. Knopf. New York, New York, USA. 1991

**SCIENTIFIC TRUTH****Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

...the time has come when scientific truth must cease to be the property of the few, when it must be woven into the common life of the world; for we have reached the point where the results of science touch the very problem of existence, and all men listen for the solving of that mystery.

*Methods of Study in Natural History*

Chapter IV (p. 42)

Ticknor &amp; Fields. Boston, Massachusetts, USA. 1863

**Black, Max** 1909–88

Anglo-American philosopher

Scientists can never hope to be in a position to know the truth, nor would they have any means of recognizing it if it came into their possession.

*Critical Thinking: An Introduction to Logic and Scientific Method*

Chapter 19 (p. 396)

Prentice-Hall. New York, New York, USA. 1952

**Broad, William** 1951–

Science writer

**Wade, Nicholas**

British-born scientific writer

Like any other profession, science is ridden with clannishness and clubbiness. This would be in no way surprising, except that scientists deny it to be the case. The pursuit of scientific truth is held to be a universal quest that recognizes neither national boundaries nor the barriers of race, creed or class. In fact, researchers tend to organize themselves into clusters of overlapping clubs.

*Betrayers of the Truth*

Chapter 9 (p. 180)

Simon &amp; Schuster. New York, New York, USA. 1982

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The initial incommunicability of truth, scientific or otherwise, shows that we think in groves, and that it is painful for us to be torn away from the womblike security of accepted concepts.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part II

The Exquisiteness of Minute Differences (p. 86)

Rockefeller University Press. New York, New York, USA. 1978

**Crichton, Michael** 1942–

American novelist

Scientists have an elaborate line of bullshit about how they are seeking to know the truth about nature.

*Jurassic Park*

Aviary (p. 284)

Alfred A. Knopf. New York, New York, USA. 1990

**de Gubernatis, Giuseppe Angelo**

No biographical data available

A scientific truth requires years and sometimes centuries of demonstration before it can obtain for itself general acceptance, and, rather than suffer martyrdom, its defender will generally prefer to succumb to the infamous papal motto of “Laudabiliter se subiecit;” but an error that is founded upon a sense of the supernatural does not need the electric wires to flash it from heart to heart and awaken a response in the credulous world; while the ponderous dialectics of an entire army of rationalists will not thereafter suffice to dislodge it.

*Zoological Mythology; or, The Legends of Animals*

Preface (pp. xi–xii)

Trübner &amp; Co. London, England. 1872

**Disraeli, Benjamin, First Earl****of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Scientific like spiritual truth has ever from the beginning been descending from Heaven to man.

*Lothair*

Introduction (pp. xvii–xviii)

Longmans, Green &amp; Co. London, England. 1879

**Dunne, Finley Peter** 1867–1936

American journalist and humorist

There’s always wan encouragin’ thing about th’ sad scientific facts that come out ivry week in th’ pa-apers. They’re usually not throe.

*Mr. Dooley on Making a Will and Other Necessary Evils*

On the Descent of Man (p. 90)

Charles Scribner’s Sons. New York, New York, USA. 1919

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Amid all our faulty attempts at expression the kernel of scientific truth steadily grows; and of this truth it may be said – The more it changes, the more it remains the same.

*The Nature of the Physical World*

Conclusion (p. 353)

The Macmillan Company. New York, New York, USA. 1930

**Editor**

The practical development of a scientific truth is somewhat like the growth from a new seed. We recognize the existence of the plant, we ascertain some of its virtues, but we cannot tell its full uses, how soon it will mature, nor how large the tree will be.

In James Means

*The Aeronautical Annual*

Samuel Pierpoint Langley (p. 9)

W.B. Clarke &amp; Co. Boston, Massachusetts, USA. 1896

**Einstein, Albert** 1879–1955

German-born physicist

It is difficult even to attach a precise meaning to the term “scientific truth.” Thus the meaning of the word “truth” varies according to whether we deal with a fact of experience, a mathematical proposition, or a scientific theory. “Religious truth” conveys nothing clear to me at all.

*Ideas and Opinions*

On Scientific Truth (p. 261)

Crown Publishers, Inc. New York, New York, USA. 1954

**Feynman, Richard P.** 1918–88

American theoretical physicist

No government has the right to decide on the truth of scientific principles, nor to prescribe in any way the character of the questions investigated.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter II (p. 57)

Perseus Books. Reading, Massachusetts, USA. 1998

**Foster, Sir Michael** 1836–1907

English physiologist

...no scientific truth is born anew, coming by itself and of itself. Each new truth is always the offspring of something which has gone before, becoming in turn the parent of something coming after.

In Robert Emmons Rogers  
*The Voice of Science in Nineteenth-century Literature*  
 The Growth of Science in the Nineteenth Century (p. 38)  
 The Atlantic Monthly Press. Boston, Massachusetts, USA. 1921

**Geikie, Sir Archibald** 1835–1924  
 English geologist

In scientific as in other mundane questions there may often be two sides, and the truth may ultimately be found not to lie wholly with either.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1892*  
 Geological Change and Time (p. 125)  
 Government Printing Office. Washington, D.C. 1893

**Gesenius, Wilhelm** 1786–1842  
 German orientalist and biblical critic

Unwearied personal observation and an impartial examination of the researches of others; the grateful admission and adoption of every real advance and illustration of science; but also a manly foresight and caution, which does not with eager levity adopt every novelty thrown out in haste and from the love of innovation, all these must go hand in hand, wherever scientific truth is to be successfully promoted.

*Hebrew Grammar*  
 Preface (p. 7)  
 Gould, Kendall & Lincoln. Boston, Massachusetts, USA. 1834

**Gore, George** 1826–1909  
 English electrochemist

In order to attain scientific truth by means of study, the mind must contain clear ideas of the great principles of nature, systematically arranged in their order of degrees of intrinsic importance, and be experienced in tracing their relations and consequences.

*The Art of Scientific Discovery*  
 Part III, Chapter XXXI (p. 305)  
 Longmans, Green & Co. London, England. 1878

**Gregory, Sir Richard Arman** 1864–1952  
 British science writer and journalist

Scientific truth is not won by prayer and fasting, but by patient observation and persistent inquiry.

*Discovery; or, The Spirit and Service of Science*  
 Chapter I (p. 12)  
 Macmillan & Company Ltd. London, England. 1918

It is necessary to believe in the holiness of scientific work in order to preserve to the end; for without the encouragement which such belief gives, many investigators would fall by the wayside.

*Discovery; or, The Spirit and Service of Science*  
 Chapter I (pp. 12–13)  
 Macmillan & Company Ltd. London, England. 1918

**Hawkins, Michael** 1942–  
 British astrophysicist

“Scientific truths” is simply another way of saying “the fittest, most beautiful, and most elegant survivors of scientific debate and testing.”

*Hunting Down the Universe: The Missing Mass, Primordial Black Holes, and Other Dark Matters*  
 Chapter 1 (p. 6)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

**Hoagland, Hudson** 1899–1982  
 American physiologist

In a scientific oriented society the quest for truth is the important thing, even though we know that ultimate, final truth with a capital T is not to be found.

Science and the New Humanism  
*Science*, Volume 143, Number 3062, 10 January, 1964 (p. 112)

### Inscription

The works of those who have stood the test of ages have a claim to that respect and veneration to which no modern can pretend.

On the dome of the National Gallery

**Jeffers, Robinson** 1887–1962  
 American poet

...they work alongside the truth  
 Never touching it; their equations are false

But the things work.

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 3)  
 The Mathematicians and Physics Men (p. 459)  
 Stanford University Press. Stanford, California, USA. 1988

**Lee, Oliver Justin** 1881–1964  
 American astronomer

The truth to a scientist is not the vague metaphysical concept about which philosophers talk and write so much and know so little. To him truth is that body of statements and conclusions about any set of features and phenomena in nature which represent most accurately all the best observations he can make and which conform most closely to all findings in adjacent or related phases and fields of investigations. He may and does often wonder what the so-called ultimate truth may be, but he does not worry about it. He knows that a priori pure thinking will never reveal it so far as knowledge of the physical universe is concerned, and that observation and deduction alone in the manner of science will ever do it.

*Measuring Our Universe: From the Inner Atom to Outer Space*  
 Chapter 14 (pp. 149–150)  
 The Ronald Press Company. New York, New York, USA. 1950

**Lerner, Eric J.** 1947–  
American popular science book

The only test of scientific truth is how well a theory corresponds to the world we observe. Does it predict things that we can then see? Or do our observations of nature show things that a theory says are impossible? No matter how well liked a theory may be, if observation contradicts it, then it must be rejected. For science to be useful, it must provide an increasingly true and deep description of nature, not a prescription of what nature must be.

*The Big Bang Never Happened*

Part One, Chapter 1 (p. 12)

Time Books. New York, New York, USA. 1991

**Maxwell, James Clerk** 1831–79  
Scottish physicist

For the sake of these different types, scientific truth should be presented in different forms, and should be regarded as equally scientific, whether it appears in the robust form of vivid colouring of a physical illustration, or in the tenuity and paleness of a symbolical expression.

*The Collected Papers of James Clerk Maxwell* (Volume 2)

Chapter XLI, Address to the Mathematical and Physical Sections of the British Association, September 15, 1870 (p. 220)

At The University Press. Cambridge, England. No data

**Mendeléeff, Maria** ca. 1800–ca. 1850  
Siberian factory manager and mother of Russian chemist Dmitri Mendeléeff

Refrain from illusions, insist on work, and not on words, patiently search divine and scientific truth.

In Benjamin Harrow

*Eminent Chemists of Our Time*

Dmitri Ivanowitch Mendeléeff (p. 22)

D. van Nostrand Company, Inc. New York, New York, USA. 1927

**Playfair, Lyon** 1818–98  
Scottish scientist and Parliamentarian

Nothing is more erroneous in their case than to neglect the acquisition of abstract scientific truths because they appear remote from practice.

*Records of the School of Mines and of Science Applied to the Arts*

(Volume 1), Part I

The Study of Abstract Science (p. 27)

Longman, Brown, Green & Longmans. London, England. 1852

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

For a superficial observer, scientific truth is beyond the possibility of doubt; the logic of science is infallible, and if the scientists are sometimes mistaken, this is only from their mistaking its rules.

*The Foundations of Science*

*Science and Hypothesis*, Introduction (p. 27)

The Science Press. New York, New York, USA. 1913

...scientific truth, which is demonstrated, can in no way be likened to moral truth, which is felt.

The Value of Science  
*The Popular Science Monthly*, Volume LXIX, Number 3, September, 1906 (p. 194)

**Raymo, Chet** 1936–  
American physicist and science writer

Science is not a smorgasbord of truths from which we can pick and choose.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 16 (p. 144)

The Viking Press. New York, New York, USA. 1991

Scientific truths are tentative and partial, and subject to continual revision and refinement, but as we tinker with truth in science – amending here, augmenting there – we always keep our ear attuned to the timbre of the web.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 16 (p. 145)

The Viking Press. New York, New York, USA. 1991

**Renan, Ernest** 1823–92  
French philosopher and Orientalist

Orthodox people have as a rule very little scientific honesty. They do not investigate, they try to prove, and this must necessarily be so. The result has been given to them beforehand; this result is true, undoubtedly true. Science has no business with it, science which starts from doubt without knowing whether it is going, and gives itself up bound hand and foot to criticism which leads it where-soever it lists.

*The Future of Science*

Chapter III (p. 33)

Roberts Brothers. Boston, Massachusetts, USA. 1893

**Serge, Corrado**  
No biographical data available

Many times a scientific truth is placed as it were on a lofty peak, and to reach it we have at our disposal at first only dark paths along perilous slopes whence it is easy to fall into the abysses where dwells error; only after we have reached the peak by these paths is it possible to lay out safe roads which lead there without peril. Thus it has frequently happened that the first way of obtaining a result has not been quite satisfactory, and that only afterwards did the science succeed in completing the demonstration.

On Some Tendencies in Geometric Investigations

*Bulletin of the American Mathematical Society*, 2nd Series, Volume 10,

June, 1904 (pp. 453–454)

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

In the Middle Ages people believed that the earth was flat, for which they at least had the evidence of their senses: we believe it to be round, not because as many as one percent of us could give the physical reasons

for so quaint a belief, but because modern science has convinced us that nothing that is obvious is true, and that everything that is magical, improbable, extraordinary, gigantic, microscopic, heartless, or outrageous is scientific.

*Man and the Gods: Three Tragedies*

Saint Joan, Preface, *The Real Joan Is Not Marvellous for Us* (p. 132)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1964

### **Spencer, Herbert** 1820–1903

English social philosopher

Scientific truths, of whatever order, are reached by eliminating perturbing or conflicting factors, and recognizing only fundamental factors.

*The Data of Ethics*

Chapter XV, Section 104 (p. 311)

William & Norgate. London, England. 1907

### **Thomas, Lewis** 1913–93

American physician and biologist

The only solid piece of scientific truth about which I feel totally confident is that we are profoundly ignorant about nature.

*The Medusa and the Snail: More Notes of a Biology Watcher*

The Hazard of Science (p. 73)

The Viking Press. New York, New York, USA. 1979

### **Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The eye which can appreciate the naked and absolute beauty of a scientific truth is far more rare than that which is attracted by a moral one. Few detect the morality in the former, or the science in the latter.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimack Rivers*

Friday (p. 476)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Weaver, Warren** 1894–1978

American mathematician

...[one] finds unresolved and apparently unresolvable disagreement among scientists concerning the relationship of scientific thought to reality – and concerning the nature of reality itself...that the explanations of science have utility, but that they do in sober fact not explain. He finds that the old external appearance of inevitability completely vanished, for he discovers a charming capriciousness in all the individual events. He finds that logic, so generally supposed to be infallible and unassailable, is in fact shaky and incomplete. He finds that the whole concept of objective truth is a will-o-the-wisp.

The Imperfections of Science

*American Scientist*, Volume 49, 1961 (pp. 99–113)

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Scientific truth is the remotest of mistresses; She hides in strange places, she is attained by tortuous and laborious roads, but she is always there! Win to her and she will not fail you; she is yours and mankind's forever. She is reality, the one reality I have found in this strange disorder of existence...

*Tono-Bungay*

Book the Third, Chapter the Third, I (p. 324)

Duffield & Company. New York, New York, USA. 1921

## SCIENTIFIC VIEWS

### **Feynman, Richard P.** 1918–88

American theoretical physicist

Scientific views end in awe and mystery, lost at the edge in uncertainty, but they appear to be so deep and so impressive that the theory that it is all arranged as a stage for God to watch man's struggle for good and evil seems inadequate.

*The Meaning of It All*

Chapter II (p. 39)

Perseus Books. Reading, Massachusetts. USA. 1998

## SCIENTIFIC VISION

### **Brown, Robert Hanbury** 1916–2002

English astronomer and physicist

We must make it clear that the scientific vision of the world is neither a rival nor an alternative to any other point of view, but is an essential part of learning to be at home in this mysterious universe.

*Man and the Stars*

Chapter 5 (p. 176)

Oxford University Press. Oxford, England. 1978

## SCIENTIFIC WORK

### **Einstein, Albert** 1879–1955

German-born physicist

To be sure, it is not the fruits of scientific research that elevate a man and enrich his nature, but the urge to understand, the intellectual work, creative or receptive.

*Ideas and Opinions*

Good and Evil (p. 12)

Crown Publishers, Inc. New York, New York, USA. 1954

### **Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The concept that the scientific worker can regard himself as an inert item in a vast co-operative concern working according to accepted rules is encouraged by directing attention away from his duty to form correct scientific conclusions, to summarize them and to communicate them to his scientific colleagues, and by stressing his



supposed duty mechanically to make a succession of automatic “decisions”...

*Statistical Methods and Scientific Inference*

Chapter IV (p. 101)

Hafner Publishing Company, New York, New York, USA. 1959

**Gregory, Sir Richard Arman** 1864–1952

English scientific writer and journalist

Scientific work must...be carried on with an open mind, uninfluenced by preconceived ideas, critical of its own observations, cautious in arriving at conclusions from them, and ready to revise any statement which has not stood the test of further experiment or reasoning.

*Discovery, Or, The Spirit and Service of Science*

Chapter I (p. 12)

Macmillan & Co Ltd. London, England. 1918

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Take from your scientific work a serious and incorruptible method of thought, help to spread it, because no understanding is possible without it. Revere those things beyond science which really matter and about which it is so difficult to speak.

*Philosophic Problems of Nuclear Science*

Chapter 8 (p. 128)

Faber & Faber Ltd. London, England. 1952

**Huxley, Thomas Henry** 1825–95

English biologist

The only people, scientific or other, who never make mistakes are those who do nothing.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

An Episcopal Trilogy (p. 156)

Macmillan & Company Ltd. London, England. 1904

**Lorand, Arnold**

American physician and prolongevity advocate

...we have often observed in persons whose lives have been devoted to serious scientific work, which has entirely absorbed them, a total absence of sexual desire for a long time, and even impotence.

*Old Age Deferred*

Chapter XLIX (p. 399)

F.A. Davis Company, Publishers, Philadelphia, Pennsylvania, USA. 1911

**Payne-Gaposchkin, Cecelia** 1900–79

British-American astronomer

Do not undertake a scientific career in quest of fame or money. There are easier and better ways to reach them. Undertake it only if nothing else will satisfy you; for nothing else is probably what you will receive. Your reward will be the widening of the horizon as you climb. And if you achieve that reward you will ask no other.

*Cecilia Payne-Gaposchkin: An Autobiography and Other Recollections*

Chapter 22 (p. 227)

Cambridge University Press. New York, New York, USA. 1984

**Rosenthal-Schneider, Ilse** 1891–1990

German physicist and author of history and philosophy of science

The deep satisfaction found in scientific work, akin to the delight derived from genuine art, is one of the fundamental human emotions which is highly intensified by personal contact with the creative mind.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Presuppositions and Anticipations in Einstein's Physics (p. 145)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Snow, Charles Percy** 1905–80

English novelist and scientist

Scientific work...has a value of its own, whether you're liking it or not. It's – there. It's permanent. It's work which is always going to last. It's a real creation.

*The Search*

Part IV, Chapter II, Section II (p. 326)

The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1935

**Weber, Max** 1864–1920

German founder of modern sociology and economic thinker

In science, each of us knows that what he has accomplished will be antiquated in ten, twenty, fifty years. That is the fate to which science is subjected; it is the very meaning of scientific work, to which it is devoted in a quite specific sense, as compared with other spheres of culture.... Every scientific “fulfillment” raises new “questions”; it asks to be surpassed and outdated. Whoever wishes to serve science has to resign himself to this fact.... We cannot work without hoping that others will advance further than we have.

In H.H. Gerth and C. Wright Mills (eds.)

*From Max Weber: Essays in Sociology*

Science as a Vocation (p. 138)

Oxford University Press, Inc. New York, New York, USA. 1970

## SCIENTIFIC WORKER

**Foster, Sir Michael** 1836–1907

English physiologist

[The scientific worker] must be alert of mind. Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint, however small, to listen to her whisper, however low.

Presidential Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 130)

[The scientific worker's] nature must be one which vibrates in unison with that of which he is in search; the seeker after truth must himself be truthful, truthful with the truthfulness of nature; which is far more imperious, far more exacting than that which man sometimes calls truthfulness.



Presidential Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 130)

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The scientific worker has elected primarily to know, not do. He does not *directly* seek, like the practical man, to realize the ideal of exploiting nature and controlling life – though he makes this more possible; he seeks rather to idealize – to conceptualize – the real, or at least those aspects of reality that are available in his experience. He thinks more of lucidity and formulae than of loaves and fishes. He is more concerned with knowing Nature than with enjoying her. His main intention is to describe the sequences in Nature in the simplest possible formulae, to make a working thought-model of the known world. He would make the world translucent, not that emotion may catch the glimmer of the indefinable light that shines through, but for other reasons – because of his inborn inquisitiveness, because of his dislike of obscurities, because of his craving for a system – an intellectual system in which phenomena are at least provisionally unified.

*Introduction to Science*

Chapter I (pp. 13–14)

Henry Holt & Co. New York, New York, USA. 1911

## SCIENTIFIC WORKSHOP

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

The scientific workshop is full of discarded keys.

*Introduction to Science*

Chapter III (p. 69)

Henry Holt & Co. New York, New York, USA. 1911

## SCIENTIFIC WORLD

### Author undetermined

The scientific world is like a colony of insects, in that the individual strives to produce that which he himself cannot hope to enjoy. One generation collects premises in order that a distant generation may discover what they mean. When a problem comes before the scientific world, a hundred men immediately set all their energies to work upon it. One contributes this, another that. Another company, standing upon the shoulders of the first, strike a little higher, until at last the parapet is attained.

In James Mark Baldwin

*Dictionary of Philosophy and Psychology* (Volume 2)

Scientific Method (p. 502)

The Macmillan Co. New York, New York, USA. 1902

**Baldwin, J. Mark** 1861–1934

Psychologist

...the method of modern science is social in respect to the solidarity of its efforts. The scientific world is like a

colony of insects, in that the individual strives to produce that which he himself cannot hope to enjoy. One generation collects premises in order that a distant generation may discover what they mean.

In James Mark Baldwin

*Dictionary of Philosophy and Psychology* (Volume 2) (p. 502)

The Macmillan Co. New York, New York, USA. 1902

## SCIENTIFIC WRITER

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

A scientific writer is placed in a difficulty by his earlier books; either his new book will appear as a rather disjointed addendum to them, or he must perfunctorily go over again a great deal of matter which he has no wish to rewrite.

*New Pathways in Science*

Preface (p. vii)

The Macmillan Co. New York, New York, USA. 1935

## SCIENTIST

**Adam, George**

No biographical data available

Scientists have been yearning for a key to a grand generalization. They have expected it to be revealed by a group of facts uncovered by experimentation, whereas its formula must necessarily spring into being as a simple creation of intuitional thought or imaginative effort, for it must deal with entities beyond observational research.

*The Solar System: An Astronomical Unit Addenda*

Introduction (p. 9)

John W. Newbegin, Publisher. San Francisco, California, USA. 1911

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

You can't possibly be a scientist if you mind people thinking that you're a fool.

*The Ultimate Hitchhiker's Guide to the Galaxy*

*So Long And Thanks For All The Fish*

Chapter 31 (p. 587)

The Ballantine Book Company. New York, New York, USA. 2002

I'm a scientist and I know what constitutes proof. But the reason I call myself by my childhood name is to remind myself that a scientist must also be absolutely like a child. If he sees a thing, he must say that he sees it, whether it was what he thought he was going to see or not.

*So Long, and Thanks for All the Fish*

Chapter 31 (p. 161)

Harmony Books. New York, New York, USA. 1984

**Agnew, Ralph Palmer**

American mathematician

Scientists, like professional golfers and piano players, should sometimes concentrate upon a task until they can perform it with professional skill.

*Differential Equations*

Chapter 1, Problem 1.49 (p. 16)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Appleton, Sir Edward** 1892–1965

English physicist

It seems to me that we must recognize that the proper use of science is one of the most important challenges of the present day. And here I think the scientist has a twofold mission, not only of extending the frontiers of knowledge but also of interpreting his results to his fellow-men.

*Les Prix Nobel. The Nobel Prizes in 1947*

Nobel banquet speech for award received in 1947

Nobel Foundation. Stockholm, Sweden. 1948

**Appleyard, Bryan** 1951–

Author and journalist

Scientists inevitably take on the mantle of the wizards, sorcerers and witch doctors. Their miracle cures are our spells, their experiments our rituals.

*Understanding the Present: Science and the Soul of Modern Man*

Chapter 1 (p. 9)

Doubleday. New York, New York, USA. 1992

**Artuad, Antonin** 1896–1948

French poet, actor, and director

But how is one to make a scientist understand that there is something unalterably deranged about differential calculus, quantum theory, or the obscene and so inanely liturgical ordeals of the precession of the equinoxes – ....

In Susan Sontag

*Selected Writings*

Part 33, van Gogh, the Man Suicided by Society (p. 497)

**Auden, W. H.** 1907–72

English-born poet

The true men of action in our time, those who transform the world, are not the politicians and statesmen, but the scientists.

*The Dyer's Hand*

Part II, The Poet and The City (p. 81)

Random House. New York, New York, USA. 1962

When I find myself in the company of scientists, I feel like a shabby curate who has strayed by mistake into a drawing room full of dukes.

*The Dyer's Hand*

Part II, The Poet and The City (p. 81)

Random House. New York, New York, USA. 1962

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Those who have treated of the sciences have been either empirics or dogmatical. The former like ants only heap up and use their store, the latter like spiders spin out their own webs. The bee, a mean between both, extracts matter from the flowers of the garden and the field, but

works and fashions it by its own efforts. The true labor of philosophy resembles hers, for it neither relies entirely nor principally on the powers of the mind, nor yet lays up in the memory of matter afforded by the experiments of natural history and mechanics in its raw state, but changes and works it in the understanding.

*In Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 95 (p. 126)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Baker, Russell** 1925–

American writer and journalist

Two leading Congressional scientists, Senator Helms and Representative Hyde, have been doing pioneering research on the nature of life. This has produced the Helms–Hyde theory which states that scientific fact can be established by a majority vote of the US Congress.

*The Rescue of Miss Yaskel and Other Pipe Dreams*

Congdom &amp; Weed. New York, New York, USA. 1983

**Barr, Amelia Edith Huddleston** 1831–1919

Anglo-American novelist

Whatever the scientists may say, if we take the supernatural out of life, we leave only the unnatural.

*All the Days of My Life*

Chapter 26 (p. 477)

Arno Press. New York, New York, USA. 1980

**Barrow, Hohn D.** 1952–

English theoretical physicist

A scientist who uses only logical reasoning from ‘self-evident’ principles will soon find himself in a cul-de-sac – like a blind landscape artist.

*The World Within the World*

Chapter 2 (pp. 40–41)

Clarendon Press. Oxford, England. 1988

**Barzun, Jacques** 1907–

French-born American educator, historian, and educator

...the scientific profession does not constitute an elite, intellectual, or other. The chances are that the ‘scientist’, from the high-school teacher of science to the head of a research institute, is a person of average capacity.

*Science: The Glorious Entertainment* (p. 75)

Harper &amp; Row Publishers. New York, New York, USA. 1964

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

The scientist who has an independent mind and is able to judge the evidence on its merits rather than in light of prevailing conceptions is the one most likely to be able to realize the potentialities in something really new.

*The Art of Scientific Investigation*

Chapter Three (p. 35)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1957

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Every sentence I utter must be understood not as an affirmation, but as a question.

*New York Times Book Review*, October 20, 1957

**Born, Max** 1882–1970  
German-born English physicist

It seems to me that the scientists who led the way to the atomic bomb were extremely skillful and ingenious, but not wise men. They delivered the fruits of their discoveries unconditionally into the hands of politicians and soldiers; thus they lost their moral innocence and their intellectual freedom...

*The Restless Universe*

Postscript (p. 280)

Dover Publications, Inc. New York, New York, USA. 1951

**Brain, Lord Walter Russell** 1895–1966  
British neurologist

Scientists...meet one another to exchange ideas, to promote their own particular branch of science, or science in general, or because they are aware of its social implications. Nevertheless, such collective activities... play a small part in their lives. Scientists, though they must always be aware of the work of their fellows in their own fields, are essentially individualists; and the body of knowledge to which they are contributing is an impersonal one. Apart from contributing to it, they have no collective consciousness, interest, or aim.

*Science and Antiscience*

*Science*, Volume 148, Number 3667, April, 1965 (p. 193)

**Brewster, Edwin Tenney** 1866–1960  
Educator

For scientific people are after all precisely like the rest of us, and can no more resist – most of them – the urge to speculate where they cannot prove than other men can.

*This Puzzling Planet*

Chapter XIX (p. 301)

The Bobbs-Merrill Company, Indianapolis, Indiana. 1928

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Dissent is the native activity of the scientist, and it has got him into a good deal of trouble in the last years. But if that is cut off, what is left will not be a scientist. And I doubt whether it will be a man.

*Science and Human Values*

The Sense of Human Dignity (p. 61)

Harper & Row, Publishers. New York, New York, USA. 1965

The society of scientists must be a democracy. It can keep alive and grow only by a constant tension between dissent and respect; between independence from the view of others, and tolerance from them.

*Science and Human Values*

The Sense of Human Dignity (pp. 62–63)

Harper & Row, Publishers. New York, New York, USA. 1965

The most remarkable discovery made by scientists is science itself.

*A Sense of the Future: Essays in Natural Philosophy*

Chapter 2 (p. 6)

The MIT Press. Cambridge, Massachusetts, USA. 1977

It is important that students bring a certain ragamuffin, barefoot irreverence to their studies; they are not here to worship what is known, but to question it.

*The Ascent of Man*

Chapter 11 (p. 360)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Buchanan, Scott** 1895–1968  
American educator and philosopher

The scientist is the contemporary monk copyist, writing over old literature on the palimpsest of experience, triumphantly announcing his faithfulness and accuracy in transferring the copy.

*Poetry and Mathematics*

Chapter I

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Buck, Pearl S.** 1892–1973  
American author

No one really understood music unless he was a scientist, her father had declared, and not just a scientist, either, oh, no, only the real ones, the theoreticians, whose language mathematics. She had not understood mathematics until he had explained to her that it was the symbolic language of relationships. “And relationships,” he had told her, “contained the essential meaning of life.”

*The Goddess Abides*

Part I

John Day Company. New York, New York, USA. 1972

**Burroughs, William S.** 1914–97  
American writer

Too many scientists seem to be ignorant of the most rudimentary spiritual concepts. And they tend to be suspicious, bristly, paranoid-type people with huge egos they push around like some elephantiasis victim with his distended testicles in a wheelbarrow terrified no doubt that some skulking ingrate of a clone student will sneak into his very brain and steal his genius work.

*The Adding Machine: Selected Essays*

Immortality (p. 132)

Seaver Books. New York, New York, USA. 1986

They [scientists] tend to be suspicious, bristly, paranoid-type people with huge egos they push around like some elephantiasis victim with his distended testicles in a wheelbarrow terrified no doubt that some skulking ingrate of a clone student will sneak into his very brain and steal his genius work.

*The Adding Machine*

Immortality (p. 133)

Arcade Publishing, New York, New York, USA. 1991

**Calder, Alexander** 1898–1976

American sculptor and inventor of the mobile

Scientists leave their discoveries, like foundlings, on the doorstep of society, while the stepparents do not know how to bring them up.

In Alan J. Friedman and Carol C. Donley

*Einstein as Myth and Muse*

Chapter 1 (p. 7)

Cambridge University Press, Cambridge, England. 1985

**Cammaerts, Émile** 1878–1953

Belgian poet

The duty of a scientist is not to distort the manifestations of natural phenomena in the light of some more or less popular idea. His duty is to explain facts.

*A History of Belgium from the Roman Invasion to the Present Day*

Chapter 1 (p. 36)

D. Appleton & Co. New York, New York, USA. 1921

**Cartmill, Matt**

American zoologist

As an adolescent I aspired to lasting fame, I craved factual certainty, and I thirsted for a meaningful vision of human life: so I became a scientist. This is like becoming an archbishop so you can meet girls.

Seventy-five Reasons to become a Scientist

*American Scientist*, Volume 76 1988 (p. 452)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Great scientists are particularly worth listening to when they speak about something of which they know little; in their own specialty they are usually great and dull.

*Heracleian Fire: Sketches from a Life before Nature*

Part II

The Hereditary Code-Script (p. 85)

Rockefeller University Press, New York, New York, USA. 1978

...outside his own ever-narrowing field of specialization, a scientist is a layman. What members of an academy of science have in common is a certain form of semiparasitic living.

Bitter Fruits from the Tree of Knowledge

*Perspectives in Biology and Medicine*, Section III, Volume 16, Number 4, Summer, 1973 (p. 492)

A scientific autobiography belongs to a most awkward literary genre. If the difficulties facing a man trying to record his life are great – and few have overcome them successfully – they are compounded in the case of scientists, of whom many lead monotonous and uneventful lives and who, besides, often do not know how to write...

Book Review of *The Double Helix*

*Science*, Volume 59, Number 3822, 29 March, 1968 (p. 1448)

No scientist's lifework is really continued when he is dead.

*Voices in the Labyrinth: Nature, Man and Science* (p. 74)

The Seabury Press, New York, New York, USA. 1977

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Apparently a scientist is a man who surveys all the sciences, without any particular study of them, and then gives expression to his own moral principles or prejudices.

*All Is Grist: A Book of Essays*

On Mr. Mencken and Fundamentalism (p. 50)

Methuen & Company Ltd, London, England. 1931

**Clarke, Arthur C.** 1917–

English science and science fiction writer

When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 2 (p. 14)

Harper & Row, Publishers, New York, New York, USA. 1973

...scientists of over fifty are good for nothing except board meetings and should at all costs be kept out of the laboratory!

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 2 (pp. 14–15)

Harper & Row, Publishers, New York, New York, USA. 1973

**Conant, James Bryant** 1893–1978

American educator and scientist

...scientists today represent the progeny of one line of descent who migrated, so to speak, some centuries ago into certain fields which were ripe for cultivation. Once science had become self-propagating, those who till these fields have had a relatively easy time keeping up the tradition of their forebears.

*Science and Common Sense*

Chapter One (p. 13)

Yale University Press, New Haven, Connecticut, USA. 1951

**Cope, Henry Frederick**

No biographical data available

A scientist is not one who worships a theory; he is one who walks obediently in the path of knowledge.

*The School in the Modern Church*

Chapter V (p. 58)

George H. Doran Co. New York, New York, USA. 1919

**Cornforth, John W.** 1917–2004

English organic chemist

Scientists do not believe; they check.

Scientists as Citizens

*Australian Journal of Chemistry*, Volume 46, 1993 (p. 266)

**Cousteau, Jacques-Yves** 1910–77

French naval officer and ocean explorer

What is a scientist after all? It is a curious man looking through a keyhole, the keyhole of nature, trying to know what's going on.

*Christian Science Monitor*, 21 July 1971

**Cramer, F.**

No biographical data available

In the long run it pays the scientist to be honest, not only by not making false statements, but by giving full expression to facts that are opposed to his views. Moral slovenliness is visited with far severe penalties in the scientific than in the business world.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eleven (p. 142)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Crichton, Michael** 1942–

American novelist

I sometimes think scientists really don't notice that their colleagues have flaws. But in my experience scientists are very human people: which means that some are troubled, deceitful, petty or vain.

*Science Views Media*, January 25, 1999

**Cronenberg, David** 1943–

Canadian film director

...everybody's a mad scientist, and life is their lab. We're all trying to experiment to find a way to live, to solve problems, to fend off madness and chaos.

In Chris Rodley

*Cronenberg on Cronenberg*

Chapter 1 (p. 7)

Faber & Faber Ltd. London, England. 1992

**de Jouvenel, Bertrand** 1903–87

French man of letters

No one can become a scientist who is not driven by a primary urge for discovery, who is not the ardent suitor of a hidden beauty. Somewhat romantically, scientists can be likened to a company of knights dispersed in search of Sleeping Princesses, all of whom are more or less distantly related. The spirit of the quest is essential to the making of a scientist, and forms a fundamental bond between scientists.

*The Logic of Personal Knowledge*

The Republic of Science

The Free Press. Glencoe, Illinois, USA. 1961

**de Madariaga, Salvador** 1886–1978

Spanish writer and statesman

There are two kinds of scientists: they were once described...as the "why" and the "how." The how-scientist

is mainly interested in the way things happen; the why-scientist seeks to find out the cause of things. The first is more of a technician; the second, more of a philosopher. The first is more of a man of talent; the second, more of a man of genius.

*Essays with a Purpose*

Science and Freedom (p. 43)

Hollis & Carter. London, England. 1954

**Derbyshire, Henry James**

No biographical data available

The first principle of a scientist is to neither deny nor affirm anything. Belief has no place in the language of a scientist. It is the one profane word of language. Doubt, which is merely its negative equivalent, is equally profane. When we eliminate these words we are beginning to be positive scientists. All we know is what we determine.

*Origin of Mental Species*

Chapter XII (p. 142)

H.J. Derbyshire. Flint, Michigan, USA. 1919

**Devine, Betsy**

No biographical data available

**Cohen, Joel E.**

No biographical data available

Scientists are funny people. Not just the great ones who think they've discovered the secret of life or of the brain or of the common cold. Even ordinary day-to-day scientists are funny, because they all think that the world makes sense! Most people know better.

*Absolute Zero Gravity: Science Jokes, Quotes, and Anecdotes*

Fireside/Simon & Shuster. New York, New York, USA.

**Dr. Kemp (Fictional character)**

Straightforward scientists have no need for barred doors and drawn blinds.

*The Invisible Man*

Film (1933)

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

The scientist with imagination is the pioneer of progress.

*The Road to Reason*

Chapter 3 (p. 81)

Longmans, Green & Company. London, England. 1949

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Scientists, like artists, unavoidably reflect the characteristics of the civilization and the time in which they live. In this sense, they are "enchained"...by the inexorable logic of their time and their work.

*Louis Pasteur: Free Lance of Science*

Introduction (p. xxxviii)

Little, Brown & Company. Boston, Massachusetts, USA. 1950



...like other men, scientists become deaf and blind to any argument or evidence that does not fit into the thought pattern which circumstances have led them to follow.

*Louis Pasteur: Free Lance of Science*

Chapter VII (p. 197)

Little, Brown & Company, Boston, Massachusetts, USA. 1950

**Dyson, Freeman J.** 1923–

American physicist and educator

When something ceases to be mysterious it ceases to be of absorbing concern to scientists. Almost all the things scientists think and dream about are mysterious.

*Infinite in All Directions*

Part One, Chapter Two (p. 14)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Egler, Frank E.** 1911–96

American botanist and ecologist

Scientists are only men, and are subject to all the foibles of their kind. They have the same drives for freedom, security, certainty, image and status as have other men.

...the same attraction for the known the familiar and the comfortable, and will cling to old and sterile ideas like a broody hen sitting on boiled eggs. Like those others, there is a lunatic fringe, and a reasonable quota of social misfits, small-pool big-frogs, megalomaniacs, prima donnas, nymphomaniacs, gold diggers, entrepreneurs, prophets and devout disciples.

*The Way of Science*

The Nature of Science (p. 1)

Hafner Publishing Company, New York, New York, USA. 1970

**Einstein, Albert** 1879–1955

German-born physicist

In an attempt to achieve a conceptual formulation of the confusingly immense body of observational data, the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts.

In Max Jammer

*Concepts of Space: The History of Theories of Space in Physics*

Foreword p. (xi)

Harvard University Press, Cambridge, Massachusetts, USA. 1969

The eyes of the scientist are directed upon those phenomena which are accessible to observation, upon their apprehension and conceptual formulation.

In Max Jammer

*Concepts of Space: The History of Theories of Space in Physics*

Preface (p. xi)

Harvard University Press, Cambridge, Massachusetts, USA. 1969

For the scientist, there is only "being," but no wishing, no valuing, no good, no evil – in short, no goal. As long as we remain within the realm of science proper, we can never encounter a sentence of the type: "Thou shalt not lie."

In Philipp Frank

*Relativity – A Richer Truth*

The Laws of Science and the Laws of Ethics (p. 9)

Jonathan Cape, London, England. 1951

...the scientist finds his reward in what Henri Poincaré calls the joy of comprehension, and not in the possibilities of application to which any discovery may lead.

In Max Planck

*Where Is Science Going?*

Epilogue (p. 211)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

To the scientist, the celestial bodies, the objects on Earth, and their chemical peculiarities, simply existed as real objects in space and time, and his task consisted solely in abstracting these laws from experience by way of hypothetical generalizations.

Physics, Philosophy, and Scientific Progress

*Physics Today* Issue 6 June, 2005 (p. 46)

**Emelyanov, A. S.**

No biographical data available

A scientist cannot be a "pure" mathematician, biophysicist or sociologist for he cannot remain indifferent to the fruits of his work, to whether they will be useful or harmful to mankind. An indifferent attitude as to whether people will be better or worse off as a result of scientific achievement is cynicism, if not a crime.

In E.H.S. Burhop In Maurice Goldsmith and Alan Mackay (eds.)

*Society and Science*

Scientist and Public Affairs (p. 31)

Simon & Schuster, New York, New York, USA. 1965

**England, Terry**

No biographical data available

...if three scientists ever agree completely on anything, it's a cult.

*Rewind* (p. 71)

Avon Books, New York, New York, USA. 1997

**Eysenck, Hans Jurgen** 1916–97

Founder of theory of personality

Scientists, especially when they leave the particular field in which they have specialized, are just as ordinary, pig-headed and unreasonable as anybody else.

Continuum

*OMNI Magazine*, Volume 2, December, 1979 (p. 49)

**Faulkner, William** 1897–1962

American novelist and short story writer

Our privacy...has been slowly and steadily and increasingly invaded until now our very dream of civilization is in danger. Who will save us but the scientist and the humanitarian? Yes, the humanitarian in science, and the scientist in the humanity of man.

Quoted in Warren Weaver

Science and People

*Science*, Volume 122, Number 3183, December 30, 1955 (p. 1259)



**Feibleman, James K.** 1904–1987  
American philosopher

It is not the business of scientists to investigate just what the business of science is.

Pure Science, Applied Science, Technology, Engineering: An Attempt at Definitions

*Technology and Culture*, Volume II, Number 4, Fall 1961 (p. 305)

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

Scientists are sculptors of reality – but sculptors in a special sense. They do not merely act causally upon the world (though they do that, too, and they have to if they want to “discover” new entities); they also create semantic conditions engendering strong inferences from known effects to novel projections and, conversely, from the projections to testable effects.

Realism and the Historicity of Knowledge

*The Journal of Philosophy*, Volume LXXXVI, Number 8, 1989 (pp. 404–405)

**Feynman, Richard P.** 1918–88  
American theoretical physicist

It is our responsibility as scientists, knowing the great progress which comes from a satisfactory philosophy of ignorance, the great progress which is the fruit of freedom of thought, to proclaim the value of this freedom; to teach how doubt is not to be feared but welcomed and discussed; and to demand this freedom as our duty to all coming generations.

*What Do You Care What Other People Think?*

The Value of Science (p. 248)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

I would like to point out that people are not honest. Scientists are not honest at all, either. It's useless. Nobody's honest. Scientists are not honest. And people usually believe that they are. That makes it worse. By honest I don't mean that you only tell what's true. But you make clear the entire situation. You make clear all the information that is required for somebody else who is intelligent to make up their mind.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter III (p. 106)

Perseus Books. Reading, Massachusetts, USA. 1998

**Finniston, Sir Monty** 1912–91  
British industrialist

You mustn't think scientists are stupid.

Saying of the Week

*Observer*, 16 January, 1983

**Fitzgerald, Penelope** 1916–2000  
English novelist and biographer

If they don't depend on true evidence, scientists are no better than gossips.

*The Gate of Angels*

Chapter 3 (p. 24)

Doubleday & Company. New York, New York, USA. 1992

**Foster, Alan Dean** 1946–  
American science fiction writer

A man of science is helpless by himself, but two of them constitute an entity capable of ignoring starvation, freezing, and prospects of imminent death just by chatting about some item of mutual interest.

*Icerigger* (p. 116)

Ballantine Books. New York, New York, USA. 1974

**Fox, Robin** 1934–  
English anthropologist, poet, and essayist

Scientists, being children of Adam, can be fools and charlatans or even just blind and biased. Indeed, my own despair at the “academic/scientific enterprise” which raised the initial question is a despair over the inevitability of human frailty, not over the ideals of scientific discovery.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 329)

New York Academy of Sciences. New York, New York, USA. 1996

The real poet, like any artist, tries all the time to see the general in the particular. In this he is no different from the scientist. They are siblings under the skin.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 343)

New York Academy of Sciences. New York, New York, USA. 1996

**Freud, Sigmund** 1856–1939  
Austrian neurologist and co-founder of psychoanalysis

I am not really a man of science, not an observer, not an experimenter, and not a thinker. I am nothing but by temperament a conquistador – an adventurer if you want to translate the word.

Mighty Minds (1900, letter to Fleiss)

*New Scientist*, 4 April, 1998 (p. 11)

**Frisch, Otto Robert** 1904–79  
Austrian-born English physicist

...a really good scientist is one who knows how to draw correct conclusions from incorrect assumptions.

*What Little I remember*

Hamburg 1930–1933 (p. 54)

University of Cambridge. Cambridge, England. 1980

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

...public journals, assumedly bespeaking public opinion, [say] scientists “wrest order out of chaos.” But the scientists who have made the great discoveries have been trying their best to tell the public that...they have never

found chaos to be anything other than the superficial confusion of innately a priori human ignorance at birth – an ignorance that is often burdened by the biases of others to remain gropingly unenlightened throughout its life.

In L.L. Larison Cudmore

*The Center of Life: A Natural History of the Cell* (p. xi)

New York Times Book Company. New York, New York, USA. 1977

What the scientists have always found by physical experiment was an a priori orderliness of nature, or Universe always operating at an elegance level that made the discovering scientist's working hypotheses seem crude by comparison. The discovered reality made the scientists' exploratory work seem relatively disorderly.

In L.L. Larison Cudmore

*The Center of Life: A Natural History of the Cell* (p. xi)

New York Times Book Company. New York, New York, USA. 1977

### **Galston, Arthur William** 1920–

American plant biologist

In my view, the only recourse for a scientist concerned about the social consequences of his work is to remain involved with it to the end.

Science and Social Responsibility

*Annals of the New York Academy of Science*, Volume 196, 1972 (p. 223)

### **Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

A special taste for science seems frequently to be so ingrained in the constitution of scientific men, that it asserts itself throughout their whole existence.

In Karl Pearson

*The Life, Letters and Labours of Francis Galton* (Volume 2) (p. 152)

At The University Press. Cambridge, England. 1914–30

### **Gardner, Martin** 1914–

American writer and mathematics games editor

When reputable scientists correct flaws in an experiment that produced fantastic results, then fail to get those results when they repeat the test with flaws corrected, they withdraw their original claims. They do not defend them by arguing irrelevantly that the failed replication was successful in some other way, or by making intemperate attacks on whomever dares to criticize their competence.

Reply to Claims for ESP

*The New York Review of Books*, February 19, 1981

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

A taste for the abstract sciences in general and, above all, for the mysteries of numbers, is very rare: this is not surprising, since the charms of this sublime science in all their beauty reveal themselves only to those who have the courage to fathom them. But when a woman, because

of her sex, our customs, and prejudices, encounters infinitely more obstacles than men in familiarizing herself with their knotty problems, yet overcomes these fetters and penetrates that which is most hidden, she doubtless has the most noble courage, extraordinary talent, and superior genius.

Letter, Carl Friedrich Gauss to Sophie Germain, 30 April, 1807

### **Gay, Frederick P.**

No biographical data available

We scientists are like rag-pickers, some fumble through masses of rubbish looking for a certain coin, while the true investigator takes up each object that is turned over and asks himself what use he can make of it.

The Contribution of Medical Science to Medical Art as shown in the Study of Typhoid Fever

*Science*, Volume XLIV, Number 1126, July 28, 1916 (pp. 112–113)

### **Gell-Mann, Murray** 1929–

American physicist

But the practitioners of science are, after all, human beings. They are not immune to the normal influences of egotism, economic self-interest, fashion, wishful thinking and laziness. A scientist may try to steal credit, knowingly initiate a worthless project for gain, or take a conventional idea for granted instead of looking for a better explanation. From time to time scientists even fudge their results, breaking one of the most serious taboos of their profession.

*The Quark and the Jaguar: Adventures in the Simple and the Complex* (p. 80)

W.H. Freeman & Company. New York, New York, USA. 1994

### **Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

A scientist without imagination is a butcher with dull knives and out-worn scales.

*Sand and Foam: A Book of Aphorisms* (p. 46)

Alfred A. Knopf. New York, New York, USA. 1959

### **Glashow, Sheldon L.** 1932–

American physicist

Many scientists are deeply religious in one way or another, but all of them have a certain rather peculiar faith – they have a faith in the underlying simplicity of nature; a belief that nature is, after all, comprehensible and that one should strive to understand it as much as we can. Now this faith in simplicity, that there are simple rules – a few elementary particles, a few quantum rules to explain the structure of the world – is completely irrational and completely unjustifiable. It is therefore a religion.

*The Quantum Universe*

Coproduced by WETA-TV and The Smithsonian Institution (1990).

**Gleck, James** 1954–

American author, journalist, and essayist

Children and scientists share an outlook on life. If I do this, what will happen? is both the motto of the child at play and the defining refrain of the physical scientist.... The unfamiliar and the strange – these are the domain of all children and scientists.

*Genius: The Life and Science of Richard Feynman*

The Rockaway (p. 19)

Pantheon Books. New York, New York, USA. 1992

Scientists still ask the what if questions. What if Edison had not invented the electric light – how much longer would it have taken? What if Heisenberg had not invented the S matrix? What if Fleming had not discovered penicillin? Or (the king of such questions) what if Einstein had not invented general relativity? “I always find questions like that...odd,” Feynman wrote to a correspondent who posed one. Science tends to be created as it is needed. “We are not that much smarter than each other,” he said.

*Genius: The Life and Science of Richard Feynman*

Caltec (p. 329)

Pantheon Books. New York, New York, USA. 1992

**Goldenweiser, Alexander** 1880–1940

American anthropologist

The scientist, when in his laboratory, is craftsman and inventor in one. He also faces nature as a learner. Like the craftsman, he is prepared to commit errors and, having learned from them, to revise his procedure. Like the inventor, he is after something new, he plans his experiments deliberately, watches carefully, ever on the alert for a promising lead – a discovery.

*Robots or Gods*

Chapter IV (p. 44)

Alfred A. Knopf. New York, New York, USA. 1931

A scientist who is no longer capable of framing a hypothesis – or never was – is not a scientist but a methodological fossil.

*Robots or Gods*

Chapter IV (p. 48)

Alfred A. Knopf. New York, New York, USA. 1931

**Goldstein, A.**

No biographical data available

Science is always a race...and scientists are competitive people. Because the monetary rewards are minimal, they go for ego rewards....

In J. Goldberg

*Anatomy of a Scientific Discovery*

Locks and Keys (p. 25)

Bantam Books. Toronto, Ontario, Canada. 1988

**Gornick, Vivian**

American critic, essayist, and memoirist

To do science today is to experience a dimension unique in contemporary working lives; the work promises something incomparable: the sense of living both personally and historically. That is why science now draws to itself all kinds of people – charlatans, mediocrities, geniuses – everyone who wants to touch the flame, feel alive in the time.

*Women in Science: Portraits from a World in Transition*

Part One (p. 26)

Simon & Schuster. New York, New York, USA. 1983

Scientists do what writers do. They also live with an active interiority, only the ongoing speculation in their heads is about relations in the physical world rather than the psychological one.

*Women in Science*

Part I (p. 39)

Simon & Schuster. New York, New York, USA. 1983

Whatever a scientist is doing – reading, cooking, talking, playing – science thoughts are always there at the edge of the mind. They are the way the world is taken in; all that is seen is filtered through an everpresent scientific musing.

*Women in Science: Portraits from a World in Transition*

Part One (p. 39)

Simon & Schuster. New York, New York, USA. 1983

...a scientist or a writer is one who ruminates continuously on the nature of physical or imaginative life, experiences repeated relief and excitement when the insight comes, and is endlessly attracted to working out the idea.

*Women in Science*

Part I (p. 40)

Simon & Schuster. New York, New York, USA. 1983

**Gray, Elisha** 1835–1901

American electrical engineer

When the uncultured man sees a stone in the road it tells him no story other than the fact that he sees a stone and that it would better be removed; and all the satisfaction he gets out of it is in the thought that he has saved some unlucky wagon wheel from being wrenched or broken. The scientist looking at the same stone perhaps will stop, and with a hammer break it open, when the newly exposed faces of the rock will have written upon them a history that is as real to him as the printed page.

*Nature's Miracles; Familiar Talks on Science*

Chapter I (p. 2)

Fords, Howard & Hulbert. New York, New York, USA. 1899

**Gray, George W.**

Freelance science writer

The modern scientist is like a detective who finds clues, but never gets a glimpse of the fugitive he seeks.

New Eyes of the Universe

*The Atlantic Monthly*, Volume 155, Number 5, May, 1935 (p. 607)

**Harding, Rosamund E. M.**

No biographical data available

If the scientist has, during the whole of his life, observed carefully, trained himself to be on the look-out for analogy and possessed himself of relevant knowledge, then the “instrument of feeling”...will become a powerful divining rod leading the scientist to discover order in the midst of chaos by providing him with a clue, a hint, or an hypothesis upon which to base his experiments.

*An Anatomy of Inspiration*

Chapter V (p. 86)

W. Heffer & Sons Ltd. Cambridge, England. 1940

**Harnwell, G. P.** 1903–1982

No biographical data available

The motivations of the pure scientist would appear to many at first thoughts as whimsical and abstract as the immediate results he achieves. The briefest explanation of why he works is curiosity rather than the necessity of earning a livelihood.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1939*

Our Knowledge of Atomic Nuclei (p. 189)

Government Printing Office. Washington, D.C. 1940

**Heinlein, Robert A.** 1907–88

American science fiction writer

Most “scientists” are bottle washers and button sorters.

*Time Enough for Love*

Intermission (p. 257)

G.P. Putnam’s Sons. New York, New York, USA. 1973

**Hight, Gilbert** 1906–78

American classicist

There are naive people all over the world – some of them scientists – who believe that all problems, sooner or later, will be solved by Science. The word Science itself has become a vague reassuring noise, with a very ill-defined meaning and a powerful emotional charge: It is now applied to all sorts of unsuitable subjects and used as a cover for careless and incomplete thinking in dozens of fields. But even taking Science at the most sensible of its definitions, we must acknowledge that it is unperfect as are all activities of the human mind.

*Man’s Unconquerable Mind*

Part Two, Chapter 4 (p. 106)

Cambridge University Press. New York, New York, USA. 1954

**Hogan, James P.** 1946–

English writer of hard science fiction

Scientists are the easiest to fool...They think in straight, predictable, directable, and therefore misdirectable, lines. The only world they know is the one where everything has a logical explanation and things are what they appear to be. Children and conjurers – they terrify me. Scientists are no problem; against them I feel quite confident.

*Code of the Lifemaker*

Chapter I (p. 14)

Ballantine Books. New York, New York, USA. 1983

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

The scientist who now takes off his shoes knows that the place whereon he stands is holy ground. Science is reverent and speaks with lowered voice, for she has caught glimpses of mysteries undefinable, and to her have come thoughts that are beyond speech. Science cultivates the receptive heart and hospitable mind, and her prayer is for more light, and to that prayer the answer is even now coming.

In *Albert Lane*

*Elbert Hubbard and His Work* (p. 100)

The Blanchard Press. Worcester, Massachusetts, USA. 1901

A metaphysician is one who proves ten times as much as he believes; a scientist is one who believes ten times as much as he can prove.

*Little Journeys*

Herbert Spencer (p. 356)

Wm. H. Wise & Co. New York, New York, USA. 1916

**Hubble, Edwin Powell** 1889–1953

American astronomer

Scientists in general are not very articulate; they work in comparative seclusion and they do not cultivate the art of persuasion.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 3)

The Huntington Library. San Marino, California, USA. 1954

The scientist, in his purely scientific moods, seeks to understand the world – not to reform it, not to control it, but merely to understand it.

*The Nature of Science and Other Lectures*

Part I, Science and Technology (p. 20)

The Huntington Library. San Marino, California, USA. 1954

**Huggins, Charles** 1901–1997

Canadian born-American surgeon

...there are two kinds of scientists – The “gee whiz” kind and the “so what” kind. Flies around the urine cause the first type to exclaim: “Gee whiz, what could that mean?” whereas the other says: “so what, let’s clean up this mess and get on with a proper experiment.”

In *Elwood V. Jensen*

*The Science of Science*

*Perspectives in Biology and Medicine*, Volume 12, Number 2, Winter, 1969 (p. 283)

**Hull, David L.** 1935–

American philosopher of biology

From the beginning of their careers, scientists are presented with a dilemma. They can make their work look as conventional as possible – just one more brick in the

edifice of science – or as novel and controversial as possible – declaring a whole new theory or possibly even a whole new science.... From my own reading of the recent history of science, I see no strong correlation between my own estimates of the novelty of an idea and the strategy that an author adopts.

*Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science*

Chapter Six (p. 202)

The University of Chicago Press. Chicago, Illinois, USA. 1988

### **Husserl, Edmund** 1859–1938

German philosopher

When it is actually natural science that speaks, we listen gladly and as disciples. But it is not always natural science that speaks when natural scientists are speaking...

Translated by W.R. Boyce Gibson

*Ideas: General Introduction to Pure Phenomenology*

Second Chapter, Section 20 (p. 86)

George Allen & Unwin Ltd. London, England. 1931

### **Ian (Fictional character)**

Your scientists were so preoccupied with whether or not they could, they didn't stop to think if they should.

*Jurassic Park*

Film (1993)

### **Imhof, Peter**

German computer scientist and social science modeler

...scientists are not a select few intelligent enough to think in terms of "broad sweeping theoretical laws and principles." Instead, scientists are people specifically trained to build models that incorporate theoretical assumptions and empirical evidence. Working with models is essential to the performance of their daily work; it allows them to construct arguments and to collect data.

Tools for Thinking (book review)

*Science*, Volume 287, 1935–1936

### **Ingram, Jay** 1945–

Canadian author and television host

The caricature of the nerdy scientist in his/her lab coat, complete with pocket protector, uttering incomprehensible jargon is bad enough. But the implied character of the person behind the wardrobe is worse: strait-jacketed by conservatism, too quick to demand hard data, hell-bent on reducing life's mysteries to uninteresting sets of numbers and graphs. ...The truth is that scientists love a mystery as much as anyone (it's their business to chase mysteries after all) even when...there is almost no chance it will be solved. Why? Because it's intriguing, challenging, and fun.

*The Barmaid's Brain and other Strange Tales from Science*

The Burning Mirrors of Syracuse

### **Jensen, Elwood V.**

No biographical data available

Research among the less imaginative scientists has been likened to a fox-hunt. A creative investigator shouts "Tally-ho", and the entire troop rides off in the same direction.

The Science of Science

*Perspectives in Biology and Medicine*, Volume 12, Number 2, Winter, 1969 (p. 278)

### **Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

When the scientist leaves his laboratory and speculates about the universe as a whole, the resultant conclusions are apt to tell us more about the scientist than about the universe.

*Philosophical Aspects of Modern Science*

Chapter XI (p. 339)

G. Allen & Unwin Ltd. London, England. 1932

### **Katscher, F.**

No biographical data available

That great scientists were believing Christians does not prove anything. In this century many free-thinkers have also made great contributions to science, scientific thinking and ethical questions regarding the application of science.

Correspondence

*Nature*, Volume 363, Number 6428, 3 June, 1993 (p. 390)

### **Kemble, Edwin Crawford** 1889–1984

American physicist

...most scientists have little enthusiasm for history. The job of the scientist is to make discoveries and develop new ideas. When new ideas prove effective they tend to make old ones obsolete: thus it is not altogether unfair to say that the typical scientist is in the business of creating the future and destroying the past.

*Physical Science, Its Structure and Development* (Volume 1) (p. 2)

M.I.T. Press. Cambridge, Massachusetts, USA. 1966

### **Killian, Jr., James R.** 1904–88

American manager

The scientist, it is repeatedly said, should be on tap but not on top. He thus is considered to be merely one of the hired men who has no business doing anything but what he is told to do in the field of his specialty. ...I do not imply that the scientist has any right or unique qualifications to be on top. I am disturbed by the attitude that because a man is a scientist, he is disqualified for public and private administrative responsibility even though he may have the qualifications.

The Shortage Re-Examined

*American Scientist*, Spring, April, 1956 (p. 126)



**Kingsley, Charles** 1819–75  
English clergyman and author

[Scientists] Good men, honest men, accurate men, righteous men, patient men, self-restraining men, fair men, modest men. Men who are aware of their own vast ignorance compared with the vast amount that there is to be learned in such a universe as this. Men who are accustomed to look at both sides of a question; who, instead of making up their minds in haste like bigots and fanatics, wait like wise men, for more facts, and more thought about the facts. *Town Geography*

Preface

D. Appleton & Company. New York, New York, USA. 1873

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

[Scientists are] Peeping Toms at the keyhole of eternity.

*The Roots of Coincidence*

Chapter 5, Section 9 (p. 140)

Random House. New York, New York, USA. 1972

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

No one devotes a lifetime to science in the hope of making small advances. Every scientist secretly or overtly hopes to make great discoveries.

*Blind Watchers of the Sky*

Chapter Two (p. 42)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

Most scientists spend their lives groping around trying to find their way, as if lost in a fog.

*Blind Watchers of the Sky*

Chapter Eight (p. 203)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kornberg, Arthur** 1918–  
American biochemist

A scientist...shouldn't be asked to judge the economic and moral value of his work. All we should ask the scientist to do is to find the truth – and then not keep it from anyone.

*San Francisco Examiner*, December 19, 1971

**Kuhn, Thomas S.** 1922–96  
American historian of science

Scientists, it should already be clear, never learn concepts, laws, and theories in the abstract and by themselves. Instead, these intellectual tools are from the start encountered in a historically and pedagogically prior unit that displays them with and through their applications.

*The Structure of Scientific Revolutions*

Chapter V (p. 46)

The University of Chicago Press. Chicago, Illinois, USA. 1970

Though many scientists talk easily and well about the particular individual hypotheses that underlie a concrete piece of current research, they are little better than laypersons at characterizing the established basis of their field, its legitimate problems and methods. If they have learned such abstractions at all they show it mainly through their ability to do successful research.

*The Structure of Scientific Revolutions*

Chapter V (p. 47)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**La Farge, Oliver Hazard Perry** 1901–63  
American writer and anthropologist

The inner nature of science within the scientist is both emotional and intellectual. The emotional element must not be overlooked, for without it there is no sound research on however odd and dull-seeming a subject. As is true of all of us, an emotion shapes and forms the scientist's life; at the same time an intellectual discipline molds his thinking, stamping him with a character as marked as a seaman's although much less widely understood.

In Harlow Shapley, Helen Wright and Samuel Rapport

*Readings in the Physical Sciences*

Scientists Are Lonely Men (p. 48)

Appleton-Century-Crofts. New York, New York, USA. 1948

**Langer, Susanne Katherina Knauth** 1895–1985  
American philosopher

The faith of scientists in the power and truth of mathematics is so implicit that their work has gradually become less and less observation, and more and more calculation.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite, and Art*

Chapter I (p. 19)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

**Larrabee, Eric** 1922–90  
Historian

Perhaps the time has come for [scientists] to wonder about why they sometimes jar the nerves and try the patience of non-scientists.

...Scientists seem able to go about their business in a state of indifference to, if not ignorance of, anything but the going, currently acceptable doctrine of their several disciplines....

Science and the Common Reader

*Commentary*, June, 1966 (p. 48)

The only thing wrong with scientists is that they don't understand science. They don't know where their own institutions come from, what forces shaped and are still shaping them, and they are wedded to an anti-historical way of thinking which threatens to deter them from ever finding out.

Science and the Common Reader

*Commentary*, June, 1966 (p. 48)



**Lebowitz, Fran** 1951–  
American comedian

Scientists are rarely to be counted among the fun people. Awkward at parties, shy with strangers, deficient in irony – they have had no choice but to turn their attention to the close study of everyday objects.

*Metropolitan Life*

Science (p. 106)

Fawcett Crest. New York, New York, USA. 1978

**Lederman, Leon** 1922–  
American high-energy physicist

Physicists today feel the same emotions that scientists have felt for centuries. The life of a physicist is filled with anxiety, pain, hardship, tension, attacks of hopelessness, depression, and discouragement. But these are punctuated by flashes of exhilaration, laughter, joy, and exultation. These epiphanies come at unpredictable times. Often they are generated simply by the sudden understanding of something new and important, something beautiful, that someone else has revealed.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

[If] you are mortal, like most of the scientists I know, the far sweeter moments come when you yourself discover some new fact about the universe. It's astonishing how often this happens at 3 A.M., when you are alone in the lab and you have learned something profound, and you realize that not one of the other five billion people on earth knows what you now know. Or so you hope. You will, of course, hasten to tell them as soon as possible. This is known as "publishing."

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

When I talk about the pain and hardship of a scientist's life, I'm speaking of more than existential angst. Galileo's work was condemned by the Church; Madame Curie paid with her life, a victim of leukemia wrought by radiation poisoning. Too many of us develop cataracts. None of us gets enough sleep. Most of what we know about the universe we know thanks to a lot of guys (and ladies) who stayed up late at night.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 16)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Lee, Gerald Stanley** 1862–1944  
Writer

I am not claiming that a scientist, simply because he is a scientist, is any unhappier or needs to be any unhappier than other men are. He does not need to be. It all comes

of a kind of brutal, sweeping, overriding prejudice he has against guessing on anything.

*The Lost Art of Reading*

Book II, Chapter I (p. 103)

G.P. Putnam's Sons. New York, New York, USA. 1907

**Leon, Mark**

No biographical data available

"Read Popper on the philosophy of science," Alan said. "I don't wholly agree with him, but he has a point when he says the scientist's job is to disprove rather than prove theories. Humans are passionate believers. The history of philosophy and religion is a grand testament to our will to believe. Scientists just try to inject a little sanity into the whole business, and that often requires a passion not to believe."

*The Unified Field* (p. 11)

Avon Books. New York, New York, USA. 1996

**Leonard, Jonathan Norton** 1903–75

No biographical data available

[A scientist's] real work is done in the silent hours of thought, the apparently aimless days of puttering around in the laboratory, and the mighty searching through reference books.

Steinmetz, Jove of Science, Part II

*The World's Work*, February, 1929 (p. 140)

**Levi, Primo** 1919–87

Italian writer and chemist

A scientist's life, the author says, is indeed conflictual, formed by battles, defeats, and victories: but the adversary is always and only the unknown, the problem to be solved, the mystery to be clarified. It is never a matter of civil war; even though of different opinions, or of different political leanings, scientists dispute each other, they compete, but they do not battle: they are bound together by a strong alliance, by the common faith "in the validity of Maxwell's or Boltzmann's equations," and by the common acceptance of Darwinism and the molecular structure of DNA.

Translated by Raymond Rosenthal

*The Mirror Maker: Stories and Essays by Primo Levi*

Bacteria Roulette (p. 123)

Shocken Books. New York, New York, USA. 1989

**Levinson-Lessing, F. Y.** 1861–1939

Russian geologist

A scientist lacking imagination can at best become a splendid walking library and source of information – he absorbs, but does not create.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Lewis, Gilbert Newton** 1875–1946  
American chemist

The average scientist unequipped with the powerful lenses of philosophy, is a nearsighted creature, and cheerfully attacks each difficulty in the hope that it may prove to be the last.

*The Anatomy of Science*

Chapter I (p. 1)

Yale University Press. New Haven, Connecticut, USA. 1926

The scientist is a practical man and his are practical aims. He does not seek the ultimate but the proximate. He does not speak of the last analysis but rather of the next approximation.... On the whole, he is satisfied with his work, for while science may never be wholly right it certainly is never wholly wrong; and it seems to be improving from decade to decade.

*The Anatomy of Science*

Chapter I (pp. 6–7)

Yale University Press. New Haven, Connecticut, USA. 1926

**Lewis, Sinclair** 1885–1951  
American novelist

He had never dined with a duchess, never received a prize, never been interviewed, never produced anything which the public could understand, nor experienced anything since his schoolboy amours which nice people could regard as romantic.

He was, in fact, an authentic scientist.

*Arrowsmith*

Chapter XII, Section I (p. 128)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

...the scientist is intensely religious – ...he will not accept quarter-truths, because they are an insult to his faith. He wants that everything should be subject to inexorable laws. He is the only real revolutionary, the authentic scientist, because he alone knows how little he knows. He lives in a cold, clear light. Yet he is not cold nor heartless. And he prays for unclouded eyes and freedom from haste, for a quiet and relentless anger against all pretence and all pretentious work and all work left slack and unfinished,...a restlessness whereby he may neither sleep nor accept praise till his observed results equal his calculated results....

*Arrowsmith* (p. 278)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

To be a scientist – it is not just a different job so that a man should choose between being a scientist and being an explorer or a bond-salesman or a physician or a king or a farmer. It is a tangle of very obscure emotions, like mysticism, or wanting to write poetry; it makes its victim all different from the good natural man.

*Arrowsmith*

Chapter XXVI, Section I (p. 290)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

The normal man, he does not care much what he does except that he should eat and sleep and make love. But the scientist is intensely religious – he is so religious that he will not accept quarter truths, because they are an insult to his faith.

*Arrowsmith*

Chapter XXVI, Section I (p. 290)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

[The scientist] hates the preachers who talk their fables, but he is not too kindly to the anthropologists and historians who can only make guesses, yet they have the nerve to call themselves scientists!

*Arrowsmith*

Chapter XXVI, Section I (p. 290)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Lightman, Alan** 1948–  
Physicist, novelist, and essayist

Scientists turn reckless and mutter like gamblers who cannot stop betting.

*Einstein's Dreams*

3 May, 1905 (p. 41)

Pantheon Books. New York, New York, USA. 1993

**Professor Oliver Lindenbrook**  
(Fictional character)

A scientist who cannot prove what he has accomplished, has accomplished nothing.

*Journey to the Center of the Earth*

Film (1959)

**Lodge, Rupert Clendon** 1886–1961  
Canadian philosopher

The scientist is like a child with a toy which he has taken apart. He understands now how it works, but not all the king's horses and all the king's men can put together that unsightly heap of torn flesh and dissected organs which was once a living frog or embryo chicken.

*An Introduction to Modern Logic*

Chapter IV (p. 45)

The Perine Book Co. Minneapolis, Minnesota, USA. 1920

**Lodge, Sir Oliver** 1851–1940  
English physicist

...there arise in every generation, here and there, one or two great souls – men who seem of another age and country, who look upon the bustle and feverish activity and are not infected by it, who watch others achieving prizes of riches and pleasure and are not disturbed, who look on the world and the universe they are born in with quite other eyes. To them it appears not as a bazaar to buy and to sell in; not as a ladder to scramble up (or down) helter-skelter without knowing whither or why; but as a fact – a great and mysterious fact – to be pondered over, studied, and perchance in some small measure understood.

*Pioneers of Science*

Lecture I (p. 6)

Macmillan &amp; Company Ltd. London, England. 1905

**Longfellow, Henry Wadsworth** 1807–82

American poet

As artist or as artisan,  
 Pursuing his own fantasies,  
 Can touch the human heart, or please,  
 Or satisfy our nobler needs,  
 In Nature's footprints, light and fleet,  
 As he who sets his willing feet  
 And follows fearless where she leads.

*The Complete Poetical Works*

The Herrons of Elmwood (p. 333)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA. 1903

**Lopez-Ibor, Jean**

No biographical data available

The man in the street once expected the scientist to interpret the universe and human life. Now he only asks the scientist to help him live, to diminish his effort and pain. The scientist is becoming more and more the technician and less and less the sage. Science no longer exists – it has been replaced by the sciences and this dispersion of knowledge, this lack of a clear image of what is happening on earth, is one cause of today's human anguish.

In Henry Margenau, David Berganiami and Time-Life editors

*The Scientist* (p. 113)

Time-Life Books. New York, New York, USA. 1971

**Lugosi, Bela** 1882–1956

Hungarian film star

A true scientist is married to his profession.

*Return of the Ape Man*

Film (1944)

**MacMahon, Percy** 1854–1929

English mathematician

The specialist who wishes to accomplish work of the highest excellence must be learned in the resources of science and have constantly in mind its grandeur and meaning.

Opening Address (Section A, Mathematics and Physics) British Association, 1901

*Nature*, September 12, 1901**Martel, Yann** 1963–

Canadian novelist

Scientists are a friendly, atheistic, hard-working, beer-drinking lot whose minds are preoccupied with sex, chess and baseball when they are not preoccupied with science.

*Life of Pi* (p. 5)

Harcourt Inc. Orlando, Florida, USA. 2001

**Maxwell, James Clerk** 1831–79

Scottish physicist

[Scientists'] actions and thoughts, being more free from the influence of passion than those of other men, are all the better materials for the study of the calmer parts of human nature.... [B]y aspiring to noble ends... [scientists] have risen above the region of storms into a clearer atmosphere, where there is no misrepresentation of opinion, nor ambiguity of expression, but where one mind comes into closest contact with another at the point where both approach nearest to the truth.

In C.C. Gillispie (ed.)

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*

Forward (pp. vii, viii)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Mayer, Joseph** 1904–83

American chemist

What does one have to do to be called a scientist? I decided that anyone who spent on science more than 10% of his waking, thinking time for a period of more than a year would be called a scientist, at least for that year.

In "The Way it Was"

*Annual Review of Physical Chemistry*, Volume 33, 1982 (pp. 1–2)**Mayo, Charles Horace** 1865–1939

American physician

The scientist is not content to stop at the obvious.

Problems in Medical Education

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 18, 1926**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

To be creative, scientists need libraries and laboratories and the company of other scientists; certainly a quiet and untroubled life is a help. A scientist's work is in no way deepened or made more cogent by privation, anxiety, distress, or emotional harassment.

*Advice to a Young Scientist*

Chapter 5 (p. 40)

Basic Books, Inc. New York, New York, USA. 1979

[T]he private lives of scientists may be strangely and even comically mixed up, but not in ways that have any special bearing on the nature and quality of their work. If a scientist were to cut off an ear, no one would interpret such an action as evidence of an unhappy torment of creativity; nor will a scientist be excused any bizarre [action], however extravagant, on the grounds that he is a scientist, however brilliant.

*Advice to a Young Scientist*

Chapter 5 (p. 40)

Basic Books, Inc. New York, New York, USA. 1979

Much of a scientist's pride and sense of accomplishment turns... upon being the first to do something – upon being

the man who did actually speed up or redirect the flow of thought and the growth of understanding.

The most heinous offense a scientist as a scientist can commit is to declare to be true that which is not so; if a scientist cannot interpret the phenomenon he is studying, it is a binding obligation upon him to make it possible for another to do so.

*The Limits of Science*

An Essay on Scians [Science] (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1984

[James] Watson's childlike vision makes them seem like the creatures of a Wonderland, all at a strange contentious noisy tea-party which made room for him because for people like him, at this particular kind of party, there is always room.

Lucky Jim

*New York Review of Books*, 28 March, 1968

...Watson had one towering advantage over all of [his classmates in other disciplines]: in addition to being extremely clever he had something important to be clever about. This is an advantage which scientists enjoy over most other people engaged in intellectual pursuits, and they enjoy it at all levels of capability. To be a first-rate scientist it is not necessary (and certainly not sufficient) to be extremely clever, anyhow in a pyrotechnic sense.

Lucky Jim

*New York Review of Books*, 28 March, 1968

One of the great social revolutions brought about by scientific research has been the democratization of learning. Anyone who combines strong common sense with an ordinary degree of imaginativeness can become a creative scientist, and a happy one besides, in so far as happiness depends upon being able to develop to the limit of one's abilities.

Lucky Jim

*New York Review of Books*, 28 March, 1968

People who criticize scientists for wanting to enjoy the satisfaction of intellectual ownership are confusing possessiveness with pride of possession. Meanness, secretiveness and, sharp practice are as much despised by scientists as by other decent people in the world of ordinary everyday affairs; nor, in my experience, is generosity less common among them, or less highly esteemed.

Lucky Jim

*New York Review of Books*, 28 March, 1968

Before a good scientist tries to persuade others that he is on to something good, he must first convince himself.

*Florey Story* (London Review of Books, 20 December, 1979)

Reprinted in "The Strange Case of the Spotted Mice and Other Classic Essays on Science"

Oxford University Press, Inc. New York, New York, USA. 1996

...scientists tend not to ask themselves questions until they can see the rudiments of an answer in their minds. Embarrassing questions tend to remain unasked or, if asked, to be asked rudely.

*The Future of Man: The BBC Reith Lectures 1959*

Chapter 4 (p. 62)

Methuen & Company Ltd. London, England. 1960

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

The scientist who yields anything to theology, however slight, is yielding to ignorance and false pretences, and as certainly as if he granted that a horse-hair put into a bottle of water will turn into a snake.

*Minority Report: H.L. Mencken's Notebooks*

No. 45 (p. 33)

Alfred A. Knopf. New York, New York, USA. 1956

**Mendeleev, Dmitry Ivanovich** 1834–1907

Russian chemist

Science exists separately from scientists, it lives autonomously, it is the sum of knowledge worked out by the whole mass of scientists, similar to how the acknowledged political order of a country is worked out by the mass of persons who live in it. Science is authoritative, separate scientists are not. A scientist can only and should only use this authority when he is following science, just as in a well-ordered state the authority of power is used only by the person who observes the law.

In Michael D. Gordin

*A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the*

*Periodic Table*

Chapter 4 (p. 103)

Basic Books, Inc. New York, New York, USA. 2004

**Mitchell, Maria** 1818–89

American astronomer and educator

The true scientist must be self-forgetting. He knows that under the best circumstances he is sowing what others must reap – or rather he is striking the mine which others must open up – for human life at longest has not the measure of a single breath in the long life of science.

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 168)

Macmillan & Company. New York, New York, USA. 1949

It is the highest joy of the true scientist...that he can reap no lasting harvest – that whatever he may bring into the storehouse today will be surpassed by the gleaners tomorrow – he studies Nature because he loves her and rejoices to "look through Nature up to Nature's God."

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 168)

Macmillan & Company. New York, New York, USA. 1949

**Montessori, Maria** 1870–1952  
Italian educationist

...what is a scientist?... We give the name scientist to the type of man who has felt experiment to be a means guiding him to search out the deep truth of life, to lift a veil from its fascinating secrets, and who, in this pursuit, has felt arising within him a love for the mysteries of nature, so passionate as to annihilate the thought of himself.

Translated by Anne E. George

*The Montessori Method*

Chapter I (p. 8)

Frederick A. Stokes Company. New York, New York, USA. 1912

The scientist is not the clever manipulator of instrument, he is the worshipper of nature and he bears the external symbols of his passion as does the follower of some religious order.

Translated by Anne E. George

*The Montessori Method*

Chapter I (p. 8)

Frederick A. Stokes Company. New York, New York, USA. 1912

Scientists are like those men of the Bible story who, after Israel had come out of Egypt, were permitted to explore the Land of Promise, and who came back with such a huge cluster of grapes that it took two men to carry it, and the people saw it with amazement.

So have the scientists of today penetrated into the Promised Land of truth, where lies the secret which enables man to scrutinize Nature; and they have come out therefrom, bearing marvelous fruits for all men to see.

Translated by Florence Simmonds

*The Advanced Montessori Method*

Chapter IX (p. 243)

Frederick A. Stokes Co. New York, New York, USA. 1917

**Moser, E. S.**

No biographical data available

No scientist should start out in search of nothing. He must have an object in view, and that object must in a measure be defined.

Immaterial Science

*The Popular Science Monthly*, Volume 44 November, 1893 (p. 86)

**Motz, Lloyd** 1910–2004

American astronomer

**Weaver, Jefferson Hane**

American science author

To the nonscientist, science, particularly in its modern dress and as pursued today, is a glittering intellectual jewel, mysterious, forbidding, and even threatening except to a few chosen ones, the scientists, who appear to be superior beings, endowed with an ability to probe and understand nature far beyond that of the average layman.

*The Concepts of Science: From Newton to Einstein*

Preface (p. vii)

Plenum Press. New York, New York, USA. 1988

**Muppets (Fictional characters)**

German scientist: We are going to perform an electronic cerebractomy.

Doc Hooper: A what?

German Scientist: An electronic cerebractomy! It's something so sensational, you'll have to hold on to your hat.... Look, when a German scientist says hold on to your hat he isn't making casual conversation, he means to hold on to your hat. Hat! Hold!

*The Muppet Movie*

Film (1979)

**National Academy of Sciences (USA)**

Scientists must be fact-seekers, open-minded, and willing to accept changes indicated by the signposts of evidence.

*Science and Creationism – A View from the National Academy of Sciences* (p. 5).

National Academy Press. Washington, D.C. 1984

**Ninotchka (Fictional character)**

[Cyd Charrise talking down love to Fred Astaire] He was one of our greatest scientists. He has proved, beyond any question, that physical affection is purely electrochemical.

*Silk Stockings*

Film (1957)

**O'Malley, Austin** 1858–1932

American physician and humorist

Only men of the strongest faith should become scientists, because scientists so readily fall into the evil and vulgar habit of Didymus – they must *touch* everything.

*Thoughts of a Recluse*

God and Religion (p. 109)

D.H. McBride & Co. Chicago, Illinois, USA. 1898

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

If you are a scientist you believe that it is good to find out how the world works, that it is good to find out what the realities are, that it is good to turn over to mankind at large the greatest possible power to control the world...

In Simon Sebag Montefiore

*Speeches That Changed the World*

Speech, Los Alamos, New Mexico, 2 November, 1945 (p. 124)

Quercus Publishing Ltd. London, England. 2005

**Pancoast, Seth**

No biographical data available

A man may observation or by experiments, or by both, discover great truths in Nature, and yet not be a Scientist; a man may be a Scientist of high repute, with all the theories of popular Science at his tongue's end or pen-tip, and



be unable to discover great truths or even to distinguish a truth, a fact, among theories.

*The Kabbala: Or, The True Science of Light*  
Chapter IX (p. 283)  
Publisher undetermined. 1883

**Pasteur, Louis** 1822–95  
French chemist

When moving forward toward the discovery of the unknown, the scientist is like a traveler who reaches higher and higher summits from which he sees in the distance new countries to explore.

In Rene Dubos  
*Louis Pasteur: Free Lance of Science*  
Chapter III (p. 87)  
Little, Brown & Company. Boston, Massachusetts, USA. 1950

The recompense and the ambition of a scientist is to conquer the approbation of his peers and of the masters whom he venerates. It would seem to me that I was committing a theft if I were to let one day go by without doing some work.

In Emile Duclaux  
*Pasteur: The History of a Mind*  
Aphorisms and Ideals of Pasteur (p. 343)  
W.B. Saunders Co. Philadelphia, Pennsylvania, USA. 1920

**Peabody, Francis Weld** 1881–1927  
American physician

...the popular conception of the scientist as a man who works in a laboratory and who uses instruments of precision is as inaccurate as it is superficial, for a scientist is known, not by his technical processes, but by his intellectual processes; and the essence of the scientific method of thought is that it precedes in an orderly manner toward the establishment of truth.

*The Care of the Patient*  
The Care of the Patient (p. 21)  
Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Pearse, A. S.** 1877–1956  
No biographical data available

Science is always right because it seeks only for truth, and truth hurts no one. Unfortunately, scientists are not always right.

Adventure, Romance and Science  
*Science*, Volume 58, Number 1492, 3 August, 1923 (p. 78)

**Perelman, S. J. (Sidney Joseph)** 1904–79  
American comic writer

I guess I'm just an old mad scientist at bottom. Give me an underground laboratory, half a dozen atom smashers, and a beautiful girl in a diaphanous veil waiting to be turned into a chimpanzee, and I care not who writes the nation's laws.

*Crazy Like a Fox*  
Captain Future, Block that Kick (p. 210)  
Random House, Inc. New York, New York, USA. 1944

**Perry, Ralph Barton** 1876–1957  
American philosopher and educator

Every scientist, furthermore, is himself a "self-made man." He owes his strictly scientific attainment to his own efforts and to the endowment with which nature has equipped him. Whatever elevation in life he reaches is not an artificial status created by institutions or traditions, but a measure of solid achievement. The scientist, therefore, respects man for what he is rather than for his class or station.

*The Present Conflict of Ideals: A Study of the Philosophical Background of the World War*  
Chapter IX (pp. 101–102)  
Longmans, Green. New York, New York, USA. 1918

**Piccard, Auguste** 1884–1962  
Swiss physicist, inventor, and explorer

The scientist, whether physicist, chemist or oceanographer; makes investigations then, first out of a taste for research; and if a new region of the earth, of the subsoil, of the atmosphere, or of the oceans opens up before him, if a new phenomenon or a new substance is discovered, he looks forward, thinking of the future. The work has not been done in vain.

Translated by Christina Stead  
*Earth, Sky and Sea*  
Introduction (p. xiii)  
Oxford University Press. New York, New York, USA. 1956

**Planck, Max** 1858–1947  
German physicist

Since the real world, in the absolute sense of the word, is independent of individual personalities, and in fact of all human intelligence, every discovery made by an individual acquires a completely universal significance. This gives the inquirer, wrestling with his problem in quiet seclusion, the assurance that every discovery will win the unhesitating recognition of all experts throughout the entire world, and in this feeling of the importance of his work lies his happiness. It compensates him fully for many a sacrifice which he must make in his daily life.

*Scientific Autobiography and Other Papers*  
The Meaning and Limits of Exact Science, Part III (p. 103)  
Philosophical Library. New York, New York, USA. 1949

A scientist is happy, not in resting on his attainments but in the steady acquisition of fresh knowledge.

Translated by W.H. Johnston  
*The Philosophy of Physics*  
Chapter I (p. 32)  
W.W. Norton & Co. New York, New York, USA. 1936

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

The scientist should not waste his time on the achievement of practical goals. He will surely reach such goals, but this must be marginal with respect to his principal



activity. He should never forget that the specific object he is investigating is part of a whole which is infinitely greater than this object; love for this whole and an interest in it should constitute the only motives of the actions of the scientist. Science has marvelous applications, but a science in which applications were the only aim would no longer be science but only a kitchen.

In Stefan Amsterdamski

*Between History and Method*

Chapter V. Crisis of the Modern Ideal (p. 94)

Kluwer Academic Publishers. Dordrecht, Netherlands. 1992

### **Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

There are differences in rank between scientists, but these are of secondary importance: everyone's position is sovereign. The Republic of Science realizes the ideal of Rousseau, of a community in which each is an equal partner in a General Will. But this identification makes the General Will appear in a new light. It is seen to differ from any other will by the fact that it cannot alter its own purpose. It is shared by the whole community because each member of it shares in a joint task.

*Science, Faith and Society*

Background and Prospect (pp. 16–17)

The University of Chicago Press. Chicago, Illinois. 1964

### **Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...what is to be called "science" and who is to be called a "scientist" must always remain a matter of convention or decision.

*The Logic of Scientific Discovery*

Part I, Chapter II, Section 10 (p. 52)

Basic Books, Inc. New York, New York, USA. 1959

### **Post, Charles Clement**

No biographical data available

I suppose that a scientist – a scientist is one who knows everything that is not worth knowing and nothing that anybody else cares about – a scientist would tell you that the sun sets just as early in a prairie country, and gets up just as late as in a mountainous one; but then, too, a scientist will tell you – some of 'em will – that the sun does not set at all; which proves how little dependence there is to be put in a scientist.

*Ten Years a Cowboy*

Chapter Eleventh (p. 163)

Rhodes & McClure Publishing Co. Chicago, Illinois, USA. 1899

### **Price, Derek John de Solla** 1922–83

English science historian and information scientist

The ivory tower of the artist can be a one-man cell; that of the scientist must contain many apartments so that he may be housed among his peers.

*Little Science, Big Science*

Chapter 3 (p. 69)

Columbia University Press. New York, New York, USA. 1963

### **Primas, Hans** 1928–

German spectroscopy scientist

The legendary image of a scientist as a humble searcher for truth is more and more replaced by the image of a scientist as a well-paid brilliant expert, speaking an unintelligible professional jargon, highly competent in a narrowly defined domain but arrogantly extending his competence into fields in which he knows nothing, and neglecting the fact that science is only a small subdivision of human knowledge.

*Chemistry, Quantum Mechanics and Reductionism: Perspectives in Theoretical Chemistry*

Chapter 1, Section 1.1 (p. 24)

Springer-Verlag, Berlin, West Germany. 1981

### **Prusiner, Stanley B.** 1942–

American neurologist

Being a scientist is a special privilege: for it brings the opportunity to be creative, the passionate quest for answers to nature's most precious secrets, and the warm friendships of many valued colleagues. Collaborations extend far beyond the scientific achievements, no matter how great the accomplishments might be, the rich friendships which have no national borders are treasured even more.

*Les Prix Nobel. The Nobel Prizes in 1997*

Nobel banquet speech for award received in 1997

Nobel Foundation. Stockholm, Sweden. 1998

### **Mark O'Brian (Fictional character)**

I'm a scientist also, Dr. Holden. I know the value of the cold light of reason. But I also know the deep shadows that light can cast. The shadows that can blind men to truth.

*The Curse of the Demon*

Film (1957)

### **Ramon y Cajal, Santiago** 1852–1934

Spanish neuropathologist

It is certainly true that the scientist's fame is not as great as the playwright or artist's glamour and popularity. People live in a world of sentiment, and it is asking too much of them to provide warmth and support for the heroes of reason.

*Advice for a Young Investigator*

Chapter 3 (p. 44)

The MIT Press. Cambridge, Massachusetts, USA. 1999

### **Richards, Ivor Armstrong** 1893–1979

English literary critic

We believe a scientist because he can substantiate his remarks, not because he is eloquent and forcible in his

enunciation. In fact, we distrust him when he seems to be influencing us by his manner.

*Science and Poetry*

Chapter II (p. 24)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1926

### **Richet, Charles** 1850–1935

French physiologist

Probably, what characterizes all scientists, whatever they may be, archivists, mathematicians, chemists, astronomers, physicists, is that they do not seek to reach a practical conclusion by their work.

*The Natural History of a Savant*

Chapter I (p. 4)

J.M. Dent & Sons Ltd. London, England. 1927

### **Richards, Theodore William** 1868–1928

American chemist

Every student of Science, even if he cannot start his journey where his predecessors left off, can at least travel their beaten track more quickly than they could while they were clearing the way: and so before his race is run he comes to virgin forest and becomes himself a pioneer. Ungrateful would he be who failed to remember his debt to his predecessors.

*Nobel Lectures, Chemistry 1901–1921*

Atomic Weights

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

### **Roe, Anne**

No biographical data available

Science is the creation of scientists and every scientific advance bears somehow the mark of the man who made it....The creative scientist, whatever his field, is very deeply involved emotionally and personally in his work, and...he himself is his own most essential tool.

*The Psychology of the Scientist*

*Science*, Volume 134, Number 3477, August 18, 1961 (p. 456)

### **Roszak, Theodore** 1933–

American social critic

...science rests itself not in the world the scientist beholds at any particular point in time, but in his mode of viewing that world. A man is a scientist not because of what he sees, but because of how he sees it.

*The Making of a Counter Culture: Reflections on the Technocratic Society and Its Youthful Opposition*

Chapter VII (p. 213)

Doubleday & Company, Inc., Garden City, New York, USA; 1969

### **Rothman, Milton A.** 1919–2001

American nuclear physicist and science writer

It makes no sense to complain about a lack of imagination in scientists when their failure is simply that they cannot make the world be what it is not, and they cannot make the world do what it cannot do.

*The Science Gap: Dispelling the Myths and Understanding the Reality of Science*

Prometheus Books. Buffalo, New York, USA. 1992

### **Rothman, Tony** 1953–

American cosmologist

The makers of *Revenge of the Nerds* know, as do millions who have seen it, that all scientists when young are undernourished sociophobics who relate best to a computer terminal through coke bottle eyeglasses after midnight in a basement laboratory.

*A Physicist on Madison Avenue*

Chapter 1 (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1991

### **Rubbia, Carlo** 1934–

Italian physicist

...the best quality of a true scientist is not sheer intelligence of Albert Einstein's approach, it is just persistence and having no fear of doing work which turns out to be useless.

In Lewis Wolpert and Alison Richards

*Passionate Minds*

Asking Nature (p. 196)

Oxford University Press. Oxford, England. 1977

...to be a scientist is not a job nine to five. When you do science you have to do science 24 hours a day.

In Lewis Wolpert and Alison Richards

*Passionate Minds*

Asking Nature (p. 197)

Oxford University Press. Oxford, England. 1977

### **Ruse, Michael** 1940–

English historian and philosopher of science

A scientist should not cheat or falsify data or quote out of context or do any other thing that is intellectually dishonest. Of course, as always, some individuals fail; but science as a whole disapproves of such action. Indeed, when transgressors are detected, they are usually expelled from the community.

Response to the Commentary: Pro Justice

*Science, Technology and Human Values*, Volume 7, Number 41, Fall 1982 (p. 74)

### **Rushton, John Phillippe** 1941–

British/Canadian experimental psychology professor and writer

Research has suggested that scientists differ from non-scientists by exhibiting a high level of curiosity, especially at an early age, and in demonstrating a relatively low level of sociability. Scientists also tend to be shy, lonely, slow in social development, and indifferent to close personal relationships, group activities and politics. Other attributes include skepticism, preoccupation, reliability, and a facility for precise, critical thinking. Generally they are cognitively complex, independent, non-conformist, assertive, and unlikely to suppress thoughts

and impulses; and, like successful entrepreneurs, eminent scientists are also calculated risk-takers.

*Journal of Social and Biological Structure*, Volume 11, 1980 (p. 140)

**Sabin, Albert** 1906–93

American medical researcher

No matter how good you are, you cannot be a scientist unless you learn to live with frustration.

I Only Ask for a Place to Work

*New Scientist*, Volume 57, Number 835, 1 March, 1973 (pp. 491–492)

**Sagan, Carl** 1934–96

American astronomer and author

[Scientists] are capable of self-deception. ...All sorts of socially abhorrent doctrines have at one time or another been supported by scientists, well-known scientists, famous brand-name scientists. And, of course, politicians. And respected religious leaders. Slavery, for instance, or the Nazi brand of racism. Scientists make mistakes, theologians make mistakes, everybody makes mistakes...

*Contact: A Novel* (p. 167)

Simon & Schuster. New York, New York, USA. 1985

Who discovered that CFCs [chlorofluorocarbons] posed a threat to the ozone layer? Was it the principal manufacturer, the DuPont Corporation, exercising corporate responsibility? Was it the Environmental Protection Agency protecting us? Was it the Department of Defense defending us? No, it was two ivory-tower, white-coated university scientists working on something else – Sherwood Rowland and Mario Molina of the University of California, Irvine. Not even an Ivy League university. No one instructed them to look for dangers to the environment. They were pursuing fundamental research. They were scientists following their own interests. Their names should be known to every schoolchild.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 14 (pp. 221–222)

Random House, Inc. New York, New York, USA. 1994

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

Without scientists, without saints, without artists, mankind would soon be reduced to a society of animals. Without saints, it would fall into sin; without artists, into ugliness; without scientists it would stop altogether and degenerate.

*The History of Science and the New Humanism*

Chapter I (p. 64)

H. Holt & Co. New York, New York, USA. 1931

**Schinz, Albert** 1870–1943

American French and philosophical scholar

A scientist is looking for general laws, it is true; but at the same time he wants to solve individual cases or problems;

laws are not science, but only a means to get science; and if a law does not solve a specific problem, the scientist will change the law and not the problem. Thus science, like ethics, aims at the individual case.

*Anti-pragmatism; an Examination Into the Respective Rights of Intellectual Aristocracy and Social Democracy*

Part I, Chapter II (p. 90)

Small, Maynard & Co. Boston, Massachusetts, USA. 1909

**Seifriz, William** 1888–1955

Professor of Botany

It is no matter of chance that the greatest scientists of all time, Copernicus, Newton, Kepler, Linnaeus, Faraday, Darwin, and Maxwell, were men of noble character, modest, straightforward, and full of human sympathy. The great French mathematician, Henri Poincaré, stated that the chief end of life is contemplation, not action.

A New University

*Science*, Volume 120, Number 3107, 16 July, 1954 (pp. 88–89)

**Selye, Hans** 1907–82

Austrian-American endocrinologist

Scientists are probably the most individualistic bunch of people in the world. All of us are and should be essentially different; there would be no purpose in trying to fit us into a common mold.

*From Dream to Discovery: On Being a Scientist*

Introduction

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Sheckley, Robert** 1928–2005

American writer

The scientist, who examines everything, should look at himself. Tentatively I would define him as a discovery-producing animal whose products fall from him as naturally and as thoughtlessly as a hen produces eggs. Like the hen, he is largely indifferent to the use made of his products. Scientists are mostly not in favor of atom bombs, of course, and hens presumably dislike omelets; but both are realists and go along with the conditions they find.

In Damon Knight

*The Observers* (p. 189)

Tor. New York, New York, USA. 1988

**Shelley, Mary Wollstonecraft** 1797–1851

English Romantic writer

The ancient teachers of this science...promised impossibilities, and performed nothing. The modern masters promise very little; they know that metals cannot be transmuted, and that the elixir of life is a chimera. But these philosophers, whose hands seem only made to dabble in dirt, and their eyes to pore over the microscope or crucible, have indeed performed miracles. They penetrate into the recesses of nature, and show how she works in her hiding-places. They ascend into the heavens: they

have discovered how the blood circulates, and the nature of the air we breathe. They have acquired new and almost unlimited powers; they can command the thunders of heaven, mimic the earthquake, and even mock the invisible world with its own shadows.

*Frankenstein: Or, The Modern Prometheus*

Chapter III (p. 64)

George Routledge & Sons. London, England. 1888

The modern masters of chemistry promise very little; they know that metals cannot be transmuted and that the elixir of life is a chimera. But these philosophers, whose hands seem only made to dabble in dirt, and their eyes to pore over the microscope or crucible, have indeed performed miracles. They penetrate into the recesses of nature and show how she works in her hiding places. They ascend into the heavens; they have discovered how the blood circulates, and the nature of the air we breathe. They have acquired new and almost unlimited powers; they can command the thunders of heaven, mime the earthquake, and even mock the invisible world with its own shadows.

*Frankenstein*

Chapter 3 (p. 39)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**Sigurdsson, Haraldur** 1939–

Icelandic volcanologist

The scientist or scholar is the keeper of the flame of knowledge and he or she also advances our knowledge in a chosen field of research, but should also be responsible for linking the present with the past and maintaining a record of the history of knowledge in that field.

*Melting the Earth*

Preface (p. viii)

Oxford University Press, Inc. New York, New York, USA. 1999

**Silver, Brian L.**

Israeli professor of physical chemistry

Scientists come in many colors, of which the green of jealousy and the purple of rage are fashionable shades.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

**Sinsheimer, Robert L.** 1920–

American molecular biologist

I am a scientist, a member of a most fortunate species. The lives of most people are filled with ephemera. All too soon, much of humanity becomes mired in the tepid tracks of their short lives. But a happy few of us have the privilege to live with and explore the eternal.

*The Strands of a Life: The Science of DNA and the Art of Education*

The University of California Press. Berkeley, California, USA. 1994

**Sir Oliver (Fictional character)**

A scientist who cannot prove what he has accomplished has accomplished nothing.

*Journey to the Center of the Earth*

Film (1959)

**Smith, Homer W.**

Renal physiologist

A scientist is one who, when he does not know the answer, is rigorously disciplined to speak up and say so unashamedly; which is the essential feature by which modern science is distinguished from primitive superstition, which knew all the answers except how to say, “I do not know.”

*From Fish to Philosopher*

Chapter XIII (p. 210)

Little, Brown & Company. Boston, Massachusetts, USA. 1953

**Snow, Charles Percy** 1905–80

English novelist and scientist

I believe the intellectual life of the whole of western society is increasingly being split into two polar groups.... Literary intellectuals at one pole – at the other scientists, and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension – sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding.

*The Two Cultures: And a Second Look*

Chapter I (p. 3)

At The University Press. Cambridge, England. 1964

**Snowden, James Henry** 1852–1936

Minister

Scientists never make science: they simply find it. Every scientific thought they think has been thought for them in the book of nature and they simply rethink it...

*The World a Spiritual System: An Outline of Metaphysics*

Chapter VIII (p. 135)

The Macmillan Co. New York, New York, USA. 1910

**Spallanzani, Lazzaro** 1729–99

Italian natural philosopher

If I set out to prove something, I am no real scientist – I have to learn to follow where the facts lead me – I have to learn to whip my prejudices.

In R. Coope

*The Quiet Art* (p. 4)

E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Standen, Anthony** 1907–?

Anglo-American science writer

When a white-robed scientist, momentarily looking away from his microscope or cyclotron, makes some pronouncement for the general public, he may not be understood but at least he is certain to be believed. Scientists are exalted beings who stand at the very topmost pinnacle of popular prestige, for they have the monopoly of the formula “It has been scientifically proved.”, which appears to rule out all possibility of disagreement. Thus the world is divided into Scientists, who practice the art

of infallibility, and non-scientists, sometimes contemptuously called “laymen”, who are taken in by it.

*Science Is a Sacred Cow*

Chapter I (p. 13)

E.P. Dutton & Company. New York, New York, USA. 1950

...we are having wool pulled over our eyes if we let ourselves be convinced that scientists, taken as a group, are anything special in the way of brains. They are very ordinary professional men, and all they know is their own trade, just like all other professional men.

*Science Is a Sacred Cow*

Chapter I (pp. 23–24)

E.P. Dutton & Company. New York, New York, USA. 1950

...scientists are convinced that they, as scientists, possess a number of very admirable human qualities, such as accuracy, observation, reasoning power, intellectual curiosity, tolerance, and even humility.

*Science Is a Sacred Cow*

Chapter I (pp. 15–16)

Dutton. New York, New York, USA. 1950

Mr. Hilaire Belloc has pointed out that science has changed greatly, and for the worse, since it has become popular. Some hundred years ago, or more, only very unusual, highly original spirits were attracted to science at all; scientific work was therefore carried out by men of exceptional intelligence. Now, scientists are turned out by mass production in our universities, and.... [T]hey are very ordinary professional men, and all they know is their own trade.

*Science Is a Sacred Cow*

Chapter I (pp. 23, 24)

Dutton. New York, New York, USA. 1950

...as advertising always convinces the sponsor even more than the public, the scientists become sold, and remain sold, on the idea that they have the Key to the Absolute, and that nothing will do for Mr. Average Citizen but to stuff himself full of electrons, protons, neutrons, neutrinos, genes, chromosomes, glands, hormones, potassium chloride, high-octane gasoline, ultrasonic vibrations, and the theory of relativity.

*Science Is a Sacred Cow*

Chapter I (p. 26)

Dutton. New York, New York, USA. 1950

The dreadful cocksureness that is characteristic of scientists in bulk is not only quite foreign to the spirit of true science, it is not even justified by a superficial view.

*Science Is a Sacred Cow*

Chapter I (p. 31)

Dutton. New York, New York, USA. 1950

“There’s many a true word spoken in jest”; scientists are abominably solemn; therefore scientists miss many a true word.

*Science Is a Sacred Cow*

Chapter v (p. 140)

Dutton. New York, New York, USA. 1950

**Stuck, Hudson** 1865–1920

Episcopal Archdeacon

A scientist is only a “scientist.” How that name tends continually to depreciate itself as the pursuit of physical science is divorced more and more completely from a knowledge of literature, from a knowledge of the humanities!

*Ten Thousand Miles With a Dog Sled*

Chapter IX (p. 269)

Charles Scribner’s Sons. New York, New York, USA. 1914

Your exclusive “scientist – and such are most of them today – may be competent to deal with circles and triangles, with wheels and levers with cells and glands, with germs and bacilli and microorganisms generally, with magnetos and dynamos, with all the heavenly host if you like, but he has no equipment to deal with man!

*Ten Thousand Miles With a Dog Sled*

Chapter IX (pp. 269–270)

Charles Scribner’s Sons. New York, New York, USA. 1914

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

The real scientist...is ready to bear privations and, if need be, starvation rather than let anyone dictate to him which direction his work must take.

Science Needs Freedom

*World Digest*, Volume 55, 1943

In the great struggle between ignorance, distrust and brutality on one side, knowledge, understanding and peace on the other the scientist must stand fearlessly on the side of the latter, strengthening link between man and man and preaching that the only effective weapon of self-defense is good-will to others.

*Les Prix Nobel. The Nobel Prizes in 1937*

Nobel banquet speech for award received in 1937

Nobel Foundation. Stockholm, Sweden. 1938

Good science is made by good scientists, poor science by poor scientists, and the most brilliant project is worthless in the hands of a poor scientist, while, conversely, a good scientist has a good chance to come up with something valuable whatever he touches, because “*die Welt rundet sich im Tautropfen*” (Goethe), which could be translated by saying that all the great laws of nature are represented in a drop of dew.

Research Grants

*Perspectives in Biology and Medicine*, Volume 18, Number 1, Autumn, 1974 (p. 41)

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

The life of a genuine scientific man is, from the common point of view, almost always uneventful. Engrossed with the paramount claims of inquiries raised high above the domain of mere human passions, he is with difficulty tempted to come forward in political discussions, even



when they are of national importance; and he regards with surprise, if not with contempt, the petty municipal squabbles in which local notoriety is so eagerly sought.

In W.J. Miller (ed.)

*Scientific Papers: By W.J. Macquorn Rankine*

Memoir (p. ix)

Charles Griffin & Company. London, England. 1881

To [the scientific man] the discovery of a new law of nature, or even of a new experimental fact, or the invention of a novel mathematical method, no matter who has been the first to reach it, is an event of an order altogether different from, and higher than, those which are so profusely chronicled in the newspapers.

In W.J. Miller (ed.)

*Scientific Papers: By W.J. Macquorn Rankine*

Memoir (p. ix)

Charles Griffin & Company. London, England. 1881

### **Taylor, Alfred Maurice** 1903–76

English optics physicist

The three attributes of commitment, imagination, and tenacity seem to be the distinguishing marks of greatness in a scientist. A scientist must be as utterly committed to the pursuit of truth as the most dedicated of mystics; he must be as pertinacious in his struggle to advance into uncharted country as the most indomitable pioneers; his imagination must be as vivid and ingenious as a poet's or a painter's. Like other men, for success he needs ability and some luck; his imagination may be sterile if he has not a flair for asking the right questions, questions to which nature's reply is intelligible and significant.

*Imagination and the Growth of Science*

Chapter I (p. 5)

Schocken Books. New York, New York, USA. 1970

### **Thomas, Lewis** 1913–93

American physician and biologist

Scientists at work have the look of creatures following genetic instructions; they seem to be under the influence of a deeply placed human instinct. They are, despite their efforts at dignity, rather like young animals engaged in savage play. When they are near to an answer their hair stands on end, they sweat, they are awash in their own adrenaline. To grab the answer, and grab it first, is for them a more powerful drive than feeding or breeding or protecting themselves against the elements.

*The Lives of a Cell: Notes of a Biology Watcher*

Natural Science (p. 101)

The Viking Press. New York, New York, USA. 1974

### **Thorne, Kip S.** 1940–

American theoretical physicist

I do not aspire to a historian's standards of completeness, accuracy, or impartiality.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 19)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

### **Timiriacheff, C. A.**

Russian botanist

...the chief object of the scientist is not to describe but to explain and command Nature; his method must not be that of a passive observer, but rather that of an active experimenter; he must engage in strife with Nature, and by the power of his mind extort from her answers to his questions, so that he may master and subordinate her at will, provoke or arrest the phenomena of life, direct or vary them.

Translated by Anna Sheremeteva

*Die Sinne der Pflanzen*

Chapter I (p. 6)

Longmans, Green & Co. London, England. 1912

### **Ting, Samuel C. C.** 1936–

Chinese-American physicist

...scientists must go beyond what is taught in the textbook, and they must think independently. Also, they cannot hesitate to ask questions, even when their view may be unpopular.

In Janet Nomura Morey and Wendy Dunn

*Famous Asian Americans*

Samuel C.C. Ting (p. 143)

### **Tolkien, J. R. R.** 1892–1973

English philologist, writer, and professor

Merry stared at the lines of marching stones: they were worn and black; some were leaning, some were fallen, some were cracked or broken; they looked like rows of old and hungry teeth. He wondered what they could be...

*The Lord of the Rings*

The Return of the King, Book Three (p. 795)

HarperCollins Publishers. 2004

### **Toulmin, Stephen** 1922–

English philosopher

No doubt, a scientist isn't necessarily penalized for being a complex, versatile, eccentric individual with lots of extra-scientific interests. But it certainly doesn't help him a bit.

*Civilization and Science in Conflict or Collaboration*

CIBA Foundation Symposium

Associated Scientific Publishers. Amsterdam, Netherlands. 1972

### **Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

That is their way, those plagues, those scientists – peg, peg, dig, dig, dig – plod, plod, plod. I wish I could catch a cargo of them for my place; it would be an economy. Yes, for years, you see. They never give up. Patience, hope, faith, perseverance; it is the way of all the breed.

*Europe and Elsewhere*

Sold to Satan

Harper & Brothers. New York, New York, USA. 1923



That is the way of the scientist. He will spend thirty years in building up a mountain range of facts with the intent to prove a certain theory; then he is so happy in his achievement that as a rule he overlooks the main chief fact of all – that his accumulation proves an entirely different thing.

*What Is Man? and Other Essays* (1917 edition)

The Bee Essay (p. 283)

Harper & Brothers. New York, New York, USA. 1917

Scientists have odious manners, except when you prop up their theory; then you can borrow money of them.

*What Is Man? and Other Essays* (1917 edition)

The Bee Essay (p. 283)

Harper & Brothers. New York, New York, USA. 1917

Such is professional jealousy; a scientist will never show any kindness for a theory which he did not start himself. There is no feeling of brotherhood among these people. Indeed, they always resent it when I call them brother. To show how far their ungenerosity can carry them, I will state that I offered to let Prof. H – y publish my great theory as his own discovery; I even begged him to do it; I even proposed to print it myself as his theory. Instead of thanking me, he said that if I tried to fasten that theory on him he would sue me for slander.

*A Tramp Abroad*

Chapter XLIII (p. 321)

Penguin Books. New York, New York, USA. 1997

## University of California, Berkeley

Scientists work better when they're all mixed-up.

Advertisement insert

*Fortune*, April, 1986 (p. 814)

## Varese, Edgar 1883–1965

French American composer

Scientists are the poets of today.

*Artspace*, Volume 9, Fall 1985 (p. 30)

## Vernadskii, Vladimir Ivanovich 1863–1945

Russian mineralogist

Scientists are in fact imaginers and artists; they are not free with their ideas; they can work well and hard only at what their thinking accepts and what their feelings are drawn to. Ideas alternate; impossible and often mad ones appear; they swarm and whirl, fuse and sparkle. Scientists live among these ideas and work for them.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

## von Frisch, Karl 1886–1982

Austrian zoologist

No competent scientist *ought* to believe these things on first hearing.

*Bees: Their Vision, Chemical Senses, and Language*

Foreword (p. vii)

Cornell University Press. Ithaca, New York, USA. 1950

## Wald, George 1906–97

American biologist and biochemist

A scientist should be the happiest of men. Not that science isn't serious; but as everyone knows, being serious is one way of being happy...

*Les Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

A scientist is in a sense a learned small boy. There is something of the scientist in every small boy. Others must outgrow it. Scientists can stay that way all their lives.

*Les Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

## Walshe, Sir F. M. R.

No biographical data available

It often is the cloistered scientist who knows least about men who is apt to pontificate most loudly and confidently about Man. Beware of him when he assures you that he knows all the answers about us, for too often his is one of those Peter Pans of science that every generation produces: a clever boy who hasn't grown up.

*Canadian Medical Association Journal*, Volume 67, 1962 (p. 395)

## Weil, Simone 1909–43

French philosopher and mystic

On could count on one's fingers the number of scientists throughout the world with a general idea of the history and development of their particular science: there is none who is really competent as regards sciences other than his own. As science forms an indivisible whole, one may say that there are no longer, strictly speaking, scientists, but only drudges doing scientific work.

Translated by Arthur Wills and John Petrie

*Oppression and Liberty*

Prospects (p. 13)

Routledge & Kegan Paul Ltd. London, England. 1958

Science is voiceless; it is the scientists who talk.

*On Science, Necessity, and the Love of God*

Chapter 3 (p. 57)

Oxford University Press. London, England. 1968

## Weinberg, Alvin Martin 1915–2006

American physicist

The traditional working scientists are at the bottom rung – each one knows almost everything about almost nothing; as one progresses toward the top of the ladder, the subject matter becomes more abstract until one finally reaches the philosopher at the top who knows almost nothing about almost everything.

*Reflections on Big Science*

Chapter II (p. 47)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Weiss, Paul A.** 1898–1989  
Austrian-born American biologist

Just like the painter, who steps periodically back from his canvas to gain perspective, so the laboratory scientist emerges above ground occasionally from the deep shaft of his specialized preoccupation to survey the cohesive, meaningful fabric developing from innumerable component tributary threads, spun underground much like his own. Only by such shuttling back and forth between the worm's eye view of detail and the bird's eye view of the total scenery of science can the scientist gain and retain a sense of perspective and proportions.

In A. Koestler and J. R. Smithies

*Beyond Reductionism: New Perspectives in the Life Sciences*

The Living System (p. 3)

Beacon Press. Boston, Massachusetts, USA. 1969

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science has become adult; I am not sure whether scientists have.

In Anthony R. Michaelis & Hugh Harvey eds.

*Scientists in Search of Their Conscience*

Conclusion (p. 193)

Springer-Verlag. Berlin, Germany. 1973

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

What there is great about [scientists] is an annoyance to their fellow scientists and a mystery to the general public, and what is not is evident. There is no doubt about what is not great, no race of men have such obvious little-nesses.... And withal the reef of science that these little "scientists" built and are yet building is so wonderful, so portentous, so full of mysterious half-shapen promises for the mighty future of man! They do not seem to realise the things they are doing.

*Seven Famous Novels by H.G. Wells*

*The Food of the Gods*

Chapter I. (p. 533)

Alfred A. Knopf. New York, New York, USA. 1934

No doubt long ago even Mr. Bensington, when...he consecrated his life to the alkaloids and their kindred compounds had some inkling of the vision – more than an inkling. Without some great inspiration, for such glories and positions only as a "scientist" may expect, what young man would have given his life to this work, as young men do? No, they must have seen the glory, they must have had the vision, but so near that it has blinded them, mercifully, so that for the rest of their lives they can hold the light of knowledge in comfort – that we may see.

*Seven Famous Novels by H.G. Wells*

*The Food of the Gods*

Chapter I. (p. 533)

Alfred A. Knopf. New York, New York, USA. 1934

In the middle years of the nineteenth century there first became abundant in this strange world of ours a class of men, men tending for the most part to become elderly, who are called, and who are very properly called, but who dislike extremely to be called "Scientists."

*Seven Science Fiction Novels of H. G. Wells*

*The Food of the Gods*

Book I, Chapter the First (p. 623)

Dover Publications, Inc. New York, New York, USA. 1934

**Weyl, Hermann** 1885–1955  
German mathematician

One of the great differences between the scientist and the impatient philosopher is that the scientist bides his time. We must await the further development of science, perhaps for centuries, perhaps for thousands of years, before we can design a true and detailed picture of the interwoven texture of matter, life and soul. But the old classical determinism of Hobbes and LaPlace need not oppress us any longer.

*The Open World: Three Lectures in the Metaphysical Implications of Science*

Lecture II (p. 55)

Yale University Press. New Haven, Connecticut, USA. 1932

**Whewell, William** 1794–1866  
English philosopher and historian

We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist. Thus we might say, that as an Artist is a Musician, Painter, or Poet, a Scientist is a Mathematician, Physicist, or Naturalist.

*Novum Organum Renovatum*

Aphorisms Concerning the Language of Science

John W. Parker & Son. London, England. 1858

The terminations *ize* (rather than *ise*), *ism*, and *ist*, are applied to words of all origins: thus we have to *pulverize*, to *colonize*, *Witticism*, *Heathenism*, *Journalist*, *Tobacconist*. Hence we may make such words when they are wanted. As we cannot use *physician* for a cultivator of physics, I have called him a *Physicist*. We need very much a name to describe a cultivator of science in general. I should incline to call him a *Scientist*. Thus we might say, that as an Artist is a Musician, Painter, or Poet, a Scientist is a Mathematician, Physicist, or Naturalist.

*The Philosophy of the Inductive Sciences, Founded Upon Their History* (Volume 2)

Aphorisms, Aphorism XVI (p. 560)

John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Many a scientist has patiently designed experiments for the purpose of substantiating his belief that animal operations are motivated by no purpose...Scientists animated by the purpose of proving that they are purposeless

constitute an interesting subject for study.

*The Function of Reason*

Chapter I (p. 12)

Beacon Press. Boston, Massachusetts, USA. 1929

A few generations ago the clergy, or to speak more accurately, large sections of the clergy were the standing examples of obscurantism. Today their place has been taken by scientists.

*The Function of Reason*

Chapter I (pp. 34–35)

Beacon Press. Boston, Massachusetts, USA. 1929

### **Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

We humans want better minds, broader horizons, and greater understanding. Scientists everywhere are at work in their respective fields searching for new truths to improve the process by which our minds, our horizons, our powers, and our outlooks grow.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*

The Vacuum – There's Something in It (p. 193)

Government Printing Office. Washington, D.C. 1925

### **Wiener, Norbert** 1894–1964

American mathematician

...the first industrial revolution,...of the “dark satanic mills,” [devalued] the human arm by the competition of machinery.... The modern industrial revolution is similarly bound to devalue the human brain...in its simpler and more routine decisions. Of course, just as the skilled carpenter, the skilled mechanic, the skilled dressmaker have in some degree survived the first industrial revolution, so the skilled scientist and the skilled administrator may survive the second. However,...the average human being of mediocre attainment or less has nothing to sell that is worth anyone's money to buy.

*Cybernetics: Or Control and Communication in the Animal and the Machine*  
Introduction (pp. 27–28)

The MIT Press. Cambridge, Massachusetts, USA. 1961

...the degradation of the position of the scientist as independent worker and thinker to that of a morally irresponsible stooge in a science-factory has proceeded even more rapidly and devastatingly than I had expected.

A Rebellious Scientist after Two Years

*Bulletin of the Atomic Scientists*, Volume 4, Number 11, November 4, 1948 (p. 338)

[A scientist] must live in a world where science is a career, where he has companions with whom to talk, and in contact with whom he may bring out his own self. It may be true that 95% of the really original scientific work is done by less than 5% of the professional scientists, but the greater part of it would not be done at all if the other 95% were not there and did not create a high level of public scientific opinion.

Science, Monkeys, and Mozart

*Saturday Review of Literature*, November 20, 1956

### **Wikström, J. E.**

Former Swedish Minister of Education and Cultural Affairs

...Scientists are like children playing with fire without heeding the disastrous consequences of their games or, even worse, “they are like incendiaries which completely destroy property.”

In Torgny Segerstedt

*Ethics for Science Policy: Proceedings of a Nobel Symposium Held at Södergarn, Sweden, 20–25 August 197*

Opening Remarks (p. xiii)

Pergamon Press. Oxford, England. 1979

### **Wilder, Thornton** 1897–1975

American playwright and novelist

Then there is technology, the excess of scientists who learn how to make things much faster than we can learn what to do with them.

In Plora Lewis

Thornton Wilder at 65 Looks Ahead – And Back

*New York Times Magazine*, 15 April, 1962 (p. 28)

### **Wilf, Alexander**

No biographical data available

A scientist cannot be measured quantitatively by the number of degrees or the accumulation of information. A true scientist should have a measure of courage to correct error and seek truth – no matter how painful. The alternative is more painful. To build error upon error is to drift into dogmas, metaphysics, science fiction, and mythology.

*Origin and Destiny of the Moral Species* (p. 9)

A.S. Barnes. South Brunswick, New Jersey, USA. 1969

### **Wilson, Edward O.** 1929–

American biologist and author

The ideal scientist thinks like a poet and works like a bookkeeper, and I suppose that if gifted with a full quiver, he also writes like a journalist. As a painter stands before canvas or a novelist recycles old emotion with eyes closed, he searches his imagination for subjects as much as for conclusions, for questions as much as for answers.

Scientists, Scholars, Knaves and Fools

*American Scientist*, Volume 86, January–February, 1998 (p. 7)

Scientists, I believe, are divided into two categories: those who do science in order to be a success in life, and those who become a success in life in order to do science.

*Naturalist*

The Forms of Things Unknown (p. 210)

Island Press. Washington, D.C. 1994

Scientists do not discover in order to know, they know in order to discover.

*Biophilia*

The Poetic Species (p. 58)

Harvard University Press. Cambridge, Massachusetts. 1984

Scientists live and die by their ability to depart from the tribe and go out into an unknown terrain and bring back,

like a carcass newly speared, some new discovery or fact or theoretical insight and lay it in front of the tribe; and then they all gather and dance around it. Symposia are held in the National Academy of Sciences and prizes are given [The symposia are] fundamentally no [different] from a Paleolithic camp site celebration.

In Edward Lueders

*Writing Natural History: Dialogues with Authors*

Dialogue One (p. 25)

University of Utah Press. Salt Lake City, Utah, USA. 1989

The scientist is not a very romantic figure. ...[His work] amounts to a sort of puttering: trying to find a good problem, thinking up experiments, mulling over data, arguing in the corridor with colleagues, and making guesses with the aid of coffee and chewed pencils until finally something – usually small – is uncovered. Then comes a flurry of letters and telephone calls, followed by the writing of a short paper in an acceptable jargon. The great majority of scientists are hard-working, pleasant journeymen, not excessively bright, making their way through a congenial occupation.

*Biophilia*

The Poetic Species (p. 59)

Harvard University Press. Cambridge, Massachusetts. 1984

Theoretical scientists, inching away from the safe and known, skirting the point of no return, confront nature with a free invention of the intellect. They strip the discovery down and wire it into place in the form of mathematical models or other abstractions that define the perceived relation exactly. The now-naked idea is scrutinized with as much coldness and outward lack of pity as the naturally warm human heart can muster. They try to put it to use, devising experiments or field observations to test its claims. By the rules of scientific procedure it is then either discarded or temporarily sustained. Either way, the central theory encompassing it grows. If the abstractions survive they generate new knowledge from which further exploratory trips of the mind can be planned. Through the repeated alternation between flights of the imagination and the accretion of hard data, a mutual agreement on the workings of the world is written, in the form of natural law.

*Biophilia*

The Poetic Species (p. 67)

Harvard University Press. Cambridge, Massachusetts. 1984

### **Winterton, Curtis C.**

No biographical data available

Any man is a scientist when he puts two and two together and draws conclusions which are justified by the observed facts, for science uses only refinements of the inductions and deductions practiced in everyday life.

The Method and the Knowledge of Science

*Natural History*, Volume XIX, February, 1919 (p. 155)

### **Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

What a curious attitude scientists have – : “We still don’t know that; but it is knowable and it is only a matter of time before we get to know it!” As if that went without saying.

Translated by Peter Winch

*Culture and Value* (p. 40e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

### **Wolpert, Lewis** 1929–

British embryologist

Both Newton and Darwin were driven by the data and were forced to recognize that they couldn’t explain everything. It may be a characteristic of great scientists to know what to accept and what to leave out.

*The Unnatural Nature of Science*

Chapter 4 (p. 72)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

### **Wood, William Hamilton**

No biographical data available

The basal fact is that the scientist worships *truth*. His search is above everything else for truth. Truth is the very breath he breathes. His findings, his beliefs must therefore be truth. He is the willing, loyal servant of this master before whom he bows down as to one greater than himself.

*The Religion of Science*

Chapter II (p. 20)

The Macmillan Co. New York, New York, USA. 1922

### **Young, John Zachary** 1907–97

English zoologist

One of the characteristics of scientists and their work, curiously enough, is a certain confusion, almost a muddle. This may seem strange if you have come to think of science with a big S as being all clearness and light.

*Doubt and Certainty in Science: A Biologist’s Reflections on the Brain*

First Lecture (p. 1)

Oxford University Press, Inc. Oxford, England. 1960

...in his laboratory he does not spend much of his time thinking about scientific laws at all. He is busy with other things, trying to get some piece of apparatus to work, finding a way of measuring something more exactly.... You may feel that he hardly knows himself what law he is trying to prove. He is continually observing, but his work is a feeling out into the dark, as it were. When pressed to say what he is doing he may present a picture of uncertainty or doubt, even of actual confusion.

*Doubt and Certainty in Science: A Biologist’s Reflections on the Brain*

First Lecture (p. 2)

Oxford University Press, Inc. Oxford, England. 1960

**Zisel, Edgar** 1891–1944

Austrian historian and philosopher of science

The modern scientist looks upon science as a great building erected stone by stone through the work of his predecessors and his contemporary fellow-scientists, a structure that will be continued but never completed by his successors.

The Genesis of the Concept of Scientific Progress

*The Journal of the History of Ideas*, Volume 6 1945 (p. 325)**SCIENTIST, FUNCTION OF****Gould, Benjamin Anthon** 1824–96

American astronomer

The function of the scientist is to attain new truths by conquering them from the limitless realm of the unknown, and whether they be brilliant or otherwise, none is too small or insignificant in aspect to deserve his earnest search or joyful welcome.

*Proceedings of the American Association for the Advancement of Science*

Address (p. 16)

Joseph Lovering. Cambridge, Massachusetts, USA. 1870

**SCINTILLATION****Hardy, Thomas** 1840–1928

English poet and regional novelist

Then, again, the scintillations vary. No star flaps his wings like Sirius when he lies low! He flashes out emeralds and rubies, amethystine flames and sapphirine colours, in a manner quite marvellous to behold, and this is only one star! So, too, do Arcturus, and Capella, and lesser luminaries...

*Two On A Tower*

Chapter VII (p. 59)

Harper &amp; Brothers Publishers. New York, New York, USA. 1905

**Taylor, June**

Twinkle, twinkle, little star...

In Eva March Tappan

*Old Fashioned Stories & Poems*

Twinkle, Twinkle, Little Star

Houghton Mifflin Co. 1907

**SCRIBBLES****Ulam, Stanislaw** 1909–84

Polish-born mathematician

It is still an unending source of surprise for me how a few scribbles on a blackboard or on a piece of paper can change the course of human affairs.

*Adventures of a Mathematician*

Prologue (p. 5)

Charles Scribner's Sons. New York, New York, USA. 1976

**SEA****Author undetermined**

The life of one who explores the mysteries of the sea, is not more perilous than fascinating.

The Ocean Depths

*Putnam's Monthly*, Volume VII, April, 1856 (p. 386)**Beebe, William** 1877–1962

American ornithologist

When once it has been seen, it will remain forever the most vivid memory in life, solely because of its cosmic chill and isolation, the eternal and absolute darkness and the indescribable beauty of its inhabitants.

*Half Mile Down*

Chapter 9 (p. 175)

Harcourt, Brace &amp; Company. New York, New York, USA. 1934

**Benitez, Sandra**

No biographical data available

In the biting honesty of salt, the sea makes her secrets known to those who care to listen.

*A Place where the Sea Remembers*

Chapter 1 (p. 2)

Touchstone. New York, New York, USA. 1993

**Berger, John** 1926–

English art critic, novelist, painter, and author

The sun is low in the sky and the sea is calm. Like a mirror as they say. Only it is not like a mirror. The waves which are scarcely waves, for they come and go in many different directions and their rising and falling is barely perceptible, are made up of innumerable tiny surfaces at variegating angles to one another – of these surfaces those which reflect the sunlight straight into one's eyes, sparkle with a white light during the instant before their angle, relative to oneself and the sun, shifts and they merge again into the blackish blue of the rest of the sea.

G

Chapter 10 (p. 310)

The Viking Press. New York, New York, USA. 1972

[A]s the sea recedes towards the sun, the number of sparkling surfaces multiplies until the sea indeed looks somewhat like a silver mirror. But...it is not still. Its granular surface is in continual agitation. The further away the ricocheting grains, of which the mass become silver and the visibly distinct minority a dark leaden colour, the greater is their apparent speed. Uninterruptedly receding towards the sun, the transmission of its reflexions becoming ever faster, the sea neither requires nor recognizes any limit. The horizon is the straight bottom edge of a curtain arbitrarily and suddenly lowered on a performance.

G

Chapter 10 (p. 310)

The Viking Press. New York, New York, USA. 1972



**Beston, Henry** 1888–1968  
American writer

Listen to the surf, really lend it to your ears, and you will hear in it a world of sounds: hollow boomings and heavy roarings, great watery tumblings and tramlings, long hissing seethes, sharp, rifle-shot reports, splashes, whispers, the grinding undertone of stones, and sometimes vocal sounds that might be the half-heard talk of people in the sea.

*The Outermost House*

Chapter III (p. 43)

Rinehart & Company. New York, New York, USA. 1928

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Like the turbulent crowd at the rim of an arena, the sea surrounds the lands and awaits the issue of combat. Fretfully the colossus chafes at the margins of battlefields it is eager but impotent to enter.

*Autobiography of Earth*

Chapter VI (p. 168)

Coward-McCann, Inc. New York, New York, USA. 1935

**Broch, Hermann** 1886–1951  
Austrian writer

Those who live by the sea can hardly form a single thought of which the sea would not be part.

*The Spell*

Forward (p. 3)

North Point Press. San Francisco, California, USA. 1989

**Burroughs, John** 1837–1921  
American naturalist and essayist

The sea, as a whole, does not flow to any particular point; it flows to all points, and in all directions; there are currents beneath currents.

*The Heart of Burroughs's Journals*

March 4, 1885 (p. 123)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Cable, Richard**  
No biographical data available

What a fascination there is in looking at the sea! Even the most vulgar soul is affected by it. On the sea-border we are on the frontier of the infinite.

*The Lightshipman*

*The Living Age*, Volume LXI, Number 2272, January 18, 1888 (p. 108)

**Carson, Rachel** 1907–64  
American marine biologist and author

There we see the parts of the plan fall into place: the water receiving from earth and air the simple materials, storing them up until the gathering energy of the spring sun wakens the sleeping plants to a burst of dynamic activity, hungry swarms of planktonic animals growing and multiplying upon the abundant plants, and them-

selves falling prey to the shoals of fish; all, in the end, to be redissolved into their component substances when the inexorable laws of the sea demand it.

*Undersea*

*Atlantic Monthly*, September, 1937 (p. 29)

The sea has always challenged the minds and imagination of men and even today it remains the last great frontier of Earth.

*The Sea Around Us*

Preface (p. vii)

Oxford University Press, Inc. New York, New York, USA. 1989

It is a curious situation that the sea, from which life first arose should now be threatened by the activities of one form of that life. But the sea, though changed in a sinister way, will continue to exist; the threat is rather to life itself.

*The Sea Around Us*

Preface (p. xiii)

Oxford University Press, Inc. New York, New York, USA. 1989

...all at last return to the sea – to Oceanus, the ocean river, like the ever-flowing stream of time, the beginning and the end.

*The Sea Around Us*

The Encircling Sea (p. 162)

Simon & Schuster. New York, New York, USA. 1958

The edge of the sea is a strange and beautiful place.

*The Edge of the Sea*

The Marginal World (p. 1)

Houghton Mifflin & Co. New York, New York, USA. 1998

**Chopin, Kate** 1851–1904  
American author of short stories and novels

The voice of the sea speaks to the soul. The touch of the sea is sensuous, enfolding the body in its soft, close embrace.

*The Awakening*

Chapter VI (p. 34)

Capricorn Books. New York, New York, USA. 1964

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

For all that has been said of the love that certain natures (on shore) have professed to feel for it, for all the celebrations it has been the object of in prose and song, the sea has never been friendly to man. At most it has been the accomplice of human restlessness ...

*The Mirror of the Sea*

Chapter XXXV (p. 135)

Doubleday, Page & Co. Garden City, New York, USA. 1924

**Cousteau, Jacques-Yves** 1910–77  
French naval officer and ocean explorer

The sea is not a bargain basement.

*The Living Sea*

Chapter Seventeen (p. 313)

Harper & Row, Publishers. New York, New York, USA. 1963



From the vast expanses of its surface waters to its beaches and marshes and tidelands and mangrove swamps, from its many thousands of miles of rocky shores to its deep-est and darkest abyss, the sea produces life in fantastic abundance.

*The Ocean World of Jacques Cousteau: The Adventure of Life*

Chapter I (p. 10)

The World Publishing Company. New York, New York, USA. 1973

The sea is the universal sewer.

House Committee on Science and Astronautics

28 January, 1971

**Cromie, William J.** 1930–

American journalist and writer

In the open ocean one sees no green meadows or fertile prairies. Away from the rim of seaweed around the coasts one is aware of only an endless confusion of seemingly barren waves. Yet there are lush pastures in the open sea.

*The Living World of the Sea*

Chapter 3 (p. 37)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1966

The sea gave birth to life and without its waters no living thing could ever survive on Earth. Now man, rightly or wrongly, is looking to the ocean as his ultimate safety valve, the answer to his problems of food, waste and even space. But the sea has no mind and the sea is not inexhaustible.

*The Living World of the Sea*

Chapter 15 (p. 332)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1966

**Deacon, G. E. R.**

No biographical data available

The sea is different. It is an alien world whose mysteries can be probed only slowly and painstakingly. Hence our knowledge of life in the sea has come late in the records of human history, and we still have a great deal to learn.

*Life in the Sea* (p. 76)

Doubleday & Co., Inc. Garden City, New York, USA. 1962

**Diolé, Philippe** 1908–77

French author and undersea explorer

Between the air and the water a steel blade quivers. What people call the surface is also a ceiling: a mirror from above, watered silk from beneath. Nothing is torn on the way through. Only a few bubbles mark the diver's channel and behind him the frontier soon closes. But once the threshold is crossed, one can turn back slowly and look up: that dazzling screen is the border between two worlds, as clear to one as to the other. Behind the looking glass the sky is made of water.

Translated by Alan Ross

*The Undersea Adventure*

Chapter 1 (pp. 6–7)

Julian Messner, Inc. New York, New York, USA. 1953

**Earle, Sylvia Alice** 1935–

American oceanographer and education advocate

If the sea is sick, we'll feel it. If it dies, we die. Our future and the state of the ocean are one.

*Sea Change*

Introduction (p. xii)

G.P. Putnam's Sons. New York, New York, USA. 1995

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

In the end the sea rejects its offspring. They cannot fight their way home through the surf which casts them repeatedly back upon the shore. The tiny breathing pores of starfish are stuffed with sand. The rising sun shrivels the mucilaginous bodies of the unprotected. The seabeach and its endless war are soundless. Nothing screams but the gulls.

*The Star Thrower*

The Star Thrower (p. 170)

Times Books. New York, New York, USA. 1978

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

To the geologist the sea is the only firmament...

*The Complete Works of Ralph Waldo Emerson* (Volume 5)

*English Traits* (p. 29)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The sea, washing the equator and the poles, offers its perilous aid, and the power and empire that follow it... "Beware of me," it says, "but if you can hold me, I am the key to all the lands."

*Ralph Waldo Emerson: Essays and Lectures*

*The Conduct of Life*

Wealth (p. 991)

The Library of America. New York, New York, USA. 1983

**Empedocles of Acragas** ca. 490 BCE–430 BCE

Greek pre-Socratic philosopher

The sea is the sweat of the earth.

In Arthur Fairbanks

*The First Philosophers of Greece*

Book I

Fragment 165 (p. 179)

**Flecker, James Elroy** 1884–15

English poet and playwright

The dragon-green, the luminous, the dark, the serpent-haunted sea.

*The Collected Poems of James Elroy Flecker*

The Gates of Damascus

West Gate

Doubleday, Page & Company. New York, New York, USA. 1916

**Garfield, James A.** 1831–81

20th president of the USA

I have seen the sea lashed into fury and tossed into spray, and its grandeur moves the soul of the dullest man; but

I remember that it is not the billows, but the calm level of the sea from which all heights and depths are measured.

*Proceedings of the Republican National Convention*  
Chicago, Illinois, June 2–8, 1880 (p. 184)

**Gosse, Philip Henry** 1810–88

English naturalist and popularizer of natural science

The insular peaks and blocks receive the incoming surge in an overwhelming flood, which, immediately, as the spent wave recedes, pours off through the interstices in a hundred beautiful jets and cascades; while in the narrow straits and passages the rushing sea boils and whirls about in curling sheets of snowy whiteness, curling the surface; or, where it breaks away, of the most delicate pea-green hue, the tint produced by the bubbles seen through the water as they crowd to the air from the depths where they were formed – the evidence of the unseen combat fiercely raging between earth and sea far below.

*A Year at the Shore*

January (p. 4)

Alexander Strahan. London, England. 1865

**Guilleimin, Amédée** 1826–93

French journalist and scientific writer

If we were to compare the sea to an immense being which lives, moves, and breathes, it is in the tempest we should see its anger, and in calms its sleeping hours, whilst the periodical movements of the tides would typify its regular and constant respiration. But these are poetical fancies on which we do not care to insist. These great phenomena of nature offer an interest so real that they require no more embellishment.

In Norman Lockyer and Richard Anthony Proctor

*The Heavens: An Illustrated Handbook of Popular Astronomy*

Part Third, Book First, Chapter IV (p. 384)

Richard Bentley & Son. London, England. 1878

**Hardy, Thomas** 1840–1928

English poet and regional novelist

Who can say of a particular sea that it is old? Distilled by the sun, kneaded by the moon, it is renewed in a year, in a day, or in an hour.

*The Return of the Native*

Book the First, Chapter I (p. 14)

The New American Library. New York, New York, USA. 1959

**Hartwig, Georg**

No biographical data available

Of all the gods that divide the empire of the earth, Neptune rules over the widest realms. If a giant-hand were to uproot the Andes and cast them into the sea, they would be engulfed in the abyss, and scarcely raise the general level of the waters.

*The Sea and Its Living Wonders* (8th edition)

Chapter I (p. 3)

Longmans, Green & Co. London, England. 1892

**Hazlitt, William Carew** 1834–1913

English bibliographer

I hate to be near the sea, and to hear it roaring and raging like a wild beast in its den. It puts me in mind of the everlasting efforts of the human mind, struggling to be free, and ending just where it began.

*Common Places*

**Heine, Heinrich** 1797–1856

German journalist and essayist

The sea knows all things; for, at night, the stars confide to it the hidden mysteries of heaven.

Translated by Simon Alder Stern

*Scintillations from the Prose Works of Heinrich Heine*

Miscellaneous (p. 170)

Henry Holt & Co. New York, New York, USA. 1873

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The mountains give their lost children berries and water ; the sea mocks their thirst and lets them die.

*The Autocrat of the Breakfast Table*

Chapter XI (p. 262)

J.M. Dent & Co. Boston, Massachusetts, USA. 1907

The mountains have a grand, stupid, lovable tranquility ; the sea has a fascinating, treacherous intelligence.

*The Autocrat of the Breakfast Table*

Chapter XI (p. 262)

J.M. Dent & Co. Boston, Massachusetts, USA. 1907

The sea remembers nothing. It is feline. It licks your feet, – its huge flanks purr very pleasantly for you; but it will crack your bones and eat you, for all that, and wipe the crimsoned foam from its jaws as if nothing had happened.

*The Autocrat of the Breakfast-table*

Chapter XI (p. 262)

J.M. Dent & Co. London, England. 1907

The sea drowns out humanity and time; it has no sympathy with either; for it belongs to eternity, and of that it sings its monotonous song forever and ever.

*The Autocrat of the Breakfast-table*

Chapter XI (p. 262)

J.M. Dent & Co. London, England. 1907

**Houot, Georges** 1913–2000

French underwater explorer

**William, Pierre**

No biographical data available

We are entering on the last stage of man's march toward a knowledge of the surface of the globe. The battle that remains to be fought will be long and hard. Despite the progress of science, the sea remains a hostile element, particularly so at the frontier between the water and the atmosphere.

Translated by Michael Bullock

*2000 Fathoms Down* (p. 182)

E.P. Dutton & Company. New York, New York, USA. 1955

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

When it wishes to be, the sea is gay.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 406)

The Heritage Press. New York, New York, USA. 1961

**Knight, Norman L.**

No biographical data available

O Sea! Thou saline and undulant aqueous solution of halides, carbonates, phosphates, sulfates, and other soluble inorganic compounds! What mysterious colloids are dispersed within thy slightly alkaline bosom? What silent and unseen reactions vibrate in dynamic equilibrium, constantly destroyed and instantly restored, among thy unnumbered oscillating molecules? What uncounted myriads of restless ions migrate perpetually throughout thy tentatively estimated volume? What unguessed phenomena of catalysis, metathesis, and osmosis transpire in thy secret fluid profundities under excessively increased pressure? What cosmic precipitates descend in countless kilograms upon thy argillaceous, gelatinous, siliceous, diatomaceous, and totally unilluminated bottom? In short, most magnificent reservoir, what is thy flow-chart and complete analysis?

A Chemist Addresses the Ocean

*Industrial and Engineering Chemistry: News Edition*, Volume 8, Number 22, September 20, 1930

**Ledbetter, B. G.**

No biographical data available

The sea often appears tranquil and serene, but its permanent hills and valleys illustrate that in fact it is restless, always in motion, mixing and flowing in ceaseless search for peace.

Sea Level Isn't Level – It's Hilly

*Science Digest*, Volume 68, Number 1, July 1970 (p. 72)

**Lindbergh, Anne Morrow** 1906–2001

American aviator and writer

The sea does not reward those who are too anxious, too greedy, or too anxious. To dig for treasures shows not only impatience and greed, but a lack of faith. Patience, patience, is what the sea teaches. Patience and faith. One should lie empty, open, choiceless as a beach-waiting for a gift from the sea.

*Gift from the Sea*

Part I, The Beach (p. 17)

Pantheon Books, Inc. New York, New York, USA. 1955

**Longfellow, Henry Wadsworth** 1807–82

American poet

Learn the secret of the sea?

Only those who brave its dangers

Comprehend its mystery.

*The Seaside and the Fireside*

The Secret of the Sea

Ticknor, Reed & Fields. Boston, Massachusetts, USA. 1850

...my soul is full of longing for the secrets of the sea.

And the heart of the great ocean

Sends a thrilling pulse through me.

*The Seaside and the Fireside*

The Secret of the Sea

Ticknor, Reed & Fields. Boston, Massachusetts, USA. 1850

**Lowell, James Russell** 1819–91

American poet, critic, and editor

The sea was meant to be looked at from shore, as mountains are from the plain.

*Fireside Travels*

At Sea (p. 155)

Ticknor & Fields. Boston, Massachusetts, USA. 1864

There is nothing so desperately monotonous as the sea, and I no longer wonder at the cruelty of pirates.

*Fireside Travels*

At Sea (p. 157)

Ticknor & Fields. Boston, Massachusetts, USA. 1864

**Lubbock, John, First Baron Avebury** 1834–1919

English banker, politician, biologist, and archaeologist

The Sea is outside time. A thousand, ten thousand, or a million years ago it must have looked just as it does now, and as it will ages hence.

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter IX (p. 340)

Macmillan & Company New York, New York, USA. 1893

**Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

The sea...we may safely infer, has its offices and duties to perform ; so, may we infer, have its currents, and so, too, its inhabitants; consequently, he who undertakes to study its phenomena must cease to regard it as a waste of waters. He must look upon it as a part of that exquisite machinery by which the harmonies of nature are preserved, and then he will begin to perceive the developments of order and the evidences of design : viewed in this light, it becomes a vast field for study – a most beautiful and interesting subject for contemplation.

*The Physical Geography of the Sea, and its Meteorology*

Chapter III (p. 61)

Sampson Low, Marston & Co. London, England. 1891

Harmonious in their action, the air and sea are obedient to law and subject to order in all their movements; when we consult them in the performance of their offices, they teach us lessons concerning the wonders of the deep, the mysteries of the sky, the greatness, and the wisdom, and goodness of the Creator.

*The Physical Geography of the Sea*

Chapter III (p. 96)

Harper & Brothers. New York, New York, USA. 1855

Astronomers had measured the volumes and weighed the masses of the most distant planets, and increased thereby the stock of human knowledge. Was it creditable to the age that the depths of the sea should remain in the category of an unsolved problem? ...Indeed, telescopes of huge proportions and of vast space-penetrating powers had been erected here and there by the munificence of individuals, and attempts made with them to gauge the heavens and sound out the regions of space. Could it be more difficult to sound out the sea than to gauge the blue ether and fathom the vault of the sky?

*The Physical Geography of the Sea*

Chapter XI (pp. 201, 202)

Harper & Brothers. New York, New York, USA. 1855

Could the waters of the Atlantic be drawn off so as to expose to view this great sea-gash...it would present a scene most rugged, grand, and imposing. The very ribs of the solid earth, with the foundations of the sea would be brought to light, and we should have presented to us at one view, in the empty cradle of the ocean, "a thousand fearful wrecks," with that dreadful array of dead men's skulls, great anchors, heaps of pearl and inestimable stones, which, in the poet's eye, lie scattered in the bottom of the sea, making it hideous with sights of ugly death.

*The Physical Geography of the Sea*

Chapter XII (p. 208)

Harper & Brothers. New York, New York, USA. 1855

### **Melville, Herman** 1819–91

American novelist

There is, one knows not what sweet mystery about the sea, whose gently awful stirrings seem to speak of some hidden soul beneath.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 107 (p. 354)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Miller, Robert C.**

No biographical data available

We can no longer think of the sea as a vast, illimitable dumping ground for products that man does not know what to do with on land. It must instead be recognized as our greatest natural resource, and one to be conserved in every possible way. So regarded, and wisely used, it can be a permanent source of raw materials, of food, of life-giving water, and of recreation, enjoyment and adventure.

*The Sea*

Chapter 15 (p. 311)

Random House, Inc. New York, New York, USA. 1966

### **Muir, John** 1838–1914

American naturalist

...both ocean and sky are already about as rosy as possible; the one with stars, the other with dulse, and foam, and wild light.

*Steep Trails*

Chapter I (p. 3)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

### **Nicks, Oran W.**

No biographical data available

It is no wonder that thoughtful men stand on a shore facing the open sea with a tingle of exhilaration as well as a feeling of solemnity and awe.

*This Island Earth*

Chapter 3 (p. 46)

National Aeronautics and Space Administration. Washington, D.C. 1970

### **Payne, Roger** 1935–

American biologist and environmentalist

The extraordinary things that occur within its [the sea's] vast spaces and corridors must in most part be deduced, for the sea is not a great communicator but the strong, silent type – a mute and patient (though sometimes wildly destructive) companion.

*Among Whales*

Chapter 1 (p. 20)

Charles Scribner's Sons. New York, New York, USA. 1995

### **Plattes, Gabriel**

No biographical data available

...the Sea never resting, but perpetually winning land in one place and losing in another, doth show what may be done in length of time by a continual operation not subject unto ceasing or intermission.

*Discovery of Subterranean Treasure*

Chapter XI (p. 22)

Printed by Robert Bell. Philadelphia, Pennsylvania, USA. 1784

### **Sandburg, Carl** 1878–1967

American poet and biographer

The sea folds away from you like a mystery. You can look and look at it and mystery never leaves it.

*Remembrance Rock* (p. 75)

Harcourt, Brace & World, Inc. New York, New York, USA. 1948

### **Schreiner, Olive** 1814–76

German-born missionary

Only the sea is like a human being; the sky is not, nor is the earth. But the sea is always moving, always something deep in itself is stirring it. It never rests; it is always wanting, wanting, wanting.

*The Story of an African Farm*

Part II, Chapter XI (p. 317)

Little, Brown, & Co. Boston, Massachusetts, USA. 1924

### **Sexton, Anne** 1928–74

American poet

The sea is mother-death and she is a mighty female, the one who wins, the one who sucks us all up.

In Howard Moss (ed.)

*The Poet's Story*

A Small Journal (p. 219)

19 November, 1971

The Macmillan Company. New York, New York, USA. 1973

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

“And what is the sea?” asked Will.  
“The sea!” cried the miller. “Lord help us all, it is the greatest thing God made! ... There are great fish in it five times bigger than a bull, and one old serpent as long as our river and as old as all the world, with whiskers like a man, and a crown of silver on her head.

*Strange Case of Dr. Jekyll and Mr. Hyde. The Merry Men and Other Tales and Fables*

Will O' the Wisp

The Plain and the Stars (pp. 77–78)

Current Literature Publishing Company New York, New York, USA. 1912

### The Bible (King James Version)

They that go down to the sea in ships, that do business in great waters; These see the works of the LORD, and his wonders in the deep.

Psalms 107:23–24

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

They say the sea is cold but the sea contains the hottest blood of all...

*Last Poems*

Whales Weep Not

The Viking Press. New York, New York, USA. 1933

**Maury, Matthew Fontaine** 1806–73  
American hydrographer and naval officer

The sea, therefore, we may safely infer, has its offices and duties to perform; so, may we infer, have its currents, and so, too, its inhabitants; consequently, he who undertakes to study its phenomena must cease to regard it as a waste of waters. He must look upon it as a part of that exquisite machinery by which the harmonies of nature are preserved, and then he will begin to perceive the developments of order and the evidences of design; viewed in this light, it becomes a most beautiful and interesting subject for contemplation.

*The Physical Geography of the Sea* (8th edition)

Chapter III (pp. 56–57)

Harper & Brothers Publishers. New York, New York, USA. 1871

**Melville, Herman** 1819–91  
American novelist

There is, one knows not what sweet mystery about the sea, whose gently awful stirrings seem to speak of some hidden soul beneath.

*Moby Dick*

Chapter CXI (p. 452)

L.C. Page & Co. Boston, Massachusetts, USA.

### Narrator

The sea, the birthplace of life, a great storehouse of minerals, the prison of haunting mysteries.

*The Incredible Petrified Forest*  
Film (1957)

**Payne, Roger** 1935  
American biologist

The extraordinary things that occur within its [the sea's] vast spaces and corridors must in most part be deduced, for the sea is not a great communicator but the strong, silent type – a mute and patient (though sometimes wildly destructive) companion.

*Among Whales*

Chapter 1 (p. 20)

Charles Scribner's Sons. New York, New York, USA. 1995

**Plattes, Gabriel** ca. 1600–44  
Writer

The sea never resting, but perpetually winning land in one place and losing in another, doth show what may be done in length of time by a continual operation, not subject unto ceasing or intermission.

*Discovery of Subterranean Treasure* (p. 52)

1639

**Verne, Jules** 1828–1905  
French novelist

Yes; I do love it! The sea is everything. It covers seven-tenths of the terrestrial globe. Its breath is pure and healthy. It is an immense desert, where man is never lonely, for he feels life stirring on all sides. The sea is only the embodiment of a supernatural and wonderful existence....

Translated by Mercier Lewis

*Twenty Thousand Leagues Under the Sea*

Part One, Chapter 10 (p. 58)

Nelson Doubleday, Inc. Garden City, New York, USA. 1900

Nature manifests herself in it by her three kingdoms, mineral, vegetable, and animal. The sea is the vast reservoir of Nature. The globe began with sea, so to speak; and who knows if it will not end with it? In it is supreme tranquility. The sea does not belong to despots. Upon its surface men can still exercise unjust laws, fight, tear one another to pieces, and be carried away with terrestrial horrors. But at thirty feet below its level, their reign ceases, their influence is quenched, and their power disappears.

Translated by Mercier Lewis

*Twenty Thousand Leagues Under the Sea*

Part One, Chapter 10 (p. 58)

Nelson Doubleday, Inc. Garden City, New York, USA. 1900

The sea is everything. It covers seven-tenths of the terrestrial globe. Its breath is healthy and pure. It is a spacious wilderness where man is never alone, for he can feel life throbbing all around him.

Translated by William Butcher

*Twenty Thousand Leagues Under The Sea*

Chapter 10 (p. 68)

Oxford University Press. Oxford, England. 1998



**van Dervoort, J. Wesley**

No biographical data available

We never tire of the sea; it is a laboratory in which delightful processes are continually being wrought out for our admiration and use. Its flora and its fauna, its waves and its tides, its salts and its currents, all afford grand and profitable themes of study and thought.

*The Physical Geography of the Sea, and Its Meteorology*

Chapter XVIII, section 740 (p. 394)

Union Publishing House. New York, New York, USA. 1886

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

All who possess an ordinary degree of mental activity, and delight to create to themselves an inner world of thought, must be penetrated with the sublime image of the infinite when gazing around them on the vast and boundless sea, when involuntarily the glance is attracted to the distant horizon, where air and water blend together, and the stars continually rise and set before the eyes of the mariner. This contemplation of the eternal play of the elements is clouded, like every human joy, by a touch of sadness and of longing.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1) (p. 310)

D. Appleton & Co. New York, New York, USA. 1850

**Walford, Lionel A.**

No biographical data available

The sea is a wilderness. Threadbare though that phrase may have become in poetic literature, it still expresses an overwhelming fact. The sea is a mysterious wilderness, full of secrets. It is inhabited only by wild animals and, with the exception of a few special situations, is uncultivated. Most of what we know about it we have had to learn indirectly with mechanical contrivances designed to probe, feel, sample, fish.

*Living Resources of the Sea: Opportunities for Research and Expansion*

Preface (p. ix)

Ronald Press. New York, New York, USA. 1958

**Young, Louise B.**

Science writer

Throughout the planet's history the sea has carved and molded the character of the land. She has scooped out steep escarpments and deep gorges, impressed the rhythm of her movement on the hard rocky shores of the continents. But still she is ever yielding. Beneath her smiling, enigmatic face there are grave depths where silence and darkness dwell always. Here in these hidden places she watches impassively while the earth tears itself violently apart and makes itself anew. Quietly giving way to make room for the growing landmass, she receives and holds this newborn substance in her soft embrace.

*The Blue Planet*

Chapter 2 (p. 46)

Little, Brown & Company. Boston, Massachusetts, USA. 1983

**SEA SHORE****Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The sea-shore is a sort of neutral ground, a most advantageous point from which to contemplate this world. It is even a trivial place. The waves forever rolling to the land are too far-travelled and untamable to be familiar.

Creeping along the endless beach amid the sun-squall and the foam, it occurs to us that we, too, are the product of sea-slime.

*Cape Cod* (Volume 2)

The Sea and the Desert (pp. 82–83)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1896

**SEASIDE****Spencer, Herbert** 1820–1903

English social philosopher

Whoever at the seaside has not had a microscope and aquarium, has yet to learn what the highest pleasures of the seaside are.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 72–73)

A.L. Fowle. New York, New York, USA. 1860

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Walk in, ladies and gentlemen! The wonderful exhibition of the Seasons is about to commence; four shows under one cover; the best ventilated place of entertainment in this or any other system; the stage lighted by solar, lunar, and astral lamps; an efficient police will preserve order. Gentlemanly ushers will introduce all new-comers to their places. Performance in twelve parts. Overture by the feathered choir; after which the white drop curtain will rise, showing the remarkable succession of natural scenery designed and executed solely for this planet, – real forests, meadows, water, earth, skies, etc. At the conclusion of each series of performances the storm-chorus will be given with the whole strength of the wind-instrument orchestra, and the splendid snow scene will be introduced, illuminated by grand flashes of the Aurora Borealis. Admittance free, refreshments furnished, complete suits of proper costume supplied at the door, to be returned on leaving the exhibition.

*The Writings of Oliver Wendell Holmes*

*Pages from an Old Volume of Life*

Chapter IV (p. 132)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1891



...those who are really awake to the sights and sounds which the procession of the months offers them find endless entertainment and instruction.

*The Writings of Oliver Wendell Holmes*

*Pages from an Old Volume of Life*

Chapter V (p. 133)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1891

## SEASON

## WINTER

**Benson, Edward Frederic** 1867–1940

English author

It was, in fact, a cold, leaden January, a succession of days in which it is wise to give up Nature as a bad job, and use to the full the aids and artifices of civilization.

*The Image in the Sand*

Fourteenth (p. 229)

J.B. Lippincott Co. Philadelphia, Pennsylvania, USA. 1905

**Jefferies, Richard** 1848–87

English nature writer

Winter shows us Matter in its dead form, like the primary rocks, like granite and basalt – clear but cold and frozen crystal.

The Pageant of Summer

*Eclectic Magazine of Foreign Literature, Science, and Art*, Volume

XXXVIII, Number 2, August, 1883 (p. 146)

## DECEMBER

**Sims, George Robert** 1847–1922

English journalist, poet, and novelist

The hedgerows are set with the crystals of winter, And ripe berries hiding from gay-feathered thieves ; The hand of December, the vigorous tinter,

Has browned and encarmined the exquisite leaves.

*The Dragonet and Other Poems*

The Devonshire Lanes, Stanza 2

George Routledge & Sons. London, England. 1903

## JANUARY

**Benson, Edward Frederick** 1813–87

American Congregational preacher and orator

It was, in fact, a cold, leaden January, a succession of days in which it is wise to give up Nature as a bad job, and use to the full the aids and artifices of civilization.

*The Image in the Sand*

Chapter XIII (p. 209)

William Heinemann. London, England. 1905

## FEBRUARY

**Coleridge, Samuel Taylor** 1765–1837

English lyrical poet, critic, and philosopher

This dark, frieze-coated, hoarse, teeth-chattering month.

*The Poetical Works of S. T. Coleridge* (Volume 1)

On Observing a Bloom on the First of February

W. Pickering. London, England. 1835

## SPRING

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

I take infinite pains to know all the phenomena of the spring, for instance, thinking that I have here the entire poem, and then, to my chagrin, I learn that it is but an imperfect copy that I possess and have read, that my ancestors have torn out many of the first leaves and grandest passages, and mutilated it in many places. I should not like to think that some demigod had come before me and picked out some of the best of the stars. I wish to know an entire heaven and an entire earth.

In Harrison Gray Otis Blake (ed.)

*The Writings of Henry David Thoreau*

May 23, 1856 (pp. 217–218)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1893

## MARCH

**Bryant, William Cullen** 1794–1878

American poet

The stormy March is come at last,  
With wind, and cloud, and changing skies,  
I hear the rushing of the blast,  
That through the snowy valley flies.

*Poems of William Cullen Bryant*

March

Thomas Y. Crowell & Co. New York, New York, USA. 1893

## APRIL

**Warren, John Leicester, Third Baron de Tabley** 1835–95

English poet and botanist

Spring sits and shivers at the porch of light : April goes weeping on her road to May.

*Poems Dramatic and Lyrical* (Volume 1)

Ode to Pan (p. 137)

Elkin Mathews & John Lane. London, England. 1843

## MAY

**Ashby-Sterry, Joseph** 1836–1917

English poet

O, May is the month when the madly aesthetical  
Plunge deep into nonsense profoundly poetical !  
They sing and they shout about sunshine and greenery.  
Of beauty and blossom and song-birds and scenery :  
I own that my notion of May is a hazy one,

And don't think its weather is good for the Lazy One :  
To go out of doors I have not the temerity –  
Now May has set in with its usual severity !

*The Lazy Minstrel*

The Merry Month of May, Stanza 1

T. Fisher Unwin. London, England. 1886

## SUMMER

**Jefferies, Richard** 1848–87

English nature writer

Summer shows us Matter changing into life, sap rising  
from the earth through a million tubes, the alchemic  
power of light entering the solid oak; and see! it bursts  
forth in countless leaves. Living things leap in the grass,  
living things drift upon the air, living things are coming  
forth to breathe in every hawthorn bush.

The Pageant of Summer

*Eclectic Magazine of Foreign Literature, Science, and Art,*

Volume XXXVIII, Number 2, August, 1883 (p. 146)

## JUNE

**Higginson, Thomas Wentworth** 1823–1911

American Unitarian minister

God offers us yearly a necklace of twelve pearls; most  
men choose the fairest, label it June, and cast the rest  
aside.

*Out-doors Papers*

April Days (p. 225)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

## JULY

### Apollo 11 crew

Here men from the planet Earth first set foot upon the  
Moon. July 1969 AD. We came in peace for all man-  
kind.

*Plaque mounted on the LM Descent Stage Ladder*

## AUGUST

**Mowbray, J. P.** 1859–1934

American author

After a prolonged hot spell in late August, we usually  
get that transformation scene that has cool reminders in  
it of the golden age. A shower in the afternoon hisses  
and splashes on the hot earth, and then dies out linger-  
ingly in what the farmers call a " drizzle-drozzle." It  
rains well on through the night softly. You can almost  
hear the muskmelons and tomatoes saying thanks. But  
the sun comes up unobscured in the morning, burning in

a fathomless blue that you seldom see anywhere outside  
of the Orient, and calling to mind that tongue-twisting  
line of Baildon's, –

“ Palely blue lucent, one great undulant gem,”

only it is not “palely,” but pronouncedly violet in the  
unflecked gulfs of it. This is the annunciation of Fall.

*A Journey To Nature*

Chapter X (p. 109)

Doubleday Page & Co. New York, New York, USA. 1903

**Morris, William** 1834–95

English textile designer and writer

Rest here awhile, not yet the eve is still,  
The bees are wandering yet, and you may hear  
The barley mowers on the trenched hill, The sheep-bells,  
and the restless changing weir,  
All little sounds made musical and clear  
Beneath the sky that burning August gives...

*The Earthly Paradise: A Poem* (Volumes 1 and 2)

August, Stanza 2

Roberts Brothers. Boston, Massachusetts, USA. 1871

## FALL

**Longfellow, Henry Wadsworth** 1807–82

American poet

Magnificent Autumn ! He comes not like a pilgrim, clad  
in russet weeds. He comes not like a hermit, clad in gray.  
But he comes like a warrior, with the stain of blood upon  
his brazen mail. His crimson scarf is rent. His scarlet  
banner drips with gore. His step is like a flail upon the  
threshing floor.

*The Prose Works of Henry Wadsworth Longfellow* (Volume 1)

Appendix, Autumn (p. 423)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1890

## SEPTEMBER

**Morris, William** 1834–95

English textile designer and writer

It was a bright September afternoon,  
The parched-up beech-trees would be yellowing soon;  
The yellow flowers grown deeper with the sun  
Were letting fall their petals one by one;  
No wind there was, a haze was gathering o'er  
The farthest bound of the faint yellow shore;  
And in the oily waters of the bay  
Scarce moving aught some fisher-cobles lay,  
And all seemed peace...

*The Earthly Paradise: A Poem* (Volumes 1 and 2)

Prologue – The Wanderers

The Wanderer, 1 87–95

Roberts Brothers. Boston, Massachusetts, USA. 1871

## OCTOBER

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

October is the opal month of the year. It is the month of glory, of ripeness. It is the picture-month.

In William Drysdale (ed.)

*Proverbs from Plymouth Pulpit*

Nature (p. 11)

D. Appleton & Co. New York, New York, USA. 1887

## NOVEMBER

**Wright, Mabel Osgood** 1859–1934  
American author

Why has no one written a November rhapsody with plenty of lilt and swing? The poets who are moved at all by this month seem only stirred to lamentation, giving us year end and “melancholy days” remarks, thereby showing that theory is stronger than observation among the rhyming brotherhood, or else that they have chronic indigestion and no gardens to stimulate them.

*The Garden of A Commuter's Wife*

Chapter VII (p. 105)

The Macmillan Co. New York, New York, USA. 1902

**Mowbray, J. P.** 1859–1934  
American author

There are some laggard days in November that have been left behind by the autumnal procession. They are wayward, dilatory, irrelevant days, and come in the rear of the retreating season, like indolent nymphs that, dressed for the nuptials, only arrived for the funeral, and could not abandon their voluptuous moods. They wear their bridal veils, and look at us reminiscently through clouds of mist. These beautiful, dreamy days appear to have been thrown off somewhere like fragments by the revolving August, and they come along like the Leonids, and as softly disappear. We call them the Indian summer.

*A Journey To Nature*

Chapter XXI (p. 256)

Doubleday Page & Co. New York, New York, USA. 1903

## SECRET

**Daly, Reginald Aldworth** 1871–1957  
Canadian-American geologist

And the secret of it all – the secret of the earthquake, the secret of the “temple of fire,” the secret of the ocean basin, the secret of the highland – is in the heart of the earth, forever invisible to human eyes.

*Our Mobile Earth*

Chapter VIII (p. 320)

Charles Scribner's Sons. New York, New York, USA. 1926

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

...there is some secret here which remains to be discovered.

Illustrations of the Logic of Science

*The Popular Science Monthly*, Volume XIII, June, 1878 (p. 214)

**Verne, Jules** 1828–1905  
French novelist

You have carried your investigations as far as terrestrial science allowed you. But on board my vessel you will have an opportunity of seeing what no man has seen before. Thanks to me, our planet will give up her last secrets.

*Twenty Thousand Leagues Under The Sea*

Part I, Chapter X (p. 55)

Ward, Lock & Co., Ltd. London, England. n.d.

## SEDIMENT

**Geikie, Sir Archibald** 1835–1924  
English geologist

I know no recent observation in physical geography more calculated to impress deeply the imagination than the testimony of this presumably meteoric iron from the most distant abysses of the ocean. To be told that mud gathers on the floor of these abysses at an extremely slow rate conveys but a vague notion of the tardiness of the process. But to learn that it gathers so slowly, that the very star-dust which falls from outer space forms an appreciable part of it, brings home to us, as hardly anything else could do, the idea of undisturbed and excessively slow accumulation.

*The Harvard Classics*

*Scientific Papers: Physiology, Medicine, Surgery, Geology: With Introductions and Notes*

Geographical Evolution (p. 347)

P.F. Collier & Son. New York, New York, USA. 1910

**Kipling, Rudyard** 1865–1936  
British writer and poet

There is no sound, no echo of sound, in the deserts of the deep,

Or the great grey level plains of ooze where the shell-burred cables creep.

Here is the womb of the world – here on the tie-ribs of earth Words, and the words of men, flicker and flutter and beat.

*Rudyard Kipling's Verse*

The Deep Sea Cables

Hodder & Stroughton. London, England. 1919

## SEED

**Baker, Henry** 1698–1774  
English naturalist

Each seed includes a Plant: that Plant, again,

Has other Seeds, which other Plants contain:  
 Those other Plants have All their Seeds, and Those  
 More Plants again, successively, inclose.  
 Thus ev'ry single Berry that we find,  
 Has, really, in itself whole Forests of its Kind.

The Discovery of a Perfect Plant in Semine  
*Philosophical Transactions of the Royal Society of London*, Number  
 457, 1740 (p. 451)

A ripe seed falling to the earth is in the condition of the  
 ovum of an animal getting loose from its ovary and drop-  
 ping into the uterus, and, to go on with the analogy, the  
 juices of the earth swell and extend the vessels of the  
 seed as the juices of the uterus do those of the ovum,  
 till the seminal leaves unfold and perform the office of  
 a placenta to the infant included plant; which, imbibing  
 suitable and sufficient moisture, gradually extends its  
 parts, fixes its own root, shoots above the ground, and  
 may be said to be born.

The Discovery of a Perfect Plant in Semine  
*Philosophical Transactions of the Royal Society of London*, Number  
 457, 1740 (p. 451)

**de la Mare, Walter** 1873–1956

English poet and novelist

The seeds I sowed –  
 For weeks unseen –  
 Have pushed up pygmy  
 Shoots of green;  
 So frail you'd think  
 The tiniest stone  
 Would never let  
 A Glimpse be shown.

*Rhymes and Verses: Collected Poems for Children*  
 Seeds

H. Holt & Company. New York, New York, USA. 1947

**Muir, John** 1838–1914

American naturalist

The dispersal of Juniper seeds is effected by the plum and  
 cherry plan of living birds at the cost of their board, and  
 thus obtaining the use of a pair of extra good wings.

*Our National Parks*

Chapter IV (p. 121)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Sequoia seeds have flat wings and glint and glance in  
 their flight like a boy's kite.

*Our National Parks*

Chapter IV (p. 121)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**President of the 1893 Horticultural Congress**

There is no more deep and subtle mystery than that which  
 conceals plant and shrub and tree in the seemingly simple  
 structure of a seed.

In Washington Atlee Burpee

*Selection in Seed Growing*

The Horticultural Congress (p. 7)

W. Atlee Burpee & Co. Philadelphia, Pennsylvania, USA. 1896

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

The reason for seeds is that flowers may be; not the  
 reason of flowers that seeds may be.

*The Queen of the Air Being a Study of the Greek Myths of Cloud and Storm*

II, Section 60, Athena in the Earth (p. 67)

Smith, Elder & Company London, England. 1869

**Tabb, John Banister** 1845–1909

American poet

Bearing a life unseen,  
 Thou lingerest between  
 A flower withdrawn,  
 And – what thou ne'er shalt see –  
 A blossom yet to be  
 When thou art gone.

*The Poetry of Father Tabb*

Nature – Miscellaneous, The Seed

Dodd, Mead. New York, New York, USA. 1928

**Thaxter, Celia** 1835–94

American poet

The Genie in the Arabian tale is not half so astonishing  
 [as a seed]. In this tiny casket lie folded roots, stalks,  
 leaves, buds, flowers, seed-vessels, – surpassing color  
 and beautiful form, all that goes to make up a plant which  
 is as gigantic in proportion to the bounds that confine it as  
 the Oak is to the acorn.

*An Island Garden* (p. 3)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1896

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

I have great faith in a seed.... Convince me that you have  
 a seed there, and I am prepared to expect wonders.

*Excursions*

The Succession of Forest Trees (p. 151)

Thomas Y. Crowell Co. New York, New York, USA. 1913

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

To look at a thing is very different from seeing a thing.

*The Decay of Lying* (p. 19)

Sunflower Company. New York, New York, USA. 1902

**SEEDMAN**

**Allen, C. L.**

No biographical data available

In a country so vast and varied as ours, where the setting  
 sun of the East is the rising sun of the West; where in

the North there is rarely a month without a frost and at the South rarely a month with one; where the soil in one locality is the most productive, in another the reverse, and this same, too, in close proximity – the seedsman has difficulties to contend with that are entirely unknown in any other country.

In Washington Atlee Burpee

*Selection in Seed Growing*

Selection in Its Relation to Seed Growing (p. 26)

W. Atlee Burpee & Co. Philadelphia, Pennsylvania, USA. 1896

## SEISMOGRAPH

**Oldham, Richard Dixon** 1858–1936

English geologist

...the seismograph, recording the unfelt motion of distant earthquakes, enables us to see up to a certain point into the Earth and determine its nature with as great a certainty, as if we could drive a tunnel through it and take samples of the matter passed through.

Geological Society, The Constitution of the Interior of the Earth as Revealed by Earthquakes

*Quarterly Journal*, Volume 62, August, 1906 (p. 456)

## SEISMOGRAPHER

**Karch, Carroll S.**

No biographical data available

Seismographer: Shudder bug.

*Quote, the Weekly Digest*, August 4, 1968 (p. 97)

## SEISMOGRAPHY

**Richter, Charles** 1900–85

American seismologist

Since my first attachment to seismology, I have had the horror of [earthquake] predictions and of predictors. Journalists and the general public rush to any suggestion of earthquake prediction like hogs toward a full trough.

Annals of the New York Academy of Sciences, Ethical and Scientific Issues Posed by Human Uses of Molecular Genetics, Announcements

*Bulletin American Seismological Society*, Volume 67, Number 4, August, 1977 (p. 1246)

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

...there are natural sciences which have obviously no practical bearing at all on the life of the human society: astrophysics, cosmology, and some branches of geophysics. Take, for instance, seismology. We know enough about earthquakes to know that there is very little chance of foretelling them, in the way of warning people to leave their houses, as we warn trawlers to return when a storm is drawing near.

*Science and Humanism: Physics in Our Time*

The Spiritual Bearing of Science on Life (pp. 2–3)

At The University Press. Cambridge, England. 1952

## SEISMOLOGIST

**Lane, Ferdinand C.**

No biographical data available

...like the doctor with his ear to the stethoscope and his finger upon the patient's pulse, the seismologist diagnoses the condition of an ailing planet.

*The Story of Mountains*

Chapter 14 (p. 64)

Doubleday & Co., Inc. Garden City, New York, USA. 1950

## SEISMOLOGY

**Bullen, K. E.**

Seismologist

Seismology has lifted our notions about the interior of our planet from the realm of wild speculation to the stage of scientific measurement and well-reasoned inferences.

The Interior of the Earth

*Scientific American*, Volume 193, Number 3, September, 1955 (p. 56)

## SELECTIVE

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Selectiveness, and with (we must allow) enormous wastage, is her method. Out of an enormous space a very small portion is occupied by matter at all. Of all the stars, perhaps very few, perhaps only one, have planets. Of the planets in our own system probably only one supports organic life. In the transmission of organic life, countless seeds and spermatozoa are emitted: some few are selected for the distinction of fertility. Among the species only one is rational. Within that species only a few attain excellence of beauty, strength, or intelligence.

*Miracles*

The Grand Miracle (p. 121)

Pan Books. London, England. 1947

## SELF

**Pascal, Blaise** 1623–62

French mathematician and physicist

When I consider the small span of my life absorbed in the eternity of all time, or the small part of space which I can touch or see engulfed by the infinite immensity of spaces that I know not and that know me not, I am frightened and astonished to see myself here instead of there...now instead of then.

In Rudy Rucker  
*Infinity and the Mind*  
 Chapter I (p. 2)  
 Princeton University Press. Princeton, New Jersey, USA. 1995

## SELF-AWARENESS

**Nuland, Sherwin B.** 1930–  
 American surgeon and teacher of bioethics and medicine

Self-awareness has never been the strong suit of those who choose to become doctors. When so much fuel is readily available for stoking the fires of ego, there is little inclination to apply it in raising the candlepower of the searching light that might illumine the inner man or woman.

The Uncertain Art: The Whole Law of Medicine  
*The American Scholar*, Volume 67, Number 3, Summer, 1998

## SELF-DELUSION

**Sylvester, James Joseph** 1814–97  
 English mathematician

It is difficult to estimate the lengths to which human self-delusion can be carried.

*The Collected Mathematical Papers of James Joseph Sylvester*  
 (Volume 3)  
 A Lady's Fan on Parallel Motion, and on an Orthogonal Web of Jointed Rods (p. 82)  
 University Press. Cambridge, England. 1904–1912

## SELF-EVIDENT

**von Ebner-Eschenbach, Marie** 1830–1916  
 Austrian novelist

Be the first to say what is self-evident, and you are immortal.

Translated by Annis Lee Wister  
*Aphorisms*  
 Number 1  
 J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

## SEMINAR

**Djerassi, Carl** 1929–  
 Austrian-born American organic chemist and educator

Seminar is not yet officially a transitive verb. Still, most graduate students in any large research-oriented university have at times felt themselves more the helpless objects of a seminar than its active participants. Seminar-ed into numbness describes that feeling of oversaturation.

*Cantor's Dilemma 1989*  
 Chapter 14 (p. 122)  
 Penguin Group Inc. New York, New York, USA.

## SENSATION

**Poincaré, Jules Henri** 1854–1912  
 French mathematician and theoretical astronomer

For an aggregate of sensations to have become a remembrance capable of classification in time, it must have ceased to be actual, we must have lost the sense of its infinite complexity, otherwise it would have remained present. It must, so to speak, have crystallized around a center of associations of ideas which will be a sort of label. It is only when they have lost all life that we can classify our memories in time as a botanist arranges dried flowers in his herbarium.

Translated by George Bruce Halsted  
*The Value of Science*  
 Part I, Chapter II (p. 26)  
 The Science Press. New York, New York, USA. 1907

## SENSE

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

the information of the sense itself I sift and examine in many ways. For certain it is that the senses deceive; but then at the same time they supply the means of discovering their own errors; only the errors are here, the means of discovery are to seek.

*The Works of Francis Bacon* (Volume 4)  
 Part I, Plan of the Work (p. 26)  
 Longman & Co. London, England. 1858

...the information of the sense itself, sometimes failing, sometimes false; observation, careless, irregular, and led by chance; tradition, vain and fed on rumor; practice, slavishly bent upon its work; experiment, blind, stupid, vague, and prematurely broken off; lastly, natural history trivial and poor; – all these have contributed to supply the understanding with very bad materials for philosophy and the sciences.

*The Works of Francis Bacon* (Volume 4)  
 Part I, Plan of the Work (p. 28)  
 Longman & Co. London, England. 1858

**Gull, Sir William Withey** 1816–90  
 English physician

My world is that part of it to which my sense extends. My eye reaches to the stars; my ears to the thunder in the sky, or to the vibrating vocal chords of the lark which sings there. My nose goes into the petals of the rose by continuity of the perfume which exhales from them; or into the joint which gives out its appetising smell in the roasting. My taste reaches into the textures brought into contact with it as the touch continues on beyond its immediate self in the tension of a cord or the extension of a rod.



In Theodore Dyke Acland  
*A Collection of the Published Writings of William Withey Gull* (Volume 2)  
 Notes and Aphorisms (p. xlvi)  
 The New Sydenham Society. London, England. 1896

**Tyndall, John** 1820–93  
 Irish-born English physicist

...the domain of the senses, in Nature, is almost infinitely small in comparison with the vast region accessible to thought which lies beyond them. From a few observations of a comet, when it comes within the range of his telescope, an astronomer can calculate its path in regions which no telescope can reach: and in like manner, by means of data furnished in the narrow world of the senses, we make ourselves at home in other and wider worlds, which can be traversed by the intellect alone.

*Fragments of Science* (5th edition)  
 On Radiant Heat in Relation to the Colour and Chemical Constitution of Bodies (p. 71)  
 D. Appleton & Co. New York, New York, USA. 1884

**Whewell, William** 1794–1866  
 English philosopher and historian

The Senses place before us the Characters of the Book of Nature; but these convey no knowledge to us, till we have discovered the Alphabet by which they are to be read.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2) (2nd edition)  
 Aphorisms Concerning Ideas (p. 443)  
 John W. Parker. London, England. 1847

## SENSE ORGANS

**Lewis, J. C.**  
 No biographical data available

The continual adjustment, so necessary for life, between internal relations of an organism and the external world would be impossible were it not for the communion of the sense organs. They stand, as it were, midway between the organism and its surroundings, keeping the internal relations aware of and alive to the external happenings and conditions.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1916)  
 Some Considerations on Sight in Birds (p. 337)  
 Government Printing Office. Washington, D.C. 1917

## SENSE PERCEPTION

**Einstein, Albert** 1879–1955  
 German-born physicist

Thinking, alone, can never lead to any knowledge of external objects. Sense perception is the beginning of all research, and the truth of theoretical thought is given exclusively by its relation to the sum total of those experiences.

Physics, Philosophy, and Scientific Progress  
*Physics Today*, Issue 6 June, 2005 (p. 48)

## SENSES

**Einstein, Albert** 1879–1955  
 German-born physicist

We can only see the universe by the impressions of our senses reflecting indirectly the things of reality.

*Cosmic Religion, with Other Opinions and Aphorisms*  
 On Science (p. 101)  
 Covici-Fiede. New York, New York, USA. 1931

**Wilson, George**

The ivory palace of the skull, which is the central abode of the soul, although it dwells in the whole body, opens to the outer world four gateways, by which its influences may enter; and a fifth, whose alleys are innumerable, unfolds its thousand doors on the surface of every limb. These gateways, – which we otherwise name the Organs of the Senses, and call in our mother speech, the Eye, the Ear, the Nose, the Mouth, and the Skin, – are instruments by which we see, and hear, and smell, and taste, and touch: at once loopholes through which the spirit gazes out upon the world, and the world gazes in upon the spirit; porches which the longing unsatisfied soul would often gladly make wider, that beautiful material nature might come into it more fully and freely; and fenced doors, which the sated and dissatisfied spirit would, if it had the power, often shut and bar altogether.

*The Five Gateways of Knowledge* (6th edition) (pp. 7–8)  
 Macmillan & Company Ltd. London, England. 1880

## SENSIBILITY

**Osler, Sir William** 1849–1919  
 Canadian physician and professor of medicine

Keen sensibility is doubtless a virtue of high order, when it does not interfere with steadiness of hand or coolness of nerve; but for the practitioner in his working-day world, a callousness which thinks only of the good to be effected, and goes ahead regardless of smaller considerations, is the preferable quality.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
 Aequanimitas (p. 5)  
 P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1904

## SENTIMENT

**Coleridge, Stephen** 1854–1936  
 English author, barrister, and opponent of vivisection

How often, without challenge, in modern writings and speech, is Science elevated above sentiment!

*The Idolatry of Science*  
 Chapter III (p. 10)  
 John Lane Co. London, England. 1920

**Melville, Herman** 1819–91  
American novelist

After science comes sentiment.

*Mardi, and a Voyage Thither*  
Chapter XXXVIII (p. 109)  
The St. Botolph Society. Boston, Massachusetts, USA. 1923

## SEQUENCE

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The difference between a sequence that stops somewhere and one that has no end is awful. No one, unless spiritually unborn or dead, can contemplate that gulf without emotions that take hold of the infinite and everlasting.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Walls of the World (pp. 90–91)  
Columbia University Press. New York, New York, USA. 1916

## SERIES

**Abel, Niels Henrik** 1802–29  
Norwegian mathematician

With the exception of the geometric series, there does not exist in all of mathematics a single infinite series whose sum has been determined rigorously.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 29)  
Birkhäuser. Boston, Massachusetts, USA. 1987

The divergent series are the invention of the devil, and it is a shame to base on them any demonstration whatsoever. By using them, one may draw any conclusion he pleases and that is why these series have produced so many fallacies and so many paradoxes...

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 33)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

No part of Mathematics suffers more from the triviality of its initial presentation to beginners than the great subject of series...the general ideas are never disclosed and thus the examples, which exemplify nothing, are reduced to silly trivialities.

*An Introduction to Mathematics*  
Chapter XIV (p. 194)  
Henry Holt & Co. New York, New York, USA. 1911

## SERMON

**Gray, Elisha** 1835–1901  
American electrical engineer

Sermons are not always preached from pulpits. They are written in the rocks and on the flowers of the field and the trees of the forest.

*Nature's Miracles; Familiar Talks on Science*  
Chapter I (pp. 3–4)  
Fords, Howard & Hulbert. New York, New York, USA. 1899

## SET THEORY

**Armstrong, David Malet** 1926–  
Australian philosopher

Set theory is peculiarly important...because mathematics can be exhibited as involving nothing but set-theoretical propositions about set-theoretical entities.

*A Combinatorial Theory of Possibility*  
Part I, Chapter 1, Section II (p. 10)  
Cambridge University Press. Cambridge, England. 1989

Philosophers have not found it easy to sort out sets...

*A Combinatorial Theory of Possibility*  
Part II, Chapter 9, Section iv (p. 133)  
Cambridge University Press. Cambridge, England. 1989

**Barwise, Jon** 1942–2000  
American mathematician, philosopher, and logician

**Moss, Lawrence**  
No biographical data available

Set theory has a dual role in mathematics. In pure mathematics, it is the place where questions about infinity are studied. Although this is a fascinating study of permanent interest, it does not account for the importance of set theory in applied areas. There the importance stems from the fact that set theory provides an incredibly versatile toolbox for building mathematical models of various phenomena.

*Vicious Circles: On the Mathematics of Non-Wellfounded Phenomena*  
Chapter 1 (p. 5)  
Center for the Study of Language and Information. Stanford, California, US. 1996

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

For a "mixt company" implies, that, save Yourself and friends, and half a hundred more, Whom you may bow to without looking grave, The rest are but a vulgar set.

*The Complete Poetical Works of Byron*  
Beppo: A Venetian Story  
Houghton Mifflin. Boston, Massachusetts, USA. 1933

**Cleveland, Richard**  
No biographical data available

We can't be assured of a full set,  
Or even a reasonable dull set.

It wouldn't be clear  
That there's any set here,  
Unless we assume there's a null set.

*The Axioms of Set Theory*  
*Mathematics Magazine*, Volume 52, Number 4, September, 1979  
(pp. 256–257)

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

Later generations will regard *Mengenlehre* as a disease from which one has recovered.

In Jeremy Gray

Did Poincaré Say “Set Theory Is a Disease”?

*The Mathematical Intelligencer*, Volume 13, Number 1, Winter, 1991 (p. 19)

**Quine, Willard van Orman** 1908–2000  
American logician and philosopher

To say that mathematics in general has been reduced to logic hints at some new firming up of mathematics at its foundations. This is misleading. Set theory is less settled and more conjectural than the classical mathematical superstructure than can be founded upon it.

*Elementary Logic*

Chapter IV, Section 48 (p. 125)

Harper & Row, Publishers. New York, New York, USA. 1965

## SEX

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Sex is a learned art, as much so as ice skating or tight wire walking or fancy diving; it is not instinct. Oh, two animals couple by instinct, but it takes intelligence and patient willingness to turn copulation into a high and lively art.

*Time Enough for Love*

Chapter XII (p. 314)

G.P. Putnam’s Sons. New York, New York, USA. 1973

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

Our civilization bothers us less with food tabus than with sexual restrictions. In modern society these have come to play the role of an injured deity that is getting its own back in every sphere of human activity, including psychology, where it would reduce “spirit” to sexual repression.

Translated by R.F.C. Hull

*Flying Saucers: A Modern Myth of Things Seen in the Skies*

Chapter Two (p. 45)

Routledge & Kegan Paul. London, England. 1959

**Stoppard, Tom** 1937–  
Czech-born English playwright

Lending one’s bicycle is a form of safe sex, possibly the safest there is.

*Arcadia*

Act I, Scene Four (p. 51)

Faber & Faber Ltd. London, England. 1993

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

I lose my respect for the man who can make the mystery of sex the subject of a coarse jest, yet, when you speak earnestly and seriously on the subject, is silent.

*The Writings of Henry David Thoreau*

*The Subject of Sex* (pp. 406–407)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**Watts, Alan Wilson** 1915–73  
American philosopher

Perhaps one of the subordinate reasons why sex is a matter for laughter is that there is something ridiculous in “doing” it with set purpose and deliberation...

*Nature, Man, and Woman*

Part II, Chapter 8 (p. 201)

Vintage Books. New York, New York, USA. 1970

## SEXUALITY

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist and explorer

The organs of generation, which in the animal kingdom are by nature generally removed from sight, in the vegetable kingdom are exposed to the eyes of all, and that when their nuptials are celebrated, it is wonderful what delight they afford to the spectator by their most beautiful colors and delicious odors.

*Oeconomia naturae*

*Amoenitates Academicæ*, Volume 2, 1752 (p. 16)

By what mechanisms are the sexuality of the worker naked mole rats suppressed, and how does the queen exert her supremacy? Research at London’s Institute of Zoology by Chris Faulkes and others shows surprisingly that the main mechanism are not pheromonal (chemical) as we might immediately suppose. Mysteriously, it is the queenly presence, her behavior, that keeps the rest so firmly switched off; which one of the British researcher has called the “Thatcher effect.”

*New Scientist*, Volume 131, No 1780, 3 August, 1991 (p. 43)

## SHADOW

**Charlie Chan (Fictional character)**

Alas, mouse cannot cast shadow like elephant.

*The Black Camel*

Film (1931)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In the world of physics we watch a shadowgraph performance of familiar life. The shadow of my elbow rests on the shadow-tables as the shadow-ink flows over the shadow-paper...The frank realisation that physical science is concerned with a world of shadows is one of the most significant of recent advances.

*The Nature of the Physical World*

Introduction (pp. xiv, xv)

The Macmillan Company. New York, New York, USA. 1930

**Nemerov, Howard** 1920–91

American poet and novelist

For “nothing in the universe can travel at the speed  
Of light,” they say, forgetful of the shadow’s speed.

*The Collected Poems of Howard Nemerov*

The First Day (p. 345)

The University of Chicago Press. Chicago, Illinois, USA. 1977

**Young, Charles Augustus** 1834–1908

American astronomer

If interplanetary space were slightly dusty, we should  
see, accompanying the earth and moon and each of the  
planets, a long black shadow projecting behind it and  
travelling with it.

*A Text-book of General Astronomy for Colleges and Scientific Schools*

Chapter XI (p. 248)

Ginn &amp; Co. Boston, Massachusetts, USA. 1898

**SHAKEN BABY SYNDROME****Caffey, John** 1895–1978

American physician

Whiplash-shaking is practiced commonly in a wide variety  
of ways, under a wide variety of circumstances, by a  
wide variety of persons, for a wide variety of reasons.

*Amer. J. Dis. Child.*, Volume 124, Number 2, August, 1972 (p. 161)

Hark ye, good parents, to my words true and plain,  
When you are shaking your baby, you could be bruising  
his brain.

So, save the limbs, the brain, even the life of your tot;  
By shaking him never; never and not.

*American Journal of Diseases of Children*, Volume 124, Number 2,  
August, 1972 (p. 169)**SHAPES****Lovecraft, H. P. (Howard Phillips)** 1890–1937

American writer of fantasy, horror, and science fiction

They told him that every figure of space is but the result  
of the intersection by a plane of some corresponding figure  
of one or more dimension – as a square is cut from a  
cube, or a circle from a sphere.

Through the Gates of the Silver Key

*Weird Tales*, Chapter 5, Volume 24, Number 1, July 1934**SHELL****Glaessner, M. F.** 1906–1989

Australian paleontologist and professor of pre-Cambrian life

The naive assumption that shells are acquired because  
they protect soft bodies seems influenced by anthropo-

centric thinking: man uses shields for protection from  
aggressors.

*The Dawn of Animal Life: A Biohistorical Study*

Chapter 4.6 (p. 174)

Cambridge University Press. Cambridge, England. 1984

**Hooke, Robert** 1635–1703

English physicist

I...humbly conceive (tho’ some possibly may think there  
is too much notice taken of such a trivial thing as a rotten  
Shell, yet) that Men do generally too much...pass over  
without regard these Records of Antiquity which Nature  
have left as Monuments and Hieroglyphick Characters of  
preceding Transactions in the like duration or Transac-  
tions of the Body of the Earth, which are infinitely more  
evident and certain tokens than anything of Antiquity  
that can be fetched out of Coins or Medals...since the  
best of those ways may be counterfeited or made by Art  
and Design...

*The Posthumous Works of Robert Hooke*

A Discourse on Earthquakes (p. 411)

S. Smith &amp; B. Walford. London, England. 1705

**Hsi, Chu (Zhu Xi)** 1130–1200

Chinese philosopher

I have seen on high mountains conchs and oyster shells,  
often embedded in the rocks. These rocks in ancient  
times were earth or mud, and the conchs and oysters  
lived in water. Subsequently everything that was at the  
bottom came to be at the top, and what was originally  
soft became solid and hard. One should meditate deeply  
on such matters, for these facts can be verified.

In Joseph Needham

*Science and Civilisation in China* (Volume 3)

Chapter 23 (p. 598ff)

The University Press. Cambridge, England. 1954

**Richardson, George Fleming** 1796–1848

Man of letters, lecturer, and geological curator

How lovely are the shells! how symmetrical – how beau-  
tiful! How vivid their colouring; how elegant their form;  
their convolutions how delicate; their outline how grace-  
ful; their adaptation how skilful; their entire structure  
how perfect!

*Geology for Beginners* (2nd edition)

Conclusion (p. 568)

Longman, Brown, Green &amp; Longmans. London, England. 1843

**Stillingfleet, Benjamin** 1702–71

Naturalist and writer

Each shell, each crawling insect holds a rank Important in  
the plan of Him, who fram’d This scale of beings; holds a  
rank, which lost Would break the chain, and leave behind  
a gap Which nature’s self would rue.

*Literary Life and Select Works of Benjamin Stillingfleet* (Volume 1)

Chapter 3 (p. 46)

J. Nichols &amp; Son. London, England. 1811

**Tennyson, Alfred (Lord)** 1809–92

English poet

See what a lovely shell,  
Small and pure as pearl,  
Lying close to my foot,  
Frail, but a work divine,  
Made so fairly well,  
With delicate spire and whorl,  
How exquisitely minute,  
A miracle of design!

*Alfred Tennyson's Poetical Works*

Maud, Part II, Section II, Stanza I

Oxford University Press, Inc. London, England. 1953

**Warren, John**

No biographical data available

Shells form a link in the great chain of nature, worthy the researches of men of science; and when we consider the wonderful diversity of singular and beautiful forms, which they present to our notice, they cannot fail to invite the attention of the most common observer.

*The Conchologist*

Introduction (p. 3)

Russell, Odiorn &amp; Metcalf. Boston, Massachusetts, USA. 1834

**SHORE****Carson, Rachel** 1907–64

American marine biologist and author

...the shore has a dual nature, changing with the swing of the tides, belonging now to the land, now to the sea. On the ebb tide it knows the harsh extremes of the land world, being exposed to heat and cold, to wind, to rain and drying sun. On the flood side it is a water world, returning briefly to the relative stability of the open sea.

*The Edge of the Sea*

Chapter I (p. 1)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

The shore is an ancient world, for as long as there has been an earth and sea there has been this place of meeting of land and water. Yet it is world that keeps alive the sense of continuing creation and of the relentless drive of life. Each time that I enter it, I gain some new awareness of its beauty and its deeper meanings, sensing that intricate fabric of life by which one creature is linked with another, and each with its surroundings.

*The Edge of the Sea*

The Marginal World (p. 2)

Houghton Mifflin &amp; Co. New York, New York, USA. 1998

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

I with my hammer pounding evermore  
The rocky coast, smite Andes into dust,

Strewing by beds and, in another age,  
Rebuild a continent for better men.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)*Seashore* (p. 243)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**SICK****Abrams, Albert** 1863–1924

American physician

An individual who regards himself as sick is as sick as he thinks he is ...

*Man and His Poisons*

Chapter X (p. 223)

E.B. Treat &amp; Co. New York, New York, USA. 1906

**Aeschylus** 525 BCE–456 BCE

Greek playwright

To the sick some gleam of comfort  
Flows from the knowledge of their pains to come.

In Craufurd Tait Ramage

*Beautiful Thoughts from Greek Authors* (p. 8)

Edward Howell. Liverpool, England. 1864

**Henry Clerval (Fictional character)**

I'm here to become a mere doctor. I'm told that has something to do with healing the sick, which is a pity really, because I find sick people rather revolting.

*Frankenstein*

Film (1994)

**SICKNESS****Barnes, Djuna** 1892–1982

American author

No man needs curing of his individual sickness; his universal malady is what he should look to.

*Nightwood*

La Somnambule (p. 41)

Harcourt, Brace &amp; Company. New York, New York, USA. 1937

**Burton, Robert** 1577–1640

English clergyman and scholar

Sickness is the mother of modesty, putteth us in minde of our mortality; and, when wee are in the full careere of worldly pompe and jollity, she pulleth us by the eare, and maketh us knowe ourselves.

*The Anatomy of Melancholy* (Volume 1)

Part II, Sect. III, Memb. IV, Subsect. 6 (p. 399)

AMS Press, Inc. New York, New York, USA. 1973

**Chrysostom, John** ?–407

Christian bishop and preacher

Princes, Masters, Parents, Magistrates, Judges, Friends, Eniemies, faire or foule meanes cannot containe, us; but a little sicknesses will correct and amend us.



In Robert Burton  
*The Anatomy of Melancholy* (Volume 2)  
 Part II, Sect. III, Memb. II (p. 157)  
 AMS Press, Inc. New York, New York, USA. 1973

**Donne, John** 1572–1631  
 English poet and divine

And can there be worse sickness, than to know that we  
 are never well, nor can be so?

*An Anatomy of the World*  
 The First Anniversary, l. 93–4  
 Presented for presentation to members of the Roxburghe Club. Cambridge,  
 England. 1951

**Dunlap, William** 1766–1839  
 American dramatist and theatrical manager

He seems a little under the weather, somehow; and yet  
 he's not sick.

*The Memoirs of a Water Drinker* (Volume 1)  
 Chapter VIII (p. 80)  
 Saunders & Otley. New York, New York, USA. 1837

**Dunne, Finley Peter** 1867–1936  
 American journalist and humorist

...whin a man's sick, he's sick an' nawthin' will cure  
 him or annything will.

*Mr. Dooley Says*  
 Drugs (p. 97)  
 Charles Scribner's Sons. New York, New York, USA. 1910

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

It is dainty to be sick, if you have leisure and conve-  
 nience for it.

*Journals of Ralph Waldo Emerson 1838–1841*  
 February 7, 1839 (p. 162)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

For sickness is a cannibal which eats up all the life and  
 youth it can lay hold of, and absorbs its own sons and  
 daughters.

*Ralph Waldo Emerson: Essays and Lectures*  
*The Conduct of Life*  
 Consideration by the Way (p. 1088)  
 The Library of America. New York, New York, USA. 1983

**Fuller, Thomas** 1608–61  
 English clergyman and author

He who was never sick dies the first fit.

In Thomas Fuller  
*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings.*  
*Ancient and Modern, Foreign and British*  
 Proverb  
 Printed for Thomas & Joseph Allman. London, England. 1816

**Harris, Joel Chandler** 1848–1908  
 American journalist

You know w'at de jay-bird say ter der squinch-owls!,  
 "I'm sickly but sassy."

*The Complete Tales of Uncle Remus*  
 Chapter 50 (p. 311)  
 Houghton Mifflin Company. New York, New York, USA. 1955

**Halsted, Anna Roosevelt** 1906–75  
 Daughter of Franklin and Eleanor Roosevelt

There are so many indignities to being sick and helpless...  
 In Joseph P. Lash

*Eleanor: The Years Alone*  
 To The End, Courage, Letter to David Gray, November 1, 1962 (p. 327)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1972

**Hood, Thomas** 1799–1845  
 English poet and editor

I'm sick of gruel, and the dietics,  
 I'm sick of pills, and sicker of emetics,  
 I'm sick of pulse, tardiness or quickness,  
 I'm sick of blood, its thinness or its thickness, –  
 In short, within a word, I'm sick of sickness!

*The Poetical Works of Thomas Campbell* (Volume 2)  
 Fragment (p. 424)  
 Wiley & Long. New York, New York, USA. 1836

**Jonson, Ben** 1573?–1637  
 English dramatist and poet

Take heed, sickness, what you do,  
 I shall fear you'll surfeit too.  
 Live not we, as all they stalls,  
 Spittles, pest-house, Hospitals,  
 Scarce will take our present store?

In Robert Bell  
*The Poems of Robert Greene, Christopher Marlowe, and Ben Jonson*  
 The Forest, viii. To Sickness  
 Hurst & Company. New York, New York, USA. ca. 1880

**Johnson, Samuel** 1696–1772  
 English critic, biographer, and essayist

... what can a sick man say, but that he is sick?  
*Boswell's "Life of Samuel Johnson"*  
 August, 1784 (p. 1347)  
 Oxford University Press, Inc. Oxford, England. 1965

**Lamb, Charles** 1775–1834  
 English essayist and critic

If there be a regal solitude, it is a sick-bed. How the  
 patient lords it there; what caprices he acts without con-  
 trol! how kinglike he sways his pillow-tumbling, and  
 tossing, and shifting, and lowering, and thumping, and  
 flattening, and molding it, to the ever-varying requisitions  
 of his throbbing temples.

*Essays of Elia*  
 The Convalescent (p. 329)  
 Henry Altemus. Philadelphia, Pennsylvania, USA. 1893

How sickness enlarges the dimensions of a man's self to  
 himself! he is his own exclusive object. Supreme selfish-  
 ness is inculcated upon him as his only duty.

*Essays of Elia*  
 The Convalescent (p. 330)  
 Henry Altemus. Philadelphia, Pennsylvania, USA. 1893



**Luttrell, Henry** 1765–1851  
English wit and writer

Come, come, for trifles never stick:  
Most servants have a failing;  
Yours, it is true, are sometimes sick,  
But mine are always ale-ing.

In William Davenport Adams

*English Epigrams*

On Ailing and Ale-ing, dclxxiii

G. Routledge. London, England. 1878

**Milton, John** 1608–74  
English poet

...all maladies

Of ghastly Spasm, or racking torture, qualms  
Of heart-sick Agonie, all feverous kinds,  
Convulsions, Epilepsies, fierce Catarrhs,  
Intestine Stone and Ulcer, Colic pangs,  
Dropsies and Astmas, and Joint-racking Rheums.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book XI, l. 480–485

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

The idea of a perfect health is interesting only in a scientific point of view. Sickness is necessary to individualization.

In Kuno Francke and Isidore Singer

*The German Classics: Masterpieces of German Literature Translated Into English*

*Aphorisms* (p. 187)

The German Publication Society. New York, New York, USA. 1914

**O'Connor, Flannery** 1926–64  
American author

I have never been anywhere but sick. In a sense sickness is a place, more instructive than a long trip to Europe, and it's always a place where there's no company, where nobody can follow. Sickness before death is a very appropriate thing and I think those who don't have it miss one of God's mercies.

*The Habit of Being*

Part II (p. 163)

Farrar, Straus & Giroux, Inc. New York, New York, USA. 1988

**Roy, Gabrielle** 1909–83  
Canadian author

The Christian Scientists held that it was not God Who wanted sickness, but man who [put] himself in the way of suffering. If this were the case, though, wouldn't we all die in perfect health?

Translated by Harry Binsse

*The Cashier*

Chapter 3 (pp. 36–37)

Harcourt, Brace. New York, New York, USA. 1955

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

This sickness doth infect  
The very life-blood of our enterprise.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The First Part of King Henry the Fourth*

Act IV, Scene i, l. 28–29

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

What, is Brutus sick,  
And will he steal out of his wholesome bed,  
To dare the vile contagion of the night?

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Julius Caesar*

Act II, Scene i, l. 263–265

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Sickness is catching.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*A Midsummer-Night's Dream*

Act I, Scene i, l. 186

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

My long sickness  
Of health and living now begins to mend,  
And nothing brings me all things.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Timon of Athens*

Act V, Scene i, l. 189–191

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sterne, Laurence** 1713–68  
English novelist and humorist

I am sick as a horse...

*The Life and Opinions of Tristram Shandy, Gentleman, and A Sentimental Journey Through France and Italy* (Volume 2)

Book VII, Chapter II (p. 66)

Macmillan & Company Ltd. London, England. 1900

**Swift, Jonathan** 1667–1745  
Irish-born English writer

Poor Miss, she's sick as a Cushion...

*The Prose Works of Jonathan Swift* (Volume the Fourth)

Polite Conversation, Dialogue I (p. 153)

Printed at the Shakespeare Head Press. Oxford, England. 1939–1968

**Weingarten, Violet**  
Writer

Sickness, like sex, demands a private room, or at the very least, a discrete curtain around the ward bed.

*Intimations of Mortality* (p. 3)

Alfred A. Knopf. New York, New York, USA. 1978

**Wolfe, Thomas** 1900–38  
American novelist

Most of the time we think we're sick it's all in the mind.

*Look Homeward, Angel*  
Part I, Chapter 1 (p. 11)  
Simon & Schuster. New York, New York, USA. 1995

## SIGHT

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

I refer to the use of dioptric media which correct the diminished refracting power of the humors of the eye, – in other words, spectacles. I don't use them. All I ask is a large, fair type, a strong daylight or gas-light, and one yard of focal distance, and my eyes are as good as ever.  
*The Autocrat of the Breakfast-Table*  
Chapter VII (p. 173)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Marsh, George Perkins** 1801–82  
American scholar, author, and statesman

Sight is a faculty; seeing, an art.  
*The Earth as Modified by Human Action: A New Edition of Man and Nature*  
Chapter I (p. 12)  
Scribner, Armstrong & Company. New York, New York, USA. 1874

**Plato** 428 BCE–347 BCE  
Greek philosopher

The sight in my opinion is the source of the greatest benefit to us, for had we never seen the stars, and the sun, and the heaven, none of the words which we have spoken about the universe would ever have been uttered. But now the sight of day and night, and the months and the revolutions of the years, have created number, and have given us a conception of time, and the power of enquiring about the nature of the universe...  
*In Great Books of the Western World (Volume 7)*  
*Timaeus*  
Section 40 (p. 455)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## SILENT

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Every candid person will confess that there are many branches of knowledge about which he had better be silent.  
*Popular Scientific Lectures*  
On Instruction in the Classics and the Sciences (p. 316)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

## SYLLOGISM

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

But I don't need a Sillygism, you know, to prove that mathematical axiom you mentioned.

*Silvie and Bruno*  
Chapter XVIII (p. 259)  
Macmillan & Co Ltd. London, England. 1890

## SIMPLE

**Verne, Jules** 1828–1903  
French novelist

All things are simple...when you know how to do them.  
*20,000 Leagues Under the Sea*  
Chapter XII (p. 97)  
Rand McNally & Co. Chicago, Illinois, USA. 1922

## SIMPLICITY

**Bailey, Janet**  
No biographical data available

It is an article of faith in physics that the world's bewildering mask of complexity hides an ultimate simplicity.  
*The Good Servant: Making Peace with the Bomb at Los Alamos*  
Chapter 4 (p. 110)  
Simon & Schuster. New York, New York, USA. 1995

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Simplicity may have merits, but credibility is not necessarily one of them.  
*The Handmaiden of the Sciences*  
Chapter 1 (p. 2)  
Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

Our striving after simplicity as the ideal for a picture of the world may after all be evidence of nothing but our simple minds.  
*The Handmaiden of the Sciences*  
Chapter 1 (p. 2)  
Williams & Wilkins Co. Baltimore, Maryland, USA. 1937

**Case, Thomas**  
No biographical data available

...as science proceeds, simplicity becomes a snare.  
Nature is complex.  
*Lectures on the Method of Science*  
Scientific Method as a Mental Operation (p. 8)  
At The Clarendon Press. Oxford, England. 1906

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

The simple is the seal of the true and beauty is the splendor of truth.  
*Nobel Lectures, Physics 1981–1990*  
Nobel lecture for award received in 1983  
On Stars, Their Evolution and Their Stability (p. 163)  
World Scientific Publishing Company. Singapore. 1993

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

I am not sure whether one can say that man – just as he possesses an almost instinctive sense of symmetry – is governed by an equally elemental desire for simplicity.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 169)  
The Rockefeller University Press. New York, New York, USA. 1978

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

We study the complex in the simple; and only from the intuition of the lower can we safely proceed to the intellection of the higher degrees. The only danger lies in the leaping from low to high, with the neglect of the intervening gradations.

*Hints Towards the Formation of a More Comprehensive Theory of Life Physiology of Life* (p. 41)  
Lea & Blanchard. Philadelphia, Pennsylvania, USA, 1848

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

Whether mathematical simplicity is God's affair or our, the fact remains that this feature more than any other remains the mainspring of progress in the physical sciences.

*The Edge of Infinity: Where the Universe Came from and How It Will End*  
Chapter 9 (p. 188)  
Simon & Schuster. New York, New York, USA. 1981

**Davy, Sir Humphry** 1778–1829  
English chemist

Complexity almost always belongs to the early epochs of every science; and the grandest results are usually obtained by the most simple means.

*The Collected Works of Sir Humphry Davy* (Volume 4)  
*Elements of Chemical Philosophy*  
Part I, Introduction (p. 14)  
Smith, Elder & Company. London, England. 1839–1840

The more the phenomena of the universe are studied, the more distinct their connection appears, the more simple their causes, the more magnificent their design, and the more wonderful the wisdom and power of their author.

*The Collected Works of Sir Humphry Davy* (Volume 4)  
*Elements of Chemical Philosophy*  
Part I, Introduction (p. 42)  
Smith, Elder & Company. London, England. 1839–1840

Have you ever thought...about whatever man builds, that all of man's industrial efforts, all his calculations and computations, all the nights spent over working draughts and blueprints, invariably culminate in the production of a thing whose sole and guiding principle is the ultimate principle of simplicity?

*Wind, Sand and Stars*  
Chapter 3 (p. 65)  
Reynal & Hitchcock. New York, New York, USA. 1939

In anything at all, perfection is finally attained, not when there is no longer anything to add, but when there is no longer anything to take away.

*Wind, Sand and Stars*  
Chapter 3 (p. 66)  
Reynal & Hitchcock. New York, New York, USA. 1939

**Dawkins, Richard** 1941–  
English biologist

In the beginning was simplicity.

*The Selfish Gene*  
Chapter 2 (p. 12)  
Oxford University Press. Oxford, England. 2006

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

The complex is not always profound; but the profound is not necessarily simple.

*The Road to Reason*  
Chapter 5 (p. 115)  
Longmans, Green & Company. London, England. 1949

**Einstein, Albert** 1879–1955  
German-born physicist

Control by experiment...is, of course, an essential prerequisite of the validity of any theory. But one can't possibly test everything. That is why I am so interested in your remarks about simplicity. Still, I should never claim that I really understood what is meant by the simplicity of natural laws.

In Werner Heisenberg  
*Physics and Beyond: Encounters and Conversations*  
Chapter 5 (p. 69)  
Harper & Row, Publishers. New York, New York, USA. 1971

In every important advance the physicist finds that the fundamental laws are simplified more and more as experimental research advances. He is astonished to notice how sublime order emerges from what appeared to be chaos. And this cannot be traced back to the workings of his own mind but is due to a quality that is inherent in the world of perception. Leibniz well expressed this quality by calling it a pre-established harmony.

In Max Planck  
*Where Is Science Going?*  
Prologue (p. 11)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Nothing is more simple than greatness; indeed, to be simple is to be great.

*Ralph Waldo Emerson: Essays and Lectures*  
Nature: Addresses, and Lectures (p. 100)  
The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88

American theoretical physicist

Perhaps a thing is simple if you can describe it fully in several different ways without immediately knowing that you are describing the same thing.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1965

The Development of the Space-Time View of Quantum Electrodynamics  
Elsevier Publishing Company. Amsterdam, Netherlands. 1972

The answer to all these questions may not be simple. I know there are some scientists who go about preaching that Nature always takes on the simplest solutions. Yet the simplest solution by far would be nothing, that there should be nothing at all in the universe. Nature is far more inventive than that, so I refuse to go along thinking it always has to be simple.

*Feynman Lectures on Gravitation*

Lecture 13 (p. 186)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Fuller, Thomas** 1608–61

English clergyman and author

Generally nature hangs out a sign of simplicity in the face of a fool.

*The Holy and Profane State*

Book III, Chapter XII, Maxim I

Maxim I (p. 171)

Printed for Thomas Tegg. London, England. 1841

**Gibbs, J. Willard** 1839–1903

American mathematician

One of the principal objects of theoretical research in any department of knowledge is to find the point of view from which the subject appears in its greatest simplicity.  
Rumford Medal Address, January 12, 1881

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

The obvious is that which is never seen until someone expresses it simply.

*Sand and Foam: A Book of Aphorisms* (p. 54)

Alfred A. Knopf. New York, New York, USA. 1959

**Goodman, Nelson** 1906–98

American philosopher

All scientific activity amounts to the invention of and the choice among systems of hypotheses. One of the primary considerations guiding this process is that of simplicity. Nothing could be much more mistaken than the traditional idea that we first seek a true system and then, for the sake of elegance alone, seek a simple one.

The Test of Simplicity

*Science*, Volume 128, 1958 (p. 1064)

**Gore, George** 1826–1909

English electrochemist

Simplicity, whether truthful or not, is often attractive to unphilosophical minds, because it requires less intellectual exertion.

*The Art of Scientific Discovery*

Chapter IV (p. 29)

Longmans, Green & Company. London, England. 1878

**Grimaux, L. E.**

No biographical data available

**Gerhardt, C.**

No biographical data available

The chemist must always compare the results of his experiments with those which precede them; for it is by this comparison alone that little by little we arrive at general laws, and consequently at the simplification of science.

In Russell McCormmach (ed.)

*Historical Studies in the Physical Sciences* (Volume 6)

In John Hedley Brooke

Laurent, Gerhardt, and the Philosophy of Chemistry (p. 424)

Princeton University Press. Princeton, New Jersey, USA. 1975

**Haldane, J. S. (John Scott)** 1860–1936

Scottish physiologist

In scientific thought we adopt the simplest theory which will explain all the facts under consideration and enable us to predict new facts of the same kind. The catch in this criterion lies in the word “simplest.” It is really an aesthetic canon such as we find implicit in our criticisms of poetry or painting. The layman finds such a law as  $x/t = k(2x/y^2)$  less simple than “it oozes,” of which it is the mathematical statement. The physicist reverses this judgment.

*On Being the Right Size and Other Essays*

Science and Theology as Art-Forms (pp. 33–34)

Oxford University Press, Inc. Oxford, England. 1985

**Hamerton, Philip Gilbert** 1834–94

English artist and art critic

Simplicity whether truthful or not, is often attractive to unphilosophical minds, because it requires less intellectual exertion.

*The Intellectual Life*

Part I, Chapter IV (p. 29)

Little, Brown & Co. Boston, Massachusetts, USA. 1901

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

You may object that by speaking of simplicity and beauty I am introducing aesthetic criteria of truth, and I frankly admit that I am strongly attracted by the simplicity and beauty of the mathematical schemes which nature presents us. You must have felt this too: the almost frightening simplicity and wholeness of the relationships, which nature suddenly spreads out before us...

*Physics and Beyond: Encounters and Conversations*  
Chapter 5 (pp. 68–69)  
Harper & Row, Publishers. New York, New York, USA. 1971

You [to Einstein] must have felt this too: the frightening simplicity and wholeness of the relationships which nature suddenly spreads out before us and for which none of us was in the least prepared.

*Physics and Beyond: Encounters and Conversations*  
Chapter 5 (p. 69)  
Harper & Row, Publishers. New York, New York, USA. 1971

**Hoagland, Mahlon** 1921–  
American biochemist

It is often the scientist's experience that he senses the nearness of truth when such connections are envisioned. A connection is a step toward simplification, unification. Simplicity is indeed often the sign of truth and a criterion of beauty.

*Toward the Habit of Truth: A Life in Science*  
Preface (p. xxiii)  
W.W. Norton & Company, Inc. New York, New York, USA. 1990

**Hoffer, Eric** 1902–83  
American longshoreman and philosopher

It is not at all simple to understand the simple.

*The Passionate State of Mind, and Other Aphorisms*  
No. 230  
Harper & Brothers. New York, New York, USA. 1955

**Hoffmann, Hans** 1848–1904  
German novelist

The ability to simplify means to eliminate the unnecessary so that the necessary may speak.

In Bradley Efron and Robert J. Tibshirani  
*An Introduction to the Bootstrap*  
Preface (p. xiv)  
Chapman & Hall. New York, New York, USA. 1993

**Jevons, William Stanley** 1835–82  
English economist and logician

Simplicity is naturally agreeable to a mind of limited powers, but to an infinite mind all things are simple.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book V, Chapter XXVII (p. 625)  
Macmillan & Company. London, England. 1887

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

It would be simple enough, if only simplicity were not the most difficult of all things.

Translated by R.F.C. Hull  
*Alchemical Studies*  
Modern Psychology Offers a Possibility of Understanding (p. 16)  
Princeton University Press. Princeton, New Jersey, USA. 1967

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

...we must not measure the simplicity of the laws of nature by our facility of conception; but when those which appear to us the most simple, accord perfectly with observations of the phenomena, we are justified in supposing them rigorously exact.

Translated by John Pond  
*The System of the World* (Volume 2)  
Book IV, Chapter I (p. 13)  
Printed for Richard Phillips  
London, England. 1809

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

In performing experiments, it is a necessary principle, which ought never to be deviated from, that they be simplified as much as possible, and that every circumstance capable of rendering their results complicated be carefully removed.

*Elements of Chemistry in a New Systematic Order*  
Translated by Kerr (p. 103)  
W. Creech. Edinburgh, Scotland. 1790

**Lindley, Dennis V.** 1923–  
American statistician

I believe that almost all important, useful ideas are simple. Peter Whittle has recently put it nicely in an autobiographical essay. "If a piece of work is heavy and complicated then it is wrong...." Some writers feel that to express their ideas in simple terms is degrading. Some use complexity to disguise the paucity of their material. In fact, simplicity is a virtue and when, as here, it is both original and useful, it can represent a real advance in knowledge.

Simplicity  
*RSS News*, April, 1995 (p. 1)

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

The point is to simplify and to order knowledge. The profession I'm part of has as its whole function the rendering of the physical world understandable and beautiful. Otherwise, you have only tables and statistics.

With Oppenheimer on an Autumn Day  
*Look*, Volume 30, Number 26, 27 December, 1966 (p. 63)

**Percy, Walker** 1916–90  
American writer

It is not merely the truth of science that makes it beautiful, but its simplicity.

*Signposts in a Strange Land*  
From Fact to Fiction (p. 187)  
Farrar, Straus & Giroux. New York, New York, USA. 1991

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

...it is because simplicity, because grandeur, is beautiful that we preferably seek simple facts, sublime facts,

that we delight now to follow the majestic courses of the stars, now to examine with the microscope that prodigious littleness which is also grandeur, now to seek in geologic time the traces of a past which attracts because it is far away.

*The Foundations of Science  
Science and Method*, Book I  
Chapter I (p. 367)

The Science Press. New York, New York, USA. 1913

**Rainich, G. Y.** 1886–1968

Ukrainian mathematical physicist

...the really fundamental things have a way of appearing to be simple once they have been stated by a genius....

*Analytic Function and Mathematical Physics*

*Bulletin of the American Mathematical Society*, October, 1931 (p. 700)

**Reid, Thomas** 1710–96

Scottish philosopher

Men are often led into errors by the love of simplicity, which disposes us to reduce things to few principles, and to conceive a greater simplicity in nature than there really is.

*Essays on the Intellectual Powers of Man*

Essay VI, Chapter VIII (p. 656)

Printed for John Bell. London, England. 1785

**Schumacher, Ernst Friedrich** 1911–77

German-born English economist

...it is rather more difficult to recapture directness and simplicity than to advance in the direction of ever more sophistication and complexity. Any third-rate engineer or researcher can increase complexity; but it takes a certain flair of real insight to make things simple again.

*Small Is Beautiful*

Part II, Chapter 5 (p. 146)

Harper & Row, Publishers. New York, New York, USA. 1973

**Slobodkin, Lawrence B.**

American ecologist and evolution scientist

The awkward richness of possibilities seems to shatter any possible coherent theory of simplicity...

*Simplicity and Complexity in Games of the Intellect*

Chapter 10 (p. 204)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Smith, George Otis** 1871–1944

American geologist

I am convinced that, at its best, science is simple – that the simplest arrangement of facts that sets forth the truth best deserves the term scientific. So the geology I plead for is that which states facts in plain words – in language understood by the many rather than only by the few. Plain geology needs little defining, and I may state my case best by trying to set forth the reasons why we have strayed so far away from the simple type.

Plain Geology

*Economic Geology*, Volume 17, Number 1, 1922 (p. 34)

**Stone, David**

No biographical data available

One man's "simple" is another man's "huh?"

*OMNI Magazine*, May, 1979

**Teague, Jr., Freeman**

No biographical data available

Nothing is so simple it cannot be misunderstood.

*OMNI Magazine*, May, 1979

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

No endeavor that is worthwhile is simple in prospect; if it is right, it will be simple in retrospect. The pursuit of simplicity in science leads to understanding and beauty.

*The Pursuit of Simplicity*

Chapter 5 (p. 152)

Pepperdine University Press. Malibu, California, USA. 1981

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Sylvester, James Joseph** 1814–97

English mathematician

No endeavor that is worthwhile is simple in prospect; if it is right, it will be simple in retrospect.

*The Pursuit of Simplicity*

Chapter Five (p. 152)

Pepperdine University Press, Malibu. 1981

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

**Talley, Wilson**

No biographical data available

It is often claimed that knowledge multiplies so rapidly that nobody can follow it. I believe this is incorrect. At least in science it is not true. The main purpose of science is simplicity and as we understand more things, everything is becoming simpler. This of course, goes contrary to what everybody accepts.

*Conversations on the Dark Secrets of Physics*

Prologue (p. 2)

Plenum Press. New York, New York, USA. 1991

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Simplify. Simplify.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter II (p. 144)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893



**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910  
American author and humorist

It's as simple as tit-tat-toe, three-in-a-row, and as easy as playing hooky. I should hope we can find a way that's a little more complicated than that...

*The Adventures of Huckleberry Finn*

Chapter XXXIV (p. 298)

Grosset &amp; Dunlap Publishers. New York, New York, USA. 1948

**Valéry, Paul** 1871–1945

French poet and critic

“Cleverness” is transmuted into “genius” when it takes the form of a simplification.

Translated by Stuart Gilbert

*The Collected Works of Paul Valéry* (Volume 14)*Analects*

Odds and Ends (p. 36)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Wright, Frank Lloyd** 1867–1959

American architect

To know what to leave out and what to put in; just where and just how, ah, that is to have been educated in knowledge of simplicity...

*Frank Lloyd Wright: An Autobiography*

Simplicity (p. 144)

Duell, Sloan &amp; Pearce. New York, New York, USA. 1943

**SIMPLIFICATION****Kac, Mark** 1914–84

Polish mathematician

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Schwartz, Jacob T.** 1930–

American mathematician

In this quest for simplification, mathematics stands to computer science as diamond mining to coal mining. The former is a search for gems.... The latter is permanently involved with bulldozing large masses of ore – extremely useful bulk material.

In Jacob T. Schwartz

*Discrete Thoughts: Essays on Mathematics, Science, and Philosophy Computer Science* (p. 64)

Birkhäuser. Boston, Massachusetts, USA. 1986

**SIMULTANEITY****Bridgman, Percy Williams** 1882–1961

American physicist

Einstein, in thus analyzing what is involved in making a judgment of simultaneity, and in seizing on the act of the observer as the essence of the situation, is actually

adopting a new point of view as to what the concepts of physics should be, namely, the operational view.

*The Logic of Modern Physics*

Chapter I (p. 8)

The Macmillan Company. New York, New York, USA. 1927

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Simultaneous discovery is utterly commonplace, and it was only the rarity of scientists, not the inherent improbability of the phenomenon, that made it remarkable in the past. Scientists on the same road may be expected to arrive at the same destination, often not far apart.

The Act of Creation

*New Statesman*, 19 June, 1964**SINGULARITY****Arnold, Vladimir Ogorevich** 1937–

Russian mathematician

The mathematical description of the world depends on a delicate interplay between continuity and discontinuous, discrete phenomena. The latter are perceived first. Functions, just like living beings, are characterised by their singularities”, as P. Montel proclaimed. *Singularities, bifurcations* and *catastrophes* are different terms for describing the emergence of discrete structures from smooth, continuous ones.

Translated by G. S. Wassermann

*Catastrophe Theory* (3rd edition)

Preface to the Third Russian Edition (p. ix)

Springer-Verlag. Berlin, Germany. 1992

**Barrow, John D.** 1952–

English theoretical physicist

In recent years cosmologists have begun to discuss the spontaneous creation of the Universe as a problem in physics. Those who do this assume that a future synthesis of quantum theory and relativity which reveals how gravity behaves when matter is enormously compressed will evade the predictions of a real singularity of the type required by the singularity theorems. Although the assumptions of the singularity theorems are not expected to hold near the singularity, we do not know whether to expect a singularity or not as yet. But even in the absence of this singularity to denote the beginning of the Universe, it has been speculated that the application of quantum theory to the whole Universe may allow physical content to be given to the concept of “creation of the Universe out of Nothing.” The goal of this research is to show that the creation of an expanding universe is inevitable. The reason there is something rather than nothing is that “nothing” is unstable.

*The World within The World* (p. 230)

Clarendon Press. Oxford, England. 1988

**Hawking, Stephen William** 1942–  
English theoretical physicist

We showed that if general relativity is correct, any reasonable model of the universe must start with a singularity. This would mean that science could predict that the universe must have had a beginning, but that it could not predict how the universe should begin: For that, one would have to appeal to God.... Now, as a result of the singularity theorems, nearly everyone believes that the universe began with a singularity, at which the laws of physics broke down. However, I now think that although there is a singularity, the laws of physics can still determine how the universe began.

*Black Holes and Baby Universes and Other Essays*  
Chapter Nine (p. 91)  
Bantam Books. New York, New York, USA. 1987

## SITE

**Bagnold, Ralph A.** 1896–1990  
English officer and engineer

There is an unflinching joy in identifying oneself with the actual sites where great things happened long ago. It appeals to a very human trait in all of us.

*Libyan Sands: Travel in a Dead World*  
Chapter III (p. 74)  
Hodder & Stoughton. London, England. 1941

**Woolley, Sir Charles Leonard** 1880–1960  
English archaeologist

If the field archaeologist had his will, every ancient capital would have been overwhelmed by the ashes of a conveniently adjacent volcano. It is with green jealousy that the worker on other sites visits Pompeii and sees the marvellous preservation of its buildings, the houses standing up to the second floor, the frescoes on the walls and all the furniture and household objects still in their places as the owners left them as they fled from the disaster.

*Digging Up the Past*  
Chapter I (p. 19)  
Charles Scribner's Sons. New York, New York, USA. 1931

## SIZE

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

There is a size at which dignity begins; further on there is a size at which grandeur begins; further on there is a size at which solemnity begins; further on, a size at which awfulness begins; further on, a size at which ghastliness begins. That size faintly approaches the size of the stellar universe.

*Two on a Tower*  
Chapter IV (p. 35)  
Harper & Brothers. New York, New York, USA. No date

The vastness of the field of astronomy reduces every terrestrial thing to atomic dimensions.

*Two on a Tower*  
Chapter XXXIV (p. 258)  
Harper & Brothers. New York, New York, USA. No date

**Landrin, Armand**  
No biographical data available

The monstrosity of greatness is a purely relative thing. To the wren the eagle appears colossal. The wren looks upon the hummingbird as an insignificant creature. The rat, compared with that, is larger than the whale compared with man. In size, as in distance, everything is relative.

*The Monsters of the Deep: And Curiosities of Ocean Life*  
Chapter I (p. 12)  
T. Nelson & Sons. London, England. 1875

**Payne, Roger** 1935–  
American biologist and environmentalist

Small things lead frantic lives. When a passing ant sets its foot in a drop of water, the amoebas in that drop experience raging tidal waves, while to the ant the footsteps of a mouse on the roof of its galleries must rattle all the cupboards and shake the pupae off the walls.

*Among Whales*  
Chapter 1 (p. 20)  
Charles Scribner's Sons. New York, New York, USA. 1995

## Scott Cary (Fictional character)

The unbelievably small and the unbelievably vast eventually meet – like the closing of a gigantic circle. I looked up, as if somehow I would grasp the heavens. The universe, worlds beyond number, God's silver tapestry spread across the night. And in that moment, I knew the answer to the riddle of the infinite. I had thought in terms of man's own limited dimension. I had presumed upon nature. That existence begins and ends in man's conception, not nature's. And I felt my body dwindling, melting, becoming nothing. My fears melted away. And in their place came acceptance. All this vast majesty of creation, it had to mean something. And then I meant something, too. Yes, smaller than the smallest. I meant something, too. To God there is no zero. I still exist!

*The Incredible Shrinking Man*  
Film (1957)

**Shapley, Harlow** 1885–1972  
American astronomer

The atomically small leads directly to the size really immense.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1946*  
On the Astronomical Dating of the Earth's Crust (p. 140)  
Government Printing Office. Washington, D.C. 1947

## SKEPTICISM

**Darwin, Charles Robert** 1809–82  
English naturalist

I am not very skeptical – a frame of mind which I believe to be injurious to the progress of science. A good deal of skepticism in a scientific man is advisable to avoid too much loss of time, but I have met with not a few men, who, I feel sure, have often thus been deterred from experiment or observations which would have proved directly or indirectly serviceable.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 83)

D. Appleton & Company. New York, New York, USA. 1896

**Davis, Andrew Jackson**

No biographical data available

Skepticism is...the handmaid of Truth.

*The Present Age and Inner Life* (3rd edition)

A Survey of Human Needs (p. 8)

W. White & Co. Boston, Massachusetts, USA. 1873

**Davy, Sir Humphry** 1778–1829

English chemist

Our knowledge is little indeed: and scepticism in regard to theory is what we ought most rigorously to adhere to.

In John Davy

*Memoirs of the Life of Sir Humphry Davy* (Volume 1)

Chapter II (p. 122)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Skepticism or debunking often receives the bad rap reserved for activities – like garbage disposal – that absolutely must be done for a safe and sane life, but seem either unglamorous or unworthy of overt celebration. Yet the activity has a noble tradition, from the Greek coinage of “skeptic” (a word meaning “thoughtful”) to Carl Sagan’s...*The Demon-Haunted World*.... Skepticism is the agent of reason against organized irrationalism – and is therefore one of the keys to human social and civic decency.... Skepticism’s bad rap arises from the impression that, however necessary the activity, it can only be regarded as a negative removal of false claims. Not so.... Proper debunking is done in the interest of an alternate model of explanation, not as a nihilistic exercise. The alternate model is rationality itself, tied to moral decency – the most powerful joint instrument for good that our planet has ever known.

In Michael Shermer

*Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*

Foreword (pp. ix–xii)

Henry Holt & Company. New York, New York, USA. 2002

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

Science is not skepticism. It is not the practice of science to look for things to doubt.

*The Open Mind*

The Encouragement of Science (p. 114)

Simon & Schuster. New York, New York, USA. 1955

**Raymo, Chet** 1936–

American physicist and science writer

The difference between Skeptics and True Believers is not that Skeptics believe what is sensible and obvious, while True Believers accept what is fanciful and far-fetched. Often, it is the other way around.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Two (p. 27)

Walker & Company. New York, New York, USA. 1998

Skepticism is a critical reluctance to take anything as absolute truth, even one’s own most cherished beliefs. Astonishment is the ability to be dazzled by the commonplace. At first glance these two qualities might seem opposed. The Skeptic is often thought to lack passionate commitment. The easily astonished person is sometimes thought of as gullible. In fact reasoned skepticism does not preclude passionate belief, and astonishment is enhanced by knowledge.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Fourteen (pp. 252–253)

Walker & Company. New York, New York, USA. 1998

**Sagan, Carl** 1934–96

American astronomer and author

...science requires the most vigorous and uncompromising skepticism, because the vast majority of ideas are simply wrong, and the only way to winnow the wheat from the chaff is by critical experiment and analysis.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 17 (p. 305)

Random House, Inc. New York, New York, USA. 1995

Finding the occasional straw of truth awash in a great ocean of confusion and bamboozle requires vigilance, dedication, and courage. But if we don’t practice these tough habits of thought, we cannot hope to solve the truly serious problems that face us – and we risk becoming a nation of suckers, a world of suckers, up for grabs by the next charlatan who saunters along.

*The Fine Art of Baloney Detection*

*Parade*, February 1, 1987

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

Skepticism alone is a cheap and barren affair. Skepticism in a man who has come nearer to the truth than anyone

before, and yet clearly recognizes the narrow limits of his own mental construction, is great and fruitful, and does not reduce but doubles the value of the discoveries.

*Nature and the Greeks*

Chapter II (p. 31)

At The University Press. Cambridge, England. 1954

## SKY

### Astronomy Survey Committee

Nature offers no greater splendor than the starry sky on a clear, dark night. Silent, timeless, jeweled with the constellations of ancient myth and legend, the night sky has inspired wonder throughout the ages.

*Astronomy and Astrophysics for the 1980s* (Volume 1)

Report to the Astronomy Survey Committee (p. 3)

### Brahe, Tycho 1546–1601

Danish astronomer

*O crassia ingenia, O coecos coeli spectatores.*

O thick wits. Oh blind watchers of the sky.

*De Nova Stella*

Preface

### Brandt, John C.

No biographical data available

### Chapman, Robert D.

No biographical data available

...each step forward in unraveling the mystery of comets (or any other natural phenomenon) brings great pleasure to all who look to the sky as a source of beauty and intellectual challenge.

*Introduction to Comets*

Chapter 10 (p. 226)

Cambridge University Press. Cambridge, England. 1981

### Browning, Robert 1812–89

English poet

Sky – what a scowl of cloud

Till, near and far,

Ray on ray split the shroud

Splendid, a star!

*The Poems and Plays of Robert Browning*

The Two Poets of Croisic

The Modern Library. New York, New York, USA. 1934

### Buchner, Ludwig 1824–99

German physician and philosopher

Every schoolboy knows that the sky is not a glass shade covering the earth, but that, in contemplating it, we behold an immense space interrupted by infinitely distant and scattered groups of worlds.

*Force and Matter*

Chapter VIII (p. 51)

Trübner & Co. London, England. 1864

### Bunch, Sterling

American poet and editor

In starry skies, long years ago,

I found my Science. Heart aglow

I watched each night unfold a maze

Of mystic suns and worlds ablaze,

That spoke: "Know us and wiser grow."

In *Starry Skies*

*Popular Astronomy*, Volume 34, 1926 (p. 288)

### Burroughs, John 1837–1921

American naturalist and essayist

What appears more real than the sky? We think of it, and speak of it, as if it were as positive and real a thing as the earth. It is blue, it is tender, it is overarching, it is clear. See how the color is laid on it at sunset. Yet what an illusion! There is no sky; it is only vacancy; it is only the absence of something. It is a glimpse of the Infinite.

*The Heart of Burroughs's Journals*

Sept. 15, 1885 (p. 125)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

### de Saint-Exupéry, Antoine 1900–44

French aviator and writer

A sky as pure as water bathed the stars and brought them out.

*Southern Mail*

Chapter I (p. 3)

Harcourt, Brace & Company New York, New York, USA. 1971

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

The sky is the daily bread of the eyes.

In Edward Waldo Emerson (ed.)

*Journals of Ralph Waldo Emerson 1841–1844*

25 May, 1843 (p. 410)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### Ferris, Timothy 1944–

American science writer

Nothing is more egalitarian than the night sky.

*Seeing in the Dark*

Chapter 13 (p. 180)

Simon & Schuster. New York, New York, USA. 2002

### Flammarion, Camille 1842–1925

French astronomer and author

Better than the spectacle of the sea calm or agitated, grander than the spectacle of mountains adorned with forests or crowned with perpetual snow, the spectacle of the sky attracts us, envelops us, speaks to us of the infinite, gives us the dizziness of the abyss; for more than any other, it seizes the contemplative mind and appeals to it, being the truth, the infinite, the eternal, the all.

*Popular Astronomy: A General Description of the Heavens*

Book VI, Chapter I (p. 554)

Chatto & Windus. London, England. 1894

**Friedman, Herbert** 1916–2000

American space scientist and astrophysicist

It is impossible for any sensitive person to look at a star-filled sky without being stirred by thoughts of creation and eternity. The mystery of the origin and destiny of the universe haunts us throughout our lives.

*The Amazing Universe*

Chapter 7 (p. 166)

National Geographic Society. Washington, D.C. 1980

**Kreymborg, Alfred** 1883–1966

American poet and anthologist

The sky is that beautiful old parchment in which the sun and the moon keep their diary.

In Louis Untermeyer (ed.)

*Modern American Poetry*

Old Manuscript

Harcourt, Brace &amp; Company. New York, New York, 1936

**Lowell, Amy** 1874–1925

American poet

A wise man,  
Watching the stars pass across the sky,  
Remarked:

In the upper air the fireflies move more slowly.

*The Complete Poetical Works of Amy Lowell*

Meditation

Houghton Mifflin. Boston, Massachusetts, USA. 1955

**Manilius, Marcus** fl. 10 AD

Roman poet

It is my delight to traverse the very air and spend my life touring the boundless skies, learning of the constellations and the contrary motions of the planets.

*Astronomica*

Book I

Publisher undetermined

**Maunder, Edward Walter** 1851–1928

English astronomer

The oldest picture book in our possession is the Midnight Sky.

The Oldest Picture-Book of All

*Nineteenth Century*, Volume 48, Number CCLXXXIII, September, 1900 (p. 451)**Moulton, Forest Ray** 1872–1952

American astronomer

It is doubtful whether there is in the whole range of human experience anymore awe-inspiring spectacle than that presented by the sky on a clear and moonless night. Under the vault of the sparkling heavens one is raised, if ever, to an actual realization of the fact that the earth beneath his feet is a relatively tiny mass in comparison with the infinite cosmos spread out above.

*Astronomy*

Chapter II (p. 14)

The Macmillan Company. New York, New York, USA. 1931

**The Bible (King James Version)**

The heavens declare the glory of God; and the firmament sheweth his handywork.

*Psalms 19:1***Raymo, Chet** 1936–

American physicist and science writer

The night sky possesses an unparalleled power to excite the human imagination. Intimate, yet infinite. Dark, yet full of light. Near, yet unreachably far.

*365 Starry Nights*

Introduction (p. ix)

Prentice-Hall. New York, New York, USA. 1982

The night sky is more like a human being, inexhaustibly complex and finally beyond reach. Knowledge only whets our interest and increases our wonder.

*365 Starry Nights*

Introduction (p. x)

Prentice-Hall. New York, New York, USA. 1982

**Schaefer, Bradley E.**

American professor of physics

The sky is beautiful and vast and harbors many secrets.

Inventory of Cosmic Mysteries

*Sky & Telescope*, Volume 94, Number 4, October, 1994 (p. 68)**Shakespeare, William** 1564–1616

English poet, playwright, and actor

My soul is in the sky.

In *Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)*A Midsummer-Night's Dream*

Act V, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shore, Jane** 1947–

American poet

Each night the sky splits open like a melon  
its starry filaments  
the astronomer examines with great intensity.

*Eye Level*

An Astronomer's Journal (p. 31)

The University of Massachusetts Press. Amherst, Massachusetts, USA. 1977

**Smoot, George** 1945–

American astrophysicist

**Davidson, Key**

American science writer

There is something about looking at the night sky that makes a person wonder.

*Wrinkles in Time*

Chapter 1 (p. 1)

William Morrow &amp; Company, Inc. New York, New York, USA. 1993

**Swings, Pol** 1906–63

Belgian astrophysicist

The sky belongs to everyone, with stars to spare for all.

In Henry Margenau and David Bergamini (eds.)

*The Scientist* (p. 116)

Time Inc. New York, New York, USA. 1964

**Thomas, Lewis** 1913–93

American physician and biologist

Taken all in all, the sky is a miraculous achievement. It works, and for what it is designed to accomplish it is as infallible as anything in nature. I doubt whether any of us could think of a way to improve on it, beyond maybe shifting a local cloud from here to there on occasion.

*The Lives of a Cell: Notes of a Biology Watcher*

The World's Biggest Membrane (p. 148)

The Viking Press. New York, New York, USA. 1974

**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

The sky looks ever so deep when you lay down on your back in the moonshine ...

*Huckleberry Finn*

Chapter VII (p. 49)

Harper &amp; Brothers Publishers. New York, New York, USA. 1912

**Tyndall, John** 1820–93

Irish-born English physicist

We live in the sky, not *under* it.

Climbing in Search of the Sky

*The Fortnightly*, Number 37, January 1, 1870 (p. 13)**Uppgren, Arthur**

No biographical data available

A dark sky filled with stars has always been one of our most cherished sights. This wonder need not and must not fade into the baleful orange glare above our cities; let the stars continue to twinkle with the fireflies along country lanes. Those stars come from one shared legacy of all people around the world, and it is by the heavens they define that we all ultimately find our way.

*Night Has a Thousand Eyes: A Naked-Eye Guide to the Sky, Its Science, and Lore*

Afterword (p. 275)

Plenum Trade. New York, New York, USA. 1998

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Over all the sky – the sky! Far, far out of reach, studded, breaking out, the eternal stars.

*Complete Poetry and Collected Prose*

Bivouac on a Mountain Side

The Library of America. New York, New York, USA. 1982

**SLEEP****Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

To sleep is to strain and purify our emotions, to deposit the mud of life, to calm the fever of the soul, to return into the bosom of maternal nature, thence to re-issue, healed and strong. Sleep is a sort of innocence and purification. Blessed be He who gave it to the poor sons of men as the sure and faithful companion of life, our daily healer and consoler.

Translated by Humphry Ward

*Amiel's Journal*

20 March, 1853 (p. 39)

Macmillan &amp; Company Ltd. London, England. 1893

**Aristotle** 384 BCE–322 BCE

Greek philosopher

The vigorous are no better than the lazy during one half of life, for all men are alike when asleep.

In *Great Books of the Western World* (Volume 8)*Eudemian Ethics*

Book II Chapter I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

Blessings on him who invented sleep, the mantle that covers all human thoughts, the food that appeases hunger, the drink that quenches thirst, the fire that warms cold, the cold that moderates heat, lastly, the general coin that purchases all things, the balance and weight that equals the shepherd and the king, the simple and the wise.

Translated by Charles Jarvis

*Don Quixote de la Mancha* (Volume 1)

Chapter LXXVIII (p. 424)

Phillips, Sampson &amp; Co. Boston, Massachusetts, USA. 1857

**SLOWER DOWNER****Wheeler, John Archibald** 1911–

American physicist and educator

The reactor...had to contain material to decelerate the neutrons. Fermi, in his straightforward way, called this material a "slower downer". That term got under my skin so much that I was forced to think up a different term. I chose "moderator" and it stuck.

*Geons, Black Holes, and Quantum Foam*

Chapter 2 (p. 40)

W.W. Norton &amp; Co. New York, New York, USA. 2000

**SMOKE****Sherman, Joe**

No biographical data available

Smoke is odd, complex, nasty, marvelous. It's older than bacteria, as modern as smog, as common as fire.



*GASP!*

Chapter 8 (p. 169)

Shoemaker & Hoard. Washington, D.C. 2004

## SNOW FLAKE

**Bentley, W. A.** 1865–1931

American amateur snowflake photographer

**Perkins, G. H.**

No biographical data available

Many have admired snowflakes as they observed their exquisite outlines and varied forms, but few have ever given them careful study or distinguished the crystals of which a flake is usually composed.

A Study of Snow Crystals

*The Popular Science Monthly*, Volume 53, May, 1898 (p. 75)

...illustrations will soon convince one that, great as is the charm of outline, the internal ornamentation of snow crystals is far more wonderful and varied.

A Study of Snow Crystals

*The Popular Science Monthly*, Volume 53, May, 1898 (p. 77)

A careful study of this internal structure not only reveals new and far greater elegance of form than the simple outlines exhibit, but by means of these wonderfully delicate and exquisite figures much may be learned of the history of each crystal, and the changes through which it has passed in its journey through cloudland. Was ever life history written in more dainty hieroglyphics!

A Study of Snow Crystals

*The Popular Science Monthly*, Volume 53, May, 1898 (p. 81)

...anyone who engages in the study of snow crystals will speedily find his task both absorbing and delightful. There is no surer road to fairyland than that which leads to the observation of snow forms.

A Study of Snow Crystals

*The Popular Science Monthly*, Volume 53, May, 1898 (p. 82)

**Chickering, Francis**

No biographical data available

No weary journey need be taken, no expensive machinery employed.... A winter's storm, an open window, a bit of fur or velvet, and a common magnifier, will bring any curious inquirer upon his field of observation with all the necessary apparatus, and he has only to open his eyes to find the grand and beautiful laboratory of nature open to his inspection.

*Cloud Crystals: A Snow-Flake Album*

Introduction (pp. 1–2)

D. Appleton & Co. New York, New York, USA. 1864

**Hart, Helen**

No biographical data available

Said a little snowflake

To a drop of rain,

“My, I am sorry dear, you are so very plain.”

Rain Drop and Snow-Flake

*Nature Magazine*, Volume I, Number 3, March, 1923 (p. 56)

**Macmillan, Hugh** 1833–1903

Minister and naturalist

No rightly constituted mind can behold the wealth of beauty in the snow-flowers without being awed and humbled.

*Two Worlds Are Ours*

Chapter XVII (p. 274)

Macmillan & Company Ltd. London, England. 1880

Lighter than a feather they [snowflakes] fall from the silent sky to the silent earth; more fragile than a foam-bell they melt and disappear before the touch of a finger. And yet these weakest and lightest of all things by their accumulation possess a power which is irresistible, and which is among the most stupendous forces of nature. They can lock up the wheels of labour; they can besiege cities, and shut them out from the rest of the world; they can stop the march of armies, and muffle the landscape into an awful silence.

*Two Worlds Are Ours*

Chapter XVII (p. 276)

Macmillan & Company Ltd. London, England. 1880

**Seligman, G.**

No biographical data available

The instant a [snow]flake has sunk to earth, changes in its structure begin to take place. As we gaze at the whitened woods stilled to silence or look through the tiny window of the alpine hut upon the dazzling snowfields, conveying to us the false message of an inert nature standing still, we are really looking upon a supremely busy laboratory in which, in sum total, vast energy is at work inducing all kinds of physical changes, so that in a short time nothing is left of the original flake of yesterday's blizzard save its whiteness.

*Snow Structure and Ski Fields*

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Nothing is cheap and coarse, neither dew-drops nor snow-flakes.

*The Journal Of Thoreau* (Volume 2)

January 5, 1856

How full of creative genius is the air in which these are generated! I should hardly admire more if real stars fell and lodged on my coat. Nature is full of genius, full of divinity. Nothing is cheap and coarse, neither dewdrops nor snowflakes.

*The Journal Of Thoreau* (Volume 2)

January 5, 1856 (pp. 87–88)

...commonly the flakes reach us travel-worn and agglomerated, comparatively without order or beauty, far down in their fall, like men in their advanced age.

*The Journal Of Thoreau* (Volume 2)  
January 5, 1856

Nature is full of genius, full of divinity, so that not a snow-flake escapes its fashioning hand.

*The Journal Of Thoreau* (Volume 2)  
January 5, 1856

A divinity must have stirred within them before the crystals did thus shoot and set. Wheels of storm-chariots. The same law that shapes the earth-star shapes the snow-stars. As surely as the petals of a flower are fixed, each of these countless snow-stars comes whirling to earth, pronouncing thus, with emphasis, the number six ...

*The Journal Of Thoreau* (Volume 2)  
January 5, 1856

## SOAP BUBBLE

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

The colours which glitter on a soap-bubble are the immediate consequence of a principle the most important from the variety of phenomena it explains, and the most beautiful, from its simplicity and compendious neatness, in the whole science of optics.

*A Preliminary Discourse on the Study of Natural Philosophy*  
Part I, Chapter I (p. 14)  
Longman, Brown, Green & Longmans. London, England. 1845

## SOCIAL BEHAVIOR

**Bridges, Robert Seymour** 1844–1930  
English poet

Even among beasts of prey the bloody wolves, who found

some selfish betterment from their hunting in packs, had thereby learn'd submission to a controlling will, their leader being so far that charioteer of their rage; while pastoral animals, or ever a drover came to pen them for his profit, had in self-defence herded together; and on the wild prairie are seen when threaten'd by attack, congregating their young within their midst for safety, and then scurrying their ranks

to a front line compact to face the dreaded foe. And this parental instinct, tho' it owns cousinship with Breed, was born of Selfhood. A nursing mammal, Since she must feed her suckling a piece of herself, wil self-preserve and shelter it as herself; and oft 'tis hard to wean.

*The Testament of Beauty – A Poem in Four Books*  
Book II  
At The Clarendon Press. Oxford, England. 2007

## SOCIETY

**Huxley, Thomas Henry** 1825–95  
English biologist

...the ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it.

*Evolution and Ethics and Other Essays*  
Chapter II (p. 83)  
Macmillan & Co Ltd. London, England. 1894

## SOIL

**Burroughs, John** 1837–1921  
American naturalist and writer

The youth of the earth is in the soil and in the trees and verdure that springs from it...

*Under the Apple-Trees*  
Chapter II (p. 40)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Every plant is a manufacturer of soil.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)  
*Society and Solitude*  
Chapter VI (p. 144)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fuller, Wallace H.** 1915–2006  
American geologist

A thin rind of loose material covering the continents of the earth is all that stands between life and lifelessness.

*Soils of the Desert Southwest*  
A Word from the Author (p. xiii)  
University of Arizona Press. Tucson, Arizona, USA. 1975

Grit and grime, crumbling rock and decaying organic residue-abrading by wind and water – weather into soil – Mother Earth. This soft and yielding earth lives and continually changes under the forces of climate, having formed through the ages as a result of meteorological, geological, and biological action on rock. The soil not only lives, but it continually renews life as well. Animal and plant residues decay into simpler constituents, and nutrient elements again are made available for new life in a perpetual cycle.

*Soils of the Desert Southwest*  
A Word from the Author (p. xiii)  
University of Arizona Press. Tucson, Arizona, USA. 1975

**Goldsmith, Oliver** 1728–74  
Anglo-Irish writer, poet, and physician

*Solo natura subest* – out of the soil comes life; and in the greenness of the earth is man's redemption.

*The Miscellaneous Works of Oliver Goldsmith*

Epilogue (p. 353)

Macmillan & Company Ltd. London, England. 1881

**Hanotaux, Gabriel** 1853–1944

French statesman

The soil speaks to the geologist, the anthropologist, the historian, the sociologist.

*Contemporary France* (Volume 2)

Chapter XII, Section III (p. 656)

Archibald Constable & Co. London, England. 1905

**Molloy, Les**

No biographical data available

...for only rarely have we stood back and celebrated our soils as something beautiful, and perhaps even mysterious. For what other natural body, worldwide in its distribution, has so many interesting secrets to reveal to the patient observer? The great events of long ago – volcanic eruptions, dust storms, floods and Ice Ages – have left their imprints as have the agricultural practices of earlier times.

*Soils in the New Zealand Landscape: The Living Mantle*

Mallison Rendel Publishers Ltd. Wellington, New Zealand. 1988

The soil can...tell us much about our present day environment. It is the home of millions of living things and a recycling factory for so much of the solar and geochemical energy that sustains life. In its form and properties it expresses the combined influences of local climate, shape of the land, and rocks and organisms that are broken down and incorporated into it.

*Soils in the New Zealand Landscape: The Living Mantle*

Mallison Rendel Publishers Ltd. Wellington, New Zealand. 1988

**Simonson, Roy**

American soil scientist

Be it deep or shallow, red or black, sand or clay, the soil is the link between the rock core of the earth and the living things on its surface. It is the foothold for the plants we grow. Therein lies the main reason for our interest in soils.

*USDA Yearbook of Agriculture*, 1957

**Wahnschaffe, Felix** 1851–1914

No biographical data available

The superficial formation of the earth's crust, which serves as the bearer and nourisher of plants, is effected either by the loosening and decomposition of the exposed rocks, or by the transport of coarse and fine materials worn from other rocks, or, finally, by the transformation into humus of decayed vegetable remains piled up in large masses.

*A Guide to the Scientific Examination of Soils*

Chapter I (p. 17)

H.C. Baird. Philadelphia, Pennsylvania, USA. 1891

**SOIL EROSION**

**Leopold, Aldo** 1886–1948

American naturalist

To those who know the speech of hills and rivers, straightening a stream is like shipping vagrants – a very successful method of passing trouble from one place to the next. It solves nothing in any collective sense.

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

Coon Valley: An Adventure in Cooperative Conservation (p. 219)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**SOLAR SYSTEM**

**Author undetermined**

Yesterday, a numerous and highly respectable meeting of gentlemen and ladies interested in the stability of the solar system was held, pursuant to advertisement in the *Vox Stellarum*, True Sun, &c. at the sign of the Great Bear in the North Hemisphere, at One P. M. (sidereal time).

*Bentley's Miscellany* (Volume 2)

Reform of The Solar System (p. 508)

Richard Bentley. London, England. 1837

**Burke, Edmund** 1729–97

English statesman and philosopher

What grander idea can the mind of man form to itself than a prodigious, glorious, and fiery globe, hanging in the midst of an infinite space, and surrounded with bodies of whom our earth is scarcely anything in the comparison!

In James Prior

*A Life of Edmund Burke* (p. 13)

George Bell & Sons. London, England. 1891

**Burroughs, John** 1837–1921

American naturalist and writer

When I look up at the starry heavens at night and reflect upon what it is that I really see there, I am constrained to say, "There is no God." ...I see no lineaments of personality, no human traits, but an energy upon whose currents solar systems are but babbles.

*The Light of the Day: Religious Discussions and Criticisms from the Naturalist's Point of View* (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Carlyle, Thomas** 1795–1881

English historian and essayist

Did not the Boy Alexander weep because he had not two Planets to conquer; or a whole Solar System; or after that, a whole universe?

*Sartor Resartus*

Book II, Chapter VIII (p. 165)

Ginn & Company. Boston, Massachusetts, USA. 1897

**Chawla, Kalpana**

Indian astronaut

When you look at the stars and the galaxy, you feel that you are not just from any particular piece of land but from the solar system.

I'd Love a Moonwalk

*India Today*, January 26, 1998**Clarke, Arthur C.** 1917–

English science and science fiction writer

The Solar System is rather a large place, though whether it will be large enough for so quarrelsome an animal as *Homo sapiens* remains to be seen.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 8)

Harper &amp; Brothers. New York, New York, USA. 1959

The Solar System, comprising the nine known worlds of our Sun and their numerous satellites, is a relatively compact structure, a snug little celestial oasis in an endless desert.

*The Challenge of the Spaceship*

The Planets Are Not Enough (p. 54)

Harper &amp; Brothers. New York, New York, USA. 1959

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

Outside the solar system, the problems which demand a practical solution are all but infinite in number and extent.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Part II, Chapter 13 (p. 528)

Adam &amp; Charles Black. London, England. 1893

The cardinal truth emerging from these inquiries is that of the extreme isolation of the solar system. A skiff in the midst of a vast unfurrowed ocean is not more utterly alone.

*The System of the Stars* (2nd edition)

Chapter XXII (p. 301)

Adam &amp; Charles Black. London, England. 1905

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

The secret of our success on planet Earth is space. Lots of it. Our solar system is a tiny island of activity in an ocean of emptiness.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*

Chapter I (p. 4)

Basic Books, Inc. New York, New York, USA. 1994

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The solar system is not the typical product of development of a star; it is not even a common variety of development; it is a freak.

Man's Place in the Universe

*Harper's Magazine*, October, 1928 (p. 574)**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The solar system has no anxiety about its reputation...

*Ralph Waldo Emerson: Essays and Lectures**The Conduct of Life*

Worship (p. 1055)

The Library of America. New York, New York, USA. 1983

**Flammarion, Camille** 1842–1925

French astronomer and author

Like a shower of stars the worlds whirl, borne along by the winds of heaven, and are carried down through immensity, suns, earths, satellites, comets, shooting stars, humanities, cradles, graves, atoms of the infinite, seconds of eternity, perpetually transform beings and things.

*Popular Astronomy: A General Description of the Heavens*

American Book Company. New York, New York, USA. 1899

**George, Walter Lionel** 1882–1926

English author

The solar system is like a roulette gone mad, and the earth is the ball. It's been rolling for millions of years; what's going to happen if it stops? What hole will the ball plump into? Thirty-six – A pocketful of money for everybody – or zero? And the eternal banker sweeps up the stakes?

*Blind Alley*

Book III, Chapter XIII (p. 400)

Little, Brown &amp; Co. Boston, Massachusetts, USA. 1921

**Hardy, Thomas** 1840–1928

English poet and regional novelist

...we will get outside the solar system altogether, leave the whole group of sun, primary, and secondary planets quite behind us in our flight, as a bird might leave its bush and sweep into the whole forest.

*Two on a Tower*

Chapter IV (pp. 36–37)

Henry Holt &amp; Co. New York, New York, USA. 1882

**Hey, Nigel S.** 1936–

American science writer

Naturally their [men and women] writings deal with spaceflight, the solar system, and the Cosmos...reveal the profoundly human aspects of this great adventure, from the excitement of solving the problems of spacecraft that are millions of miles distant to the self-examination that occurs when considering whether we might someday send robots, and not people, as our ambassadors to distant star systems. Some of the nobility of the human condition, so often obscured, shines through their words.

*Solar System*

Introduction (p. 8)

Weidenfield &amp; Nicolson. London, England. 2002

Our explorations of the solar system are the first halting steps in a journey that will transform our kind into

a species that knowingly lives among the stars, in mind and possibly in body. Our destiny awaits in the planets and their moons, in this star system and in the galaxy beyond. Without exaggeration this journey is epochal in its significance to the human race.

*Why People Need Space*

Lecture, National Space Centre, October, 2002

**Horowitz, Norman H.** 1915–2005

American geneticist

If the exploration of the solar system in our time bring home to us a realization of the uniqueness of our small planet and thereby increase our resolve to avoid self-destruction, [it] will have contributed more than just science to the human future.

*To Utopia and Back: The Search For Life in the Solar System*

Chapter Eight (p. 146)

W.H. Freeman & Company. San Francisco, California, USA. 1986

**Jastrow, Robert** 1925–

American space scientist

Nearly five billion years ago, in one of the spiral arms of the Milky Way Galaxy, a cloud of gaseous matter formed by accident out of the swirling tendrils of the primal mist. The history of the solar system began in that softly glowing nebulosity, bathed in the black light of nearby stars. If the observer were prescient, he would see in the moving shadows of the cloud the faint outlines of the sun, the earth, and men walking on the earth.

*Until the Sun Dies*

Chapter 6 (p. 54)

W.W. Norton & Co. New York, New York, USA. 1977

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

Damn the solar system. Bad light; planets too distant; pestered with comets; feeble contrivance; could make a better one myself.

In John D. Barrow

*The Artful Universe* (p. 34)

Clarendon Press. Oxford, England. 1995

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

Nothing is more simple than the plan of the Solar System...

Translated by James Jacque

*The System of the World*

Part I, Chapter I (p. 1)

Printed for Vernor & Hood. London, England. 1800

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

If the solar system was brought about by an accidental collision, then the appearance of organic life on this planet was also an accident, and the whole evolution

of Man was an accident too. If so, then all our present thoughts are mere accidents – the accidental by-product of the movement of atoms. And this holds for the thoughts of the materialists and astronomers as well as for anyone else's. But if their thoughts – i.e., of Materialism and Astronomy – are merely accidental by-products, why should we believe them to be true? I see no reason for believing that one accident should be able to give me a correct account of all the other accidents. It's like expecting that the accidental shape taken by the splash when you upset a milk-jug should give you a correct account of how the jug was made and why it was upset.

*God in the Dock: Essays on Theology and Ethics*

Answers to Questions on Christianity (pp. 52–53)

Wm. B. Erdmans

Grand Rapids, Michigan, USA. 1994

**Lowell, Percival** 1855–1916

American astronomer

Now when we think that each of these stars is probably the center of a solar system grander than our own, we cannot seriously take ourselves to be the only minds in it all.

*Mars*

Chapter I (p. 5)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**MacLennan, Hugh** 1907–99

Canadian author and professor of English

We have just reached the outer fringes of the Solar System. Can any sane man possibly argue that we should stop there?

*Scotchman's Return and Other Essays*

Remembrance Day, 2010 A.D. (p. 89)

Charles Scribner's Sons. New York, New York, USA. 1960

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

We have mapped out our solar system with great precision. But how with that great universe of millions of stars in which our solar system is only a speck of star dust, a speck which a traveler through the wilds of space might pass a hundred times without notice? We have learned much about this universe, though our knowledge of it is still dim. We see it as a traveler on a mountain top sees a distant city in a cloud of mist, by a few specks of glimmering light from steeples or roofs.

*Aspects of American Astronomy*, Volume 6, Number 4, November, 1897 (pp. 293–294)

...our solar system is like a little colony, separated from the rest of the universe by an ocean of void space almost immeasurable in extent.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter I (p. 1)

Harper & Brothers Publishers. New York, New York, USA. 1906



**Patten, William** 1861–1932  
American biologist

A solar system...has attributes and powers that cannot be defined or measured in terms of its members, or of its ultimate chemical elements, for a solar system is not merely an aggregate, or the algebraic sum of its various elements and qualities.... It is a system, a new type of individuality, with special creative powers of its own.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*  
Chapter I (p. 34)  
Richard G. Badger. Boston, Massachusetts, USA. 1920

Out of the nebular pull and thrust, and meteoric collision came the germs of celestial spheres and a measure of celestial order. In the wide womb of the cosmic night commingling, nebular gametes the germ plasma of the sun and her family of planets engendered.

*The Grand Strategy of Evolution: The Social Philosophy of a Biologist*  
Chapter IV (p. 86)  
Richard G. Badger. Boston, Massachusetts, USA. 1920

**Peterson, Ivars**  
Mathematics and computer writer and editor

We can...be thankful that the solar system in which we live has been unreasonably kind throughout the long history of human efforts to understand its dynamics and to extend that knowledge to the rest of the universe. At each step along the way, it has served as a perspicacious teacher, posing questions just difficult enough to prompt new observations and calculations that have led to fresh insights, but not so difficult that any further study becomes mired in a morass of confusing detail.

*Newton's Clock: Chaos in the Solar System*  
Chapter 12 (p. 286)  
W.H. Freeman & Company. New York, New York, USA. 1993

**Pliny (C. Plinius Secundus)** 23–79  
Roman savant and author

Most men are not acquainted with a truth known to the founders of the science from their arduous study of the heavens, that what when they fall to earth are termed thunderbolts are the fires of the three upper planets, particularly those of Jupiter, which is in the middle position – possibly because it voids in this way the charge of excessive moisture from the upper circle (of Saturn) and of excessive heat from the circle below (of Mars); and that this is the origin of the myth that thunderbolts are the javelins hurled by Jupiter. Consequently heavenly fire is spit forth by the planet as crackling charcoal flies from a burning log, bringing prophecies with it. And this is accompanied by a very great disturbance of the air, because moisture collected causes an overflow or because it is disturbed by the birth-pangs so to speak of the planet in travail.

*Natural History* (Volume 1)  
Book II, sec 84  
Harvard University Press. Cambridge, Massachusetts, USA. 1947

**Rice, Harvey** 1800–91  
American lawyer and newspaper publisher

Vast as our solar system truly is, it may still be regarded as but a chandelier suspended in the entrance-hall of Nature's great temple.

*Nature and Culture*  
Chapter 1 (p. 38)  
Lee & Shepard. Boston, Massachusetts, USA. 1875

**Sagan, Carl** 1934–96  
American astronomer and author

The emerging picture of the early Solar System does not resemble a stately progression of events designed to form the Earth. Instead, it looks as if our planet was made, and survived, by mere lucky chance, amid unbelievable violence. Our world does not seem to have been sculpted by a master craftsman. Here, too, there is no hint of a Universe made for us.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 17 (p. 295)  
Random House, Inc. New York, New York, USA. 1994

**Somerville, Mary** 1780–1872  
English mathematician

Yonder starry sphere  
Of planets and of fix'd, in all her wheels,  
Resembles nearest mazes intricate,  
Eccentric, intervolved, yet regular,  
Then most, when most irregular they seem.

*The Connexion of the Physical Sciences* (9th edition)  
Section III (p. 23)  
John Murray. London, England. 1858

**Taylor, Bert Leston** 1866–1921  
American Poet

How nicely is our solar system spaced!  
How orderly the planet movements are!  
Aloof, sedate, self-centered, sober-paced,  
Each plods its way around the central star.  
Far out, far out upon the soundless sea  
The derelicts of Cosmos rush and roll –

*A Penny Whistle*  
In Status Quo (p. 25)  
Alfred A. Knopf. New York, New York, USA. 1921

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

Vast as is the Solar System, then, it is excessively minute in comparison with the Stellar System, the universe of the Stars, which is on a scale far transcending anything the human mind can apprehend.

*The Outline of Science: A Plain Story Simply Told*  
Introduction (p. 15)  
G.P. Putnam's Sons. New York, New York, USA. 1922



**Tsiolkovsky, Konstantin Eduardovich** 1857–1935  
Russian research scientist

Should man penetrate the solar system, should he learn to comport himself there as the mistress in her home – would the secrets of the world then open for him? Not in the least. Not anymore that inspecting a pebble or shell would reveal to him the secrets of the ocean.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneerson

Progress Publishers. Moscow, Russia. 1979

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Few people without a training in science can realise the huge isolation of the solar system. The sun with its specks of planets, its dust of planetoids, and its impalpable comets, swims in a vacant immensity that almost defeats the imagination.

*Tales of Space and Time*

The Star (p. 38)

Harper & Brothers Publishers. New York, New York, USA. 1900

## SOLID STATE

**Updike, John** 1932–  
American novelist, short story writer, and poet

Textbooks & Heaven only are Ideal;  
Solidity is an imperfect state,  
Within the cracked and dislocated Real  
Nonstoichiometric crystals dominate.  
Stray Atoms sully and precipitate;  
Strange holes, excitons, wander loose; because  
Of Dangling Bonds, a chemical Substrate  
Corrodes and Catalyzes – surface Flaws  
Help Expitazial Growth to fix absorptive claws.

*Midpoint and Other Poems*

The Dance of the Solids

Stanza 9

Fawcett Publications, Inc. Greenwich, Connecticut, USA. 1970

## SOLUBILITY

**Witt, Otto N.** 1853–1915  
German chemist

In the strictly scientific sense of the word insolubility does not exist, and even those substances characterized by the most obstinate resistance to the solvent action of water may properly be designated as extraordinarily difficult of solution, not as insoluble.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 13 (p. 177)

Longmans, Green & Company Ltd. London, England. 1967

## SOLUTION

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Every great and deep difficulty bears in itself its own solution. It forces us to change our thinking in order to find it.

In Brian VanDeMark

*Pandora's Keepers*

Chapter 1 (p. 29)

Little, Brown & Company. Boston, Massachusetts, USA. 2003

**Charlie Chan (Fictional character)**

Not always wise to accept simplest solution.

*Charlie Chan at the Circus*

Film (1936)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In science we sometimes have convictions as to the right solution of a problem which we cherish but cannot justify; we are influenced by some innate sense of the fitness of things.

*The Nature of the Physical World*

Chapter XV (p. 337)

The Macmillan Company. New York, New York, USA. 1930

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

I make bold to take the chalk in hand myself, to seize the rudder of our algebraical boat. I comment on the book, interpret it in my own fashion, expound the text, sound the reefs until daylight comes and leads us to the haven of the solution.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 299)

Dodd, Mead & Co. New York, New York, USA. 1925

**Forbes, Malcolm**

It's so much easier to suggest solutions when you don't know too much about the problem.

*Forbes* (p. 350)

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

Finally, two days ago, I succeeded, not on account of my painful efforts, but by the grace of God. Like a sudden flash of lightning, the riddle happened to be solved. I myself cannot say, what was the conducting thread, which connected what I previously knew, with what made my success possible.

*Musings of the Masters: An Anthology of Mathematical Reflections* (p. 89)  
Mathematical Association of America. Washington, D.C. 2004

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...the genuine solution of a difficult problem is neither more nor less than a glimpse of the wider context, a glimpse that helps us to clear away other difficulties as well, including many whose existence we do not even suspect.

*Physics and Beyond: Encounters and Conversations*

Chapter 8 (p. 102)

Harper & Row, Publishers. New York, New York, USA. 1971

**Hoffer, Eric** 1902–83

American longshoreman and philosopher

... every solution serves only to sharpen the problem, to show us more clearly what we are up against ...

*Reflections on the Human Condition* (p. 61)

Harper & Row. New York, New York, USA. 1973

**Kosko, Bart** 1960–

American electrical engineer

A solution has a way of bubbling up out of your subconscious if you brood about a problem long enough.

*Fuzzy Thinking*

Chapter 3 (p. 61)

Hyperion. New York, New York, USA. 1993

**Lowell, Percival** 1855–1916

American astronomer

To any real solution, the problem must be attacked analytically with all the rigor possible. Before entering upon such an investigation it is well to state the problem generally, showing the data upon which it rests and the limitations to which it is necessarily subject. For lack of appreciation of these points has led to mistaken ideas of what is or is not possible.

Memoir on A Trans-Neptune Planet

*Memoirs of the Lowell Observatory*, Volume 1, Number 1, 1915 (p. 4)

**MacCready, Paul** 1925–?

American aeronautical engineer

When you do dome up with a solution, you can always explain it logically, even though it's the absurd approach that gave you the solution.

In Kenneth A. Brown

*Inventors at Work*

Paul MacCready (p. 11)

Microsoft Press. Redmond, Washington, USA. 1988

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

...there is always a well-known solution to every human problem – neat, plausible, and wrong.

*Prejudices: Second Series*

The Divine Afflatus (p. 158)

Alfred A. Knopf. New York, New York, USA. 1922

**Robinson, Julia** 1919–85

American mathematician

I have been told that some people think that I was blind not to see the solution myself when I was so close to it. On the other hand, no one else saw it either. There are lots of things, just lying on the beach as it were, that we don't see until someone else picks one of them up. Then we all see that one.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 278)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Szilard, Leo** 1898–1964

Hungarian-born American nuclear physicist

Once a man has missed the solution to a problem when he passes by, it is less likely he will find it the next time.

In Editors of International Science and Technology

*The Way of the Scientist: Interviews from the World of Science and Technology*

Leo Szilard (p. 28)

Simon & Schuster. New York, New York, USA. 1966

**SOLUTIONS****Boyle, Robert** 1627–91

English natural philosopher and theological writer

But...there are other clusters wherein the particles stick not so close together, but that they may meet with corpuscles of another denomination, which are dispos'd to be more closely united with some of them, then[than] they were among themselves. And in such case, two thus combining corpuscles losing that shape, or size, or motion, or other accident, upon whose account they were endow'd with such a determinate quality or nature, each of them really ceases to be a corpuscle of the same denomination it was before, and from the coalition of these there may emerge a new body, as really one.

*The Sceptical Chymist*

The Second Part (p. 87)

Courier Dover Publications. Mineola, New York, USA. 2003

**SOUL****Pollock, Sir Frederick** 1845–1937

English jurist

A soul eager for new mastery and ever looking forward cares little to dwell upon the past ...

In William Kingdon Clifford

*Lectures and Essays*

Introduction (p. 6)

Macmillan & Co Ltd. London, England. 1901

**Russell, Sir Edward John** 1872–1965

British agriculturalist and writer

Those young people of today, who will be the leaders of thought and of action tomorrow, are faced with the

problem of enduring that, in gaining control over Nature, man does not lose his own soul.

*Science and Modern Life* (p. 101)

Philosophical Library. New York, New York, USA. 1955

## SOUND

**Beston, Henry** 1888–1968

American writer

The three great elemental sounds in nature are the sound of rain, the sound of wind in a primeval wood, and the sound of outer ocean on a beach.

*The Outermost House: A Year of Life on the Great Beach of Cape Cod*  
Chapter III (p. 43)

The Macmillan Co. New York, New York, USA. 2003

**Hooke, Robert** 1635–1703

English physicist

‘Tis not impossible to hear a whisper a furlong’s distance, it having been already done; and perhaps the nature of the thing would not make it more impossible, though that furlong should be ten times multiply’d...for that [air] that is not the only medium, I can assure the Reader, that I have, by the help of a distended wire, propagated the sound to a very considerable distance in an instant, or with as seemingly quick a motion as that of light, at least, incomparably swifter than that, which at the same time was propagated through the Air...

*Micrographia*

Preface

Printed for Jo. Martyn and Ja. Allestry. London, England. 1665

**Pepys, Samuel** 1633–1703

English naval administrator

Discoursed with Mr. Hooke about the nature of sounds, and he did make me understand the nature of musical sounds made by strings, mighty prettily; and told me that having come to a certain number of vibrations proper to make any tone, he is able to tell how many strokes a fly makes with her wings (those flies that hum in their flying) by the note that it answers to in music during their flying. That, I suppose, is a little too much refined; but his discourse in general of sound was mighty fine.

*Diary of Samuel Pepys*

August 8, 1666 (p. 407)

Macmillan & Company Ltd. London, England. 1905

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

The sensation of sound is a thing *sui generis*, not comparable with any of our other sensations. No one can express the relation between a sound and a colour or a smell.

*The Theory of Sound* (Volume 1)

Chapter I (p. 1)

Macmillan & Co Ltd. London, England. 1877

When once we have discovered the physical phenomena which constitute the foundation of sound, our explorations are in great measure transferred to another field lying within the domain of the principles of Mechanics.

*The Theory of Sound* (Volume 1)

Chapter I (p. 1)

Macmillan & Co Ltd. London, England. 1877

## SOUND FROM SPACE

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

“What is this sound so strong and so sweet that fills my ears?”

“This,” he replied, “is the melody which, at intervals unequal, yet differing in exact proportions, is made by the impulse and motion of the spheres themselves, which, softening shriller by deeper tones, produce a diversity of regular harmonies. Nor can such vast movements be urged on in silence; and by the order of nature the shriller notes sound from one extreme of the universe, the deeper from the other.”

*De Amicitia and Scipio’s Dream*

Scorpio’s Dream, 5 (p. 80)

Little, Brown, & Co. Boston, Massachusetts, USA. 1884

## SPACE

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Space...is big, really big...You may think it’s a long way down the street to the chemists’ but that’s just peanuts to space.

*The Ultimate Hitchhiker’s Guide to the Galaxy*

*The Hitchhiker’s Guide to the Galaxy*

Chapter 8 (p. 53)

The Ballantine Book Company. New York, New York, USA. 2002

**Alfven, Hannes** 1908–95

Swedish physicist

Having probes in space was like having a cataract removed.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 45)

Random House, Inc. New York, New York, USA. 1991

**Ampère, Jean-Jacques** 1800–64

French philologist

...on a sondé ces régions voilées;

Les bornes du possible ont été reculées !

Un mortel a pu voir; armé d’un oeil géant,

Osciller des lieux aux confins du néant.

Man has plumbed these veiled realms,

The boundaries of the possible have been extended.  
A mortal, armed with the eye of a giant,  
Has been enabled to see gleams of light oscillating on the  
confines of empty space.

*Littérature, Voyages & Poésies*  
Urania (pp. 51–52)  
Didier et Co. Paris, France. 1858

**Archimedes of Syracuse** 287 BCE–212 BCE  
Sicilian mathematician

Any solid lighter than a fluid will, if placed in the fluid,  
be so far immersed that the weight of the solid will be  
equal to the weight of the fluid displaced.

*The Works of Archimedes*  
Book I, Postulate I, Proposition 5 (p. 257)  
At The University Press. Cambridge, England. 1897

**Bailey, Philip James** 1816–1902  
English poet

Unimaginable space,  
As full of suns as is earth's sun of atoms.

*Festus: A Poem*  
Scene IV (p. 61)  
George Routledge & Sons, Ltd. London, England. 1893

**Barnes, Bishop**  
Bishop of San Bernardino

It is fairly certain that our space is finite though  
unbounded. Infinite space is simply a scandal to human  
thought.

In Joseph Silk  
*The Big Bang* (p. 81)  
W.H. Freeman & Company. San Francisco, California, USA. 1980

**Bergaust, Erik** 1925–95  
American writer and journalist

As far as man on Earth is concerned, space begins at the  
high border of the Earth's atmosphere and extends to  
infinity.

*Wernher von Braun*  
Are Flying Saucers Real? (p. 546)  
National Space Institute. Washington, D.C. 1976

**Bergson, Henri** 1859–1941  
French philosopher

For it is scarcely possible to give any other definition of  
space: space is what enables us to distinguish a number of  
identical and simultaneous sensations from one another;  
it is thus a principle of differentiation, and consequently  
it is a reality with no quality.

Translated by F.L. Pogson  
*Time and Free Will: An Essay on the Immediate Data of Consciousness*  
Chapter II (p. 95)  
George Allen & Unwin Ltd. London, England. 1950

**Bradbury, Ray** 1920–  
American writer

Man does not need escape so much as he needs release  
into a new spirit, a transcendent knowledge of himself  
that only Space can give him.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and  
Walter Sullivan  
*Mars and the Mind of Man*  
Foreword (p. XI)  
Harper & Row, Publishers. New York, New York, USA. 1973

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

A sea whose shores no eyes have ever seen, whose depth  
no instrument can fathom, whose waters no scientist  
can analyze – such is the sea of space. Nothing can be  
as empty and cold as the gulf wherein our destinies are  
immersed.

*Parade of the Living*  
Part I, Chapter I (p. 3)  
Coward-McCann, Inc. New York, New York, USA. 1930

Nothing can be as empty and cold as the gulf wherein our  
destinies are immersed.

*Parade of the Living*  
Chapter I (p. 3)  
Coward-McCann. New York, New York, USA. 1930

**Bruno, Giordano** 1548–1600  
Italian philosopher and pantheist

There are countless constellations, suns and planets;  
we see only the suns because they give light; the plan-  
ets remain invisible, for they are small and dark. There  
are also numberless earths circling around their suns, no  
worse and no less than this globe of ours.

*On the Infinite Universe and Worlds*  
Henry Schuman, Inc. New York, New York, USA. 1950

There is a single general space, a single vast immensity  
which we may freely call Void: in it are innumerable  
globes like this on which we live and grow; this space we  
declare to be infinite, since neither reason, convenience,  
sense-perception nor nature assign it a limit.

In Joseph Silk  
*The Big Bang* (p. 81)  
W.H. Freeman & Company. San Francisco, California, USA. 1980

### Captain Kirk (Fictional character)

Space, the final frontier...

Opening lines  
*Star Trek*  
Television series

**Chamberlin, Thomas Chrowder** 1843–1928  
American geologist

Space has commonly been pictured as an unbounded  
receptacle for all that is and all that takes place, and time,  
as the tally sheet of the on-sweep of an active world. Free  
room for the great deployments of the cosmos have been

thought to be offered by unlimited space and ample duration for their evolutions in unrestricted time.

In Charles Lane Poor

*Gravitation Versus Relativity: A Non-technical Explanation of the Fundamental Principles of Gravitational Astronomy and a Critical Examination of the Astronomical Evidence Cited as Proof of the Generalized Theory of Relativity*

A Preliminary Essay (p. viii)

Putnam's Sons. New York, New York, USA. 1922

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

Go out beneath the stars on a clear winter night, and look up at the Milky Way spanning the heavens like a bridge of glowing mist. Up there, ranged one beyond the other to the end of the Universe, suns without number burn in the loneliness of space. Down to the south hang the brilliant, unwinking lanterns of other worlds – the electric blue of Jupiter, the glowing ember of Mars. Across the zenith, a meteor leaves a trail of fading incandescence, and a tiny voyager of space has come to a flaming end.

In Neil McAleer

*Odyssey: The Authorized Biography of Arthur C. Clarke* (p. 34)

Victor Gollancz. London, England. 1993

The sea which beats against the coasts of Earth, which seems so endless and so eternal, is as the drop of water on the slide of a microscope compared with the shoreless sea of space.

*The Challenge of the Spaceship*

Across the Sea of Stars (p. 128)

Harper & Brothers. New York, New York, USA. 1959

In space there are no horizons; the questing eye reaches out forever, in all directions, and finds no fixed point at which to rest.

*The Challenge of the Spaceship*

Which Way Is Up? (p. 143)

Harper & Brothers. New York, New York, USA. 1959

### **Collins, Billy** 1941–

American poet

Here's to the wind blowing against this lighted house and to the vast, windless spaces between the stars.

*The Art of Drowning*

Chapter XXXIII, Cheers

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1995

### **Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

For those who think of space as emptiness, the assignment of an adjective, especially one as enigmatic as “curved”, might be regarded as cryptic.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

Curved Space (p. 78)

Pergamon Press. Oxford, England. 1977

### **de Quincey, Thomas** 1785–1859

English author

To man is as much reserved the prerogative of perceiving space in its higher extensions, as of geometrically constructing the relations of space.

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 177)

Adam & Charles Black. Edinburgh, Scotland. 1871

### **Deudney, Daniel**

American political scientist

Space is only 80 miles from every person on earth – far closer than most people are to their own national capitals...

*Space: The High Frontier in Perspective*

Introduction (p. 6)

Worldwatch Institute. Washington, D.C. 1982

### **Drew, Joseph**

No biographical data available

The most sober-thinking man, the most profound philosopher, is bewildered when he tries to grasp, even in thought, the immensity of space; and no writer, however logical his mind, has yet conveyed, by analogy or otherwise, any adequate or satisfactory idea of that infinity of distance through which those brilliant orbs perform their allotted course.

*Our Home in the Stars*

Our Home in the Stars (p. 22)

Elliot Stock. London, England. 1872

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

To put the conclusion rather crudely – space is not a lot of points close together; it is a lot of distances interlocked.

*The Mathematical Theory of Relativity*

Chapter I, Section 1 (p. 10)

At The University Press. Cambridge, England. 1930

When we have taken together the sun and all the naked-eye stars and many hundreds of millions of telescopic stars, we have not reached the end of things; we have explored with one island – and oasis in the desert of space. Other islands lie beyond.

*The Expanding Universe*

Chapter I (p. 3)

At The University Press. Cambridge, England. 1952

### **Empson, William** 1906–84

English literary critic and poet

Space is like earth, rounded, a padded cell;  
Plumb the stars' depth, your lead bumps you behind...

*The Complete Poems of William Empson*

The World's End (p. 13)

University Press of Florida. Gainesville, Florida, USA. 2001

### **Faraday, Michael** 1791–1867

English physicist and chemist

...I do not perceive in any part of space, whether (to use the common phrase) vacant or filled with matter, anything but forces and the lines in which they are exerted.

*Experimental Researches in Electricity* (Volume 3)  
Thoughts on Ray-Vibrations (p. 450)  
Bernard Quaritch. London, England. 1855

**Ferris, Timothy** 1944–  
American science writer

While walking with Heisenberg, the physicist Felix Bloch, who had just read Weyl's *Space, Time and Matter*, felt moved to declare that space is simply the field of linear equations. Heisenberg replied, "Nonsense. Space is blue and birds fly through it." "What he meant, Bloch writes", "was that it was dangerous for a physicist to describe Nature in terms of idealized abstractions too far removed from the evidence of actual observation."

*The Whole Shebang: A State-of-The Universe's Report*  
Notes, 3 (p. 320)  
Simon & Schuster. New York, New York, USA. 1996

**Frost, Robert** 1874–1963  
American poet

Space ails us moderns: we are sick with space.  
Its contemplation makes us out as small  
As a brief epidemic of microbes.

*Complete Poems of Robert Frost*  
The Lesson for Today  
Henry Holt & Company. New York, New York, USA. 1949

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

We must confess in all humility that, while number is a product of our mind alone, space has a reality beyond the mind whose rules we cannot completely prescribe.

In Charles W. Misner et al.  
*Gravitation*  
Part III, Chapter 8 (p. 195)  
W.H. Freeman & Company. San Francisco, California, USA. 1973

**Giberne, Agnes** 1845–1939  
English writer

...there is no getting to the borders of space. As one telescope after another is made, each one stronger in power and able to reach farther than the last, still more and more stars are seen, and yet more and more behind and beyond, in countless millions.

*Sun, Moon, and Stars*  
Chapter I (p. 5)  
Seeley & Co., Ltd. London, England. 1894

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

Space is not space between the earth and the sun to one who looks down from the windows of the Milky Way.

*Sand and Foam: A Book of Aphorisms* (p. 7)  
Alfred A. Knopf. New York, New York, USA. 1959

**Glenn, Jr., John** 1921–  
American astronaut and politician

In space one has the inescapable impression that here is a virgin area of the universe in which civilized man, for the first time, has the opportunity to learn and grow without the influence of ancient pressures. Like the mind of a child, it is yet untainted with acquired fears, hate, greed, or prejudice.

In Kevin W. Kelley  
*The Home Planet*  
With Plate 136  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1988

**Grissom, Virgil I.** 1926–67  
American astronaut

If we die, we want people to accept it. We are in a risky business, and we hope that if anything happens to us it will not delay the program. The conquest of space is worth the risk of life.

In John Andrews Barbour  
*Footprints on the Moon* (p. 125)  
Associated Press. New York, New York, USA. 1969

**Guillemin, Amédée** 1826–93  
French journalist and scientific writer

...in the contemplation of celestial phenomena, the idea of infinite duration impresses itself on the mind with the same irresistible power as the idea of the infinity of space.

*The Heavens: An Illustrated Handbook of Popular Astronomy* (2nd edition)  
The Heavens (p. 6)  
Richard Bentley. London, England. 1567

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Space is blue and birds fly through it.

In Harald Fritzsch  
Translated by Jean Steinberg  
*The Creation of Matter: The Universe from Beginning to End*  
Chapter 1 (pp. 12–13)  
Basic Books, Inc. New York, New York, USA. 1984

**Herschel, Friedrich Wilhelm**  
**(Sir William)** 1738–1822  
English astronomer

I have looked farther into space than ever human being did before me. I have observed stars of which the light, it can be proved, must take two millions of years to reach this earth!

In James P. Holcombe  
*Literature in Letters, Or, Manners, Art, Criticism, Biography, History, and, and Morals*  
Book Fifth, Chapter XXV (p. 445)  
D. Appleton & Co. New York, New York, USA. 1866

**Hey, Nigel S.** 1936–  
American science writer

People...regardless of their educational, religious, or economic background, are blessed with the ability to



look into the sky and marvel at the greatness of all that is out there. ...It transports us beyond ourselves and our artifacts. It is another way in which we are able to emerge from our self-centered psychological neighborhoods, to explore a multidimensional realm where self is of no particular significance. It is one path among many through which individual people may comprehend the close community of all life and all humanity, and, with the accession of humility, the rightness of compassion and peace.

*Solar System*

Introduction (pp. 7–8)

Weidenfield & Nicolson. London, England. 2002

### **Hubble, Edwin Powell** 1889–1953

American astronomer

The outstanding feature, however, is the possibility that the velocity-distance relation may represent the de Sitter effect, and hence that numerical data may be introduced into discussions of the general curvature of space.

A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae

*Proceedings of the National Academy of Science*, Volume 15, 1929 (p. 168)

### **Ivy, Andrew C.**

American physician

Through science we seek to awaken man to his philosophical significance in the setting of the universe. This activity of science has never been more dominant than it is today. For, whereas the men of yesterday were interested in extending their frontiers merely over the face of the earth, we are today extending our frontiers into outer space, thinking not of One World but of many. We are hoping to solve the mysteries of the void.

In John P. Marbarger

*Space Medicine*

Foreword (p. 9)

The University of Illinois Press. Urbana, Illinois, USA. 1951

### **Jammer, Max** 1915–

Israeli physicist and philosopher

Space is as different from position as time is different from motion.

*Concepts of Space: The History of Theories of Space in Physics*

Chapter 3 (p. 58)

Harvard University Press. Cambridge, Massachusetts, USA. 1969

...the problem of space will have to be classed as unfinished business.

*Concepts of Space: The History of Theories of Space in Physics*

Chapter 5 (p. 214)

Harvard University Press. Cambridge, Massachusetts, USA. 1969

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The immensity of space is paralleled by that of time.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspects of Cosmogony (p. 171)

Government Printing Office. Washington, D.C. 1929

...space, regarded as a receptacle for radiant energy, is a bottomless pit.

Supplement to "Nature"

*Nature*, Volume 122, Number 3079, November 3, 1928 (p. 698)

### **Kant, Immanuel** 1724–1804

German philosopher

Space is not a conception which has been derived from outward experiences. For, in order that certain sensations may relate to something without me (that is, to something which occupies a different part of space from that in which I am); in like manner, in order that I may represent them not merely as without, of, and near to each other, but also in separate places, the representation of space must already exist as a foundation. Consequently, the representation of space cannot be borrowed from the relations of external phenomena through experience; but, on the contrary, this external experience is itself only possible through the said antecedent representation.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

First Part, Of Space, Metaphysical Exposition of this Conception, 1  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Kennedy, John F.** 1917–63

26th president of the USA

Space offers no problems of sovereignty; by resolution of this Assembly, the members of the United Nations have foresworn any claim to territorial rights in outer space or on celestial bodies, and declared that international law and the United Nations Charter will apply.

Address before the 18th General Assembly of the United Nations

September 20, 1963

We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.

Address at Rice University

Houston, Texas

September 12, 1962

...the eyes of the world now look into space, to the moon and to the planets beyond, and we have vowed that we shall not see it governed by a hostile flag of conquest, but by a banner of freedom and peace.

Address at Rice University

Houston, Texas

September 12, 1962

The exploration of space will go ahead, whether we join in it or not, and it is one of the great adventures of all

time, and no nation which expects to be the leader of other nations can expect to stay behind in the race for space.

Address at Rice University  
Houston, Texas  
September 12, 1962

...this city of Houston, this State of Texas, this country of the USA was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward – and so will space.

Address at Rice University  
Houston, Texas  
September 12, 1962

### **Keyser, Cassius Jackson** 1862–1947

American mathematician

It will be sufficient to regard space as being what, to the layman and to the student of natural science, it has always seemed to be: a vast region or room roundabout us, an immense exteriority, locus of all suspended and floating objects of outer sense, the whence, where and whither of motion, theater, in a word, of the ageless drama of the physical universe.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Walls of the World (p. 84)  
Columbia University Press. New York, New York, USA. 1916

### **Kidger, Mark**

No biographical data available

No explorer, no nation, has ever become great by retreating in the face of difficulties. If we give up on space now, not only will we be turning our back on the future, but a great many lives will have been sacrificed in vain.

*Astronomical Enigmas*

Afterword (p. 271)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2005

### **Lardner, Dionysius** 1793–1859

British physicist and astronomer

That the infinitude of space should exist without a purpose, unoccupied by any works of creation, is plainly incompatible with all our notions of the character and attributes of the Author of the universe, whether derived from the voice of revelation or from the light of nature.

*Popular Lectures on Science and Art* (Volume 2)

The Stellar Universe (Second Lecture) (p. 381)

Greeley & McElrath. New York, New York, USA. 1846

### **Leonov, Aleksei** 1934–

Soviet cosmonaut

What struck me most was the silence. It was a great silence, unlike any I have encountered on Earth, so vast and deep that I began to hear my own body: my heart beating, my blood vessels pulsing, even the rustle of my muscles moving over each other seemed audible. There were more stars in the sky than I had expected.

The sky was deep black, yet at the same time bright with sunlight.

*The View from Out There: In Words and Pictures*  
*Life*, Volume 11, Number 13, November, 1988 (p. 197)

### **Lewis, Gilbert Newton** 1875–1946

American chemist

...when we analyze the highly refined concept of space used by mathematicians we find it to be quite similar to the concept of number.

*The Anatomy of Science*

Chapter II (p. 29)

Yale University Press. New Haven, Connecticut, USA. 1926

### **Locke, John** 1632–1704

English philosopher and political theorist

...to measure motion, space is as necessary to be considered as time....[They] are made use of to denote the position of finite: real beings, in respect one to another, in those infinite uniform oceans of duration and space.

*An Essay Concerning Human Understanding* (Volume 1)

Chapter XIV (pp. 116, 124, 250, 261)

At The Clarendon Press. Oxford, England. 1894

### **Lodge, Sir Oliver**

Those who study the stars have impressed upon them the existence of the most immeasurable distances, which yet are swallowed up as nothing in the infinitude of space.

*Pioneers of Science*

Chapter XVIII (p. 397)

Macmillan & Company Ltd. London, England. 1905

### **Macvey, John W.**

No biographical data available

The land lies sleeping under the enveloping mantle of night. Bright stars gleam like jewels from out the velvet darkness of the moonless sky. Beyond these points of celestial beauty, in depths frightening in their sheer immensity, lies realms powdered in stellar glory.

*Whispers from Space*

Chapter 1

Macmillan Publishing Company. New York, New York, USA. 1973

### **Maxwell, James Clerk** 1831–79

Scottish physicist

...the aim of the space-crumplers is to make its curvature uniform everywhere, that is over the whole of space whether that whole is more or less than  $\tilde{N}$ . The direction of the curvature is not related to one of the  $x y z$  more than another or to  $-x -y -z$  so that as far as I understand we are once more on a pathless sea, starless, windless and poleless...

*The Scientific Letters and Papers of James Clerk Maxwell: Volume 2, 1862–1873*

Postcard to Peter Guthrie Tait, 11 November, 1874 (p. 137)

Clarendon Press. Oxford, England. 1988

**Mitchel, Ormsby MacKnight** 1805–62

American astronomer

Beyond the limits of the earth, a multitude of objects present themselves for examination . . .

*The Orbs of Heaven*

Introductory (p. 6)

Office of the National Illustrated Library. London, England. 1851

Worlds and systems, and schemes and clusters and universes, rise in sublime perspective, fading away in the unfathomable regions of space, until even thought itself fails in its efforts to plunge across the gulf by which we are separated from these wonderful objects.

*The Planetary and Stellar Worlds*

Lecture VIII (p. 216)

T. Nelson &amp; Sons. London, England. 1859

**Morehouse, George Wilkinson** 1840–?

American naturalist

I raise my eyes and look outward into space. I see the wilderness of worlds. The one on which I stand seems of immense size. The innumerable multitude beyond fade in the distance.

*The Wilderness of Worlds*

Preface (p. 4)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Murray, Bruce** 1932–

American professor of planetary science and geology

Space . . . is a colorful thread intimately woven into the enormous tapestry of human existence and experience.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Bruce Murray (p. 47)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Absolute space, in its own nature, without relation to anything external, remains always similar and immovable.

*Mathematical Principles of Natural Philosophy*

Scholium, II

E.P. Dutton &amp; Company. New York, New York, USA. 1922

**Nichol, John Pringle** 1804–59

Scottish educator, astronomer, and economist

We have gazed awhile upon the gorgeous firmaments of space, and descried not a trace, not a hint, of anything like an end to their number, or a boundary to their un-repeated variety of form.

*The Stellar Universe*

Conclusion (p. 223)

John Johnstone. London, England. 1848

**Pearson, Karl** 1857–1936

English mathematician

The mystery of space, whether it be the finite space of perception or the infinite space of conception, lies in, and not outside, each human consciousness.

*The Grammar of Science* (2nd edition) (p. 159)

Adam &amp; Charles Black. 1900

**Poe, Edgar Allan** 1809–49

American short story writer

Our telescopes and our mathematical investigations assure us on every hand – notwithstanding the cant of the more ignorant of the priesthood – that space, and therefore that bulk, is an important consideration in the eyes of the Almighty.

*The Works of Edgar Allan Poe* Volume 2

The Island of the Fay (p. 102)

Charles Scribner's Sons. New York, New York, USA. 1914

**Pouchet, Félix Archimède** 1800–72

French biologist

Space being infinite, and our minds finite, they can only take in some small portions of it, and' yet, though these are very limited compared to the field of immensity, they are enough to confound the human comprehension.

*The Universe: Or, The Infinitely Great and the Infinitely Little*

Book I, Chapter I (p. 733)

Blackie &amp; Son. London, England. 1892

**Ockels, Wubbo** 1946–

Dutch astronaut and aerospace engineer

Space is so close: It took only eight minutes to get there and twenty to get back.

The View from Out There: In Words and Pictures

*Life*, Volume 11, Number 13, November, 1988 (p. 198)**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Space is only a word that we have believed a thing.

*The Foundations of Science*

Author's Preface to Translation (p. 5)

The Science Press. New York, New York, USA. 1913

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

It is utterly impossible for an edifice altogether of brick to look affected or absurd; it may look rude, it may look vulgar, it may look disgusting, in a wrong place; but it cannot look foolish, for it is incapable of pretension.

*The Poetry of Architecture: Cottage, Villa, Etc.*

The Villa (pp. 166–167)

John Wiley &amp; Sons. New York, New York, USA. 1877

**Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Tell me no more, I pray, of your suns and nebulous hazes; Think you Nature is vast only to set you a sum? Nothing

in infinite space is so august as your object, But there is nought august, friend, in indefinite space.

*The Poems of Schiller*

To the Astronomers (p. 312)

H. Holt & Co. New York, New York, USA. 1902

### Shaw, James Byrnie

American mathematician

Space is neither an external absolute whose laws we discover, nor is it a purely artificial game with which we amuse ourselves; it is the result of the living act of creation of the intellect.

*Lectures on the Philosophy of Mathematics* (p. 40)

The Open Court Publishing Co. Chicago, Illinois, USA. 1918

### Siegel, Eli 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Space won't keep still, and it won't budge either: so give up trying.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #396 (p. 153)

Definition Press. New York, New York, USA. 1972

### Smith, Logan Pearsall 1865–1946

American author

So gazing up on hot summer nights at the London stars, I cool my thoughts with a vision of the giddy, infinite, meaningless waste of Creation, the blazing Suns, the Planets and frozen Moons, all crashing blindly forever across the void of space.

*Trivia*

Book II, Mental Vice (p. 97)

Doubleday, Page & Company. Garden City, New York, USA. 1917

I think of Space, and the unimportance in its unmeasured vastness, of our toy solar system; I lose myself in speculations of the lapse of Time, reflecting how at the best our human life on this minute and perishing planet is as brief as a dream.

*Trivia*

Book II, Self-Analysis (pp. 121–122)

Doubleday, Page & Company. Garden City, New York, USA. 1917

### Somerville, Mary 1780–1872

English mathematician

...however profoundly we may penetrate the depths of space, there still remain innumerable systems, compared with which those which seem so mighty to us must dwindle into insignificance, or even become invisible; and that not only man, but the globe he inhabits, nay the whole system of which it forms so small a part, might be annihilated, and its extinction be unperceived in the immensity of creation.

*Mechanism of the Heavens*

Preliminary Dissertation (p. vii)

John Murray. London, England. 1831

### Sorensen, Ulrich

No biographical data available

Peaceful uses of Outer Space provide a powerful tool to bring about global cooperation and thus to further progress for the well-being of humanity, protecting our planet's environment and managing its resources. There is a Universe to explore and applications to be developed and utilised for the benefit of all mankind.

Statement to the United Nations, Fourth Committee, October 7, 2002

### Sylvester, James Joseph 1814–97

English mathematician

Space is the *Grand Continuum* from which, as from an inexhaustible reservoir, all the fertilizing ideas of modern analysis are derived; and as Brindley, the engineer, once allowed before a parliamentary committee that, in his opinion, rivers were made to feed navigable canals, I feel almost tempted to say that one principal reason for the existence of space, or at least one principal function which it discharges, is that of feeding mathematical invention.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association

Exeter British Association Report (1869) (p. 659)

University Press. Cambridge, England. 1904–1912

### Tennyson, Alfred (Lord) 1809–92

English poet

...The clear galaxy  
Shorn of its hoary lustre, wonderful,  
Distinct and vivid with sharp point of light,  
Blaze within blaze, an unimagined depth  
And harmony of planet-girded suns  
And moon – encircled planets, wheel in wheel,  
Arch'd the wan sapphire. Nay, the hum of men.  
Or other things talking in unknown tongues,  
And notes of busy life in distant worlds  
Beat like a far wave on my anxious ear.

*Alfred Tennyson's Poetical Works*

Timbuctoo, l. 105–113

Oxford University Press, Inc. London, England. 1953

### Mulder (Fictional character)

MULDER: Hey, Scully, we send those men up into space to unlock the doors of the universe, and we don't even know what's behind them.

*The X-Files*

Space

Television program

Season 1, 1993

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

There is grandeur in the spectacle of the star-strewn sky, so apparently crowded, but there are thousands of worlds

unseen for everyone our unaided eyes can image, and yet the astronomers tell us that the emptiness of space is its most striking characteristic.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 30)

William & Norgate. London, England. 1920

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935  
Russian research scientist

Man will not always stay on earth; the pursuit of light and space will lead him to penetrate the bounds of the atmosphere, timidly at first, but in the end to conquer the whole of solar space.

In Herbert Friedman

*The Amazing Universe*

Chapter I (p. 28)

National Geographic Society. Washington DC. 1980

**Tyndall, John** 1820–93  
Irish-born English physicist

We cannot think of space as finite, for wherever in imagination we erect a boundary we are compelled to think of space as existing beyond that boundary. Thus by the incessant dissolution of limits we arrive at a more or less adequate idea of the infinity of space.

*Fragments of Science for Unscientific People*

Chapter I (p. 9)

D. Appleton & Co. New York, New York, USA. 1875

**vas Dias, Robert**

Anglo-American poet and writer

The premise... is that outer space is as much a territory of the mind as it is a physical concept.

*Inside Outer Space: New Poems of the Space Age*

Introduction (p. xxxix)

Anchor Press. Garden City, New York, USA. 1970

**von Bitter Rucker, Rudy** 1946–

American mathematician and science fiction writer

What is the shape of space? Is it flat, or is it bent? Is it nicely laid out, or is it warped and shrunken? Is it finite, or is it infinite? Which of the following does space resemble more: (a) a sheet of paper, (b) an endless desert, (c) a soap bubble, (d) a doughnut, (e) an Escher drawing, (f) an ice cream cone, (g) the branches of a tree, or (h) a human body?

*The Fourth Dimension: Toward a Geometry of Higher Reality*

Chapter 7 (p. 91)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1984

**von Braun, Wernher** 1912–77

German-American rocket science

...the progress of mankind here on Earth is directly linked to the future that man builds for himself in space.

In Erik Bergaust

*Wernher von Braun*

A Horse Named Susie (p. 373)

National Space Institute. Washington, D.C. 1976

Oh, to be in space.... It's so quiet up there.

Reach for the Stars

*Time*, February 17, 1958

There is beauty in space, and it is orderly. There is no weather, and there is regularity. It is predictable.

Reach for the Stars

*Time*, February 17, 1958

...don't tell me that man doesn't belong out there. Man belongs wherever he wants to go – and he'll do plenty well when he gets there.

Reach for the Stars

*Time*, 17 February, 1958

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

In infinity of space as well as in eternity of time, all things are shrouded in an uncertain and frequently deceptive twilight.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 3)

Special Results of OBSERVATION IN THE DOMAIN OF COSMICAL PHENOMENA (p. 29)

Harper & Brothers Publishers. New York, New York, USA. 1851

**Weyl, Hermann** 1885–1955

German mathematician

Nowhere do mathematics, natural sciences, and philosophy permeate one another so intimately as in the problem of space.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter III (p. 67)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Wheeler, John Archibald** 1911–

American physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

Space tells matter how to move...and matter tells space how to curve.

In Charles W. Misner et al

*Gravitation*

Part I, Chapter 1 (p. 23)

W.H. Freeman & Company. San Francisco, California, USA. 1973

...in essence, the curvature in space created by the electromagnetic field is the electromagnetic field; and this curvature can in principle be detected by purely geometric measurements.

The Dynamics of Space-Time

*International Science and Technology*, December, 1963 (p. 72)

**Whewell, William** 1794–1866

English philosopher and historian

...space is not an object of which we perceive the properties, but a form of our perception; not a thing which affects our senses, but an idea to which we conform the impressions of sense.



*History of Scientific Ideas: Being the First Part of The Philosophy of the Inductive Sciences* (3rd edition)  
Part I, Book II, Chapter III (p. 96)  
John W. Parker & Son. London, England. 1858

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

All space measurement is from stuff in space to stuff in space.

*The Aims of Education and Other Essays*  
Chapter X (p. 233)  
The Macmillan Company. New York, New York, USA. 1959

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

Now while the great thoughts of space and eternity fill me I will measure myself by them. And now touch'd with the lives of other globes arrived as far long as those of the earth or waiting to arrive, or pass'd on farther than those of the earth, I henceforth no more ignore them than I ignore my own life.

*Complete Poetry and Collected Prose*  
Night on the Prairies  
The Library of America. New York, New York, USA. 1982

Every cubic inch of space is a miracle.  
*Complete Poetry and Collected Prose*  
Miracles  
The Library of America. New York, New York, USA. 1982

**Winchell, Alexander** 1824–91  
American geologist

In the midst of this universe of seething movements is our home. The mind, uplifted in the effort to contemplate them and grasp their method, grows giddy and impotent. How sublime these activities! To what a numerous and lofty companionship does our little planet belong! Hard it seems to be imprisoned here while the realm of the universe tempts us to its exploration. How can a human soul content itself to roll and whirl through space during its mortal days, and eat and sleep and trifle, like rats in a ship at sea, without wondering where we are and whither we are bound.

*World-Life or Comparative Geology*  
Part I, Chapter II, Section 4.7 (p. 142)  
S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**Zubrin, Robert** 1952–  
Engineer

Like the philosophy of Greece, the paintings of the Renaissance and the music of the Enlightenment, the explosion of knowledge about our solar system and the surrounding universe will be remembered for thousands of years as the defining brilliance of our age. To destroy [the space] program for the sake of bean counting, or perhaps as part of some obscure political maneuver, is not tolerable. It is not just a mistake, it is a crime – an

infamous crime against civilization that is comparable to the burning of the Library of Alexandria.

*Space News*, September 13, 1999

Americans are proud of our space exploration program, and rightly so. It is a statement that we continue to be a nation of explorers and pioneers. But more than that, it is a statement that we are a truly great nation, great not because of our military might...but because we do great things for all humanity and for all time. Killing our space exploration program amounts to nothing less than pulling some of the stars off our flag. This is a desecration we cannot allow.

*Space News*, September 13, 1999

## SPACE AGE

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Across the gulf of centuries, the blind smile of Homer is turned upon our age. Along the echoing corridors of time, the roar of the rockets merges now with the creak of the wind-taut rigging. For somewhere in the world today, still unconscious of his destiny walks the boy who will be the first Odysseus of the Age of Space...

*The Challenge of the Spaceship*  
Envoi (p. 213)  
Harper & Brothers. New York, New York, USA. 1959

## SPACE AND TIME

**Berlinski, David** 1942–  
American mathematician

Whatever the physicists may say, both space and time, it would seem. Go on and on: the imaginary eye pushed to the very edge of space and time finds nothing to stop it from pushing further, every conceivable limit a seductive invitation to examine the back side of the beyond.

*A Tour of the Calculus*  
Introduction (p. xii)  
Pantheon Books. New York, New York, USA. 1995

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

Mathematicians call this combination [space and time] a *quadratic form of the differentials of four variables*, but we may call it more briefly, with Minkowski, “the Universe.”

*Space and Time*  
Introduction (pp. 35–36)  
Dover Publications. New York, New York, USA. 1960

**Carlyle, Thomas** 1795–1881  
English historian and essayist

But deepest of all illusory Appearances, for hiding Wonder, as for many other ends, are your two grand



fundamental world-enveloping Appearances, SPACE and TIME.

*Sartor Resartus*

Book III, Chapter VIII (p. 236)

Ginn & Co. Boston, Massachusetts, USA. 1896

## SPACE EXPLORATION

**Armstrong, Neil A.** 1930–

American astronaut

The *Eagle* has landed.

*The Washington Post*, July 21, 1969 (p. 1)

**Arnold, James R.**

No biographical data available

Space is the empty place next to the full place where we live. I believe we will be true to our nature and go there. The Frontier in Space. Will One Be True to Our Nature and Accept the Challenge of the Next Frontier?

*American Scientist*, Volume 68, Number 3, May–June, 1980 (p. 304)

**Asimov, Isaac** 1920–92

American author and biochemist

Throughout the history of humanity, we have been extending our range until it is now planet-wide, covering all parts of the Earth's surface and reaching to the bottom of the ocean, to the top of the atmosphere, and beyond it to the Moon. We will flourish only as long as we continue to extend that range, and although the potential range is not infinite, it is incredibly vast even by present standards. We will eventually extend our range to cover the whole of the solar system, and then we will head outward to the stars.

In James Burke, Jules Bergman and Isaac Asimov

*The Impact of Science on Society*

Our Future in the Cosmos – Space (p. 79)

National Aeronautics and Space Administration. Washington, D.C. 1985

Unless we are willing to settle down into a world that is our prison, we must be ready to move beyond Earth....

In James Burke, Jules Bergman and Isaac Asimov

*The Impact of Science on Society*

Our Future in the Cosmos – Space (p. 80)

National Aeronautics and Space Administration. Washington, D.C. 1985

**Bernal, John Desmond** 1901–71

Irish-born physicist and X-ray crystallographer

On earth, even if we should use all the solar energy which we receive, we should still be wasting all but one two-billionths of the energy the sun gives out. Consequently, when we have learnt to live on this solar energy and also to emancipate ourselves from the earth's surface, the possibilities of the spread of humanity will be multiplied accordingly.... There will, from desire or necessity, come the idea of building a permanent home for men in space.... At first space navigators, and then scientists

whose observations would be best conducted outside the earth, and then finally those who for any reason were dissatisfied with earthly conditions would come to inhabit these bases and found permanent spatial colonies.

*The World, the Flesh and the Devil: An Enquiry Into the Future of the Three Enemies of the Rational Soul*

Chapter II (pp. 11–12)

Indiana University Press. Bloomington, Indiana, USA. 1969

**Blagonravov, Anatoly A.** 1894–1975

Russian scientist

The exploration of the cosmos – the moon and the planets – is a noble aim. Our generation has the right to be proud of the fact that it has opened the space era of mankind.

In Mose L. Harvey

The Lunar Landing and the US–Soviet Equation

*Bulletin of the Atomic Scientists*, Volume 25, Number 7, September, 1969 (p. 29)

**Bradbury, Ray** 1920–

American writer

Get along to Mars and beyond.

The journey is long, the end uncertain, and there is more dark along the way than light, but you can whistle. Come with me by the wall of the great tombyards of all time which lie a billion years ahead. What shall we whistle as we stroll in our rocket, hoping to make it by the vast darkness where shadows wait to seize and keep us?

Follow me.

I know a tune.

Here...listen.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 143)

Harper & Row, Publishers. New York, New York, USA. 1973

...I would not see our candle blown out in the wind. It is a small thing, this dear gift of life handed us mysteriously out of immensity. I would not have that gift expire. ... What's the use of looking at Mars through a telescope, sitting on panels, writing books, if it isn't to guarantee, not just the survival of mankind, but mankind surviving forever!"

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 133)

Harper & Row, Publishers. New York, New York, USA. 1973

**Clarke, Arthur C.** 1917–

English science and science fiction writer

There are still some scientists who consider that there is no point in sending men into space, even when it becomes technically possible; machines, they argue, can do all that is necessary. Such an outlook is incredibly shortsighted;

worse than that, it is stupid, for it completely ignores human nature.

Lecture

St Martin's Technical School on Charing Cross Road, October 5, 1946

Though the specific ideals of astronautics are new, the motives and impulses underlying them are old as the race – and in the ultimate analysis, they owe as much to emotion as to reason. Even if we could learn nothing in space that our instruments would not already tell us, we should go there just the same.

Lecture

St Martin's Technical School on Charing Cross Road, October 5, 1946

To find anything comparable with our forthcoming ventures into space, we must go back far beyond Columbus, far beyond Odysseus – far, indeed, beyond the first apeman. We must contemplate the moment, now irrevocably lost in the mists of time, when the ancestor of all of us came crawling out of the sea.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 8 (p. 94)

Harper & Row, Publishers. New York, New York, USA. 1973

This [the sea] is where life began, and where most of this planet's life remains to this day, trapped in a meaningless cycle of birth and death. Only the creatures who dared the hostile, alien land were able to develop intelligence; now that intelligence is about to face a still greater challenge. It may even be that this beautiful Earth of ours is no more than a brief resting-place between the sea of salt where we were born, and the sea of stars on which we must now venture forth.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 8 (p. 94)

Harper & Row, Publishers. New York, New York, USA. 1973

Even if we never reach the stars by our own efforts, in the millions of years that lie ahead it is almost certain that the stars will come to us. Isolationism is neither a practical policy on the national or the cosmic scale. And when the first contact with the outer universe is made, one would like to think that Mankind played an active and not merely a passive role – that we were the discoverers, not the discovered.

*The Exploration of Space*

Chapter 17 (p. 182)

Harper & Brothers. New York, New York, USA. 1951

With the landing of the first spaceship on Mars and Venus, the Childhood of our race was over and history as we know it began...

*The Exploration of Space*

Chapter 18 (p. 195)

Harper & Brothers. New York, New York, USA. 1951

The challenge of the great spaces between the worlds is a stupendous one; but if we fail to meet it, the story of our race is drawing to a close. Humanity will have

turned its back upon the still untrodden heights and will be descending again the long slope that stretches, across a thousand million years of time, down to the shores of the primeval sea.

*Interplanetary Flight: An Introduction to Astronautics*

Chapter 10 (p. 127)

Harper & Row, Publishers. New York, New York, USA. 1960

Long before the Sun's radiation has shown any measurable increase, Man will have explored all the Solar System and, like a cautious bather testing the temperature of the sea, will be making breathless little forays into the abyss that separates him from the stars.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 4)

Harper & Brothers. New York, New York, USA. 1959

Interplanetary travel is now the only form of "conquest and empire" compatible with civilization. Without it, the human mind, compelled to circle forever in its planetary goldfish bowl, must eventually stagnate.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 7)

Harper & Brothers. New York, New York, USA. 1959

...there is no way back into the past; the choice, as Wells once said, is the universe – or nothing. Though men and civilizations may yearn for rest, for the dream of the lotus-eaters, that is a desire that merges imperceptibly into death. The challenge of the great spaces between the worlds is a stupendous one; but if we fail to meet it, the story of our race will be drawing to its close.

*Interplanetary Flight: An Introduction to Astronautics*

Chapter 10 (p. 127)

Harper & Row, Publishers. New York, New York, USA. 1960

...who can guess what strange roads there may yet be on which we may travel to the stars?

*The Promise of Space*

To the Stars (p. 299)

Harper & Row, Publishers. New York, New York, USA. 1968

### **Commoner, Barry** 1917–

American biologist, ecologist, and educator

Explorations of space, like the earlier explorations, are great adventures because they are bold, and they are bold because they are hazardous.

*Science and Survival*

Chapter 4 (p. 56)

The Viking Press. New York, New York, USA. 1966

### **Cousins, Norman** 1912–90

American editor and author

The justification for exploring the cosmos rests not on tangible benefits, but on philosophical grounds and on our instinctive need to evolve.

*Rendezvous with Infinity*

*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979 (p. 30)

**Deudney, Daniel**

American political scientist

...for all our looking and probing of the universe, we have yet to find any place as habitable as the remotest, most forbidding parts of this planet. Space exploration has taught us just how rare and precious the earth is.

*Space: The High Frontier in Perspective*  
Toward an Earth-Oriented Space Program (p. 51)  
Worldwatch Institute. 1982

**Dyson, Freeman J.** 1923–

American physicist and educator

When we are a million species spreading through the galaxy, the question “Can man play God and still stay sane?” will lose some of its terrors. We shall be playing God, but only as local deities and not as lords of the universe. There is safety in numbers. Some of us will become insane, and rule over empires as crazy as Doctor Moreau’s island. Some of us will shit on the morning star. There will be conflicts and tragedies. But in the long run, the sane will adapt and survive better than the insane.

*Disturbing the Universe*  
Chapter 21 (pp. 236–237)  
Basic Books, Inc. New York, New York, USA. 1979

Nature’s pruning of the unfit will limit the spread of insanity among species in the galaxy, as it does among individuals on earth. Sanity is, in its essence, nothing more than the ability to live in harmony with nature’s laws.

*Disturbing the Universe*  
Chapter 21 (pp. 236–237)  
Basic Books, Inc. New York, New York, USA. 1979

**Ferris, Timothy** 1944–

American science writer

We who came down from out of the forest seek to grow a forest of knowing among the stars.

*The Mind’s Sky: Human Intelligence in a Cosmic Context*  
It (p. 222)  
Bantam Books. New York, New York, USA. 1992

We don’t know whether human music will mean anything to nonhuman intelligences on other planets. But any creature that comes across Voyager and recognizes the record as an artifact can realize that it was dispatched with no hope of return. That gesture may speak more clearly than music. It says: However primitive we seem, however crude this spacecraft, we knew enough to envision ourselves citizens of the cosmos. ...However small we were, something in us was large enough to want to reach out to discoverers unknown, in times when we shall have perished or changed beyond recognition. ...Whoever and whatever you are, we too once lived in this house of stars, and we thought of you.

*Murmurs of Earth: The Voyager Interstellar Record*  
Voyager’s Music  
Random House, Inc. New York, New York, USA. 1978

**Firsoff, Valdemar Axel** 1910–82

English astronomer and author

Yet if we go into space, let us do so humbly, in the spirit of cosmic piety. We know very little. We are face to face with the great unknown and have no right to assume that we are alone in the Solar System.

*Exploring the Planets*  
Chapter XV (p. 160)  
Sidgwick & Jackson. London, England. 1964

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

Man as a physical being is but a microscopic part of the universe, yet his mind carries him ever upward, and with spirit bold and unconquerable he seeks to reach the summit of Mount Olympus. Infinite space remains to humble his pride in spite of the knowledge he has obtained of the starry heavens; yet he pursues his inquiries into the unknown, and his children’s children will continue to search.

*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 21)  
Macmillan & Company Ltd. London, England. 1918

**Hale, George Ellery** 1868–1938

American astronomer

Like buried treasures, the outposts of the universe have beckoned to the adventurous from immemorial times. Princes and potentates, political or industrial, equally with men of science, have felt the lure of the uncharted seas of space, and through their provision of instrumental means the sphere of exploration has rapidly widened...

Possibilities of Large Telescopes  
*Harper’s Magazine*, April, 1928 (p. 639)

**Hawking, Stephen William** 1942–

English theoretical physicist

I don’t think the human race will survive the next thousand years, unless we spread into space. There are too many accidents that can befall life on a single planet. But I’m an optimist. We will reach out to the stars.

By Roger Highfield, Science Editor  
Colonies in space may be only hope, says Hawking  
*Telegraph*, Filed: 16/10/2001

**Heinlein, Robert A.** 1907–88

American science fiction writer

But space travel can’t ease the pressure on a planet grown too crowded not even with today’s ships and probably not with any future ships – because stupid people won’t leave the slopes of their home volcano even when it starts to smoke and rumble. What space travel does do is drain off the best brains: those smart enough to see a catastrophe before it happens and with the guts to pay the price – abandon home, wealth,

friends, relatives, everything – and go. That’s a tiny fraction of one percent. But that’s enough.

*Time Enough for Love*

Chapter XIV (p. 413)

G.P. Putnam’s Sons. New York, New York, USA. 1973

**Heppenheimer, T. A.** 1947–

Aviation writer

...if humanity persists and endures, in time we will come face to face with the evolution of our sun. In a few billion years its slow brightening will speed up as it swells into a red giant. Earth will then be uninhabitable, as will the inner regions of the Solar System. Yet there will be other more clement stars to which our descendents may wish to migrate. Certainly a society that has developed space flight and space colonization will have the advantage of never thereafter having to stand hostage to fortune.

*Toward Distant Suns*

Chapter 13 (p. 244)

Stackpole Books. Harrisburg, Pennsylvania, USA. 1979

**Hey, Nigel S.** 1936–

American science writer

Space scientists and engineers serve the intangible needs of humankind, and share common ground with the poet. It is self-deceptive to suppose that society is wholly bound up in supplying life-or-death needs. Humans are thinkers, explorers, wonderers, and dreamers. If we were not, we would not need space exploration; but then we would also lead a listless and uncreative existence.

*How We Will Explore the Outer Planets* (p. 142)

G.P. Putnam’s Sons. New York, New York, USA. 1973

Most of our knowledge of this marvel-filled universe is due to astronomy, telescopes and to robotic spaceflight. It is impossible to think of anything that more exquisitely embodies the technical genius of humankind, in so small a package, as the interplanetary spacecraft.

*Solar System*

Chapter 3 (p. 61)

Weidenfield & Nicolson. London, England. 2002

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Space isn’t remote at all. It’s only an hour’s drive away if your car could go straight upwards.

*Observer*, September 9, 1979

The seemingly insuperable difficulties of deep-space travel suggest an intention to keep us fixed at home in our own solar system, and the physical nature of our part of the Universe, as well as the basic rules of physics and chemistry, have a warning look about them, like barriers designed to isolate intelligent life. This means that for us, unlike the situation for humble microorganisms, deep-space travel is probably a stark impossibility.

*The Intelligent Universe*

Chapter 6 (p. 156)

Holt, Rinehart & Winston. New York, New York, USA. 1983

**Hubble, Edwin Powell** 1889–1953

American astronomer

Thus the explorations of space end on a note of uncertainty. And necessarily so. We are, by definition, in the very center of the observable region. We know our immediate neighborhood rather intimately. With increasing distance, our knowledge fades, and fades rapidly. Eventually, we reach the dim boundary – the utmost limits of our telescopes. There, we measure shadows, and we search among ghostly errors of measurement for landmarks that are scarcely more substantial.

The search will continue. Not until the empirical resources are exhausted, need we pass on to the dreamy realms of speculation.

*The Realm of the Nebulae*

Chapter VIII (p. 202)

Dover Publications, Inc. New York, New York, USA. 1958

The exploration of space has swept outward in successive waves, first, through the system of the planets, then, through the stellar system, and finally, into the realm of the nebulae. Today we study a region of space so vast and so homogeneous that it may well be a fair sample of the universe. At any rate, we are justified in adopting the assumption as a working hypothesis and attempting to infer the nature of the universe from the observed characteristics of the sample.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1942*

The Problem of the Expanding Universe (p. 119)

Government Printing Office. Washington, D.C. 1943

**Johnson, Lyndon B.** 1908–73

36th president of the USA

No national sovereignty rules in outer space. Those who venture there go as envoys of the entire human race. Their quest, therefore, must be for all mankind, and what they find should belong to all mankind.

News Conference

Johnson City, Texas, 29 August, 1965

**Kennedy, John F.** 1917–63

35th president of the USA

We choose to go to the Moon in this decade and do the other things, not because they are easy – but because they are hard!

Speech, Rice University, 12 September, 1962

I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth. No single space project in this period will be more impressive to

mankind, or more important in the long-range exploration of space; and none will be so difficult or expensive to accomplish.

Announcement to American Congress  
25 May, 1961

**Kepler, Johannes** 1571–1630  
German astronomer

Provide ship or sails adapted to the heavenly breezes, and there will be some who will not fear even that void.... So, for those who will come shortly to attempt this journey, let us establish the astronomy: Galileo, you of Jupiter, I of the moon.

In John Lear  
*Kepler's Dream*

Introduction and Interpretation, I (p. 3)  
University of California Press. Berkeley, California, USA. 1965

**Lewis, John S.**  
American professor of planetary science

It is in the interests of all the residents of Earth to see exploration continue and to see our realm of competence expand to fill the Solar System. Like our ancient ancestors at the time of their emergence from the sea onto the land, we are challenged by events to master this great new environment, to drink of its knowledge, and to feast on its boundless resources. Let us not squander this golden opportunity.

In John S. Lewis  
*Physics and Chemistry of the Solar System*  
Chapter XII (p. 517)

Academic Press. San Diego, California, USA. 1995

**Lowell, Percival** 1855–1916  
American astronomer

From time immemorial travel and discovery have called with strange insistence to him who, wandering on the world, felt adventure in his veins. The leaving familiar sights and faces to push forth into the unknown has with magnetic force drawn the bold to great endeavor and fired the thought of those who stayed at home.

*Mars and Its Canals*  
Chapter I (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

...he passed far beyond the flaming walls of the world and traversed throughout in mind and spirit the immeasurable universe...

In *Great Books of the Western World* (Volume 12)  
*The Nature of the Universe*

Book I, 62 (p. 2)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Makarov, Oleg** 1933–2003  
Soviet cosmonaut

You keep returning to the thought that only very thin walls separate you from the deathly cold and incomprehensible emptiness of space, which can extinguish life instantly and piteously.

The View from Out There: In Words and Pictures  
*Life*, Volume 11, Number 13, November, 1988 (p. 198)

**Martin, Charles-Noël** 1923–  
French nuclear physicist

As men travel further and further into space they are bound to meet sights beyond their wildest expectations.

Translated by A.J. Pomerans  
*The Role of Perception in Science*  
Chapter 4 (p. 92)

Hutchinson of London. London, England. 1963

**Moulton, Forest Ray** 1872–1952  
American astronomer

...there is not the slightest possibility of [travel to other worlds]. There is not in sight any source of energy that would...be necessary to get us beyond the gravitative control of the earth; there is not theory that would guide us through interplanetary space to another world even if we could control our departure from the earth; there is no means of carrying the large amount of oxygen, water, and food that would be necessary for such a long journey; and there is no known way of easing our ether ship down onto the surface of another world, if we could get there at low enough speed to avoid destruction.

*Consider the Heavens*

Chapter VII  
Chapter II (p. 107)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1935

**Nixon, Richard M.** 1913–94  
37th president of the USA

We must see our space effort, then, not only as an adventure of today but also as an investment in tomorrow. We did not go to the Moon merely for the sport of it. To be sure, those undertakings have provided an exciting adventure for all mankind and we are proud that it was our nation that met this challenge. But the most important thing about man's first footsteps on the Moon is what they promise for the future.

Statement by President Nixon on the Space Program  
Released from the Office of the White House  
Press Secretary, Key Biscayne, Florida, 7 March, 1970

From time immemorial, man has insisted on venturing into the unknown despite his inability to predict precisely the value of any given exploration. He has been willing to take risks, willing to be surprised, willing to adapt to new experiences. Man has come to feel that such quests are worthwhile in and of themselves – for they represent one way in which he expands his vision and expresses the human spirit. A great nation must always be an exploring nation if it wishes to remain great.



Statement by President Nixon on the Space Program  
Released from the Office of the White House  
Press Secretary, Key Biscayne, Florida, 7 March, 1970

As we enter a new decade, we are conscious of the fact that man is also entering a new historic era. For the first time, he has reached beyond his planet; for the rest of time, we will think of ourselves as men from the planet Earth. It is my hope that as we go forward with our space program, we can plan and work in a way which makes us proud both of the planet from which we come and of our ability to travel beyond it.

Statement by President Nixon on the Space Program  
Released from the Office of the White House  
Press Secretary, Key Biscayne, Florida, 7 March, 1970

**Oberth, Hermann** 1894–1989  
German mathematician and physicist

This is the goal:

To make available for life every place where life is possible.

To make inhabitable all worlds as yet uninhabitable, and all life purposeful.

Translated by G.P.H. de Freville  
*Man into Space: New Projects for Rocket and Space Travel*  
Chapter VIII (p. 167)  
Harper & Brothers. New York, New York, USA. 1957

**O'Neill, Gerard K.** 1927–92  
American physicist

Clearly our first task is to use the material wealth of space to solve the urgent problems we now face on Earth: to bring the poverty-stricken segments of the world up to a decent living standard, without recourse to war or punitive action against those already in material comfort; to provide for a maturing civilization the basic energy vital to its survival.

*The High Frontier*  
Bantam Dell Doubleday Publishing Group. New York, New York, USA. 1978

**Purcell, Edward** 1912–97  
American physicist

All this stuff about traveling around the universe... belongs back where it came from, on the cereal box.

In A.G.W. Cameron (ed.)  
*Interstellar Communication; A Collection of Reprints and Original Contributions*  
Radio Astronomy and Communication Through Space (p. 143)  
W.A. Benjamin, Inc. New York, New York, USA. 1963

**Reade, Winwood** 1838–75  
English philosopher and historian

A time will come when science will transform [our bodies] by means which we cannot conjecture.... And then, the earth being small, mankind will migrate into space, and will cross the airless Saharas which separate

planet from planet, and sun from sun. The earth will become a Holy Land which will be visited by pilgrims from all quarters of the universe.

*The Martyrdom of Man*  
Chapter IV (pp. 459, 460)  
E.P. Dutton & Company. New York, New York, 1926

**Roddenberry, Gene** 1921–91  
American television producer and writer

Let me end with an explanation of why I believe the move into space to be a human imperative. It seems to me obvious in too many ways to need listing that we cannot much longer depend upon our planet's relatively fragile ecosystem to handle the realities of the human tomorrow. Unless we turn human growth and energy toward the challenges and promises of space, our only other choice may be the awful risk, currently demonstrable, of stumbling into a cycle of fratricide and regression which could end all chances of our evolving further or of even surviving.

Hailing Frequencies Open!  
*Planetary Report*, Volume 1, April/May, 1981 (p. 3)

**Russen, David**  
No biographical data available

Since Springiness is a cause of forcible motion; and a Spring will, when bended and let loose, extend its self to its length; could a Spring of well-tempered steel be framed, whose basis being fastened to the Earth, and on the other end placed a Frame or Seat, wherein a Man with other necessaries could abide in safety, this Spring being with Cords, Pullies, or other Engines bent, and then let loose by degrees by those who manage the Pullies, the other end...reach the Moon, where the Person who ascended landing, the Spring might again be bent, till the end touching the earth, should discharge the passenger again in safety.

In Noel Deisch  
The Navigation of Space in Early Speculation and in Modern Research  
*Popular Astronomy*, Volume 38, Number 2, February, 1930 (p. 81)

**Sagan, Carl** 1934–96  
American astronomer and author

Since, in the long run, every planetary civilization will be endangered by impacts from space, every surviving civilization is obliged to become spacefaring – not because of exploratory or romantic zeal, but for the most practical reason imaginable: staying alive.... If our long-term survival is at stake, we have a basic responsibility to our species to venture to other worlds.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 21 (p. 371)  
Random House, Inc. New York, New York, USA. 1994

Centuries hence, when current social and political problems may seem as remote as the problems of the Thirty



Years' War are to us, our age may be remembered chiefly for one fact: It was the time when the inhabitants of the earth first made contact with the vast cosmos in which their small planet is embedded.

The Solar System

*Scientific American*, Volume 233, Number 3, 1975 (p. 30)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...perchance, coming generations will not abide the dissolution of the globe, but, availing themselves of future inventions in aerial locomotion, and the navigation of space, the entire race may migrate from the earth, to settle some vacant and more western planet.... It took but little art, a simple application of natural laws, a canoe, a paddle, and a sail of matting, to people the isles of the Pacific, and a little more will people the shining isles of space. Do we not see in the firmament the lights carried along the shore by night, as Columbus did? Let us not despair or mutiny.

*The Maine Woods*

Paradise (to Be) Regained (p. 58)

Houghton Mifflin Company. New York, New York, USA. 1893

**Tipler, Frank J.** 1947–

American physicist

If the human species, or indeed any part of the biosphere, is to continue to survive, it must eventually leave the Earth and colonize space. For the simple fact of the matter is, the planet Earth is doomed.... Let us follow many environmentalists and regard the Earth as Gaia, the mother of all life (which indeed she is). Gaia, like all mothers, is not immortal. She is going to die. But her line of descent might be immortal...Gaia's children might never die out – provided they move into space. The Earth should be regarded as the womb of life – but one cannot remain in the womb forever.

*The Physics of Immortality: Modern Cosmology, God and the Resurrection of the Dead*

Chapter II (pp. 18–19)

Doubleday & Company, Inc. New York, New York, USA. 1994

**van der Riet Wooley, Sir Richard** 1906–1986

British Astronomer Royal

...the whole procedure [of shooting rockets into space]... presents difficulties of so fundamental a nature, that we are forced to dismiss the notion as essentially impracticable, in spite of the author's insistent appeal to put aside prejudice and to recollect the supposed impossibility of heavier-than-air flight before it was actually accomplished.

Rockets in Space

*Nature*, Supplement, March 14, 1936 (p. 442)

It's utter bilge. I don't think anybody will ever put up enough money to do such a thing...What good would it do us? If we spend the same amount of money on prepar-

ing first-class astronomical equipment we would learn much more about the universe...It is all rather rot.

Utter Bilge

*Time*, January 16, 1956 (p. 42)

**Verne, Jules** 1828–1905

French novelist

In spite of the opinions of certain narrow-minded people, who would shut up the human race upon this globe, as within some magic circle which it must never outstep, we shall one day travel to the moon, the planets, and the stars, with the same facility, rapidity, and certainty as we now make the voyage from Liverpool to New York.

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter XIX (p. 97)

A.L. Burt Company. New York, New York, USA. 1890

...I repeat that the distance between the earth and her satellite is a mere trifle, and undeserving of serious consideration. I am convinced that before twenty years are over one-half of our earth will have paid a visit to the moon.

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter XIX (p. 99)

A.L. Burt Company. New York, New York, USA. 1890

**von Braun, Wernher** 1912–77

German-American rocket scientist

[Space travel] will free man from his remaining chains, the chains of gravity which still tie him to this planet. It will open to him the gates of heaven.

The Jupiter People

*Time*, February 10, 1958 (p. 18)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

All this world is heavy with the promise of greater things, and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool and laugh and reach out their hands amidst the stars.

The Discovery of the Future

*Nature*, Volume 65, Number 1684, February 6, 1902 (pp. 326–331)

**Whipple, Fred L.** 1906–2004

American comet research pioneer

In conquering space, man will take his greatest single step forward in his ever-expanding struggle against the limitations set by nature. The scientist, by knowing more about the universe, may find paths that will lead to still further conquests of nature. And it may be truly said that man will no longer be limited to seeing "as through a glass darkly." The universe will be spread out clearly before him.

In Cornelius Ryan (ed.)

*Across the Space Frontier*

The Heavens Open (p. 143)

The Viking Press. New York, New York, USA. 1952

**Wilkins, Bishop John** 1614–72  
Co-founder of the Royal Society

We see a great ship swims as well as a small cork, and an eagle flies in the air as well as a little gnat.... 'Tis likely enough that there may be means invented of journeying to the moon; and how happy they shall be that are first successful in this attempt.

*A Discourse Concerning a New World and Another Planet*  
Book 1, Chapter 14  
J. Maynard. London, England. 1640

**Wren, Sir Christopher** 1632–1723  
English mathematician and architect

A time would come when Men should be able to stretch out their Eyes...they should see the Planets like our Earth. Inauguration Speech, Gresham College, 1657

## SPACE FLIGHT

**Burroughs, Edgar Rice** 1875–1950  
American writer

I knew that I had ample room in which to wander, since science has calculated the diameter of space to be eighty-four thousand million light years, which, when one reflects that light travels at the rate of one hundred eighty-six thousand miles a second, should satisfy the wanderlust of the most inveterate roamer.

*Pirates of Venus*  
Chapter Two (p. 19)  
University of Nebraska Press. Lincoln, Nebraska, USA. 2001

...man is an artifact designed for space travel. He is not designed to remain in his present biologic state anymore than a tadpole is designed to remain a tadpole.

*The Adding Machine: Selected Essays*  
Civilian Defense (p. 82)  
Seaver Books. New York, New York, USA. 1986

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

It has often been said – and though it is becoming platitudinous it is nonetheless true – that only through space-flight can mankind find a permanent outlet for its aggressive and pioneering instincts. The desire to reach the planets is only an extension of the desire to see what is over the next hill.

*The Exploration of Space*  
Pocket Books. New York, New York, USA. 1979

**Cousins, Norman** 1912–90  
American editor and author

What was most significant about the first lunar voyage was not that men set foot on the moon, but that they set eye on earth.

*Rendezvous with Infinity*  
*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979 (p. 31)

**Dyson, Freeman J.** 1923–  
American physicist and educator

There are three reasons,...apart from scientific considerations, mankind needs to travel in space. The first...is garbage disposal; we need to transfer industrial processes into space so that the earth may remain a green and pleasant place for our grandchildren to live in. The second...to escape material impoverishment: the resources of this planet are finite, and we shall not forego forever the abundance of solar energy and minerals and living space that are spread out all around us. The third...our spiritual need for an open frontier.

*Disturbing the Universe*  
Chapter 10 (p. 116)  
Basic Books, Inc. New York, New York, USA. 1979

When will the third romantic age in the history of space-flight begin? The third romantic age will see little model sailboats spreading their wings to the sun in space...

*Disturbing the Universe*  
Chapter 10 (p. 116)  
Basic Books, Inc. New York, New York, USA. 1979

**Feynman, Richard P.** 1918–88  
American theoretical physicist

[Regarding space shuttle concept] It appears that there are enormous differences of opinion as to the probability of a failure with loss of vehicle and of human life. The estimates range from roughly 1 in 100 to 1 in 100,000. The higher figures come from the working engineers, and the very low figures from management.... For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.

*Roger's Commission Report on the Space Shuttle Challenger Accident*  
Personal observations on the reliability of the Shuttle, Appendix

**Haber, Heinz** 1868–1934  
German physical chemist

The conquest of space hinges on man's survival in space. And the crews of rocket ships and space stations, while they can never be completely protected against hazards such as meteors, will probably be safer than pedestrians crossing a busy street at a rush hour.

In Cornelius Ryan (ed.)  
*Across the Space Frontier*  
Can We Survive in Space? (p. 97)  
The Viking Press. New York, New York, USA. 1952

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

Space flights are merely an escape, a fleeing away from oneself, because it is easier to go to Mars or to the moon than it is to penetrate one's own being.

In Miguel Serrano  
*C.G. Jung and Hermann Hesse*  
The Farewell (p. 102)  
Schocken Books. New York, New York, USA. 1966

**Kepler, Johannes** 1571–1630  
German astronomer

There will certainly be no lack of human pioneers when we have mastered the art of flight. Who would have thought that navigation across the vast ocean is less dangerous and quieter than in the narrow, threatening gulfs of the Adriatic, or the Baltic, or the British straits? Let us create vessels and sails adjusted to the heavenly ether, and there will be plenty of people unafraid of the empty wastes. In the meantime, we shall prepare, for the brave sky travelers, maps of the celestial bodies – I shall do it for the moon, you, Galileo, for Jupiter.

In Arthur Koestler

*The Watershed – A Biography of Johannes Kepler*

Letter from Kepler to Galileo

April, 1610 (p. 195)

Doubleday & Company, Inc. Garden City. New York, New York, USA. 1960

**Mallove, Eugene F.** 1947–2004  
American physicist

Starflight is not just very hard, it is very, very, very hard.

*Starflight Handbook*

Introduction (p. 5)

John Wiley & Sons, Inc. New York, New York, USA. 1989

**von Braun, Wernher** 1912–77  
German-American rocket scientist

With our present knowledge, we can respond to the challenge of stellar space flight solely with intellectual concepts and purely hypothetical analysis. Hardware solutions are still entirely beyond our reach and far, far away.

Can We Ever Go to the Stars?

*Popular Science*, Volume 183, Number 1, July, 1963 (p. 170)

## SPACE JUNK

### Photo Journalist (Fictional character)

Today, a belated apology to the much maligned Chicken Little. It turns out you were right – the sky is falling. The National Space Administration informs us that Uncle Sam's Com-Sat 4 satellite is in a rapidly decaying orbit. That's their way of saying a ton of angry space trash is heading back home at fifteen thousand miles an hour. What does that make me think of? Makes me think of a triceratops, innocently munching a palm frond when out of the sky, whammo, a meteor sucker punches old mother Earth. Next thing you know, that triceratops, along with a hundred and seventy-five million years of dinosaur evolution, is nothing but history. To that unsung triceratops and all its kin, here's a song for you ...

*Apocalypse Now*

Film (1970)

## SPACE PROGRAM

**Nixon, Richard M.** 1913–94  
37th president of the USA

Over the last decade, the principal goal of our nation's space program has been the Moon. By the end of that decade men from our planet had traveled to the Moon on four occasions and twice they had walked on its surface. With these unforgettable experiences, we have gained a new perspective of ourselves and our world.

Statement on the Space Program

## SPACE SETTLEMENT

**Wolfe, Steven**

No biographical data available

Remember, the space settlement dream was born in you so that you would strive for its fulfillment in this generation, not defer it to the next. It was, and is, a call to you to take some action in this lifetime; and if you are not meant to see it through to completion, than you must at least lay a foundation on which those who will follow can build.

Space Settlement: The Journey Inward

*Ad Astra*, Jan/Feb/Mar 2004

## SPACE SHIP

**de Bergerac, Cyrano** 1619–55  
French dramatist

I had made myself a Machine which I fancied my carry me up as high as I pleased ...

*A Voyage to the Moon*

Chapter IV (p. 38)

Doubleday & McClure Co. New York, New York, USA. 1849

**Dornberger, Walter** 1895–1980  
German artillery officer

Today the space ship was born.

Comment to Werner von Braun upon successful firing of A-4 rocket on October 3, 1942

Reach for the Stars

*Time*, February 17, 1958

## SPACE SHUTTLE

**Fletcher, James C.**

No biographical data available

The space shuttle is much more than just a new vehicle. It is a whole new approach to space.

*Calvin Bullock Forum*, January 20, 1972 (p. 6)

We can no longer be satisfied with occasional or exotic use of space.

We cannot serve the national interest by just dabbling in space. We need the ability to use space routinely and

cheaply and extensively for practical benefits. And for this there is no rival, no substitute for the Shuttle.

*Calvin Bullock Forum*, January 20, 1972 (p. 5)

## SPACE TRAVEL

**Asimov, Isaac** 1920–92

American author and biochemist

Reaching the moon by three-man vessels in one long bound from Earth is like casting a thin thread across space. The main effort, in the coming decades, will be to strengthen this thread; to make it a cord, a cable, and, finally, a broad highway.

*The Beginning and the End*

The Coming Decades in Space

**Bruno, Giordano** 1548–1600

Italian philosopher and pantheist

Henceforth, I spread confident wings to space;

I fear no barrier of crystal or of glass;

I cleave the heavens and soar to the infinite.

And while I rise from my own globe to others

And penetrate ever further through the eternal field,

That which others saw from afar, I leave far behind me.

Translated by Dorothea Waley Singer

In Dorothea Waley Singer

*Giordano Bruno*

*On the Infinite Universe and Worlds* (p. 251)

Schuman. New York, New York, USA. 1950

**Burroughs, William S.** 1914–97

American writer

The step into space is a step into the unknown, a change as drastic as the transition from water to land.

*The Adding Machine*

Civilian Defense (p. 86)

Arcade Publishing. New York, New York, USA. 1991

**Bush, George W.** 1946–

43rd president of the USA

Inspired by all that has come before, and guided by clear objectives, today we set a new course for America's space program. We will give NASA a new focus and vision for future exploration. We will build new ships to carry man forward into the universe, to gain a new foothold on the moon, and to prepare for new journeys to worlds beyond our own.

Press Release, January 14, 2004

*President Bush Announces New Vision for Space Exploration Program*

Mankind is drawn to the heavens for the same reason we were once drawn into unknown lands and across the open sea. We choose to explore space because doing so improves our lives, and lifts our national spirit. So let us continue the journey.

Press Release, January 14, 2004

*President Bush Announces New Vision for Space Exploration Program*

**Cadwell, J.**

No biographical data available

**Bourki, W.**

No biographical data available

Nevertheless, we acknowledge that a few percent of the 200 Earths that Kepler is expected to find may be erroneous, and we urge travellers to confirm their hotel reservations directly before setting out to visit one of them.

Hubble Space Telescope Parallel Observations Supporting the Kepler Mission

*Bulletin of the American Astronomical Society*, Volume 31, 1999 (p. 1077)

**Clarke, Arthur C.** 1917–

English science and science fiction writer

It has often been said – and though it is becoming platitudinous it is none the less true – that only through space-flight can mankind find a permanent outlet for its aggressive and pioneering instincts.

*The Exploration of Space*

Chapter 18 (p. 186)

Harper & Brothers Publishers. New York, New York, USA. 1951

It is not easy to see how the more extreme forms of nationalism can long survive when men have seen the Earth in its true perspective as a single small globe against the stars.

*The Exploration of Space*

Chapter 18 (p. 187)

Harper & Brothers Publishers. New York, New York, USA. 1951

If ships from Earth ever set out to conquer other worlds they may find themselves, at the end of their journeys, in the position of painted war-canoes drawing slowly into New York Harbor.

*The Exploration of Space*

Chapter 18 (p. 192)

Harper & Brothers Publishers. New York, New York, USA. 1951

**de Bergerac, Cyrano** 1619–55

French dramatist

“And why not?” said I instantly to myself. “*Prometheus* heretofore went up to Heaven, and stole fire from thence. Have not I as much Boldness as he? And why should not I, then, expect as favourable a Success?”

*A Voyage to the Moon*

Chapter I (p. 15)

Doubleday & McClure Co. New York, New York, USA. 1849

**Duke of Argyll (George Douglas Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

On the earth and on the sea man has attained the powers of locomotion with which in strength, endurance, and in velocity, no animal movement can compare. But the air is an element on which he cannot travel an ocean which he cannot navigate. The birds of heaven are still his envy,

and on the paths they tread he cannot follow. As yet! for it is not certain that this exclusion is to be perpetual. His failure has resulted quite as much from his ignorance of natural laws as from his inability to meet the conditions which they demand.

*The Reign of Law* (4th American edition)

Chapter 3 (p. 169)

George Routledge & Sons. New York, New York, USA. 1873

...if man is ever destined to navigate the air it will be in machines formed in strict obedience to the mechanical laws which have been employed by the Creator for the same purpose in flying animals.

*The Reign of Law* (4th American edition)

Chapter 3 (p. 170)

George Routledge & Sons. New York, New York, USA. 1873

### Halpern, Paul

Professor of mathematics and physics

Like an infant falcon we sit perched on the lonely rock of Earth, our new-formed wings poised, waiting for the inevitable instant of freedom. Eyeing the incredibly vast expanse around us, a universe of virtually unlimited possibilities, we pine for other roosts, but see none in the haze. We cock our heads as we listen for sounds from afar, but all we hear, day after day, is silence.

*The Quest for Alien Planets: Exploring Worlds outside the Solar System* (p. 267)

Plenum Trade. New York, New York, USA. 1997

### Hubbard, Earl

Artist

Man's earthbound history has ended; universal history has begun. Mankind stands alone in the universe as he once did on this earth.

*The Challenge is Freedom* (p. 17)

Gallery of Modern Art. 1965

### Kennedy, John F. 1917–63

26th president of the USA

Why, therefore, should man's first flight to the moon be a matter of national competition? Why should the USA and the Soviet Union, in preparing for such expeditions, become involved in immense duplications of research, construction, and expenditure? Surely we should explore whether the scientists and astronauts of our two countries – indeed of all the world – cannot work together in the conquest of space, sending someday in this decade to the moon not the representatives of a single nation, but the representatives of all of our countries.

Address before the 18th General Assembly of the United Nations

September 20, 1963

### Kepler, Johannes 1571–1630

German astronomer

There will certainly be no lack of human pioneers when we have mastered the art of flight. Who would

have thought that navigation across the vast ocean is less dangerous and quieter than in the narrow, threatening gulfs of the Adriatic, or the Baltic, or the British straits? Let us create vessels and sails adjusted to the heavenly ether, and there will be plenty of people unafraid of the empty wastes. In the meantime, we shall prepare, for the brave sky travelers, maps of the celestial bodies -- I shall do it for the moon, you, Galileo, for Jupiter.

In Arthur Koestler

*The Watershed: A Biography of Johannes Kepler*

Letter From Johannes Kepler to Galileo Galilei, April of 1610

### Lovell, Sir Alfred Charles Bernard 1913–

English physicist, radio astronomer, and author

We have observed and admired the universe, now we have begun to move into it in a decisive manner. It is a movement which is revolutionary...which has never before occurred in man's history.

Man Moves into the Universe

*Bulletin of the Atomic Scientists*, Volume XXV, Number 7, September, 1969 (p. 4)

### Narrator

Captain Video! Master of space! Hero of science! Captain of the Video Rangers! Operating from his secret mountain headquarters on the planet Earth, Captain Video rallies men of good will everywhere. As he rockets from planet to planet, let us follow the champion of justice, truth, and freedom throughout the universe!

*Captain Video and His Video Rangers*

Film (1949)

### Norton, Andre 1912–2005

American science fiction and fantasy author

Nothing can stop the questing of men, not even Man. If we will it, not only the wonders of space, but the very stars are ours.

*Star Flight*

Treaty and Alliance (p. 189)

Baen Publishing. Riverdale, New York, USA. 1954

### Robinson, Stanley 1952–

American science fiction writer

Science is part of a larger human enterprise, and that enterprise includes going to the stars, adapting to other planets, adapting them to us.... The whole meaning of the universe, its beauty, is contained in the consciousness of intelligent life. We are the consciousness of the universe, and our job is to spread that around, to go look at things, to live everywhere we can.

*Red Mars*

Part III (pp. 174, 175)

Random House, Inc. New York, New York, USA. 1993



**Rostand, Edmond** 1868–1918  
French poet and dramatist

Or else, mechanic as well as artificer, I could have fashioned a giant grasshopper, with steel joints, which, impelled by successive explosions of saltpeter, would have hopped with me to the azure meadows where graze the starry flocks!

Translated by Gertrude Hall  
*Cyrano de Bergerac* (p. 150)  
Doubleday & McClure Co. New York, New York, USA. 1898

I could have placed myself upon an iron plate, have taken a magnet of suitable size, and thrown it in the air! That way is a very good one! The magnet flies upward, the iron instantly after; the magnet no sooner overtaken than you fling it up again.... The rest is clear! You can go upward indefinitely.

Translated by Gertrude Hall  
*Cyrano de Bergerac* (p. 151)  
Doubleday & McClure Co. New York, New York, USA. 1898

**Sagan, Carl** 1934–96  
American astronomer and author

We embarked on our cosmic voyage with a question first framed in the childhood of our species and in each generation asked anew with undiminished wonder: What are the stars? Exploration is in our nature. We began as wanderers, and we are wanderers still. We have lingered long enough on the shores of the cosmic ocean. We are ready at last to set sail for the stars.

*Cosmos*  
Chapter VII (p. 160)  
Ballentine Books. New York, New York, USA. 1985

**Shklovskii, Josef Samuelovich** 1916–  
Russian astrophysicist

The erection of artificial worlds in space is inevitable. Once man's breakthrough into space has begun, it will be as invincible as the discovery, colonization, and exploration of new countries during the age of great historical discoveries.

*Antimatter*, Volume 6, Number 1, October, 1983 (p. 172)

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Come, my friends,  
'Tis not too late to seek a newer world....  
To sail beyond the sunset, and the baths  
Of all the western stars ...

*The Works of Alfred, Lord Tennyson* (Volume I)  
Ulysses (p. 341)  
Macmillan & Company Ltd. London, England. 1908

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

All this world is heavy with the promise of greater things,

and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amid the stars.

*The Discovery of the Future* (p. 60)  
A.C. Fifield. London, England. 1913

**Young, Edward** 1683–1765  
English poet

The soul of man was made to walk the skies ...

*Night Thoughts on Life, Death and Immortality*  
Night IX  
A.S. Barnes & Co. New York, New York, USA. 1856

## SPACE, CURVATURE OF

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

When a physicist refers to curvature of space he at once falls under suspicion of talking metaphysics.

*The Expanding Universe*  
Chapter II (p. 29)  
Cambridge University Press. Cambridge, England. 1987

## SPACE-TIME

**Barnett, Lincoln Kinnear** 1909–79  
American science writer

...the universe is not a rigid and inimitable edifice where independent matter is housed in independent space and time; it is an amorphous continuum, without any fixed architecture, plastic and variable, constantly subject to change and distortion. Wherever there is matter and motion, the continuum is disturbed. Just as a fish swimming in the sea agitates the water around it, so a star, a comet, or a galaxy distorts the geometry of the space-time through which it moves.

*The Universe and Dr. Einstein*  
Chapter 11 (pp. 81–82)  
William Sloane Associates. New York, New York, USA. 1948

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

This [that space-time is a contortion of curvatures] is the sort of advance in mathematicized physics which causes some of the older conservatives to exclaim that mathematics is more confusing than hashish in our attempts to paint coherent pictures of the world. But the confusion is only apparent, and those who have had the time to master a little modern mathematics admit that they have been helped, not hindered, in their vision.

*The Handmaiden of the Sciences*  
Chapter 1 (p. 3)  
Williams & Wilkins Co. Baltimore, Maryland, USA. 1937



**Berlinski, David** 1942–  
American mathematician

Yet everything has a beginning, everything comes to an end, and if the universe actually began in some dense explosion, thus creating time and space, so time and space are themselves destined to disappear, the measure vanishing with the measured, until with another ripple running through the primordial quantum field, something new arises from nothingness once again.

*A Tour of the Calculus*

Chapter 26 (p. 309)

Pantheon Books. New York, New York, USA. 1995

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

We must, therefore, be prepared to find that further advance into this region will require a still more extensive renunciation of features which we are accustomed to demand of the space time mode of description.

*Atomic Theory and the Description of Nature*

Introductory Survey (p. 14)

Cambridge University Press. Cambridge, England. 1934

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Deepest of all illusory Appearances, for hiding Wonder, as for many other ends, are your two grand fundamental world-enveloping Appearances, Space and Time.

*Sartor Resartus*

Chapter VIII

Ginn & Company. Boston, Massachusetts, USA. 1897

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Through all the ages, man has fought against two great enemies – time and space. Time he may never wholly conquer, and the sheer immensity of space may also defeat him when he has ventured more than a few light-years from the Sun. Yet on this little Earth, at least, he may one day claim a final victory.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 8 (p. 81)

Harper & Row, Publishers. New York, New York, USA. 1973

**Cole, K. C.** 1946–  
American science writer

...Space and time are us...

*The Hole in the Universe: How Scientists Peered Over the Edge of Emptiness and Found Everything*

Chapter 5 (p. 109)

Harcourt, Inc. New York, New York, USA. 2001

**de Beauregard, Costa**  
No biographical data available

There can no longer be any objective and essential...division of space-time between “events which have already

occurred” and “events which have not yet occurred.”... Relativity is a theory in which everything is “written” and where change is only relative to the perceptual mode of living beings.

In J.T. Fraser

*The Voices of Time: A Cooperative Survey of Man's Views of Time as Expressed by the Sciences and by the Humanities*

Time in Relativity Theory: Arguments for a Philosophy of Being (p. 429)

G. Braziller. New York, New York, USA. 1966

**de Broglie, Louis** 1892–1987  
French physicist

In space-time, everything which for each of us constitutes the past, the present, and the future is given in block, and the entire collection of events, successive for us, which form the existence of a material particle is represented by a line, the world-line of the particle. Each observer, as his time passes, discovers, so to speak, new slices of space-time which appear to him as successive aspects of the material world, though in reality the ensemble of events constituting space-time exist prior to his knowledge of them.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

A General Survey of the Scientific Work of Albert Einstein (p. 114)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Dixon, William MacNeile** 1866–1946  
English author and scholar

Everything lies within space, and everything happens within time.

*The Human Situation* (p. 328)

Longmans, Green & Company. London, England. 1937

**Dyson, Freeman J.** 1923–  
American physicist and educator

Not only is Space from the point of view of life and humanity empty, but Time is empty also. Life is like a little glow, scarcely kindled yet, in these void immensities.

*Infinite in All Directions*

Part One, Chapter One (p. 9)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

It [the physical world is a *thing*; not like space, which is a mere negation; nor like time, which is – Heaven knows what!

*The Nature of the Physical World*

Introduction (p. ix)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955  
German-born physicist

Time and space are modes by which we think and not conditions in which we live.

In Alyesa Forsee

*Albert Einstein, Theoretical Physicist* (p. 81)

The Macmillan Company. New York, New York, USA. 1963

**Ferris, Timothy** 1944–  
American science writer

Newton viewed space and time as separate and absolute. As conceived by Einstein they are united in a flexible continuum that responds to the presence of matter. The stars and planets wrap the spacetime continuum around themselves, in a sense, each sitting in the center of a sort of spacetime whirlpool.

*The Red Limit: The Search for the Edge of the Universe*  
Chapter 3 (p. 71)

William Morrow & Company, Inc. New York, New York, USA. 1977

[Einstein explained] the commerce we call gravity occurs because objects follow the easiest, most efficient course over the undulations of the continuum. Earth in its orbit glides along inside the sun's spacetime vortex like a roulette ball whirling above the wheel, balancing its velocity against its tendency to slide toward the sun. That tendency is equivalent to gravity, but no "force" of gravity is postulated. Light beams also follow the dips and hills of the continuum. They trace trajectories we call "bent," though that is just three-dimensional parochialism talking; they are going just as straight as the shape of spacetime allows.

*The Red Limit: The Search for the Edge of the Universe*  
Chapter 3 (p. 71)

William Morrow & Company, Inc. New York, New York, USA. 1977

**Hawking, Stephen William** 1942–  
English theoretical physicist

The theory of relativity does, however, force us to change fundamentally our ideas of space and time. We must accept that time is not completely separate from and independent of space, but is combined with it to form an object called space-time.

*A Brief History of Time: From the Big Bang to Black Holes*  
Chapter 2 (p. 123)

Bantam Books. Toronto, Ontario, Canada. 1988

**Hoffmann, Banesh** 1906–86  
Mathematician and educator

What is it that pulls the apple to the ground, bends the circling moon to the earth and makes the planets captive of the sun? ... It is intangible time and space themselves, acting in awesome concert as curved space-time holding sway over all things in the universe.

*Relativity and Its Roots*  
Chapter 6 (pp. 156–157)

W.H. Freeman & Company. New York, New York, USA. 1983

### John Shade (Fictional character)

Space is a swarming of the eyes, and Time a singing in the ears.

In Vladimir Nabokov  
*Ada or Ardor: A Family Chronicle*  
Part Four (p. 542)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

**Joubert, Joseph** 1754–1824  
French moralist

There is something divine about the ideas of space and eternity which is wanting in those of pure duration and simple extension.

Translated by H.P. Collins

*Pensées and Letters of Joseph Joubert*  
Chapter XII (p. 90)

Books for Libraries Press. Freeport, New York, USA. 1972

**Lamb, Charles** 1775–1834  
English essayist and critic

Nothing puzzles me more than time and space; and yet nothing troubles me less, as I never think about them.

Quoted by James R. Newman

*The World of Mathematics* (Volume 1)

Letter to Thomas Manning, January 2, 1806 (p. 552)

Simon & Schuster. New York, New York, USA. 1956

**MacLeish, Archibald** 1892–1982  
American poet and Librarian of Congress

Spacetime has no beginning and no end.  
It has no door where anything can enter.  
How break and enter what will only bend?

*Songs for Eve*

Reply to Mr. Wordsworth (p. 39)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1954

**Maeterlinck, Maurice** 1862–1949  
Belgian playwright and poet

To attempt to explain space by time and time by space is to seek to explain the night by darkness and the darkness by the night; it is to revolve hopelessly in the circle of the unknowable.

Translated by Bernard Miall

*The Life of Space*

The Fourth Dimension, XXIX (pp. 96–97)

Dodd, Mead & Company. New York, New York, USA. 1928

Space is the present made visible. Time is space that is on the move and becoming the future or the past. Space is time extended; it is horizontal time; time is space perpendicular, vertical space. Space is time that endures; time is space that flies.

Translated by Bernard Miall

*The Life of Space*

The Fourth Dimension, XXIX (p. 97)

Dodd, Mead & Company. New York, New York, USA. 1928

**Maxwell, James Clerk** 1831–79  
Scottish physicist

March on, symbolic host! with step sublime,  
Up to the flaming bounds of Space and Time!  
There pause, until by Dickenson depicted,  
In two dimensions, we the form may trace  
Of him whose soul, too large for vulgar space,  
In  $n$  dimensions flourished unrestricted.

In Lewis Campbell and William Garnett  
*The Life of James Clerk Maxwell with Selections from his Correspondence and Occasional Writings*  
 To the Committee of the Cayley Portrait Fund (p. 637)  
 Macmillan & Company. London, England. 1882

**Minkowski, Hermann** 1864–1909  
 German mathematician

From this hour on, space as such and time as such shall recede to the shadows and only a kind of union of the two retain significance.

In A.P. French  
*Einstein: A Centenary Volume*  
 Chapter 12 (p. 231)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1979

The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. Henceforth space by itself and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.

*Space and Time*  
 80th Assembly of German Natural Scientists and Physicians, September 21, 1908

The objects of our perception invariably include places and times in combination. Nobody has ever noticed a place except at a time, or a time except at a place. But I still respect the dogma that both space and time have independent significance. A point of space at a point of time, that is a system of values  $x, y, z, t$ , I will call a world-point.

*The Principle of Relativity: A Collection of Original Memoirs on the Special and General Theory of Relativity*  
 Space and Time (p. 76)  
 Dover Publications, Inc. New York, New York, USA. 1952

**Murchie, Guy** 1907–97  
 American biologist

...the key to comprehending space-time is the obvious (to me) fact that space is the relationship between things and other things while time is the relationship between things and themselves.

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*  
 Part Three, Chapter 12 (p. 331)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

**Pope, Alexander** 1688–1744  
 English poet

Ye Gods! annihilate but space and time,  
 And make two lovers happy.

*The Complete Poetical Works*  
 Martinus Scriblerus of The Art of Sinking in Poetry, 11  
 Houghton Mifflin Company. New York, New York, USA. 1903

**Reichenbach, Hans** 1891–1953  
 German philosopher of science

It appears that the solution of the problem of time and space is reserved to philosophers who, like Leibnitz, are mathematicians, or to mathematicians who, like Einstein, are philosophers.

In Paul Arthur Schlipp (ed.)  
*Albert Einstein: Philosopher-Scientist*  
 The Philosophical Significance of the Theory of Relativity, IV (p. 307)  
 The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Stenger, Victor J.** 1935–  
 American physicist

Great physicists from Galileo to Einstein have clarified the meanings of space and time for us, not overthrown their basic conceptions nor declared them obsolete.

*Physics and Psychics: The Search for a World Beyond the Senses*  
 Chapter 13 (p. 295)  
 Prometheus Books. Buffalo, New York, USA. 1990

**Synge, John L.** 1897–1995  
 Irish mathematician and physicist

Anyone who studies relativity without understanding how to use simple space-time diagrams is as much inhibited as a student of functions of a complex variable who does not understand the Argand diagram.

*Relativity: The Special Theory* (p. 63)  
 North-Holland Publishing Company. Amsterdam, Netherlands. 1965

**Taylor, Edwin F.**  
 American physicist

**Wheeler, John Archibald** 1911–  
 American physicist and educator

Never make a calculation until you know the answer: Make an estimate before every calculation, try a simple physical argument (symmetry! invariance! conservation!) before every derivation, guess the answer to every puzzle. Courage: no one else needs to know what the guess is. Therefore make it quickly, by instinct. A right guess reinforces this instinct. A wrong guess brings the refreshment of surprise. In either case, life as a spacetime expert, however long, is more fun!

*Spacetime Physics*  
 Chapter 1 (p. 60)  
 W.H. Freeman & Company. San Francisco, California, USA. 1966

**Thorne, Kip S.** 1940–  
 American theoretical physicist

...spacetime is like a piece of wood impregnated with water. ...the wood represents space, the water represents time.... [W]ood and water; space and time...are tightly interwoven, unified. The singularity and the laws of quantum gravity that rule it are like a fire into which the water impregnated wood is thrown. The fire boils the water out of the wood, leaving the wood alone and vulnerable; in the singularity, the laws of quantum gravity destroy

time, leaving space alone and vulnerable. The fire then converts the wood into a froth of flakes and ashes; the laws of quantum gravity then convert space into a random, probabilistic froth.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Chapter 13 (p. 477)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

...Space and time, unified as spacetime, do not merely witness great masses struggling to bend the motion of other masses. Like the gods of ancient Greece, spacetime helps guide the battle and itself participates.... The scope and power of this century's new view of gravity and spacetime is seen nowhere more dramatically than in its prediction of the expansion of the universe. To have predicted...against all expectation, a phenomenon so fantastic is the greatest token yet of our power to understand this strange and beautiful universe.

*A Journey into Gravity and Spacetime*

Chapter 1 (p. 2)

Scientific American Library. New York, New York, USA. 1990

**Valéry, Paul** 1871–1945

French poet and critic

Space is an imaginary body, as time is fictive movement. When we say “in space” or “space is filled with” we are positing a body.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

*Analects*, CIX (p. 321)

Princeton University Press. Princeton, New Jersey, USA. 1971

## SPATIAL GEOMETRICIAN

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

I've certainly never come across any irreversible mathematics involving sofas. Could be a new field. Have you spoken to any spatial geometricians?

*Dirk Gently's Holistic Detective Agency*

Chapter 8 (p. 66)

Simon & Schuster. New York, New York, USA. 1987

## SPECIALIST

**Hollister, John Hamilcar** 1824–1911

American physician

Specialists are a necessity and are not to be ruled out, but for the all-round needs of the family the old family doctor will have the last smile. He may disappear for the time, but he will come back again, and when he does he will come to stay.

*Memories of Eighty Years; Autosketches, Random Notes and Reminiscences*

Chapter XII (p. 72)

Publisher undetermined

Chicago, Illinois, USA. 1912

**Loeb, Morris** 1863–1912

Chemist

Loosed from the leash of rhetoric and dogmatism, the pursuers of knowledge have spread in all directions over the field, each so eager on his own particular trail that he has no eye for the discoveries of his neighbor; he forgets, indeed, that there is need of keeping in touch to the right and left, lest important clues be passed unobserved.

In Theodore William Richards

*The Scientific Work of Morris Loeb*

The Fundamental Ideas of Physical Chemistry (p. 3)

Harvard University Press. Cambridge, Massachusetts, USA. 1913

**Witt, Otto N.** 1875–1923

German chemist

Every chemist, to be worthy of the name, should in his own work be a specialist; but there are few amongst us to whom it has been given to produce in their own particular line of research results of deep general interest.

*Evolution in Applied Chemistry*

*Nature*, Volume 81, Number 2071, July 8, 1909 (p. 51)

**Woodward, Robert Simpson** 1849–1924

American physicist and mathematician

There is a tradition, still tacitly sanctioned even by men of science, that there have been epochs when the more eminent minds were able to compass the entire range of knowledge. Amongst the vanishing heroic figures of the past it seems possible, indeed, to discern, here and there, a Galileo, a Huygens, a Descartes, a Leibnitz, a Newton, a Laplace or a Humbolt [sic], each capable, at least, of summing up with great completeness the state of contemporary knowledge. Traditions, however, are generally more or less mythical, and the myth in this case seems to be in flat contradiction with the fact that there never was such an epoch, that the great masters of our distinguished predecessors were, after all, much like the masters of today, simply the leading specialists of their times.

*The Unity of Physical Science*

*Science*, Volume 20, Number 509, September 30, 1904 (p. 417)

## SPECIALIZATION

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

A man cannot be a professor of zoology on one day, and of chemistry on the next, and do good work in both. As in a concert all are musicians – one plays one instrument, and one another, but none all in perfection.

In Charles Frederick Holder

*Louis Agassiz: His Life and Work*

At Penikese (p. 174)

G.P. Putnam's Sons. New York, New York, USA. 1893

You cannot do without one specialty; you must have some base-line to measure the work and attainments of others.

In Charles Frederick Holder  
*Louis Agassiz: His Life and Work*  
At Penikese (p. 174)

G.P. Putnam's Sons. New York, New York, USA. 1893

**Asimov, Isaac** 1920–92  
American author and biochemist

...the orchard of science is a vast globe-encircling monster, without a map, and known to no one man; indeed, to no group of men fewer than the whole international mass of creative scientists. Within it, each observer clings to his own well-known and well-loved clump of trees. If he looks beyond, it is usually with a guilty sigh.

*View from a Height*

Introduction (p. 7)

Avon Books. New York, New York, USA. 1975

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

To interrupt one's own researches in order to follow those of another is a scientific pleasure which most experts delegate to their assistants. Consequently, the confusion of tongues increases as the square of the number of talkers, until only ever more select coteries of narrow specialists really understand the refinements of their esoteric vocabularies.

*The Development of Mathematics* (p. 510)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Burnet, Sir Frank Macfarlane** 1899–1985  
Australian virologist

We may well find that the men who staff the hospitals of next century will include many who are much more mathematicians and biochemists than physicians as we know them today, but there will still be wide range of surgical and other specialists.... I fancy that those men will still need to be able to apply common sense, courage, and compassion in dealing with all the human difficulties that escape the machines.

*Changing Patterns: An Atypical Autobiography* (pp. 251–252)  
William Heineman. London, England. 1968

**Einstein, Albert** 1879–1955  
German-born physicist

Specialization in almost all branches of human endeavor has, to be sure, resulted in unprecedented achievements—however, at the expense of narrowing the individual's field of vision. Thus it is hard nowadays to find anyone able to repair, properly, a garment, a piece of furniture, let alone a watch.

Physics, Philosophy, and Scientific Progress

*Physics Today*, Volume 58 Issue 6 June, 2005 (p. 46)

**Groen, Janny**  
No biographical data available

**Smit, Eefke**  
No biographical data available

Scientific information is essential, not only for the scientist. The politician, the entrepreneur and the public at large need to know about it too. The people in business find that neither the mass media nor the specialized scientific press are providing the information needed. General information is no longer enough, specialist information is only digestible for the learned. Who will bridge the gap?

*The Discipline of Curiosity: Science in the World*

Introduction (p. 4)

Elsevier Science. Amsterdam, Netherlands. 1990

**Heinlein, Robert A.** 1907–88  
American science fiction writer

A human being should be able to change a diaper, plan an invasion, butcher a hog, conn a ship, design a building, write a sonnet, balance accounts, build a wall, set a bone, comfort the dying, take orders, give orders, cooperate, act alone, solve equations, analyze new problems, pitch manure, program a computer, cook a tasty meal, fight efficiently, die gallantly.

Specialization is for insects.

*Time Enough for Love*

Intermission (pp. 265–266)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Lerner, Eric J.** 1947–  
American popular science book

The combination of growing specialization and the peer-review system have fractured science into isolated domains, each with a built-in tendency toward theoretical orthodoxy and a hostility to other disciplines.

*The Big Bang Never Happened*

Part Two, Chapter 8 (pp. 374–375)

Time Books. New York, New York, USA. 1991

**Morrow, Prince Albert** 1846–1913  
American dermatologist and sociologist

The genius of modern medical literature is clearly in the direction of division of labor and associated effort.

*A System of Genito-Urinary Diseases, Syphilology, and Dermatology*

Preface

D. Appleton & Company. New York, New York, USA. 1893–4

**Ortega y Gasset, José** 1883–1955  
Spanish philosopher

For the purpose of innumerable investigations it is possible to divide science into small sections, to enclose oneself in one of these, and to leave out of consideration all the rest. The solidity and exactitude of the methods allow...this temporary but...disarticulation of knowledge. The work...done under [such] methods [is] as with a machine, and in order to obtain quite abundant results



it is not even necessary to have rigorous notions of their meaning and foundations.

*The Revolt of the Masses*

Chapter 12 (p. 111)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

[The division of science into specialties means] the majority of scientists help the general advance of science while shut up in the narrow cell of their laboratory, like the bee in the cell of its hive, or the turnspit in its wheel.

*The Revolt of the Masses*

Chapter 12 (p. 111)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

The extraordinary development of modern science may be her undoing. Specialism, now a necessity, has fragmented the specialties themselves in a way that makes the outlook hazardous. The workers lose all sense of proportion in a maze of minutiae.

*The Old Humanities and the New Science*

Chapter III (p. 49)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1920

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

It is my contention that specialization should be left to those who are not mentally gifted at generalization.

*An Almanac for Moderns*

September Twenty-First (p. 199)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Stevens, Rosemary** 1935–

No biographical data available

In the whole process of reassessment...of the medical profession...has come the recognition of medicine as an interdependent, not independent, profession and as one consisting of a complex of specialties rather than one general discipline.

*American Medicine and the Public Interest* (p. 413)

Yale University Press. New Haven, Connecticut, USA. 1971

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

Too great specialization leads to pedantry; too little of it to superficiality.

*Introduction to Science*

Chapter IV (p. 82)

Henry Holt & Co. New York, New York, USA. 1911

**Vesalius, Andreas** 1514–64

Flemish physician and anatomist

Great harm is caused by too wide a separation of the disciplines which work toward the perfection of each individual art, and much more by the meticulous distribution of the practices of this art to different workers.

*The Fabric of the Human Body*

Preface

1543

**Weiner, Jonathan** 1953–

American fiction and non-fiction writer

Specialization has gotten out of hand. There are more branches in the tree of knowledge than there are in the tree of life. A petrologist studies rocks; a pedologist studies soils. The first one sieves the soil and throws away the rocks. The second one picks up the rocks and brushes off the soil. Out in the field, they bump into each other only like Laurel and Hardy, by accident, when they are both backing up.

*The Next One Hundred Years: Shaping the Fate of Our Living Earth*

Chapter 10 (pp. 198–199)

Bantam Books. New York, New York, USA. 1990

## SPECIALTY

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

You cannot do without one specialty. You must have some base-line to measure the work and attainments of others. For a general view of the subject, study the history of the sciences. Broad knowledge of all Nature has been the possession of no naturalist.

Quoted in David Starr Jordan

*Science Sketches*

Quoted in David Starr Jordan (p. 146)

A.C. McClurg & Co. Chicago, Illinois, USA. 1896

## SPECIES

**Bessey, Charles E.** 1845–1915

American botanist

Nature produces individuals and nothing more

The Taxonomic Aspect of the Species Question

*The American Naturalist*, Volume 42, Number 496, April, 1908 (p. 218)

**Blumenbach, Johann Friedrich** 1752–1840

German naturalist and anthropologist

What is species? We say that animals belong to one and the same species if they agree so well in form and constitution that those things in which they differ may have arisen from degeneration.... Now we come to the real difficulty, which is to set forth the characters by which in the natural world we may distinguish mere varieties from genuine species.

*The Anthropological Treatises of Johann Friedrich Blumenbach*

Section II (p. 188)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Colinvaux, Paul**

No biographical data available

Every species has its niche, its place in the grand scheme of things.

*Why Big Fierce Animals are Rare: An Ecologist's Perspective*

Chapter Two (p. 11)

Princeton University Press. Princeton, New Jersey, USA. 1978



**Cook, O. F.**

No biographical data available

A species is a species, not through the workings of any hidden cause of evolution, but because the component individuals breed together, and thus remain in interconnected coherent whole.

*Annual Report of the Board of Regents of the Smithsonian Institution (1904)*

The Evolutionary Significance of Species (p. 398)  
Government Printing Office. Washington, D.C. 1905

**Cuvier, Georges** 1769–1832

French zoologist and statesman

The immutability of species is a necessary condition of the existence of scientific natural history.

Quoted in Ernst Heinrich Philipp August Haeckel  
*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition) (p. 52)

D. Appleton & Co. New York, New York, USA. 1892

All those individual animals and plants belong to one species which can be proved to be either descended from one another, or from common ancestors, or which are as similar to these as the latter are among themselves.

Quoted in Ernst Heinrich Philipp August Haeckel  
*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition) (pp. 52–53)

D. Appleton & Co. New York, New York, USA. 1892

**Darwin, Charles Robert** 1809–82

English naturalist

Unless we suppose the same species to have been created in two different countries, we ought not to expect any closer similarity between the organic beings on the opposite sides of the Andes than on shores separated by a broad strait of the sea.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter X (p. 365)

D. Appleton & Company, New York, New York, USA. 1896

It is really laughable to see what different ideas are prominent in various naturalists' minds, when they speak of "species:" in some, resemblance seems to go for nothing, and Creation the reigning idea – in some, descent is the key, – in some, sterility an unailing test, with others it is not worth a farthing. It comes, I believe, from trying to define the undefinable.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Letter to J.D. Hooker, December 24, 1856 (p. 446)  
D. Appleton & Company, New York, New York, USA. 1896

...I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other...

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter II (p. 29)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Widely ranging species, abounding in individuals, which have already triumphed over many competitors in their own widely extended homes will have the best chance of seizing on new places, when they spread into new countries.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter XII (p. 182)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Vries, Hugo** 1848–1935

Dutch botanist

Among the many advantages which have lent such a prominent significance to the theory of descent in the investigation of living nature, the shattering of the old conception of species occupies an important place. Formerly every species was regarded as a unit and the totality of its specific attributes as an indivisible concept. Even the latest theories on heredity accept this concept as one that does not require any further analysis.

Translated by C. Stuart Gager  
*Intracellular Pangenesis: Including a Paper on Fertilization and Hybridization*  
Chapter I (p. 11)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1910

**Falk, Donald**

American ecologist and biologist

We consider species to be like a brick in the foundation of a building. You can probably lose one or two or a dozen bricks and still have a standing house. But by the time you've lost 20% of species, you're going to destabilize the entire structure. That's the way ecosystems work.

*Christian Science Monitor*, 26 May, 1989

**Forbes, Edward** 1815–54

English naturalist

...every true species presents in its individuals, certain features, specific characters, which distinguish it from every other species; as if the Creator had set an exclusive mark or seal on each type.

*The Natural History of the European Seas*  
Chapter I (p. 8)  
John van Voorst. London, England. 1859

**Ford, Henry Jones** 1851–1925

American political scientist, journalist, and university professor

Animals belonging to the same species are like-minded, just as they are like-headed, like-bellied, like-limbed.

The Claims of Sociology Examined  
*The American Journal of Sociology*, Volume 15, Number 2, September, 1909 (p. 254)

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

When scientific work is instituted solely with the object of securing commercial gain, its correlative selfishness; when it is confined to the path of narrow specialisation, it leads to arrogance; and when its purpose is materialistic domination, without regard for the spiritual needs of humanity, it is a social danger and may become an excuse for learned barbarity.

*Discovery: Or the Spirit and Service of Science*

Preface (pp. v–vi)

Macmillan & Company Ltd. London, England. 1918

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

It is not a futile purpose to decide definitely what we mean by the so-called species among living bodies, and to enquire if it is true that species are of absolute constancy, as old as nature, and have all existed from the beginning just as we see them today; or if, as a result of changes in their environment, albeit extremely slow, they have not in course of time changed their characters and shape.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter III (p. 35)

The University of Chicago Press. Chicago, Illinois, USA. 1984

What a swarm of mollusk shells are furnished by every country and every sea, eluding our means of distinction and draining our resources.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition With Regard to the Natural History of Animals*

Chapter III (p. 38)

The University of Chicago Press. Chicago, Illinois, USA. 1984

The idea of bringing together under the name of species a collection of like individuals, which perpetuate themselves unchanged by reproduction and are as old as nature, involved the assumption that the individuals of one species could not unite in reproductive acts with individuals of another species.

Unfortunately, observation has proved and continues every day to prove that this assumption is unwarranted; for the hybrids so common among plants, and the copulations so often noticed between animals of very different species, disclose the fact that the boundaries between these alleged constant species are not so impassable as had been imagined.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition With Regard to the Natural History of Animals*

Chapter III (p. 39)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Leakey, Richard Erskine** 1944–  
Kenyan paleoanthropologist and politician

As a species, we are blessed with a curiosity about the world of nature and our place in it. We want to know – *need* to know – how we came to be as we are, and what our future is.

*The Origin of Humankind*

Preface (p. xv)

Basic Books, Inc. New York, New York, USA. 1994

**Locke, John** 1632–1704

English philosopher and political theorist

...the boundaries of the species, whereby men sort them, are made by men.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book III, Chapter VI, Section 37 (p. 279)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lyell, Sir Charles** 1797–1875

English geologist

...species are abstractions, not realities – are like genera. Individuals are the only realities. Nature neither makes nor breaks molds – all is plastic, unfixed, transitional, progressive, or retrograde. There is only one great resource to fall back upon, a reliance that all is for the best, trust in God, a belief that truth is the highest aim, that if it destroys some idols it is better that they should disappear, that the intelligent ruler of the universe has given us this great volume as a privilege, that its interpretation is elevating.

In Leonard G. Wilson (ed.)

*Sir Charles Lyell's Scientific Journals on the Species Question*

Journal II, July 10, 1856 (p. 121)

Yale University Press. New Haven, Connecticut, USA. 1970

...amidst the vicissitudes of the earth's surface, species cannot be immortal, but must perish, one after the other, like the individuals which compose them.

*Principles of Geology* (Volume II)

Chapter X (p. 87)

James Kay, Jun. & Brother. Philadelphia, Pennsylvania, USA. 1837

**Mayr, Ernst** 1904–2005

German-born American biologist

We had an international conference in Rome in 1981 on the mechanisms of speciation. It was attended by many of the leading botanists, zoologists, paleontologists, geneticists, cytologists and biologists. The one thing on which they all agreed was that we still have no idea what happens genetically during speciation. That's a damning statement, but it's the truth.

*OMNI Magazine*, February, 1983 (p. 78)

It may not be exaggeration if I say that there are probably as many species concepts as there are thinking systematists and students of speciation.

*Systematics and the Origin of Species*  
Chapter V (p. 115)  
Harvard University Press. Cambridge, Massachusetts, USA. 1942

### **Morton, Ron L.**

No biographical data available

Species come,  
species go;  
Some real fast,  
some real slow...

*Music of the Earth: Volcanoes, Earthquakes and Other Geological Wonders*

Chapter 10 (p. 267)  
Plenum Press. New York, New York, USA. 1996

### **Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

The species does not grow into perfection: the weak again and again get the upper hand of the strong, – their large number, and their greater cunning are the cause of it.

In Alexander Tille (ed.)

*The Works of Friedrich Nietzsche* (Volume 11)

The Twilight of the Idols, Roving Expeditions of an Inopportune Philosopher, Section 14 (p. 174)

### **Terborgh, John** 1936 –

Species are the units of evolution.

*Diversity and the Tropical Rain Forest*

Chapter 1 (p. 6)

Scientific American Library. New York, New York, USA. 1992

### **Veil, Anna Murray**

No biographical data available

Species to me are like islands; sub-species are like peninsulas. A peninsula may be vastly more important and more distinct than the little island off the shores; but nevertheless it remains a peninsula, and the island, however small, is an island.

Studies in the Asclepiadaceae

*Bulletin of the Torrey Botanical Club*, Volume 31, Number 9, September, 1904 (p. 467)

### **Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

The rule...I have endeavored to adopt [in determining what is a species and what is a species variety] is, that when the difference between two forms inhabiting separate areas seems quite constant, when it can be defined in words, and when it is not confined to a single peculiarity only, I have considered such forms to be species. When... the individuals of each locality vary among themselves, so as to cause the distinctions between the two forms to become inconsiderable and indefinite, or where the differences, though constant, are confined to one particular only, such as size, tint, or a single point of difference in marking or in outline, I class one of the forms as a variety of the other.

On the Phenomena of Variation and Geographical Distribution as Illustrated by the Papilionidae of the Malayan Region  
*Transactions of the Linnean Society of London*, Volume 25, 1865 (p. 4)

Species are merely those strongly marked races or local forms which, when in contact, do not intermix, and when inhabiting distinct areas are generally regarded to have had a separate origin, and to be incapable of producing a fertile hybrid offspring.

On the Phenomena of Variation and Geographical Distribution as Illustrated by the Papilionidae of the Malayan Region  
*Transactions of the Linnean Society of London*, Volume 25, 1865 (p. 12)

[A]s the test of hybridity cannot be applied [to species identification] in one case in ten thousand, and even if it could be applied, would prove nothing, since it is founded on an assumption of the very question to be decided – and as the test of origin is in every case inapplicable – and as, further, the test of non-intermixture is useless, except in those rare cases where the most closely allied species are found inhabiting the same area, it will be evident that we have no means whatever of distinguishing so-called “true species” from the several modes of variation here pointed out, and into which they so often pass by an insensible gradation.

On the Phenomena of Variation and Geographical Distribution as Illustrated by the Papilionidae of the Malayan Region  
*Transactions of the Linnean Society of London*, Volume 25, 1865 (p. 12)

...The essential character of a species in biology is that it is a group of living organisms, separated from all other such groups by a set of distinctive characters, having relations to the environment not identical with those of any other group of organisms, and having the power of continuously reproducing its like. Genera are merely assemblages of a number of these species which have a closer resemblance to each other in certain important and often prominent characters than they have to any other species...  
*Fortnightly Review*, Volume 57, New Series, 1895 (p. 441)

### **Wilson, Edward O.** 1929–

American biologist and author

Every species lives a life unique to itself, and every species dies a different way.

*The Diversity of Life*

Chapter Eleven (p. 215)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

### **Wilson, John** 1785–1854

Scottish writer

...to an entomological collector the rarity of a species enhances its value, to a fly-fisher, on the other hand, the frequent occurrence of a species, and its being widely dispersed, or found upon all waters, constitute the strongest reasons for preferring it...

*The Recreations of Christopher North*

Preface (p. ix)

D. Appleton & Co. New York, New York, USA. 1870

## SPECIES DIVERSITY

**Wilson, Edward O.** 1929–  
American biologist and author

The worst thing that can happen – will happen [in the 1980s] – is not energy depletion, economic collapse, limited nuclear war, or conquered by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendents are least likely to forgive us.

*Harvard Magazine*, January-February, 1980

## SPECIFIC GRAVITY

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

...the mean specific gravity of this our planet is, in all human probability, quite as well determined as that of an ordinary hand specimen in a mineralogical cabinet, – a marvelous result, which should teach us to despair of nothing which lies within the compass of number, weight, and measure.

*Journal of a Tour in Unsettled Parts of North America in 1796 & 1797*  
Francis Baily (p. 39)  
Baily Brothers. London, England. 1856

## SPECIFICATION

**Alger, John R. M.**  
American design engineer

**Hays, Carl V.**  
No biographical data available

Once a problem is recognized clearly and all the parties concerned have agreed on its nature, the development of detailed specifications becomes vital.

*Creative Synthesis in Design* (p. 15)  
Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1964

A good engineer is adroit in negotiating changes in specifications or trade-offs...

*Creative Synthesis in Design* (p. 16)  
Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1964

**Hoover, Herbert** 1874–1964  
31st president of the USA

Specifications are the formulated, definite, and complete statements of what the buyer requires of the seller.

*National Directory of Commodity Specifications*  
M 65, Forward (p. 1)

**Matthews, J. A.**

No biographical data available

Good sense is highly desirable in writing specifications and is even more necessary in interpreting them. If they only contained the minimum number of requirements to define the character of material wanted...the matter would be greatly simplified. Rarely do they cover the only material suited to the purpose intended, and more rarely do they cover the best material for the purpose intended. Once written, they become as the laws of the Medes and Persians, which alter not. They acquire a sort of sanctity, like the Ten Commandments or the Constitution before the adoption of the Eighteenth Amendment. Present Tendencies in Engineering Materials

*Mechanical Engineering*, Volume 48, Number 8, August, 1926 (p. 792)

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Nature, in her process of specification, seems to get, so to speak, into a *cul de sac*, where she cannot advance, and whence she will not recede.

In John Stuart Blackie  
*The Wisdom of Goethe*  
Nature – Natural History (p. 186)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

## SPECTRA

**Kirchoff, Gustav Robert** 1824–87  
German physicist

**Bunsen, Robert** 1811–99  
German chemist

It is known that several substances have the property of producing certain bright lines when brought into the flame. A method of qualitative analysis can be based on these lines, whereby the field of chemical reactions is greatly widened and hitherto inaccessible problems are solved. We limit ourselves here to developing the method for alkali and earth-alkali metals and demonstrating its value. By some examples.

*Chemical Analysis by Observation of Spectra*  
*Annalen der Physik und der Chemie*, Volume 110, 1860 (p. 161)

## SPECTROSCOPE

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

Custom can never blunt the wonder with which we must regard the achievement of compelling rays emanating from a source devoid of sensible magnitude through immeasurable distances, to reveal, by its distinctive qualities, the composition of that source.

*A Popular History of Astronomy During the Nineteenth Century*  
Part II, Chapter XII (p. 372)  
A. & C. Black. London, England. 1908

**Crookes, Sir William** 1832–1919

English chemist and physicist

The spectroscope reveals that the elementary components of the stars and the earth are pretty much the same.

In Frederick Houk Law

*Science in Literature*

The Romance of the Diamonds (p. 111)

Harper &amp; Brothers. New York, New York, USA. 1929

**Draper, John William** 1811–82

American scientist, philosopher, and historian

And now, while we have accomplished only a most imperfect examination of objects that we find on earth, see how, on a sudden, through the vista that has been opened by the spectroscope, what a prospect lies beyond us in the heavens! I often look at the bright yellow ray emitted from the chromosphere of the sun, by that unknown element, Helium, as the astronomers have ventured to call it. It seems trembling with excitement to tell its story, and how many unseen companions it has. And if this be the case with the sun, what shall we say of the magnificent hosts of the stars? May not everyone of them have special elements of its own? Is not each a chemical laboratory in itself?

Presidential Address

American Chemical Society, November 16, 1876

**Huggins, Sir William** 1824–1910

English astronomer

One important object of this original spectroscopic investigation of the light of the stars and other celestial bodies, namely to discover whether the same chemical elements as those of our earth are present throughout the universe, was most satisfactorily settled in the affirmative; a common chemistry, it was shown, exists throughout the universe.

*The Scientific Papers of Sir William Huggins*

Spectra of the Fixed Stars (p. 49)

W. Wesley &amp; Son. London, England. 1909

I looked into the spectroscope. No spectrum such as I expected! A single bright line only!...The riddle of the nebulae was solved. The answer, which had come to us in the light itself, read: Not an aggregation of stars, but a luminous gas. Stars after the order of our own sun, and of the brighter stars, would give a different spectrum; the light of this nebula had clearly been emitted by a luminous gas.

*The Scientific Papers of Sir William Huggins*

Historical Statement (p. 106)

W. Wesley &amp; Son. London, England. 1909

On the evening of August 29, 1864, I directed the telescope for the first time to a planetary nebula in Draco. I looked into the spectroscope. No spectrum such as I expected! A single bright line only! At first I suspected

some displacement of the prism, and that I was looking at a reflection of the illuminated slit from one of its faces. This thought was scarcely more than momentary; then the true interpretation flashed upon me. The light of the nebula was monochromatic; and so, unlike any other light I had as yet subjected to prismatic examination, could not be extended out to form a complete spectrum.

*An Introduction to the Study of Spectrum Analysis*

Chapter VII (p. 84)

Longmans, Green &amp; Co. London, England. 1904

**Keeler, James E.** 1847–1900

American astrophysicist

It was only after the discovery was made, that the light which reveals to us the existence of the heavenly bodies also bears the secret of their constitution and physical condition, that the basis for a real science was obtained. The spectroscope placed new and hitherto undreamed of powers in the hands of men. It is to the astrophysicist what the graduated circle and the telescope are to the astronomer.

The Importance of Astrophysical Research and Their Relation of Astrophysics to Other Physical Sciences

*The Astrophysical Journal*, Volume 6, Number 4, November, 1897

(p. 273)

It [the spectroscope] is to the astrophysicist what the graduated circle and the telescope are to the astronomer.

The Importance of Astrophysical Research and the Relation of Astrophysics to Other Physical Sciences

*The Astrophysical Journal*, Volume 6, Number 4, November, 1897

(p. 273)

**Maxwell, James Clerk** 1831–79

Scottish physicist

The vast interplanetary and interstellar regions will no longer be regarded as waste places in the universe, which the Creator has not seen fit to fill with the symbols of the manifold order of His kingdom. We shall find them to be already full of this wonderful medium; so full, that no human power can remove it from the smallest portion of space, or produce the slightest flaw in its infinite continuity. It extends unbroken, from star to star; and when a molecule of hydrogen vibrates in the dog-star, the medium receives the impulses of these vibrations; and after carrying them in its immense bosom for three years, delivers them in due course, regular order, and full tale into the spectroscope...

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Action at a Distance (p. 322)

At The University Press. Cambridge, England. 1890

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

It had occurred towards midnight of the 12th; and the spectroscope, to which he had at once resorted, indicated



a mass of flaming gas, chiefly hydrogen, moving with an enormous velocity towards this earth.

*The War of the Worlds*

Book One, Chapter I (p. 15)

Bernhard Tauchnitz. Leipzig, Germany. 1898

## SPECTROSCOPIC

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

...spectroscopic coincidences admit of no compromise. Either they are absolute, or they are worthless.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Part II, Chapter XII (p. 455)

Adam & Charles Black. London, England. 1893

## SPECTROSCOPIC ANALYSIS

**Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

May not the chemical properties of the prismatic colours be as different as those which relate to light and heat? Adequate methods for an investigation of them may easily be found; and we cannot too minutely enter into an analysis of light, which is the most subtle of all the active principles that are concerned in the mechanism of the operations of nature.

Investigation of the Powers the Prismatic Colours to Heat and Illuminate Objects

*Philosophical Transactions of the Royal Society of London*,

Volume 90, 1800 (pp. 270–271)

## SPECTROSCOPY

**Huggins, Sir William** 1824–1910

English astronomer

In no science, perhaps, does the sober statement of the results which have been achieved appeal so strongly to the imagination, and make so evident the almost boundless powers of the mind of man. By means of its light alone to analyse the chemical nature of a far distant body; to be able to reason about its present state in relation to the past and future; to measure within an English mile or less per second the otherwise invisible motion which it may have towards or from us; to do more, to make even that which is darkness to our eyes light, and from vibrations which our organs of sight are powerless to perceive to evolve a revelation in which we see mirrored some of the stages through which the stars may pass in their slow evolutionary progress – surely the record of such achievements, however poor the form of words in which they may be described, is worthy to be regarded as the scientific epic of the present century.

*Report of the Sixty-first Meeting of the British Association for the Advancement of Science*

Address by William Huggins (p. 4)

John Murray. London, England. 1892

This news was to me like the coming upon a spring of water in a dry and thirsty land. Here at last presented itself the very order of work for which in an indefinite way I was looking – namely, to extend his novel methods of research upon the sun to the other heavenly bodies.

In W.W. Campbell

*Annual Report of the Board of Regents of the Smithsonian Institution*

Sir William Huggins (p. 308)

US Government Printing Office. Washington, D.C. 1911

## SPECTRUM

**Thomson, James** 1700–48

Scottish poet

First the flaming red

Sprang vivid forth; the tawny orange next,

And next delicious yellow; by whose side

Fell the kind beams of all-refreshing green.

Then the pure blue that swells autumnal skies, Ethereal play'd; and then, of sadder hue

Emerged the deeper indigo (as when

The heavy-skirted evening droops with frost), While the

last gleamings of refracted light

Died in the fainting violet away.

*Poetical Works of James Thomson*

A Poem Sacred to the Memory of Sir Isaac Newton

Reeves & Turner. London, England. 1895

## SPECTRUM ANALYSIS

**Bunsen, Robert W.** 1811–1899

German chemist

At the moment I am occupied by an investigation with Kirchhoff which does not allow us to sleep. Kirchhoff has made a totally unexpected discovery, inasmuch as he has found out the cause for the dark lines in the solar spectrum and can produce these lines artificially intensified both in the solar spectrum...

In Henry Enfield Roscoe

*The Life & Experiences of Sir Henry Enfield Roscoe*

Chapter IV (p. 81)

Macmillan & Co Ltd. London, England. 1906

**de la Rue, Warren** 1815–89

English astronomer and inventor

...if we were to go to the sun, and to bring away some portions of it and analyze them in our laboratories, we could not examine them more accurately than we can by this new mode of spectrum analysis....

*Chemical News*, Volume 4, 1861 (p. 130)



**Lockyer, Joseph Norman** 1836–1920

English astronomer and physicist

...we believe that each molecular vibration disturbs the ether; that spectra are thus begotten' each wavelength of light resulting from a molecular tremor of corresponding wavelength. The molecule is, in fact, the sender, the ether the wire, and the eye the receiving instrument, in this new telegraphy.

*Studies in Spectrum Analysis*

Chapter IV (pp. 118–119)

D. Appleton &amp; Company. New York, New York, USA. 1878

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Spectrum analysis of the black powder points unmistakably to the presence of an unknown element with a brilliant group of three lines in the green, and it is possible that it combines with argon to form a compound which acts at once with deadly effect upon some constituent in the blood.

*The War of the Worlds*

Book Two, Chapter X (p. 283)

Bernhard Tauchnitz. Leipzig, Germany. 1898

**White, H. E.**

No biographical data available

That photographs are an extremely important feature of any book on atomic spectra may be emphasized by pointing out that, of all the theories and knowledge concerning atoms, the spectrum lines will remain the same for all time.

*Introduction to Atomic Spectra* (p. vii)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1934

**SPECTRUM APPORTIONMENT****Vanden Bout, Paul A.**

Radio astronomer

In matters of spectrum apportionment, astronomers think like wilderness preservationists.

*The Vanishing Universe: Adverse Environmental Impacts on Astronomy*

Preserving Wilderness in the Radio Spectrum (p. 97)

Cambridge University Press. Cambridge, England. 1994

**SPECULATE****da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

You who speculate on the nature of things, I praise you not for knowing the processes which nature ordinarily effects of herself, but rejoice if so be that you know the issue of such things as your mind conceives.

Translated by Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I (p. 54)

Duckworth &amp; Co. London, England. 1906

**SPECULATION****Comfort, Alex** 1920–2000

English gerontologist and author

Rash speculation does not bother the physicists – it has got them where they are today. And it is high time that the life sciences looked critically at the solidity of their tribal idols, including stochastic-genetic evolution, morphogenesis and the “mind-body problem” – while being mindful that, in the present climate, work on some quite unrelated matter may prove, incidentally and quite unwittingly, to have altered the entire face of the problem. Nor will the answers obtained lie within any existing frame of discourse.

*On Physics and Biology: Getting Our Act Together**Perspectives in Biology and Medicine*, Volume 29, Number 1, Autumn, 1985 (p. 9)**Author undetermined**

A distinction must be observed between scientific certitude and scientific speculation. What has been established beyond all doubt must be accepted in its bearing upon religious problems, while what is merely speculation should command only respectful consideration.

Scientific Speculation and Biblical Interpretation

*The Methodist Review*, Volume 89 July, 1897 (p. 636)**Brewster, David** 1781–1868

Scottish scientist, inventor, and writer

The extravagant speculations which often precede and lead to discovery differ in no respect from the creations of a rich poetical fancy. Wild and unsubstantial in themselves, they pass over the mind like a shadow, and it is only when they are clothed in the imagery of external nature, and invested with the realities of human feeling, that they begin to exercise their power over the heart.

In Margaret Maria Gordon

*The Home Life of Sir David Brewster* (3rd edition)

Chapter VIII (p. 72)

David Douglas. Edinburgh, Scotland 1881

**Comte, Auguste** 1798–1857

French philosopher

Our power of speculation, limited as it is, still far surpasses our capacity for action...

*The Positive Philosophy of Auguste Comte* (Volume 2)

Book V, Chapter I (p. 4)

George Bell &amp; Sons. London, England. 1896

**Darwin, Charles Robert** 1809–82

English naturalist

All young geologists have a great turn for speculation; I have burned my fingers pretty sharply in that way, and am now inclined to cavil at speculation when the direct and immediate effect of a cause in question cannot be shown.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 2)  
 Letter 487, Darwin to C.H.L. Wood, March 4, 1850 (p. 133)  
 D. Appleton & Company. New York, New York, USA. 1903

**Davy, Sir Humphry** 1778–1829  
 English chemist

To be attached to mere speculation is to be directed by a dream.

In John Davy (ed.)  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
 Chapter III (p. 216)  
 Longman, Rees, Orme, Brown, Green & Longman London, England.  
 1836

The men who begin with speculation and end with facts, begin at the wrong end; the firmest materials should be in the foundations; the embellishments should be made after the structure is completed.

In John Davy  
*Fragmentary Remains, Literary and Scientific, of Sir Humphry Davy*  
 Chapter III (p. 116)  
 John Churchill. London, England. 1858

**Dr. Seuss (Theodor Seuss Geisel)** 1904–1991  
 American children's book author and illustrator

Some have two feet and some have four. Some have six feet and some have more. Where do they come from? I can't say. But I bet they have come a long long way.

*One Fish, Two Fish, Red Fish, Blue Fish* (p. 12)  
 Beginner Books Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

If we are not content with the dull accumulation of experimental facts, if we make any deductions or generalizations, if we seek for any theory to guide us, some degree of speculation cannot be avoided. Some will prefer to take the interpretation which seems to be most immediately indicated and at once adopted as an hypothesis; others will rather seek to explore and classify the widest possibilities which are not definitely inconsistent with the facts. Either choice has its dangers: the first may be too narrow a view and lead progress into a cul-de-sac; the second may be so broad that it is useless as a guide and diverge indefinitely from experimental knowledge.

The Internal Constitution of the Stars  
*Observatory*, Volume 43, 1920 (p. 356)

**Einstein, Albert** 1879–1955  
 German-born physicist

I think that only daring speculation can lead us further and not accumulation of facts.

In Michele Besso  
*Correspondence 1903–1955*  
 Letter to M. Besso, October 8, 1952 (p. 487)  
 Hermann. Paris, France. 1972

**Feuerbach, Ludwig** 1804–72  
 German philosopher

Speculation is philosophy intoxicated; let philosophy get sober again; it will then be to the mind what pure spring water is to the body.

In Ludwig Buchner  
*Force and Matter*  
 Preface to the First Edition (p. xx)  
 Trubner & Company. London, England. 1864

**Geikie, Sir Archibald** 1835–1924  
 English geologist

...with a certain class of minds, fancy comes in to supply the place of facts that fail.

*The Founders of Geology* (2nd edition)  
 Chapter I (p. 3)  
 Macmillan & Co Ltd. London, England. 1905

**Grandi, S. A.**  
 No biographical data available

**Phillips, M. M.**  
 No biographical data available

Our conclusion is that we cannot satisfactorily account for the broad hump. Thus unbridled speculation is presumably in order.

Large- and Small-scale Structure in the Continuum Energy Distributions of Quasi-stellar Objects and Seyfert 1 Galaxies  
*Astrophysical Journal, Part 1*, Volume 239, July 15, 1980 (p. 479)

**Gruenberg, Benjamin C.**  
 No biographical data available

We all know that there can be no true science that does not rest solidly upon facts. But the thought must often occur to many of us that there is some danger, especially among the younger scientists, that we may become obsessed with an exaggerated sense of the value of facts as such. Is there not too much emphasis laid by many professors in charge of research students on the mere accumulation of observational, statistical or experimental facts, with too little attention to that side of science which concerns itself with those analytical and synthetic processes that convert facts into valuable ideas? It seems to me that this latter kind of work needs at the present time at least as much encouragement as the other. Of course, there is the possibility for "thinking" to degenerate into profitless speculation; but we are certainly as much in need of the results of thinking about the facts already accumulated as we are of more facts.

Facts Vs. The Advancement of Science  
*Science*, N.S. Volume XXXI, Number 798, April 15, 1910 (p. 579)

**Hill, Alexander**  
 No biographical data available

Philosophical speculation takes a plunge, as it were, into the uncertain sea, trusting to reach firm ground again

before its power of swimming is exhausted; whereas science, more cautious, builds solid facts into a cause-way, and never allows the waves of uncertainty to wet it above the ankles.

*Introduction to Science*

Chapter I (pp. 28–29)

The Macmillan Co. New York, New York, USA. 1900

**James, William** 1842–1910

American philosopher and psychologist

...to pass from mystical to scientific speculations is like passing from lunacy to sanity ...

*The Will to Believe and Other Essays in Popular Philosophy*

What Psychological Research Has Accomplished (p. 301)

Longmans, Green & Co. New York, New York, USA. 1897

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

The problem of the origin and development of the solar system suffers from the label “speculative.” It is frequently said that as we were not there when the system was formed, we cannot legitimately arrive at any idea as to how it was formed.

In B. Gutenberg (ed.)

*Internal Constitution of the Earth*

The Origin of the Solar System

Dover Publications. New York, New York, USA. 1951

**Lady Smith**

Speculation engenders doubt; and doubt is frequently the parent either of apathy or of impiety.

Article II

*The Edinburgh Review*, Volume 57, 1833 (p. 41)

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

The astronomer cannot afford to waste his energies on hopeless speculation about matters of which he cannot learn anything ...

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter XVII (p. 272)

Harper & Brothers Publishers. New York, New York, USA. 1906

**Osborn, Henry Fairfield** 1857–1935

American paleontologist and geologist

His speculations were as unsound as his observations had been sound and valuable.

*From the Greeks to Darwin: An Outline of the Development of the Evolution Idea*

Chapter IV (p. 119)

The Macmillan Co. New York, New York, USA. 1905

**Ramsay, Sir William** 1852–1916

English chemist

Speculation...has a deep fascination for many minds...

*Essays Biographical and Chemical*

Chemical Essays

What Is an Element? (p. 149)

Archibald Constable & Company Ltd. London, England. 1908

Chemistry and physics are experimental sciences; and those who are engaged in attempting to enlarge the boundaries of science by experiment are generally unwilling to publish speculations; for they have learned, by long experience, that it is unsafe to anticipate events.

*Essays Biographical and Chemical*

Chemical Essays

Radium and Its Products (p. 179)

Archibald Constable & Company Ltd. London, England. 1908

I am leaving the regions of fact, which are difficult to penetrate, but which bring in their train rich rewards, and entering the regions of speculation, where many roads lie open, but where a few lead to a definite goal.

*Nobel Lectures, Chemistry 1901–1921*

The Rare Gases of the Atmosphere

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Romanes, George John** 1848–94

English psychologist

The spirit of speculation is the same as the spirit of science, namely...a desire to know the causes of things.

*Darwin and After Darwin* (4th edition)

Chapter I (p. 6)

The Open Court Publishing Co. Chicago, Illinois, USA. 1910

**Ross, Sir Ronald** 1857–1932

Scottish physician

We must not accept any speculations merely because they now appear pleasant, flattering, or ennobling to us. We must be content to creep upwards step by step, planting each foot on the firmest finding of the moment, using the compass and such other instruments as we have, observing without either despair or contempt the clouds and precipices above and beneath us. Especially our duty at present is to better our present foothold; to investigate; to comprehend the forces of nature; to set our State rationally in order; to stamp down disease in body, mind, and government; to lighten the monstrous misery of our fellows, not by windy dogmas, but by calm science.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter VIII (p. 233)

Macmillan & Co Ltd. London, England. 1916

**Sylvester, James Joseph** 1814–97

English mathematician

Let him [the author] be permitted also in all humility to add...that in consequence of the large arrears of algebraical and arithmetical speculations waiting in his mind their turn to be called into outward existence, he is driven to the alternative of leaving the fruits of his meditations to perish (as has been the fate of too many foregone theories, the stillborn progeny of his brain, now forever resolved back again into the primordial

matter of thought), or venturing to produce from time to time such imperfect sketches as the present, calculated to evoke the mental cooperation of his readers, in whom the algebraical instinct has been to some extent developed, rather than to satisfy the strict demands of rigorously systematic exposition.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 2)

63 (p. 337)

At The University Press. Cambridge, England. 1908

## Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910

American author and humorist

Spectrum analysis enabled the astronomer to tell when a star was advancing head on, and when it was going the other way. This was regarded as very precious. Why the astronomer wanted to know, is not stated; nor what he could sell out for, when he did know. An astronomer's notions about preciousness were loose. They were not much regarded by practical men, and seldom excited a broker.

*Mark Twain's Fables of Man*

The Secret History of Eddypus

University of California Press. Berkeley, California, USA. 1972

## von Goethe, Johann Wolfgang

1749–1832

German poet, novelist, playwright, and natural philosopher

Man must always in some sense cling to the belief that the unknowable is knowable, otherwise speculation would cease.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 152)

William Blackwood & Sons. Edinburgh, Scotland. 1883

## Whewell, William

1794–1866

English philosopher and historian

The mind cannot but claim a right to speculate concerning all its own acts and creations; yet, when it exercises this right upon its common practical notions, we find that it runs into barren abstractions and ever-recurring cycles of subtlety. Such Notions are like waters naturally stagnant; however much we urge and agitate them, they only revolve in stationary whirlpools.

*History of the Inductive Sciences from the Earliest to the Present Time*

(3rd edition)

Introduction (pp. 13–14)

John W. Parker & Son. London, England. 1857

## Whyte, A. Gowans

Scottish writer

The Golden Age of speculation was the Stone Age of knowledge.

The Triumph of Physics

*The Rationalist Annual*, 1931 (p. 28)

## Woodford, F. Peter

American editor

Of course speculation is in order in a Discussion, but it must be reasonable, firmly founded on observation, and subject to test, if it is to get past a responsible editorial board.

*Scientific Writing for Graduate Students* (p. 29)

Council of Biology Editors. Bethesda, Maryland, USA. 1986

## SPHERE

### Marquis, Don

1878–1937

American newspaperman, poet, and playwright

...we approached a mood of wonder as to the shape of the universe itself. We decided that it is spherical. We do not know how we know it is spherical; but we defy you to say over and over to yourself, rapidly and steadily for thirty minutes, that the universe is spherical, and then think of it as being any other shape. That is our dogma: The Universe Is Spherical; we shall be at no pains to impose it upon you; we merely point out to you how you may impose it upon yourself, if you wish ...

*Prefaces*

Preface to a Book of Patterns (p. 139)

D. Appleton & Co. New York, New York, USA. 1919

## SPHINX

### Loti, Pierre

1850–1923

French author

Is that a hill of sand that rises yonder? One can scarcely tell, for it has as it were no shape, no outline; rather it seems like a great rosy cloud, or some huge, trembling billow, which once perhaps raised itself there, forthwith to become motionless forever.... And from out this kind of mummified wave a colossal human effigy emerges, rose-coloured too, a nameless, elusive rose; emerges, and stares with fixed eyes and smiles. It is so huge it seems unreal, as if it were a reflection cast by some mirror hidden in the moon...

Translated by W. P. Baines

*Egypt*

Chapter 1 (p. 3)

Duffield & Co. New York, New York, USA. 1910

## SPIDER WEB

### Cook, Eliza

1818–89

English author

...the bright slime that cunning reptiles spread To catch their prey ...

*The Poetical Works of Eliza Cook*

Silence – A Fragment

Frederick Warne & Co. London, England. 1870

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

To appoint one's self...an inspector of Spiders' webs, for many years in succession and for long seasons, means joining a not overcrowded profession, I admit. Heaven knows, it does not enable one to put money by! No matter: the meditative mind returns from that school fully satisfied.

Translated by Alexander Teixeira de Mattos  
*The Life of the Spider*  
Chapter IX (p. 232)  
Dodd Mead & Co. New York, New York, USA. 1917

The spider's web is a glorious mathematical problem.

Translated by Alexander Teixeira de Mattos  
*The Life of the Fly*  
Chapter XII (p. 276)  
Dodd, Mead & Co. New York, New York, USA. 1925

**Oehlenschläger, Adam Gottlob** 1779–1850  
Danish poet

Look upon my web so fine, See how threads with threads entwine; If the evening wind alone Thus within the dark-est place Breathe upon it, all is gone.

In William Chambers and Robert Chambers  
*Chambers's Miscellany of Useful and Entertaining Tracts*  
The Spider's Web (p. 17)  
William & Robert Chambers. Edinburgh, Scotland. 1847

## SPIN

**Goudsmit, Samuel A.** 1902–78  
Dutch-born American physicist

It was a little over fifty years ago that George Uhlenbeck and I introduced the concept of spin. It is therefore not surprising that most young physicists do not know that spin had to be introduced. They think that it was revealed in Genesis or perhaps postulated by Sir Isaac Newton, which most young physicists consider to be about simultaneous.

In Anthony French and Edwin Taylor  
*An Introduction to Quantum Physics* (p. 424)  
W.W. Norton & Company, Inc. New York, New York, USA. 1978

## SPIRAL

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

The logarithmic spiral of the mollusc is as old as the centuries. It proceeds from the Sovran Geometry Which rules the world, attentive alike to the Wasp's cell and to the Snail's spiral.

Translated by Alexander Teixeira de Mattos  
*The Mason-Wasps*  
Insect Geometry (p. 237)  
Dodd, Mead & Co. New York, New York, USA. 1919

**Payne-Gaposchkin, Cecilia** 1900–79  
British-American astronomer

Wherever we look in nature we can see spiral forms: the uncurling fern, the snail, the nautilus shell, the hurricane, the stirred cup of coffee, the water that swirls out of a washbowl. Perhaps we should not be surprised to see spirals in the great star systems whirling in space.

Why Do Galaxies Have a Spiral Form  
*Scientific American*, Volume 189, Number 3, September, 1953 (p. 89)

## SPIRAL ARMS

**van de Hulst, H. C.** 1918–2000  
Dutch astronomer

The discovery of spiral arms and – later – of molecular clouds in our Galaxy, combined with a rapidly growing understanding of the birth and decay process of stars, changed interstellar space from a stationary “medium” into an “environment” with great variations in space and time.

In A. Bonetti, J.M. Greenberg and S. Aiello (eds.)  
*Evolution in Interstellar Dust and Related Topics* (p. 5)  
North-Holland Publishing Company. Amsterdam, Netherlands. 1989

## SPIRIT

**Buchner, Ludwig** 1824–99  
German physician and philosopher

A spirit independent of nature cannot exist; for never has an unprejudiced mind, cultivated by science, perceived its manifestations.

*Force and Matter*  
Chapter VI (p. 36)  
Trübner & Co. London, England. 1864

## SPITS

**Schwartz, Maurice L.**  
American geologist

As industrial, residential, and recreational pressures are intensified in the coastal zone our knowledge of the processes operating there must keep ahead, or at least abreast, of man's intrusion. Spits and bars in populated areas throughout the world are becoming encroached upon by some form of human exploitation. Too often after the fact, when the morphology of the structure continues its relentless change, does the populace become aware of what is then called an emergency condition. Suddenly, countermeasures are taken to remedy what was inevitable to begin with.

In Maurice L. Schwartz  
*Spits and Bars*  
Introduction (p. 1)  
Dowden, Hutchinson & Ross, Inc. Stroudsburg, Pennsylvania, USA. 1972



**SPONTANEOUS GENERATION****Urey, Harold Clayton** 1893–1981

American chemist

The common assumption is that the earth and its atmosphere have always been as they are now, but if this is assumed it is necessary to account for the present highly oxidized conditions by some processes taking place early in the earth's history. Briefly, the highly oxidized condition is rare in the cosmos.

On the Early Chemical History of the Earth and the Origin of Life  
*Proceedings of the National Academy of Science USA*, Volume 38, 1952

**SQUARE ROOT****Berlinski, David** 1942–

American mathematician

The square root of 2 is like the Yeti or the Loch Ness monster, the snows of yesterday, the dusky ghost of the dusty window – it is not there, it cannot be found, it is not a part of the furniture of this or any other world.

*A Tour of the Calculus*

Chapter 5 (p. 34)

Pantheon Books. New York, New York, USA. 1995

**SQUARE THE CIRCLE****Aristophanes** 448 BCE–380 BCE

Greek playwright

Met. These are – “Instruments”

An atmospherical geometrical scale.

First, you must understand, that the atmosphere

Is form'd, – in a manner, – altogether, – partly, In the fashion of a furnace, or a funnel; I take this circular arc, with the moveable arm,

And so, by shifting it round, till it coincides At the angle – you understand me?

Pei. Not in the least.

Met. (with animation) I obtain a true division, with the quadrature

Of the equilateral circle.

Translated by J.H. Frere

*The Birds of Aristophanes* (p. 45)

At The University Press. Cambridge, England. 1883

**de Morgan, Augustus** 1806–71

English mathematician and logician

Madmen reason rightly upon wrong premises: Mr. Smith [a circle squarer] reasons wrongly upon no premises at all.

*A Budget of Paradoxes* (p. 319)

Longmans, Green &amp; Co. London, England. 1872

**London, Jack** 1876–1916

American author

I know that at the time I was confident, I had discovered the formula for squaring the circle; but I resolutely deferred the working of it out until after the examinations. Then I would show them.

*John Barleycorn*

Chapter XXII (p. 188)

Mills &amp; Boon. London, England. 1914

**STABILITY****Author undetermined**

Stability is only good if you aren't heading straight into the ground.

Source undetermined

**STALK****Ruskin, John** 1819–1900

English writer, art critic, and social reformer

I perceive, farther, that this disorderly flower [violet] is lifted on a lanky, awkward, springless, and yet stiff flower-stalk; which is not round, as a flower-stalk ought to be, but obstinately square, and fluted, with projecting edges, like a pillar run thin out of an iron-foundry for a cheap railway station.

*Proserpina: Studies of Wayside Flowers* (Volume 2)

Part VII, Chapter I (p. 16)

George Allen. London, England. 1882

**STAMP COLLECTING****Alvarez, Luis Walter** 1911–88

American experimental physicist

Paleontologists...they're really not very good scientists. They're more like stamp collectors.

*New York Times*, 19 January, 1988**Birch, Arthur J.** 1915–1995

Australian chemist

I have never been emotionally attracted by exactitude of detail, but rather by the broad sweep of ideas collected around philosophically defined examples that can be tested experimentally. I have never been a scientific “stamp collector”, although it takes all types to make the world and I have greatly benefited by the “collections” of others...

*To See the Obvious*

Why Chemistry? (pp. 13–14)

American Chemical Society. Washington, D.C. 1995

**Rutherford, Ernest** 1871–1937

English physicist

All science is either physics or stamp collecting.



In J.B. Birks  
*Rutherford at Manchester*  
 Memories of Rutherford (p. 108)  
 W.A. Benjamin Inc. New York, New York, USA. 1963

**Simpson, George Gaylord** 1902–84  
 American paleontologist

Biology starts with biochemistry and goes on to neuro-physiology and genetics. All else is stamp-collecting.  
*This View of Life: The World of an Evolutionist*  
 Chapter Six (p. 108)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1964

## STANDARD

**Woll, Matthew** 1880–1956  
 Luxembourg-born American photo engraver

I know very well that in a great many circles the man who does not enter with a neatly arranged plan, with a set of doctrines, with a rounded and sonorous formula, and with assurance about everything, is set down as something of an old fogey, perhaps reactionary, certainly not one of the elect who are “doing things” and providing guidance for the race. I must assume the risk. I have no formula. [But I shall resist] those who have the formula for so many things and who seek so avidly to force it down the throats of everyone else.

Standardization  
*Annals of the American Academy of Political and Social Science*, Volume 137, May, 1928 (p. 47)

## STAR

**Acton, Loren** 1936–  
 American astronaut and solar physicist

When you look out the other way toward the stars you realize it’s an awful long way to the next watering hole.  
 In Kevin W. Kelley  
*The Home Planet*  
 With Plate 84  
 Addison-Wesley, Reading, Massachusetts, USA. 1988

**Adams, George** 1750–95  
 English instrument maker

New stars offer to the mind a phenomenon more surprising, and less explicable, than almost any other in the science of astronomy.  
*Lectures on Natural and Experimental Philosophy* (Volume 4)  
 Chapter XLIV (p. 213)  
 Printed by R. Hindmarsh. London, England. 1794

**Aiken, Conrad** 1889–1973  
 American poet, short story writer, and novelist

Ice is the silent language of the peak; and fire is the silent language of the star.

*Collected Poems*  
 Sonnet 10  
 Oxford University Press, Inc. New York, New York, USA. 1970

**Alighieri, Dante** 1265–1321  
 Italian poet and writer

...and thence we issued forth again to see the stars.  
 In *Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
 Hell, Canto XXXIV, l. 138–139  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Andreas, Brian** 1956–  
 American artist, sculpture, and storyteller

We lay there & looked up at the night sky & she told me about stars called blue squares & red swirls & I told her I’d never heard of them. Of course not, she said, the really important stuff they never tell you. You have to imagine it on your own.  
*Blue Squares*

**Aratus** 271 BCE–213 BCE  
 Greek statesman

In his fell jaw  
 Flames a star above all others with searing beams  
 Fiercely burning, called by mortals Sirius.  
 In Garrett P. Serviss  
*Astronomy with the Naked Eye*  
 Chapter III (p. 42)  
 Harper & Brothers New York, New York, USA. 1908

**Aristotle** 384 BCE–322 BCE  
 Greek philosopher

We may object that we have been of the stars as mere bodies, and as units with a serial order indeed but entirely inanimate; but should rather conceive them as enjoying life and action.  
 In *Great Books of the Western World* (Volume 8)  
*On the Heavens*  
 Book I, Chapter 12 (p. 383)  
 Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

## Author undetermined

The innumerable, stars like luminous bugs, crawled up the dome of night, but the moon, like a gorgeous shining beetle, had crept with a good deal of briskness out of sight.  
 The Symbol of Darkness  
*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 217)

**Aurelius Antoninus, Marcus** 121–180  
 Roman emperor

The Pythagoreans bid us in the morning look to the heavens that we may be reminded of those bodies which continually do the same thing and in the same manner perform their work, and also be reminded of their purity and nudity. For there is no veil over a star.

In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
 Book XI, # 27 (p. 306)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Look around at the courses of the stars, as if thou wert going along with them; and constantly consider the changes of the elements into one another; for such thoughts purge away the filth of the terrene life.

In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
 Book VII, #47 (p. 282)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bailey, Philip James** 1816–1902  
 English poet

...the stars  
 As dewdrops countless on the aetherial fields  
 Of the skies...

*Festus: A Poem*  
 Scene I (p. 32)  
 George Routledge & Sons, Ltd. London, England. 1893

Surely the stars are images of love.  
*Festus: A Poem*  
 Scene XXXI (p. 510)  
 George Routledge & Sons, Ltd. London, England. 1893

**Baudelaire, Charles** 1821–67  
 French poet

...those stars whose light speaks a known language...  
*The Flowers of Evil*  
 Obsession (p. Ixxix)  
 Wesleyan University Press. Middletown, Connecticut, USA. 1979

**Benét, William Rose** 1886–1950  
 American poet and editor

One speck within vast star-space lying  
 Awoke, arose, resumed its clothing,  
 And crawled another day toward dying.  
*Animalcule*  
 Stanza 7  
 George H. Doran Company. New York, New York, USA. 1927

**Berry, Richard** 1946–  
 American amateur astronomer and author

It is a pity, in an age of rockets and space telescopes, that so few people have a direct acquaintance with the stars. Learning the stars and following their nightly courses across the sky brings a deep satisfaction, a satisfaction born of familiarity with something both ancient and ageless.  
*Discover the Stars* (p. 2)  
 Harmony Books. New York, New York, USA. 1987

**Blake, William** 1757–1827  
 English poet, painter, and engraver

When the stars threw down their spears,

And water'd heaven with their tears,  
 Did he smile his work to see?  
 Did he who made the Lamb make thee?  
*The Complete Poetry and Prose of William Blake*  
 The Tyger  
 University of California Press. Berkeley, California, USA. 1982

**Borland, Hal** 1900–78  
 American writer

...it is the stars that lure man's mind to the endless immensity of a universe so broad that tangible reality can never span it.

*An American Year: Country Life and Landscapes Through the Seasons*  
 June (p. 46)  
 Simon & Schuster. New York, New York, USA. 1946

**Brecht, Bertolt** 1898–1956  
 German writer

SAGREDO [reluctant to go to the telescope]: I feel something not all that remote from fear, Galileo.  
 GALILEO: I'm about to show you one of the shining milkwhite clouds in the Milky Way. Tell me what it's made up of.  
 SAGREDO: Those are stars, innumerable stars.  
 Translated by John Willett  
*Life of Galileo*  
 Scene 3 (p. 26)  
 Arcade Publishing. New York, New York, USA. 1994

**Brewster, David** 1781–1868  
 English physicist

It is no ways probable that the Almighty, who always acts with infinite wisdom, and does nothing in vain, should create so many glorious suns, fit for so many important purposes, and place them at such distances from one another, without proper objects near enough to be benefited by their influences. Whoever imagines they were created only to give a faint glimmering light to the inhabitants of this globe, must have a very superficial knowledge of astronomy, and a mean opinion of the Divine wisdom: since, by an infinitely less exertion of creating power, the Deity would have given our earth much more light by one single additional moon.

*Ferguson's Astronomy, Explained upon Sir Isaac Newton's Principles*  
 (Volume 1)  
 Chapter I (p. 3)  
 Printed for the author. London, England. 1756

**Brood, William J.**  
 No biographical data available

A telescope in the void recently found cosmic “maternity wards” where clouds of interstellar gas and dust appear to be in various stages of giving birth to stars.  
 “Golden Age” of Astronomy Peers to the Edge of the Universe  
*New York Times*, C1, May 8, 1984

**Brown, Fredric** 1906–72  
American writer of science fiction and mystery

Overhead and in the far distance are the lights in the sky that are stars. The stars they tell us we can never reach because they are too far away. They lie; we'll get there. If rockets won't take us, something will.

*The Lights in the Sky Are Stars* (p. 20)

**Browne, J. Stark**  
No biographical data available

The stillness of the heavens is, however, apparent only, for commotion of the fiercest kind is raging on all sides. Stars are suns, and the suns are spheres of fire blazing with fury indescribable; scenes of activity so tremendous that no vehemence of tempest or tornado on earth can give the slightest idea of their fearfulness.

The Number and Distances of the Stars  
*The Rationalist Annual*, 1931 (p. 61)

**Browning, Robert** 1812–89  
English poet

All that I know  
of a certain star,  
Is, it can throw,  
(Like the angled spar)

Now a dart of red,  
Now a dart of blue.

*The Poems and Plays of Robert Browning*  
Dramatic Lyrics, My Star  
The Modern Library. New York, New York, USA. 1934

**Bryant, William Cullen** 1794–1878  
American poet

The sad and solemn night  
Hath yet her multitude of cheerful fires;  
The glorious host of light  
Walk the dark hemisphere till she retires;  
All through her silent watches, gliding slow,  
Her constellations come and climb the heavens and go.

In Parke Godwin (ed.)  
*Poems*  
Hymn to the North Star  
D. Appleton & Company. New York, New York, USA. 1874

**Meredith, Owen (Edward Robert Bulwer-Lytton, First Earl Lytton)** 1831–91  
English statesman and poet

When stars are in the quiet skies,  
Then most I pine for thee;  
Bend on me then thy tender eyes,  
As stars look on the sea.

*The Works of Edward Bulwer-Lytton* (Volume 6)  
Night and Love (p. 59)  
Peter Fenelon Collier. New York, New York, USA. 1892

**Bunting, Basil** 1900–85  
English modernist poet

Furthest, fairest thing, stars, free of our humbug,  
each his own, the longer known, the more alone,  
wrapt in emphatic fire roaring out to a black flue...  
Then is Now. The star you steer by is gone.

*Collected Poems*  
Briggflats, V (p. 58)  
Oxford University Press, Inc. London, England. 1978

**Burke, Edmund** 1729–97  
English statesman and philosopher

The starry heaven, though it occurs so very frequently to our view, never fails to excite an idea of grandeur. This cannot be owing to the stars themselves, separately considered. The number is certainly the cause. The apparent disorder augments the grandeur, for the appearance of care is highly contrary to our idea of magnificence. Besides, the stars lie in such apparent confusion, as makes it impossible on ordinary occasions to reckon them. This gives them the advantage of a

*On Taste; On the Sublime and Beautiful*  
Part I, Magnificence (p. 68)  
P.F. Collier & Son. New York, New York, USA. 1909

**Burnet, Thomas** 1635–1715  
English cleric and scientist

They lie carelessly scatter'd, as if they had been sown in the Heaven, like Seed, by handfuls; and not by a skilful hand neither. What a beautiful Hemisphere they would have made, if they had been plac'd in rank and order, if they had been all dispos'd into regular figures, and the little ones set with due regard to the greater. Then all finished and made up into one fair piece or great Composition, according to the rules of Art and Symmetry.

*The Sacred Theory of the Earth* (2nd edition)  
Book II, Chapter XI (p. 220)  
Printed by R. Norton. London, England. 1691

**Burritt, Elijah H.** 1794–1838  
American astronomer

These vast globes of light then, could never have been designed merely to diversify the voids of infinite space, nor to shed a few glimmering rays on our far distant world, for the amusement of a few astronomers, who, but for the most powerful telescopes, had never seen the ten thousandth part of them.

*The Geography of the Heavens*  
Chapter XVI (p. 154)  
Huntington & Savage, Mason & Law. New York, New York, USA. 1850

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Cry out upon the stars for doing  
Ill offices, to cross their wooing.

*The Poetical Works of Samuel Butler* (Volume 1)  
Part III, Canto I, l. 17  
Bell & Daldy. London, England. 1835

**Campbell, Thomas** 1777–1844  
Scottish poet

...the sentinel stars set their watch in the sky.

*The Complete Poetical Works*  
The Soldier's Dream  
Chadwyck-Healey. Cambridge, England. 1992

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Canopus shining-down over the desert, with its blue diamond brightness (that wild, blue, spirit-like brightness far brighter than we ever witness here), would pierce into the heart of the wild Ishmaelitish man, whom it was guiding through the solitary waste there.

*On Heroes and Hero Worship*  
Lecture I (p. 13)  
John B. Alden, Publisher. New York, New York, USA. 1887

...when I gazed into these Stars, have they not looked down on me as if with pity, from their serene spaces; like Eyes glistening with heavenly tears over the little lot of man! Thousands of human generations, all as noisy as our own, have been swallowed up of Time, and there remains no wreck of them anymore; and Arcturus and Orion and Sirius and the Pleiades are still shining in their courses, clear and young, as when the Shepherd first noted them in the plain of Shinar.

*Sartor Resartus*  
Book II, Chapter VIII (p. 165)  
Ginn & Company. Boston, Massachusetts, USA. 1897

...when I gazed into these Stars, have they not looked down on me as if with pity, from their serene spaces; like Eyes glistening with heavenly tears over the little lot of man! Thousands of human generations, all as noisy as our own, have been swallowed up of Time, and there remains no wreck of them anymore; and Arcturus and Orion and Sirius and the Pleiades are still shining in their courses, clear and young, as when the Shepherd first noted them in the plain of Shinar.

*Sartor Resartus* (Volume 12)  
Book II, Chapter VIII (p. 138)  
Peter Fenelon Collier, Publisher. New York, New York, USA. 1897

The chambers of the East are opened in every land, and the sun comes forth to sow the earth with orient pearl. Night, the ancient mother, follows him with her diadem of stars; and Arcturus and Orion call me into the Infinitudes of space as they called the Druid priest or the shepherd of Chaldea. Bright creatures! how they gleam like spirits through the shadows of innumerable ages from their thrones in the boundless depths of heaven.

In James Anthony Froude  
*Thomas Carlyle* (Volume 1)  
Chapter XVII (p. 244)  
Charles Scribner's Sons. New York, New York, USA. 1882

**Cernan, Eugene** 1934–  
American astronaut

I know the stars are my home. I learned about them, needed them for survival in terms of navigation. I know where I am when I look up at the sky. I know where I am when I look up at the Moon; it's not just some abstract romantic idea, it's something very real to me. See, I've expanded my home.

The View from Out There: In Words and Pictures  
*Life*, Volume 11, Number 13, November, 1988 (p. 198)

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

No one regards things before his feet  
But views with care the regions of the sky.

Translated by William Armistead Falconer  
*Cicero: De Senectute, De Amicitia, De Divinatione*  
De Divinatione, II, XIII (p. 403)  
Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

No man who has lived all his life on the surface of a planet has ever seen the stars, only their feeble ghosts.

The Road to the Sea, Spring  
*Fiction House Magazine*, Volume 1, Number 2, 1951

Overhead, without any fuss, the stars were going out.

*The Collected Stories of Arthur C. Clarke*  
*The Nine Billion Names of God* (p. 422)  
Tom Doherty Associates. New York, New York, USA. 2001

Sooner or later we will come to the edge of the Solar System and will be looking out across the ultimate abyss. Then we must choose whether we reach the stars – or whether we wait until the stars reach us.

*The Challenge of the Spaceship*  
The Planets Are Not Enough (p. 65)  
Harper & Brothers. New York, New York, USA. 1959

The thing's hollow – it goes on forever – and – oh my God! – it's full of stars.

*2001: A Space Odyssey*  
V. The Moons of Saturn, Chapter 39 (p. 191)  
New American Library, New York, New York, USA. 1968

**Clarke, M'Donald (The Mad Poet)** 1798–1842  
American poet

Whilst twilight's curtain spreading far,  
Was pinned with a single star.

*Poems of M'Donald Clarke*  
Death in Disguise, l. 227  
J.W. Bell. New York, New York, USA. 1837

**Clegg, Johnny** 1953–  
English musician

...we are the scatterlings of Africa

On a journey to the stars...

*Scatterlings of Africa*

From the CD *Scatterlings of Africa*

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

That a science of stellar chemistry should not only have become possible, but should already have made material advances, is assuredly one of the most amazing features in the swift progress of knowledge our age has witnessed. Custom can never blunt the wonder with which we must regard the achievement of compelling rays emanating from a source devoid of sensible magnitude through immeasurable distance, to reveal, by its peculiarities, the composition of that source.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Chapter XII (p. 450)

Adam & Charles Black. London, England. 1893

When all the stars blaze out on a clear, moonless night, it seems as if it would be impossible to count them...

*The System of the Stars* (2nd edition)

Chapter 1 (p. 1)

Adam & Charles Black. London, England. 1905

**Cohen, Martin**

No biographical data available

To be a star is to know eternal stress. To live as a star is to walk a never ending tightrope, knowing that there can be only one outcome – your fall.

In Byron Preiss (ed.)

*The Universe*

Star Birth and Maturity (p. 68)

Bantam Books. Toronto, Ontario, Canada. 1987

**Cole, Thomas** 1627–97  
English theologian

How lovely are the portals of the night,

When stars come out to watch the daylight die.

Twilight

Source undetermined

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

...the stars hang bright above her dwelling,

Silent as though they watched the sleeping Earth!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

Dejection: An Ode, Stanza VIII

The Clarendon Press. Oxford, England. 1912

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

How dismal a universe it would be without the lights of the stars to probe its infinite blackness.

*The Endless Adventure*

The Early Days of May (p. 148)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Comte, Auguste** 1798–1857  
French philosopher

We can imagine the possibility of determining the shapes of stars, their distances, their sizes, and their movements; whereas there is no means by which we will ever be able to examine their chemical composition, their mineralogical structure, or especially, the nature of organisms that live on their surfaces.... Our positive knowledge with respect to the stars is necessarily limited to their observed geometrical and mechanical behavior.

*The Positive Philosophy of Auguste Comte* (Volume 2) (p. 9)

John Chapman. London, England. 1853

On the subject of stars, all investigations which are not ultimately reducible to simple visual observations are... necessarily denied to us.... We shall never be able by any means to study their chemical composition.

In Neil deGrasse Tyson

Over the Rainbow

*Natural History*, Volume 110, Number 7, September, 2001 (p. 33)

**Cooper, James Fenimore** 1789–1851  
American writer

No star seemed less than what science has taught us that it is...

*The Sea Lions; Or, The Lost Sealers*

Chapter 28 (p. 401)

Hurd & Houghton. New York, New York, USA. 1871

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The eye so soon as ever it is opened beholds all the stars of our hemisphere.

In Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I: Life (p. 56)

Duckworth & Co. London, England. 1906

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

...the first and highest of all is the sphere of the fixed stars, which comprehends itself and all things, and is accordingly immovable.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Chapter 10 (p. 526)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Crane, Hart** 1899–1932  
American poet

Stars scribble on our eyes the frosty sagas,

The gleaming cantos of unvanquished space.

In Brom Weber (ed.)

*The Complete Poems and Selected Letters and Prose of Hart Crane*

Cape Hatteras

Anchor Books. Garden City, New York, USA. 1966

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

The stars have larger agendas in which the preoccupations of human pettiness do not figure.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 6 (p. 117)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil, no good, nothing but blind, pitiless indifference.

*River Out of Eden: A Darwinian View of Life*

Chapter 4 (p. 133)

Basic Books, Inc. New York, New York, USA. 1995

**de la Mare, Walter** 1873–1956

English poet and novelist

Wide are the meadows of night  
And daisies are shining there,  
Tossing their lovely dew,  
Lustrous and fair,  
And through these sweet fields go,  
Wanderers amid the stars –  
Venus, Mercury, Uranus, Neptune,  
Saturn, Jupiter, Mars.

*Peacock Pie: A Book of Rhymes*

The Wanderers

A. Constable & Company. London, England. 1913

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

All men have the stars...but they are not the same things for different people. For some, who are travelers, the stars are guides. For others they are no more than little lights in the sky. For others, who are scholars, they are problems. For my businessman they were wealth. But all these stars are silent. You – you alone – will have the stars as no one else has them...

Translated by Katherine Woods

*The Little Prince*

Chapter XXVI (p. 85)

Harcourt, Brace & Company. New York, New York, USA. 1943

**de Tabley, Lord** 1835–95

English literary scholar and botanist

The May-fly lives an hour,  
The star a million years;  
But as a summer flower,  
Or as a maiden's fears,  
They pass, and heaven is bare  
As tho' they never were.

*The Collected Poems of Lord de Tabley*

Hymn to Astarte

Chapman and Hall. London, England. 1903

**Dee, John** 1527–1609

English mathematician and occultist

The stars and celestial powers are like seals whose characters are imprinted differently by reason of differences in the elemental matter.

*John Dee on Astronomy*

XXVI (p. 135)

University of California Press. Berkeley, California, USA. 1978

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Come forth, O man! yon azure round survey,  
And view those lamps which yield eternal day.  
Bring forth thy glasses; clear thy wondering eyes;  
Millions beyond the former millions rise;  
Look further; – millions more blaze from yonder skies.

*The Works of Thomas Dick, LL.D.*

The Solar System, Volume 10, Chapter VIII (p. 197)

**Dickinson, Emily** 1830–86

American lyric poet

“Arcturus” is his other name –  
I'd rather call him “star.”

It's very mean of Science

To go and interfere!

*The Complete Poems of Emily Dickinson*

No. 70 (p. 36)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Disraeli, Benjamin, First Earl**

**of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

It shows you exactly how a star is formed; nothing can be so pretty! A cluster of vapor, the cream of the milky way, a sort of celestial cheese, churned into light...

*Tancred*

Book I, Chapter IX

H. Colburn. London, England. 1847

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Are you conscious of the restful influence which the stars exert? To me they are the most soothing things in Nature. I am proud to say that I don't know the name of one of them. The glamour and romance would pass away from them if they were all classified and ticketed in one's brain. But when a man is hot and flurried, and full of his own little ruffled dignities and infinitesimal misfortunes, then a star bath is the finest thing in the world.

*The Stark Munro Letters*

Letter VIII (p. 170)

D. Appleton & Company. New York, New York, USA. 1895

**Eastman, Barrett**

No biographical data available

...Up there in the darkness behind the stars...

In Sidney A. Witherbee

*Spanish-American War Songs*

In A Hammock Shroud (p. 341)

Sidney A. Witherbee. Detroit, Michigan, USA. 1898



**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We are bits of stellar matter that got cold by accident, bits of a star gone wrong.

*New York Times Magazine*, October 9, 1932

...with this brief glance at the scenery that we pass we shall plunge into the deep interior [of a star] – where the eye cannot penetrate, but where it is yet possible by scientific reasoning to learn a great deal about the conditions.

*Stars and Atoms*

Lecture I (p. 11)

Yale University Press. London, England. 1927

Our object in diving into the interior [of a star] is not merely to admire a fantastic world with conditions transcending ordinary experience; it is to get at the inner mechanism which makes stars behave as they do. If we are to understand the surface manifestations, if we are to understand why “one star differeth from another star in glory,” we must go below to the engine-room – to trace the beginning of the stream of heat and energy which pours out through the surface.

*Stars and Atoms*

Lecture I (p. 20)

Yale University Press. London, England. 1927

We can now form some sort of a picture of the inside of a star – a hurly burly of atoms, electrons and ether-waves. Disheveled atoms tear along at a hundred miles a second, their normal array of electrons being torn from them in the scrimmage. The lost electrons are speeding a hundred times faster to find new resting places...

*Stars and Atoms*

Lecture I (p. 26)

Yale University Press. London, England. 1927

I am aware that many critics consider the conditions in the stars not sufficiently extreme...the stars are not hot enough. The critics lay themselves open to an obvious retort: we tell them to go and find a hotter place.

*Stars and Atoms*

Lecture III (p. 102)

Yale University Press. London, England. 1927

...it is reasonable to hope that in a not too distant future we shall be competent to understand so simple a thing as a star.

*The Internal Constitution of the Stars*

Chapter XIII (p. 393)

At The University Press. Cambridge, England. 1930

The star has to go on radiating and radiating and contracting and contracting until, I suppose, it gets down to a few km. radius, when gravity becomes strong enough to hold in the radiation, and the star can at last find peace.... I think there should be a law of Nature to prevent a star from behaving in this absurd way!

January 11 meeting of the Royal Astronomical Society

*The Observatory*; Volume 58, Number 729, February, 1935 (p. 38)

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

The stars are golden fruit upon a tree

All out of reach.

*The Spanish Gypsy*

Book II

Blackwood and Sons. Edinburgh, Scotland. 1868

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The stars awaken a certain reverence, because though always present, they are inaccessible...

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

*Nature: Addresses and Lectures*

Chapter I (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

But every night comes out the envoys of beauty, and light the universe with their admonishing smile.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Nature (p. 9)

The Library of America. New York, New York, USA. 1983

If a man would be alone, let him look at the stars. The rays that come from those heavenly worlds, will separate between him and what he touches. One might think the atmosphere was made transparent with this design, to give man, in the heavenly bodies, the perpetual presence of the sublime. Seen in the streets of cities, how great they are!

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses and Lectures*

Nature (p. 9)

The Library of America. New York, New York, USA. 1983

If the stars should appear one night in a thousand years, how would men believe and adore and preserve for many generations the remembrance of the city of God which had been shown.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Nature (p. 9)

The Library of America. New York, New York, USA. 1983

The stars awaken a certain reverence, because though always present, they are always inaccessible...

*Essays, Orations and Lectures*

*Nature*

Chapter I (p. 3)

William Tegg & Co. London, England. 1848

**Flecker, James Elroy** 1884–1915

English poet and playwright

West of these out to seas colder than the Hebrides I must go

Where the fleet of stars is anchored and the young Star-captains glow.

*The Collected Poems of James Elroy Flecker*

*The Dying Patriot*

Martin Secker. London, England. 1916

**Fraunhofer, Joseph von** 1787–1826  
German optician and physicist

*Approximavit sidera*  
He brought the stars closer  
*Epitaph on his gravestone*

**Frost, Robert** 1874–1963  
American poet

They cannot scare me with their empty spaces  
Between stars – on stars where no human race is.  
*Complete Poems of Robert Frost*  
Desert Places  
Henry Holt & Company. New York, New York, USA. 1949

I could be worse employed  
Than as a watcher of the void,  
Whose part should be to tell  
What star if any fell.  
Suppose some seed-pearl sun  
Should be the only one;  
Yet still I must report  
Some cluster one star short.  
I should justly hesitate  
To frighten church or state  
By announcing a star down  
From, say, the Cross or Crown.  
To make sure what star I missed  
I should have to check on my list  
Every star in sight.  
It might take me all night.

*Complete Poems of Robert Frost*  
On Making Certain Anything Has Happened  
Henry Holt & Company. New York, New York, USA. 1949

**Gamow, George** 1904–68  
Russian-born American physicist

Twinkle, twinkle, quasi-star  
Biggest puzzle from afar  
How unlike the other ones  
Brighter than a billion suns  
Twinkle, twinkle, quasi-star  
How I wonder what you are.

In Louis Berman  
*Exploring the Cosmos*  
Chapter 14 (p. 311)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

Whereas all humans have approximately the same life expectancy, the life expectancy of stars varies as much as from that of a butterfly to that of an elephant.

*A Star Called the Sun* (p. 145)  
The Viking Press. New York, New York, USA. 1964

**Gill, Sir David** 1843–1914  
Scottish astronomer

The stars are the crucibles of the Creator.

Inaugural Address  
*Nature*, Volume 76, Number 1970, August 1, 1907 (p. 326)

**Goddard, Robert H.** 1882–1945  
American physicist

There can be no thought of finishing, for “aiming at the stars,” both literally and figuratively, is a problem to occupy generations, so that no matter how much progress one makes, there is always the thrill of just beginning.

In Eugene Mallove and Gregory Matloff  
*The Starflight Handbook*  
Letter to H.G. Wells, April 20, 1932 (p. 1)  
John Wiley & Sons, Inc. New York, New York, USA. 1989

**Goodenough, Ursula** 1943–  
American biologist

I lie on my back under the stars and the unseen galaxies and I let their enormity wash over me. I assimilate the vastness of the distances, the impermanence, the fact of it all. I go all the way out and then I go all the way down, to the fact of photons without mass and gauge bosons that become massless at high temperatures. I take in the abstractions about forces and symmetries and they caress me, like Gregorian chants because the words are so haunting.

*The Sacred Depths of Nature*  
Chapter I. Reflections (pp. 12–13)  
Oxford University Press, Inc. New York, New York, USA. 1998

**Greenstein, George** 1940–  
American astronomer

Overhead, the stars are strewn across a darkness, a blackness so profound that for a moment, for the barest flicker of an instant, I can almost sense their inconceivable distance. In a sudden; exalting burst of vertigo I fancy what it would be like to fly, to fall up and into that ocean.

*The Symbiotic Universe*  
Prologue (p. 29)  
William Morrow & Company, Inc. New York, New York, USA. 1988

**Gronidal, Florence Armstrong**  
American astronomer and photographer

...if all the wondrous phenomena of visible stars could be seen on but one of the nights of our long ride about the sun, the civilized world would spend its last cent on glasses and sit up until dawn to feast its eyes on the sublimity of the spectacle.

*The Music of the Spheres: A Nature Lover's Astronomy*  
Chapter II (p. 16)  
The Macmillan Company. New York, New York, USA. 1926

If all the diamonds in the world were melted into one huge magical jewel, its sparkling brilliance would pale beside Sirius, the diamond of the heavens.

*The Music of the Spheres: A Nature Lover's Astronomy*  
Chapter VIII (p. 159)  
The Macmillan Company. New York, New York, USA. 1926

**Guilleimin, Amédée** 1826–93

French journalist and scientific writer

What are those brilliant points – those innumerable stars, which, never dim, shine out unceasingly from the dark profound? Are they sown broadcast – orderless, with no other bond save that which perspective lends to them? Or, if not immovable, as we have so long imagined if not golden nails fixed to a crystal vault, whither are they bound?

*The Heavens: An Illustrated Handbook of Popular Astronomy*

(2nd edition)

The Heavens (p. 1)

Richard Bentley. London, England. 1868

Nothing is more fitted to elevate the mind towards the infinite than the thoughtful contemplation of the starry vault in the silent calm of night. A thousand fires sparkle in all parts of the sombre azure of the sky. Varied in colour and brilliancy, some shine with a vivid light, perpetually changing and twinkling; others, again, with a more constant one – more tranquil and soft; while very many only send us their rays intermittently, as if they could scarce pierce the profundity of space.

In Norman Lockyer and Richard Anthony Proctor

*The Heavens: An Illustrated Handbook of Popular Astronomy*

The Heavens (p. 2)

Richard Bentley &amp; Son. London, England. 1878

**Guiterman, Arthur** 1871–1943

Austrian-American poet

While poets feign that, passing earthly bars,  
We Fireflies shall someday shine as Stars,  
Our scientists, more plausibly surmise  
That Stars are underdeveloped Fireflies.

*Gaily the Troubadour*

My Firefly Stars (p. 187)

E.P. Dutton &amp; Company, Inc. New York, New York, USA. 1936

When the bat's on the wing and the bird's in the tree,  
Comes the starlighter, whom none may see.

First in the West where the low hills are,

He touches his wand to the Evening Star.

Then swiftly he runs on his rounds on high,

Till he's lit every lamp in the dark blue sky.

*Gaily the Troubadour*

The Starlighter (p. 190)

E.P. Dutton &amp; Company, Inc. New York, New York, USA. 1936

**Habington, William** 1605–54

English poet

The starres, bright cent'nels of the skies.

*The Poems of William Habington*

Dialogue between Night and Araphil, l. 3

University Press of Liverpool. Liverpool, England. 1948

**Halpern, Paul**

Professor of mathematics and physics

Stars are not shy. They make their presence known for

trillions of miles around them by the generous stream of radiation that they cast off each second into space.

*The Quest for Alien Planets: Exploring Worlds outside the Solar System*

Chapter VI (p. 169)

Plenum Press. New York, New York, USA. 1997

**Hardy, Thomas** 1840–1928

English poet and regional novelist

The sky was clear – remarkably clear – and the twinkling of all the stars seemed to be but throbs of one body, timed by a common pulse.

*Far from the Madding Crowd*

Chapter 2 (p. 9)

Harper &amp; Row, Publishers. New York, New York, USA. No date

The sovereign brilliance of Sirius pierced the eye with a steely glitter, the star called Capella was yellow, Aldebaran and Betelgeux shone with a fiery red. To persons standing alone on a hill during a clear midnight such as this, the roll of the world eastward is almost a palpable movement.

*Far from the Madding Crowd*

Chapter 2 (p. 9)

Harper &amp; Row, Publishers. New York, New York, USA. No date

... whatever the stars were made for, they were not made to please our eyes.

*Two on a Tower* (Volume 1)

Chapter IV (p. 71)

Sampson, Low, Marston, Searle &amp; Rivington. London, England. 1882

**Harjo, Joy** 1951–

Native American poet

I can hear the sizzle of newborn stars, and know anything of meaning, of the fierce magic emerging here. I am witness to flexible eternity, the evolving past, and I know we will live forever, as dust or breath in the face of stars, in the shifting pattern of winds.

*Secrets from the Center of the World* (p. 56)

The University of Arizona Press, Tucson, Arizona. 1989

**Hearn, Lafcadio** 1850–1904

Greek-born American writer

The infinite gulf of blue above seems a shoreless sea, whose foam is stars, a myriad million lights are throbbing and flickering and palpitating...

In Elizabeth Bisland

*The Life and Letters of Lafcadio Hearn* (Volume 1)

Letter to H.E. Krehbiel, 1877 (p. 170)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Hegel, Georg Wilhelm Friedrich** 1770–1831

German philosopher

The stars are not pulled this way and that by mechanical forces; theirs is a free motion. They go on their way, as the ancients said, like the blessed gods.

*Werke*

Bd. 7, Abt. I (p. 97)

Publisher undetermined

**Hein, Robert**

No biographical data available

The stars are luminous dandruff from the deity's beard.  
When the god-head combs his hair  
A new star appears in the sky;  
Yet God is not almost bald...

*Quest of the Singing Tree*

Stanzas on the Stars

H. Harrison. New York, New York, USA. 1938

**Heine, Heinrich** 1797–1856

German poet

Perhaps the stars in the sky only appear to us to be so beautiful and pure because we are so far away from them and do not know their intimate lives. Up above there are certainly a few stars that lie and beg; stars that put on airs; stars that are forced to commit all possible transgressions; stars that kiss and betray each other; stars that flatter their enemies and, what is even more painful, their friends, just as we do here below.

*The Romantic School and Other Essays*

The Romantic School, Book Two, Chapter III (p. 73)

Continuum. New York, New York, USA. 1985

**Heppenheimer, T. A.** 1947–

American space aviation writer

From the stars has come the matter of our world and of our bodies, and it is to the stars that we will someday return.

*Toward Distant Suns*

Preface (p. 13)

Stackpole Books. Harrisburg, Pennsylvania, USA. 1979

**Herrick, Robert** 1591–1674

English poet

The starres of the night  
Will lend thee their light  
Like Tapers cleare without number.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

The Night-Piece, to Julia, Stanza 3

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

We may strongly suspect that there is not, in strictness of speaking, one fixed star in the heavens, and reasons which I shall adduce will render this so obvious that there can hardly remain a doubt of the general motion of all the starry systems, and, consequently, of the solar one among the rest.

On the Proper Motion of the Sun and Solar System

*Philosophical Transactions of the Royal Society of London,*

Volume 73, 1783 (p. 248)

“We ought perhaps,” says [Sir John Frederick William] Herschel, “to look upon certain clusters of stars, and the destruction of a star now and then in some thousands of ages, as the very means by which the whole is preserved and renewed. These clusters may be the laboratories of the universe, wherein the most salutary remedies for the decay of the whole are prepared.”

*Philosophical Transactions of the Royal Society of London,* 1785 (p. 217)

That stars are suns can hardly admit of a doubt. The sun turns on its axis; so do variable stars; most probably all stars. Stars have spots like the sun; in some stars we know these spots to be changeable.

On the Nature and Contraction of the Sun and Fixed Stars

*Philosophical Transactions of the Royal Society of London,*

Volume 85, 1795 (p. 68)

I resolved to examine every star in the heavens with the utmost attention, and a very high power, that I might collect such materials for this research as would enable me to fix my observations on those that would best answer my end. The subject has already proved so extensive, and still promises so rich a harvest to those who are inclined to be diligent in the pursuit, that I cannot help inviting every lover of astronomy to join with me in observations that must inevitably lead to new discoveries.

In Edward Crossley & Joseph Gledhill

*A Handbook of Double Stars*

Part I, Part I, Chapter I (p. 3)

Macmillan & Co Ltd. London, England. 1879

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

The stars are the land-marks of the universe...

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

An Address

April 11, 1827 (p. 469)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

If it were not perhaps too hazardous to pursue a former surmise of a renewal in what I figuratively called the Laboratories of the universe, the stars forming these extraordinary nebulae, by some decay or waste of nature, being no longer fit for their former purposes, and having their projectile forces, if any such they had, retarded in each other's atmosphere, may rush at last together, and either in succession, or by one general tremendous shock, unite into a new body. Perhaps the extraordinary and sudden blaze of a new star in Casiopeia's chair, in 1572, might possibly be of such a nature.

On the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London,*

Volume 75, 1785

**Hilliard, George Stillman** 1808–79  
American politician

The stars are the poetry of heaven, but do they become its prose to the instructed eye, which sees in them, not points of gold upon a ground of blue, but worlds of beauty peopling the infinite depths of space?

*The Relation of the Poet to His Age*

Discourse (p. 38)

Charles C. Little & James Brown. Boston, Massachusetts, USA. 1843

**Hodgson, Ralph** 1871–1962  
English poet

I stood and stared, the sky was lit,  
The sky was stars all over it,  
I stood, I knew not why,  
Without a wish, without a will,  
I stood upon that silent hill  
And stared into the sky until  
My eyes were blind with stars and still  
I stared into the sky.

*Collected Poems*

The Song of Honour

Macmillan & Company Ltd. London, England. 1961

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

And Science lifts her still unanswered cry:  
“Are all these worlds, that speed their circling flight,  
Dumb, vacant, soulless – baubles of the night?”  
...Or rolls a sphere in each expanding zone  
Crowned with a life as varied as our own?

*The Poems of Oliver Wendell Holmes: With Numerous Illustrations*

The Secret of The Stars

Houghton Mifflin Company. Boston, Massachusetts, USA. 1887

**Hopkins, Gerard Manley** 1844–89  
English poet and Jesuit priest

Look at the stars! look, look up at the skies!  
O look at all the fire-folk sitting in the air!

In Norman H. MacKenzie (ed.)

*The Poetical Works of Gerard Manley Hopkins*

The Starlight Night

Clarendon Press. Oxford, England. 1990

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE  
Roman philosopher and dramatic critic

With my head exalted I shall touch the stars.

*Carmina*

I, I, 36

Rupert Hart-Davis. London, England. 1963

**Hovey, Richard** 1864–1900  
American composer, poet, and artist

The dawn is lonely for the sun,  
And chill and drear;

The one lone star is pale and wan,  
As one in fear.

*Along the Trail: A Book of Verse*

Chanson de Rosemonde

Small, Maynard & Company. Boston, Massachusetts, 1898

**Howe, Herbert Alonzo** 1858–1926  
American astronomer

The starry spheres which roll and shine, uncounted millions, in the infinite depths of space call us away from the common things of earth, and bid us plume our spirits for the loftiest flights.

*A Study of the Sky*

Chapter I (p. 15)

Charles Scribner's Sons. New York, New York, USA. 1901

...when the clangor and roar of the world's traffic have died away, and the last glint of the retiring sun has vanished from the mountain top; when the soft shades of the evening twilight gradually melt into the darkness of the night, and the blessed shadow of the earth steals over the abodes of men, bringing rest and refreshment of mind, then come forth the troops of radiant orbs, filling the sky with their splendid array, and giving to the mind of the beholder a portion of their own eternal calm.

*A Study of the Sky*

Chapter I (p. 15)

Charles Scribner's Sons. New York, New York, USA. 1901

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

The stars are best seen as a spectacle, not from everyday surroundings where trees and buildings, to say nothing of street lighting, distract the attention too much, but from a steep mountainside on a clear night, or from a ship at sea. Then the vault of heaven appears incredibly large and seems to be covered by an uncountable number of fiery points of light.

*The Nature of the Universe*

Chapter 3 (p. 51)

The University Press. Cambridge. 1933

It is unlikely that stars die without a spectacular protest.

*Frontiers of Astronomy*

Chapter Nine (p. 160)

Harper & Row, Publishers. New York, New York, USA. 1955

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

An ant weighs upon the earth; a star can well weigh upon the universe.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 409)

The Heritage Press. New York, New York, USA. 1961



**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

And all about the cosmic sky,  
The black that lies beyond our blue,  
Dead stars innumerable lie,  
And stars of red and angry hue  
Not dead but doomed to die.

*The Captive Shrew and Other Poems of a Biologist*  
Cosmic Death  
Harper & Brothers. New York, New York, USA. 1933

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

For if 25 years are required for a Bullet out of a Cannon,  
with its utmost Swiftness, to travel from the Sun to  
us...such a Bullet would spend almost seven hundred  
thousand years in its Journey between us and the fix'd  
Stars. And yet when in a clear night we look upon them,  
we cannot think them above some few miles over our  
heads.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions* (pp. 154–155)  
Printed for T. Childe. London, England. 1698

**Jacobson, Ethel** 1877–1965  
New Zealand teacher, newspaper editor, and journalist

Crystal fish  
Caught in the seine  
Of the trawler, Night.

Stars  
*Nature Magazine*, May, 1958 (p. 260)

**Jastrow, Robert** 1925–  
American space scientist

The stars seem immutable, but they are not. They are  
born, evolve and die like living organisms.

*Red Giants and White Dwarfs*  
Chapter 4 (p. 50)  
Harper & Row. New York, New York, USA. 1969

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The ages of the stars are not the same thing as the age of  
the universe, nor even are they necessarily comparable  
with that age. The star may be likened to icebergs coming  
down from the North and melting as they drift into tropical  
waters. We can estimate the age of the icebergs within  
our vision, but we cannot say for how long the stream of  
icebergs has been drifting down from the pole to equator  
nor for how long new icebergs will continue to form and  
come down to replace those that pass southward to their  
doom.

*Annual Report of the Board of Regents of the Smithsonian Institution*,  
1926  
The New Outlook in Cosmogony (p. 159)  
Government Printing Office. Washington, D.C. 1928

Any small bit of the sky does not look very different from  
what it would if bright and faint stars had been sprinkled  
out of a celestial pepper pot.

*The Universe Around Us*  
Chapter I (p. 37)  
The Macmillan Company. New York, New York, USA. 1929

Empty Waterloo Station of everything except six specks  
of dust and it is still far more crowded with dust than  
space is with stars.

*The Universe Around Us*  
Chapter I (p. 84)  
The Macmillan Company. New York, New York, USA. 1929

**Jefferies, Richard** 1848–87  
English naturalist and author

The first appearance of a star is very beautiful; the actual  
moment of first contact, as it were, of the ray with the  
eye is always a surprise, however often you may have  
enjoyed it, and notwithstanding that you are aware it  
will happen. Where there was only the indefinite violet  
before, the most intense gaze into which could discover  
nothing, suddenly, as if at that moment born, the point  
of light arrives. So glorious is the night that not all London,  
with its glare and smoke, can smother the sky; in  
the midst of the gas, and the roar, and the driving crowd,  
look up from the pavement, and there, straight above, are  
the calm stars.

*Nature near London*  
Magpie Fields (p. 179)  
Chatto & Windus. London, England. 1883

Above the clear sky was full of stars, and among them  
the beautiful planet Jupiter shone serene. The sky was  
of a lovely night blue; it was an hour to think, to dream,  
to revere, to love – a time when, if ever it will, the soul  
reigns, and the coarse rude acts of day are forgotten in  
the aspirations of the inmost mind. The night was calm –  
still; it was in no haste to do anything – it had nothing it  
needed to do. To be is enough for the stars.

*The Dewy Morn*  
Chapter XX (p. 141)  
Macmillan & Company Ltd. London, England. 1900

**Jeffers, Robinson** 1887–1962  
American poet

Antares reddens  
The great one, the ancient torch, a lord among lost children,  
The earth's orbit doubled would not girdle his greatness,  
one fire  
Globed, out of grasp of the mind enormous; but to you  
O Night  
What? Not a spark?...

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 1)  
Night (p. 115)  
Stanford University Press. Stanford, California. USA. 1988



We know the stars, hotter and more fatal than earth; we  
 have learned lately the fire-wheel galaxies,  
 Infinite in number or all but infinite, among which our  
 great sun's galaxy's  
 Flight is as a gnat's, one grain of sand in the Sahara: it is  
 necessary to stretch our minds  
 To these dimensions...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 4)

Not Solid Earth (p. 538)

Stanford University Press. Stanford, California. USA. 1988

**Joyce, James** 1882–1941

Irish expatriate writer and poet

...of the parallax or parallactic drift of so called fixed  
 stars, in reality ever moving wanderers from immeasurably  
 remote eons to infinitely remote futures in comparison  
 with which the years threescore and ten, of allotted  
 life formed a parenthesis of infinitesimal brevity.

*Ulysses* (p. 683)

Random House, Inc. New York, New York, USA. 1946

**Kapteyn, Jacobus Cornelius** 1851–1922

Dutch astronomer

Undoubtedly one of the greatest difficulties, if not the  
 greatest of all, in the way of obtaining an understanding  
 of the real distribution of stars in space, lies in our uncer-  
 tainty about the amount of loss suffered by the light of  
 the stars on its way to the observer.

On the Absorption of Light in Space

*The Astrophysical Journal*, Volume XXIX, Number 1, January, 1909

(p. 46)

**Keats, John** 1795–1821

English Romantic lyric poet

Bright star, would I were steadfast as thou art –  
 Not in lone splendor hung aloft the night  
 And watching, with eternal lids apart,  
 Like Nature's patient, sleepless Eremite,  
 The moving waters at their priest-like task  
 Of pure abluion round earth's human shores.

*The Complete Poetical Works and Letters of John Keats*

Bright Star

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

The fixed stars appear to be of different bignesses, not  
 because they really are so, but because they are not all  
 equally distant from us; those that are nearest will excel  
 in Luster and Bigness; the more remote stars will give a  
 fainter Light, and appear smaller to the Eye.

*An Introduction to the True Astronomy*

Lecture VI (p. 47)

Printed for Bernard Lintot. London, England. 1721

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

The stars are little twinkling rogues who light us home  
 sometimes when we are drunk but care for neither you  
 nor me nor any man.

*The Twelve Seasons*

June (p. 46)

W. Sloane Associates. New York, New York, USA. 1949

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

While we raise our eyes to the firmament, we see the  
 whole of the stars attached, as it were, to the same  
 vaulted surface; this, however, is an optical illusion; they  
 are, in reality, at very different distances from us, as well  
 as from the Sun, which is the fixed star of our system.

Translated by James Jacque

*Kosmologischen Brief*

1761

**Lee, Nathaniel** 1653?–92

English dramatist

The stars, heav'n sentry, wink and seem to die.

*Theodosius*

Printed for Tho. Chapman. London, England. 1692

**Levy, David H.** 1948–

Canadian astronomer and science writer

Our fondness for the stars has touched our souls. We all  
 share the feeling of discovery, whether the object we  
 have found is new to all or new only to us. The thrill  
 penetrates our being, as we try to describe...how we have  
 been changed by the universe sharing a secret with us.

*David Levy's Guide to the Night Sky*

A Miscellany (p. 322)

Cambridge University Press. Cambridge, England. 2000

...observing is an activity that can rapidly become your  
 outlet to relax, your means to commune with the uni-  
 verse, and a vital key to knowing yourself...a voyage on  
 a magic carpet that takes you to other places and other  
 times. Even a casual look at the stars gives you a share  
 in the company of timelessness that they represent. Look  
 through your telescope thoughtfully...for it is more than  
 starlight that the mirror will reflect. Through the vastness  
 of space and time will return also a part of yourself.

*The Royal Astronomical Society of Canada*

The Joy of Gazing, 1982, Montreal Centre

**Longfellow, Henry Wadsworth** 1807–82

American poet

Silently one by one, in the infinite meadows of heaven  
 Blossomed the lovely stars, the forget-me-nots of the angels.

*The Poetical Works of Henry Wadsworth Longfellow*

Evangeline, Part iii

Houghton, Mifflin Company. Boston, Massachusetts, USA. 1883

The stars arise, and the night is holy.

*The Poetical Works of Henry Wadsworth Longfellow*

Hyperion, Book I, Chapter 1

Houghton, Mifflin. Boston, Massachusetts, USA. 1883

**Lowell, Percival** 1855–1916

American astronomer

...when we think that each of these stars is probably the centre of a solar system grander than our own, we cannot seriously take ourselves to be the only minds in it all.

*Mars*

Chapter I (p. 5)

Longmans, Green, & Co. London, England. 1896

Bright points in the sky or a blow on the head will equally cause one to see stars.

*Mars*

Chapter IV (p. 159)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Macfie, Ronald Campbell** 1867–1931

Scottish poet and physician

One thing is certain, that space is full of millions and millions of shining suns, wherever they came from and however they were evolved, and that there are millions and millions more of dead, dark stars we cannot see. One is apt to forget the dead, dark stars, but they far outnumber those that shine – so much so that Sir Robert Ball says that luminous stars are but the glowworms and fireflies of the universe as compared with the myriads of other animals.

*Science, Matter and Immortality*

Chapter XI (p. 131)

William & Norgate. London, England. 1909

**Mandino, Og** 1923–96

American sales guru and author

I will love the light for it shows me the way; yet I will love the darkness for it shows me the stars.

*The Greatest Salesman in the World*

Chapter Nine (p. 59)

Bantam Trade Edition. New York, New York, USA. 1985

**Martin, Martha Evans**

No biographical data available

...a starry night is beautiful and we gaze at it and enjoy it and do not care to know more about it in detail. But if by chance we come to know by name one bright star, it immediately separates itself from all the others and becomes an individual.

*The Friendly Stars*

Introduction (p. 4)

Harper & Brothers Publishers. New York, New York, USA. 1907

**Milton, John** 1608–74

English poet

Witness this new-made World, another Heav'n

from Heaven Gate not farr, founded in view  
On the clear Hyaline, the Glassie Sea;  
Of amplitude almost immense, with starr's  
Numerous, and every Starr perhaps a World  
Of destined habitation.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VII, l. 617–622

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the stars,

That nature hung in heaven, and filled their lamps  
with everlasting oil, to give due light  
To the misled and lonely traveler.

In *Great Books of the Western World* (Volume 32)

*Comus*, l. 197–200

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

So sinks the day-star in the ocean-bed,  
And yet anon repairs his drooping head,  
And tricks his beams, and with new-spangled ore  
Flames in the forehead of the morning sky.

*Lycidas*, l. 168–171

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mitchel, Ormsby MacKnight** 1805–62

American astronomer

Blot out the stars, and give to the sun, moon, and planets,  
a blank heavens in which to move, and the possibility of  
unravelling their mysterious motions, mutual relations,  
and common laws is gone forever.

*The Orbs of Heaven*

Introductory (p. 8)

Office of the National Illustrated Library. London, England. 1851

If human genius is not to be baffled either by distance or time, numbers shall overwhelm it, and the stars shall find their safety in their innumerable millions.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*

Lecture I (p. 39)

Baker & Scribner. New York, New York, USA. 1848

When we look out upon the multitude of stars which adorn the nocturnal heavens, scattered in bright profusion in all directions. without law, and regardless of order – when with telescopic aid, thousands are increased to millions, and suns and systems and universes, rise in sublime perspective, as the visual ray sweeps outward to distances which defy the powers of arithmetic to express, how utterly futile does it seem, for the mind to dare, to pierce and penetrate, to number, weigh, measure and circumscribe, these innumerable millions?

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*

Lecture II (p. 41)

Baker & Scribner. New York, New York, USA. 1848

**Mitchell, Maria** 1818–89

American astronomer and educator

When we are chaffed and fretted by small cares, a look at the stars will show us the littleness of our own interests.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter VII (p. 138)

Lee &amp; Shepard. Boston, Massachusetts, USA. 1896

We call the stars garnet and sapphire; but these are, at best, vague terms. Our language has not terms enough to signify the different delicate shades; our factories have not the stuff whose hues might make a chromatic scale for them.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter XI (p. 235)

Lee &amp; Shepard. Boston, Massachusetts, USA. 1896

**Moore, Thomas** 1779–1852

Irish poet

Thus, when the lamp that lighted  
The traveler at first goes out,  
He feels awhile benighted,  
And looks around in fear and doubt.  
But soon, the prospect clearing,  
By cloudless starlight on he treads,  
And thinks no lamp so cheering  
As that light which Heaven sheds.

*The Poetical Works of Thomas Moore*

I'd Mourn the Hopes

Lee &amp; Shepard. Boston, Massachusetts, USA. 1873

**Mullaney, James**

Astronomy writer, lecturer, and consultant

The telescope is not just another gadget or material possession, but a magical gift to humankind – a window on creation, a time machine, a spaceship of the mind that enables us to roam the universe in a way that is surely the next best thing to being out there.

Focal Point

*Sky & Telescope*, March, 1990 (p. 244)

...metaphysical aspects of star gazing – its potential as a vehicle for therapeutic relaxation, meditation, and spiritual contact with the awesome creative power manifests in all of nature but is pinnacled in the stars.

Focal Point,

*Sky & Telescope*, March, 1990 (p. 244)**Noyes, Alfred** 1880–1958

English poet

And all those glimmerings where the abyss of space  
Is powdered with a milky dust, each grain  
A burning sun, and every sun the lord  
Of its own darkling planets...

*The Torch Bearers: Watchers of the Sky*

Prologue (p. 8)

Frederick A. Stokes Company. New York, New York, USA. 1922

Could new stars be born?

Night after night he watched that miracle

Growing and changing colour as it grew...

*The Torch Bearers: Watchers of the Sky*

Tycho Brahe, IV (p. 57)

Frederick A. Stokes Company. New York, New York, USA. 1922

**Old Woman**

The stars I know and recognize and even call by name. They are my names, of course; I don't know what others call the stars. Perhaps I should ask the priest. Perhaps the stars are God's to name, not ours to treat like pets...

In Robert Coles

*The Old Ones of New Mexico*

Two Languages, One Soul (p. 10)

University of New Mexico Press. Albuquerque, New Mexico, USA.

1973

**Oort, Jan Hendrik** 1900–92

Dutch astronomer

Man in the past couple of centuries has been in a position like that of a lookout watching the approach of an armada of strange objects. The objects came into view first as dim fuzzy forms. As more powerful telescopes brought them closer and closer, they were identified as collections of stars, then distinguished into systems of varied shapes and types; today we can resolve the details of internal structure in many of them.

In Heinz Haber

*Stars, Men and Atoms*

Chapter 11 (p. 168)

Golden Press. New York, New York, USA. 1962

**Pagels, Heinz R.** 1939–88

American physicist and science writer

Stars are born, they live and they die. Filling the night sky like beacons in an ocean of darkness, they have guided our thoughts over the millennia to the secure harbor of reason.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 2 (p. 30)

Simon &amp; Schuster. New York, New York, USA. 1985

Stars are like animals in the wild. We may see the young but never their actual birth, which is a veiled and secret event.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 2 (p. 44)

Simon &amp; Schuster. New York, New York, USA. 1985

Stars are an image of eternity.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 3 (p. 54)

Simon &amp; Schuster. New York, New York, USA. 1985

**Pasachoff, Jay M.** 1943–  
American astronomer

Twinkle, twinkle, pulsing star  
Newest puzzle from afar.  
Beeping on and on you sing –  
Are you saying anything?  
Twinkle, twinkle more, pulsar,  
How I wonder what you are.  
Pulsars in Poetry  
*Physics Today*, Volume 22, February, 1969 (p. 19)

**Peirce, Benjamin** 1809–80  
American mathematician

The brilliant and majestic firmament is studded with stars, distributed under no order which can be deciphered, and with an irregularity greater than that of the spots of water on a floor, dashed from a dripping brush.  
*Ideality in the Physical Sciences*  
Lecture 1 (p. 22)  
Little, Brown & Co. Boston, Massachusetts, USA. 1881

**Peltier, Leslie C.** 1900–80  
American comet hunter

So clear and sparkling is this autumn night that, with averted vision, I can see quite readily the wraithlike wisps of nebulosity that festoon and enmesh this entire little cluster.  
*Starlight Nights*  
Chapter 1 (p. 5)  
Harper & Row, Publishers. New York, New York, USA. 1965

The skies were full of stars for me to learn.  
*Starlight Nights*  
Chapter 6 (p. 39)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Peattie, Donald Culross** 1898–1964  
American botanist, naturalist, and author

Star gazing is a common name for harmless futility.  
*An Almanac for Moderns*  
August Seventeenth (p. 161)  
G.P. Putnam's Sons. New York, New York, USA. 1935

**Piechowski, Otto Rushe**  
Astronomy writer

For most of us stargazing remains a soothing balm and intellectual uplift – even if it isn't cutting edge science. It satisfies human needs. Sometimes out of embarrassment, we might shroud these deeper yearnings with scientific talk. But we shouldn't need such "covers." If our romantic encounters with stars reach some psychological, emotional, or spiritual level, so be it.  
*Sky & Telescope*, February, 1993

**Plato** 428 BCE–347 BCE  
Greek philosopher

Vain would be the attempt of telling all the figures of them circling as in a dance, and their juxtapositions, and the return of them in their revolutions upon themselves, and their approximations...  
In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
Section 40 (p. 452)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...he who has not contemplated the mind of nature which is said to exist in the stars, and gone through the previous training, and seen the connection of music with these things, and harmonized them all with laws and institutions, is not able to give a reason of such things as have a reason.  
In *Great Books of the Western World* (Volume 7)  
*Laws*  
Book XII, 967 (p. 798)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49  
American short story writer

Were the succession of stars endless, then the background of the sky would present us a uniform luminosity, like that displayed by the galaxy – since there could be absolutely no point, in all that background, at which would not exist a star. The only mode, therefore, in which, under such a state of affairs, we could comprehend the voids which our telescopes find in innumerable directions, would be by supposing the distance of the invisible background so immense that no ray from it has yet been able to reach us at all.  
*Eureka*  
Line 12 (p. 100)  
Geo. P. Putnam. New York, New York, USA. 1848

Look down into the abysmal distances! – attempt to force the gaze down the multitudinous vistas of the stars, as we sweep slowly through them thus – and thus – and thus! Even the spiritual vision, is it not all points arrested by the continuous golden walls of the universe? – the walls of the myriads of the shining bodies that mere number has appeared to blend into unity?  
In H. Beaver (ed.)  
*The Science Fiction of Edgar Allan Poe*  
*The Power of Words* (p. 171)  
Penguin Books. Hammondsworth, England. 1976

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

The stars send us not only that visible and gross light which strikes our bodily eyes, but from them also comes to us a light far more subtle, which illuminates our minds...  
*The Foundations of Science*  
*The Value of Science*  
Part II, Chapter VI (p. 290)  
The Science Press. New York, New York, USA. 1921

The stars are majestic laboratories, gigantic crucibles, such as no chemist could dream.

*The Foundations of Science*

*The Value of Science*, Astronomy (p. 295)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

The Dog-star rages!

*The Complete Poetical Works*

Epistle to Dr. Arbuthnot

Houghton Mifflin Company. New York, New York, USA. 1903

**Proctor, Mary** 1862–1957

American popularizer of astronomy

Countless stars pass across the rich regions of the galaxy. Stars of all orders of brightness, from those resembling the leading glories of the firmament, to tiny points of light only captured by momentary twinklings seen in the far distance.

The Silver River of Heaven

*The Chautauquan*, Volume 21, Number 4, July, 1895 (p. 459)

**Ptolemy** 85–165

Greek astronomer

I know that I am mortal and ephemeral. But when I search for the close-knit encompassing convolutions of the stars, my feet no longer touch the earth, but in the presence of Zeus himself I take my fill of ambrosia which the gods produce.

In Johannes Kepler

*Mysterium Cosmographicum*

Title page

**Raymo, Chet** 1936–

American physicist and science writer

We are not ruled by stars; we and the stars are one.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 21 (p. 196)

The Viking Press. New York, New York, USA. 1991

I weigh out nebulas. I dam up the Milky Way and use it to grind my grain. I put up summer stars like vegetables in jars for my delectation in winter. I have winter stars folded in boxes in the attic for cloudy summer nights.

Night Brought to Numbers

*Sky & Telescope*, Volume 71, Number 6, June, 1966 (p. 555)

**Rhodes, Cecil** 1853–1902

British-born South African businessman, mining magnate, and politician

The world is nearly all parceled out, and what there is left of it is being divided up, conquered and colonized. To think of these stars that you see overhead at night, these vast worlds which we can never reach. I would annex the planets if I could; I often think of that. It makes me sad to see them so clear and yet so far.

*The Last Will and Testament of Cecil John Rhodes: With Elucidatory Notes to Which Are Added Some Chapters Describing the Political and Religious Ideas of the Testator*

Part III (p. 190)

“Review of Reviewers” Office. London, England. 1902

**Rilke, Ranier Maria** 1875–1926

Czech-born German language poet and novelist

...between stars, what distances...

*Sonnets to Orpheus*

Second Part, XX

University of California Press. Berkeley, California, USA. 1977

**Russell, Peter** 1921–2003

British poet and editor

...The fixed stars

Are moving really, and the whole Galaxy turning Round and round on its own axis agitatedly...

*All for the Wolves*

Elegiac

Black Swan Books. Redding Ridge, Connecticut, USA. 1971

**Sagan, Carl** 1934–96

American astronomer and science writer

It will not be we who reach Alpha Centauri and the other nearby stars. It will be a species very much like us, but with more of our strengths and fewer of our weaknesses, a species returned to circumstances more like those for which it was originally evolved, more confident, farseeing, capable, and prudent – the sorts of beings we would want to represent us in a Universe that, for all we know, is filled with species much older, much more powerful, and very different.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 19 (p. 329)

Random House, Inc. New York, New York, USA. 1994

If we long to believe that the stars rise and set for us, that we are the reason there is a Universe, does science do us a disservice by deflating our conceits?

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 1 (p. 12)

Random House, Inc. New York, New York, USA. 1995

**Sagan, Carl** 1934–96

American astronomer and science writer

**Druyan, Ann** 1949–

American author and television producer

Nothing lives forever, in Heaven as it is on Earth. Even the stars grow old, decay, and die. They die, and they are born. There was once a time before the Sun and Earth existed, a time before there was day or night, long, long before there was anyone to record the Beginning for those who might come after.

*Shadows of Forgotten Ancestors: A Search for Who We Are*

Chapter 1 (p. 11)

Random House, Inc. New York, New York, USA. 1992



**Seares, Frederick H.** 1873–1964  
American astronomer

Counting stars is not unlike counting people or sheep or pebbles on the seashore. The astronomer's difficulties are not in the counting, but rather in knowing when the counting must start and stop.

*Annual Report of the Board of Regents of the Smithsonian Institution (1929)*

Counting the Stars and Some Conclusions (p. 183)  
Government Printing Office, Washington, D.C. 1930

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

As long as the ordinary course of heaven runs on, custom robs it of its real size. Such is our constitution that objects of daily occurrence pass us unnoticed even when most worthy of our admiration. On the other hand, the sight even of trifling things is attractive if their appearance is unusual. So this concourse of stars, which paints with beauty the spacious firmament on high, gathers no concourse of the nation. But when there is any change in the wonted order, then all eyes are turned to the sky.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*

Book VII, Chapter I (p. 271)  
Macmillan & Company Ltd. London, England. 1910

*Non est ad astra mollis e terris via.*

There is no easy way to the stars from the earth.

*Hercules Furens*

Act II, 437  
Cornell University Press. Ithaca, New York, USA. 1987

**Service, Robert William** 1874–1958  
Canadian poet and novelist

The waves have a story to tell me,  
As I lie on the lonely beach;  
Chanting aloft in the pine-tops,  
The wind has a lesson to teach;  
The stars sing an anthem of glory  
I cannot put into speech.

*Collected Poems of Robert Service*

The Three Voices  
Dodd, Mead & Company New York, New York, USA. 1961

**Serviss, Garrett Putman** 1851–1921  
American science fiction writer

The stars are the true landmarks which are never changed.

*Astronomy with the Naked Eye*

Chapter I (p. 1)  
Harper & Brothers. New York, New York, USA. 1908

It was the friendly stars that first led men round the globe. As long as those well-known sentinels shone, tranquil and steadfast overhead, they had courage to go on and on. If the stars had deserted, even Columbus would have lost heart.

*Astronomy with the Naked Eye*

Chapter I (p. 1)  
Harper & Brothers. New York, New York, USA. 1908

Regarded in their broader relations and constraints, the stars as a whole possess a marvelous harmony of effect. It is the true music of the spheres, for who shall say that the universally felt influence of the star-bedight heavens does not arise from our instinctive, but as yet uneducated, perception of a concord which is not of "sweet sounds," but of light and color, whose range of vibrations in the ether infinitely exceeds that of sonant oscillations in the atmosphere?

*Astronomy with the Naked Eye*

Chapter I (p. 13)  
Harper & Brothers. New York, New York, USA. 1908

As long as men have eyes to see and minds to think, it needs but a word, a hint, a glance, to turn them with rapt and ever increasing attention to the wonders overhead.

*Astronomy with the Naked Eye*

Chapter I (p. 15)  
Harper & Brothers. New York, New York, USA. 1908

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Look, th' unfolding star calls up the shepherd.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Measure for Measure*

Act IV, Scene iii, l. 218  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But I am constant as the northern star,  
Of whose true-fix'd and resting quality  
There is no fellow in the firmament.  
The skies are painted with unnumber'd sparks,  
They are all fire and everyone doth shine;  
But there's but one in all doth hold his place.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*Julius Caesar*

Act III, Scene i, l. 60–65  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sherrod, P. Clay**  
American astronomer and educator

Above us, the sparkling stars of the night skies stretch out like thousands of diamonds suspended on the curtain of space. Unfolding through the beauty and the mysteries of this seemingly endless expanse are patterns and answers familiar to those willing to study them...

There is an affinity for the eternity of space experienced by all mankind, a kind of motherhood in the stars to those who study space.

*A Complete Manual of Amateur Astronomy*

Preface (p. xii)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1981



**Smith, Logan Pearsall** 1865–1946

American author

“But what are they really? What do they say they are?”  
the young lady asked me. We were looking up at the  
Stars.

*Trivia*Book I, *The Starry Heaven* (p. 51)

Doubleday, Page &amp; Company. Garden City, New York, USA. 1917

**Smythe, Daniel** 1908–81

American poet

The years of sky are now galactic,  
So deep that we have little trace.  
Our spectrographs, cool and emphatic,  
Betray the depths of stars and space.  
What do we seek on dizzying borders  
Or groups of systems we have classified?  
We cannot search in these huge orders  
And find the answers they have passed.

*Strange Horizons**Nature Magazine*, February, 1958 (p. 101)**Spenser, Edmund** 1552–99

English poet

He that strives to touch the stars  
Oft stumbles at a straw.

*The Complete Poetical Works of Edmund Spenser*

The Shepherdess Calendar

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Stapledon, Olaf** 1886–1950

English author

Very soon the heavens presented an extraordinary appearance, for all the stars directly behind me were now deep red, while those directly ahead were violet. Rubies lay behind me, amethysts ahead of me. Surrounding the ruby constellations there spread an area of topaz stars, and round the amethyst constellations an area of sapphires.

*Last and First Men, and Star Maker*

Chapter II (p. 262)

Dover Publications, Inc. New York, New York, USA. 1968

Great are the stars, and man is of no account of them.

*Last and First Men*

Chapter XVI (p. 303)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1988

**Steele, Joel Dorman** 1836–86

American educator

Those far-off lights [stars] seem full of meaning to us, could we but read their message; they become real and sentient, and, like the soft eyes in pictures, look lovingly and inquiringly upon us. We come into communion with another life, and the soul asserts its immortality more strongly than ever before. We are humbled as we gaze upon the infinity of suns, and strive to comprehend their

enormous distances, and their magnificent retinue of worlds. The powers of the mind are aroused, and eager questionings crowd upon us.

*The Story of the Stars: New Descriptive Astronomy*

Introductory Remarks (pp. 1–2)

American Book Co. Chicago, Illinois, USA. 1884

**Stetson, Harlan True** 1885–1964

American astronomer and physicist

The stars came out like street lamps lighted by the angels,  
to guide and guard man’s ways by night.

*Man and the Stars*

Chapter I (p. 6)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1930

**de Morgan, Augustus** 1806–71

English mathematician and logician

Imagine a person with a gift of ridicule, and knowledge enough, trying his hand on the junction of the assertions which he will find in various books of algebra. First, that a negative quantity has no logarithm; secondly, that a negative quantity has no square root; thirdly, that the first non-existent is to the second as the circumference of a circle to its diameter.

*A Budget of Paradoxes*

Satirical Criticism (pp. 193–194)

Longmans, Green &amp; Co, London, England. 1872

**Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

Kind Nature has held before our eyes the smoked glass of the night and of the distance. And what do we see through it? We see that the world of stars is still. For we see these stars in their relation to each other, and they appear to us like chains of diamonds hanging on the neck of some god of silence. But Astronomy like a curious child plucks out an individual star from that chain and then we find it rolling about.

*Personality*

The World of Personality (p. 59)

The Macmillan Company. New York, New York, USA. 1917

**Taylor, Ann** 1782–1866

English poet and children’s author

Twinkle, twinkle, little star!  
How I wonder what you are.  
Up above the world so high,  
Like a diamond in the sky...

*Rhymes for the Nursery*

The Star

Printed and sold by Peter B. Gleason &amp; Company. Hartford, Connecticut, USA. 1813

**Taylor, Bayard** 1825–78

American journalist and author

Each separate star  
Seems nothing, but a myriad scattered stars

Break up the night, and make it beautiful.

*Lars: A Pastoral of Norway*

Book III, Conclusion

James R. Osgood & Company. Boston, Massachusetts, USA. 1873

**Teasdale, Sara** 1884–1933

American writer and poet

Stars over snow,  
And in the west a planet  
Swinging below a star –  
Look for a lovely thing and you will find it  
It is not far – It will never be far.

*The Collected Poems of Sara Teasdale*

Night (p. 197)

Collier Books. New York, New York, USA. 1966

**Tennyson, Alfred (Lord)** 1809–92

English poet

“The stars,” she whispers, “blindly run:  
A web is wov’n across the sky;  
From our waste places comes a cry,  
And murmurs from the dying sun.”

*Alfred Tennyson’s Poetical Works*

In Memoriam A.H.H., Section III, Stanza II

Oxford University Press, Inc. London, England. 1953

Many a night I saw the Pleiades, rising  
thro’ the mellow shade,  
Glitter like a swarm of fireflies, tangled in  
a silver braid.

*Alfred Tennyson’s Poetical Works*

Locksley Hall, Stanza 5

Oxford University Press, Inc. London, England. 1953

...the fiery Sirius alters hue  
And bickers into red and emerald.

*Alfred Tennyson’s Poetical Works*

The Princess, Part Fifth, l. 252–253

Oxford University Press, Inc. London, England. 1953

### The Bible (King James Version)

...the morning stars sang together, and all the sons of  
God shouted for joy?...

Job 38:7

Lift up your eyes on high, and behold who hath created  
these things, that bringeth out their host by number: he  
calleth them all by names by the greatness of his might,  
for that he is strong in power; not one faileth.

Isaiah 40:26

### The Hon. Mrs. Ward

No biographical data available

Stars – each, perhaps a sun! Far, far away from the earth  
and its troubles is the mind carried by such thoughts and  
remembrances.

*The Telescope*

Preface, Dedication to William Parsons, the Earl of Rosse 1870

**Thompson, Francis** 1859–1907

English writer

Thou canst not stir a flower  
Without troubling of a star.

*Complete Poetical Works of Francis Thompson*

The Mistress of Vision, Stanza XXII

Boni & Liveright, Inc. New York, New York, USA. 1923

**Thomson, James** 1700–48

Scottish poet

But who can count the stars of Heaven?

*Seasons*

Winter, l. 528

Printed by John Mycall. Newburyport, Massachusetts, USA. 1790

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Truly the stars were given for a consolation to man.

*The Writings of Henry David Thoreau* (Volume 9)

*A Walk to Wachusett* (p. 178)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

The stars are the apexes of what wonderful triangles!  
What distant and different beings in the various man-  
sions of the universe are contemplating the same one at  
the same moment!

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter I (p. 19)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

When I consider how, after sunset, the stars come out  
gradually in troops from behind the hills and woods,  
I confess that I could not have contrived a more curious  
and inspiring night.

*Journal* (Volume 1)

July 26, 1840 (p. 158)

Princeton University Press. Princeton, New Jersey, USA. 1981

When I look at the stars, nothing which the astrono-  
mers have said attaches to them, they are so simple and  
remote.

In Bradford Torrey and Francis H. Allen (eds.)

*The Journal of Henry D. Thoreau* (Volume 7)

September 29, 1854, The Red of the Young Oak (p. 60)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

**Thorne, Kip S.** 1940–

American theoretical physicist

A star is only a glowing pause in the inescapable contraction  
of a gas cloud to an uncertain, sometimes fantastic end.

The Death of a Star

*The Physics Teacher*, Volume 9, Number 6, June, 1971 (p. 326)

**Travers, Pamela Lyndon** 1899–1996

Australian-born English writer

[Jane] was watching Mrs. Corry splashing the glue on the  
sky and Mary Poppins sticking on the star...

“What I want to know,” said Jane, “is this: Are the stars gold paper or is the gold paper stars?”

There was no reply to her question and she did not expect one. She knew that only someone very much wiser than Michael could give her the right answer.

*Mary Poppins* (Revised edition)

Chapter 8 (p. 128)

Harcourt, Inc. San Diego, California, USA. 1981

**Trevelyan, George Macaulay** 1876–1962

English historian

The stars out there rule the sky more than in England, big and lustrous with the honour of having shone upon the ancients and been named by them.

*Clio, A Muse, and Other Essays*

Walking

Longmans, Green & Company London, England. 1930

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

There are too many stars in some places and not enough in others, but that can be remedied presently, no doubt.

*Eve's Diary*

Sunday (p. 7)

Harper & Brothers. New York, New York, USA. 1906

Stars are good, too. I wish I could get some to put in my hair. But I suppose I never can.

*Eve's Diary*

Saturday (p. 11)

Harper & Brothers. New York, New York, USA. 1906

There's another trouble about theories: there's always a hole in them somewheres, sure, if you look close enough. It's just so with this one of Jim's. Look what billions and billions of stars there is. How does it come that there was just exactly enough star-stuff, and none left over? How does it come there ain't no sand-pile up there?

*The Complete Works of Mark Twain* (Volume 14)

*Tom Sawyer Abroad* (pp. 78–79)

Harper & Brothers Publishers. New York, New York, USA. 1899

The stars ain't so close together as they look to be.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Extract from Captain Stormfield's Visit to Heaven (pp. 829–830)

The Library of America. New York, New York, USA. 1992

It's lovely to live on a raft. We had the sky, up there, all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made, or only just happened – Jim he allowed they was made, but I allowed they happened; I judged it would have took too long to make so many. Jim said the moon could have a laid them; well, that looked kind of reasonable, so I didn't say nothing against it because I've seen a frog lay most as many, so of course it could be done. We used to watch the stars that fell, too, and see them streak

down. Jim allowed they'd got spoiled and was hove out of the nest.

*The Adventures of Huckleberry Finn*

Chapter XIX (pp. 153–154)

Grosset & Dunlap Publishers. New York, New York, USA. 1948

We had the sky up there all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made or only just happened. Jim he allowed they was made, but I allowed they happened; I judged it would have took too long to *make* so many. Jim said the moon could a *laid* them; well that looked kind of reasonable, so I didn't say nothing against it, because I've seen a frog lay most as many, so of course it could be done. We used to watch the stars that fell, too, and see them streak down. Jim allowed they'd got spoiled and was hove out of the nest.

*The Adventures of Tom Sawyer*

Chapter XIX (pp. 158–159)

Harper & Brothers Publishers. New York, New York, USA. 1904

**Updike, John** 1932–

American novelist, short story writer, and poet

Welcome, welcome, little star

I'm delighted that you are

Up in Heaven's vast extent,

No bigger than a continent.

*Telephone Poles and Other Poems*

White Dwarf (p. 10)

Alfred A. Knopf. New York, New York, USA. 1969

When, on those anvils at the center of stars,  
and those even more furious anvils  
of the exploding supernovae,  
the heavy elements were beaten together  
to the atomic number 94...

*Facing Nature*

Ode to Crystallization

Alfred A. Knopf. New York, New York, USA. 1985

**van de Hulst, H. C.**

No biographical data available

For those wishing to dream away into the universe the stars are lights on little islands in an infinite sea.

“Empty” Space

*Scientific American*, Volume 193, Number 5, November, 1955 (p. 73)

**van Gogh, Vincent Willem** 1853–90

Dutch painter

One night I went for a walk by the sea along the empty shore. It was not gay, but neither was it sad – it was – beautiful. The deep blue sky was flecked with clouds of a blue deeper than the fundamental blue of intense cobalt, and others of a clearer blue, like the blue whiteness of the Milky Way. In the blue depth the stars were sparkling, greenish, yellow, white, rose, brighter, flashing, more like jewels, than they do at home – even in Paris.

*The Complete Letters of Vincent van Gogh with Reproductions of All the Drawings in the Correspondence* (Volume 2)  
Letter 499 (p. 589)  
New York Graphic Society. Greenwich, Connecticut, USA. 1958

To express hope by some star, the eagerness of a soul by a sunset.

*The Complete Letters of Vincent van Gogh with Reproductions of All the Drawings in the Correspondence* (Volume 3)  
Letter 531 (p. 26)  
New York Graphic Society. Greenwich, Connecticut, USA. 1958

That does not prevent me from having a terrible need of – shall I say the word? – of religion. Then I go out and paint the stars...

*The Complete Letters of Vincent van Gogh with Reproductions of All the Drawings in the Correspondence* (Volume 3)  
Letter 543 (p. 16)  
New York Graphic Society. Greenwich, Connecticut, USA. 1958

Stars, you are unfortunate, I pity you,  
Beautiful as you are, shining in your glory...

*Night Thoughts*  
Printed by R. Nobels for R. Edwards. London, England. 1797

**Vaughan, Henry** 1621–95  
English metaphysical poet

The Jewel of the Just,  
Shining nowhere but in the dark;  
What mysteries do lie beyond thy dust,  
Could man outlook that mark!

*Poetry and Selected Prose*  
Accession Hymn  
Oxford University Press, Inc. London, England. 1963

**Warren, Henry White** 1831–1912  
American Methodist Episcopal bishop and author

One never can be alone if he is familiarly acquainted with the stars.

*Recreations in Astronomy*  
Chapter X (p. 197)  
Harper & Brothers Publishers. New York, New York, USA. 1895

We are charmed with the variegated flowers of our gardens of earth, but he who makes the fields blush with flowers under the warm kisses of the sun has planted his wider gardens of space with colored stars.

*Recreations in Astronomy*  
Chapter X (p. 215)  
Harper & Brothers Publishers. New York, New York, USA. 1895

**Weil, Simone** 1909–43  
French philosopher and mystic

The stars, those marvelous, brilliant, inaccessible objects, at least as remote as the horizon, which we can neither change nor touch, and which in their turn, touch only our eyes, are what is furthest away from us and closest to us.

*On Science, Necessity, and the Love of God*  
Classified Science and After (p. 40)  
Oxford University Press, Inc. London, England. 1968

**Weinberg, Steven** 1933–  
American nuclear physicist

A look at the night sky gives a powerful impression of a changeless universe. True, clouds drift across the moon, the sky rotates around the polar star, and over longer times the moon itself waxes and wanes and the moon and planets move against the background of stars. But we know that these are merely local phenomena caused by motions within our solar system. Beyond the planets, the stars seem motionless.

*The First Three Minutes: A Modern View of the Origin of the Universe*  
Chapter II (p. 11)  
Basic Books, Inc. New York, New York, USA. 1993

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Looking at these stars suddenly dwarfed my own troubles and all the gravities of terrestrial life. I thought of their unfathomable distance, and the slow inevitable drift of their movements out of the unknown past into the unknown future.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today, 1971*  
*The Time Machine*  
Chapter Seven (p. 484)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

Those who have only seen the starry sky from the earth cannot imagine its appearance when the vague half-luminous veil of our air has been withdrawn. The stars we see on earth are the mere scattered survivors that penetrate our misty atmosphere.

*The First Men in the Moon*  
Chapter V (pp. 61–62)  
George Newnes, Ltd. London, England. 1901

All this world is heavy with the promise of greater things, and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amid the stars.

*The Discovery of the Future*  
The Discovery of the Future (pp. 60–61)  
B.W. Huebsch. New York, New York, USA. 1914

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

I believe a leaf of grass is no less than the journey-work of the stars.

*Complete Poems and Collected Prose*  
Song of Myself  
Section 31  
The Library of America. New York, New York, USA. 1982

I was thinking the day most splendid till I saw what the not-day exhibited;  
I was thinking of this globe enough till there

sprang out so noiseless around me myriads of other globes.

*Complete Poetry and Collected Prose*

Night on the Prairies

The Library of America. New York, New York, USA. 1982

**Wilcox, Ella Wheeler** 1850–1919

American poet and journalist

Since Sirius crossed the Milky Way  
Full sixty thousand years have gone,  
Yet hour by hour and day by day  
This tireless star speeds on and on.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter III (p. 43)

Harper & Brothers New York, New York, USA. 1908

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

LORD DARLINGTON: We are all in the gutter, but some of us are looking at the stars.

*The Works of Oscar Wilde* (Volume 5)

*Lady Windermere's Fan*

Act Three

Lamb Publishing Company. New York, New York, USA. 1909

**Williams, Sarah** 1837–68

American poet

I have loved the stars too fondly to be fearful of the night.

*The Best Loved Poems of the American People*

The Old Astronomer to His Pupil

Garden City publishing Company. Garden City, New York USA. 1936

**Wordsworth, William** 1770–1850

English poet

The stars are mansions built by Nature's hand,  
And, haply, there the spirits of the blest  
Dwell clothed in radiance, their immortal vest...

*The Complete Poetical Works of William Wordsworth*

Miscellaneous Sonnets, XXV

Crowell. New York, New York, USA. 1888

Look for the stars, you'll say that there are none;

Look up a second time, and, one by one,  
You mark them twinkling out with silvery light,  
And wonder how they could elude the sight!

*The Complete Poetical Works of William Wordsworth*

Calm Is the Fragrant Air

Crowell. New York, New York, USA. 1888

**Yeats, William Butler** 1865–1939

Irish poet and playwright

Under the passing stars, foam of the sky  
Live on this lonely face.

*The Collected Poems of W.B. Yeats*

The Rose of the World (p. 36)

The Macmillan Company. New York, New York, USA. 1956

**Young, Edward** 1683–1765

English poet and dramatist

How distant some of these nocturnal Suns?  
So distant (says the Sage) 'twere not absurd  
To doubt, if Beams, set out at Nature's Birth,  
Are yet arriv'd at this so foreign World...

*Night Thoughts*

Night IX, l. 1226–1229

Printed by R. Nobels for R. Edwards. London, England. 1797

**Zubrin, Robert** 1952–

American aerospace engineer and author

Today the stars beckon again, but this time not to new continents, but new solar systems.

*Entering Space: Creating a Spacefaring Civilization*

Chapter 12 (p. 283)

Penguin Putnam Inc. New York, New York, USA. 1999

## STARDUST

**Calder, Nigel** 1931–

English writer

In a sense human flesh is made of stardust.

*The Key to the Universe*

Chapter 2 (p. 32)

Penguin Books. Middlesex, England. 1978

## STARGAZER

**Ferris, Timothy** 1944–

American science writer

Stargazers, like musicians, typically learn on inferior instruments...

*Seeing in the Dark*

Chapter I (p. 9)

Simon & Schuster. New York, New York, USA. 2002

## STARLIGHT

**Hale, George Ellery** 1868–1938

American astronomer

Starlight is falling on every square mile of the earth's surface, and the best we can do at present is to gather up and concentrate the rays that strike an area 100 inches in diameter.

The Possibilities of Large Telescopes

*Harper's Weekly*, April, 1928 (p. 640)

**Huggins, Sir William** 1824–1910

English astronomer

Within this unraveled starlight exists a strange cryptography. Some of the rays may be blotted out, others may be enhanced in brilliancy. Their differences, countless in variety, form a code of signals, in which is conveyed to

us, when once we have made out the cipher in which it is written, information of the chemical nature of the celestial gases.... It was the discovery of this code of signals, and of its interpretation, which made possible the rise of the new astronomy.

In D.R. Danielson

*The Book of the Cosmos: Imaging the Universe from Heraclitus to Hawking*

Chapter 52 (p. 319)

Perseus Publishing, Cambridge, Massachusetts, USA. 2000

**Stein, Gertrude** 1874–1946

American writer

Star-light, what is star-light, star-light is a little light that is not always mentioned with the sun, it is mentioned with the moon and the sun, it is mixed up with the rest of the time.

*Three Lives & Tender Buttons*

Rooms (p. 295)

Penguin Putnam, Inc. New York, New York, USA. 2003

## STARS

### Author undetermined

The meek shall inherit the Earth, the rest of us will go to the stars.

Source undetermined

**Ball, Philip** 1962–

English science writer

The stars are more than mere fireballs – they are engines of creation, and out of their fiery hearts come the elements needed to make the worlds.

*Life's Matrix*

The First Flood (p. 10)

Farrar, Straus & Giroux. New York, New York, USA. 1999

**Bradley Jr., John Hodgdon** 1898–1962

American geologist

Star worlds, like fish in schools, drift through the void, star worlds as large as our sun and many time larger, in schools of hundreds of millions. Unlike a school of fish, whose direction may be changed by the whim of the leader...the stars in their galaxy move with the majesty of perfect orderliness.

*Parade of the Living*

Chapter I (p. 3)

Coward-McCann. New York, New York, USA. 1930

**Bürgel, Bruno Hans** 1875–1948

German astronomer

We stand in solemn silence and gaze at the eternal lights overhead. They appear in stately measure, one after the other – first the large bright ones, and then the smaller... the starry robe of the goddess of the skies is spread out

wide above us, sparkling as though millions of diamonds had been lavishly scattered all over it.

Translated by Stella Bloch

*Astronomy for All*

Chapter I (p. 1)

Cassell & Co., Ltd. London, England. 1911

**Carlyle, Thomas** 1795–1881

English historian and essayist

Stars, have they not looked-down...like Eyes glistening with heavenly tears over the little lot of man! Thousands 'of human generations, all as noisy as our own, have been swallowed-up of Time, and there remains no wreck of them anymore; and Arcturus and Orion and Sirius and the Pleiades are still shining in their courses, clear and 'young, as when the Shepherd first noted them in-the plain of Shinar.

In Archibald MacMechan

*Sartor Resartus* (p. 165)

Ginn & Co. Boston 1897

**Dickens, Charles** 1812–70

English novelist

She raised her eyes to the bright stars, looking down so mildly from the wide worlds of air, and, gazing on them, found new stars burst upon her view, and more beyond, and more beyond again, until the whole great expanse sparkled with shining spheres, rising higher and higher in immeasurable space, eternal in their numbers as in their changeless and incorruptible existence.

*The Old Curiosity Shop*

Chapter XLII (p. 125)

D. Appleton & Co. New York, New York, USA. 1868

**Kippax, John Robert**

No biographical data available

The process of...evolution of matter is...continuously going on, suns and star systems are ever being evolved...

*The Call of the Stars*

Book I, Chapter I (p. 15)

G.P. Putnam's Sons. New York, New York, USA. 1914

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

...in the motions of the stars we are brought face to face with eternity and infinity, covered by no veil whatever.

In Richard Anthony Proctor

*The Skies and the Earth*

Problems of Astronomy (p. 44)

Doubleday, Page & Co. New York, New York, USA. 1902

**Raleigh, Sir Walter** 1552–1618

Renaissance English courtier and poet

...it was well said of Plotinus, that the stars were significant, but not efficient...

*The Works of Sir Walter Raleigh* (Volume 2)

Book I, Chapter I (p. 33)

At The University Press. Oxford, England. 1829



**Rodd, Thomas**

I love to rove amidst the starry height,  
 To leave the little scenes of Earth behind,  
 And let Imagination wing her flight  
 On eagle pinions swifter than the wind.  
 I love the planets in their course to trace;  
 To mark the comets speeding to the Sun,  
 Then launch into immeasurable space,  
 Where, lost to human sight, remote they run.  
 I love to view the Moon, when high she rides  
 Amidst the heav'ns, in borrowed lustre bright,  
 To fathom how she rules the subject tides,  
 And how she borrows from the Sun her light.  
 O! these are the wonders of th' Almighty hand,  
 Whose wisdom first the circling orbits planned.

*Sonnets, Amatory, Descriptive and Religious: Odes, Songs and Ballads*

Love of Night

Printed by the author

London, England. 1814

**Thomson, James** 1700–48

Scottish poet

...but who can count the stars of heaven ...

*Seasons*

Winter

Chiswick. London, England. 1822

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Looking at these stars suddenly dwarfed my own troubles and all the gravities of terrestrial life. I thought of their unfathomable distance, and the slow inevitable drift of their movements out of the unknown past into the unknown future.

*Seven Science Fiction Novels of H. G. Wells*

*The Time Machine*

Chapter 6 (p. 51)

Dover Publications, Inc. New York, New York, USA. 1934

**STARS, COLLISION OF****Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

In the vast expanse of the heavens the traffic is so thin that a star may reasonably count on travelling for the whole of its long life without serious risk of collision. The risk is negligible for any individual star; but ten thousand million stars in our own system and more in the systems beyond afford a wide playground for chance.

*Science and the Unseen World*

Lecture I (p. 15)

The Macmillan Co. New York, New York, USA. 1929

**STATIONARY****von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Nothing is stationary in space. Even the fixed stars move ...

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 3)

Special Results of OBSERVATION IN THE DOMAIN OF COSMICAL PHENOMENA (p. 26)

Harper & Brothers Publishers. New York, New York, USA. 1851

**STATISTICAL****Born, Max** 1882–1970

German-born English physicist

There is no doubt that the formalism of quantum mechanics and its statistical interpretation are extremely successful in ordering and predicting physical experiences. But can our desire of understanding, our wish to explain things, be satisfied by a theory which is frankly and shamelessly statistical and indeterministic? Can we be content with accepting chance, not cause, as the supreme law of the physical world?

*Natural Philosophy of Cause and Chance*

Chapter IX (p. 101)

Clarendon Press. Oxford, England. 1949

**STATISTICAL ANALYSIS****Hooper, Wynnard**

No biographical data available

It may be said that in the case of Statistical Analysis the instrument employed is easily handled, and that it cannot correctly be said to require scientific knowledge in those who use it. I am not myself of this opinion, and I should think it strange if such an idea found acceptance within these walls. It is true that much good statistical work has been done by men who have made no study of the method by which they were working. But this only shows that able men may do much while their knowledge is imperfect.

On the Method of Statistical Analysis

*Journal of the Statistical Society of London*, Volume 44 March, 1881 (p. 47)

**Moroney, Michael Joseph** 1918–90

English statistician

A statistical analysis, properly conducted, is a delicate dissection of uncertainties, a surgery of suppositions.

*Facts from Figures* (p. 3)

Penguin Books Ltd. Harmondsworth, England. 1951

## STATISTICAL INFERENCE

### Bartholomew, D. J.

Statistician

Statistical inference is thus the process of finding the simplest model (or theory) capable of accounting for our data and then of estimating its parameters. In practice, simplicity is usually judged by the number of adjustable parameters which a model contains.... This philosophy implies the null hypothesis has a favoured status resulting from its greater simplicity.

Hypothesis Testing when the Sample Size is Treated as a Random Variable

*Journal of the Royal Statistical Society*, Volume 29, Number 1, 1967 (p. 81)

## STATISTICAL MECHANICS

### Goodstein, David L.

1939–  
US physicist and educator

Ludwig Boltzmann, who spent much of his life studying statistical mechanics, died in 1906, by his own hand. Paul Ehrenfest, carrying on the work, died similarly in 1933. Now it is our turn to study statistical mechanics. Perhaps it will be wise to approach the subject cautiously.

*States of Matter*

Chapter One (p. 1)

Dover Publications. Mineola, New York, USA. 1985

## STATISTICAL METHOD

### Thomson, Sir John Arthur

1861–1933  
Scottish naturalist

Complex as are the inborn variations of plants and animals, they can be treated by the same statistical methods as are used in recording the simple phenomena observed when dice are thrown ten thousand times.

*Introduction to Science*

Chapter II (p. 52)

Henry Holt & Co. New York, New York, USA. 1911

## STATISTICAL PROBLEM

### Galton, Sir Francis

1822–1911  
English anthropologist, explorer, and statistician

It is always well to retain a clear geometric view of the facts when we are dealing with statistical problems, which abound with dangerous pitfalls, easily overlooked by the unwary, while they are cantering gaily along upon their arithmetic.

*Natural Inheritance*

Chapter V (pp. 66–67)

Macmillan & Company Ltd. London, England. 1889

## STATISTICAL TEST

### Anscombe, Francis John

1918–2001  
English-born American statistician

Rejection rules are not significance tests.

Rejection of Outliers

*Technometrics*, Volume 2, 1960 (p. 126)

### Chatfield, Christopher

British statistician

The result is that non-statisticians tend to place undue reliance on single “cookbook” techniques, and it has for example become impossible to get results published in some medical, psychological and biological journals without reporting significance values even if of doubtful validity. It is sad that students may actually be more confused and less numerate at the end of a “service course” than they were at the beginning, and more likely to overlook a descriptive approach in favor of some inferential method which may be inappropriate or incorrectly executed.

The Initial Examination of Data

*Journal of the Royal Statistical Society*, Series A, Volume 148, 1985

### Clark, C. A.

No biographical data available

The null hypothesis of no difference has been judged to be no longer a sound or fruitful basis for statistical investigation.... Significance tests do not provide the information that scientists need, and, furthermore, they are not the most effective method for analyzing and summarizing data.

Hypothesis Testing in Relation to Statistical Methodology

*Review of Educational Research*, Volume 33, 1963

### Cochran, William G.

1909–80  
Scottish-born American statistician

### Cox, Gertrude M.

1900–78  
American statistician

A useful property of a test of significance is that it exerts a sobering influence on the type of experimenter who jumps to conclusions on scanty data, and who might otherwise try to make everyone excited about some sensational treatment effect that can well be ascribed to the ordinary variation in his experiment.

*Experimental Designs* (2nd edition)

Chapter 1 (p. 5)

John Wiley & Sons, Inc. New York, New York, USA. 1992

### Cohen, Jacob

1923–  
American behavioral psychologist and statistical analyst

After four decades of severe criticism, the ritual of null hypothesis significance testing – mechanical dichotomous decisions around a sacred .05 criterion – still persist. This article reviews the problems with this practice.... What’s

wrong with [null hypothesis significance testing]? Well, among many other things, it does not tell us what we want to know, and we so much want to know what we want to know that, out of desperation, we nevertheless believe that it does!

The Earth Is Round ( $p < .05$ )

*American Psychologist*, Volume 49, December, 1994 (p. 997)

A little thought reveals a fact widely understood among statisticians: The null hypothesis, taken literally (and that's the only way you can take it in formal hypothesis testing), is always false in the real world.... If it is false, even to a tiny degree, it must be the case that a large enough sample will produce a significant result and lead to its rejection. So if the null hypothesis is always false, what's the big deal about rejecting it?

Things I Have Learned (So Far)

*American Psychologist*, December, 1990 (p. 1308)

### **Cox, Sir David Roxbee** 1924–

English statistician

It has been widely felt, probably for thirty years and more, that significance tests are overemphasized and often misused and that more emphasis should be put on estimation and prediction. While such a shift of emphasis does seem to be occurring, for example in medical statistics, the continued very extensive use of significance tests is on the one hand alarming and on the other evidence that they are aimed, even if imperfectly, at some widely felt need.

Some General Aspects of the Theory of Statistics

*International Statistical Review*, Volume 54, 1986

### **Deming, William Edwards** 1900–93

American statistician, educator, and consultant

Under the usual teaching, the trusting student, to pass the course must forsake all the scientific sense that he has accumulated so far, and learn the book, mistakes and all.

On Probability as Basis for Action

*American Statistician*, Volume 29, Number 4, November 1975

Pencil and paper for construction of distributions, scatter diagrams, and run-charts to compare small groups and to detect trends are more efficient methods of estimation than statistical inference that depends on variances and standard errors, as the simple techniques preserve the information in the original data.

On Probability as Basis for Action

*American Statistician*, Volume 29, Number 4, November 1975

### **Devons, Ely** 1913–67

English economist

I cannot oscillate a time series or properly analyze a variance...

*Essays in Economics*

Chapter 6 (p. 105)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

### **Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

There is no more pressing need in connection with the examination of experimental results than to test whether a given body of data is or is not in agreement with any suggested hypothesis.

*Statistical Methods for Research Workers*

Chapter VIII (p. 256)

Oliver & Boyd. Edinburgh, Scotland. 1938

### **Lewis, Sir Thomas** 1881–1945

No biographical data available

When we ponder upon the bedside tests, general and special, now in vogue, and ask ourselves how many of these have filtered through the sieve of rigidly controlled experiment, when we ask how many when filtering comes to them as come it must, will show a casting in so fine a mould that nets, though strictly meshed, will not entangle them; then do we probe the foundation upon which an art, aspiring to the place of science, rests.

*The Mechanism and Graphic Registration of the Heart Beat*

Preface (p. vi)

Shaw & Sons. London, England. 1920

### **McCloskey, D. N.**

Economist

### **Ziliak, S. T.**

No biographical data available

The low and falling cost of calculation, together with a widespread though unarticulated realization that after all the significance test is not crucial to scientific questions, has meant that statistical significance has been valued at its cost. Essentially no one believes a finding of statistical significance or insignificance. This is bad for the temper of the field. My statistical significance is a "finding"; yours is an ornamented prejudice.

The Standard Error of Regressions

*Journal of Economic Literature*, Volume 34, 1996

### **Morrison, D. E.**

No biographical data available

### **Henkel, R. E.**

No biographical data available

What do we do without the tests, then? What we do without the tests has always in some measure been done in behavioral science and needs only to be done more and better: the application of imagination, common sense, and informed judgment, and the appropriate remaining research methods to achieve the scope, form, process, and purpose of scientific inference.

*The Significance Test Controversy – A Reader*

Significance Tests in Behavioral Research: Skeptical Conclusions and Beyond

Aldine Publishing Company. Chicago, Illinois, USA. 1970

**Parkhurst, D. F.**

No biographical data available

Failing to reject a null hypothesis is distinctly different from proving a null hypothesis; the difference in these interpretations is not merely a semantic point. Rather, the two interpretations can lead to quite different biological conclusions.

Interpreting Failure to Reject a Null Hypothesis

*Bulletin of the Ecological Society of America*, Volume 66, 1985

**Rozeboom, W. W.**

No biographical data available

The statistical folkways of a more primitive past continue to dominate the local scene.

The Fallacy of the Null-Hypothesis Significance Test

*Psychological Bulletin*, Volume 57, 1960

**Salsburg, David S.**

No biographical data available

Most readers of this journal will recognize the limited value of hypothesis testing in the science of statistics. I am not sure that they all realize the extent to which it has become the primary tool in the religion of Statistics. Since the practitioners of that faith seem unable to cure their own folly, it is time we priests of the faith brought them around to realizing that there are more appropriate ways to get useful answers.

The Religion of Statistics as Practiced in Medical Journals

*American Statistician*, Volume 39, 1985

**Schmidt, Frank L.**

American industrial and organizational psychology researcher

I believe that...false beliefs are a major cause of the addiction of researchers to significance tests. Many researchers believe that statistical significance testing confers important benefits that are in fact completely imaginary.

Statistical Significance Testing and Cumulative Knowledge in Psychology: Implications for Training of Researchers

*Psychological Methods*, Volume 1, Number 2, 1996

If the null hypothesis is not rejected, [Sir Ronald] Fisher's position was that nothing could be concluded. But researchers find it hard to go to all the trouble of conducting a study only to conclude that nothing can be concluded.

Statistical Significance Testing and Cumulative Knowledge in Psychology: Implications for Training of Researchers

*Psychological Methods*, Volume 1, Number 2, 1996

**Yates, Frances** 1899–1981

English historian

The most commonly occurring weakness in the application of Fisherian methods is, I think, undue emphasis on tests of significance, and failure to recognize that in many

types of experimental work, estimates of the treatment effects, together with estimates of the error to which they are subject, are the quantities of primary interest.

Sir Ronald Fisher and the Design of Experiments

*Biometrics*, Volume 20, 1964

**STATISTICAL TABLE****Melville, Herman** 1819–91

American novelist

Most statistical tables are parchingly dry in the reading; not so in the present case, however, where the reader is flooded with whole pipes, barrels, quarts, and gills of good gin and good cheer.

*Moby Dick*

Chapter CI (p. 419)

L.C. Page & Co. Boston, Massachusetts, USA. 1892

**STATISTICIAN****Bailey, W. B.** 1873–?

No biographical data available

**Cummings, John**

No biographical data available

While, therefore, tabulation is a final process, the formulation of the scheme of tabulation should be the initial process, preceding even the formulation of the schedule, which should be determined by the character of the tables to be produced. Failure to observe this fundamental principle in statistical practice, perhaps more than any other characteristic, distinguishes the work of the amateur from that of the expert, the work of the untrained social investigator from that of the experienced scientific statistician.

*Statistics* (p. 26)

A.C. McClurg & Company. Chicago, Illinois, USA. 1917

**Balchin, Nigel** 1908–70

English novelist

He divided people into statisticians, people who knew about statistics, and people who didn't. He liked the middle group best. He didn't like the real statisticians much because they argued with him, and he thought people who didn't know any statistics were just animal life.

*The Small Back Room* (p. 137)

Collins. London, England. 1943

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The statistician was let loose.

*The Silence of the Sea*

On Statistics (p. 172)

Sheed & Ward. New York, New York, USA. 1940

**Bellow, Saul** 1915–  
American novelist

An utterly steady, reliable woman, responsible to the point of grimness. Daisy was a statistician for the Gallup Poll.

*Herzog* (p. 221)

The Viking Press, New York, New York, USA. 1964

**Blodgett, James H.**  
American statistician

The individual statistician must scan closely the authority on which he rests, and guard his statements with all the cautionary words which imperfect knowledge requires, or some mere child will point out the errors in his statements and his conclusions and set people wondering of what value the rest of his work may be.

Obstacles to Accurate Statistics

*Journal of the American Statistical Association*, New Series Number 41, March, 1898 (p. 19)

**Bowley, Arthur Lyon** 1869–1957  
English statistician and economist

Perhaps statisticians themselves have not always fully recognized the limitations of their work.

*Elements of Statistics*

Part I, Chapter I (p. 13)

P.S. King & Son Ltd. London, England. 1937

The statistician's contribution to a sociological problem is only one of objective measurement, and this is frequently among the less important of the data; it is as necessary, however, to its solution as accurate measurements are for the construction of a building.

*Elements of Statistics*

Chapter I (p. 13)

P.S. King & Son. London, England. 1901

**Braddon, Mary Elizabeth** 1835–1915  
English novelist

It is the habit of many to sneer at statisticians, because a foolish man once said that you could prove anything from statistics; but statistics are like circumstantial evidence, which cannot err in itself, though false deductions

Our Criminals

*Belgravia*, Volume VII, Third Series, October, 1875 (p. 484)

**Chernoff, H.** 1923–  
American mathematician and statistician

**Moses, L. E.** 1921–  
American statistician and social scientist

Years ago a statistician might have claimed that statistics deals with the processing of data...today's statistician will be more likely to say that statistics is concerned with decision making in the face of uncertainty.

*Elementary Decision Theory*

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1959

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

The statistician accepts in any engagement certain responsibilities and obligations to his client and to the people that he works with. In the first place, he is the architect of a survey or experiment. It is his business to fit the various skills together to make them effective. It is important that he clarify the various responsibilities at the outset of the study.

*Sample Design in Business Research* (p. 10)

John Wiley & Sons, Inc. New York, New York, USA. 1960

The minute a statistician steps into the position of the executive who must make decisions and defend them, the statistician ceases to be a statistician.

*Sample Design in Business Research* (p. 13)

John Wiley & Sons, Inc. New York, New York, USA. 1960

The only useful function of a statistician is to make predictions, and thus to provide a basis for action.

In W.A. Wallis

The Statistical Research Group

*Journal of the American Statistical Association*, 1942–1945, Volume 75, Number 370, June, 1980 (p. 321)

It should be emphasized that the statistician is not necessarily abler at handling data than his colleagues trained in economics, sociology, engineering, physics, business, etc. However, because of the high transferability of the statistician's mathematical techniques, and because he acquires a broad knowledge in many fields, he is frequently adept at discovering and measuring errors in data and determining the source of the errors. He avoids drawing wrong conclusions from data whether the data be good or bad.

On the Classification of Statisticians

*The American Statistician*, Volume 2, Number 2, April, 1948 (p. 16)

A statistician's responsibility is not confined to plans: he must also seek assurance of cooperation in field and office, and maintain constant touch with the work, also with the interpretation of the results.

*Some Theory of Sampling* (p. 8)

John Wiley & Sons, Inc. New York, New York, USA. 1950

**Finney, D. J.**  
English biometric statistician

Too often, in many fields of science, the statistician is regarded as someone who comes on stage after data have been collected, performs standard calculations, delivers a verdict "Significant" or "Not Significant", and then departs. The Questioning Statistician

*Statistics in Medicine*, Volume 1, 1982 (p. 5)

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

We have the duty of formulating, of summarizing, and of communicating our conclusions, in intelligible form, in



recognition of the right of other free minds to utilize them in making their own decisions.

B, Statistical methods and scientific induction

*Journal of the Royal Statistical Society*, Volume 17, 1955

The statistician cannot evade the responsibility for understanding the process he applies or recommends.

*The Design of Experiments*

Introduction (p. 1)

Hafner Publishing Company. New York, New York, USA. 1971

The statistician cannot excuse himself from the duty of getting his head clear on the principles of scientific inference, but equally no other thinking man can avoid a like obligation.

*The Design of Experiments*

Introduction (p. 2)

Hafner Publishing Company. New York, New York, USA. 1971

### **Fleiss, Joseph L.**

American statistician

There was a statistician from Needham,  
Who was so bright, his clients would heed him.  
Yet his embarrassed confession  
Was that, in linear regression,  
He'd never subtract an extra degree of freedom.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October, 1967 (p. 49)

There was a statistician from Knossus,  
Who had a nonnormal neurosis.  
With techniques of newness, He'd measure the skewness,  
And also the data's kurtosis.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October, 1967 (p. 49)

There was a biometrician named Mabel,  
Who'd never look at populations unstable.  
Using intricate relations,  
She'd find life expectations,  
From the lx's of the life table.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October, 1967 (p. 49)

### **Forster, E. M. (Edward Morgan)** 1879–1970

English novelist

We are not concerned with the very poor. They are unthinkable, and only to be appreciated by the statistician or the poet.

*Howards End*

Chapter VI (p. 45)

Vintage Books. New York, New York, USA. 1954

### **Good, I. J.** 1916–

English statistician and cryptographer

The mathematician, the statistician, and the philosopher do different things with a theory of probability. The mathematician develops its formal consequences, the

statistician applies the work of the mathematician and the philosopher describes in general terms what this application consists in. The mathematician develops symbolic tools without worrying overmuch what the tools are for; the statistician uses them; the philosopher talks about them. Each does his job better if he knows something about the work of the other two.

Kinds of Probability

*Science*, Volume 129, Number 3347, February 20, 1959 (p. 443)

### **Goschen, Georg Joachim** 1752–1828

Publisher and printer

The statistician, or more properly speaking the administrator of statistics, is like a showman who is exhibiting certain figures.

The Increase of Moderate Incomes

*Journal of the Royal Statistical Society*, Volume L, Part IV December, 1887 (p. 590)

### **Hart, Anna**

Medical statistician

Statisticians are like apples, bananas and healthcare studies – some are better than others.

*Making Sense of Statistics in Healthcare*

Chapter Nine (p. 131)

Radcliff Medical Press, Ltd. Abingdon, England. 2001

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

There are three classes of lookers-on at the show of Nature who may be distinguished from each other. The first set includes the patient statisticians who addict themselves to particular series of facts, such as those relating to temperature, to the course of storms, and other specific objects of study. They give us infinite unreadable tables, out of which are extracted certain average results, which we are all willing to make use of.

*Pages from an Old Volume of Life: A Collection of Essays*

The Seasons (p. 133)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1883

### **Hooke, Robert** 1635–1703

English physicist

It is commonly believed that anyone who tabulates numbers is a statistician. This is like believing that anyone who owns a scalpel is a surgeon.

*How to Tell the Liars from the Statisticians*

Chapter 1 (p. 1)

Marcel-Dekker, Inc. New York, New York, USA. 1983

### **Hopkins, Harry**

No biographical data available

Increasingly, we find ourselves caught up in the new contemporary dualism; there is the muddling-on, verbalizing, impressionistic, human old world down there, and there is that Other, Finer, Rational World to which the



better statisticians have already been called. Communications between the two can be tenuous.

*The Numbers Game: The Bland Totalitarianism*

Chapter 6 (p. 134)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

### **Kerridge, D. F.**

No biographical data available

It is not primarily the responsibility of a statistician to make decisions for other people – not in general at any rate.... It is for someone else to say what decisions should be made with [inferential]...information. In other words, ideally, it is the statisticians job to inform not to decide.

Discussion on Paper by Dr. Marshall and Professor Olkin

*Journal of the Royal Statistical Society*, Series B, Volume 30, 1968 (p. 440)

### **Kirkman, Marshall Monroe** 1842–1921

American authority on railways

The statistician comes after the harvest. He succeeds the crops. His life is passed in the stubble, amidst limp, frost-bitten vines. It is his office to recount the rich man's exploits on the outskirts of the crowd. He is an oracle and delver in details. His sky is dull and leaden. All seasons are alike to him. The traits he has in common with the worldlings of life are his weaknesses. These, however, are mere infinitesimal specks, so to speak.

*The Science of Railways*

Chapter II (p. 16)

The World Railway Publishing Co. New York, New York, USA. 1899

We search in vain for any mention of the statistician in our directories. Strange omission! Where shall we look for him, what cover lift; what mask pluck off? He lives under a *nom de plume*. His titles are as multitudinous as the stars, and his costumes as shifting as the clouds.

*The Science of Railways*

Chapter II (p. 16)

The World Railway Publishing Co. New York, New York, USA. 1899

Like most men devoted to an idea, the statistician lacks imagination. He knows that the universe is made up of infinitesimal molecules. He is, therefore, infinitesimal. He distrusts things that cannot be demonstrated; the emanations of genius alarm him; man's restlessness fills him with forebodings. He discovers sinister meanings therein. Happily he is not superstitious; the creaking of the trees, the sighing of the wind, the flying clouds, foretell to him only practical things.

*The Science of Railways*

Chapter II (p. 17)

The World Railway Publishing Co. New York, New York, USA. 1899

Man's ambition finds its reflection in the statistician's work. While the former has absorbed all that has gone before, the statistician recounts the facts of history, often in secret, attributing their potency to his own agency. Vain conceit!

*The Science of Railways*

Chapter II (p. 20)

The World Railway Publishing Co. New York, New York, USA. 1899

The itch of inquiry is ever vehement in him [the statistician], and he attaches himself to new questions as buoys made to float him into paradise.

*The Science of Railways*

Chapter II (p. 20)

The World Railway Publishing Co. New York, New York, USA. 1899

### **Kruskal, William** 1919–2005

American mathematician and statistician

An occupational hazard to which we statisticians are exposed occurs in the context of a social occasion, perhaps a dinner party. I am, let us say, seated next to a charming lady whom I have just met, and, as an initial conversational ice-breaking, she turns to me with a winning smile and says: "Now tell me what is it you do?" We must tell the truth, of course, so I reply that I am a statistician. That usually ruins a fine conversation, for in 8.6 cases out of 10 the lady's smile disappears, she turns to my rival on her other side, and I attack the fried chicken in lonely, misunderstood dignity.

Statistics, Moliere, and Henry Adams

*American Scientist Magazine*, Volume 55, 1967 (p. 416)

### **Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

Statisticians deal with precious, intangible stuff, with the flecks and atomies of faery – and how few of them dare rise to the full possibilities of their medium!

*Prefaces*

Preface to a Book of Statistics (p. 188)

D. Appleton & Co. New York, New York, USA. 1919

### **Miksch, W. F.** 1861–1927

No biographical data available

A couple of government statisticians recently threw dust on the wedding ring business by coming right out with the fact that for every male there are 1.03 females. It's about time they stop shoving the American taxpayer behind decimal points.

The Average Statistician

*Collier's*, Volume 125, June 17, 1950 (p. 10)

### **Mitchell, Wesley C.** 1874–1948

American economist

A statistician is usually either right or wrong...

Statistics and Government

*Journal of the American Statistical Association*, Volume 16, Number 125, March, 1919 (p. 236)

### **Moroney, Michael Joseph** 1918–90

English statistician

There is more than a germ of truth in the suggestion that, in all society where statisticians thrive, liberty and individuality are likely to be emasculated.

*Facts from Figures*

Statistics Undesirable (p. 1)

Penguin Books Ltd., Harmondsworth, England. 1951

The statistician's job is to draw general conclusions from fragmentary data. Too often the data supplied to him for analysis are not only fragmentary but positively incoherent, so that he can do next to nothing with them. Even the most kindly statistician swears heartily under his breath whenever this happens.

*Facts from Figures*

What Happens When We Take a Sample (p. 120)

Penguin Books Ltd., Harmondsworth, England. 1951

**Pearson, Karl** 1857–1936

English mathematician

The statistician dealing with heredity is like the physicist dealing with the atom, he can say little or nothing of the individual, his knowledge is of the group containing great numbers.

*The Grammar of Science* (2nd edition)

Chapter XI (pp. 457–458)

Adam &amp; Charles Black. London, England. 1900

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

I like to think of the constant presence in any sound Republic of two guardian angels: the Statistician and the Historian of Science. The former keeps his finger on the pulse of Humanity...

*Sarton on the History of Science*

Quetelet (p. 241)

Harvard University Press. Cambridge, Massachusetts, USA. 1962

**Seaton, G. L.**

No biographical data available

...as the job of finding the truth and explaining it continues to become more complex and more difficult, management again casts a doubtful eye at the statistician, for a different reason. Management's big question is no longer "What can the statistician do for us that we can't do just as well ourselves?"; the question now is, "Do our statisticians have the tools and the capacity and the experience and the persistence and the breadth of vision to seek the truth and to know it when they have found it?"

## The Statistician and Modern Management

*The American Statistician*, Volume 2, Number 6, December, 1948 (p. 10)**Snedecor, G. W.**

Statistician

The characteristic which distinguishes the present-day professional statistician, is his interest and skill in the measurement of the fallibility of conclusions.

## On a Unique Feature of Statistics

Presidential Address to the American Statistical Association, December, 1948

*Journal of the American Statistical Association*, Volume 44, Number 245, March, 1949**Stamp, Josiah** 1880–1941

English economist and financier

Most of you would as soon be told that you are cross-eyed or knock-kneed as that you are destined to be a statistician...

*Some Economic Factors in Modern Life*

Chapter VIII (p. 253)

P.S. King &amp; Son Ltd. London, England. 1929

I sometimes think that statisticians do not deserve quite all the hard things that are said about them. They are supposed to be cold, unemotional, bloodless and steely-eyed. But, as a matter of fact, we are all statisticians nowadays. We are either forming opinions on other people's statistics, whether we like it or not, or we are providing the raw material of statistics.

*Some Economic Factors in Modern Life*

Chapter VIII (p. 253)

P.S. King &amp; Son Ltd. London, England. 1929

**Thurber, James** 1894–1961

American writer and cartoonist

Though statisticians in our time have never kept the score, Man wants a great deal here below and Women even more.

*Further Fables of Our Times*

The Godfather and His Godchild

Simon &amp; Schuster. New York, New York, USA. 1956

**Tukey, John W.** 1915–2000

American statistician

Predictions, prophecies, and perhaps even guidance – those who suggested this title to me must have hoped for such – even though occasional indulgences in such actions by statisticians has undoubtedly contributed to the characterization of a statistician as a man who draws straight lines from insufficient data to foregone conclusions!

## Where Do We Go From Here?

*Journal of the American Statistical Association*, Volume 55, Number 289, March, 1960 (p. 80)

The most important maxim for data analysis to heed, and one which many statisticians seem to have shunned is this: "Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise." Data analysis must progress by approximate answers, at best, since its knowledge of what the problem really is will at best be approximate.

## The Future of Data Analysis

*Annals of Mathematical Statistics*, Volume 33, Number 1, March, 1962 (pp. 13–14)

(The experimental statistician dare not shrink from the war cry of the analyst "Only a fool would use it, but it's better than we used to use!")

## Unsolved Problems of Experimental Statistics

*Journal of the American Statistical Association*, Volume 49, Number 268, December, 1954 (p. 718)

**Wang, Chamont** 1949–  
American statistician

Flip a coin 100 times. Assume that 99 heads are obtained. If you ask a statistician, the response is likely to be: “It is a biased coin.” But if you ask a probabilist, he may say: “Wooow, what a rare event.”

*Sense and Nonsense of Statistical Inference: Controversy, Misuse, and Subtlety*

Chapter 6 (p. 154)

Marcel-Dekker, Inc. New York, New York, USA. 1993

**Webster, Miriam (Amy Babich)**

No biographical data available

Collecting data – any data – is one of the simple pleasures of the statistician.

*After Math*

Chapter 8 (p. 86)

Zinka Press. Wayne, Pennsylvania, USA. 1997

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Behind the adventurer, the speculator, comes that scavenger of adventurers, the statistician.

*The Work, Wealth and Happiness of Mankind*

Chapter Nine, Part 10 (p. 390)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

...the movement of the last hundred years is all in favor of the statistician.

*The Work, Wealth and Happiness of Mankind*

Chapter Nine, Part 10 (p. 391)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

There is a story about two friends, who were classmates in high school, talking about their jobs. One of them became a statistician and was working on population trends. He showed a reprint to his former classmate. The reprint started, as usual with the Gaussian distribution and the statistician explained to his former classmate the meaning of the symbols for the actual population, for the average population, and so on. His classmate was a bit incredulous and was not quite sure whether the statistician was pulling his leg

*The Unreasonable Effectiveness of Mathematics in the Natural Sciences Communications on Pure and Applied Mathematics*, Volume 13, Number 1, February, 1960 (p. 1)

**Yule, G. U.** 1871–1951

Scottish statistician

Since the statistician can seldom or never make experiments for himself, he has to accept the data of daily experiences, and discuss as best he can the relations of a whole group of changes...

*On the Theory of Correlation*

*Journal of the Royal Statistical Society*, Volume LX, December, 1897 (p. 812)

## STATISTICS

**Adams, Henry Brooks** 1838–1918

American man of letters

History has never regarded itself as a science of statistics. It was the Science of Vital Energy in relation with time; and of late this radiating center of life has been steadily tending, – together with every form of physical and mechanical energy, – toward mathematical expression.

*A Letter to American Teachers of History*

Chapter I (p. 115)

Press of J.H. Furst Company. Washington, D.C. 1910

### Advertisement

...and you thought “impressive” statistics were 36–24–36. *The American Statistician*, Volume 33, Number 4, November 1979 (p. 248)

**Alexander, Carter**

No biographical data available

...giving a school man only a little, or very superficial, knowledge of statistics is like putting a razor in the hands of a baby.

*School Statistics and Publicity*

Chapter Three (p. 91)

Silver, Burdett & Co. Boston, Massachusetts, USA. 1919

**Allen, Roy George Douglas** 1906–83

English economist and mathematician

A knowledge of statistical methods is not only essential for those who present statistical arguments it is also needed by those on the receiving end.

*Statistics for Economists*

Chapter I (p. 9)

Hutchinson’s University Library. London, England. 1951

**Angell, Roger** 1920–

American fiction writer and essayist

Statistics are the food of love.

*Late Innings: A Baseball Companion*

Chapter 1 (p. 9)

Simon & Schuster. New York, New York, USA. 1982

### Author undetermined

Statistics are like sausages. It all depends on the old woman who makes them.

*Is Insanity Increasing?*

*Medical Record*, Volume 32, August 14, 1897 (p. 235)

Statistics are, like pigs and children, all very well – in their place.

*Wealthy Desolation*

*London Society*, Volume XIV, July, 1868 (p. 502)

To be utilized, statistics must be classified and the relation which the classes bear to each other must be carefully and correctly studied. It is not a simple matter to use these accumulated facts so that correct and

valuable conclusions may be drawn from them. Their true interpretation in all their significance can only be rendered by those who are skilled and experienced in their application. Novices in their use often develop very remarkable errors and fallacies, and malicious persons may designedly vise them for the special purpose of misrepresentation and deceit.

*Twenty-Second Annual Report of the State Board of Health of Indiana* (p. 98)  
1904

...statistics cannot err, but they may be mere skeletons of facts, which require to be vivified by being brought in contact with other facts, when their real importance will be seen.

Our Criminals

*Belgravia*, Volume VII, Third Series, October, 1875

**Baines, J. A.**

No biographical data available

Once again, but not I hope, too often, or for the last time, do I dip into the well of Mr. Courtney’s sagacity:—  
“We may quote to one another with a chuckle the words of the Wise Statesman, lies, damned lies and statistics, still there are some easy figures which the simplest must understand but the astutest cannot wriggle out of.”

Parliamentary Representation in England Illustrated by the Elections of 1892 and 1895

*Journal of the Royal Statistical Society*, Volume 59, 1896 (p. 87)

**Balchin, Nigel** 1908–70

English novelist

Organic chemist!” said Tilley expressively. “Probably knows no statistics whatever.”

*The Small Back Room* (p. 136)

Collins. London, England. 1943

**Bailey, W. B.** 1873–?

No biographical data available

**Cummings, John**

No biographical data available

Statistical tables are essentially specific in their meaning, and they require data that are uniformly specific in the same kind and degree.

*Statistics* (p. 33)

McClurg. Chicago, Illinois, USA. 1917

**Barrett-Browning, Elizabeth** 1806–61

English poet

There’s too much abstract willing, purposing,  
In this poor world. We talk by aggregates,  
And think by systems and being used to face  
Our evils in statistics, are inclined  
To cap them with unreal remedies  
Drawn out in haste on the other side.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Eighth Book, l. 800

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Bartlett, Maurice Stevenson** 1910–2002

English statistician

[Statistics] is concerned with things we can count. In so far as things, persons, are unique or ill-defined, statistics are meaningless and statisticians silenced; in so far as things are similar and definite – so many workers over 25, so many nuts and bolts made during December – they can be counted and new statistical facts are born.

*Essays on Probability and Statistics*

Some Remarks on the Theory of Statistics (p. 11)

Methuen & Company Ltd. London, England. 1962

**Baudrillard, Jean** 1929–

French cultural theorist

Like dreams, statistics are a form of wish fulfillment.

Translated by Chris Turner

*Cool Memories*

October, 1983 (p. 147)

Verso. London, England. 1990

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The statistical method is social mathematics par excellence.

*The Development of Mathematics* (p. 582)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

Mankind in the mass is more despotically governed by the laws of chance than it ever was by the decrees of any tyrant. If our shambling race is ever to get anything but suicidal destruction out of science, it may be a necessary first step that half a dozen human beings in every hundred thousand understand the mass-reactions of creatures who, as individuals, occasionally show that they can stand erect and walk like men. To grasp and analyze mass-reactions, whether of atoms or of human beings, a mastery of the modern statistical method is essential.

*The Development of Mathematics* (p. 582)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Belloc, Hilaire** 1870–1953

French-born poet and historian

It has long been recognized by public men of all kinds... that statistics come under the head of lying, and that no lie is so false or inconclusive as that which is based on statistics.

*The Silence of the Sea*

On Statistics (p. 170)

Sheed & Ward. New York, New York, USA. 1940

Before the curse of statistics fell upon mankind we lived a happy, innocent life, full of merriment and go, and informed by fairly good judgment.

*The Silence of the Sea*

On Statistics (p. 171)

Sheed & Ward. New York, New York, USA. 1940

Statistics are the triumph of the quantitative method, and the quantitative method is the victory of sterility and death.

*The Silence of the Sea*

On Statistics (p. 173)

Sheed & Ward. New York, New York, USA. 1940

### **Berger, J. O.**

No biographical data available

### **Berry, D. A.**

No biographical data available

...to acknowledge the subjectivity inherent in the interpretation of data is to recognize the central role of statistical analysis as a formal mechanism by which new evidence can be integrated with existing knowledge. Such a view of statistics as a dynamic discipline is far from the common perception of a rather dry, automatic technology for processing data.

Statistical Analysis and the Illusion of Objectivity

*American Scientist*, Volume 76, 1988 (p. 159)

### **Bernard, Claude** 1813–78

French physiologist

Only when a phenomenon includes conditions as yet undefined, can we compile; we must learn, therefore, that we compile statistics only when we cannot possibly help it.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section IX (p. 137)

Henry Schuman, Inc. New York, New York, USA. 1927

I do not understand how we can teach practical and exact science on the basis of statistics.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section ix (p. 138)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Billings, John Shaw** 1838–1913

American surgeon and librarian

Statistics are somewhat like old medical journals, or like revolvers in newly opened mining districts. Most men rarely use them, and find it troublesome to preserve them so as to have them easy of access; but when they do want them, they want them badly.

On Vital and Medical Statistics

*The Medical Record* Volume 36 Number 22, November 30, 1889 (p. 589)

### **Blalock, Jr., Hubert M.** 1927–91

American sociologist and statistical methods researcher

The manipulation of statistical formulas is no substitute for knowing what one is doing.

*Social Statistics*

Chapter 19 (p. 448)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1960

### **Bloch, Arthur** 1948–

American humorist

If enough data is collected, anything may be proved by statistical methods.

*Murphy's Law*

William and Holland's Law (p. 47)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

### **Blodgett, James H.**

American statistician

In statistical work we should be able to presume upon honesty, fidelity, and diligence.

Obstacles to Accurate Statistics

*Journal of the American Statistical Association*, New Series Number 41,

March, 1898 (p. 1)

### **Boorstin, Daniel J.** 1914–2004

American historian

...statistics have tended to make facts into norms.

*The Decline of Radicalism*

Chapter I (p. 18)

Random House, Inc. New York, New York, USA. 1969

...statistics, which first secured prestige here by a supposedly impartial utterance of stark fact, have enlarged their dominion over the American consciousness by becoming the most powerful statement of the "ought" – displacers of moral imperatives, personal ideals, and unfulfilled objectives.

*The Decline of Radicalism*

Chapter I (p. 19)

Random House, Inc. New York, New York, USA. 1969

### **Bowley, Arthur Lyon** 1869–1957

English statistician and economist

Great numbers are not counted correctly to a unit, they are estimated; and we might perhaps point to this as a division between arithmetic and statistics, that whereas arithmetic attains exactness, statistics deals with estimates, sometimes very accurate, and very often sufficiently so for their purpose, but never mathematically exact.

*Elements of Statistics*

Part I, Chapter I (p. 3)

P.S. King & Son Ltd. London, England. 1937

A knowledge of statistics is like a knowledge of foreign languages or of algebra; it may prove of use at any time under any circumstances.

*Elements of Statistics*

Part I, Chapter I (p. 4)

P.S. King & Son Ltd. London, England. 1937

A statistical estimate may be good or bad, accurate or the reverse; but in almost all cases it is likely to be



more accurate than a casual observer's impression, and the nature of things can only be disproved by statistical methods.

*Elements of Statistics*

Part I, Chapter I (p. 9)

P.S. King & Son Ltd. London, England. 1937

Some of the common ways of producing a false statistical argument are to quote figures without their context, omitting the cautions as to their incompleteness, or to apply them to a group of phenomena quite different to that to which they in reality relate; to take these estimates referring to only part of a group as complete; to enumerate the events favorable to an argument, omitting the other side; and to argue hastily from effect to cause, this last error being the one most often fathered on to statistics. For all these elementary mistakes in logic, statistics is held responsible.

*Elements of Statistics*

Part I, Chapter I (pp. 12–13)

P.S. King & Son Ltd. London, England. 1937

The most important function of statistics is to produce evidence showing the relation of one group of phenomena to another; for the information obtained is presumably intended as a guide for action, the guidance is generally needed to show what actions are likely to produce certain desired effects, and this is best investigated by finding how such effects have been produced in the past.

*Elements of Statistics*

Chapter II (p. 20)

P.S. King & Son. London, England. 1901

Very many definitions have been given of the word statistics, and each author who has written on the subject has assigned new limits to the field which should be included in its scope.

*Elements of Statistics* (4th edition)

Part I, Chapter I (p. 3)

P.S. King & Son. London, England. 1920

**Bowman, Scotty** 1933–

Canadian Hockey Coach

**Bowley, Arthur Lyon** 1869–1957

English statistician and economist

Statistics are for losers.

A Lot More Where They Come From

*Sports Illustrated*, April 2, 1973

**Bowman, W. E.** 1912–1985

English amateur hill hiker and satirist

The various estimates of the height of the true summit vary considerably, but by taking an average of these figures it is possible to say confidently that the summit of Rum Doodle is 40,000 1/2 feet above sea level.

*The Ascent of Rum Doodle*

Chapter 3 (pp. 32–33)

The Vanguard Press. New York, New York, USA. 1956

**Buchner, Ludwig** 1824–99

German physician and philosopher

The science of statistics, which has only been turned to proper account in modern times, has the great honor of having proved the existence of definite rules in a number of phenomena, which had hitherto been looked upon as merely accidental or as owing their origin to an arbitrary power.

*Force and Matter*

Free Will (p. 367)

Truth Seeker. New York, New York, USA. 1950

**Burgess, Robert W.** 1887–1969

American statistician

The fundamental gospel of statistics is to push back the domain of ignorance, prejudice, rule-of-thumb, arbitrary or premature decisions, tradition, and dogmatism and to increase the domain in which decisions are made and principles are formulated on the basis of analyzed quantitative facts.

The Whole Duty of the Statistical Forecaster

*Journal of the American Statistical Association*, Volume 32, Number

200, December, 1937 (p. 636)

**Burnan, Tom**

No biographical data available

No matter how much reverence is paid to anything purporting to be “statistics,” the term has no meaning unless the source, relevance, and truth are all checked.

*The Dictionary of Misinformation*

Statistics, Use, Misuse, and Abuse Of (p. 271)

Ballantine Books. New York, New York, USA. 1975

...the worship of statistics has had the particularly unfortunate result of making the job of the plain, outright liar that much easier.

*The Dictionary of Misinformation*

Statistics, Use, Misuse, and Abuse Of (p. 274)

Ballantine Books. New York, New York, USA. 1975

**Carlyle, Thomas** 1795–1881

English historian and essayist

Statistics is a science which ought to be honorable, the basis of many most important sciences; but it is not to be carried on by steam, this science, anymore than others are; a wise head is requisite for carrying it on.

*English and Other Critical Essays*

Chartism (p. 170)

J.M. Dent & sons Ltd. London, England. 1950

Statistics is a science which ought to be honourable, the basis of many most important sciences; but it is not to be carried on by steam, this science, anymore than others are; a wise hand is requisite for carrying it on. Conclusive facts are inseparable from unconvulsive except by a head that already understands and knows.



*Critical and Miscellaneous Essays*

Chartism, II

D. Appleton &amp; Company. New York, New York, USA. 1860

Statistics, one may hope, will improve gradually, and become good for something. Meanwhile, it is to be feared the crabbed satirist was partly right, as things go.

*English and Other Critical Essays*

Chartism, Chapter II (p. 171)

J.M. Dent &amp; sons Ltd. London, England. 1950

**Carolsfeld, Joachim**

No biographical data available

Management of fisheries in the absence of reliable statistics is like minding a store with no record of sales and no inventory.

*Migratory Fishes of South America*

Chapter 1 (p. 13)

International Development Research Centre

2003

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“And on the dead level our pace is – ?” the younger suggested; for he was weak in statistics, and left all such details to his aged companion.

*The Complete Works of Lewis Carroll**A Tangled Tale*

Knot 1 (p. 983)

The Modern Library. New York, New York, USA. 1936

**Chatfield, Christopher**

British statistician

Thus statistics should generally be taught more as a practical subject with analyses of real data. Of course some theory and an appropriate range of statistical tools need to be learnt, but students should be taught that Statistics is much more than a collection of standard prescriptions.

The Initial Examination of Data

*Journal of the Royal Statistical Society*, Series A, Volume 148, 1985**Cogswell, Theodore R.** 1918–87

American science fiction author

Statistics show that you have nothing to worry about.

In Harry Harrison

*Astounding: John W. Campbell Memorial Anthology*

Probability Zero (p. 329)

Random House, Inc. New York, New York, USA. 1973

**Cohen, Jacob** 1923–

American behavioral psychologist and statistical analyst

I have learned repeatedly, however, that the typical behavioral scientist approaches applied statistics with considerable uncertainty (if not actual nervousness), and

requires a verbal-intuitive exposition, rich in redundancy and with many concrete illustrations.

*Statistical Power Analysis for the Behavioral Sciences*

Preface to the Original Edition (p. xx)

Lawrence Erlbaum Associates, Publishers. Hillsdale, New Jersey, USA. 1988

Since statistical significance is so earnestly sought and devoutly wished for by behavioral scientists, one would think that the a priori probability of its accomplishment would be routinely determined and well understood. Quite surprisingly, this is not the case.

*Statistical Power Analysis for the Behavioral Sciences*

Chapter 1 (p. 1)

Lawrence Erlbaum Associates. Hillsdale, New Jersey, USA. 1988

**Cox, Sir David Roxbee** 1924–

English statistician

**Hinkley, D. V.** 1924–

English statistician

Statistical methods of analysis are intended to aid the interpretation of data that are subject to appreciable haphazard variability.

*Theoretical Statistics* (p. 1)

Introduction (p. 1)

Chapman &amp; Hall. London, England. 1974

**Crichton, Michael** 1942–

American novelist

Conversation and statistics. Really boring.

*Rising Sun*

Second Day (p. 254)

Ballantine Books. New York, New York, USA. 1993

**Cutter, C. A.**

No biographical data available

Statistics are like the notices that we post: few persons read them, still fewer heed them; but we are obliged to post them lest we be asked, Why did you not tell me? So we must have statistics, I suppose. There are persons who, like children, must pull up their plants to see if they are growing. And they want to know such details, – how many bakers and how many candlestick makers use the library, what percentage of fiction and what percentage of theology is used, on what day in the year the most books were taken out and on what the fewest. Yes, it is all interesting; looks as if it ought to be useful; is sometimes needed as a defence against the attacks of the unfriendly; but one would like to know how often any practical measure is the result of the figures so laboriously got together.

*Annual Conference Proceedings of the American Library Association*

Common Sense in Libraries (p. 2)

Library Bureau. Boston, Massachusetts, USA. 1889

**Darwin, Charles Robert** 1809–82  
English naturalist

One has, however, no business to feel so much surprise of one's ignorance, when one knows how impossible it is without statistics to conjecture the duration of life and percentage of deaths to births in mankind.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
C. Darwin to L. Jenyns, [1845?] (p. 394)  
D. Appleton & Company. New York, New York, USA. 1896

**Davies, John Tasman** 1924–?  
Chemist

Operational research is the application of methods of the research scientist to various rather complex practical operations.... A paucity of numerical data with which to work is a usual characteristic of the operations to which operational research is applied.

*The Scientific Approach*  
Chapter 7 (p. 86)  
Academic Press. London, England. 1965

**Davis, Joseph S.**  
No biographical data available

Statistics are proverbially dry – forgive me if I say they are far better dry than “wet” – but to give them optimum moisture content is simply a matter of mastering fundamentals that no one should hold in contempt.

Statistics and Social Engineering  
*Journal of the American Statistical Association*, Volume 32, Number 197, March, 1937 (p. 6)

**Dawkins, Richard** 1941–  
British ethologist, evolutionary biologist, and popular science writer

The essence of life is statistical improbability on a colossal scale.

*The Blind Watchmaker*  
Chapter 11 (p. 317)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**de Bow, James Dunwoody Brownson** 1820–67  
American statistician and editor

Statistics are far from being the barren array of figures ingeniously combined into columns and tables, which many persons are apt to suppose them. They constitute rather the ledger of the Nation, in which, like the merchant in his books, the citizen can read at one view, all the results of a year or period of years, as compared with other periods, and deduce the profit or the loss which has been made in morals, education, wealth or power.

*Statistical View of the United States*  
Introductory Remarks (p. 9)  
Washington, D.C. 1854

**de Jonnes, Moreau**  
No biographical data available

Statistics are like the hieroglyphics of ancient Egypt, where the lessons of history, the precepts of wisdom, and the secrets of the future were concealed in mysterious characters.

*Elements de Statistique* (p. 5)

**de Leeuw, A. L.**  
No biographical data available

The method used by the scientist to find probable exact truth is what he calls “the method of least squares.”

*Rambling Through Science*  
Gambling (p. 88)  
Whittlesey House. London, England. 1932

**de Madariaga, Salvador** 1886–1978  
Spanish writer and statesman

Statistics only work well when they dwell on large numbers of absolutely free motions, or what has been described as “perfect disorder.” If an element of deliberate direction, of conscious “order”, meddles with their utter “innocence”, the facts in question cease to follow statistical laws.

*Essays with a Purpose*  
Freedom and Science (p. 50)  
Hollis & Carter. London, England. 1954

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

You need not be a mathematical statistician to do good statistical work, but you will need the guidance of a first class mathematical statistician.

Some Principles of the Shewhart Method of Quality Control  
*Mechanical Engineering*, Volume 66, March, 1944

A good engineer, or a good economist, or a good chemist, already has a good start, because the statistical method is only good science brought up to date by the recognition that all laws are subject to the variations which occur in nature.

Some Principles of the Shewhart Method of Quality Control  
*Mechanical Engineering*, Volume 66, March, 1944

Your study of statistical methods will not displace any other knowledge that you have; rather, it will extend your knowledge of engineering, chemistry, or economics, and make it more useful.

Some Principles of the Shewhart Method of Quality Control  
*Mechanical Engineering*, Volume 66, March, 1944

Statistical research is particularly necessary in the government service because of the high level of quality and economy that the public has the right to expect in government statistics.

*Some Theory of Sampling* (p. viii)  
John Wiley & Sons, Inc. New York, New York, USA. 1950

The statistical method is more than an array of techniques. The statistical method is a Mode of Thought; it is

**Sharpened Thinking; it is Power.**

Paper presented at meeting of the International Statistical Institute, September, 1953

Unfortunately and inadvertently, intellectual gulfs have grown up between writers in statistics, least squares, and curve fitting. Each of the three groups has gone its own way, rediscovering developments long since discovered by the others, or – what is worse – not rediscovering them.

*Statistical Adjustment of Data* (p. iv)

John Wiley & Sons, Inc. New York, New York, USA. 1938

**Devons, Ely** 1913–67

English economist

The experience of falling in love could be adequately described in terms of statistics. A record of heart beats per minute, the stammering and hesitation in speech, the number of calories consumed per day, the heightening of poetic vision, measured by the number of lines of poetry written to the beloved – I won't go on; no doubt you can think of further measures.

*Essays in Economics*

Chapter 6 (p. 105)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

The two most important characteristics of the language of statistics are first, that it describes things in quantitative terms, and second, that it gives this description an air of accuracy and precision.

*Essays in Economics*

Chapter 6 (p. 106)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

There are those who are so impressed by the notion that “quantification” is the only form of scientific knowledge, that they see no danger in the distorted, misleading, or simply ineffective picture that a statistical description of events may give. To such people the statistical picture is always to be preferred as the most meaningful and objective. It is indeed because this view is so widespread, that an argument stated in statistical terms has such a powerful influence in policy decision, and induces everyone to try to impress their case on public attention by peppering it with statistics.

*Essays in Economics*

Chapter 6 (p. 106)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

How to use a language which by its very nature implies objectivity, precision and accuracy, in such a way that the subjective element of judgment, imprecision and inaccuracy are fully taken into account? It is because this task is so difficult and so rarely achieved that statistics are frequently referred to as “the hard facts”, and yet we talk of three kinds of lies – “lies, damn lies, and statistics.”

*Essays in Economics*

Chapter 6 (p. 111)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

...“statistics are only for the statistician”, and even then, I might add, only for the good statistician.

*Essays in Economics*

Chapter 6 (p. 118)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

This exaggerated influence of statistics resulting from willingness, indeed eagerness, to be impressed by the “hard facts” provided by the “figures”, may play an important role in decision-making.

*Essays in Economics*

Chapter 7 (p. 134)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

Statistical magic, like its primitive counterpart, is a mystery to the public; and like primitive magic it can never be proved wrong.... The oracle is never wrong; a mistake merely reinforces the belief in magic.

*Essays in Economics*

Chapter 7 (p. 135)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

**Dewey, John** 1859–1952

American philosopher and educator

Factual science may collect statistics, and make charts. But its predictions are, as has been well said, but past history reversed.

*Art as Experience*

Chapter XIV (p. 346)

Milton, Balch and Company. New York, New York, USA. 1934

**Dickens, Charles** 1812–70

English novelist

Mr. Gradgrind sat writing in the room with the deadly statistical clock, proving something no doubt – probably, in the main, that the Good Samaritan was a bad economist.

*Hard Times*

Book the Second, Chapter XII (p. 192)

J.M. Dent & Sons Ltd. London, England. 1966

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

...Statistics reigns and revels in the very heart of Physics.

On the Use of the Theory of Probabilities in Statistics Relating to Society

*Journal of the Royal Statistical Society*, January, 1913 (p. 167)

**Edwards, A. W. F.** 1935–

English statistician, geneticist, and evolution biologist

There comes a time in the life of a scientist when he must convince himself either that his subject is so robust from a statistical point of view that the finer points of statistical inference he adopts are irrelevant or that the precise mode of inference he adopts is satisfactory.

*Likelihood* (p. xi)

Cambridge University Press. Cambridge, England. 1972

**Efron, Bradley** 1938–  
American statistician

**Tibshirani, Robert J.**

No biographical data available

Statistics is a subject of amazingly many users and surprisingly few effective practioners.

*An Introduction to the Bootstrap*

Preface (p. xiv)

Chapman & Hall. New York, New York, USA. 1993

Statistics is the science of learning from experiences, especially experiences that arrive a little bit at a time.

*An Introduction to the Bootstrap*

Chapter 1 (p. 1)

Chapman & Hall. New York, New York, USA. 1993

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

By applying the statistical method we cannot foretell the behavior of an individual in a crowd. We can only foretell the chance, the probability, that it will behave in some particular manner.

*The Evolution of Physics*

Probability Waves (p. 284)

Simon & Schuster. New York, New York, USA. 1961

**Eisenhart, Churchill** 1913–94

American statistician

The primary function of a statistical consultant in a research organization is to furnish advice and guidance in the collection and use of numerical data to provide quantitative foundations for decisions.

The Role of a Statistical Consultant in a Research Organization

*The American Statistician*, Volume 2, Number 2, April, 1948 (p. 6)

**Ellis, Havelock** 1859–1939

English sexuality researcher

...the methods of statistics are so variable and uncertain, so apt to be influenced by circumstances, that it is never possible to be sure that one is operating with figures of equal weight.

*The Dance of Life*

Chapter VII, I (p. 286)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

One more fagot of these adamantine bandages is the new science of Statistics. It is a rule that the most casual and extraordinary events, if the basis of population is broad enough, become matter of fixed calculation.

*The Conduct of Life*

Fate (p. 17)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Farr, William** 1807–83

English statistician

You complain that your report would be dry. The dryer the better. Statistics should be the driest of all reading.

Nightingale on Quetelet

*Journal of the Royal Statistical Society*, Series A, 1981 (p. 144)

**Ferguson, Kitty**

Science writer

Compared with the adventure of discovering them, the statistics themselves often seem terribly dry.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*

Prologue (p. 3)

Walker & Company. New York, New York, USA. 1999

**Fienberg, Stephen E.** 1942–

American statistician

Although advice on how and when to draw graphs is available, we have no theory of statistical graphics...

Graphical Methods in Statistics

*The American Statistician*, Volume 13, Number 4, November, 1979

(p. 165)

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

This rather tumultuous overflow of statistical techniques from the quiet backwaters of theoretical methodology... into the working part of going concerns of the largest size, suggest that hidden causes have been at work...preparing men's minds, and shaping the institutions through which they work...

The Expansion of Statistics

*American Scientist Magazine*, Volume 42, Number 2, April, 1954

(p. 277)

Statistical procedure and experimental design are only two different aspects of the same whole, and that whole is the logical requirements of the complete process of adding to natural knowledge by experimentation.

*The Design of Experiments*

Introduction (p. 3)

Hafner Publishing Company. New York, New York, USA. 1971

In the original sense of the word, "statistics" was the science of Statecraft: to the political arithmetician of the eighteenth century, its function was to be the eyes and ears of the central government.

Presidential Address, First Indian Statistical Conference

*Sankhya*, 1938, Volume 4, 1938 (p. 14)

**Fitzgerald, F. Scott** 1896–1940

American novelist and short story writer

I was counting the waves," replied Amory gravely, "I'm going in for statistics."

*This Side of Paradise* (p. 213)

Ann Arbor Media Group, LLC. Ann Arbor, Michigan, USA. 2006

**Freeman, Linton C.**

No biographical data available

We are all victims of statistics.

*Elementary Applied Statistics*

Section A (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1965

**Gallup, George** 1901–84

American journalist and statistician

I could prove God statistically.

*OMNI Magazine*, Volume 2, Issue 2, November, 1979 (p. 42)

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

The object of statistical science is to discover methods of condensing information concerning large groups of allied facts into brief and compendious expressions suitable for discussion. The possibility of doing this is based on the constancy and continuity with which objects of the same species are found to vary.

*Inquiries into Human Faculty and Its Development*

Statistical Methods (p. 33)

AMS Press. New York, New York, USA. 1973

**Gann, Ernest K.** 1910–91

Author, sailor, fisherman, film producer, and airline captain

No, Mother dear, I do not hop into bed with every man I meet, despite your nasty little secret thoughts, but I do very much enjoy a more than occasional roll in the hay, which, if I have my statistics right, is a good deal more often than the average wife enjoys.

*Brain 2000* (pp. 27–28)

Doubleday & Company, Inc. New York, New York, USA. 1980

**Gissing, George** 1857–1903

English novelist

...bits of jokes, bits of statistics, bits of foolery.

*New Grub Street*

The Sunny Way (p. 492)

The Modern Library. New York, New York, USA. 1926

**Green, Celia** 1935–

English philosopher and psychologist

When people talk about “the sanctity of the individual” they mean “the sanctity of the statistical norm.”

*The Decline and Fall of Science*

Aphorisms (p. 4)

Hamilton. London, England. 1976

**Greenwood, M.**

No biographical data available

Sometimes a David felled a Goliath of a statistical difficulty with a smooth stone. It might take a mathematician to prove how truly the stone was aimed.

Discussion, to the paper “Some Aspects of the Teaching of Statistics”

*Journal of the Royal Statistical Society*, Volume 102, 1939 (p. 522)

**Gregory, John** 1724–73

Scottish physician and philosopher

The advancement of the sciences...requires only an attention to probabilities...a quick discernment where the greatest probability lies, and habits, of acting in consequence of this with facility and vigor.

*Lectures on the Duties and Qualifications of a Physician* (p. 164)

W. Strahan. London, England. 1772

**Habera, Audrey**

Statistician

**Runyon, Richard P.**

Statistician

When we can't prove our point through the use of sound reasoning, we fall back upon statistical “mumbo jumbo” to confuse and demoralize our opponents.

*General Statistics*

Chapter 1 (p. 3)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1973

Statistics is the refuge of the uninformed.

*General Statistics*

Chapter 1 (p. 3)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1973

Statistics is “hocus-pocus” with numbers.

*General Statistics*

Chapter 1 (p. 3)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1973

**Hailey, Arthur** 1920–2004

English/Canadian author

Legal proceedings are like statistics. If you manipulate them, you can prove anything.

*Airport*

Part 3, Chapter 11 (p. 385)

Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Hancock, William Keith** 1808–?

Australian author

Oratory is dying; a calculating age has stabbed it to the heart with innumerable dagger-thrusts of statistics.

*Australia* (p. 146)

E. Benn Ltd. London, England. 1945

**Hand, D. J.**

No biographical data available

Statistics has been likened to a telescope. The latter enables one to see further and to make clear objects which were diminished or obscured by distance. The former enables one to discern structure and relationships which were distorted by other factors or obscured by random variation.

The Role of Statistics in Psychiatry

*Psychological Medicine*, Volume 15, 1985 (p. 471)



**Hawkins, Francis Bisset** 1796–1894  
No biographical data available

Statistics has become the key to several sciences...and there is reason to believe, that a careful cultivation of it, would materially assist the completion of a philosophy of medicine.... Medical statistics affords the most convincing proofs of the efficacy of medicine.

*Elements of Medical Statistics* (pp. 2–3)  
Longman. London, England. 1829

**Hayford, F. Leslie**  
No biographical data available

In the everyday use of statistics in business, complicated statistical methods rarely are necessary and always are to be avoided if possible. Simplicity of treatment and presentation is a requisite in the making of statistics useful in executive control.

Some Uses of Statistics in Executive Control  
*Journal of the American Statistical Association*, Volume 31, Number 193, March, 1936 (p. 36)

...neither statistics nor the statistician can ordinarily give the executive the final answer to his problems.

Some Uses of Statistics in Executive Control  
*Journal of the American Statistical Association*, Volume 31, Number 193, March, 1936 (p. 36)

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Oh, the hell with! – it did not change the statistical outcome.

*Time Enough for Love*  
Chapter VI (p. 208)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Henderson, Charles Richmond** 1861–1941  
American educator

Imported statistics are like charged mineral water left in an open vessel; for the sparkle and zest are volatile.

*The Making of America* (Volume 10)  
Charity, – Theory and Practice (p. 16)  
The Making of America Co. Chicago, Illinois, USA. 1906

**Hinsdale, Burke Aaron** 1837–1900  
American educator

The legislator without statistics is like the mariner at sea without the compass. Nothing can safely be committed to his guidance.

*The Republican Text-book for the Campaign of 1880*  
Chapter VI (p. 36)  
D. Appleton & Co. New York, New York, USA. 1880

**Hoel, P. G.**  
Statistician

Statistical methods are essentially methods for dealing with data that have been obtained by repetitive operations.

*Introduction to Mathematical Statistics*  
Chapter 1 (p. 1)  
John Wiley & Sons, Inc. New York, New York, USA. 1954

**Hogben, Lancelot** 1895–1975  
English zoologist

Acceptability of a statistically significant result of an experiment on animal behavior in contradistinction to a result which the investigator can repeat before a critical audience naturally promotes a high output of publication. Hence, the argument that the techniques work has a tempting appeal to young biologists.

*Statistical Theory: The Relationship of Probability, Credibility and Error* (p. 27)  
George Allen & Unwin Ltd. London, England. 1957

The word statistics has at least six different meanings in current use, four in the context of statistical theory alone.

*Science in Authority*  
The Present Crisis in Statistical Theory (pp. 94–95)  
Unwin University Books. London, England, USA. 1963

**Holmes, Jr., Oliver Wendell** 1841–1935  
American jurist

For the rational study of the law the black-letter man may be the man of the present, but the man of the future is the man of statistics and the master of economics.

Path of the Law  
*The Harvard Law Review*, Volume 10, 1897

**Hooke, Robert** 1635–1703  
English physicist

Don't waste time arguing about the merits or demerits of something if you can gather some statistics that will answer the question realistically.

In J.M. Tanur  
*Statistics: A Guide to the Unknown*  
Statistics, Sports, and Some Other Things (p. 195)  
Wadsworth & Brooks. Pacific Grove, California, USA. 1989

Do remember that your experiment is merely a hodge-podge of statistics, consisting of those cases that you happen to remember. Because these are necessarily small in number and because your memory may be biased toward one result or another, your experience may be far less dependable than a good set of statistics.

In J.M. Tanur  
*Statistics: A Guide to the Unknown*  
Statistics, Sports, and Some Other Things (p. 195)  
Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Hopkins, Harry**  
No biographical data available

Confidence in the omniscience of statistical reasoning grows by what it feeds on.

*The Numbers Game: The Bland Totalitarianism*  
Chapter 6 (p. 132)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973



And when, in pursuit of the black cat of definitive truth, more refined techniques of statistical analysis, factor analysis, and so forth, are developed, the researcher is more and more distanced from the subject of his pursuit, and the real human world in which it exists. He raises as by a sort of mathematical levitation, into that other, finer sphere, where black cats are clawless, mewless and abstract...

*The Numbers Game: The Bland Totalitarianism*

Chapter 7 (p. 141)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

You can't argue with statistics; generally you can't even get at them.

*The Numbers Game: The Bland Totalitarianism*

Chapter 11 (p. 232)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE  
Roman philosopher and dramatic critic

As they put it in Greek, we simply don't COUNT. We consume.

*The Satires and Epistles of Horace*

Epistle I, to Lollius Maximus

**Hotelling, Harold** 1895–1973  
American mathematical economist

Research in statistical theory and technique is necessarily mathematical, scholarly, and abstract in character, requiring some degree of leisure and detachment, and access to a good mathematical and statistical library.

*Memorandum to the Governor of India*

24 February, 1940

The purely random sample is the only kind that can be examined with entire confidence by means of statistical theory, but there is one thing wrong with it. It is so difficult and expensive to obtain for many uses that sheer cost eliminates it.

*How to Lie with Statistics*

Chapter 1 (p. 21)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

**Huff, Darrell** 1913–2001  
American writer

The secret language of statistics, so appealing in a fact-minded culture, is employed to sensationalize, inflate, confuse, and oversimplify.

*How to Lie with Statistics*

Introduction (p. 8)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

A well-wrapped statistic is better than Hitler's "big lie"; it misleads, yet it cannot be pinned on you.

*How to Lie with Statistics*

Introduction (p. 9)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

**Hughes, Rupert** 1872–1956  
American historian and novelist

You can prove anything by statistics, if you can only choose your statistics and stop when you want to. But statistics are like automobiles. Sometimes if you hitch yourself up with a statistic, you meet the fate of the farmer who put his fool head in the yoke with a skittish steer.

*The Love Affairs of Great Musicians* (Volume 2)

Chapter VII (p. 257)

L.C. Page & Co. Boston, Massachusetts, USA. 1904

**Jahoda, Marie** 1907–2001  
Austrian social psychologist

**Deutsch, Morton** 1920–  
American social psychologist

The use of available statistical records requires, first, that the social scientist be familiar with the better known sources of such data and that he display some ingenuity in discovering less obvious material.

*Research Methods in Social Relations*

Basic Process, Part I (p. 232)

Dryden Press. New York, New York, USA. 1951

**Johnny Farrell (Fictional character)**

Statistics show that there are more women in the world than anything else. Except insects.

*Gilda*

Film (1946)

**Johnson, Alvin S.**  
No biographical data available

To submit subtle questions of economic theory to the arbitrament of statistics is like submitting abstruse philosophical questions to a popular vote.

Book Reviews

*The South Atlantic Quarterly*, Volume 8, Number 4, October, 1909 (p. 383)

**Johnson, Lyndon B.** 1908–73  
36th president of the USA

The economy was never stronger in your lifetime. But statistics must not be sedatives. Economic power is important only as it is put to human use.

Speech

United Automobile Worker's Convention, Atlantic City, N.J., 23 March, 1964

**Johnson, Palmer O.** 1891–?  
No biographical data available

There was a time when statistics as a tool in experimentation was almost completely ignored by the experimenter; in fact, it was regarded [as] "introducing unnecessary confusion into otherwise plain issues."

Modern Statistical Science and its Function in Educational and Psychological Research  
*The Scientific Monthly*, June 1951 (p. 385)

**Jones, Franklin P.**

No biographical data available

Sarah Bascomb was well aware that she didn't live in the same world with her husband, and that made it rather nice, she thought. It would have been exceedingly boring if they both talked of nothing but expectancy tables and statistical probabilities, or the PTA and young Chuck's music lessons.

*The Non-Statistical Man* (p. 10)  
 Belmont Books, New York, New York, USA. 1964

[S]tatistics had to be invented...because people were so unstable and irrational, taken one at a time.

*The Non-Statistical Man* (p. 15)  
 Belmont Books, New York, New York, USA. 1964

In statistics, you look for the common factor in order to lump otherwise dissimilar items in a single category.

*The Non-Statistical Man* (p. 17)  
 Belmont Books, New York, New York, USA. 1964

Statistical laws enable the insurance company to function, and make a profit for its shareholders. But what does statistics do for the policyholder? Not one damn thing!

*The Non-Statistical Man* (p. 32)  
 Belmont Books, New York, New York, USA. 1964

**Kahn, S. J.**

No biographical data available

Statistics in Israel today are like potatoes: they lie in the mud, but they're growing!

*Menorah Journal*, Volume 42, 1954 (p. 125)

**Kaplan, Abraham** 1918–93

American philosopher of science, author, and educator

...statistical techniques are tools of thought, and not substitutes for thought.

*The Conduct of Inquiry: Methodology for Behavioral Science*  
 Chapter VI, Section 29 (p. 257)  
 Chandler Publishing Company. San Francisco, California, USA. 1964

**Kelley, Francis Clement** 1870–1948

Canadian-born US prelate

To me a page of statistics is like an icy bath.

*The Story of Extension*  
 Chapter Twenty-third (p. 252)  
 Extension Press. Chicago, Illinois, USA. 1922

**Kendall, Maurice G.** 1907–83

Statistician

**Stuart, A.** 1932–

American theoretical and physical chemist

Statistics is the branch of scientific method which deals with the data obtained by counting or measuring the

properties of populations of natural phenomena. In this definition "natural phenomena" includes all the happenings of the external world, either human or not.

*The Advanced Theory of Statistics* (Volume 1)  
 Chapter 1, Section 1.4 (p. 2)  
 Charles Griffin & Company Ltd. London, England. 1947

**King, Willford** 1880–1962

American economist and statistician

Archaeologists unearthed today in Babylon a remarkable set of clay tablets recording the minutes of the 1242 annual meeting of the Babylonical Statistical Association.

Consolidating Our Gains  
*Journal of the American Statistical Association*, Volume 31, Number 193, March, 1936 (p. 2)

**Kirkman, Marshall Monroe** 1842–1921

American authority on railways

Statistics are the electric lights thrown on industrial and social affairs, illuminating the acts of all concerned.

*The Science of Railways*  
 Chapter II (p. 10)  
 The World Railway Publishing Co. New York, New York, USA. 1907

Statistics are like accounts. The latter cannot be explained: they must be pored over as we would study an algebraic problem. Only men driven thereto or who possess a stout resolution are able to do this.

*The Science of Railways* (Volume 10) (9th edition)  
 Chapter III (p. 21)  
 The World Railway Publishing Co. New York, New York, USA. 1899

**Koshland, Jr., Daniel E.** 1920–

American biochemist

Science. I'm afraid, Dr. Noitall, you do not have any understanding of statistics.

Editorial  
*Science*, Volume 263, Number 5144, 14 January, 1994 (p. 155)

**Kruskal, William** 1919–2005

American mathematician and statistician

It is all too easy to notice the statistical sea that supports our thoughts and actions. If that sea loses its buoyancy, it may take a long time to regain the lost support.

Coordination Today: A Disaster or a Disgrace  
*The American Statistician*, Volume 37, Number 3, 1983 (p. 179)

What is there about the word "statistics" that so often provokes strained silence?

Statistics, Moliere, and Henry Adams  
*American Scientist Magazine*, Volume 55, 1967 (p. 416)

Statistics is the art of stating in precise terms that which one does not know.

Statistics, Moliere, and Henry Adams  
*American Scientist Magazine*, Volume 55, 1967 (p. 417)

...each of us has been doing statistics all his life, in the sense that each of us has been busily reaching conclusions

based on empirical observations ever since birth.  
 Statistics, Moliere, and Henry Adams  
*American Scientist Magazine*, Volume 55, 1967 (p. 417)

**LaGuardia, Fiorello** 1882–1947  
 American civil servant, congressman, and New York City mayor

Statistics are like alienists – they will testify for either side.  
 The Banking Investigation  
*Liberty*, May 13, 1933

**Lang, Andrew** 1844–1912  
 Scottish scholar and man of letters

He uses statistics as a drunken man uses lamp-posts – for support rather than illumination.  
 In Evan Esar  
*The Dictionary of Humorous Quotations*  
 Doubleday & Company, Inc. Garden City, New York, USA. 1949

**Lapin, Lawrence**  
 No biographical data available

Statistics is a body of methods and theory applied to numerical evidence in making decisions in the face of uncertainty.  
*Statistics for Modern Business Decisions*  
 Chapter I (p. 2)  
 Harcourt Brace Jovanovich, Inc. New York, New York, USA. 1973

**Leacock, Stephen** 1869–1944  
 Canadian humorist

“I’ve been reading some very interesting statistics,” he was saying to the other thinker.  
 “Ah, statistics!” said the other, “wonderful things, sir, statistics; very fond of them myself.”  
*Literary Lapses*  
 A Force of Statistics (p. 74)  
 John Lane. London, England. 1911

**Lehmann, Karl Gotthelf**  
 No biological data available

Statistics manufacture certainty out of random events, just as they ensure the profits of Monte Carlo, provided the roulette wheels run truly.  
*Physiological Chemistry*  
 Chapter IX (p. 124)  
 Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1855

**Lem, Stanislaw** 1912–2006  
 Polish science fiction, philosophical, and satirical writer

...the rationalist’s substitute for demonology – statistics.  
 Translated by Michael Kandel  
*His Master’s Voice*  
 Preface (p. 10)  
 Northwestern University Press. Evanston, Illinois, USA. 1999

**Lewis, Clarence Irving** 1883–1964  
 American philosopher

...the statistical prediction of the future from the past cannot be generally valid, because whatever is future to any given past, is in turn past for some future. That is, whoever continually revises his judgment of the probability of a statistical generalization by its successively observed verifications and failures, cannot fail to make more successful predictions than if he should disregard the past in his anticipation of the future. This might be called the “Principle of statistical accumulation.”  
*Mind and the World-Order: Outline of a Theory of Knowledge*  
 Chapter XI (p. 386)  
 Charles Scribner’s Sons. New York, New York, USA. 1929

**Lippmann, Walter** 1889–1974  
 American journalist and author

...all statistical devices are open to abuse and require constant correction.  
*A Preface to Politics*  
 The Golden Rule and After (p. 91)  
 M. Kennerley. New York, New York, USA. 1913

The statistical method is of use only to those who have found it out.  
*A Preface to Politics*  
 The Golden Rule and After (p. 92)  
 M. Kennerley. New York, New York, USA. 1913

Statistics then is no automatic device for measuring facts.  
*A Preface to Politics*  
 The Golden Rule and After (p. 92)  
 M. Kennerley. New York, New York, USA. 1913

Even the most refined statistics are nothing but abstractions.  
*A Preface to Politics*  
 The Golden Rule and After (pp. 93–94)  
 M. Kennerley. New York, New York, USA. 1913

**Lloyd George, David, First Earl of Dwfors** 1863–1945  
 English prime minister

You can’t feed the hungry on statistics.  
 Advocating Tariff Reform  
 Speech 1904

**Longacre, William A.** 1937–  
 American anthropologist

...statistical techniques are not magical.  
 Current Thinking in American Archaeology  
*Bulletin of the American Anthropological Association*, Volume 3, Number 3, Part 2, 1970 (p. 132)

**Louis, Pierre-Charles-Alexandre** 1787–1872  
 French physician

As to different methods of treatment, it is possible for us to assure ourselves of the superiority of one or other...by enquiring if the greater number of individuals have been

cured by one means than another. Here it is necessary to count. And it is, in great part at least, because hitherto this method has not at all, or rarely been employed, that the science of therapeutics is so uncertain.

Translated by P. Martin

*Essay on Clinical Instruction* (pp. 26, 28)

S. Highley. London, England. 1834

**Ludlum, Robert** 1927–2001

American writer

“There are three major and perhaps a dozen minor rental agencies, not counting the hotels, which we’ve covered separately. These are manageable statistics, but, of course, the garages are not.”

*The Bourne Supremacy*

Chapter 18 (p. 260)

Random House, Inc. New York, New York, USA. 1986

I don’t believe you. Not because you’re a poor liar, but because it doesn’t conform with the facts. I work with statistics, Mr. Washburn, or Mr. Bourne, or whatever your name is. I respect observable data and I can spot inaccuracies; I’m trained to do that.

*The Bourne Identity*

Chapter 9 (p. 128)

Richard Marek Publishers. New York, New York, USA. 1980

Death is a statistic for the computers.

*The Bourne Identity*

Chapter 29 (p. 401)

Richard Marek Publishers. New York, New York, USA. 1980

Daniel’s a statistician. He sees numbers – fractions, equations, totals – and they spell out the odds for him. God knows he’s brilliant at it; he’s saved the lives of hundreds with those statistics.

*The Parsifal Mosaic*

Chapter 10 (p. 137)

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

Statistics have always pleased us. They thrill us. There is something romantic about them. They scratch and tickle our imagination till it wakes and yodels.

*Prefaces*

Preface to a Book of Statistics (p. 183)

D. Appleton & Co. New York, New York, USA. 1919

...statistics do not necessarily have any close connection with either facts or ideas.

*Prefaces*

Preface to a Book of Statistics (p. 183)

D. Appleton & Co. New York, New York, USA. 1919

[Statistics] skip over the boundary into a sort of fourth dimensional land. And there they dance like the motes one sees if one stares at the wind long enough so that the little veins in one’s eyes become congested with blood corpuscles.

*Prefaces*

Preface to a Book of Statistics (p. 183)

D. Appleton & Co. New York, New York, USA. 1919

...we like to wonder about them [statistics]; we look at them and thrill and speculate and doubt and conjecture. But it is no joy to us to know what statistics are about. We do not wish to have them tied down to any specific subject. We love to see them dart and frolic through the pages of great tomes just for the sake of the dance itself.

*Prefaces*

Preface to a Book of Statistics (p. 184)

D. Appleton & Co. New York, New York, USA. 1919

**Marshall, Alfred** 1842–1924

English economist

Statistics are the straw out of which I, like every other economist, have to make the bricks.

In Arthur L. Bowley

*Elements of Statistics*

Part I, Chapter I (p. 8)

P.S. King & Son Ltd. London, England. 1926

**Maxwell, James Clerk** 1831–79

Scottish physicist

...molecular science teaches us that our experiments can never give us anything more than statistical information, and that no law deduced from them can pretend to absolute precision. But when we pass from the contemplations of our experiment to that of the molecules themselves, we leave the world of chance and change, and enter a region where everything is certain and immutable.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 374)

At The University Press. Cambridge, England. 1890

**Meitzen, August** 1822–1910

German geographer

No statistical judgment deals with the unit, but strictly and only with the aggregate. The variable elements of persons and things otherwise typical, that are enumerated, are always counted in a specific aggregate and under certain specific circumstances. The qualities of the objects themselves, so far as they are not typical, or the subject of the investigation, are completely unknown.

History, Theory and Techniques of Statistics

*American Academy of Political and Social Sciences*, May, 1898 (p. 168)

No matter what the statistical problem may be, it must proceed according to a plan. It is always a specific question which may be answered in several more or less accurate ways. The end in view and the reasoning which can be drawn upon will indicate in which manner and within which limits the answer is to be given. According to the choice made, it may be very simple or very complicated.

But under all circumstances a definite plan providing for all the detail is an absolute prerequisite.

History, Theory and Techniques of Statistics

*American Academy of Political and Social Sciences*, May, 1898 (p. 168)

**Melville, Herman** 1819–91

American novelist

The skeleton dimensions I shall now proceed to set down are copied verbatim from my right arm, where I had them tattooed; as in my wild wanderings at that period, there was no other secure way of preserving such valuable statistics.

*Moby Dick*

Chapter CII (p. 424)

L.C. Page & Co. Boston, Massachusetts, USA. 1892

**Meyers, Jr., G. J.**

No biographical data available

Statistical methods serve as land marks which point to further improvement beyond that deemed obtainable by experienced manufacturing men. Hence, after all obvious correctives have been exhausted and all normal logic indicates no further gain is to be made, statistical methods still point toward a reasonable chance for yet further gains; thereby giving the man who is doing trouble shooting sufficient courage of his convictions to cause him to continue to the ultimate gain, in spite of expressed opinion on all sides that no such gain exists.

American Society of Mechanical Engineers, Discussion of E.G. Olds,

On Some of the Essentials of the Control Chart Analysis

*Transactions*, Volume 64, July 1942

**Moroney, Michael Joseph** 1918–90

English statistician

The organized charity, scrimped and iced,

O'Reilly, John Boyle

In the name of a cautious, statistical Christ.

*In Bohemia*

In Bohemia

A statistical analysis, properly conducted, is a delicate dissection of uncertainties, a surgery of suppositions.

*Facts from Figures*

Statistics Undesirable (p. 3)

Penguin Books Ltd. Harmondsworth, England. 1951

Historically, Statistics is no more than State Arithmetic, a system of computation by which differences between individuals are eliminated by the taking of an average. It has been used – indeed, still is used – to enable rulers to know just how far they may safely go in picking the pockets of their subjects.

*Facts from Figures*

Statistics Undesirable (p. 1)

Penguin Books Ltd. Harmondsworth, England. 1951

If you are young, then I say: Learn something about statistics as soon as you can. Don't dismiss it through igno-

rance or because it calls for thought.... If you are older and already crowned with the laurels of success, see to it that those under your wing who look to you for advice are encouraged to look into this subject. In this way you will show that your arteries are not yet hardened, and you will be able to reap the benefits without doing overmuch work yourself. Whoever you are, if your work calls for the interpretation of data, you may be able to do without statistics, but you won't do as well.

*Facts from Figures*

Statistics Desirable (p. 463)

Penguin Books Ltd., Harmondsworth, England. 1951

**Mr. Gregory (Fictional character)**

Well, statistics prove that you're far safer in a modern plane than in a bathtub.

*Charlie Chan at Treasure Island*

Film (1939)

**Neuman, James R.**

No biographical data available

Statistics was founded by John Graunt of London, a "haberdasher of small-wares" in a tiny book called *Natural and Political Observations Made upon the Bills of Mortality*.

*The World of Mathematics* (Volume 3)

Commentary on an Ingenious Army Captain and on a Generous and

Many-sided Man (p. 1416)

Simon & Schuster. New York, New York, USA. 1956

**O. Henry (William Sydney Porter)** 1862–10

American short story writer and journalist

His mathematics carried with it a momentary qualm and a lesson. The thought had not occurred to him that the thought could possibly occur to me not to ride at his side on that red road to revenge and justice. It was the higher calculus. I was booked for the trail. I began to eat more beans.

*Tales of O. Henry*

A Technical Error (p. 1059)

Doubleday & Company, Inc. Garden City, New York, USA. 1953

"What you've got," says Idaho, "is statistics, the lowest grade of information that exists. They poison your mind..."

*Tales of O. Henry*

The Handbook of Hymen (p. 113)

Doubleday & Company, Inc. Garden City, New York, USA. 1969

**Orwell, George (Eric Arthur Blair)** 1903–50

English novelist and essayist

Statistics were just as much a fantasy in their original version as in their rectified version. A great deal of the time you were expected to make them up out of your head. For example, the Ministry of Plenty's forecast had estimated the output of boots for the quarter at a hundred and forty-five millions pairs. The actual output was given



as sixty-two millions. Winston, however, in rewriting the forecast, marked the figure down to fifty-seven millions, so as to allow for the usual claim that the quota had been overfilled. In any case, sixty-two millions was no nearer the truth than fifty-seven millions, or a hundred and forty-five millions. Very likely no boots had been produced at all. Likelier still, nobody knew how many had been produced, much less cared.

*Nineteen Eighty-Four*

Part One, Chapter IV (pp. 41–42)

Buccaneer Books. Cutchogue, New York, USA. 1949

The fabulous statistics continued to pour out of the tele-screen. As compared with last year there was more food, more clothes, more houses, more furniture, more cooking pots, more fuel, more ships, more helicopters, more books, more babies – more of everything except disease, crime, and insanity.

*Nineteen Eighty-Four*

Part One, Chapter V (p. 59)

Buccaneer Books. Cutchogue, New York, USA. 1949

**Paulos, John Allen** 1945–

American mathematician

It’s been estimated that, because of the exponential growth of the world’s population, between 10 and 20% of all the human beings who have ever lived are alive now. If this is so, does this mean that there isn’t enough statistical evidence to conclusively reject the hypothesis of immortality?

*Innumeracy*

5 Statistics, Trade-offs, and Society (p. 99)

Hill & Wang. New York, New York, USA. 1988

**Pearson, E. S.** 1895–1980

English statistician

**Hartley, H. Q.**

No biographical data available

...it is a function of statistical method to emphasize that precise conclusions cannot be drawn from inadequate data.

*Biometrika Tables for Statisticians* (Volume 1) (p. 83)

**Pearson, Karl** 1857–1936

English mathematician

There is much value in the idea of the ultimate laws being statistical laws, though why the fluctuations should be attributed to a Lucretian “Chance”, I cannot say. It is not an exactly dignified conception of the Deity to suppose him occupied solely with first moments and neglecting second and higher moments!

*The History of Statistics in the 17th and 18th Centuries Against the Changing Background of Intellectual, Scientific, and Religious Thought* (p. 160)

[Florence Nightingale’s] statistics were more than a study, they were indeed her religion. For her Quete-

let was the hero as scientist, and the presentation copy of his *Physique Sociale* is annotated by her on every page. Florence Nightingale believed – and in all the actions of her life acted upon the belief – that the administrator could only be successful if he were guided by statistical knowledge. The legislator – to say nothing of the politician – too often failed for want of this knowledge.

*Life, Letters and Labours of Francis Galton* (Volume 2) (p. 57)

At The University Press. Cambridge, England. 1914–30

[Florence Nightingale]...held that the universe – including human communities – were evolving in accordance with a divine plan; that it was man’s business to endeavor to understand this plan and guide his actions in sympathy with it. But to understand God’s thoughts, she held we must study statistics, for these are the measure of His purpose. Thus, the study of statistics was for her a religious duty.

*Life, Letters and Labours of Francis Galton* (Volume 2) (p. 57)

At The University Press. Cambridge, England. 1914–30

**Perrin, Jean** 1870–1945

French physicist

It is thus that statistics reveals more and more the inconsistency and the irregularity of much social phenomena, when in lieu of applying it to a great nation altogether, one descends to a province, a town, a village.

In Mary Jo Nye

*Molecular Reality: A Perspective on the Scientific Work of Jean Perrin* (p. 25)

MacDonald. London, England. 1972

**Playfair, William** 1759–1823

English publicist

No study is less alluring or more dry and tedious than statistics, unless the mind and imagination are set to, or that the person studying is particularly interested in, the subject; which last can seldom be the case with young men in any rank of life.

*The Statistical Breviary* (p. 16)

J. Wallis. London, England. 1801

Statistical knowledge, though in some degree searched after in the most early ages of the world, has not till within these last 50 years become a regular object of study.

*The Statistical Breviary*

J. Wallis. London, England. 1801

**Price, Derek John de Solla** 1922–83

English science historian and information scientist

His passion was to count everything and reduce it to statistics.

*Little Science, Big Science*

Chapter 2 (p. 33)

Columbia University Press. New York, New York, USA. 1963



**Proschan, Frank**

American statistician

Pronouncing each word with great deliberateness, Rep. Resent asked, "Are you now, or have you ever been, a member of the American Statistical Association?"

...

Looking Rep. Resent straight in the eye, Minnie defiantly replied, "I refuse to answer on the grounds that it might incriminate me."

Investigation of Latin Squares

*Industrial Quality Control*, Volume 11, Number 1, July, 1954 (p. 31)**Puckett, Andrew**

British crime novelist

They were in monthly columns. I added them and then compared the two tables. Well, there was a difference, and a difference on the right side, more blood packs had been separated in the Centre than plasma packs had arrived in CPPL, but it wasn't as large as I would have thought. I stared at the figures for a moment, then I worked out a statistical error rate on them. The difference between them was not significant; it could be explained by random error. Statistics don't lie, not in the right hands.

*Bloodstains* (p. 79)

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1987

For the first five months they were virtually identical, but for the past four, they showed an increasing difference! With shaking fingers, I worked out a Standard Deviation on the sets of totals. There was no doubt: the difference[s] between the Centre's and CPPL's totals were significant. Statistics don't lie...

*Bloodstains* (p. 80)

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1987

**Puzo, Mario** 1920–99

American novelist and screenwriter

"You got a ninety percent chance," he said.

Osno said quickly, "How do you get that figure?" He always did that whenever somebody pulled a statistic on him. He hated statisticians.

*Fools Die: A Novel*

Chapter 24 (p. 270)

Putnam. New York, New York, USA. 1978

**Pynchon, Thomas** 1937–

American novelist

"I'm sorry. That's the Monte Carlo Fallacy. No matter how many have fallen inside a particular square, the odds remain the same as they always were. Each hit is independent of all the others. Bombs are not dogs. No link. No memory. No conditioning."

*Gravity's Rainbow*

Part 1 (p. 56)

The Viking Press. New York, New York, USA. 1973

That he must always be lovable, in need of her and never, as now, the hovering statistical cherub who's never quite been to hell but speaks as if he's one of the most fallen.

*Gravity's Rainbow*

Part 1 (p. 57)

The Viking Press. New York, New York, USA. 1973

**Reynolds, H. T.**

No biographical data available

...statistics – whatever their mathematical sophistication and elegance – cannot make bad variables into good ones.

*Analysis of Nominal Data*

Chapter 1 (p. 8)

Sage Publications. Beverly Hills, California, USA. 1977

**Rogers, Will** 1879–1935

American actor and humorist

Everything is figured out down to a Gnat's tooth according to some kind of statistics.

*The Writings of Will Rogers*

Volume 4–3 (p. 254)

Oklahoma State University Press. Stillwater, Oklahoma, USA. 1973

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Statistics can provide a ready proof

For doubtful facts which ought to stay aloof.

*Encyclopedia of Thoughts*

Couplets

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Statistics, ideally, are accurate laws about large groups; they differ from other laws only in being about groups, not about individuals.

*The Analysis of Matter*

Chapter XIX (p. 191)

Harcourt, Brace &amp; Company, Inc. New York, New York, USA. 1927

**Salt, Henry** 1851–1939

English writer

I hate statistics, hate the very name ...

In John James Halls

*The Life and Correspondence of Henry Salt* (Volume 2)

Egypt: A Poem (p. 417)

Richard Bentley. London, England. 1834

**Samuels, Ernest** 1903–96

American biographer and lawyer

Taking for granted that the alternative to art was arithmetic, he plunged deep into statistics, fancying that education would find the surest bottom there; and the study proved the easiest he had ever approached. Even the Government volunteered unlimited statistics,

endless columns of figures, bottomless averages merely for the asking. At the Statistical Bureau, Worthington Ford supplied any material that curiosity could imagine for filling the vast gaps of ignorance, and methods for applying the plasters of fact.

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
 Chapter XXIII (p. 351)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

No honest historian can take part with – or against – the forces he has to study. To him even the extinction of the human race should be merely a fact to be grouped with other vital statistics.

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
 Chapter XXX (p. 447)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Schölzer, Ludwig** 1735–1809

No biographical data available

History is statistics in a state of progression; statistics is history at a stand.

Transactions of the Statistical Society of London  
 Article II, Footnote on page 72  
*Westminster Review*, Volume 1, Part I, April-August, 1838

History is for him continuous statistics, statistics stationary history.

In August Meitzen  
*History, Theory, and Technique of Statistics* (p. 37)  
 American Academy of Political Science. Philadelphia, Pennsylvania, USA. 1891

**Segal, Erich** 1937–

American novelist

“How are you, Mrs. Coleman?”  
 “Not too bad. How’s yer statistics?”

*Man, Woman and Child*  
 Chapter 1 (p. 8)  
 Harper & Row, Publishers. New York, New York, USA. 1980

He turned over on his side and picked up the American Journal of Statistics. Better than a sleeping pill. He idly leafed through a particularly unoriginal piece on stochastic processes, and thought, Christ, I’ve said this stuff a million times. And then he realized that he himself was the author.

*Man, Woman and Child*  
 Chapter 5 (p. 42)  
 Harper & Row, Publishers. New York, New York, USA. 1980

The emergency room was a madhouse. The stormy holiday roads had yielded more than the statistical expectation of traffic accidents.

*Man, Woman and Child*  
 Chapter 26 (p. 191)  
 Harper & Row, Publishers. New York, New York, USA. 1980

“I mean, here you are a professor of statistics.”  
 “So?”

“So you have one lousy affair in your whole life. For a few lousy days. And you get a kid as evidence. Christ, what are the odds of that happening to anybody?”

“Oh,” said Bob bitterly, “about a billion to one.”

*Man, Woman and Child*  
 Chapter 13 (p. 109)  
 Harper & Row, Publishers. New York, New York, USA. 1980

“I am Professor Beckworth,” he pronounced in a kind of soprano-baritone. “Would you like to ask me some statistics, sir?”

“Yes,” replied Bob. “What are the chances of this damn rain stopping today, Professor?”

“Mmm,” said Jean-Claude, pondering earnestly, “You’ll have to see me tomorrow about that.”

*Man, Woman and Child* (p. 178)  
 Harper & Row, Publishers. New York, New York, USA. 1980

**Shapiro, Karl Jay** 1913–2000

American poet

We ask for no statistics of the killed,  
 For nothing political impinges on  
 This single Casualty, or all those gone,  
 Missing or healing, sinking or dispersed,  
 Hundreds of thousands counted, millions lost.

*Collected Poems 1940–1978*  
 Elegy for a Dead Soldier  
 Stanza V (p. 90)  
 Random House, Inc. New York, New York, USA. 1978

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Even trained statisticians often fail to appreciate the extent to which statistics are vitiated by the unrecorded assumptions of their interpreters.

*The Doctor’s Dilemma*  
 Preface on Doctors  
 Statistical Illusions (p. lxii)  
 Brentano’s. New York, New York, USA. 1920

**Smith, Reginald H.** 1889–1966

American lawyer and social activist

Lawyers like words and dislike statistics.  
 A Sequel: The Bar Is Not Overcrowded  
*American Bar Association Journal*, Volume 45, September, 1959 (p. 945)

**Spengler, Oswald** 1880–1936

German philosopher

Statistics belong, like chronology, to the domain of the organic, to fluctuating Life, to Destiny and Incident, and not to the world of laws and timeless causality.

*The Decline of the West*  
 Chapter X (p. 218)  
 Alfred A. Knopf. New York, New York, USA. 1962

**Stalin, Joseph** 1879–1953

Soviet Russian political leader and general secretary of Communist Party

A single death is a tragedy, a million deaths is a statistic.

Quoted by Anne Fremantle

Unwritten Pages at the End of the Diary

*The New York Times Book Review*, September 28, 1958 (p. 3)

**Stamaty, Mark Alan**

American cartoonist and children's book writer

I propose that infinitely refutable statistics be declared the official language of politics.

Washington

*Time*, September 25, 1995 (p. 21)

**Stamp, Josiah** 1880–1941

English economist and financier

You cannot escape the statistical method, so you may as well make friend with it. You think it is cold and inhuman and impersonal, but, as a matter of fact, it is fuller of red blood and human nature than half the descriptive literature in the world.

*Some Economic Factors in Modern Life*

Chapter VIII (p. 256)

P.S. King & Son Ltd. London, England. 1929

**Stekel, Wilhelm** 1868–1940

Austrian psychoanalyst

Statistics is the art of lying by means of figures.

*Marriage at the Crossroads*

Chapter II (p. 20)

W. Godwin, Inc. New York, New York, USA. 1931

**Sterne, Laurence** 1713–68

English novelist and humorist

It was demonstrated however very satisfactorily, that such a ponderous mass of heterogeneous matter could not be congested and conglomerated to the nose, whilst the infant was *in Utero*, without destroying the statistical balance of the foetus, and throwing it plump upon its head nine months before the time.

*The Life and Opinions of Tristram Shandy, Gentleman, and A Sentimental Journey Through France and Italy* (Volume 1)

Book IV (p. 228)

Macmillan & Company Ltd. London, England. 1900

**Steuart, John Alexander** 1861–1932

No biographical data available

Statistics are like an anatomical statement of the number of bones in a skeleton: you have the information, but the living organism remains vague. It is hard to conjure living reality out of dry bones.

*Wine on the Lees*

Chapter VII (p. 258)

Dodd, Mead & Co. New York, New York, USA. 1899

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

Here he comes, big with statistics...

*The Complete Poems of Robert Louis Stevenson*

Troubled and sharp about fac's, LXVI

Charles Scribner's Sons. New York, New York, USA. 1923

**Stigler, Stephen M.** 1941–

American historian and statistician

...elementary statistics texts tell us that the method of least squares was first discovered about 1805. Whether it had one or two or more discoverers can be argued; still the method dates from no later than 1805. We also read that Sir Francis Galton discovered regression about 1885, in studies of heredity. Already we have a puzzle – a modern course in regression analysis is concerned almost entirely with the method of least squares and its variations. How could the core of such a course date from both 1805 and 1885? Is there more than one way a sum of squared deviations can be made small?

*The History of Statistics*

Introduction (p. 2)

Harvard University Press. Cambridge, Massachusetts, USA. 1986

**Stout, Rex** 1886–1975

American writer

There are two kinds of statistics, the kind you look up and the kind you make up.

*Death of a Doxy* (p. 90)

Bantam Book. New York, New York, USA. 1967

Statistics show that seventy-four percent of wives open letters, with or without a teakettle.

*Death of a Doxy* (p. 120)

Bantam Book. New York, New York, USA. 1967

**Strunsky, Simeon** 1879–1948

American essayist

Statistics are the heart of democracy.

*Topics of The Times*, November 30, 1944

**Tchekhov, Anton** 1860–1904

Russian writer

Everything is quiet, peaceful and against it all is only the silent protest of statistics...

*Tchekhov's Plays and Stories*

*Gooseberries*

J.M. Dent & Sons Limited. London, England. 1958

**The Editors**

To some people, statistics is “quartered pies, cute little battleships and tapering rows of sturdy soldiers in diversified uniforms.” To others, it is columns and columns of numerical facts. Many regard it as a branch of economics.

The beginning student of the subject considers it to be largely mathematics.

Statistics, the Physical Sciences and Engineering  
*The American Statistician*, Volume 11, Number 4, August, 1948

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

But lo! men have become the tools of their tools.

*The Writings of Henry David Thoreau* (Volume 2)  
*Walden*  
 Chapter I (p. 61)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Thorn, John** 1947–  
 Sports historian

While he is racing to the hole, the shortstop is figuring: Based on the speed of the runners and how hard the ball is hit, he probably has no chance of a double play; he may have a little chance of a play at second; and he almost certainly has no play at first. He throws to third because the distance from the hole to the bag is short, his calculation of the various probabilities led him to conclude that this was his “percentage play.” Now not so much as a glimmer of any number entered the shortstop’s head in this time, yet he was thinking statistically.

*The Hidden Game of Baseball: A Revolutionary Approach to Baseball and Its Statistics* (p. 5)  
 Doubleday & Company Inc. Garden City, New York, USA. 1984

**Thurstone, Louis Leon** 1887–1955  
 American psychologist and psychometrician

Factor analysis is useful especially in those domains where basic and fruitful concepts are essentially lacking and where crucial experiments have been difficult to conceive.... They enable us to make only the crudest first map of a new domain. But if we have scientific intuition and sufficient ingenuity, the rough factorial map of a new domain will enable us to proceed beyond the factorial stage to the more direct form of psychological exploration in the laboratory.

Current Issues in Factor Analysis  
*Psychological Bulletin*, Volume 37, April, 1940 (p. 189)

It is not wise for a statistician who knows factor analysis to attempt problems in a science which he has not himself mastered.

Current Issues in Factor Analysis  
*Psychological Bulletin*, Volume 37, April, 1940 (p. 235)

**Tiffany, Louis McLane**  
 Physician

Statistics are like a generous and large-hearted Irishman, – anybody’s friend.

Surgical Diseases  
*Annual of the Universal Medical Sciences*, Volume III, 1890 (p. O-6)

**Tobnet, George B.**  
 No biographical data available

Statistics are like stones taken from the quarry and piled by the roadside. The contentious may use thorn as missile to hurl at an adversary, or the mischievous to break windows, but the honest laborer will employ them only for the purpose for which they are intended, to pave the difficult road which leads toward the truth.

The Army Canteen  
*Journal of the American Medical Association*, Volume LVIII, Number 3, January 20, 1912 (p. 214)

**Tolstoy, Leo** 1828–1910  
 Russian writer

The actions of men are subject to general immutable laws expressed in statistics.

*Great Books of the Western World* Volume 51  
*War and Peace*  
 Second Epilogue, Chapter VIII (p. 689)  
 Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Trollope, Anthony** 1815–82  
 English novelist

We have no statistics to tell us whether there be any such disproportion in class where men do not die early from overwork.

*The Eustace Diamond* (Volume 1)  
 Chapter XXIV (p. 223)  
 Oxford University Press, Inc. London, England. 1973

As one of the legislators of the country I am prepared to state that statistics are always false.

*The Eustace Diamond* (Volume 1)  
 Chapter XXIV (p. 223)  
 Oxford University Press, Inc. London, England. 1973

**Tukey, John W.** 1915–2000  
 American statistician

A sort of question that is inevitable is: “someone taught my students exploratory, and now (boo hoo) they want me to tell them how to assess significance or confidence for all these unusual functions of the data. (Oh, what can we do?)” To this there is an easy answer: TEACH them the JACKKNIFE.

*The American Statistician*, Volume 34, Number 1, February, 1980 (p. 25)

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
 American author and humorist

Personally, I never care for fiction or story-books. What I like to read about are facts and statistics of any kind.

In Rudyard Kipling  
*From Sea to Sea*  
 An Interview with Mark Twain  
 Macmillan & Company Ltd. London, England. 1900

Sometimes, half a dozen figures will reveal, as with a lighting-flash, the importance of a subject which ten thousand labored words with the same purpose in view, had left at last but dim and uncertain.

*Life on the Mississippi*

Chapter XXVIII (p. 241)

Harper & Row, Publishers. New York, New York, USA. 1951

July 4. Statistics show that we lose more fools on this day than in all the other days of the year put together.

*Pudd'nhead Wilson*

Chapter XVII (p. 164)

Harper & Brothers Publishers. New York, New York, USA. 1904

I was deducing from the above that I have been slowing down steadily in these thirty-six years, but I perceive that my statistics have a defect: 3,000 words in the spring of 1868, when I was working seven or eight or nine hours at a sitting, has little or no advantage over the sitting of today, covering half the time and producing half the output. Figures often beguile me, particularly when I have the arranging of them myself; in which case the remark attributed to Disraeli would often apply with justice and force:

“There are three kinds of lies: lies, damned lies, and statistics.”

In Albert Bigelow Paine (ed.)

*Mark Twain's Autobiography* (Volume 1)

Chapters Added in Florence (p. 246)

Harper & Brothers Publishers. New York, New York, USA. 1924

## US Department of State

...statistics are like common sense – there are some circumstances in which they are no good.

*Commercial Relations of the United States With Foreign Countries*

(Volume 2)

UK (p. 797)

Government Printing Office. Washington, D.C. 1902

**van der Post, Laurens** 1906–96

Afrikaner author

Thinking has its place...but, only when one is confronted with known facts and statistics. When you're in the unknown and the dark...you surrender your thinking in trust to the feelings that come to you out of the bush.

*A Far-Off Place*

Chapter 9 (p. 183)

The Hogarth Press. London, England. 1974

**von Mises, Richard** 1883–1953

Austrian-born American mathematician

The problems of statistical physics are of the greatest in our time, since they lead to a revolutionary change in our whole conception of the universe.

*Probability, Statistics, and Truth*

Sixth Lecture (p. 219)

Dover Publications, Inc. New York, New York, USA. 1981

**Walcott, Derek** 1930–

West Indian dramatist and poet

Statistics justify and scholars seize

The salients of colonial policy.

*Collected Poems*

A Far Cry from Africa, I. 7–8

Farrar, Straus & Giroux. New York, New York, USA. 1986

**Walker, Marshall John**

American physicist

Statistics provides a quantitative example of the scientific process usually described qualitatively by saying that scientists observe nature, study the measurements, postulate models to predict new measurements, and validate the model by the success of prediction.

*The Nature of Scientific Thought*

Chapter IV (p. 46)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

Mathematical statistics provides an exceptionally clear example of the relationship between mathematics and the external world. The external world provides the experimentally measured distribution curve; mathematics provides the equation (the mathematical model) that corresponds to the empirical curve. The statistician may be guided by a thought experiment in finding the corresponding equation.

*The Nature of Scientific Thought*

Chapter IV (p. 50)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

**Wang, Chamont** 1949–

American statistician

Statistics has been called a science. It is said to connect its facts by a chain of causation: if it did so, it would be a science, though even then not a distinct and separate science. But the observations of astronomy may be called the science of astronomy as properly as statistics may be denominated a science. No mere record and arrangement of facts can constitute a science.

Transactions of the Statistical Society of London, Art II

*Westminster Review*, Volume I, Part I, 1838 (p. 69)

But statistics is not a science, and cannot be one. Studied as the statistical council have decreed statistics shall be studied, no department of human knowledge ever could become a science – a collection of theories – because they have put their veto on theorizing. But statistics is not even a department of human knowledge; it is merely a form of knowledge – a mode of arranging and stating facts which belong to various sciences.

Transactions of the Statistical Society of London, Art II

*Westminster Review*, Volume I, Part I, 1838 (p. 70)

As a matter of fact, the whole notion of “statistical inference” often is more of a plague and less of a blessing to research workers.



*Sense and Nonsense of Statistical Inference: Controversy, Misuse, and Subtlety*  
 Chapter 2 (p. 29)  
 Marcel Dekker. New York, New York, USA. 1993

**Waugh, Evelyn** 1903–66  
 English author of satirical novels

O god thou has appointed three score years and ten as man's allotted span but O god statistics go to prove that comparatively few ever attain that age...

In Mark Amory  
*The Letters of Evelyn Waugh*  
 Letter to Laura Herbert, dated October, 1935 (p. 99)  
 Weidenfeld & Nicolson. London, England. 1980

**Webster, Martha Farnham**  
 No biographical data available

...statistics are like the fabled toads which bore jewels in their heads; the ordinary user throws away the jewels and carefully preserves the toads!

*Seventy-five Significant Years: The Story of Knox College. 1837–1912*  
 Address before the Alumni (p. 159)  
 Wagoner Printing Co. Galesburg, Illinois, USA. 1912

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

Satan delights equally in statistics and in quoting scripture.  
*The Undying Fire*  
 Chapter the First Section 3 (p. 9)  
 The Macmillan Company. New York, New York, USA. 1919

Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write.  
 In Warren Weaver  
 Statistics  
*Scientific American*, Volume 186, Number 1, January, 1952 (p. 60)

**White, William Frank** 1872–1952  
 No biographical data available

Just as data gathered by an incompetent observer are worthless – or by a biased observer, unless the bias can be measured and eliminated from the result – so also conclusions obtained from even the best data by one unacquainted with the principles of statistics must be of doubtful value.

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*  
 The Mathematical Treatment of Statistics (p. 156)  
 The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

There is a curious misconception that somehow the mathematical mysteries of Statistics help Positivism to evade its proper limitation to the observed past. But statistics tell you nothing about the future unless you make the assumption of the permanence of statistical form. For example,

in order to use statistics for prediction, assumptions are wanted as to the stability of the mean, the mode, the probable error, and the symmetry or skewness of the statistical expression of functional correlation.

*Adventures of Ideas*  
 Chapter VIII (p. 161)  
 The Macmillan Company. New York, New York, USA. 1956

**Wigner, Eugene Paul** 1902–95  
 Hungarian-born American physicist

With classical thermodynamics, one can calculate almost everything crudely; with kinetic theory, one can calculate fewer things, but more accurately; and with statistical mechanics, one can calculate almost nothing exactly.  
 In Edward B. Stuart, Benjamin Gal-Or, and Alan J. Brainard (eds.)  
*A Critical Review of Thermodynamics* (p. 205)  
 Publisher undetermined

**Wilson, Albert**  
 No biographical data available

Statistics are like potters' clay, and can be moulded in any direction to suit any opinion.  
*Education, Personality & Crime*  
 Section III, Chapter XXIII (p. 254)  
 Greening & Co., Ltd. London, England. 1908

**Wilson, Edwin B.** 1879–1964  
 American statistician

Figures may not lie, but statistics compiled unscientifically and analyzed incompetently are almost sure to be misleading, and when this condition is unnecessarily chronic the so-called statisticians may be called liars.  
*Bulletin of the American Mathematical Society*, Volume 18, 1912

**Wolfowitz, J.** 1910–  
 No biographical data available

Except perhaps for a few of the deepest theorems, and perhaps not even these, most of the theorems of statistics would not survive in mathematics if the subject of statistics itself were to die out. In order to survive the subject must be more responsive to the needs of application.  
 In R.C. Bose and others (eds.)  
*Essays In Probability and Statistics* (p. 748)  
 University of North Carolina Press. Chapel Hill, North Carolina, USA. 1970

**Wonnacott, Ronald J.**  
 No biographical data available

“Those Platonists are a curse.” he said,  
 “God’s fire upon the wan,  
 A diagram hung there instead,  
 More women born than men.”  
*The Collected Poems of W.B. Yeats*  
 Statistics  
 The Macmillan Company. New York, New York, USA. 1940



**Wodehouse, Sir Pelham Grenville** 1881–1975

English writer

He gave her some chocolates to eat in the Tube. He entertained her with amazing statistics, culled from the weekly paper which he bought on Tuesdays. He was, in short, the perfect lover.

*The Man Upstairs and Other Stories*

When Doctors Disagree (p. 55)

Arc Manor. 2008

**Yates, Frances** 1899–1981

English historian

It is very easy to devise different tests which, on the average, have similar properties, ...they behave satisfactorily when the null hypothesis is true and have approximately the same power of detecting departures from that hypothesis. Two such tests may, however, give very different results when applied to a given set of data. The situation leads to a good deal of contention amongst statisticians and much discredit of the science of statistics. The appalling position can easily arise in which one can get any answer one wants if only one goes around to a large enough number of statisticians.

Discussion on the Paper by Dr. Box and Dr. Andersen

*Journal of the Royal Statistical Society*, Series B, Volume 17, 1955 (p. 31)

**STATISTICS AND MEDICINE****Bernard, Claude** 1813–78

French physiologist

[S]tatistics...are given a great role in medicine, and they therefore raise a medical question which we should examine here. The first requirement in using statistics is that the facts treated shall be reduced to comparable units. Now this is very often not the case in medicine. Everyone familiar with hospitals knows what errors may mark the definitions on which statistics are based. The names of diseases are very often given are haphazard, either because the diagnosis is obscure, or because the cause of death is carelessly recorded by a student who has not seen the patient, or by an employee unfamiliar with medicine. For this reason pathological statistics can be valid only when compiled from data collected by the statistician himself.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section ix (p. 136)

Henry Schuman, Inc. New York, New York, USA. 1927

...the goal of scientific physicians...is to reduce the indeterminate. Statistics therefore apply only to cases in which the cause of the facts observed is still indeterminate.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section IX (p. 139)

Henry Schuman, Inc. New York, New York, USA. 1927

When a physician is called to a patient, he should decide on the diagnosis, then the prognosis, and then the treatment... Physicians must know the evolution of the disease, its duration and gravity in order to predict its course and outcome. Here statistics intervene to guide physicians, by teaching them the proportion of mortal cases; and if observation has also shown that the successful and unsuccessful cases can be recognized by certain signs, then the prognosis is more certain.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter IV, Section III (p. 213)

Henry Schuman, Inc. New York, New York, USA. 1927

**Blane, Gilbert Sir** 1749–1834

Scottish physician

There is...a great difficulty attending all practical inquiries in medicine; for in order to ascertain truth, in a manner that is satisfactory to a mind habituated to chaste investigation, there must be a series of patient and attentive observations upon a great number of cases, and the different trials must be varied, weighed, and compared, in order to form a proper estimate of the real efficacy of different remedies and modes of treatment.

*Observations on the Diseases Incident to Seamen* (p. ix)

Joseph Cooper. London, England. 1785

**Fenger, Carl Emil** 1814–84

Danish physician and politician

The use of the numerical method in medicine is not essentially new. From the time of Hippocrates to our day any doctor would say that this symptom is rare in a particular disease, but that one common; that this cause is more common than that one; that this treatment cures more patients than that one. All these expressions rare, common, more, etc. are indeterminate numerical expressions and presuppose a count, be it methodical or not.

Om den numeriske metode

*Ugeskr Laeger*, Volume 1, 1839

**Salsburg, David S.**

No biographical data available

After 17 years of interacting with physicians, I have come to realize that many of them are adherents of a religion they call Statistics. Statistics refers to the seeking out and interpretation of p values. Like any good religion, it involves vague mysteries capable of contradictory and irrational interpretation. It has a priesthood and a class of mendicant friars. And it provides Salvation: Proper invocation of the religious dogmas of Statistics will result in publication in prestigious journals.

The Religion of Statistics as Practiced in Medical Journals

*The American Statistician*, Volume 39, Number 3, August, 1985 (p. 220)

## STATISTICS AND SOCIETY

### **Boorstin, Daniel J.** 1914–2004

American historian

The science of statistics is the chief instrumentality through which the progress of civilization is now measured and by which its development hereafter will be largely controlled.

*The Decline of Radicalism*

Chapter I (p. 8)

Random House, Inc. New York, New York, USA. 1969

### **Coats, R. H.**

No biographical data available

Beginning softly, statistics has long been handmaid to these exact sciences, apprenticed in the scullery, but now risen housekeeper, eating with the family.

Science and Society

*Journal of the American Statistical Association*, Volume 34, Number 205, March, 1939 (p. 3)

### **Devons, Ely** 1913–67

English economist

What more tempting facade of rationality than the portrayal of some statistics that seem to point to policy in one direction rather than another?

*Essays in Economics*

Chapter 7 (p. 134)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

No Chancellor of the Exchequer could introduce his proposals for monetary and fiscal policy in the House of Commons by saying “I have looked at all the forecasts, some go one way, some another; so I decided to toss a coin and assume inflationary tendencies if it came down heads and deflationary if it came down tails....” And statistics, however uncertain, can apparently provide some basis.

*Essays in Economics*

Chapter 7 (p. 134)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

...there seems to be striking similarities between the role of economic statistics in our society and some of the functions which magic and divination play in primitive society.

*Essays in Economics*

Chapter 7 (p. 135)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

### **Kline, Morris** 1908–92

American mathematics professor and writer

The Mathematical Theory of Ignorance: The Statistical Approach to the Study of Man

*Mathematics in Western Culture*

Title to Chapter XXII

Oxford University Press, Inc. New York, New York, USA. 1953

### **Lippmann, Walter** 1889–1974

American journalist and author

You and I are forever at the mercy of the census-taker and the census maker. That impertinent fellow who goes from house to house is one of the real masters of the statistical situation. The other is the man who organizes the results.

*A Preface to Politics*

The Golden Rule and After (p. 92)

M. Kennerley. New York, New York, USA. 1913

### **Ramsey, James B.**

No biographical data available

The political practice of citing only agreeable statistics can never settle economic arguments.

*Economic Forecasting – Models or Markets?: An Introduction to the Role of Econometrics in Economic Policy* (p. 77)

Institute of Economic Affairs. London, England. 1977

### **Robinson, Lewis Newton**

No biographical data available

In this country the statistical side of criminology is very imperfectly developed, and while the same cannot be said with equal force of other English-speaking countries, it yet remains true that the statistical terminology of this social science is characterized, so far as the English language is concerned, by great vagueness and uncertainty.

*History and Organization of Criminal Statistics in the United States*

Chapter I (p. 1)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### **Rogers, Will** 1879–1935

American actor and humorist

The government keeps statistics on every known thing. But there is yet to be a statistics on how many laws we are living under.

*The Writings of Will Rogers*

Volume 4–1 (p. 167)

Oklahoma State University Press. Stillwater, Oklahoma, USA. 1973

### **Smith, Logan Pearsall** 1865–1946

American author

For I am one of the unpraised, unrewarded millions without whom Statistics would be a bankrupt science. It is we who are born, who marry, who die, in constant ratios.

*Trivia*

Book II, Where Do I Come In? (p. 106)

Doubleday, Page & Company. Garden City, New York, USA. 1917

## STATISTICS, TABLE OF

### **Huebner, Grover G.**

No biographical data available

To the average layman a table of statistics is like a juggler’s wand, the result depending wholly upon the skill and desire of the particular juggler.

Teaching of Statistics  
*Publications of the American Statistical Association*, Volume XI,  
 Number 86, June, 1909 (p. 518)

## STEAM

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

Steam is no stronger now than it was a hundred years ago; but is put to better use.

*The Conduct of Life*  
 Wealth (p. 86)  
 Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

## STEAM ENGINE

**Lardner, Dionysius** 1793–1859  
 British physicist and astronomer

That the history of the invention of a piece of mechanism [the steam engine], and the description of its structure, operation, and uses, should be capable of being rendered a subject-matter destined not alone for the instruction of engineers or machinists, but for the information and amusement of the public in general, is a statement which at no very remote period would have been deemed extravagant and incredible.

*Popular Lectures on Science and Art* (Volume 2)  
 The Steam Engine (First Lecture) (p. 399)  
 Greeley & McElrath. New York, New York, USA. 1846

## STEEP-SPECTRUM SOURCES

**Spangler, S. R.**  
 No biographical data available

**Cook, D. B.**  
 No biographical data available

Steep-spectrum sources, on the other hand, are usually inferred to have linear sizes of the order of kiloparsecs, and it is very difficult to see how such objects could show significant variations on astronomically relevant time-scales such as the duration of a graduate student stipend or the tenure trial period of a faculty member.

VLA Observations of Ssteep-spectrum, Variable Radio Sources  
*Astronomical Journal*, Volume 85 June, 1980 (p. 559)

## STELLAR EVOLUTION

**Tennyson, Alfred (Lord)** 1809–92  
 English poet

This world was once a fluid haze of light, Till toward the centre set the starry tides, And eddied into suns, that wheeling cast The planets: then the monster, then the man;

*The Works of Alfred Lord Tennyson, Poet Laureate*  
 The Princess: A Medley (p. 170)  
 The Macmillan Co. New York, New York, USA. 1898

I saw the flaring atom-streams And torrents of her myriad universe, Ruining along the illimitable inane, Fly on to clash together again, and make Another and another frame of things Forever:

*The Works of Alfred Lord Tennyson, Poet Laureate*  
 Lucretius (p. 157)  
 The Macmillan Co. New York, New York, USA. 1898

## STETHOSCOPE

**Byford, W. H.** 1817–90  
 No biographical data available

The flexible stethoscope is a very handy instrument to relieve us from a fatiguing and not very delicate posture.

Advantages of the Prone Position in Examining the Foetal Circulation as a Diagnostic Sign of Pregnancy  
*Chicago Medical Journal*, Volume 15, 1858

**Laennec, René-Théophile-Hyacinthe** 1781–1826  
 French physician

I had not imagined it would be necessary to give a name to such a simple device, but others thought differently. If one wants to give it a name, the most suitable would be “stethoscope.”

*Traité de l'Auscultation Médiate* (Volume 1) (p. 11)  
 J.A. Brosson & J.S. Chaude. Paris, France. 1819

**Stokes W.**  
 No biographical data available

The stethoscope is an instrument, not, as some represent it, the bagatelle of a day, the brain-born fancy of some speculative enthusiast, the use of which, like the universal medicine of animal magnetism, will be soon forgotten, or remembered only to be ridiculed. It is one of those rich and splendid gifts which Science now and then bestows upon her most favored votaries, which, while they extended our views and open to us wide and fruitful fields of inquiry, confer in the meantime the richest benefits and blessings on mankind.

*An Introduction to the Use of the Stethoscope*  
 Machlachlan & Stewart. Edinburgh, Scotland. 1825

## STIOCHIOMETRY

**Boyle, Robert** 1627–91  
 English natural philosopher and theological writer

And that which I would have you peculiarly consider on this occasion is, that not only in chymical anatomies there is a separation made of the elementary ingredients, but that some mixt bodies afford a very much greater quantity of this or that element or principle than of another, as we see that turpentine and amber yield much more oyl and sulphur than they do water...

*The Sceptical Chymist*  
 The Second Part (p. 83)  
 J.M. Dent & Son. London, England. 1911

## STONE

### Howell, James

No biographical data available

I then spied a great stone, and sitting a while upon it, I fell to weigh in my thoughts that that stone was in a happier condition in some respects, than either those sensitive creatures or vegetables I saw before; in regard that that stone, which propagates by assimilation, as the philosophers say, needed neither grass nor hay, or any aliment for restoration of nature, nor water to refresh its roots, or the heat of the sun to attract the moisture upwards to increase growth, as the other did.

In Precept

*Precept and Example*

Letter to Sir S.C. (p. 91)

Taylor & Hessey. London, England. 1825

### Linnaeus, Carl (von Linné) 1707–78

Swedish botanist and explorer

My mind reels when, on this height, I look down on the long ages that have flowed by like waves in the sound and have left traces of the ancient world, traces so nearly obscured that they can only whisper now that everything else has been silenced.

In A.G. Nathorst

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

Carl von Linné as a Geologist (p. 738)

Government Printing Office. Washington, D.C. 1909

### Parkinson, Cornelia

No biographical data available

Was it a flash of divine insight, or the slower process of observation and deduction, that led human beings to perceive [an] esoteric quality in stones? They saw beauty in the sunrise; but the sun became blinding by midday. There was color in leaves and flowers, until they withered. Water sparkled, but it could not be worn for long. Of all the natural wonders of the earth, only the stones endured. They must indeed be magical; and those who possess magical things can sometimes put to work the magic in them.

*Gem Magic: The Wonder of Your Birthstone*

Ballentine Books. New York, New York, USA. 1988

### Ruskin, John 1819–1900

English writer, art critic, and social reformer

Then are no natural object out of which more can be thus learned than out of stones. They seem to have been created especially to reward a patient observer.

*Modern Painters*

Part V, Chapter XVIII (p. 303)

John Wiley & Sons. New York, New York, USA. 1890

...do but give it [stone] some reverence and watchfulness, and there is bread of thought in it, more than in any

other lowly feature of all the landscape.

*Modern Painters*

Part V, Chapter XVIII (p. 304)

John Wiley & Sons. New York, New York, USA. 1890

...a stone, when it is examined, will be found a mountain in miniature. The fineness of Nature's work is so great, that, into a single block, a foot or two in diameter, she can compress as many changes of form and structure, on a small scale, as she needs for her mountains on a large one; and, taking moss for forests, and grains of crystal for crags, the surface of a stone, in by far the plurality of instances, is more interesting than the surface of an ordinary hill; more fantastic in form and incomparably richer in color...

*Modern Painters*

Part V, Chapter XVIII (p. 304)

John Wiley & Sons. New York, New York, USA. 1890

## STONEHENGE

### James, Henry 1843–1916

American-born English author and literary critic

It [Stonehenge] stands as lonely in history as it does on the great plain, whose many-tinted green waves, as they roll away from it, seem to symbolize the ebb of the long centuries which have left it so prodigiously unexplained. You may put a hundred questions to these rough-hewn giants as they bend in grim contemplation of their fallen companions; but your curiosity falls dead in the vast sunny stillness that enshrouds them, and the strange monument, with all its unspoken memories, becomes simply a heart-stirring picture in a land of pictures.

*Foreign Parts*

Swiss Notes (p. 52)

Bernhard Tauchnitz. Leipzig, Germany. 1883

## STRATIGRAPHY

### Brown, Hugh Auchincloss 1878–1975

Electrical engineer

Each single layer of earth

Tells a story that's all its own;

The sands of the ancient beaches

Have changed into strata of stone.

*Cataclysms of the Earth*

The Earth Is a Great Stone Book (p. 275)

Twayne Publishers. New York, New York, USA. 1967

### Chandler, Mary

No biographical data available

The shatter'd Rocks and Strata seem to say,

"Nature is old, and tends to her Decay":

Yet, lovely in Decay and green in Age,

Her Beauty lasts to her latest Stage.

In Robert Arnold Aubin  
*Topographical Poetry in XVIII Century England*  
 Chapter IV (p. 164)  
 The Modern Language Association of America. New York, New York,  
 USA. 1936

### Savage, D. E.

American paleontologist

The fossil-mammal worker accepts that many mammals, marine or nonmarine, contributed fossils which are admirable tools for paleontologic stratigraphy and geochronology, and especially for age-magnitude correlations from continent to continent.

In E. Kauffman and J.E. Hazel (eds.)  
*Concepts and Methods of Biostratigraphy*  
 Aspects of Vertebrate Paleontological Stratigraphy and Geochronology  
 Dowden, Hutchinson & Ross. Stroudsburg, Pennsylvania, USA. 1977

### Shaw, Alan B.

No biographical data available

Preoccupation with the unattainable is a stultifying approach to any problem. Practical paleontology cannot be concerned with any of the fossils we cannot find. Geologically, we can only be interested in finding the total stratigraphic range through which a species is preserved. While the life and death of millions of unrepresented individuals is of theoretical interest, we cannot gain practically useful information from them.

*Time in Stratigraphy*  
 Chapter 17 (p. 103)  
 McGraw-Hill Book Company. New York, New York, USA. 1964

## STRAIN

### Commonwealth v. Sturtivant (1875)

A. "If the force of a stream of fluid, whatever it may be, and especially blood, be from below upward, the heaviest portion of the drop will stop at the further end of the stain; if from above downward, it will stop below." Defendant's counsel. "That is pure opinion as to a matter of mechanics, not chemistry. Any butcher is just as good an expert on that as this witness."

In John Henry Wigmore  
*Select Cases on the Law of Evidence* (2nd edition) (p. 236)  
 Little, Brown & Co. Boston, Massachusetts, USA. 1913

## STRATA

### Chamberlin, Thomas Chrowder 1843–1928

American geologist

### Salisbury, Rollin D. 1858–1928

American geologist

The strata of the earth reveal its history with great fidelity for long periods previous to the present, but earlier than

that the record becomes indistinct, and if we attempt to follow it back to the beginning, the indistinctness merges into extreme obscurity.

*Geology* (Volume 2) (2nd edition)  
 Chapter I (p. 1)  
 Henry Holt & Co. New York, New York, USA. 1907

### Lyell, Sir Charles 1797–1875

English geologist

...when we see thousands of full-grown shells dispersed everywhere throughout a long series of strata, we cannot doubt that time was required for the multiplication of successive generations; and the evidence of slow accumulation is rendered more striking from the proofs, so often discovered, of fossil bodies having lain for a time on the floor of the ocean after death, before they were imbedded in sediment.

*Elements of Geology* (Volume 1)  
 Chapter III (p. 47)  
 Hilliard, Gray, & Co. Boston, Massachusetts, USA. 1841

### Miller, Hugh 1802–56

Scottish geologist and theologian

We may turn over these wonderful leaves one after one, like the leaves of a herbarium, and find the pictorial records of a former creation in every page ...

*The Old Red Sandstone*  
 Chapter I (p. 10)  
 John B. Alden, Publisher. New York, New York, USA. 1892

### Playfair, John 1748–1819

Scottish geologist, physicist, and mathematician

It is well known that, on removing the loose earth which forms the immediate surface of the land, we come to the solid rock, of which a great proportion is found to be regularly disposed in strata, or beds of determinate thickness, inclined at different angles to the horizon, but separated from one another by equidistant superficies, that often maintain their parallelism to a great extent.

*The Works of John Playfair* (Volume 1)  
 Section 1, I (p. 22)  
 Printed for Archibald Constable & Co. Edinburgh, Scotland. 1822

### Saint Magnus Albertus 1193–1280

German scholar and theologian

We may observe in some of the abrupt grounds we meet with, sections of great masses of strata, where it is as easy to read the history of the sea, as it is to read the history of Man in the archives of any nation.

Translated by D. Wyckoff  
*On Minerals*  
 Book I, tract I, chapter 4  
 1264



**STRATEGY**

**Weil, André** 1906–98  
French mathematician

...strategy means the art of recognizing the main problems, attacking them at their weak points, setting up future lines of advance. Mathematical strategy is concerned with long-range objectives; it requires a deep understanding of broad trends and of the evolution of ideas over long periods.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*  
History of Mathematics (p. 205)

Mathematical Association of America. Washington, D.C. 2004

**STRATIFIED**

**Davis, William Morris** 1850–1934  
American geographer, geologist, and teacher

The columnar sections of stratified rocks, for example, so useful in the understanding of historical geology, are like the edgewise view of a closed book. The book must be opened, the leaves must be turned over one by one, the pages of these early records must be read, like so many gazetteers of ancient times. Never mind if some pages are worn and others are missing: those that can still be deciphered assure us that the past was generally like the present, and warrant the generalization that geology is like nothing so much as a whole series of geographies.

*Congress of Arts and Science: Universal Exposition, St. Louis, 1904*  
Volume 4

The Relations of the Earth-Sciences in View of Their Progress in the Nineteenth Century (p. 497)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1906

**STREAM**

**Muir, John** 1838–1914  
American naturalist

...silvery branches interlacing on a thousand mountains, singing their way home to the sea...

*Our National Parks*

Chapter VIII (p. 241)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...ungovernable energy, rushing down smooth inclines in wide foamy sheets fold over fold, springing up here and there in magnificent whirls, scattering crisp clashing spray for the sunbeams to iris, bursting with hoarse reverberating roar through ragged gorges and boulder dams, booming in falls, gliding, glancing with cooler soothing, murmuring...

*Our National Parks*

Chapter VIII (p. 242)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**STREPTOMYCIN**

**Waksman, Selman A.** 1888–1973  
Ukrainian-born American biochemist

The highest scientific award and honor presented to me the day before yesterday gives me the opportunity to summarize briefly the discovery and utilization of streptomycin for disease control, notably in the treatment of tuberculosis, the “Great White Plague” of man.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1952

Streptomycin: Background, Isolation, Properties, and Utilization (p. 370)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**STRING THEORY**

**Amati, Danielle**  
Italian physicist

String theory is twenty-first century physics that fell accidentally into the twentieth century.

*Attributed*

**Ferris, Timothy** 1944–  
American science writer

The odd thing about string theory was very odd indeed. It required that the universe have at least ten dimensions. As we live in a universe of only four dimensions, the theory postulated that the other dimensions...had collapsed into structures so tiny that we do not notice them.

*Coming of Age in the Milky Way*

Chapter 16 (p. 331)

William Morrow & Company, Inc. New York, New York, USA. 1988

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

For more than ten years, my theory was in limbo. Then, finally, in the late 1980s, physicists at Princeton said, ‘There’s nothing wrong with this theory. It’s the only one that works, and we have to open our minds to hyperspace.’ We weren’t destined to discover this theory for another 100 years because it’s so bizarre, so different from everything we’d been doing. We didn’t use the normal sequence of discoveries to get to it.

In Nina L. Diamond

*Voices of Truth*

Part Three, Chapter Eleven (p. 326)

Lotus Press. Twin Lakes, Wisconsin, USA. 2000

[The discovery of string theory is like] wandering around the desert and then stumbling on a tiny pebble. But when we examine it carefully, we find that it is the tip of a gigantic pyramid.

Quote in Keay Davidson

‘Theory of Everything’ Tying Researchers Up in Knots

*San Francisco Chronicle*, March 14, 2005



**Ovrut, Burt**

Physicist

It has been thought since physics began that matter was made up of particles. We had changed that point of view now. We now think that matter is made up of little strings.

Parallel Universes

BBC broadcast February 14, 2002

**Witten, Edward** 1951–

American theoretical physicist

To appreciate string theory, one must understand what it is that is being generalized.

Physical Law and the Quest for Mathematical Understanding

*Bulletin of the American Mathematical Society*, Volume 40, Number 1, October 2, 2002 (p 24).**STRUCTURE****Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

It is much more important for a naturalist to understand the structure of a few animals than to command the whole field of scientific nomenclature.

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907**Clark, R. B.** 1923–

Zoologist

It is an indispensable principle that structure must be considered in relation to function; in isolation it is meaningless.

*Dynamics in Metazoan Evolution: The Origin of the Coelom and Segments*

Conclusion (p. 260)

Clarendon Press, Oxford, England, 1964

**Spencer, Herbert** 1829–1903

English social philosopher

Where there are no distinctions of structure there are no distinctions of function.

*The Principles of Biology* (Volume 1)

Part I, Chapter II (p. 200)

D. Appleton &amp; Co. New York, New York, USA, 1910

**STUBBORN****Robinson, Julia** 1919–85

American mathematician

I would say that my stubbornness has been to a great extent responsible for whatever success I have had in mathematics. But then it is a common trait among mathematicians.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 265)

Harcourt Brace Jovanovich, Boston, Massachusetts, USA, 1990

**STUDENT****Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

It is important that students bring a certain ragamuffin, barefoot, irreverence to their studies; they are not here to worship what is known, but to question it.

*The Ascent of Man*

Knowledge or Certainty (p. 360)

Little, Brown &amp; Co. Boston, Massachusetts, USA, 1973

**de Morgan, Augustus** 1806–71

English mathematician and logician

The number of mathematical students, increased as it has been of late years, would be much augmented if those who hold the highest rank in science would condescend to give more effective assistance in clearing the elements of the difficulties which they present.

*On the Study and Difficulties of Mathematics*

Author's Preface (p. vii)

The Open Court Publishing Co. Chicago, Illinois, USA, 1898

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

As the light of the untried world to the infant, so is the dawning of the light resting over the unexplored realms of science to the student.

*The Writings of Oliver Wendell Holmes* (Volume 9)*Medical Essays: 1842–1882*

Chapter IV (p. 209)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA, 1911

In the name of the Faculty I welcome you, Gentlemen of the Medical Class, new-born babes of science, or lustier nurslings, to this morning of your medical life, and to the arms and the bosom of this ancient University.

*The Writings of Oliver Wendell Holmes* (Volume 9)*Medical Essays: 1842–1882*

Chapter IV (p. 209)

Houghton Mifflin &amp; Co. Boston, Massachusetts, USA, 1911

**Jackman, Wilbur Samuel** 1855–1907

American educator

He comes to the teacher with his eyes filled with a thousand pictures, but they are ignored, and he is robbed of them one by one until at last the beauty of this world fades from his sight and it is changed to a vale of tears.

*Nature Study for the Common Schools* (2nd edition)

Chapter II (p. 10)

Henry Holt &amp; Co. New York, New York, USA, 1894

In the beginning of science instruction and to the end, the fact must be recognized that the child stands at the

center of the universe, and from first to last is touched by everything in it.

*Nature Study for the Common Schools* (2nd edition)

Chapter II (p. 10)

Henry Holt & Co. New York, New York, USA. 1894

**Kingsley, Charles** 1819–75

English clergyman and author

I found him in a room lined with cabinets of curiosities, and hung all over with strange horns, bones, and slabs of fossils. But I was not allowed much time to look about me; for he commenced at once on the subject of my studies, by asking me whether I was willing to prepare myself for the university by entering on the study of mathematics?

*Alton Locke*

Chapter XV (p. 130)

Macmillan & Co Ltd. London, England. 1862

**Kleiner, Israel** 1948–

Ukrainian-born author

Can we not at least have a better appreciation of students' difficulties...having witnessed mathematicians of the first rank make mistakes, "prove" erroneous theorems, and often come to the right conclusions for insufficient or invalid reasons?

Thinking the Unthinkable: The Story of Complex Numbers (with a Moral)

*Mathematics Teacher*, October, 1988

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Learn to love the freedom of the student life, only too quickly to pass away; the absence of the coarser cares of after days, the joy in comradeship, the delight in new work, the happiness in knowing that you are making progress. Once only can you enjoy these pleasures.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Master-Word in Medicine (p. 362)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Shah, Idries** 1924–96

Persian author and teacher in the Sufi tradition

You will know the real student because he seeks whatever there is to be found.

*Thinkers of the East*

Shakir Amali (p. 108)

Jonathan Cape. London, England. 1971

**Slosson, Edwin E.** 1865–1919

Chemist and author

...professors give too many lectures and the students listen to too many. Or pretend to; really they do not listen, however attentive and orderly they may be. The bell rings and a troop of tired-looking boys, followed perhaps by a

larger number of meek-eyed girls, file into the classroom, sit down, remove the expressions from their faces, open their notebooks on the broad chair arms, and receive. It is about as inspiring an audience as a roomful of phonographs holding up their brass trumpets.

Great American Universities – XV

*The Independent*, Volume LXVIII, Number 3196, March 3, 1910 (p. 463)

The secret is that they [students] have, without knowing anything about physiological psychology, devised an automatic cut-off which goes into operation as they open their notebooks and short-circuits the train of thought from the ear directly to the hand, without its having to pass thru the pineal gland or wherever the soul may be at the time residing and holding court.

Great American Universities – XV

*The Independent*, Volume LXVIII, Number 3196, March 3, 1910 (p. 463)

**Tyndall, John** 1820–93

Irish-born English physicist

When the student of physical science has to investigate the character of any natural force, his first care must be to purify it from the mixture of other forces, and thus study its simple action.

*Fragments of Science for Unscientific People*

Chapter XIV (p. 383)

D. Appleton & Co. New York, New York, USA. 1875

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

It is a misfortune to pass at once from observation to conclusion, and to regard both as of equal value; but it befalls many a student.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

517 (p. 183)

The Macmillan Co. New York, New York, USA. 1906

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Each individual student must be content to find his reward in rejoicing over new discoveries, as over new victories of mind over reluctant matter, or in enjoying the aesthetic beauty of a well-ordered field of knowledge, where the connection and filiation of every detail is clear to the mind, and where all denotes the presence of a ruling intellect; he must rest satisfied with the consciousness that he too has contributed something to the increasing fund of knowledge on which the dominion of man over all the forces hostile to intelligence reposes.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

First Series

On the Relation of Natural Science to General Science (p. 29)

D. Appleton & Co. New York, New York, USA. 1897

**Winchell, Alexander** 1824–91  
American geologist

The student may plod ever so diligently and ever so intelligently through the details of a science; he is apt to gain only vague impressions and floating ideas, unless enabled to take a comprehensive survey of the field, with the details all left in the background, and the great outlines and prominent landmarks all brought saliently into proper relations to each other.

*Sketches of Creation*

Preface (p. v)

Harper & Brothers Publishers. New York, New York, USA. 1870

## STUDENT, MEDICAL

**Brinton, William**  
English physician

...as the progress of physical science adds, day by day and year by year, to that large mass of information which the practitioner of Medicine has to acquire, it becomes more and more important for the student, either to extend his period of education, or at any rate so to arrange his studies, and to economize his time, as to compensate for these increasing requirements. Above all, he must be increasingly jealous and watchful, lest, in grasping at accomplishments, he lose essentials.

Introductory Lecture

*The London Lancet*, Volume 2, Number 6, December, 1857 (p. 434)

## STUDIES

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Crafty men condemn studies, simple men admire them, and wise men use them, for they teach not their own use; but that is a wisdom without them, and above them, won by observation.

*Bacon's Essays*

Of Studies (p. 472)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1875

To spend too much time in studies, is sloth; to use them too much for ornament, is affectation; to make judgment wholly by their rules, is the humor of a scholar; they perfect nature, and are perfected by experience...

*Bacon's Essays*

Of Studies (p. 472)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1875

Studies serve for delight, for ornament, and for ability.

In James Spedding, Robert Leslie Ellis, Douglas and Denon Heath

*The Works of Francis Bacon* (Volume 6)

Of Studies (p. 497)

Longman & Co. London, England. 1858

## STUDY

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

Lay aside all conceit. Learn to read the book of nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search.

In David Stair Jordan

*Popular Science Monthly*, Volume 40, 1891/92

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Studies serve for delight, for ornament, and for ability.

In C.W. Eliot (ed.)

*The Harvard Classics*, Volume 3

Of Studies

P.F. Collier & Son. New York, New York, USA. 1909–10

To spend too much time in studies, is sloth: to use them too much for ornament, is affectation; to make judgment wholly by their rules, is the humor of a scholar; they perfect nature, and are perfected by experience: for natural abilities are like natural plants, that need pruning by study; and studies themselves do give forth directions too much at large, except they be bounded in by experience. Crafty men condemn studies, simple men admire them, and wise men use them; for they teach not their own use; but that is a wisdom, without them and above them, won by observation.

*Essays*

Of Studies (p. 178)

John B. Alden, Publisher. New York, New York, USA. 1885

**Cooke, Josiah Parsons** 1827–94  
American chemist

To study the natural sciences merely as a collection of interesting facts which it is well for every educated man to know, seldom serves a useful purpose. The young mind becomes wearied with the details, and soon forgets what it has never more than half acquired.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 41)

D. Appleton & Co. New York, New York, USA. 1855

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Just as eating contrary to the inclination is injurious to the health, so study without desire spoils the memory, and it retains nothing that it takes in.

In Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I: Life (p. 52)

Duckworth & Co. London, England. 1906

**Dalton, John** 1766–1844  
English chemist and physicist

If I have succeeded better than many who surround me, it has been chiefly, nay, I may say, almost solely from unwearied assiduity. It is not so much from any superior genius that one man possesses over another, but more from attention to study, and perseverance in the objects before them, that some men rise to greater eminence than others.

In John Price Millington  
*John Dalton*  
Introduction (p. 4)  
J.M. Dent & Co. London, England. 1906

**Daly, Reginald Aldworth** 1871–1957  
Canadian-American geologist

Our study deals with numbers, quantities, measurements, for these form the essence of the truth of nature.

*Our Mobile Earth*  
Chapter I (p. 5)  
Charles Scribner's Sons. New York, New York, USA. 1926

**Einstein, Albert** 1879–1955  
German-born physicist

Never regard your study as a duty, but as the enviable opportunity to learn to know the liberating influence of beauty in the realm of the spirit for your own personal joy and to the profit of the community to which your later work belongs.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives*  
(p. 96)  
Princeton University Press. Princeton, New Jersey, USA. 1979

**London, Jack** 1876–1916  
American author

For five weeks I crammed, until simultaneous quadratic equations and chemical formulas fairly oozed from my ears.

*John Barleycorn*  
Chapter XXII (p. 210)  
The Century Co. New York, New York, USA. 1913

**Lubbock, John, First Baron Avebury** 1834–1919  
English banker, politician, biologist, and archaeologist

There is no species of animal or plant which would not well repay, I will not say merely the study of a day, but even the devotion of a lifetime.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter II (p. 41)  
Macmillan & Company Ltd. London, England. 1903

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Do not seek happiness in what is misnamed pleasure; seek it rather in what is termed study.

*The Old Red Sandstone*  
Chapter I (p. 1)  
John B. Alden, Publisher. New York, New York, USA. 1892

**Platt, John R.**  
No biographical data available

We praise the “lifetime of study,” but in dozens of cases, in every field, what was needed was not a lifetime but rather a few short months or weeks of analytical inductive inference. In any new area we should try, like Roentgen, to see how fast we can pass from the general survey to analytical inductive inference. We should try, like Pasteur, to see whether we can reach strong inferences that encyclopedism could not discern.

Strong Inference  
*Science*, Volume 146, Number 3641, 16 October, 1964 (p. 251)

**Rowland, Henry Augustus** 1848–1901  
American physicist

The whole universe is before us to study. The greatest labor of the greatest minds has only given us a few pearls; and yet the limitless ocean, with its hidden depths filled with diamonds and precious stones, is before us. The problem of the universe is yet unsolved, and the mystery involved in one single atom yet eludes us. The field of research only opens wider and wider as we advance, and our minds are lost in wonder and astonishment at the grandeur and beauty unfolded before us.

*The Physical Papers of Henry Augustus Rowland*  
A Plea for Pure Science (p. 613)  
Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Skinner, Burrhus Frederic** 1904–90  
American psychologist

When you run into something interesting, drop everything else and study it.

*Cumulative Record*  
A Case History in Scientific Method (p. 81)  
Appleton-Century-Crofts, Inc. New York, New York, USA. 1959

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935  
Russian research scientist

To place one's feet on the soil of asteroids, to lift a stone from the moon with your hand, to construct moving stations in ether space, to organize inhabited rings around Earth, moon and sun, to observe Mars at the distance of several tens of miles, to descend to its satellites or even to its own surface – what could be more insane! However, only at such a time when reactive devices are applied, will a great new era begin in astronomy: the era of more intensive study of the heavens.

In M.K. Tikhonravov (ed.)  
*Works on Rocket Technology*  
The Investigation of Universal Space by Means of Reactive Devices  
(p. 95)  
Publisher undetermined

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

The universe is a harmonious whole, each creature is but a note, a shade of a great harmony, which man must study in its entirety and greatness, lest each detail should remain a dead letter.

Letter to C.L. Knebel, November 17, 1784

## STUDY HABIT

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

I keep...the subject constantly before me, and wait till the first dawns open slowly, by little and little, into a full and clear light.

Quoted in John Watkins

*Characteristic Anecdotes of Men of Learning and Genius*

Sir Isaac Newton (p. 415)

J. Cundee. London, England. 1808

## STUPIDITY

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

I am an Evolutionist, not a Multiplicationist. It seems rather stupid to keep doing the same thing over and over again.

*The Nature of the Physical World*

Chapter IV (p. 86)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955  
German-American physicist

Everyone has to sacrifice at the altar of stupidity from time to time, to please the Deity and the human race.

In Max Born

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*

Letter 219 September, 1920 (p. 35)

Walker & Company. New York, New York, USA. 1971

**Levi, Primo** 1919–87  
Italian writer and chemist

To accuse another of having weak kidneys, lungs, or heart, is not a crime; on the contrary, saying he has a weak brain is a crime. To be considered stupid and to be told so is more painful than being called gluttonous, mendacious, violent, lascivious, lazy, cowardly: every weakness, every vice, has found its defenders, its rhetoric, its ennoblement and exaltation, but stupidity hasn't.

*Other People's Trades*

The Irritable Chess-Players

Summit Books. New York, New York, USA. 1989

## STYLE

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

Others have reproached me with my style.... They fear lest a page that is read without fatigue should not always be the expression of the truth. Were I to take their word for it, we are profound only on condition of being obscure.

Translated by Alexander Teixeira de Mattos and Bernard Miall

*The Wonders of Instinct*

Chapter I (p. 5)

The Century Co. New York, New York, USA. 1918

## SUBMARINE

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

I must confess that my imagination, in spite even of spurring, refuses to see any sort of submarine doing anything but suffocate its crew and founder at sea.

*Anticipations of the Reaction of Mechanical and Scientific Progress*

*Upon Human Life and Thought*

War in the Twentieth Century (p. 217)

Harper & Brothers Publishers. New York, New York, USA. 1901

## SUBSTANCE

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...we now know that there is, in principle, no permanence in substance; it is mere bottled energy, and possesses no more inherent permanence than bottled beer...

*Physics and Philosophy*

Chapter II (p. 41)

Dover Publications, Inc. New York, New York, USA. 1981

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Our conception of substance is only vivid so long as we do not face it. It begins to fade when we analyse it. We may dismiss many of its supposed attributes which are evidently projections of our sense-impressions outwards into the external world.

*The Nature of the Physical World*

Chapter XIII (p. 273)

The University Press. New York, New York, USA. 1929

## SUBSTANTIVE TERM

**Owen, Richard** 1804–92  
English biologist, comparative anatomist, and paleontologist

A single substantive term is a better instrument of thought than a paraphrase.

*On the Anatomy of Vertebrates* (Volume I)

Preface (p. xiv)

Longmans, Green & Co. London, England. 1866

**SUBTERRANEAN****Clarke, John**

No biographical data available

Beneath the earth likewise there are laws of nature, less familiar to us, but no less fixed. Be assured that there exists below everything that you see above. There, too, there are antres vast, immense recesses, and vacant spaces, with mountains overhanging on either hand. There are yawning gulfs stretching down into the abyss, which have buried in their depths their mighty ruins. These retreats are filled with air, for nowhere is there a vacuum in nature; through their ample spaces stretch marshes over which darkness ever broods. Animals also are produced in them, but they are slow-paced and shapeless; the air that conceived them is dark and clammy, the waters are torpid through inaction.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*

Book III, Chapter XVI (pp. 128–129)

Macmillan & Company Ltd. London, England. 1910

**Cloos, Hans** 1885–1951

German geologist

A subterranean landscape is the ramified labyrinth of crevices and caves, of pores and seams, through which the trolls and earth-sprites climb up and down.

*Conversations with the Earth*

Chapter IV (p. 48)

Alfred A. Knopf. New York, New York, USA. 1953

**Deetz, James** 1930–2000

American archaeologist

Archaeology by its formal etymology, is the study of the old; and the old, more often than not, is buried. As a result, archaeologists have traditionally been concerned with the subterranean world. Like Lewis Carroll's Alice, they are confronted with the curious underground world, and attempt to understand and explain it.

In James Deetz (ed.)

*Man's Imprint from the Past: Readings in the Methods of Archaeology*

Chapter 1 (p. 4)

Little, Brown & Company. Boston, Massachusetts, USA. 1971

**SUMMER EQUINOX****Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

...in the Town of Syene (which is above Alexandria fifty Stadia), at Noon, in the midst of Summer, there is no Shadow: and that for Experiment thereof, a Well that was sunk in the Ground was lighted to the Bottom; whereby it appeareth that the Sun at that Time is directly over that Place.

*Pliny's Natural History. In Thirty-seven Books*

Book II, Chapter LXXIII (p. 116)

Printed for the Club by G. Barclay. London, England. 1847–1849

**SUN****Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Several billion trillion tons of super hot exploding hydrogen nuclei rose slowly above the horizon and managed to look small, cold and slightly damp.

*The Ultimate Hitchhiker's Guide to the Galaxy*

*Life, the Universe, and Everything*

Chapter 7 (p. 349)

Ballantine Books. New York, New York, USA. 2002

**Allen, Woody** 1935–

American film director and actor

The sun, which is made of gas, can explode at any moment, sending our entire planetary system hurtling to destruction; students are advised what the average citizen can do in such a case.

*Getting Even*

Spring Bulletin (p. 58–59)

Random House, Inc. New York, New York, USA. 1971

**Arnold, Matthew** 1822–88

English poet

Is it so small a thing To have enjoy'd the sun ...

*Poetical Works of Matthew Arnold*

Empedocles on Etna

Macmillan & Co Ltd. London, England. 1907

**Author undetermined**

We poor planets are like a swarm of minnows shut up in a pond with a pike, or like rabbits in the cage of the boa constrictor in the Zoological Gardens, – permitted to live and circle about, until the monster [the sun] has need of us to satisfy his appetite and maintain his existence.

In Mary Elizabeth Braddon

Sensationalism in Science

*Belgravia*, Volume VI, October, 1868 (p. 78)

**Bailey, Philip James** 1816–1902

English poet

The sun, bright keystone of Heaven's world-built arch...

*Festus: A Poem*

Scene I (p. 32)

George Routledge & Sons, Ltd. London, England. 1893

**Blackmore, Richard** 1825–1900

English Victorian novelist

The sun, a globe of fire, a glowing mass, Hotter than melting flint, or fluid glass, Of this our system holds the middle place.

*Creation: A Philosophical Poem, in Seven Books* (p. 94)

Robert Johnson. Philadelphia, Pennsylvania, USA. 1806



**Bourdillon, Francis William** 1852–1921  
English poet and translator

The night has a thousand eyes,  
And the day but one;  
Yet the light of the bright world dies,  
With the dying Sun.

*Among the Flowers, and Other Poems*

The Night Has a Thousand Eyes  
Marcus Ward & Company. London, England. 1878

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

As the other planets, so also our earth, is not only enlightened, warmed, cherished, and made fruitful by the power, virtue, and influence of the sun, but it hath, moreover, its proper, magnetical, planetary force awakened, fermented, excited, and agitated, which it sends back with the reflected Light of that luminary.

*The Philosophical Works of the Honorable Robert Boyle* (Volume 3)  
(2nd edition)

A New Use of Astronomy (pp. 35–36)  
Printed by T.W. London, England. 1738

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Since a time so remote that imagination falters in the attempt to conceive it, the sun has mothered her brood of planets.

*Autobiography of Earth*

Chapter V (p. 133)  
Coward-McCann, Inc. New York, New York, USA. 1935

**Cook, J. Gordon** 1916–  
No biographical data available

The darkness of night is dissolving in light that flows steadily across the sky. Over the eastern horizon a curved shoulder of fire appears; our sun has arrived, bringing with it another day of glorious light.

*We Live by the Sun*

Chapter 2 (p. 18)  
The Dial Press. New York, New York, USA. 1957

**Core, Thomas H.**  
Astronomer

Our knowledge of the sun has of late years greatly increased; of old our luminary did two things for us like a benevolent parent he smiled upon us, while at the same time he kept us in leading strings.

*Essays and Addresses*

Lecture IV (p. 59)  
Macmillan & Co Ltd. London, England. 1874

...by gazing anxiously and often into the face of our great luminary, we have come to recognise certain delicate changes of expression and meaning, so that we may be said to have taken our first lesson in Solar Physiognomy.

*Essays and Addresses*

Lecture IV (p. 60)  
Macmillan & Co Ltd. London, England. 1874

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

Since the newness of the hypotheses of this work – which sets the earth in motion and puts an immovable sun at the centre of the universe – has already received a great deal of publicity, I have no doubt that certain of the savants have taken grave offense and think it wrong to raise any disturbance among liberal disciplines which have had the right set-up for a long time now.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Introduction, to the Reader Concerning the Hypothesis of this Work (p. 505)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In the center of all rests the sun. For who would place this lamp of a very beautiful temple in another or better place than this wherefrom it can illuminate everything at the same time? As a matter of fact, not unhappily do some call it the lantern; others, the mind and still others, the pilot of the world. Trismegistus calls it a “visible god”; Sophocles’ Electra, “that which gazes upon all things.” And so the sun, as if resting on a kingly throne, governs the family of stars which wheel around.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Chapter 10 (pp. 526–528)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Crane, Stephen** 1871–1900  
American writer

The sun was pasted in the sky like a wafer.

*The Red Badge of Courage*

IX (p. 115)

Random House, Inc. New York, New York, USA. 1925

**Crosby, Harry** 1898–1929  
American financial heir, bon vivant, and poet

The Sun! The Sun! a fish in the aquarium of sky or golden net to snare the butterfly of soul or else the hole through which stars have disappeared...

*Sun Rhapsody*

Six Poems 1928

Publisher undetermined

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

Our sun enlightens the planets that belong to him; why may not every fixed star also have planets to which they give light?

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 151)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Deutsch, Armin J.** 1918–1969  
American astronomer and science fiction writer

The face of the sun is not without expression, but it tells us precious little of what is in its heart.

The Sun  
*Scientific American*, Volume 179, Number 5, November, 1948 (p. 38)

**Dick, Thomas** 1600–80  
Scottish theologian and philosopher

Without the influence of this august luminary [the sun], a universal gloom would ensue, and surrounding worlds, with all their trains of satellites, would be shrouded in perpetual darkness.

*Celestial Scenery, Or, The Wonders of the Planetary System Displayed*  
Chapter 10 (p. 220)  
Merriam & Cooke. West Brookfield, Massachusetts, 1847  
USA.

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

The glorious lamp of heaven, the radiant sun,  
Is Nature's eye...

*The Poetical Works of Dryden*  
The Fable of Acis, Polyphemus, and Galatea from the Thirteenth Book of Ovid's *Metamorphoses* (p. 405)  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

And since the vernal equinox, the sun  
In Aries twelve degrees, or more, had run.

*The Poetical Works of Dryden*  
The Cock and the Fox, l. 448–449  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

Behold him setting in his western skies,  
The shadows lengthening as the vapours rise.

*The Poetical Works of Dryden*  
Absalom and Achitophel  
Part I, l. 268  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Ehrlich, Gretel** 1946–  
American travel writer, novelist, and essayist

We forget that our sun is only a star destined to someday burn out. The time scale of its transience so far exceeds our human one that our unconditional dependence on its life-giving properties feels oddly like an indiscretion we'd rather forget.

*The Solace of Open Spaces*  
To Live in Two Worlds (p. 105)  
Penguin Books. New York, New York, USA. 1986

**Eudoxus of Cnidus** ca. 400 BCE–ca. 350 BCE  
Greek astronomer, mathematician, and physician

Willingly would I burn to death like Phaeton, were this the price for reaching the sun and learning its shape, its size, and its substance.

In Carl B. Boyer  
*A History of Mathematics* (p. 91)  
John Wiley & Sons, Inc. New York, New York, USA. 1968

**Falconer, William** 1744–1824  
Poet

High in his chariot glow'd the lamp of day.

*The Shipwreck*  
Canto I, III, l. 3

**Flammarion, Camille** 1842–1925  
French astronomer and author

The sun is but a star; he will meet with the fate of his sisters; suns, like worlds, are born to die, and in eternity their long career will have endured but 'the space of a morning.'

Translated by J. Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter VII (pp. 79–80)  
Chatto & Windus. London, England. 1894

Dazzling source of light and heat, of motion, life, and beauty, the inimitable sun has in all ages received the earnest and grateful homage of mortals. The ignorant admire it because they feel the effects of its power and its value; the savant appreciates it because he has learned its unique importance in the system of the world; the artist salutes it because he sees in its splendor the virtual cause of all harmonies.

*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter I (p. 207)  
Chatto & Windus. London, England. 1894

If the comparison were not offensive to the sun-god, we might say that he [the Sun] is like the spider at the centre of his web. In the net of his attraction the worlds are sustained. Relatively to his magnitude and might, the planets are but toys turning round him.

Translated by John Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter I (p. 208)  
Chatto & Windus. London, England. 1907

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

The doctrine of the movement of the earth and the fixity of the sun is condemned on the ground that the Scriptures speak in many places of the sun moving and the earth standing still. The Scriptures not being capable of lying or erring, it followeth that the position of those is erroneous and heretical who maintain that the sun is fixed and the earth in motion.

*The Authority of Scripture in Philosophical Controversies*  
Section I  
The Defenders of Fallacy

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

The Sun, whose rays  
Are all ablaze

With ever-living glory,  
Does not deny  
His majesty –  
He scorns to tell a story!

*The Complete Plays of Gilbert and Sullivan*  
*The Mikado*

Act II (p. 322)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Heraclitus** 540 BCE–480 BCE  
Greek philosopher

The sun...is new each day.

In G.S Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 228 (p. 202)

At The University Press. Cambridge, England. 1963

**Herschel, Friedrich Wilhelm**  
**(Sir William)** 1738–1822  
English astronomer

The sun is the celestial body which should first attract our notice, not only on its own account but since the fixed stars are, by the strictest analogy, similar bodies.

On the Nature and Construction of the Sun and Fixed Stars  
*Philosophical Transactions of the Royal Society of London*,  
Volume 85, 1795 (p. 46)

I should not wonder if [considering what we know] we were induced to think that nothing remained to be added; and yet we are still very ignorant in regard to the internal construction of the sun.

On the Nature and Contraction of the Sun and Fixed Stars  
*Philosophical Transactions of the Royal Society of London*,  
Volume 85, 1795 (p. 47)

The sun itself has been called a globe of fire, though perhaps metaphorically.

On the Nature and Contraction of the Sun and Fixed Stars  
*Philosophical Transactions of the Royal Society of London*,  
Volume 85, 1795 (p. 48)

This way of considering the sun removes the great dissimilarity between its condition and that of the other great bodies of the system. The sun then appears to be nothing else than a very eminent, large, and lucid planet ‘...most probably also inhabited by beings whose organs are adapted to the peculiar circumstances of that vast globe.

On the Nature and Contraction of the Sun and Fixed Stars  
*Philosophical Transactions of the Royal Society of London*,  
Volume 85, 1795 (p. 63)

The influence of this eminent body [the sun], on the globe we inhabit, is so great, and so widely diffused, that it becomes almost a duty for us to study the operations which are carried on upon the solar surface.

Observations tending to investigate the Nature of the Sun, in order to find the Causes or Symptoms of its variable Emission of Light and Heat  
*Philosophical Transactions of the Royal Society of London*, 1801 (p. 265)

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Giant Size and Giant Strength are ugly qualities without beneficence. But the sun is the almoner of the Almighty, the delegated dispenser to us of light and warmth, as well as the centre of attraction; and as such the immediate source of all our comforts, and indeed of the very possibility of our existence on earth.

*Familiar Lectures on Scientific Subjects*

Lecture II (p. 62)

George Routledge & Sons. New York, New York, USA. 1871

The great mystery, however, is to conceive how so enormous a conflagration [as the sun] can be kept up. Every discovery in chemical science here leaves us completely at a loss, or rather, seems to remove farther the prospect of probable explanation.

*Astronomy*

Chapter V (p. 212)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1893

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Now, if the sun is not created a miraculous body, to shine on and give out heat forever, we must suppose it to be a body subject to the laws of matter (I do not say there may not be laws which we have not discovered) but, at all events, not violating any laws we have discovered or believe we have discovered. We should deal with the sun as we should with any large mass of molten iron, or silicon, or sodium.

*On Geological Time* (p. 18)

Address

Geological Society of Glasgow

February 27, 1868

It seems, therefore, on the whole most probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say, with equal certainty, that inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer unless sources now unknown to us are prepared in the great storehouse of creation.

The Age of the Sun's Heat

*Macmillan's Magazine*, March 5, 1862 (p. 293)

**Langley, Samuel Pierpoint** 1834–1906  
American astronomer and aviation pioneer

...the fields glitter with snow-crystals in the winter noon, and the eye is dazzled with a reflection of the splendor which the sun pours so fully into every nook that by it alone we appear to see everything.

The New Astronomy

*The Century Illustrated Monthly Magazine*, Volume 28, New Series,  
Volume 6 (p. 922)

As the thought of man is widened with the process of the suns, let us hope that we shall one day know more.

The New Astronomy

*The Century Illustrated Monthly Magazine*, Volume 28, New Series, Volume 6 (p. 936)

**Ledger, Edmund** 1841–1913

English astronomer

Discovery has followed upon discovery, and victory upon victory, as astronomers have stormed one outlying fortress after another of the Sun's hidden secrets ...

*The Sun, Its Planets and their Satellites*

Lecture I (p. 2)

Edward Stanford. London, England. 1882

**Lockyer, Joseph Norman** 1836–1920

English astronomer and physicist

Slowly, but very surely, by means of quiet sap, but little of which meets the eye, we are effecting an entrance into the treasure-house wherein are kept the secrets of the sun.

What is the Sun Made of?

*The Nineteenth Century*, Volume 4, July, 1878 (p. 75)

**Longfellow, Henry Wadsworth** 1807–82

American poet

Down sank the great red sun, and in golden glimmering vapours

Veiled the light of his face, like the Prophet descending from Sinai.

*The Poetical Works of Henry Wadsworth Longfellow*

Evangeline, Part I, Section 4

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Macpherson, James** 1736–1796

Scottish poet

Whence are thy beams, O sun! thy everlasting light! Thou comest forth in thy awful beauty; the stars hide themselves in the sky; the moon, cold and pale, sinks in the western wave; but thou thyself movest alone.

*The Poems of Ossian*

Carthon (p. 233)

Printed by Dewick & Clarke. London, England. 1806

**Mann, Thomas** 1875–1955

German-born American novelist

“He does seem rather weird,” was Hans Castorp's view. “Some of the things he said were very queer: it sounded as if he meant to say that the sun revolves round the earth.”

*The Magic Mountain*

Chapter VI

Of City of God, and Deliverance by Evil (p. 407)

Alfred A. Knopf. New York, New York, USA. 1966

**Mayer, Robert**

No biographical data available

The Sun...is an inexhaustible source of physical force – that continuously wound-up spring which sustains in motion the mechanism of all the activities on Earth.

In L.I. Ponomarev

*The Quantum Dice* (p. 228)

Institute of Physics Publishing. Bristol, England. 1993

**Melville, Herman** 1819–91

American novelist

Life or death, weal or woe, the sun stays not his course. Oh: over battlefield and bower; over tower, and town, he speeds, – peers in at births, and death-beds; lights up cathedral, mosque, and pagan shrine; – laughing over all; – a very Democritus in the sky; and in one brief day sees more than any pilgrim in a century's round.

*Typee, Omoo, Mardi*

*Mardi*

Chapter 184 (p. 1277)

The Library of America. New York, New York, USA. 1982

**Moulton, Forest Ray** 1872–1952

American astronomer

If the sun were created expressly to light and heat the earth, what a waste of energy!

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 17)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Muir, John** 1838–1914

American naturalist

The sun, looking down on the tranquil landscape, seems conscious of the presence of every living thing on which he is pouring his blessings, while they in turn, with perhaps the exception of man, seem conscious of the presence of the sun as a benevolent father and stand hushed and waiting.

*Steep Trails*

Chapter XVII (p. 226)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Newcomb, Simon** 1835–1909

Canadian-born American astronomer

...it is remarkable that modern science has shown us more mysteries in the sun than it has explained; so that we find ourselves farther than before from a satisfactory explanation of solar phenomena.

*Popular Astronomy* (6th edition)

Part III, Chapter II (p. 257)

Harper & Brothers Publishers. New York, New York, USA. 1893

**Parker, E. N.** 1927–

No biographical data available

The riddles the sun presents are signposts to new horizons.

The Sun

*Scientific American*, Volume 233, Number 3, September, 1975 (p. 50)

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Let man then contemplate the whole of nature in her full and grand majesty, and turn his vision from the low objects which surround him. Let him gaze on that brilliant light, set like an eternal lamp to illumine the universe.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section II, 72  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Plato** 428 BCE–347 BCE  
Greek philosopher

That there might be some visible measure of their relative swiftness and slowness as they proceeded in their eight courses, God lighted a fire, which we now call the sun, in the second from the earth of these orbits...

In *Great Books of the Western World* (Volume 7)  
*Timæus*  
Section 39 (p. 451)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Proctor, Mary** 1862–1957  
American popularizer of astronomy

The music of the spheres that are swayed and held in bondage by our own sun, is echoed by that of ten million moving suns, singing their solemn chant – the grandest of epics – the Poem of the Universe, as they wing their flight through infinite space.

The Silver River of Heaven  
*The Chautauquan*, Volume 21, Number 4, July, 1895 (p. 459)

**Proctor, Richard Anthony** 1837–88  
English astronomer

All the wonderful processes taking place within and around the globe of our own sun have their analogues in that distant orb. Let it be remembered also that our sun himself presents an aspect which in no sense suggests his real condition. If we would picture him as he actually is, we must consider the uproar and tumult which prevail where, to our ordinary perceptions, all seems at perfect rest. The least movement on that glowing photosphere represents the action of forces so tremendous that they would be competent to destroy in an instant this earth on which we live. The most hideous turmoil, outvying a million-fold the roar of the hurricane or the crash of the thunderbolt, must prevail forever in every part of the solar atmosphere.

*Light Science for Leisure Hours* Second series (3rd edition)  
Movements in the Star-depths (p. 31)  
Longmans, Green & Co. London, England. 1889

...if there is any object which men can properly take as an emblem of the power and goodness of Almighty God, it is the sun.

*The Expanse of Heaven: A Series of Essays on the Wonders of the Firmament*

A Dream That Was Not The Sun (p. 11)  
Longmans, Green, & Co. London, England. 1897

**Raymo, Chet** 1936–  
American physicist and science writer

For 5 billion years the sun has exhaled a faint breath as it burns, bathing the Earth in the flux of its exhalations, a wind of atoms and subatomic particles that feeds the Earth's atmosphere and ignites auroras.

*The Soul of the Night*  
Chapter 8 (p. 81)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1985

**Riley, James Whitcomb** 1849–1916  
American poet

And the sun had on a crown  
Wrought of gilded thistle-down,  
And a scarf of velvet vapor  
And a raveled rainbow gown;  
And his tinsel-tangled hair  
Tossed and lost upon the air  
Was glossier and flossier  
Than any anywhere.

*The Complete Works of James Whitcomb Riley in Ten Volumes* (Volume 4)  
*The South Wind and the Sun*  
Harper & Brothers Publishers. New York, New York, USA. 1916

**Rutherford, Mark (William Hale White)** 1831–1913  
English writer

The sun, we say, is the cause of heat, but the heat is the sun, hence on this window-ledge.

*More Pages from a Journal*  
Notes (p. 120)  
H. Frowde. London, England. 1910

**Sagan, Carl** 1934–96  
American astronomer and science writer

**Druyan, Ann** 1949–  
American author and television producer

The immense, overpowering blackness is relieved here and there by a faint point of light – which, upon closer approach, is revealed to be a mighty sun, blazing with thermonuclear fire and warming a small surrounding volume of space.

*Shadows of Forgotten Ancestors: A Search for Who We Are*  
Prologue (p. 3)  
Random House, Inc. New York, New York, USA. 1992

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the glorious sun,  
Stays in his course and plays the alchemist,  
Turning with splendor of his precious eye  
The meagre cloddy earth to glittering gold.



In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Twelfth Night*  
 Act V, Scene i, l. 77–80  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smart, Christopher** 1722–71  
 English poet

Glorious the sun in mid-career;  
 Glorious th' assembled fires appear.  
*Collected Poems*  
 A Song to David, LXXXIV  
 Routledge & Kegan Paul. London, England. 1949

**Starr, Victor P.**  
 No biographical data available

**Gilman, Peter A.**  
 No biographical data available

It has always been easier to record and describe solar events than to provide theoretical explanations for them. The Circulation of the Sun's Atmosphere  
*Scientific American*, Volume 218, Number 1, January 1968 (p. 100)

**Stoppard, Tom** 1937–  
 Czech-born English playwright

Meeting a friend in a corridor, Wittgenstein said: "Tell me, why do people always say it was natural for men to assume that the sun went round the earth, rather than that the earth was rotating?" His friend said, "Well, obviously, because it looks as if the sun is going round the earth." To which the philosopher replied, "Well, what would it have looked like if it had looked as if the earth was rotating?"

*Jumpers*  
 Act Two (p. 65)  
 Grove Press, Inc. New York, New York, USA. 1972

**Swedenborg, Emanuel** 1688–1772  
 Swedish scientist, philosopher, and Christian mystic

...it is perceived that the sun of the world, with all its essence, which is heat and light, flows into every tree, and into every shrub and flower, and into every stone, mean as well as precious; and that every object takes its portion from this common influx, and that the sun does not divide its light and heat, and dispense a part to this and a part to that. It is similar with the sun of heaven, from which the Divine love proceeds as heat, and the Divine wisdom as light; these two flow into human minds, as the heat and light of the sun of the world into bodies, and vivify them according to the quality of the minds, each of which takes from the common influx as much as is necessary.

*The True Christian Religion*  
 Concerning Faith, 364 (p. 257)  
 J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1875

**Swift, Jonathan** 1667–1745  
 Irish-born English writer

These people [Laputians] are under continual disquietudes, never enjoying a minute's peace of mind; and their disturbances proceed from causes which very little affect the rest of mortals. Their apprehension arises from several changes they dread in the celestial bodies. For instance...that the sun, daily spending its rays without any nutriment to supply them, will at last be wholly consumed and annihilated; which must be attended with the destruction of this earth, and all the planets that receive their light from it.

In *Great Books of the Western World* (Volume 36)  
*Gulliver's Travels*  
 Part III, Chapter II (p. 98)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tennyson, Alfred (Lord)** 1809–92  
 English poet

There sinks the nebulous star we call the sun.  
*Alfred Tennyson's Poetical Works*  
 The Princess, Part IV, l. 19  
 Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

It is true, I never assisted the sun materially in his rising; but doubt not, it was of the last importance only to be present at it.

*The Writings of Henry David Thoreau* (Volume 2)  
*Walden*  
 Chapter I (p. 30)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Updike, John** 1932–  
 American novelist, short story writer, and poet

The zeros stared back, everyone a wound leaking the word "poison." "That's the weight of the Sun," Caldwell said.

*The Centaur*  
 Chapter I (p. 37)  
 Alfred A. Knopf. New York, New York, USA. 1995

**Warder, George Woodward** 1848–1907  
 American attorney

I hold that the suns are not hot, nor burning gaseous spheres, but are the self-luminous perfected worlds of the universe and the future abode of man. I claim that man is the product of planetary forces, and the planets are the hatcheries of human souls, and the suns the places of their development and growth to perfection.

*The Cities of the Sun*  
 Chapter I (p. 11)  
 G.W. Dillingham Co, Publishers. New York, New York, USA. 1901



**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...the sun, red and very large, halted motionless upon the horizon, a vast dome glowing with a dull heat, and now and then suffering a momentary extinction...[it] grew larger and duller in the westward sky, and the life of the old earth ebbed away. At last, more than thirty million years hence, the huge red-hot dome of the sun had come to obscure nearly a tenth part of the darkling heavens.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1971

*The Time Machine*, Chapter 11

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

It is usual to assume that the sun will go on cooling steadily in the future. But people...forget that the planets must ultimately fall back one by one into the parent body. As these catastrophes occur, the sun will blaze with renewed energy.

*Seven Science Fiction Novels of H. G. Wells*

*The Time Machine*

Chapter 5 (p. 38)

Dover Publications, Inc. New York, New York, USA. 1934

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Give me a splendid silent sun, with all his beams full-dazzling.

*Complete Poetry and Collected Prose*

Give Me a Splendid Sun

The Library of America. New York, New York, USA. 1982

**Xenophanes** ca. 575 BCE–ca. 478 BCE

Greek philosopher

The sun comes into being each day from little pieces of fire that are collected...

In G.S Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 178 (p. 172)

At The University Press. Cambridge, England. 1963

## SUN LIGHT

**Hale, George Ellery** 1868–1938

American astronomer

No archaeologist, whether Young or Champollion deciphering the Rosetta Stone, or Rawlinson copying the cuneiform inscription on the cliff of Behistun, was ever faced by a more fascinating problem than that which confronts the solar physicist engaged in the interpretation of the hieroglyphic lines of sun-spot spectra.

*The New Heavens*

Chapter III (p. 64)

Charles Scribner's Sons. New York, New York, USA. 1922

**Herschel, Friedrich Wilhelm (Sir William)** 1738–1822

English astronomer

The light of the sun itself has been supposed invisible and not to be perceived except by reflection, though the proofs seem to me to amount to no more than saying that we cannot see when rays of light do not enter the eye. But it is time now to profit by the observations we are in possession of.

On the Nature and Contraction of the Sun and Fixed Stars

*Philosophical Transactions of the Royal Society of London*,

Volume 85, 1795 (p. 48)

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

The sun's rays are the ultimate source of almost every motion which takes place on the surface of the earth. By its heat are produced all winds.... By their vivifying action vegetables are elaborated from inorganic matter, and become, in their turn, the support of animals and of man, and the sources of those great deposits of dynamical efficiency which are laid up for human use in our coal strata.

*Outlines of Astronomy*

Chapter VI (p. 211)

Blanchard & Lea. Philadelphia, Pennsylvania, USA. 1853

## SUNSPOT

**Birrell, Augustine** 1850–1933

English author and politician

The sun is not all spots.

*Obiter Dicta* Second Series

John Milton

Elliot Stock. London, England. 1884

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

Neither the satellites of Jupiter nor any other stars are spots or shadows, nor are the sunspots stars. It is indeed true that I am quibbling over names, while I know that anyone may impose them to suit himself. So long as a man does not think that by names he can confer inherent and essential properties on things, it would make little difference whether he calls these "stars."

Translated by Stillman Drake

*Discoveries and Opinions of Galileo*

Letters on Sunspots, Third Letter on Sunspots, From Galileo Galilei to

Mark Welser (p. 139)

Doubleday & Company, Inc. New York, New York, USA. 1957

**Harris, John** 1667?–1719

No biographical data available

Spots! Said she, What, are there Spots in the Sun, which sometimes appear there, and sometimes not; for God's sake what are those Spots?

*Astronomical Dialogues Between a Gentleman and a Lady* (p. 74)  
Printed by T. Wood for Benj. Cowse. London, England. 1719

The spots have been supposed to be solid bodies, the smoke of volcanoes, the scum floating on an ocean of fluid matter, clouds, opaque masses, and to be many other things.

On the Nature and Contraction of the Sun and Fixed Stars  
*Philosophical Transactions of the Royal Society of London*, Volume 85  
1795 (p. 47)

**Horrocks, Jeremiah** 1618–41  
English astronomer

Hail! then, ye eyes that penetrate the inmost recesses of the heavens, and gazing upon the bosom of the sun with your sight-assisting tube, have dared to point out the spots on that eternal luminary !

In R. A. Proctor  
Past and Coming Transits of Venus  
*The Cornhill Magazine*, Volume 31, January 1875 (p. 93)

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Come, cheer up, old man; there's no use in losing your grip and going back to this child's play merely because this big sunspot is drifting across your shiny new disk.

*Pudd'n'head Wilson*  
Chapter XX (p. 182)  
Harper & Brothers Publishers. New York, New York, USA. 1922

**Zirin, Harold**  
Astrophysicist

Just like the green fields and virgin forests, the granules, the sunspots, the elegant prominences reflect the pure beauty of nature. They offer aesthetic pleasure, as well as scientific challenge, to those who study them.

*Astrophysics of the Sun*  
Preface (p. ix)  
Cambridge University Press. Cambridge, England. 1988

## SUNRISE

**Thackeray, William Makepeace** 1811–63  
English writer

And lo! in a flash of crimson splendour, with blazing scarlet clouds running before his chariot, and heralding his majestic approach, God's sun rises upon the world ...

*The Kickleburys on the Rhine*  
The Sea of Rocks and the Giant's Pillar (p. 114)  
Printed for Charles Jugel. Frankfurt, Germany. 1851

## SUNSET

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

The sky was as a shield that caught the stain  
Of blood and battle from the dying sun ...

In Robert Ross (ed.)  
*Complete Works of Oscar Wilde*  
*Ravenna*  
The Wymann-Fogg Co. Boston, Massachusetts, USA. 1909

## SUPERCONDUCTOR

“Don't you see?” said the Professor. “It's a superconductor.”

“But that's incredible!” Dr. Fenster said. “At room temperature?”

“So it appears. There's no other explanation.”

“A superconductor?” Danny put in. “What's that?”

*Danny Dunn and the Swamp Monster*  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1971

## SUPERNATURAL

**Gray, Asa** 1810–88  
American botanist

...I do not approve either the divinity or the science of those who are prompt to invoke the supernatural to cover our ignorance of natural causes ...

*Natural Science and Religion, 2 Lectures*  
Lecture 2 (p. 100)  
Charles Scribner's Sons. New York, New York, USA. 1880

**Jordan, David Starr** 1851–1931  
American scientist and university administrator

The creation of man or the growth of a state is as natural as the formation of an apple or the growth of a snow-bank. All are alike supernatural, for they all rest on the huge unseen solidity of the universe, the imperishability of matter, the conservation of energy, and the immanence of law.

*Evolution and Animal Life*  
Chapter I (p. 9)  
D. Appleton & Co. New York, New York, USA. 1907

## SUPERNOVA

**Crowley, Abraham** 1618–67  
English poet

So when by various Turns of the Celestial Dance,  
In many thousand years,  
A Star, so long unknown, appears,  
Though Heaven itself more beauteous by it grow,  
It troubles and alarms the World below,  
Does to the Wise a Star, to Fools a Meteor show.

In Thomas Sprat  
*The History of the Royal-Society of London for Improving of Natural Knowledge*  
To the Royal Society  
Printed for A. Millar. London, England. 1756–1757

**Schaaf, Fred**

No biographical data available

...a star gone to seed – a star spectacularly sowing space with heavy elements and the promise of new stars, worlds, life, and eyes.

*The Starry Room: Naked Eye Astronomy in the Intimate Universe*  
Chapter 11 (p. 194)  
John Wiley & Sons, Inc. New York, New York, USA. 1988

**Wosley, Stan**

No biographical data available

**Weaver, Tom**

No biographical data available

The collapse and explosion of a massive star is one of nature's grandest spectacles. For sheer power nothing can match it. During the supernova's first 10 seconds... it radiates as much energy from a central region 20 miles across as all the other stars and galaxies in the rest of the visible universe combined.... It is a feat that stretches even the well-stretched minds of astronomers.

The Great Supernova of 1987  
*Scientific American*, Volume 261, Number 2, August, 1989 (p. 32)

**SUPERPOSITION****Laurance, John**

No biographical data available

It is the uniformity of superposition, the invariable order of succession, sometimes disturbed but never inverted, on which Geology depends as a practical science ...

*Geology in 1835* (p. 13)  
Simpkin, Marshall, & Co. London, England. 1835

**SUPERSTITION****Gell-Mann, Murray** 1929–

American physicist

Unscientific approaches to the construction of models of the world around us have characterized much of human thinking since the time immemorial, and they are still widespread. Take, for example, the version of sympathetic magic based on the idea that similar things must be connected. It seems natural to many people around the world that, when in need of rain, they should perform a ceremony in which water is procured and poured on the ground.

*The Quark and the Jaguar: Adventures In the Simple and the Complex*  
(p. 89)  
W.H. Freeman & Company. New York, New York, USA. 1994

**Bridgman, Percy Williams** 1882–1961

American physicist

Freedom from superstition is the result of the conviction that the world is not governed by caprice, but that it is a

world of order and can be understood by man if he will only try hard enough and be clever enough.

*Reflections of a Physicist*  
Chapter 10 (p. 167)  
Philosophical Library. New York, New York, USA. 1955

**Bürgel, Bruno Hans** 1875–1948

German astronomer

Superstition that extraordinarily rank weed, has struck strong roots in the very depths of human nature. Man, so little able after all to control the course of events and his own destiny, is again and again forced to recognise that he is but a toy in the hand of something so vast, so incomprehensible and so unknowable that it cannot be conceived or included as a unit in life's formula.

Translated by Stella Bloch  
*Astronomy for All*  
Chapter VIII (p. 76)  
Cassell & Co., Ltd. London, England. 1911

**de Gubernatis, Angelo**

No biographical data available

Nothing clings more to the earth, nothing is more vegetative, than a superstition.

*Zoological Mythology; or, The Legends of Animals* (Volume 1)  
Preface (p. xi)  
Trübner & Co. London, England. 1872

**Froude, James Anthony** 1818–94

English historian and biographer

The superstition of science scoffs at the superstition of faith.

*Short Studies on Great Subjects* (Volume 1)  
The Lives of the Saints (p. 575)  
Longmans, Green & Co. London, England. 1873

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

...the beauty of the universe and the order of celestial things force us to recognize some superior nature which ought to be remarked and admired by the human race. But as far as it is proper to propagate religion, which is joined to the knowledge of nature, so far it is necessary to work toward the extirpation of superstition, for it torments one, importunes one, and pursues one continually and in all places.

*A Philosophical Essays on Probabilities*  
Chapter XVI (p. 174)  
Dover Publications, Inc. New York, New York, USA. 1951

**Marsh, Othniel Charles** 1831–99

American paleontologist

In a superstitious age, when every natural event is referred to a supernatural cause, science cannot live; and often as the sacred fire may be kindled by courageous

farseeing souls, will it be quenched by the dense mist of ignorance around it.

History and Methods of Palaeontological Discoveries  
*Nature*, Volume 20, September 18, 1879 (p. 498)

**van Sloan, Edward** 1882–1964  
American actor

Superstition? Who can define the boundary line between the superstition of yesterday and the scientific fact of tomorrow?

*Dracula's Daughter*  
Film (1936)

**Mellor, Joseph William** 1863–1938  
Chemist

The mists of superstition are always dissipated as positive knowledge extends into wider and wider fields.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry*  
(Volume I)  
Chapter I (p. 2)  
Longman, Green & Co. London, England. 1922

## SUPERSTRING

**Dyson, Freeman J.** 1923–  
American physicist and educator

Superstrings and butterflies are examples illustrating two different aspects of the universe and two different notions of beauty. Superstrings come at the beginning and butterflies at the end because they are extreme examples. Butterflies are at the extreme of concreteness, superstrings at the extreme of abstraction. They mark the extreme limits of the territory over which science claims jurisdiction. Both are, in their different ways, beautiful. Both are, from a scientific point of view, poorly understood. Scientifically speaking, a butterfly is at least as mysterious as a superstring....

*Infinite in All Directions*

Part One, Chapter Two (p. 14)  
HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Ginsparg, Paul**  
American physicist

**Glashow, Sheldon** 1932–  
American physicist

Contemplation of superstrings may evolve into an activity as remote from conventional particle physics as particle physics is from chemistry, to be conducted at schools of divinity by future equivalents of medieval theologians. For the first time since the Dark Ages, we can see how our noble search may end, with faith replacing science once again.

Desperately Seeking Superstrings?  
*Physics Today*, May, 1986

In lieu of the traditional confrontation between theory and experiment, superstring theorists pursue an inner harmony where elegance, uniqueness and beauty define truth. The theory depends for its existence upon magical coincidences, miraculous cancellations and relations among seemingly unrelated (and possibly undiscovered) fields of mathematics.

Desperately Seeking Superstrings?  
*Physics Today*, May, 1986 (p. 7)

## SUPPOSITION

**Stoney, George Johnstone** 1826–1911  
Irish physicist

A theory is a supposition which we hope to be true, a hypothesis is a supposition which we expect to be useful; fictions belong to the realm of art; if made to intrude elsewhere, they become either make believes or mistakes.

In Sir William Ramsay  
*Essays Biographical and Chemical*  
*Chemical Essays*  
Radium and Its Products (p. 179)  
Archibald Constable & Company Ltd. London, England. 1908

## SURFACE TENSION

**Roth, V. Louise**  
American zoologist

You may have inner tranquility, but you can't escape surface tension.

In Steven Vogel  
*Life's Devices: The Physical World of Animal and Plants*  
Chapter 5 (p. 82)  
Princeton University Press. Princeton, New Jersey, USA. 1988

## SURGEON

### Author undetermined

A good surgeon must have an eagle's eye, a lion's heart, and a lady's hand.

In John Timbs  
*Doctors and Patients, or, Anecdotes of the Medical World and Curiosities of Medicine* (Volume 2) (p. 155)  
Richard Bentley & Son. London, England. 1873

A Probe in the hands of a dirty or rough surgeon is like a loaded pistol in the paw of a monkey.

Items of Interest  
*Medical Review*, Volume XXV, Number 7, July, 1892 (p. 133)

**Aylett, Robert** 1583–1655?  
Religious poet

For Mercy doth like skillful Surgeon deal,  
That hath for ev'ry sore a remedy:  
If gentle drawing plaisters cannot heal

The wound, because it festreth inwardly,  
 He sharper corrasives must then apply,  
 And as he oft cuts off some member dead,  
 Or rotten, lest the rest should putrifie,  
 So Mercy wicked Members off doth shred,  
 Lest they should noysome prove to body and the head.  
*Peace with Her Foure Gardners*  
 The Brides Ornaments, Meditation III, l. 307–315

### Caldwell, George W.

No biographical data available

Who is the man in sterile white  
 Delving deep at the point of light,  
 With nurses, trained, at left and right?  
*Poet Physician: An Anthology of Medical Poetry Written by Physicians*  
 The Surgeon (p. 136)  
 C.C. Thomas. Springfield, Illinois, USA. 1945

### Carnochan, John Murray 1817–87

American surgeon

While respect for life will dictate to the surgeon the greatest prudence – will counsel him to attempt no operation which he would not be willing to perform on his own child – it will also teach him, that if the extremes of boldness are to be shunned, pusillanimity is not the necessary alternative.

*Contributions to Operative Surgery and Surgical Pathology*  
 Preface  
 Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1857

### Celsus, Aulus Cornelius fl. 14 AD

Roman medical writer

A surgeon ought to be young, or at any rate, not very old; his hand should be firm and steady, and never shake; he should be able to use his left hand with as much dexterity as his right; his eye-sight should be acute and clear; his mind intrepid, and so far subject to pity as to make him desirous of the recovery of his patient, but not so far as to suffer himself to be moved by his cries; he should neither hurry the operation more than the case requires, nor cut less than is necessary, but do everything just as if the other's screams made no impression upon him.

In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 30)  
 The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

### Crichton-Browne, Sir James 1840–1938

English physician

“Oh, sir, we made a terrible mistake in the case of that man yesterday! We amputated the wrong leg!”

“Ah well,” the surgeon replied, complacently, “it’s of no consequence, for I have just been looking at the other leg, and it’s going to get better.”

*The Doctor’s After Thoughts* (p. 15)  
 E. Benn Ltd. London, England. 1932

Every great surgeon, it used to be said, shakes, swears or sweats when he operates.

*The Doctor Remembers*  
 Bret Harte (p. 170)  
 Duckworth & Company. London, England. 1938

### Croll, Oswald 1560–1609

German chemist and physician

...it is necessary that every Surgeon should be a Physitian, and every Physitian a Chyrugion, that there may be a sound Bridegroom for a sound Bride...

*Philosophy Reformed and Improved in Four Profound Tractates* (p. 151)  
 Printed by M.S. for Lodowick Lloyd. London, England. 1657

### Cvikota, Raymond J.

No biographical data available

Surgeon: Fee lancer.

*Quote, the Weekly Digest*, June 9, 1968 (p. 457)

### da Costa, J. Chalmers 1863–1933

American physician

A vain surgeon is like a milking stool; of no use except when sat upon.

*The Trials and Triumphs of the Surgeon* (p. 17)  
 Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

A surgeon is like a postage stamp. He is useless when stuck on himself.

*The Trials and Triumphs of the Surgeon* (p. 17)  
 Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

### Davies, Robertson 1913–95

Canadian novelist

A man mentioned casually to me this afternoon that his brother was in a hospital, having his appendix removed. This operation is now undertaken without qualm; surgeons regard it as a pastime, something to keep the hands busy, like knitting or eating salted nuts.

*The Table Talk of Samuel Marchbanks* (p. 176)  
 Clarke, Irwin. Toronto, Ontario, Canada. 1949

### de Balzac, Honoré 1799–1850

French novelist

The glory of a surgeon is like that of an actor: they live only so long as they are alive, and their talent leaves no trace when they are gone. Actors and Surgeons, like great singers too, like the executants who by their performance increase the power of music tenfold, are all the heroes of a moment.

*The Works of Honoré de Balzac*  
*The Atheist’s Mass* (p. 379)  
 Avil Publishing Co. Philadelphia, Pennsylvania, USA. 1901

### de Chauliac, Guy

No biographical data available

The surgeon should be learned, skilled, ingenious, and of good morals. Be bold in things that are sure, cautious in

dangers; avoid evil cures and practices; be gracious to the sick, obliging to his colleagues, wise in his predictions. Be chaste, sober, pitiful, and merciful; not covetous nor extortionate of money, but let the recompense be moderate, according to the work, the means of the sick, the character of the issue or event, and its dignity.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 262)  
The S. E. Massengill Company. Bristol, Tennessee, USA. 1943

**de Mondeville, Henri** 1260–1320

French pioneer surgeon

The surgeon should be fairly audacious [yet] he should operate with prudence and sagacity; he should never commence perilous operations unless he has provided everything in order to avoid danger; ...he should not sing his own praises; he should not cover his colleagues with blame; he should not cause envy among them; he should work always with the idea of acquiring a reputation of probity; he should be reassuring to his patients by kind words and acquiesce to their requests when nothing harmful will result from them as to their cure.

In C.G. Cumston

Henry de Mondeville, the Man and His Writings, with Translations of Several Chapters of His Works  
*Buffalo Medical Journal*, Volume 42, 1903

A Surgeon ought to be fairly bold. He ought not to quarrel before the laity, and although he should operate wisely and prudently, he should never undertake any dangerous operation unless he is sure that it is the only way to avoid a greater danger. His limbs, and especially his hands, should be well shaped with long, delicate and supple fingers which must not be tremulous.

In John Arderne

*Treatise of Fistula in Ano* (p. xx)

**Dickens, Charles** 1812–70

English novelist

What! don't you know what a Sawbones is, Sir? inquired Mr. Weller. I thought everybody know'd as a Sawbones was a Surgeon.

*The Posthumous Papers of the Pickwick Club*

Chapter XXX (p. 348)

Dodd, Mead & Company. New York, New York, USA. 1944

**Dickinson, Emily** 1830–86

American lyric poet

Surgeons must be very careful  
When they take the knife!  
Underneath their fine incisions  
Stirs the Culprit, – Life!

*The Complete Poems of Emily Dickinson*

No. 108 (p. 52)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Dimmick, Edgar L.**

No biographical data available

The public views his *status regas*,  
In the profession he's "The Eagle."  
With super-supple fingers slim  
(Pus, blood, and guts don't bother him),  
Up to his elbows, filled with glee,  
With snick and slice sadistically,  
Into a jar, up on a shelf  
He puts a fragment of yourself.  
For him no diagnostic doubt –  
He'll operate, and so find out.

The In-Side of Two

*Journal of the American Medical Association*, Volume 199, Number 6,  
1967 (p. 274)

**Dunlap, William** 1766–1839

American dramatist and theatrical manager

There is hardly on the face of the earth a less enviable situation than that of an Army Surgeon after a battle...

*Recollection of the American War, 1812–1814*

Chapter III (p. 54)

Historical Publishing Company. Toronto, Ontario, Canada. 1906

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

The wounded surgeon plies the steel  
That questions the distempered part;  
Beneath the bleeding hands we feel  
The sharp compassion of the healer's art  
Resolving the enigma of the fever chart.

*The Collected Poems and Plays 1909–1950*

East Coker, Part IV (p. 127)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Findley, Thomas**

Physician

The surgeon...is a man of action. He lives in an exhilarating world of knives, blood, and groans. His tempo is of necessity rapid. He is inclined to look at his less kinetic colleague with an air of puzzled condescension but may, in a relaxed moment, admit that the medical man is occasionally able to assist uncomfortable dowagers in the selection of a cathartic.

The Obligations of an Internist to a General Surgeon

*Surgery*, Volume 16, 1944 (p. 557)

**Gilbertus, Anglicus**

No biographical data available

Why in God's name is there such a great difference between a physician and a surgeon?

Surgery

*Time*, May 3, 1963 (p. 44)



**Gogarty, Oliver St. John** 1878–1957  
Irish author

Let Surgeon MacCardle confirm you in Hope.  
A jockey fell off and his neck it was broke.  
He lifted him up like a fine, honest man;  
And he said “He is dead; but I’ll do all I can.”

*The Collected Poems of Oliver St. John Gogarty*  
The Three (p. 109)  
Constable. London, England. 1951

**Gross, S. D.** 1805–84  
American emeritus professor of surgery

It is impossible for any man to be a great surgeon if he is destitute...of the finer feelings of our nature.... I do not think that it is possible for a criminal to feel much worse the night before his execution than a surgeon when he knows that upon his skill and attention must depend the fate of a valuable citizen, husband, father, mother or child. Surgery under such circumstances is a terrible task master, feeding like a vulture upon a man’s vitals.

*Autobiography of Samuel D. Gross, MD.* (p. 172)  
George Barrie. Philadelphia, Pennsylvania, USA. 1887

**Hazlitt, William Carew** 1834–1913  
English bibliographer

An ignorant drunken Surgeon that kil’d all men that came under his hands, boasted himself a better man than the Parson; for, said he, your Cure maintains but yourself, but my Cures maintaine all the Sextons in the Towne.

*Shakespeare Jest Books* (Volume 3)  
Conceit, Clichés, Flashes and Whimzies, Number 163  
Willis & Sotheran. London, England. 1864

**Helmuth, William Tod** 1833–1902  
American physician

...doctors are the Devil’s progeny,  
While surgeons come directly down from God!

*Scratches of a Surgeon*  
Surgery vs. Medicine (p. 66)  
W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Jones J.**  
No biographical data available

It might...be of singular advantage to young surgeons, particularly before they begin an operation to go through every part of it attentively in their own minds to consider every possible accident which may happen and to have the proper remedies at hand in case they should; and in all operations of delicacy and difficulty to act with deliberation...

*Plain, concise, practical remarks on treatment of wounds and fractures; to which is added, a short appendix on camp and military hospitals; principally designed for the use of young military surgeons in North America* (pp. 39–40)  
John Holt. New York, New York, USA. 1775

**Judson, Adoniram Brown**  
American physician

The confident surgeon is like a military captain who by a well-timed advance changes defeat into victory, returning with the priceless trophy of life and health.

*The Influence of Growth on Congenital and Acquired Deformities*  
Chapter III (p. 66)  
William Wood & Co. New York, New York, USA. 1905

**Kafka, Franz** 1883–1924  
German-language novelist

That is what people are like in my district. Always expecting the impossible from the doctor. They have lost their ancient beliefs; the parson sits at home and unravels his vestments, one for another; but the doctor is supposed to be omnipotent with his merciful surgeon’s hands. Well, as it pleases them; I have not thrust my services on them...

*The Complete Stories*  
*A Country Doctor* (p. 224)  
Schocken Books. New York, New York, USA. 1971

**Macleane, David**  
American physician

The ophthalmologist or the gynecologist who is not a general surgeon is like a sailor whose powers as a navigator are confined only to one side of his ship.

*Observations on the Progress of Surgery in Our Own Day*  
*The Physician and Surgeon*, Volume XIV, Number 11, November, 1892 (p. 484)

**Massinger, Philip** 1583–1640  
English dramatic poet

WELL.: Thou wert my surgeon; you must tell no tales;  
Those days are done.

I will pay you in private.  
*A New Way to Pay Old Debts*  
Act IV, Scene II (p. 123)

**Ogilvie, Sir Heneage** 1887–1971  
English physician

A surgeon conducting a difficult case is like the skipper of an ocean-going racing yacht. He knows the port he must make, but he cannot foresee the course of the journey.

*A Surgeon’s Life*  
*The Lancet*, Volume 255, July 3, 1948 (p. 1)

**Paretsky, Sara** 1947–  
American author

Heart surgeons do not have the world’s smallest egos: when you ask them to name the world’s three leading practitioners, they never can remember the names of the other two.

In Marilyn Wallace (ed.)  
*Sisters in Crime* (Volume 1)  
 The Case of the Pietro Andromache II (p. 116)  
 Berkley Books. New York, New York, USA. 1989

### Ross, J. F. W.

American physician

The surgeon is, like the actor, set for a part either in the comedy or tragedy of life. Some seem set in tragedy so frequently that they should give up surgery and try medicine. Others seem eternally set for comedy without any intermixture of the tragedy. These men conceal the truth and mislead their audiences.

Personal Experience With Pus Tubes  
*The American Practitioner and News*, Volume VII, 1894 (p. 245)

### Selzer, Richard 1928–

American physician and essayist

In the operating room the patient must be anaesthetized in order that he or she feel no pain. The surgeon too must be anaesthetized, insulated against the emotional heat of the event so that he can perform this act of laying open the body of a fellow human being, which, take away the purpose for which it is being done, is no more than an act of assault and battery. A barbaric act. So the surgeon dons a carapace which keeps him from feeling. It is what gives many surgeons the appearance of insensitivity.

Speech  
 Humanities Symposium, Dalhousie University, 1991

### Shadwell, Thomas 1642?–92

English dramatist and poet

Oh this Surgeon! this damn'd Surgeon, will this Villainous Quack never come to me? Oh this Plaster on my Neck! It gnaws more than Aqua-Fortis: this abominable Rascle has mistaken sure, and given me the same Cautstick he appli'd to my Shins, when they were open'd last.

*The Complete Works of Thomas Shadwell* (Volume 1)  
*The Humorists*, The First Act (p. 193)  
 The Fortune Press. London, England. 1927

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

It is a gratification to me to know that I am ignorant of art, and ignorant also of surgery. Because people who understand art find nothing in pictures but blemishes, and surgeons and anatomists see no beautiful women in all their lives, but only a ghastly stack of bones with Latin names to them, and a network of nerves and muscles and tissues.

*Mark Twain's Travels with Mr. Brown*  
 Academy of Design (p. 238)  
 Alfred A. Knopf. New York, New York, USA. 1946

## SURGERY

### Clendening, Logan 1884–1945

No biographical data available

Surgery does the ideal thing – it separates the patient from his disease.

*Modern Methods of Treatment*  
 Part I, Chapter I (p. 17)  
 The C.V. Mosby Company. St. Louis, Missouri, USA. 1924

### Dennis, F. S.

No biographical data available

There is no science that calls for greater fearlessness, courage, and nerve than that of surgery, none that demands more of self-reliance, principle, independence and the determination in the man. These were the characteristics which were chiefly conspicuous in the early settlers of this country. And it is these old-time Puritan qualities, which descending to them in succeeding generations, have passed into surgeons of America, giving them boldness in their art, and enabling them to win that success in surgery, which now commands the admiration of the civilized world.

Address  
 The History and Development of Surgery during the Past Century,  
 International Congress of Arts and Sciences  
 St. Louis, Missouri, September, 1904

### Fenger, Carl Emil 1814–84

Danish physician and politician

We must naturally ask ourselves: Does suffering humanity gain anything by this operation? or, in other words, Does the operation enable us to save, or only to prolong, life, and is it worthwhile for patients having uterine cancer to undergo this severe operation?

The Total Extirpation of the Uterus Through the Vagina  
*American Journal of Medical Science*, Volume 83, January, 1883 (p. 45)

### Giles, Roscoe C.

No biographical data available

It cannot be too often emphasized, however, that the post-operative treatment is as essential as the operation, and the surgeon is as much responsible for the post-operative treatment as for the operation.

Rickets, the Surgical Treatment of the Chronic Deformities of, with Emphasis on Bow-Legs and Knock-Knees  
*Journal of the National Medical Association*, Volume 14, 1922

### Helmuth, William Tod 1833–1902

American physician

There is not one man in a hundred outside of the medical profession, and scarcely one man in ten in it, who understands and appreciates the marvels of modern surgery.

*Scratches of a Surgeon*  
 Some of the Wonders of Modern Surgery (p. 42)  
 W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Hippocrates** 460 BCE–377 BCE  
Greek physician

The prime object of the physician in the whole art of medicine should be to cure that which is diseased; and if this can be accomplished in various ways, the least troublesome should be selected; for this is more becoming a good man, and one well skilled in the art, who does not covet popular coin of base alloy.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*

On the Articulations, 78 (p. 119)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The things relating to surgery, are – the patient; the operator; the assistants; the instruments; the light, where and how; how many things, and how; where the body, and the instruments; the time; the manner; the place.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On the Surgery, 2 (p. 70)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hubbard, Elbert** 1856–1915  
American editor, publisher, and author

**SURGERY:** An adjunct, more or less valuable to the diagnostician.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 143)

The Roycrofters. East Aurora, New York, USA. 1914

**Johnson, Ernest**  
No biographical data available

[Back fusions are] like killing a fly on a windowpane with a sledgehammer. The fly is dead, but you've also broken the glass.

That Aching Back

*Time*, 14 July 1980 (p. 34)

**Jones J.**  
No biographical data available

The exterior of this science, has nothing pleasing or attractive in it, but is rather disgusting to nice, timid, and delicate persons; Its objects too, except in time of war, lying chiefly among the poor and lower classes of mankind, do not excite the industry of the ambitious or avaricious, who find their best account among the rich and great.

*Plain, concise, practical remarks on treatment of wounds and fractures; to which is added, a short appendix on camp and military hospitals; principally designed for the use of young military surgeons in North America* (pp. ii–iii)

John Holt. New York, New York, USA. 1775

**Kirklin, John** 1917–2004  
American cardiovascular surgeon

Surgery...is always second best. If you can do something else, it's better. Surgery is limited. It is operating on someone who has no place else to go.

Surgery

*Time*, May 3, 1963 (p. 60)

**Mayo, William J.** 1861–1939  
American physician

Surgery is more a matter of mental grasp than it is of handicraftsmanship.

Master Surgeons of America; Frederic S. Dennis

*Surgery, Gynecology and Obstetrics*, Volume 67, October, 1938

**Ogilvie, Sir Heneage** 1887–1971  
English physician

Surgery thus attracts the man whose interest in medicine is humanitarian rather than scientific, who loves his fellow men, who wishes to help them and to see that his help is effective. It appeals to the craftsman who enjoys the use of his hands, to the artist whose mind works on visual images, to the romantic who enjoys the drama of life, particularly when it affords him the opportunity to play a decisive role, to the extrovert.

A Surgeon's Life

*The Lancet*, Volume 255, July 3, 1948 (p. 1)

**O'Malley, Austin** 1858–1932  
American physician and humorist

**Surgery:** by far the worst snob among the handicrafts.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#5724 (p. 322)

Harper & Row, Publishers. New York, New York, USA. 1969

**Ovid** 43 BCE–17 AD  
Roman poet

But that which is incurable must be cut away with the knife, lest the untainted part also draw infection.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 1)

Book I, l. 190–191 (p. 15)

William Heinemann. London, England. 1916

**Selzer, Richard** 1928–  
American physician and essayist

One enters the body in surgery, as in love, as though one were an exile returning at last to his hearth, daring uncharted darkness in order to reach home.

*Mortal Lessons*

The Surgeon as Priest (p. 25)

Simon & Schuster. New York, New York, USA. 1976

...surgery is the red flower that blooms among the leaves and thorns that are the rest of Medicine.

*Letters to a Young Doctor*

Letter II (p. 510)

Simon & Schuster, Inc. New York, New York, USA. 1982

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

We do not go to the operating table as we go to the theatre, to the picture gallery, to the concert room, to be entertained and delighted; we go to be tormented and

maimed, lest a worse thing should befall us.... The experts on whose assurance we face this horror and suffer this mutilation should have no interests but our own to think of; should judge our cases scientifically; and should feel about them kindly.

*The Doctor's Dilemma*

Preface on Doctors

Psychology of Self Respect in Surgeons (p. xxii)

Brentano's. New York, New York, USA. 1920

The notion that therapeutics or hygiene or surgery is any more or less scientific than making or cleaning boots is entertained only by people to whom a man of science is still a magician who can cure diseases, transmute metals, and enable us to live forever.

*The Doctor's Dilemma*

Preface on Doctors

The Technical Problem (p. lxxxii)

Brentano's. New York, New York, USA. 1920

**Sigerist, Henry E.** 1891–1957

German-born medical historian

Ignorance is more immediately fatal in surgery than in medicine, or rather, mistakes are more easily apparent to the layman.

*A History of Medicine* (Volume 2)

Chapter III, Section 1 (p. 203)

Oxford University Press, Inc. New York, New York, USA. 1961

**Yeo, R.**

No biographical data available

The work was in a moment done.

If possible, without a groan:

So swift thy hand, I could not feel

The progress of the cutting steel....

For quicker e'en than sense, or thought,

The latent ill view was brought;

And I beheld with ravish'd eyes,

The cause of all my agonies.

And above all the race of men,

I'll bless my GOD for Cheselden.

The Grateful Patient

*Gentlemen's Magazine*, Volume 2, 1732 (p. 769)

## SURPRISE

**Faraday, Michael** 1791–1867

English physicist and chemist

Let us now consider, for a little while, how wonderfully we stand upon this world. Here it is we are born, bred, and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. So small, indeed, is our wonder, that we are never taken by surprise.

*On the Various Forces of Nature and Their Relations to Each Other: A Course of Lectures Delivered Before a Juvenile Audience at the Royal*

*Institution*

Lecture 1 (p. 14)

George Routledge & Sons. New York, USA. 1874

**Kearton, Richard** 1862–1928

English naturalist

Among the greatest delights of natural history are its surprises.

*Wild Nature's Ways*

Chapter 2 (p. 53)

Cassell & Co., Ltd. London, England. 1903

**Planck, Max** 1858–1947

German physicist

...compared with immeasurably rich, ever young Nature, advanced as man may be in scientific knowledge and insight, he must forever remain the wondering child and must constantly be prepared for new surprises.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part IV (p. 117)

Philosophical Library. New York, New York, USA. 1949

**Thomas, Lewis** 1913–93

American physician and biologist

The safest and most prudent of bets to lay money on is surprise. There is a very high probability that whatever astonishes us in biology today will turn out to be useable, and useful, tomorrow.

*The Medusa and the Snail: More Notes of a Biology Watcher*

Medical Lessons from History (p. 172)

The Viking Press. New York, New York, USA. 1979

**Watson, Sir William** 1858–1935

English author of lyrical and political verse

Strange the world about me lies,

Never yet familiar grown – Still disturbs me with surprise,

Haunts me like a face half known.

*The Poems of William Watson*

World Stangeness

The Macmillan Company. New York, New York, USA. 1893

## SURVEY

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

A perfect survey is a myth.

*Some Theory of Sampling* (p. 24)

John Wiley & Sons, Inc. New York, New York, USA. 1950

A questionnaire is never perfect: some are simply better than others.

*Some Theory of Sampling* (p. 31)

John Wiley & Sons, Inc. New York, New York, USA. 1950

The only excuse for taking a survey is to enable a rational decision to be made on some problem that has arisen and

on which decision, right or wrong, will be made.

*Some Theory of Sampling* (p. 545)

John Wiley & Sons, Inc. New York, New York, USA. 1950

### Deutscher, I.

No biographical data available

...neither the interviewer nor the instrument should act in any way upon the situation. The question, ideally, should be so put and so worded as to be unaffected by contextual contaminations. The interviewer must be an inert agent who exerts no influence or response by tone, expression, stance, or statement. The question must be unloaded in that it does not hint in any way that one response is more desirable or more correct than any other response. It must be placed in the sequence of the instrument in such a way that the subject's response is not affected by previous queries or by his own previous responses.

In S.Z. Nagi and R.G. Corwin

*The Social Contexts of Research*

Public and Private Opinions: Social Situations and Multiple Realities

(p. 325)

John Wiley & Sons, Inc. New York, New York, USA. 1972

### Fisher, Sir Ronald Aylmer 1890–1962

English statistician and geneticist

No aphorism is more frequently repeated with field trial, than that we must ask Nature few questions or, ideally, one question at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logical and carefully thought out questionnaire; indeed, if we ask her a single question, she will often refuse to answer until some other topic has been discussed.

*Journal of the Ministry of Agriculture of Great Britain*, Volume 33

(p. 511)

### Heinlein, Robert A. 1907–88

American science fiction writer

But what is the purpose of your survey? he asked.

“Does it need a purpose? I tell you, I just made it up.”

“But your numbers are too few to be significant. You can't fair a curve with so little data. Besides, your conditions are uncontrolled. Your results don't mean anything.”

*Beyond this Horizon*

Chapter One (p. 2)

Gregg Press. Boston, Massachusetts, USA. 1981

### Hickson, Sydney John 1859–1940

Zoologist

The time may come when there will be no portion of the earth's surface that has not been surveyed and explored by man.

*The Fauna of the Deep Sea*

Preface (p. vii)

Kegan Paul, Trench, Turbner & Co. London, England. 1894

### Norton, John K.

No biographical data available

The time of busy people is sometimes wasted by time-consuming questionnaires dealing with inconsequential topics, worded so as to lead to worthless replies, and circulated by untrained and inexperienced individuals, lacking in facilities for summarizing and disseminating any worthwhile information which they may obtain.

In Douglas R. Berdie and John F. Anderson

*Questionnaires: Design and Use* (p. ix)

The Scarecrow Press, Inc. Metuchen, New Jersey, USA. 1974

### Oppenheim, Abraham Naftali 1924–

No biographical data available

A questionnaire is not just a list of questions or a form to be filled out. It is essentially a scientific instrument for measurement and for collection of particular kinds of data. Like all such instruments, it has to be specifically designed according to particular specifications and with specific aims in mind, and the data it yields are subject to error. We cannot judge a questionnaire as good or bad, efficient or inefficient, unless we know what job it was meant to do. This means that we have to think not merely about the wording of particular questions, but first and foremost, about the design of the investigation as a whole.

*Questionnaire Design and Attitude Measurement*

Chapter 1 (pp. 2–3)

Basic Books, Inc. New York, New York, USA. 1966

### Perelman, Sidney Joseph 1904–79

American comic writer

There is nothing like a good, painstaking survey full of decimal points and guarded generalizations to put a glaze like a Sung vase on your eyeballs.

*Keep it Crisp*

Sleepy-Time Extra (p. 173)

Random House, Inc. New York, New York, USA. 1946

### Strong, Lydia

No biographical data available

Your sales last year just paralleled the sales of rum cokes in Rio de Janeiro, as modified by the sum of the last digits of all new telephone numbers in Toronto. So, why bother with surveys of your own market? Just send away for the data from Canada and Brazil.

Sales Forecasting: Problems and Prospects

*Management Review*, September, 1956 (p. 803)

## SURVEYOR

### Everett, Edward 1794–1865

Whig Party politician

The pen of inspiration, ranging all nature and life for imagery to set forth the Creator's power and wisdom, finds them best symbolized in the skill of the surveyor.



*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*  
Mr. Everett's Inaugural Address on Academic Education (p. 91)  
Little, Brown & Co. Boston, Massachusetts, USA. 1857

## SURVIVAL

### Anderson, Clifford N.

No biographical data available

Nature's pattern is one of promiscuous and bountiful production of innumerable forms. Then, instead of making it easy to survive, Nature makes it difficult. Life is a struggle. The species that survive are those that can cope with the environment.

*The Fertile Crescent* (p. 11)  
Sylvester Press. Fort Lauderdale, Florida, USA. 1972

### Arnold, Sir Edwin 1832–1904

English poet

How lizard fed on ant, and snake on him,  
And kite on both; and how the fish-hawk robbed  
The fish-tiger of that which it had seized;  
The shrike chasing the bulbul, which did chase  
The jeweled butterflies; till everywhere  
Each slew a slayer and in turn was slain,  
Life living upon death.

*Edwin Arnold's Poetical Works* (Volume 1)  
The Light of Asia, Book the First (p. 21)  
Roberts Brothers. Boston, Massachusetts, USA. 1889

### Darwin, Charles Robert 1809–82

English naturalist

What a trifling difference must often determine which shall survive, and which shall perish.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Darwin to Asa Gray, September 5, 1857 (p. 480)  
D. Appleton & Company. New York, New York, USA. 1896

I should premise that I use this term [Struggle for Existence] in a large and metaphorical sense including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny....

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter III (p. 33)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Fort, Charles 1874–1932

American writer

The fittest survive. What is meant by the fittest? Not the strongest; not the cleverest. Weakness and stupidity everywhere survive. There is no way of determining fitness except in that a thing does survive. "Fitness," then, is only another name for "survival."

*The Book of the Damned*  
Chapter III (p. 26)  
Boni & Liveright. New York, New York, USA. 1919

### Sagan, Carl 1934–96

American astronomer and science writer

If we have a profound respect for other human beings as co-equal recipients of this precious patrimony of 4.5 billion years of evolution, why should the identification not apply also to all the other organisms on Earth which are equally the product of 4.5 billion years of evolution? We care for a small fraction of the organisms on Earth – dogs, cats, and cows, for example – because they are useful or because they flatter us. But spiders and salamanders, salmon and sunflowers are equally our brothers and sisters.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 1 (p. 7)  
Dell Publishing, Inc. New York, New York, USA. 1975

### Thomson, Sir John Arthur 1861–1933

Scottish naturalist

The shore is almost noisy with the conjugation of the verb to eat in its many tenses.

*The Outline of Science* (Volume 1)  
Chapter III (p. 117)  
G.P. Putnam's Sons. New York, New York, USA. 1937

### Walker, Marshall John

American physicist

The survival technique of the tyrannosaurus was ferocity; it is extinct. The survival technique of the dodo was passive resistance; it is extinct. The survival technique of man is science...

*The Nature of Scientific Thought*  
Chapter XV (p. 179)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

## SURVIVAL OF THE FITTEST

### Standen, Anthony

Anglo-American science writer

"Survival of the fittest" led to the concept of "nature red in tooth and claw" and this is not sufficiently wishy-washy for modern scientists.

*Science Is a Sacred Cow*  
Chapter IV (p. 107)  
E.P. Dutton. New York, New York, USA. 1950

### Sonneberg, Walter

No biographical data available

The "Survival of the Fittest" means the survival of the survivor.

*Social Eccentricities*  
Social Eccentricities (p. 37)  
Broadway Publishing Co. New York, New York, USA. 1906



**SWAMP**

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Surely one may as profitably be soaked in the juices of a swamp for one day as pick his way dry-shod over sand.

*A Week on the Concord and Merrimack Rivers*

Thursday (p. 139)

James S. Osgood & Co. Boston, Massachusetts, USA. 1873

**SWELLS**

**Burroughs, John** 1837–1921  
American naturalist and essayist

The swells that beat upon the ocean are not the result of a local agitation of the water; the pulse of the earth is in them; the pull of the sun and the moon is in them. They are more cosmic than terrestrial.

*The Heart of Burroughs's Journals*

January, 1920 (p. 328)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**SYMBIOTICISM**

**Wallin, Ivan E.** 1883–1969  
American anatomist

Their universal presence in the cell, coupled with the known properties of bacteria, appear to indicate that mitochondria represent the end adjustment of a fundamental biologic process. The establishment of intimate microsymbiotic complexes has been designated “symbioticism” by the author....

*Symbioticism and the Origin of Species*

Chapter I (p. 8)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

Symbioticism, then is proposed as the fundamental factor or the cardinal principle involved in the origin of species.

*Symbioticism and the Origin of Species*

Chapter I (p. 8)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**SYMBIOSIS**

**de Bary, Anton** 1831–88  
German scientist and physician

Parasitism, mutualism, lichenism, etc., are each special cases of that one general association for which the term symbiosis is proposed as the collective name.

*Vortrag auf der Versammlung der Naturforscher und Ärzte zu Cassel*

Die Erscheinung der Symbiose (p. 21)

Publisher undetermined

**Merezhkovskii, Konstantine** 1855–1921  
Russian biologist

Above all, a plant, an oak for example, is an animal. An enormous animal in which live parasites or rather symbionts, an infinite multitude of small microscopic green organisms, of the species of unicellular “algae,” cyanophyceae.

In Jan Sapp

*Evolution by Association: A History of Symbiosis*

Chapter 4 (p. 47)

Oxford University Press, Inc. New York, New York, USA. 1994

**Pound, Roscoe** 1870–1964  
American jurist

Ethically, there is nothing in the phenomena of symbiosis to justify the sentimentalism they have excited in certain writings. Practically, in some instances, symbiosis seems to result in mutual advantage. In all cases it results advantageously to one of the parties, and we can never be sure that the other would not have been nearly as well off, if left to itself.

*Symbiosis and Mutualism*

*The American Naturalist*, Volume 27, Number 318, June, 1893 (p. 520)

**Sapp, Jan**

No biographical data available

We have located studies of symbiosis peering through the cracks and creeping across the boundaries which separated ecology from evolution, plants from animals, health from disease, nurture from nature, and the individual from the community. In doing so, we have uncovered layers of oppositions, doctrines and disciplines, and diverse phenomena that have led to disparate interpretations of symbiosis, its scope and significance. In summarizing them here, we see that this history is not a matter of peeling off obstacles to come closer to some hidden core of naked truth. Symbiosis is as much like an onion today as it was a century ago.

*Evolution by Association: A History of Symbiosis*

Concluding Remarks (p. 205)

Oxford University Press, Inc. New York, New York, USA. 1994

**SYMBIOTE**

**Portier, Paul** 1866–1922  
French biologist

All Living beings, all animals from Amoeba to Man, all plants from Cryptogams to Dicotyledons are constituted by an association, the “*emboîtement*” of two different beings.

Each living cell contains in its protoplasm formations which histologists designate by the name of “mitochondria.” These organelles are, for me, nothing other than symbiotic bacteria, which I call “symbiotes.”

*Les Symbiotes* (p. vii)

Masson. Paris, France. 1918

**SYMBOL****Author undetermined**

There were the warlike Symbols, who had borne the royal flag through many perilous campaigns; tall people of fight, lordly with plumes and armor. There were the mysterious Surds, the princely Polynomials, and the uneasy Radicals, who were suspected of Red Republicanism ...

The Symbol of Darkness

*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 214)

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

If a lunatic scribbles a jumble of mathematical symbols it does not follow that the writing means anything merely because to the inexperienced eye it is indistinguishable from higher mathematics.

*Men of Mathematics* (p. 232)

Simon & Schuster. New York, New York, USA. 1986

**Bers, Lipman** 1914–93

Mathematician

What is the strength of mathematics? What makes mathematics possible? It is symbolic reasoning. It is like “canned thought.” You have understood something once. You encode it, and then you go on using it without each time having to think about it. Now there may be people who are totally unable to follow symbolic reasoning – just as I am unable to carry a tune (and yet I do say to myself that I enjoy music). So you must try to explain mathematics without using any symbols. But this may be impossible. Without symbolic reasoning you cannot make a mathematical argument.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations*

Lipman Bers (p. 16)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Boole, George** 1815–64

English mathematician

The most accomplished in the use of symbols must sometimes throw aside his abstractions and resort to homelier methods for trial and verification – not doubting, in so doing, the truth which lies at the bottom of his symbolism, but distrusting his own powers.

*A Treatise on Differential Equations* (4th edition)

Preface (p. vii)

Macmillan & Co Ltd. London, England. 1877

**Brodie, Sir Benjamin Collins** 1817–80

English chemist

A symbol, however, should be something more than a convenient and compendious expression of facts. It is, in the strictest sense, an instrument for the discovery of

facts, and is of value mainly with reference to this end, by its adaptation to which it is to be judged.

The Calculus of Chemical Observations

*Philosophical Transactions of the Royal Society of London*, Volume 156, 1866 (p. 857)

**Buchanan, Scott** 1895–1968

American educator and philosopher

Symbols, formulae and proofs have another hypnotic effect. Because they are not immediately understood, they, like certain jokes, are suspected of holding in some sort of magic embrace the secret of the universe, or at least some of its more hidden parts.

*Poetry and Mathematics*

Chapter 1 (p. 37)

The University of Chicago Press. Chicago, Illinois, USA. 1975

Each symbol used in mathematics, whether it be a diagram, a numeral, a letter, a sign, or a conventional hieroglyph, may be understood as a vehicle which someone has used on a journey of discovery.

*Poetry and Mathematics*

Chapter 2 (p. 47)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Butler, James Newton**

No biographical data available

**Bobrow, Daniel Gureasko**

No biographical data available

“When I use a symbol, it means just what I choose it to mean – neither more nor less.”

“The question is, whether you can make symbols mean so many different things?”

“The question is, which is to be master – that’s all.”

*The Calculus of Chemistry*

Chapter 2 (p. 7)

W.A. Benjamin, Inc. New York, New York, USA. 1965

**Chester, Marvin** 1930–

American physicist

Meaning does not reside in the mathematical symbols. It resides in the cloud of thought enveloping these symbols. It is conveyed in words; these assign meaning to the symbols.

*Primer of Quantum Mechanics*

Chapter 1 (p. 2)

Dover Publications. New York, New York, USA. 2003

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The symbol A is not the counterpart of anything in familiar life. To the child the letter A would seem horribly abstract; so we give him a familiar conception along with it.

*The Nature of the Physical World*

Introduction (p. xiv)

The Macmillan Company. New York, New York, USA. 1930

Science aims at constructing a world which shall be symbolic of the world of commonplace experience. It is not at all necessary that every individual symbol that is used should represent something in common experience or even something explicable in terms of common experience. The man in the street is always making this demand for concrete explanation of the things referred to in science; but of necessity he must be disappointed.

*The Nature of the Physical World*

Introduction (p. xv)

Ann Arbor Paperbacks. Ann Arbor, Michigan, USA. 1958

the mind is not content to leave scientific Truth in a dry husk of mathematical symbols, and demands that it shall be alloyed with familiar images. The mathematician, who handles  $x$  so lightly, may fairly be asked to state, not indeed the inscrutable meaning of  $x$  in nature, but the meaning which  $x$  conveys to *him*.

*Space, Time and Gravitation*

Preface (p. vi)

At The University Press. Cambridge, England. 1921

**Flammarion, Camille** 1842–1925

French astronomer and writer

The study of Astronomy is not, as many suppose, the sacrifice of oneself in a cerebral torture that obliterates all the beauty, the fascination, and the grandeur of the pageant of Nature. Figures, and naught but figures, would not be entertaining, even to those most desirous of instruction. Let the reader take courage! We do not propose that he shall decipher the hieroglyphics of algebra and geometry. Perish the thought! For the rest, figures are but the scaffolding, the method, and do not exist in Nature.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 14)

D. Appleton & Co. New York, New York, USA. 1915

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

The mathematician requires tact and good taste at every step of his work, and he has to learn to trust to his own instinct to distinguish between what is really worthy of his efforts and what is not; he must take care not to be the slave of his symbols, but always to have before his mind the realities which they merely serve to express.

*Report of the Sixtieth Meeting of the British Association for the Advancement of Science*

Presidential address (p. 725)

John Murray. London, England. 1891

**Goldstein, Herbert** 1922–2005

American Physicist and author

It has been remarked in a jocular vein that if H stands for the Hamiltonian, K must stand for the Kamiltonian!

*Classical Mechanics* (2nd edition)

Classical Transformations (p. 380)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1980

**Hertz, Heinrich** 1857–94

German physicist

Experience is the collecting of what is similar in different particular perceptions.

Translated by D.E. Jones and J.T. Walley

*The Principles of Mechanics Presented in a New Form*

Introduction (p. 1)

Macmillan & Co. London, England. 1899

**Hilbert, David** 1862–1943

German mathematician

Arithmetical symbols are written diagrams and geometrical figures are graphic formulas.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902

(p. 443)

In the beginning there was the symbol.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 7, Section 7. 1 (p. 164)

The Macmillan Company. New York, New York, USA. 1967

**Huxley, Aldous** 1894–1963

English writer and critic

...some of the greatest advances in mathematics have been due to the invention of symbols, which it afterwards became necessary to explain; from the minus sign proceeded the whole theory of negative quantities.

*Jesting Pilate*

India and Burma (p. 108)

Chatto & Windus. London, England. 1926

**Jefferies, Richard** 1848–87

English naturalist and author

In the mind all things are written in pictures – there is no alphabetical combination of letters and words; all things are pictures and symbols.

*The Open Air*

Wild Flowers

Chatto & Windus. London, England. 1908

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Thus a word or an image is symbolic when it implies something more than its obvious and immediate meaning. It has a wider “unconscious” aspect that is never precisely defined or fully explained. . . . As the mind explores the symbols it is led to ideas that lie beyond the grasp of reason.

*Man and His Symbols*

Part I. The Importance of Dreams (p. 20)

Doubleday & Company, Inc. Garden City, New York, USA. 1964

The Sign is always less than the concept it represents, while a symbol always stands for something more than its obvious and immediate meaning. Symbols, moreover, are natural and spontaneous products.

*Man and His Symbols*

Part I. The Analysis of Dreams (p. 55)  
Doubleday & Company, Inc. Garden City, New York, USA. 1964

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The use of the signs of algebra and analysis, which are merely symbols of operations to be performed, is due to the observation that we can materially disburden the mind in this way and spare its powers for more important and more difficult duties, by imposing all mechanical operations upon the hand.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On the Economical Nature of Physical Inquiry (p. 196)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Nicholas of Cusa** 1401–64

German philosopher, mathematician, and physician

If we approach the Divine through symbols, then it is most suitable that we use mathematical symbols, these have an indestructible certainty.

In Stanley Gudder

*A Mathematical Journey* (p. 349)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Pearson, Karl** 1857–1936

English mathematician

...the mathematician carried along on his flood of symbols, dealing apparently with purely formal truths, may still reach results of endless importance for our description of the physical universe.

*The Grammar of Science*

Chapter XII (p. 505)

Adam & Charles Black. London, England. 1900

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...if we wish to learn the whole of Arithmetic, Algebra, the Calculus, and indeed all that is usually called pure mathematics (except Geometry), we must start with a dictionary of three words. One symbol stands for *zero*, another for *number*, and a third for *next after*.

*Mysticism and Logic: And Other Essays*

Chapter V (p. 78)

Longmans, Green & Co. London, England. 1919

**Tillyard, E. M. W.** 1889–1962

English classical scholar

**Lewis, C. S. (Clive Staples)** 1898–1963

English author

Two kinds of symbol must surely be distinguished. The algebraic symbol comes naked into the world of mathematics and is clothed with value by its masters. A poetic symbol – like the Rose, for Love, in Guillaume de Lorris – comes trailing clouds of glory from the real world,

clouds whose shape and colour largely determine and explain its poetic use. In an equation, x and y will do as well as a and b; but the Romance of the Rose could not, without loss, be re-written as the Romance of the Onion, and if a man did not see why, we could only send him back to the real world to study roses, onions, and love, all of them still untouched by poetry, still raw.

*The Personal Heresy: A Controversy*

Chapter V (p. 97)

Oxford University Press, Inc. London, England. 1939

**Truesdell, Clifford** 1919–2000

American mathematician, mathematics historian, and natural philosopher

There is nothing that can be said by mathematical symbols and relations which cannot also be said by words. The converse, however, is false. Much that can be and is said by words cannot successfully be put into equations, because it is nonsense.

*Six Lectures on Modern Natural Philosophy*

III, Thermodynamics of Visco-Elasticity (p. 35)

Springer-Verlag. Berlin, West Germany. 1966

**von Neumann, Johann** 1903–57

Hungarian-American mathematician

We must regard classical mathematics as a combinatorial game played with symbols ...

In Paul Benacerraf and Hillary Putnam

*Philosophy of Mathematics: Selected Readings* (2nd edition)

The Formalist Foundations of Mathematics (p. 62)

Cambridge University Press. Cambridge, England. 1983

**Westaway, Frederic William**

No biographical data available

...once a science lesson arrives at the stage of symbols, it may cease to be Science altogether; once a “law” is established, the subsequent work is likely to take the form of mere Algebra.

*Scientific Method: Its Philosophical Basis and Its Modes of Application*

Chapter I (p. 4)

Blackie & Son. London, England. 1924

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Mathematics is often considered a difficult and mysterious science, because of the numerous symbols which it employs. Of course, nothing is more incomprehensible than a symbolism which we do not understand. Also a symbolism, which we only partially understand and are unaccustomed to use is difficult to follow. In exactly the same way the technical terms of any profession or trade are incomprehensible to those who have never been trained to use them. But this is not because they are difficult in themselves. On the contrary they have invariably been introduced to make things easy.

*An Introduction to Mathematics*

Chapter 5 (p. 40)

Oxford University Press, Inc. New York, New York, USA. 1958

...in mathematics, granted that we are giving any serious attention to mathematical ideas, the symbolism is invariably an immense simplification.

*An Introduction to Mathematics*

Chapter 5 (p. 40)

Oxford University Press, Inc. New York, New York, USA. 1958

There is an old epigram which assigns the empire of the sea to the English, of the land to the French, and of the clouds to the Germans. Surely it was from the clouds that the Germans fetched + and – ; the ideas which these symbols have generated are much too important to the welfare of humanity to have come from the sea or from the land.

*An Introduction to Mathematics*

Chapter 6 (p. 60)

Oxford University Press, Inc. New York, New York, USA. 1958

**Young, Jacob William Albert** 1865–1948

American mathematician

The training which mathematics gives in working with symbols is an excellent preparation for other sciences... the world's work requires constant mastery of symbols.

*The Teaching of Mathematics in the Elementary and the Secondary School*

Chapter II (p. 42)

Longmans, Green & Co. New York, New York, USA. 1907

## SYMBOLIC LOGIC

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Symbolic Logic has been disowned by many logicians on the plea that its interest is mathematical, and by many mathematicians on the plea that its interest is logical.

*Universal Algebra*

Preface (p. 6)

Cambridge University Press. Cambridge, England. 1898

## SYMBOLS

**Carrel, Alexis** 1873–1944

French surgeon and biologist

They [astronomy, mechanics and physics] search for reality beyond the realm of common thought up to unutterable abstractions consisting only of equations of symbols.

*Man, The Unknown*

Chapter I (p. 1)

Harper & Brothers Publishers. New York, New York, USA. 1935

## SYMMETRY

**Aristotle** 384 BCE–322 BCE

Greek philosopher

A rose which varies from the ideal of straightness to a hook or snub may still be of good shape and agreeable to the eye.

*Politics*

Book V, Chapter 9, 1309b [20]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Blake, William** 1757–1827

English poet, painter, and engraver

Tyger, Tyger, burning bright

In the forest of the night,

What immortal hand or eye

Could frame thy fearful symmetry?

*The Complete Poetry and Prose of William Blake*

The Tyger

University of California Press. Berkeley, California, USA. 1982

**Borges, Jorge Luis** 1899–1986

Argentine writer

...reality favors symmetry.

In Richard Burgin

*Conversations with Jorge Luis Borges*

Chapter VI (p. 109)

Holt, Rinehart & Winston. New York, New York, USA. 1969

**Bulwer, John** 1606–56

English physician and writer

True and native beauty consists in the just composure and symmetry of the parts of the body.

*Anthropometamorphosis*

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Perhaps Looking-glass milk isn't good to drink...

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter I (p. 147)

The Modern Library. New York, New York, USA. 1936

You boil it in saw dust: you salt it in glue:

You condense it with locust and tape:

Still keeping one principle object in view –

To preserve its symmetrical shape.

*The Complete Works of Lewis Carroll*

*The Hunting of the Snark*

Fit the Fifth (p. 772)

The Modern Library. New York, New York, USA. 1936

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Suppose some mathematical creature from the moon were to reckon up the human body; he would at once see that the essential thing about it was that it was duplicate. A man is two men, he on the right exactly resembling him on the left. Having noted that there was an arm on the right and one on the left, a leg on the right and one on the left, he might go further and still find on each side the



same number of fingers, the same number of toes, twin eyes, twin ears, twin nostrils, and even twin lobes of the brain. At last he would take it as a law; and then, where he found a heart on one side, would deduce that there was another heart on the other. And just then, where he most felt he was right, he would be wrong.

*Orthodoxy*

Chapter VI (p. 149)

John Lane Company. New York, New York, USA. 1918

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Anyone who, upon looking down at his bare feet, doesn't laugh, has either no sense of symmetry or no sense of humor.

In Abdus Salam

The Role of Chirality in the Origin of Life

*Journal of Molecular Evolution*, Volume 33, Number 2, August, 1991

(p. 105)

**Ferris, Timothy** 1944–

American science writer

...let us pause to slake our thirst one last time at symmetry's bubbling spring.

*Coming of Age in the Milky Way*

Chapter 20 (p. 385)

William Morrow & Company, Inc. New York, New York, USA. 1988

**Frankland, A.**

No biographical data available

When the formulae of inorganic compounds are considered even a superficial observer is struck with the general symmetry of their construction; the compounds of nitrogen, phosphorous, antimony and arsenic especially exhibit the tendency of these elements to form compounds containing three or five equivalents of other elements, and it is in these proportions that their affinities are best satisfied.

*Philosophical Transactions of the Royal Society of London*, Volume 67, 1852 (p. 417)

**Gross, David J.** 1941–

American particle physicist

As we explore physics at higher and higher energy, revealing its structure at shorter and shorter distances, we discover more and more symmetry.

The Role of Symmetry in Fundamental Physics

*Proceedings of the National Academy of Sciences of the United States of America*, Volume 23, Number 95, December 10, 1996 (p. 14256)

**Herbert, George** 1593–1633

English clergyman and metaphysical poet

My body is all symmetry,  
Full of proportions, one limb to another,  
And all to all the world besides:  
Each part may call the farthest, brother:

For head with foot hath private smity,  
And both with moon and tides.

*The Works of George Herbert*

*The Temple, Man*

Thomas Y. Crowell & Company. Birmingham, England. No date

**Joyce, James** 1882–1941

Irish expatriate writer and poet

ZOE: Come and I'll peel off.

BLOOM: (Feeling his occiput dubiously with the unparalleled embarrassment of a harassed peddler gauging the symmetry of her peeled pears.) Somebody would be dreadfully jealous if she knew.

*Ulysses* (p. 490)

Random House, Inc. New York, New York, USA. 1946

**Kaku, Michio** 1947–

Japanese-American theoretical physicist

**Thompson, Jennifer Trainer**

American author

...nature, at the fundamental level, does not just prefer symmetry in a physical theory; nature demands it.

*Beyond Einstein: The Cosmic Quest for the Theory of the Universe*

Chapter 6 (p. 108)

Bantam Books. Toronto, Ontario, Canada. 1987

**Mackay, Charles** 1814–89

English poet and journalist

Truth...and if mine eyes

Can bear its blaze, and trace its symmetries,

Measure its distance, and its advent wait,

I am no prophet – I but calculate.

*The Poetical Works of Charles Mackay*

The Prospects of the Future

G. Routledge & Sons. London, England. 1857

**Mao Zedong** 1893–1976

Chinese political and military leader and Communist Party chairman

Tell me why should symmetry be of importance?

In T.D. Lee

*Symmetries, Asymmetries, and the World of Particles*

30 May, 1974 (p. xi)

Washington University Press. Seattle, Washington, USA, and London, England. 1988

**Maxwell, James Clerk** 1831–79

Scottish physicist

The mathematician has, above all things, an eye for symmetry ...

*Report for the Fortieth Meeting of the British Association for the Advancement of Science*

Mathematics and Physics (p. 1)

John Murray. London, England. 1871

**National Research Council (USA)**

Not only physicists but everyone who has studied quantum mechanics knows that all known particles, without



exception, fall into one or the other of just two classes, called fermions and bosons, which differ from one another profoundly on a certain question of symmetry. The difference is as fundamental as any difference could be. Although usually expressed somewhat abstractly, the distinction is less recondite than some theological distinctions over which men have quarreled fiercely.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 64)

National Academy of Sciences

Washington, D.C. 1972

**Newman, James Roy** 1907–66

Mathematician and mathematical historian

Symmetry establishes a ridiculous and wonderful cousinship between objects, phenomena, and theories outwardly unrelated: terrestrial magnetism, women's veils, polarized light, natural selection, the theory of groups, invariants and transformations, the work habits of bees in the hive, the structure of space, vase designs, quantum physics, scarabs, flower petals, X-ray interference patterns, cell division in sea urchins, equilibrium positions in crystals, Romanesque cathedrals, snowflakes, music, the theory of relativity.

*The World of Mathematics* (Volume 1)

Commentary On Symmetry (p. 670)

Simon & Schuster. New York, New York, USA. 1956

**Pascal, Blaise** 1623–62

French mathematician and physicist

Those who make antitheses by forcing words are like those who make false windows for symmetry.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 27

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Symmetry is what we see at a glance...

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 28

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Valéry, Paul** 1871–1945

French poet and critic

The universe is built on a plan the profound symmetry of which is somehow present in the inner structure of our intellect.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2)

O.2 (p. 521)

Simon & Schuster. New York, New York, USA. 1987

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

An umbrella, Lueli, when in use resembles the – the shell that would be formed by rotating an arc of curve about its

axis of symmetry, attached to a cylinder of small radius whose axis is the same as the axis of symmetry of the generating curve of the shell. When not in use it is properly an elongated cone, but it is more usually helicoidal in form.

Lueli made no answer. He lay down again, this time face downward.

*Mr. Fortune's Maggot*

Mr. Fortune's Maggot (p. 115)

New York Review of Books. New York, New York, USA. 1927

**Weyl, Hermann** 1885–1955

German mathematician

Symmetry, as wide or as narrow as you may define its meaning, is one idea by which man through the ages has tried to comprehend and create order, beauty, and perfection.

*Symmetry*

Bilateral Symmetry (p. 5)

Princeton University Press. Princeton, New Jersey, USA. 1960

As far as I can see, all a priori statements in physics have their origin in symmetry.

*Symmetry*

Crystals. The General Mathematical Idea of Symmetry (p. 126)

Princeton University Press. Princeton, New Jersey, USA. 1952

Symmetry is a vast subject, significant in art and nature. Mathematics lies at its root, and it would be hard to find a better one on which to demonstrate the working of the mathematical intellect.

*Symmetry*

Crystals: The General Mathematical Idea of Symmetry (p. 145)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Wickham, Anna (Edith Alice Mary**

**Harper)** 1884–1947

English poet

God, Thou great symmetry,

Who put a biting lust in me

From whence my sorrows spring

For all the frittered days

That I have spent in shapeless ways

Give me one perfect thing.

*The Contemplative Quarry, and The Man with a Hammer*

Envoi

Harcourt Brace. New York, USA. 1921

**Yang, Chen Ning** 1922–

Chinese-born American theoretical physicist

Nature seems to take advantage of the simple mathematical representations of the symmetry laws. When one pauses to consider the elegance and the beautiful perfection of the mathematical reasoning involved and contrast it with the complex and far-reaching physical consequences, a deep sense of respect for the power of the symmetry laws never fails to develop.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1957

The Law of Parity Conservation and Other Symmetry Laws of Physics (p. 394)

Elsevier Publishing Company, Amsterdam, Netherlands. 1964

### Zee, Anthony

Chinese-American physicist and author

Pick your favorite group: write down the Yang-Mills theory with your groups as its local symmetry group; assign quark fields, lepton fields, and Higgs fields to suitable representations; let the symmetry be broken spontaneously. Now watch to see what the symmetry breaks down to. ...that, essentially, is all there is to it. Anyone can play. To win, one merely has to hit on the choice used by the Greatest Player of all time. The prize? Fame and glory, plus a trip to Stockholm.

*Fearful Symmetry*

Chapter 14 (pp. 253–254)

Macmillan Publishing Company, New York, New York, USA. 1986

## SYMPATHY

### Author undetermined

A want of sympathy on the part of the nurse is like a perpetual cold bath to a patient.

In Edward Everett Hale

*Modern Achievement*

Blunders in the Sick-Room (p. 419)

New York, New York, USA. 1902

## SYMPTOM

### Harc, Hobart Amory 1862–1931

American physician

A clear understanding by the physician of the value of the symptoms of disease which he sees and of those described by the patient is of vital importance for the purpose of diagnosis and treatment, and one of the advantages of older physicians over their younger brethren is the ability which they have gained through long training to grasp the essential details of a case almost at their first glance at the patient.

*Practical Diagnosis*

Introduction (p. 17)

Lea Brothers & Company, Philadelphia, Pennsylvania, USA. 1902

### Latham, Peter Mere 1789–1875

English physician

It is by symptoms, and by symptoms only, that we can learn the existence, and seat, and nature, of diseases in the living body, or can direct and methodize their treatment.

In William B. Bean

*Aphorisms from Latham* (p. 59)

Prairie Press, Iowa City, Iowa, USA. 1962

There is nothing that we call the symptom of a disease, which does not contain within itself much more than a mere sign. Heat, pain, redness, swelling, are called the signs of inflammation; but nature does not intend by them barely to intimate that inflammation exists; they are essentially connected with the processes she is carrying on.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture VI (p. 143)

Longman, Rees, Orme, Brown, Green & Longman, London, England. 1836

## SYNTHESES

### Borel, Félix Edouard Justin Emile 1871–1956

French mathematician

It is the only worthy aim of human activity is the conquest of truth, we can hope to come near this inaccessible goal only by means of constantly widening syntheses.

*Space and Time*

Introduction (p. 33)

Dover Publications, New York, New York, USA. 1960

## SYNTHESIS

### Bernard, Claude 1813–78

French physiologist

It is generally agreed that synthesis reunites what analysis has divided, and that synthesis therefore verifies analysis, of which it is merely the counterproof or necessary complement.

Translated by Henry Copley Green

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter 4 (p. 90)

Henry Schuman, Inc. New York, New York, USA. 1949

### Berthelot, Marcellin (or Marcellin) Pierre

Eugène 1827–1907

French chemist and politician

The domain in which chemical synthesis exercises its creative power is vaster than that of nature herself.

In Philip Ball

*Designing the Molecular World: Chemistry at the Frontier* (p. 13)

Princeton University Press, Princeton, New Jersey, USA. 1994

### Cousin, Victor 1792–1867

French educational leader and philosopher

On the one hand, synthesis without analysis, gives a false science; on the other hand, analysis without synthesis, gives an incomplete science.

Translated by O.W. Wight

*Course of the History of Modern Philosophy* (Volume 1) (p. 325)

D. Appleton & Co. New York, New York, USA. 1852

### Dalton, John 1766–1844

English chemist and physicist

Chemical analysis and synthesis go no farther than the separation of particles one from another, and their reunion.

No new creation or destruction of matter is within the reach of chemical agency. We might as well attempt to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen.

*A New System of Chemical Philosophy* (Volume 1)  
Part I, Chapter III (p. 212)  
R. Bickerstaff. London, England. 1810

**Mayr, Ernst** 1904–2005  
German-born American biologist

What is still lacking is a critical analysis of the writings of the architects of the synthesis.

*The Growth of Biological Thought: Diversity, Evolution, Inheritance*  
Chapter 12 (p. 568)  
Harvard University Press. Cambridge, Massachusetts, USA. 1982

We didn't sit down together and forge a synthesis. We all knew each other's writings; all spoke with each other. We all had the same goal, which was simply to understand fully the evolutionary process.... By combining our knowledge, we managed to straighten out all the conflicts and disagreements so that finally a united picture of evolution emerged.

In Pamela Weintraub (ed.)  
*The Omni Interviews*  
Darwin Flights (p. 47)  
Ticknor & Fields. New York, New York, USA. 1984

The term "evolutionary synthesis" was introduced by Julian Huxley in *Evolution: The Modern Synthesis* to designate the general acceptance of two conclusions: gradual evolution can be explained in terms of small genetic changes ("mutations") and recombination, and the ordering of this variation by natural selection; and the observed evolutionary phenomena, particularly macro-evolutionary processes and speciation, can be explained in a manner that is consistent with the known genetic mechanisms.

*The Evolutionary Synthesis*  
Prologue: Some Thoughts on the History of Evolutionary Synthesis (p. 1)  
Harvard University Press. Cambridge, Massachusetts, USA. 1980

**Seebach, D.**  
No biographical data available

No matter what the narrow goal of any particular project, whether the work involved is groundbreaking or of a more routine nature, synthesis and analysis are crucial to every chemist's activities.

*Organic Synthesis – Where Now?*  
*Angewandete Chemie International Edition in English*, Volume 29, 1990  
(p. 1321)

**Stryker, Melancthon Woolsey** 1851–1929  
American minister

Analysis is like turning a stocking inside out to mend it; synthesis is like turning it back to wear it.

*Hamilton, Lincoln & Other Addresses*  
Creeds (p. 158)  
William T. Smith & Co. Utica, New York, USA. 1896

**Vivilov, N. I.**  
No biographical data available

We are now entering an epoch of differential ecological, physiological and genetic classification. It is an immense work. The ocean of knowledge is practically untouched by biologists. It requires the joint labors of many different specialists – physiologists, cytologists, geneticists, systematists, and biochemists. It requires international spirit, the cooperative work of investigators throughout the whole world...it will bring us logically to the next step: integration and synthesis.

In Julian Huxley  
*The New Systematics*  
The New Systematics of Cultivated Plants (p. 565)  
University Press. Oxford, England. 1940

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

"Affinities begin really to interest only when they bring about separations."

"What...is that miserable word, which unhappily we hear so often now-a-days – in the world; is that to be found in nature's lessons too?"

"Most certainly," answered Edward; "the title with which chemists were supposed to be most honorably distinguished was, artists of separation."

"It is not so anymore," replied Charlotte; "and it is well that it is not. It is a higher art, and it is a higher merit, to unite. An artist of union is what we should welcome in every province of the universe."

*Elective Affinities*  
Chapter IV (p. 38)  
Frederick Unger Publishing Company. New York, New York, USA. 1962

**Woodward, Robert Burns** 1917–79  
American chemist

The structure known, but not yet accessible by synthesis, is to the chemist what the unclimbed mountain, the uncharted sea, the untilled field, the unreachd planet, are to other men.... The unique challenge which chemical synthesis provides for the creative imagination and the skilled hands ensures that it will endure as long as men write books, paint pictures, and fashion things which are beautiful, or practical, or both.

In William H. Brock  
*The Norton History of Chemistry*  
Chapter 16 (p. 633)  
W.S. Norton & Company, Inc. New York, New York, USA. 1993

[S]ynthetic objectives are seldom if ever taken by chance, nor will the most painstaking, or inspired, purely

observational activities suffice. Synthesis must always be carried out by plan, and the synthetic frontier can be defined only in terms of the degree to which realistic planning is possible, utilizing all of the intellectual and physical tools available. It can scarcely be gainsaid that the successful outcome of a synthesis of more than thirty stages provides a test of unparalleled rigor of the predictive capacity of the science, and of the degree of its understanding of its portion of the environment.

In A.R. Todd (ed.)

*Perspectives in Organic Chemistry*

Synthesis (p. 155)

Interscience, Inc. New York, New York, USA. 1956

## SYSTEM

### Coates, Robert M.

No biographical data available

He has so clearly laid open and set before our eyes the most beautiful frame of the System of the World, that if King Alphonse were now alive he would not complain for want of the graces of simplicity or of harmony in it.

In Robert H. March

*Physics for Poets*

Preface to the Principia (p. 35)

McGraw-Hill, Inc. New York, New York, USA. 1996

### Cobb, Cathy

Chemist

In physical science, there is always the danger of falling in love with the system rather than the nature that inspired it.

*Magick, Mayhem, and Mavericks*

Part I, Introduction (p. 28)

Prometheus Books. Amherst, New York, USA. 2002

### de Morgan, Augustus 1806–71

English mathematician and logician

In every age of the world there has been an established system, which has been opposed from time to time by isolated and dissentient reformers. The established system has sometimes fallen, slowly and gradually: it has either been upset by the rising influence of some one man, or it has been sapped by gradual change of opinion in the many.

*A Budget of Paradoxes* (Volume 1) (2nd edition)

Introductory (p. 1)

The Open Court Publishing Co. Chicago, Illinois, USA. 1915

### Jantsch, Erich 1929–80

Austrian astrophysicist

...a system now appears as a set of coherent, evolving, interactive processes which temporarily manifest in globally stable structures that have nothing to do with the equilibrium and the solidity of technological structures.

Caterpillar and butterfly, for example, are two temporarily stabilized structures in the coherent evolution of one and the same system.

*The Self-organizing Universe* (p. 6)

Pergamon Press. Oxford, England. 1980

### Lavoisier, Antoine Laurent 1743–94

French chemist

Systems in physical science...are no more than appropriate instruments to aid the weakness of our organs: they are, properly speaking, approximate methods which put us on the path to the solution of the problem; these are the hypotheses which, successively modified, corrected, and changed in proportion as they are found false, should lead us infallibly one day, by a process of exclusion, to the knowledge of the true laws of nature.

*Mémoires de l'Académie Royale des Sciences 1777*

Memoir on Combustion in General (p. 592)

Facts, observations, experiments – these are the materials of a great edifice, but in assembling them we must combine them into classes, distinguish which belongs to which order and to which part of the whole each pertains.

*Mémoires de l'Académie Royale des Sciences 1777*

Memoir on Combustion in General (p. 592)

As dangerous as is the desire to systematize in the physical sciences, it is, nevertheless, to be feared that in storing without order a great multiplicity of experiments we obscure the science rather than clarify it, render it difficult of access to those desirous of entering upon it, and finally, obtain at the price of long and tiresome work only disorder and confusion.

*Mémoires de l'Académie Royale des Sciences 1777*

Memoir on Combustion in General (p. 592)

### Lincoln, Almira H. 1793–1884

Botanist

System is necessary in every science. It not only assists in the acquisition of knowledge, but enables us to retain what is thus acquired; and, by the laws of association, to call forth at will what is treasured up in the storehouse of the mind.

*Familiar Lectures on Botany, Practical, Elementary and Physiological*

Introduction (p. 10)

F.J. Huntington & Co. New York, New York, USA. 1853

### Peacock, Thomas Love 1785–1866

English writer

All philosophers who find  
Some favorite system to their mind,  
In every point to make it fit  
Will force all nature to submit.

*Headlong Hall* (p. 44)

J.M. Dent & Company London, England. No date

**Thomas, Lewis** 1913–93

American physician and biologist

You cannot meddle with one part of a complex system from the outside without the almost certain risk of setting off disastrous events that you hadn't counted on in other, remote parts.

*The Medusa and the Snail: More Notes of a Biology Watcher*

On Meddling (p. 110)

The Viking Press. New York, New York, USA. 1979

**Thompson, William Robin** 1887–1972

Canadian entomologist

The good systematist develops what the medieval philosophers called a habitus, which is more than a habit and is better designated by its other name of *secunda natura*. Perhaps, like a tennis player or a musician, he works best when he does not get too introspective about what he is doing.

The Philosophical Foundation of Systematics

*Canadian Entomology*, Volume 84, 1952 (p. 5)

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Natural system – a contradiction in terms. Nature has no system; she has, she is life and its progress from an unknown center toward an unknowable goal. Scientific research is therefore endless, whether one proceed analytically into minutiae or follow the trail as a whole, in all its breadth and height.

*Goethe's Botanical Writings*

Problems (p. 116)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

**SYSTEMATICS****Darwin, Charles Robert** 1809–82

English naturalist

Systematize and study affinities.

*The Autobiography of Charles Darwin, 1809–1882: With Original Omissions Restored*

Appendix, Quotations (p. 160)

Harcourt, Brace. New York, New York, USA. 1959

**de Queiroz, K.**

Phylogeneticist

**Donoghue, M. J.**

Phylogeneticist

If the goal of systematics is to depict relationships accurately, then any tradition that interferes with this goal should be abandoned.

Phylogenetic Systematics of Nelson's Version of Cladistics

*Cladistics*, Volume 4, Number 4, December, 1988 (p. 332)

**Elton, Charles S.** 1900–91

English biologist

The extent to which progress in ecology depends upon accurate identification and upon the existence of sound systematic groundwork for all groups of animals, cannot be too much impressed upon the beginner in ecology. This is the essential basis of the whole thing; without it the ecologist is helpless, and the whole of his work may be rendered useless.

*Animal Ecology*

Chapter XI (p. 165)

Sidgwick & Jackson, Ltd. London, England. 1927

**Hennig, W.**

No biographical data available

In order to be able to judge correctly the position of systematics in the field of biology and the role that it is called upon to play in the solution of the basic problems of this science, one must first make clear that there is a systematics not only in biology, but that it is rather an integrating part of any science whatever. It is surprising and peculiar to see to what degree the original significance of this concept has been forgotten in biology in the course of the fundamentally inadmissible but now general limitation of the concept of systematics to a particular subdivision of the science as a whole.

In George Gaylord Simpson

*Principles of Animal Taxonomy*

Systematics, Taxonomy, Classification, Nomenclature (p. 6)

Columbia University Press. New York, New York, USA. 1961

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

...the system of this earth has either been intentionally made imperfect, or has not been the work of infinite power and wisdom.

*The Theory of the Earth* (Volume 1)

Part I, Chapter I, Section I (p. 17)

Messrs Cadwell, Junior, and Davies. London, England. 1795

**Mayr, Ernst** 1904–2005

German-born American biologist

The amount of diversity in the living world is staggering. About 1 million species of animals and half a million species of plants have already been described, and estimates on the number of still undescribed species range from 3 to 10 million.... It would therefore be impossible to deal with this enormous diversity if it were not ordered and classified. Systematic zoology endeavors to order the rich diversity of the animal world and to develop methods and principles to make this task possible.

*Principles of Systematic Zoology*

Chapter 1 (p. 1)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

The systematist who studies the factors of evolution wants to find out how species originate, how they are related, and what this relationship means. He studies species not only as they are, but also their origin and changes.

He tries to find his answers by observing the variability of natural populations under different external conditions and he attempts to find out which factors promote and which inhibit evolution. He is helped in this endeavor by his knowledge of the habits and the ecology of the studied species.

*Systematics and the Origin of Species*

Chapter I (p. 11)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

**Simpson, George Gaylord** 1902–84

American paleontologist

Systematics is the scientific study of the kinds and diversity of organisms and of any and all relationships among them.

*Principles of Animal Taxonomy*

Systematics, Taxonomy, Classification, Nomenclature (p. 7)

Columbia University Press. New York, New York, USA. 1961

## SYSTEMATIST

**Darwin, Charles Galton** 1809–82

English naturalist

Systematic work would be easy were it not for this confounded variation, which, however, is pleasant to me as a speculatist, though odious to me as a systematist.

*The Life and Letters of Charles Darwin* (Volume 1)

Darwin to J.D. Hooker (pp. 397–398)

D. Appleton & Co. New York, New York, USA. 1904



## T

### TABLE

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Tables are like cobwebs, like the sieve of the Danaides; beautifully reticulated, orderly to look upon, but which will hold no conclusion. Tables are abstractions.... There are innumerable circumstances; and one circumstance left out may be the vital one on which all turned.... Conclusive facts are inseparable from inconclusive except by a head that already understands and knows.

*English and Other Critical Essays*

Chartism, Chapter II (p. 170)

J.M. Dent & Sons Ltd. London, England. 1950

**Devons, Ely** 1913–67  
English economist

The way statistics are presented, their arrangement in a particular way in tables, the juxtaposition of sets of figures, in itself reflects the judgment of the author about what is significant and what is trivial in the situation which the statistics portray.

*Essays in Economics*

Chapter 6 (p. 109)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1961

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

I will give you a “celestial multiplication table”. We start with a star as the unit most familiar to us, a globe comparable to the sun. Then –

A hundred thousand million Stars make one Galaxy;

A hundred thousand million Galaxies make one Universe.

*The Expanding Universe*

Chapter I (p. 4)

Cambridge University Press. Cambridge, England. 1920

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

[Referring to] ...witty comments made by A.L. Bowley]

(a) The terms used in the headings and margins of the table are all employed in a technical sense, known only to the officers who compiled it, and which they are unable for official reasons to divulge. (b) The sub-divisions of the table and the region to which it refers have been changed since the last return was published. (c) Before tabulation the data have been subjected to numerous adjustments, allowances and other corrections, of a kind to vitiate any tests of significance which the reader may be tempted to apply to them.

Presidential Address, First Indian Statistical Conference, 1938  
*Sankhya*, Volume 4, 1938 (p. 15)

**Playfair, William** 1759–1823  
English publicist

Information that is imperfectly acquired, is generally as imperfectly retained; and a man who has carefully investigated a printed table, finds, when done, that he has only a very faint and partial idea of what he has read; and that like a figure imprinted on sand, is soon totally erased and defaced.

*The Commercial and Political Atlas* (p. 3)

Printed for J. Debrett. London, England. 1786

**Morrison, Philip**  
American physicist

**Morrison, Emily**

The periodic table, that ingenious roll call of the elements...

The Neutron

*Scientific American*, Volume 185, Number 4, October, 1951 (p. 44)

**X. Y. Z.**

The multiplication table contains a great deal of sound and valuable learning, but its acquisition is no mean attainment. If anyone doubts this last proposition, let him try to learn that interesting collocation of figures from 13 to 24...

How I Did (Not) Learn Arithmetic

*The Indiana School Journal*, Volume 16, 1871 (p. 21)

### TABULATION

**Author undetermined**

To call such a tabulation statistics, is like calling the map of a November shower of meteors a text book on astronomy.

Fourth Kansas Insurance Report

*The Chronicle*, Volume XIII, Number 24, June 11, 1874 (p. 370)

### TACHYON

**Herbert, Nick**  
American physicist

Although most physicists today place the probability of the existence of tachyons only slightly higher than the existence of unicorns, research into the properties of these hypothetical FTL [faster than light] particles has not been entirely fruitless.

*Faster Than Light: Superluminal Loopholes in Physics*

Chapter 7 (p. 137)

New American Library. New York, New York, USA. 1988

**Nahin, Paul J.**

American electrical engineering professor and author

...if tachyons are one day discovered...the day before the momentous occasion a notice from the discoverers should appear in newspapers announcing "tachyons have been discovered tomorrow."

*Time Machines: Time Travel in Physics, Metaphysics, and Science Fiction*

Notes and References, Note 36 (p. 408)

Springer-Verlag. New York, New York, USA. 1993

**TALENT****Whewell, William** 1794–1866

English philosopher and historian

The hidden fountain of our unbidden thoughts is for us a mystery; and we have, in our consciousness, no standard by which we can measure our own talents ...

*History of the Inductive Sciences from the Earliest to the Present Time* (3rd edition)

Book VII, Chapter II (p. 140)

John W. Parker & Son. London, England. 1857

**TANGIBLE****Tyndall, John** 1820–93

Irish-born English physicist

One of the most important functions of physical science, considered as a discipline of the mind, is to enable us by means of the tangible processes of Nature to apprehend the intangible.

*Fragments of Science for Unscientific People*

Chapter IX (p. 213)

D. Appleton & Co. New York, New York, USA. 1875

**TARDIGRADE****Shiple, Arthur Everett** 1861–1927

Zoologist

Some species look like dear little sucking-pigs in plate armour.

*Hunting Under the Microscope* (p. 16)

The Macmillan Company. New York, New York, USA. 1928

...they are so plump that you feel inclined to pat them, only they are too small.

*Hunting Under the Microscope* (p. 17)

The Macmillan Company. New York, New York, USA. 1928

**TAXONOMIST****Moss, W. W.**

No biographical data available

Taxonomists have always had the reputation of being difficult. Intransigence may be rooted in the necessity

of defending prolonged self-immersion in a taxon that others find a total bore; it is frustrating to have one's work greeted with a yawn.

In J. Felsenstein (ed.)

*Numerical Taxonomy*

Taxa, Taxonomists, and Taxonomy (p. 73)

Springer-Verlag. New York, New York, USA. 1983

Numerical taxonomists have proved to be just as prickly as conventional taxonomists, possibly more so because some of the brightest people in systematics are involved in the current taxonomic battles. The political maneuvering and character assassination that characterize certain taxonomists today may not be atypical for science; they certainly provide a fine example of its seamier side. If Feyerabend is correct, it may even be a requirement of human nature that scientific progress occur in this manner.

In J. Felsenstein (ed.)

*Numerical Taxonomy*

Taxa, Taxonomists, and Taxonomy (p. 73)

Springer-Verlag. New York, New York, USA. 1983

**TAXONOMY****Abbott, Donald Putnam** 1920–86

American marine biologist and professor

You'll be tempted to grouse about the instability of taxonomy: but stability occurs only where people stop thinking and stop working.

In Galen Howard Hilgard (ed.)

*Observing Marine Invertebrates: Drawings from the Laboratory*

Author's Preface (p. xvi)

Stanford University Press. Stanford, California, USA. 1987

**Blackwelder, R. E.**

No biographical data available

Much has been written in recent decades about subspecies and their use in taxonomy. There are strong feelings that they are usable, useful and desirable. There are also strong feelings that they are not really relevant to taxonomy and are an unnecessary encumbrance to classification and nomenclature.

*Taxonomy: A Text and Reference Book* (p. 171)

John Wiley & Sons, Inc. New York, New York, USA. 1967

**Brew, John O.** 1906–88

American archaeologist

...classificatory systems are merely tools, tools of analysis, manufactured and employed by students, just as shovels, trowels and whisk brooms are tools of excavation.

Papers of the Peabody Museum of American Archaeology and Ethnology

*The Archaeology of Alkali Ridge, Southeastern Utah*

The Use and Abuse of Taxonomy, Volume 21 (p. 46)

Peabody Museum. Cambridge, Massachusetts, USA. 1946

**Burt, B. L.**

No biographical data available

Numerical taxonomy uses statistical methods to form groups whereas traditional taxonomy only uses them to discriminate more precisely between groups already perceived. If it becomes increasingly apparent that there is a fundamental divergence here, let us remember Whitehead's dictum, that a clash of doctrines is not a disaster – it is an opportunity.

Andanson and Modern Taxonomy

*Edinburgh Royal Botanic Gardens. Notes*, Volume 26, 1966

**Cain, A. J.**

Taxonomist

It is not extraordinary that young taxonomists are trained like performing monkeys, almost wholly by imitation, and that in only the rarest cases are they given any instruction in taxonomic theory.

In George Gaylord Simpson

*Principles of Animal Taxonomy*

Preface (p. vii)

Columbia University Press. New York, New York, USA. 1961

**Constance, L.**

No biographical data available

Plant taxonomy has not outlived its usefulness: it is just getting under way on an attractively infinite task.

Plant Taxonomy in an Age of Experiment

*American Journal of Botany*, Volume 44, Number 1, January, 1957 (p. 92)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Parochial taxonomies are a curse of intellectual life.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 3)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

Taxonomy (the science of classification) is often undervalued as a glorified form of filing – with each species in its folder, like a stamp in its prescribed place in an album; but taxonomy is a fundamental and dynamic science, dedicated to exploring the causes of relationships and similarities among organisms. Classifications are theories about the basis of natural order, not dull catalogues compiled only to avoid chaos.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter III (p. 98)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

**Heywood, V. H.** 1947–

No biographical data available

In these days when Molecular Biology is beginning to be seen as a restricted science, narrowing our vision by concentrating on the basic uniformity of organisms at the macromolecular level, the need for taxonomists to draw

attention to the enormous diversity and variation of this earth's biota becomes more and more pressing.

In Tod. F. Stuessy

*Plant Taxonomy: The Systematic Evaluation of Comparative Data*

Plant Taxonomy (p. xvii)

Columbia University Press. New York, New York, USA. 1990

**Jeffrey, C.** 1866–1952

Canadian-American botanist

The bringing to light of overlooked names in the old literature is perhaps nearing completion...it is hoped that this will lead to name-changes for nomenclature reasons becoming ever fewer and fewer until eventually they cease to trouble us. Unfortunately, the same cannot be said of name-changes that become necessary for taxonomic reasons. These arise from taxonomic research itself and are inevitable accompaniments of our systems of classifications.

*Biological Nomenclature* (3rd edition) (p. 31)

Edward Arnold. London, England. 1989

**Kevan, D. Keith McE.** 1920–1991

British ethnoentomologist

Bad taxonomy, of which there has been plenty, persists. Unlike bad chemistry or bad physiology, of which there has probably been equally as much, it cannot be ignored; it must be undone and redone. Poor taxonomy is not only an ill unto itself; it is contagious, often with a very long incubation period.... One assumes that when [experimental biologists] state that they used 5 ml ethanol, they were not using 6 ml of methanol; and yet, if the experimental animal is wrongly identified, what are the grounds for such an assumption?

The Place of Classical Taxonomy in Modern Systematic Entomology

*Canadian Entomology*, Volume 105, 1973 (p. 1212)

**Rollins, R. C.** 1911–1998

No biographical data available

In other words, the field of taxonomy in a way epitomizes the work of all other branches of biology centered on the organism itself, and brings the varied factual information from them to bear on the problems of interrelationship, classification and evolution. Thus taxonomy, as has been aptly remarked, is at once the alpha and omega of biology.

Taxonomy of the Higher Plants

*American Journal of Botany*, Volume 44, Number 1, January, 1957 (p. 188)

**Simpson, George Gaylord** 1902–84

American paleontologist

Taxonomy is a science, but its application to classification involves a great deal of human contrivance and ingenuity, in short, of art. In this art there is leeway for personal taste, even foibles, but there are also canons that help to make some classifications better, more meaningful, more useful than others.

*Principles of Animal Taxonomy*

From Taxonomy to Classification (p. 107)  
Columbia University Press. New York, New York, USA. 1961

**Stace, C.** 1938–  
English botanist and author

The species is the lowest rank which it is essential to recognize for general taxonomic purposes. It is not, however, the lowest rank which it is desirable and useful to recognize.

*Plant Taxonomy and Biosystematics* (2nd edition) (p. 192)  
Edward Arnold Publishers Ltd. London, England. 1989

**Stuessy, Tod F.** 1943–  
No biographical data available

We as taxonomists celebrate diversity. We celebrate the wildness of the planet. We celebrate the numerous human attempts to understand this wilderness, and we mourn its loss through human miscalculation. We sense the aesthetic of life and much of our efforts are aimed at reflecting this composition. Above all we celebrate the challenges of being alive and dealing with the living world. There is no greater responsibility, privilege, nor satisfaction.

*Plant Taxonomy: The Systematic Evaluation of Comparative Data*  
Epilogue (p. 406)  
Columbia University Press. New York, New York, USA. 1990

The rise beyond the generic level in classification is to enter a world of much greater uncertainty.... Taxa at higher levels will be well-defined or ill-defined depending on the group in question.

*Plant Taxonomy: The Systematic Evaluation of Comparative Data* (p. 207)  
Columbia University Press. New York, New York, USA. 1990

**Wald, George** 1906–97  
American biologist and biochemist

The most important thing about a name, after all, is that it remain attached to the thing it designates. One wishes that once a name had come into common use for an organism, it could be stabilized for the use of busy persons who want nothing but that each animal have a name.

In E.S. Guzman Barron (ed.)  
*Modern Trends in Physiology and Biochemistry*  
Biochemical Evolution (fn p. 339)  
Academic Press, Inc. New York, New York, USA. 1952

**TEACH**

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

Never try to teach what you do not yourself know and know well.

Quoted in David Starr Jordan  
*Science Sketches*

Quoted in David Starr Jordan (p. 145)  
A.C. McClurg & Co. Chicago, Illinois, USA. 1896

**Austen, Jane** 1775–1817  
English novelist

We all love to instruct, though we can teach only what is not worth knowing.

*Pride and Prejudice*  
Chapter LIV (p. 353)  
Charles Scribner's Sons. New York, New York, USA. 1918

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Teaching school is but another word for sure and not very slow destruction ...

In Moncure Daniel Conway  
*Thomas Carlyle*  
March, 1820 (p. 180)  
Harper & Brothers Publishers. New York, New York, USA. 1881

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

We always cram the newest into our students: lost souls teaching the young how to lose theirs.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 164)  
The Rockefeller University Press. New York, New York, USA. 1978

**Davies, Charles** 1798–1876  
American mathematician

All good teaching must flow from copious sources of knowledge. The shallow fountain cannot emit a vigorous stream.

*The Logic and Utility of Mathematics; With the Best Methods of Instruction Explained and Illustrated*  
Introduction (p. 25)  
A.S. Barnes & Burr Co. New York, New York, USA. 1860

**de Vries, Hugo** 1848–1935  
Dutch botanist

The noble aim of university teaching is the lifting of mankind to a higher appreciation of the ideas of life and truth. It has to cultivate the most intimate connection between theory and practice, between abstract science and actual life.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
(1904)  
The Evidence of Evolution (p. 389)  
Government Printing Office. Washington, D.C. 1905

**Dickens, Charles** 1812–70  
English novelist

If he had only learnt, a little less, how infinitely better he might have taught much more!

*Hard Times*  
Book I, Chapter II (p. 211)  
Chapman & Hall, Ltd. London, England. 1858

**Hall, Granville Stanley** 1844–1924  
American psychologist and educator

...the nature of youth demand that science should be taught at first in a large, all-comprehensive way, not without a distinctly religious spirit, reopening the half-obscured but broad road by which man passes from nature to nature's God.

*Adolescence: Its Psychology and Its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education* (Volume 2)

Chapter XII (p. 151)

D. Appleton & Co. New York, New York, USA. 1907

### **Harris, James** 1709–80

English grammarian

He thinks nothing more absurd than the common notion of Instruction, as if Science were to be poured into the Mind, like water into a cistern, that passively waits to receive all that comes.

*Hermes: Or, A Philosophical Inquiry Concerning Universal Grammar*

Preface (p. v)

Printed for J. Collingwood. London, England. 1825

### **Humphrey, Heman**

No biographical data available

The object of teaching should never be, to excuse the student from thinking and reasoning, but to learn him how to think and to reason.

*Miscellaneous Discourses and Reviews*

Inaugural Discourse (p. 233)

J.S. & C. Adams. Amherst, Massachusetts, USA. 1834

### **Huxley, Thomas Henry** 1825–95

English biologist

...unless that which is taught is based on actual observation and familiarity with facts, it is better left alone.

*Science and Education*

Chapter VII (p. 150)

American Home Library Co. New York, New York, USA. 1902

### **Mangus, Philip**

No biographical data available

...the aim of teaching [mathematics] should be rather to strengthen his [the student's] faculties, and to supply a method of reasoning applicable to other subjects, than to furnish him with an instrument for solving practical problems.

In Professor Perry

*Discussion on the Teaching of Mathematics* (p. 84)

Macmillan & Co Ltd. London, England. 1902

### **Mitchel, Ormsby MacKnight** 1805–62

American astronomer

...I shall endeavor to shun all attempt at critical scientific demonstration, which could only be intelligible to the professed student of astronomy, I shall on the other hand fearlessly attempt such an exposition of the processes and trains of reasoning by which great truths have been elicited, as to show to every intelligent mind that the problem

is not impossible; by simplicity of language, by familiar illustrations, to fling light enough upon these mysterious propositions; – to show a pathway, though it be dim and rugged, still a pathway, which, if pursued, shall certainly lead to a full and perfect solution.

*The Orbs of Heaven, or, The Planetary and Stellar Worlds*

Lecture I (p. 4)

Office of the National Illustrated Library. London, England. 1851

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

First let a man teach himself, and then he will be taught by others.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

519 (p. 184)

The Macmillan Co. New York, New York, USA. 1906

### **Whately, Richard** 1787–1863

English theologian

To teach one who has no curiosity to learn, is to sow a field without ploughing it.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard Whately, D.D.*

Apothegm 66 (p. 7)

Longman, Green, Longman, Roberts & Green. London, England. 1865

## **TEACHER**

### **Adams, Henry Brooks** 1838–1918

American man of letters

A teacher affects eternity; he can never tell, where his influence stops.

*The Education of Henry Adams: An Autobiography*

Chapter XX (p. 300)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1918

### **Alexander, Burton F.**

American mathematics teacher

The responsibility of developing and improving the general and technical vocabularies that are associated with elementary mathematics lies in the hand of the subject teacher.

Language Development in Mathematics Through Vocabularies

*The Mathematics Teacher*, Volume 40, Number 8, December, 1947 (p. 389)

### **Author undetermined**

Our teacher was a good man, and taught us all he knew. But his attainments were not great. As to astronomy, he never had an idea but that the earth was as flat as the plate on which he ate his breakfast; and as to mathematics, the difference between the numerator and denominator of a vulgar fraction, was a mystery of science altogether beyond his depth.

Education in the Backwoods

*American Annals of Education*, May, 1838 (p. 215)



**Bailey, Liberty Hyde** 1858–1954

American horticulturist and botanist

A good teacher is better than all the laboratories and apparatus.

*Botany: An Elementary Text for Schools* (4th edition)

Paragraphs for the Teacher (p. viii)

The Macmillan Co. New York, New York, USA. 1901

The teacher who thinks first of his subject teaches science; he who thinks first of his pupil teaches nature-study.

*Botany: An Elementary Text for Schools* (4th edition)

Paragraphs for the Teacher (p. ix)

The Macmillan Co. New York, New York, USA. 1901

**Branford, Victor**

No biographical data available

The American “School-ma’rm” balances the American Viking, and the world trembles in the hope and expectation that someday she may succeed in taming and domesticating him. In no other way, probably, can his disforestings and devastations be effectually stopped, and his destructive energies converted to more constructive ideals.

*Science and Citizenship*

Section VIII (pp. 19–20)

George Allen. London, England. 1906

**Chargaff, Erwin** 1905–2002

Austrian biochemist

A good teacher can only have dissident pupils.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 7)

The Rockefeller University Press. New York, New York, USA. 1978

**Gies, William J.** 1872–1956

US biochemist and dentist

...teachers are simply your guides. You yourselves must do the travelling.

Research in Dentistry

*Journal of Dental Research*, Volume 3, Number 3, September, 1921 (p. xcvi)

**Hall, Granville Stanley** 1844–1924

American psychologist and educator

...the teacher should...forage widely and incessantly, and bring everything within reach in his field to [his class]... [T]he lecture method [should be] made the most of, being conversational and designed to provoke reaction.... He should teach every topic broadly and comprehensively, and instead of disparaging mere information, it should ooze from his every pore.

*Adolescence: Its Psychology and Its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education* (Volume 2)

Chapter XVI (p. 532)

D. Appleton & Co. New York, New York, USA. 1907

**Huxley, Thomas Henry** 1825–95

English biologist

...the teacher should always recollect that his business is to feed, and not to cram the intellect.

*Lay Sermons, Addresses and Reviews*

Chapter VI (p. 111)

D. Appleton & Co. New York, New York, USA. 1903

...the great business of the scientific teacher is, to imprint the fundamental, irrefragable facts of his science, not only by words upon the mind, but by sensible impressions upon the eye, and ear, and touch of the student, in so complete a manner, that every term used, or law enunciated, should afterwards call up vivid images of the particular structural, or other, facts which furnished the demonstration of the law, or the illustration of the term.

*Lay Sermons, Addresses and Reviews*

Chapter VI (p. 112)

D. Appleton & Co. New York, New York, USA. 1903

**Mitchell, Maria** 1818–89

American astronomer and educator

It is not exactly my way, but I do think, as a general rule, that teachers talk too much! A book is a very good institution! To read a book, to think it over, and to write out notes is a useful exercise; a book which will not repay some hard thought is not worth publishing. The fashion of lecturing is becoming a rage; the teacher shows herself off, and she does not try enough to develop her pupils.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 180)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

When you aid a teacher, you improve the education of your children. It is a wonder that teachers work as well as they do. I never look at a group of them without using, mentally, the expression, ‘The noble army of martyrs’!

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 184)

Lea & Shepard Publishers. Boston, Massachusetts, USA. 1896

**Nunn, T. F.**

No biographical data available

It is not sufficient that the teacher should have a competent knowledge of the subject which he professes...he must (in addition) have considered his science from the point of view at which it appears as a human acquisition.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 8 (p. 111)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

The true responsibility of a scientist...is to the integrity and vigor of his science. And because most scientists, like all men of learning, tend in part also to be teachers, they have a responsibility for the communication of the truths they have found.



*The Open Mind*

Physics in the Contemporary World (p. 91)

Simon & Schuster. New York, New York, USA. 1955

**Pearson, Karl** 1857–1936

English mathematician

The true aim of the teacher must be to impart an appreciation of method and not a knowledge of facts.

*The Grammar of Science* (2nd edition)

Introductory (p. 7)

Adam & Charles Black. London, England. 1900

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

A good teacher does not teach facts, he or she teaches enthusiasm, open-mindedness and values. ...

*Indiscrete Thoughts*

Chapter XX (p. 207)

Birkhäuser. Boston, Massachusetts, USA. 1997

**Standen, Anthony**

Anglo-American science writer

There are science teachers who actually claim that they teach "a healthy skepticism." They do not. They teach a profound gullibility, and their dupes, trained not to think for themselves, will swallow any egregious rot, provided it is dressed up with long words and an affectation of objectivity to make it sound scientific.

*Science Is a Sacred Cow*

Chapter VII (p. 189)

E.P. Dutton. New York, New York, USA. 1950

**Tyndall, John** 1820–93

Irish-born English physicist

...after the discoverer comes the teacher, whose function it is so to exalt and modify the experiments of his predecessor as to render them fit for public presentation.

*Six Lectures on Light Delivered in America in 1872–1873* (3rd edition)

Lecture I (p. 3)

D. Appleton & Co. New York, New York, USA. 1901

**Vail, Albert Ross**

No biographical data available

**McClellan Vail, Emily**

No biographical data available

Scientists who work in laboratories are like divers. They search for the pearls called Truth. From the depths of the sea of knowledge they come with glistening jewels in their hands. Teachers take these treasures that they may give them to their pupils. Both are needed if the jewels are to be given to the world.

*Heroic Lives in Universal Religion*

Chapter VI (p. 60)

The Beacon Press. Boston, Massachusetts, USA. 1917

**Young, Thomas** 1773–1829

English polymath

The most difficult thing for a teacher is, to recollect how much it cost himself to learn, and to accommodate his instruction to the apprehension of the uninformed ...

*A Course of Lectures on Natural Philosophy and the Mechanical Arts*

Lecture I (p. 8)

Taylor & Walton. London, England. 1845

## TEACHING

**Acton, F. S.**

No biographical data available

When an engineer apologetically approaches a statistician, graph in hand, and asks how he should fit a straight line to these points, the situation is not unlike the moment when one's daughter inquires where babies come from. There is a need for tact, there is a need for delicacy, but here is opportunity for enlightenment and it must not be discarded casually – or destroyed with the glib answer.

*National Bureau of Standards Report 12–10–51* (p. 1)

U.S. Government Printing Office, Washington, D.C. 1951

### Author undetermined

It is not needful in the present day to discourage thinkers, they are not too numerous.

Exclusion of Opinion

*Westminster Review*, Volume 29, 1838 (p. 49)

**Barzun, Jacques** 1907–

French-born American educator, historian, and author

To begin with, no school subject should be treated like a bitter pill that will go down only if sugar-coated. The merest hint of this confirms the pupil's belief that he faces something dreadful and is a victim.

*Begin Here: The Forgotten Conditions of Teaching and Learning* (p. 81)

University of Chicago Press. Chicago, Illinois, USA. 1992

**Berrill, Norman John** 1903–96

English-born American biologist

A great teacher is not simply one who imparts knowledge to his students but is one who awakens their interest in the subject and makes them eager to pursue it for themselves.

An outstanding teacher is a spark plug, not a fuel line.

In B.W. Rossiter

*Journal of Chemical Education*, Volume 49, 1972 (p. 388)

**Blake, William** 1757–1827

English poet, painter, and engraver

To teach doubt and Experiment

Certainly was not what Christ meant.

*The Complete Writings of William Blake*

The Everlasting Gospel, d. l. 49

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Boerhaave, Herman** 1668–1738

Dutch Chemist, physician, and botanist

As you have put yourselves under my care, to instruct you in the knowledge of Chemistry, I shall think it my duty to endeavor as much as possible to answer your expectations.

*Elements of Chemistry* (Volume 1)

The Design (p. 1)

Printed for J. & J. Pemberton. London, England. 1735

**Bruner, Jerome Seymour** 1915–

American psychologist

The teaching of probabilistic reasoning, so very common and important a feature of modern science, is hardly developed in our educational system before college.

*The Process of Education*

Chapter 3 (p. 45)

Harvard University Press. Cambridge, Massachusetts, USA. 1961

**Darwin, Charles Robert** 1809–82

English naturalist

I am inclined to give up the attempt as hopeless. Those who do not understand, it seems cannot be made to understand.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Hooker, June 5th, 1860 (p. 110)

D. Appleton & Company. New York, New York, USA. 1896

**Ehrensvärd, Gosta Carl Henrik** 1910–1980

Swedish biochemist

...consciousness will always be one dimension above comprehensibility.

Translated by Lennart Rodén

*Man on Another World*

Chapter X (p. 151)

The University of Chicago Press. Chicago, Illinois, USA. 1961

**Eldridge, Paul** 1888–1982

American educator

What difference does it make how often we lower and raise the bucket into the well if the bucket has no bottom?

*Maxims for a Modern Man*

484

T. Yoseloff. New York, New York, USA. 1965

**Faraday, Michael** 1791–1867

English physicist and chemist

A lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him and his mind clear for the contemplation and description of his subject. His action should be slow, easy and natural consisting principally in changes of posture of the body, in order to avoid the air of stiffness or sameness that would otherwise be unavoidable.

In J.M. Thomas

*Michael Faraday – and the Royal Institution*

Chapter 3 (p. 18)

Adam Hilger. Bristol, England. 1991

The most prominent requisite to a lecturer, though perhaps not really the most important, is a good delivery; for though to all true philosophers science and nature will have charms innumerable in every dress, yet I am sorry to say that the generality of mankind cannot accompany us one short hour unless the path is strewn with flowers.

In J.M. Thomas

*Michael Faraday – and the Royal Institution*

Chapter 5 (p. 97)

Adam Hilger. Bristol, England. 1991

...a truly popular lecture cannot teach, and a lecture that truly teaches cannot be popular.

In J.M. Thomas

*Michael Faraday – and the Royal Institution*

Chapter 8 (p. 192)

Adam Hilger. Bristol, England. 1991

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

A good teacher will not just make people accept a form of life, he will also provide them with means of seeing it in perspective and perhaps of even rejecting it.

In Gerard Radnitzky and Gunnar Andersson

*The Structure and Development of Science*

Dialogue on Method (p. 86)

D. Reidel Publishing Company. Dordrecht, Germany. 1979

**Feynman, Richard P.** 1918–88

American theoretical physicist

What I am going to tell you about is what we teach our physics students in the third or fourth year of graduate school.... It is my task to convince you not to turn away because you don't understand it. You see my physics students don't understand it.... That is because I don't understand it. Nobody does.

*QED: The Strange Theory of Light and Matter*

Chapter 1 (p. 9)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

I am giving this winter two courses of lectures to three students, of which one is only moderately prepared, the other less than moderately, and the third lacks both preparation and ability. Such are the onera of a mathematical profession.

*Briefwechsel zwischen Gauss und Bessel*

Letter 4, Letter to Bessel, January 7, 1810 (p. 107)

**Heiss, E. D.** 1899–?

No biographical data available

**Osborn, E. S.** 1897–?

No biographical data available

Science teaching has long concerned itself chiefly with the mastery of laws, facts, and principles to the neglect

of certain of the less tangible, but non the less desirable outcomes, such as attitude of mind.

*Modern Methods and Materials for Teaching Science*

Chapter 2 (p. 15)

The Macmillan Company. New York, New York, USA. 1940

**Herbert, George** 1593–1633

English metaphysical poet

Teach me, my God and King,

In all things thee to see,

And what I do in anything,

To do it as for thee...

*The Elixir*

**Hutchison, Sir Robert Grieve** 1871–1960

English radiologist

Those of us who have the duty of training the raising generation of doctors...must not inseminate the virgin minds of the young with the tares of our own fads. It is for this reason that it is easily possible for teaching to be top "up to date." It is always well, before handing the cup of knowledge to the young, to wait until the froth has settled.

*British Medical Journal*, Volume 1, 1925 (p. 995)

**Huxley, Aldous** 1894–1963

English writer and critic

Ram it in, ram it in!

Children's heads are hollow.

Ram it in, ram it in!

Still there's more to follow.

*Proper Studies*

Education (p. 111)

Chatto & Windus. London, England. 1957

**Huxley, Thomas Henry** 1825–95

English biologist

Therefore, the great business of the scientific teacher is, to imprint the fundamental, irrefragable facts of his science, not only by words upon the mind, but by sensible impressions upon the eye, and ear, and touch of the student, in so complete a manner, that every term used, or law enunciated, should afterwards call up vivid images of the particular structural, or other, facts which furnished the demonstration of the law, or the illustration of the term.

*Lay Sermons, Addresses and Reviews*

On the Study of Zoology (p. 112)

New York, New York, USA. 1872

**Jaffe, Bernard** 1896–1968

Freelance science writer

An effective way to teach the methods of science is to show how our great scientists reached their goals and how their minds worked in the process.

*Journal of Chemical Education*, Volume 15, 1938 (p. 383)

**Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children's writer, and playwright

He learns.

He becomes educated... He instigates knowledge.

*The Complete Tales and Poems of Winnie-the-Pooh*

*The House at Pooh Corner* (p. 254)

Dutton Children's Books. New York, New York, USA. 2001

**Moroney, Michael Joseph** 1918–90

English statistician

Statistics is not the easiest subject to teach, and there are those to whom anything savoring of mathematics is regarded as forever anathema.

*Facts from Figures*

Statistics Desirable (p. 458)

Penguin Books Ltd., Harmondsworth, England. 1951

**Noble, D. F.**

No biographical data available

You will please keep in mind that this is a college and not a technical school. The students who come here are not to be trained as chemists, or geologists or physicists. They are to be taught the great fundamental truths of all sciences. The object aimed at is culture, not practical knowledge.

In George E. Peterson

*The New England College in the Age of the University* (pp. 4–7)

Amherst College Press. Amherst, Massachusetts, USA. 1964

**Olds, Edwin G.**

No biographical data available

It is hard to understand why he failed to appreciate the pedagogical value of designing an experiment to illustrate a point of theory, predicting the result, running the experiment, and then taking the consequences if it turned out wrong.

Teaching Statistical Quality Control for Town and Gown

*Journal of the American Statistical Association*, Volume 44, 1949

(pp. 223–224)

**Regnault, Noël** 1702–62

Jesuit mathematician

Will you discover to me...those Secrets which Nature has imparted to you?

*Philosophical Conversations* (Volume 1)

Conversation XII (p. 154)

Printed for W. Innys, C. Davis, and N. Prevost. London, England. 1731

**Rohrlich, Fritz**

No biographical data available

Come, join me on an adventure of the mind. The going will be a little demanding at times but there will be rich rewards. The new vistas are spectacular. Come with me, I am an experienced guide!

*From Paradox to Reality: Our Basic Concepts of the Physical World*

Preface (p. vii)

Cambridge University Press. Cambridge, England. 1987

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

True teaching is a grave profession – Demands most thoughtful, wise discretion.

*Encyclopedia of Thoughts*

Couplets

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Schufle, J. A.**

No biographical data available

The teaching of chemistry has for too long been a process in which facts are transmitted from the notebook of the professor into the notebook of the student without going through the heads of either.

The Use of Case Histories in the Teaching of History of Science

*The Texas Journal of Science*, Volume 21, Number 1, October, 1969

(p. 101)

**Stoppard, Tom** 1937–

Czech-born English playwright

THOMASINA: If you do not teach me the true meaning of things, who will?

SEPTIMUS: Ah. Yes, I am ashamed. Carnal embrace is sexual congress, with the insertion of the male genital organ into the female genital organ for purposes of procreation and pleasure. Fermat's last theorem, by contrast, asserts that when  $x$ ,  $y$ , and  $z$  are whole numbers each raised to power of  $n$ , the sum of the first two can never equal the third when  $n$  is greater than 2. (Pause.)

THOMASINA: Eurghhhh!

SEPTIMUS: Nevertheless, that is the theorem.

THOMASINA: It is disgusting and incomprehensible. Now when I am grown to practice it myself I shall never do so without thinking of you.

*Arcadia*

Act I, Scene One (p. 3)

Faber &amp; Faber Ltd. London, England. 1993

**Sylvester, James Joseph** 1814–97

English mathematician

...the two functions of teaching and working in science should never be divorced.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

An Inquiry into Newton's Rule for the Discovery of Imaginary

Roots (p. 75)

University Press. Cambridge, England. 1904–1912

May the time never come when the two offices of teaching and researching shall be sundered in this University [Johns Hopkins]! So long as man remains a gregarious and sociable being, he cannot cut himself off from the gratification of the instinct of imparting what he is learning, of propagating through others the ideas and impressions seething in his own brain, without stunting

and atrophying his moral nature and drying up the surest sources of his future intellectual replenishment.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

Proof of the Fundamental Theorem of Invariants (1878) (p. 77)

University Press. Cambridge, England. 1904–1912

**Truesdell, Clifford** 1919–2000

American mathematician, natural philosopher, historian of mathematics

Formerly, the beginner was taught to crawl through the underbrush, never lifting his eyes to the trees; today he is often made to focus on the curvature of the universe, missing even the earth.

*Six Lectures on Modern Natural Philosophy*

Lecture I (p. 22)

Springer-Verlag. New York, New York, USA. 1966

**Tukey, John W.** 1915–2000

American statistician

Teaching data analysis is not easy, and the time allowed is always far from sufficient.

The Future of Data Analysis

*Annals of Mathematical Statistics*, Volume 33, Number 1, March, 1962

(p. 11)

**Weinberg, Alvin Martin** 1915–

American physicist

Very typically a field that was once fashionable eventually ceases to command the interest of the scientists in that field and becomes the concerns of scientists in another field. Nuclear chemistry is a good example of this trend: it began as nuclear physics, was taken over by the chemists, and now, insofar as nuclear properties of radionuclide are important for technology, parts of nuclear chemistry are being taken over by engineers. This tendency for fashions in science to come and go greatly complicates the teaching of science. For, as science proliferates, the discrepancy tends to widen between the older, consolidated body of scientific knowledge and the parts of science that excite the active researcher.

*Reflections on Big Science*

Chapter II (p. 46)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

No man can be a good teacher when his subject becomes inexplicable.

*Experiment in Autobiography*

Chapter 5, Section 2 (p. 176)

The Macmillan Company. New York, New York, USA. 1934

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Education is an admirable thing, but it is well to remember from time to time that nothing that is worth knowing can be taught.

*Epigrams: Phrases and Philosophies for the Use of the Young*  
 Sebastian Melmoth  
 A.R. Keller. London, England. 1907

**Wright, Charles R. A.**

No biographical data available

...in teaching the science of chemistry it is preferable, first, to enumerate the facts in language independent of any hypothesis, and then to enunciate the various hypotheses that have been and are held, showing how far each is in accordance or contradiction with the observed facts; rather than to mix up from the outset one particular hypothesis with the facts, so as finally to impress on the mind the manifestly erroneous conclusion that the facts have no evidence apart from the hypothesis that more or less clearly explains them.

Atoms

*The Athenaeum*, Number 2398, 11 October, 1873 (p. 468)

**TECHNICAL TERM**

**Smith, George Otis** 1871–1944

American geologist

Technical terms have their places, and I am on record as admitting that exact scientific statement needs special terms, words that best keep their razor edge when used only for hairsplitting distinctions. This limited use of a highly specialized terminology is wholly defensible, for it would be folly to throw away tools so well-fitted for special purposes, just as it is unwise to put them to everyday uses with everyday people. Transubstantiation, transpiration, and transgression are technical words that are useful enough to the professional theologian, biologist, and geologist, but they are code words that must be decoded before others can understand them.

Paper presented to the Society of Economic Geologists at the Amherst Meeting  
 December 28, 1921

**TECHNOLOGY**

**Abbey, Edward** 1927–89

American environmentalist and nature writer

High technology has done us one great service: It has retaught us the delight of performing simple and primordial tasks – chopping wood, building a fire, drawing water from a spring...

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
 Chapter 10 (p. 92)  
 St. Martin's Press. New York, New York, USA. 1989

**Adler, Alfred** 1870–1937

Austrian psychiatrist

The confusion of science with technology is understandable. Certainly the two often appear to be aspects of a

single larger process, as when science proposes new laws of physics, which inspire the development of a technology for their exploration, which in turn exposes inaccuracies in the laws and forces science to seek a more profound level of theory. But in fact their divergence is great. It is in the divergence of engagement from fulfillment, of means from ends....

*Atlantic Monthly*, Volume 279, Number 2, February, 1997 (p. 16)

If truth is a path, then science explores it, and the brief stops along the way are where technologies begin (they build towns and pave a highway). Technology is results, science is process; though the two fuse and separate and then fuse once more, as ends and means must, their opposition is profound.

*Atlantic Monthly*, Volume 279, Number 2, February, 1997 (p. 16)

**Allen, Charles M.**

American academic

If the human race wants to go to hell in a basket, technology can help it get there by jet. It won't change the desire or the direction, but it can greatly speed the passage.

Speech

Wake Forest University, Winston-Salem, North Carolina, April 25, 1967

**Ashby, Sir Eric** 1904–82

British botanist and educator

The habit of apprehending a technology in its completeness: this is the essence of technological humanism, and this is what we should expect education in the higher technology to achieve. I believe it could be achieved by making specialists' studies the core around which are grouped liberal studies which are relevant to these specialist studies. But they must be relevant; the path to culture should be through a man's specialism, not by-passing it.

*Technology and the Academics: An Essay on Universities and the Scientific Revolution*  
 Chapter 4 (p. 84)  
 St. Martin's Press. New York, New York, USA. 1959

A student who can weave his technology into the fabric of society can claim to have a liberal education; a student who cannot weave his technology into the fabric of society cannot claim even to be a good technologist.

*Technology and the Academics: An Essay on Universities and the Scientific Revolution*  
 Chapter 4 (p. 85)  
 St. Martin's Press. New York, New York, USA. 1959

**Association of American Colleges**

...we have become a people unable to comprehend the technology we invent...

*Integrity in the College Curriculum*, February, 1985 (p. 2)

**Ballard, James Graham** 1930–

English writer



Science and technology multiply around us. To an increasing extent they dictate the languages in which we speak and think. Either we use those languages, or we remain mute.

*Crash*

Introduction (p. 7)

Flamingo. London, England. 1993

**Barzun, Jacques** 1907–

French-born American educator, historian, and author

...something pervasive that makes the difference, not between civilized man and the savage, not between man and the animals, but between man and the robot, grows numb, ossifies and falls away like black mortified flesh when techne assails the senses and science dominates the mind.

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 5 (p. 103)

The New American Library, Inc. New York, New York, USA. 1967

**Beer, Stafford** 1926–2002

English theorist academic and consultant

If it works, it's out of date.

*Brain of the Firm: A Development in Management Cybernetics*

Dedication (p. v)

Herder & Herder. New York, New York, USA. 1972

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

Every civilization has been grounded on technology: what makes ours unique is that for the first time we believe that every man is entitled to all its benefits.

Technology and Culture in Evolution

*The American Scholar*, Volume 41, Number 2, Spring 1972 (p. 207)

**Bunge, Mario** 1919–

Argentine philosopher and physicist

...whereas science elicits changes in order to know, technology knows in order to elicit changes.

In G. Bugliarello and D. B. Doner (eds.)

*The History and Philosophy of Technology*

Chapter 15 (p. 264)

University of Illinois Press. Urbana, Illinois, USA. 1979

**Byrom, Gletcher L.**

No biographical data available

Technology is like having a spouse who helps you with the problems that you wouldn't have had if you hadn't gotten married in the first place.

Technology Is...and Where It's Taking Us

*Science Digest*, Volume 83, Number 2, February, 1978 (p. 25)

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Any sufficiently advanced technology is indistinguishable from magic.

*The Lost Worlds of 2001*

Chapter 34 (p. 189)

New American Library. New York, New York, USA. 1972

...we know now that comet and asteroid impacts have changed history, and soon we will have the technology to avert that disaster. ...[T]he dinosaurs became extinct because they didn't have a space program.

Interview

*Discover Magazine*, July 1999

**Clinton, William Jefferson** 1946–

42nd president of the USA

Technology is almost magical, and ambition for a better life is now universal.

Inaugural Speech

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

Despite the dazzling successes of modern technology and the unprecedented power of modern military systems, they suffer from a common and catastrophic fault. While providing us with a bountiful supply of food, with great industrial plants, with high-speed transportation, and with military weapons of unprecedented power, they threaten our very survival.

*Science and Survival*

Chapter 7 (p. 126)

The Viking Press. New York, New York, USA. 1966

**de Bono, Edward** 1933–

Maltese psychologist and writer

Those who assert that technology has done more harm than good are thinking of a romantic dream world in which a select elite lived a short life of ease and intellectual sophistication surrounded by a population living an even shorter life of poverty, starvation and disease.

*Technology Today*, 1971

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

...the machine does not isolate man from the great problems of nature but plunges him more deeply into them.

*Wind, Sand, and Stars*

Chapter 3 (p. 67)

Reynal & Hitchcock. New York, New York, USA. 1939

**DeSimone, Daniel V.**

No biographical data available

**Cross, Hardy** 1885–1959

American engineer

Technological invention and innovation are the business of engineering. They are embodied in engineering change.

*Education for Innovation*

Introduction (p. 4)

Pergamon Press. New York, New York, USA. 1968



**Drexler, K. Eric** 1955–

American nanotechnology engineer and researcher, and futurist

The promise of technology lures us onward, and the pressure of competition makes stopping virtually impossible. As the technology race quickens, new developments sweep toward us faster, and a fatal mistake grows more likely. We need to strike a better balance between our foresight and our rate of advance. We cannot do much to slow the growth of our technology, but we can speed growth of foresight. And with better foresight, we will have a better chance to steer the technology race in safe directions.

*Engines of Creation*

Finding the Facts (p. 203)

Anchor Press/Doubleday. Garden City, New York, USA. 1986

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The idealistic and the demonic forces in nationalism are as powerful today as they were in the past but their expressions are changing, because human history is moving from its hallowed parochial traditions to the era of global technology.... The one credo of technology which has been accepted practically all over the world is that nature is to be regarded as a source of raw materials to be exploited for human ends rather than as an entity to be appreciated for its own value.

*A God Within*

Chapter 10 A Demon Within (p. 204)

Charles Scribner's Sons. New York, New York, USA. 1972

**Dyson, Freeman J.** 1923–

American physicist and educator

If we had a reliable way to label our toys good and bad, it would be easy to regulate technology wisely. But we can rarely see far enough ahead to know which road leads to damnation. Whoever concerns himself with big technology, either to push it forward or to stop it, is gambling in human lives.

*Disturbing the Universe*

Chapter 1 (p. 7)

Basic Books, Inc. New York, New York, USA. 1979

**Editorial**

Technology, when misused, poisons air, soil, water and lives. But a world without technology would be prey to something worse: the impersonal ruthlessness of the natural order, in which the health of a species depends on relentless sacrifice of the weak.

*New York Times*, 29 August, 1986

**Embree, Alice** 1945–

American peace and women's rights activist

America's technology has turned in upon itself; its corporate form makes it the servant of profits, not the servant of human needs.

In Robin Morgan

*Sisterhood Is Powerful: An Anthology of Writings from the Women's Liberation Movement*

Media Images 1 (p. 211)

Random House, Inc. New York, New York, USA. 1970

**Feynman, Richard P.** 1918–88

American theoretical physicist

For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.

*What Do You Care What Other People Think?*

Appendix F (p. 237)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Frisch, Max** 1911–

Novelist, playwright and diarist

We live technologically, with man as the master of nature, man as the engineer, and let anyone who raises his voice against it stop using bridges not built by nature.... No electric light bulbs, no engines, no atomic energy, no calculating machines, no anesthetics – back to the jungle.

Translated by Michael Bullock

*Homo Faber: A Report* (p. 103)

Harcourt Brace Jovanovich. San Diego, California, USA. 1959

Technology is the knack of so arranging the world that we don't have to experience it.

In Rollo May

*The Cry for Myth*

Chapter Three (p. 57)

W.W. Norton & Company, Inc. New York, New York, USA. 1991

**Gäbor, Dennis** 1900–79

Hungarian-English physicist

The most important and urgent problems of the technology of today are no longer the satisfactions of the primary needs or of archetypal wishes, but the reparation of the evils and damages by technology of yesterday.

*Innovations: Scientific, Technological and Social*

Introduction (p. 9)

Oxford University Press, Inc. Oxford, England. 1970

**Galbraith, John Kenneth** 1908–2006

Canadian-American economist

The imperatives of technology and organization, not the images of ideology, are what determine the shape of economics.

*The New Industrial State*

Chapter I, Section 3 (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

It is a commonplace of modern technology that there is a high measure of certainty that problems have solutions before there is knowledge of how they are to be solved.

*The New Industrial State*

Chapter II, Section 4 (p. 19)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**Gore, Al** 1948–

45th vice-president of the United States and environmentalist

Mistakes in our dealings with Mother Nature can now have much larger unintended consequences, because many of our new technologies confer upon us new power without automatically giving us new wisdom.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 247)  
Rodale. New York, New York, USA. 2006

### **Greene, Charles H.**

No biographical data available

It does no harm to be reminded occasionally that modern technologies still contain large elements of empiricism.

Glass  
*Scientific American*, Volume 204, Number 1, January, 1961 (p. 92)

### **Hanham, H. J.**

No biographical data available

Great technological advances are always around the corner.

Clio's Weapons  
*Daedalus*, Spring 1971 (p. 509)

### **Heidegger, Martin** 1889–1976

German philosopher

...the essence of technology...is nothing technological.

*Basic Writings*  
The Question Concerning Technology (p. 285)  
Harper & Row. New York, New York, USA. 1977

### **Hoffer, Eric** 1902–83

American longshoreman and philosopher

Where there is the necessary technical skill to move mountains, there is no need for the faith that moves mountains.

*The Passionate State of Mind, and Other Aphorisms*  
No. 12  
Harper & Brothers. New York, New York, USA. 1955

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Science is unique to human activities in that it possesses vast areas of certain knowledge. The collective opinion of scientists in these areas about any problem covered by them will almost always be correct. It is unlikely that much in these areas will be changed in the future, even in a thousand years. And because technology rests almost exclusively on these areas the products of technology work as they are intended to do.

*The Origin of the Universe and the Origin of Religion* (p. 17)  
Moyer Bell. Wakefield, Rhode Island, USA. 1993

### **Huxley, Aldous** 1894–1963

English writer and critic

Advances in technology do not abolish the institution of war; they merely modify its manifestations.

*Science, Liberty and Peace*

Chapter II (p. 47)

William Morrow & Company, Inc. New York, New York, USA. 1967

### **Jones, Barry**

No biographical data available

The reality is that many of the changes in science and technology are complex because of the complexity of them.

Sayings of the Week  
*Sydney Morning Herald*, 12 July 1986

### **Kaysen, Carl** 1920–

American economist

...the advance of technology, like the growth of population and industry, has also been proceeding exponentially. Limits to Growth

*Foreign Affairs*, Volume 50, Number 4, July 1972 (p. 664)

### **Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

Technology made large populations possible; large populations now make technology indispensable.

*Human Nature and the Human Condition*  
Chapter VIII (p. 145)  
Random House, Inc. New York, New York, USA. 1959

### **Lerner, Max** 1902–92

American educator and author

...a world technology means either a world government or world suicide.

*Actions and Passions: Notes on the Multiple Revolution of Our Time*  
The Imagination of H.G. Wells (p. 17)  
Simon & Schuster. New York, New York, USA. 1949

### **Lilienthal, David E.** 1899–1981

American businessman and Tennessee Valley Authority administrator

The machine that frees man's back of drudgery does not thereby make his spirit free. Technology has made us more productive, but it does not necessarily enrich our lives. Engineers can build us great dams, but only great people make a valley great. There is no technology of goodness. Men must make themselves spiritually free.

*TVA: Democracy on the March* (p. 218)  
Harper & Brothers. New York, New York, USA. 1944

### **Lovins, Amory B.** 1947–

American physicist and industry consultant

Any demanding high technology tends to develop influential and dedicated constituencies of those who link its commercial success with both the public welfare and their own. Such sincerely held beliefs, peer pressures, and the harsh demands that the work itself places on time and energy all tend to discourage such people from acquiring a similarly thorough knowledge of alternative policies and the need to discuss them.

Energy Strategy  
*Foreign Affairs*, Volume 55, Number 1, October, 1976 (p. 93)

**Meadows, Donella H.** 1941–2001  
American scientist, sustainability advocate, and writer

**Meadows, Dennis L.**  
American professor of systems science

Technology can relieve the symptoms of a problem without affecting the underlying causes. Faith in technology as the ultimate solution to all problems can thus divert our attention from the most fundamental problem – the problem of growth in a finite system – and prevent us from taking effective action to solve it.

*The Limits to Growth: The 30 Year Update*  
Chapter IV (p. 154)  
Chelsea Green Publishing, White River Junction, Vermont, USA. 2004

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

The open society, the unrestricted access to knowledge, the unplanned and uninhibited association of men for its furtherance – these are what may make a vast, complex, ever growing, ever changing, ever more specialized and expert technological world, nevertheless a world of human community.

*Science and the Common Understanding*  
Chapter 6 (p. 95)  
Simon & Schuster, New York, New York, USA. 1953

In fact, most people – when they speak of Science as a good thing – have in mind such Technology as has altered the condition of their life.

*The Sacred Beetle and Other Great Essays in Science*  
Physics in the Contemporary World (p. 194)  
Prometheus Books, Buffalo, New York, USA. 1984

## Organisation for Economic Co-Operation and Development

Science and technology...have a number of distinguishing characteristics [that] cause special problems or complications. One...is ubiquity: they are everywhere. They are at the forefront of social change. They not only serve as agents of change, but provide the tools for analysing social change. They pose, therefore, special challenges to any society seeking to shape its own future and not just to react to change or to the sometimes undesired effects of change.

*Technology on Trial: Public Participation in Decision-Making Related to Science and Technology*  
Chapter I, Section B (p. 16)  
Organization for Economic Co-operation and Development, Paris, France. 1979

**Orwell, George (Eric Arthur Blair)** 1903–50  
English novelist and essayist

...men are only as good as their technical development allows them to be.

*Critical Essays*  
Charles Dickens, I (p. 40)  
Secker & Warburg, London, England. 1946

**Panofsky, Wolfgang** 1919–2007  
German-born American particle physicist

...the definition of conventional technology is that it worked once.

In Gary Taubes  
*Nobel Dreams*  
Chapter 4 (p. 51)  
Random House, Inc. New York, New York, USA. 1986

**Perry, Ralph Barton** 1876–1957  
American realist philosopher

The greatest of all modern ideas, in its originality, in its widespread adoption, and in its far-reaching importance, is...the idea that man can make his way through all the difficulties and dangers that beset him, by means of applied science or technology.

*The Present Conflict of Ideals*  
Chapter V (p. 58)  
Longmans, Green & Co. New York, New York, USA. 1918

**Pirsig, Robert M.** 1928–  
American writer

The way to solve the conflict between human values and technological needs is not to run away from technology, that's impossible. The way to resolve the conflict is to break down the barriers of dualistic thought that prevent a real understanding of what technology is – not an exploitation of nature, but the fusion of nature and the human spirit into a new kind of creation that transcends both.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part III, Chapter 25 (p. 291)  
William Morrow & Company, Inc. New York, New York, USA. 1974

**Pope Pius XII** 1876–1958  
Bishop of Rome

The Church welcomes technological progress and receives it with love, for it is an indubitable fact that technological progress comes from God and, therefore, can and must lead to Him.

Christmas message, 1953

**Primack, Joel**  
Astronomer

**von Hippel, Frank**  
Nuclear physicist

It has been remarked that all technology is a Faustian bargain: one obtains conveniences and sometimes luxuries, but in exchange one gets increased potential for catastrophes.

Nuclear Reactor Safety  
*Bulletin of the Atomic Scientists*, Volume XXX, Number 8, October, 1974 (p. 5)

**Reich, Charles A.**  
No biographical data available

Technology and production can be great benefactors of man, but they are mindless instruments, and if undirected they careen along with a momentum of their own. In our country, they pulverize everything in their path: the landscape, the natural environment, history and tradition, the amenities and civilities, the privacy and spaciousness of life, beauty, and the fragile, slow-growing social structures which bind us together.

*The Greening of America*

Chapter 1 (pp. 5–6)

Bantam Books. New York, New York, USA. 1971

**Rickover, Hyman G.** 1900–86

American naval nuclear engineer

...technology can have no legitimacy unless it inflicts no harm.

A Humanistic Technology

*Mechanical Engineering*, November, 1982 (p. 45)

**Sagan, Carl** 1934–96

American astronomer and science writer

Many visionary leaders have imagined a time when the allegiance of an individual human being is not to his particular nation-state, religion, race, or economic group, but to mankind as a whole; when the benefit to a human being of another sex, race, religion, or political persuasion ten thousand miles away is as precious to us as to our neighbor or our brother. The trend is in this direction, but is agonizingly slow. There is a serious question whether such a global self-identification of mankind can be achieved before we destroy ourselves with the technological forces our intelligence has unleashed.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 1 (p. 6)

Dell Publishing, Inc. New York, New York, USA. 1975

The so-called generation gap is a consequence of the rate of social and technological change.

Even within a human lifetime, the change is so great that many people are alienated from their own society. Margaret Mead had described older people as involuntary immigrants from the past to the present.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 5 (p. 36)

Dell Publishing, Inc. New York, New York, USA. 1975

We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology.

Why We Need to Understand Science

*Parade magazine*, September 10, 1989

**Schumacher, Ernst Friedrich** 1911–77

German-born British economist

...the system of nature, of which man is a part, tends to be self-balancing, self-adjusting, self-cleansing. Not so with technology.... The technology of mass production is

inherently violent, ecologically damaging, self-defeating in terms of non-renewable resources, and stultifying for the human person.

*Small Is Beautiful*

Part II, Chapter V (p. 145)

Harper & Row, Publishers. New York, New York, USA. 1973

**Snow, Charles Percy** 1905–80

English novelist and scientist

Technology...is a queer thing. It brings you great gifts with one hand, and it stabs you in the back with the other.

*New York Times*, 15 March, 1971

**Sophocles** 496 BCE–406 BCE

Greek playwright

Wonders are many, and none is more wonderful than man; the power that crosses the white sea, driven by the stormy south-wind, making a path under surges that threaten to engulf him...turning the soil with the offspring of horses, as the ploughs go to and fro from year to year.... And speech, and windswift thought, and all the moods that mould a state, hath he taught himself; and how to flee the arrows of the frost, when 'tis hard lodging under the clear sky, and the arrows of the rushing rain; yea, he hath resource for all....

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

*Antigone*, l. 333–340, 349–354

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Soulé, Michael E.**

American conservation biologist

Since we have no choice but to be swept along by this vast technological surge, we might as well learn to surf.

In David Western and Mary C. Pearl

*Conservation for the Twenty-First Century*

*Conservation Biology in the Twenty-First Century: Summary and Outlook* (p. 303)

Oxford University Press. New York, New York, USA. 1989

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

Technology, while adding daily to our physical ease, throws daily another loop of fine wire around our souls. It contributes hugely to our mobility, which we must not confuse with freedom. The extensions of our senses, which we find so fascinating, are not adding to the discrimination of our minds, since we need increasingly to take the reading of a needle on a dial to discover whether we think something is good or bad, or right or wrong.

My Faith in Democratic Capitalism

*Fortune Magazine*, October, 1955 (p. 156)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Our inventions are wont to be pretty toys, which distract our attention from serious things. They are but improved means to an unimproved end.

*The Writings of Henry David Thoreau* (Volume 2)  
Walden

Chapter 1 (p. 84)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Toffler, Alvin** 1928–

American writer and futurist

...[a] great, growling engine of change – technology.

*Future Shock*

Chapter 2 (p. 25)

Random House, Inc. New York, New York, USA. 1979

...technology feeds on itself. Technology makes more technology possible...

*Future Shock*

Chapter 2 (p. 27)

Random House, Inc. New York, New York, USA. 1979

If technology...is to be regarded as a great engine, a mighty accelerator, then knowledge must be regarded as its fuel. And we thus come to the crux of the accelerative process in society, for the engine is being fed a richer and richer fuel every day.

*Future Shock*

Chapter 2 (pp. 29–30)

Random House, Inc. New York, New York, USA. 1979

**Wilkins, Maurice** 1916–2004

New Zealand-born English molecular biologist

Science, with technology, is the only way we have to avoid starvation, disease, and premature death. The misapplication of science and technology is due to the fact that the politics are wrong. Now my own view is that the politics are indeed wrong; but politics and science are so closely interrelated that they can hardly be separated.

In Horace Freeland Judson

*The Eighth Day of Creation: Makers of the Revolution in Biology*

DNA, You Know, Is Midas' Gold (p. 97)

Simon & Schuster. New York, New York, USA. 1979

## TECTONICS

### Author undetermined

I believe in Plate Tectonics Almighty, Unifier of the Earth Sciences, and explanation of all things geological and geophysical; and in our Xavier le Pichon, revealer of relative motion, deduced from spreading rates about all ridges; Hypothesis of Hypothesis, Theory of Theory, Very Fact of Very Fact; deduced not assumed; Continents being of one unit with the Oceans, from which all plates spread; Which when they encounter another plate and are subducted, go down in Benioff Zones, and are resorbed into the Asthenosphere, and are made Mantle; and cause earthquake foci also under Island Arcs; They soften and

can flow; and at the Ridges Magma rises again according to Vine and Matthews; and ascends into the Crust, and maketh symmetrical magnetic anomalies; and the sea floor shall spread again, with continents, to make both mountains and faults, Whose evolution shall have no end.

And I believe in Continental Drift, the Controller of the evolution of Life, Which proceedeth from Plate Tectonics and Sea-Floor Spreading; Which with Plate Tectonics and Sea-Floor Spreading together is worshipped and glorified; Which was spake of by Wegner; And I believe in one Seismic and Volcansitic pattern; I acknowledge one Cause for the deformation of rocks; and I patiently look for the eruption of new Ridges and the subduction of the Plates to come. Amen.

Source undetermined

## TEKTITES

**Faul, Henry** 1920–81

Czech-American geochronologist

To anyone who has worked with them, tektites are probably the most frustrating stones ever found on Earth.

Tektites are Terrestrial

*Science*, Volume 152, Number 3727, 3 June, 1966 (p. 1341)

## TELEOLOGY

**Ayala, Francisco J.** 1934–

Spanish-American biologist and philosopher

Biological evolution can however be explained without recourse to a Creator or a planning agent external to the organisms themselves. The evidence of the fossil record is against any directing force, external or immanent, leading the evolutionary process toward specified goals. Teleology in the stated sense is, then, appropriately rejected in biology as a category of explanation.

Biology as an Autonomous Science

*American Scientist*, Volume 56, Number 3, Autumn 1968 (p. 213)

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Of all the questions now engaging the attention of those whose destiny has commanded them to take more or less exercise of mind, I know of none more interesting than that which deals with what is called teleology – that is to say, with design or purpose, as evidenced by the different parts of animals and plants.

*Evolution, Old and New*

Chapter 1 (p. 1)

Hardwicke & Bogue. London, England. 1879

**Huxley, Thomas Henry** 1825–95

English biologist



Nevertheless it is necessary to remember that there is a wider Teleology, which is not touched by the doctrine of Evolution, but is actually based upon the fundamental proposition of Evolution. That proposition is, that the whole world, living and not living, is the result of the mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed. If this be true, it is no less certain that the existing world lay, potentially, in the cosmic vapour; and that a sufficient intelligence could, from a knowledge of the properties of the molecules of that vapour, have predicted, say the state of the Fauna of Britain in 1869, with as much certainty as one can say what will happen to the vapour of the breath in a cold winter's day.

*Critiques and Addresses* (pp. 272–273)

**Reichenbach, Hans** 1891–1953

German philosopher of science

Teleology is analogism, is pseudo explanation; it belongs in speculative philosophy, but has no place in scientific philosophy.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 195)

University of California Press. Berkeley, California, USA. 1951

**von Brücke, Ernst** 1819–92

German-born physicist and physiologist

Teleology is a lady without whom no biologist can live. Yet he is ashamed to show himself with her in public.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Five (p. 61)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

## TELESCOPE

### Author undetermined

He [man] cannot but feel a sense of pleasure, and even of power, when the telescope reveals to his gaze not only the worlds that constitute his own so-called Solar System, but the suns that light up the borders of the Universe, system upon system, sun upon sun, covering the unbounded area almost as thickly as the daisies cover a meadow in spring.

*The Story of The Herschels: A Family of Astronomers*

Chapter I

T. Nelson & Sons. London, England. 1889

In the old Telescope's tube we sit,  
And the shades of the past around us flit;  
His requiem sing we, with shout and with din,  
While the old year goes out, and the new one comes in.  
*Chorus of youths and virgins.* Merrily, merrily, let us all sing,

And make the old Telescope rattle and ring.

In Charles Richard Weld (ed.)

*A History of the Royal Society, With Memoirs of the Presidents* Volume 2

The Herschelian Telescope Song (p. 195)

John Parker. London, England. 1848

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

Telescope (n): A device having a relation to the eye similar to that of a telephone to the ear, enabling distant objects to plague us with a multitude of needless details.

*The Devil's Dictionary*

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**Brecht, Bertolt** 1898–1956

German writer

LUDOVICO: ...look at that queer tube thing they're selling in Amsterdam. I gave it a good looking-over. A green leather casing and a couple of lenses, one this way [he indicates a concave lens].... One of them's supposed to magnify and the other reduces. Anyone in his right mind would expect them to cancel out. They don't. The thing makes everything appear five times the size. That's science for you.

Translated by John Willett

*Life of Galileo*

Scene 1 (pp. 12–13)

Arcade Publishing. New York, New York, USA. 1994

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

And now the lofty telescope, the scale  
By which they venture Heav'n itself t' assail,  
Was raised, and planted full against the Moon...

*The Poetical Works of Samuel Butler* (Volume 2)

Elephant in the Moon

Bell & Daldy. London, England. 1835

**Carpenter, William Benjamin** 1813–85

English physiologist and naturalist

...in the *telescope*, by which our power of sight is so wonderfully augmented, that we are enabled, when gazing through it into the unfathomable depths of space, to take cognizance of world beyond world and system beyond system, whose remoteness cannot be expressed by any form of words that shall convey a distinct idea to the mind, and to bring the members of our own group within such visual proximity to ourselves, that we can scrutinize their appearance nearly as well as if they had actually been brought a thousand times nearer to us.

*The Microscope and Its Revelations*

Introduction (pp. 1–2)

John Churchill. London, England. 1866

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician



All this time the Guard was looking at her, first through a telescope, then through a microscope, and then through an opera-glass.

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter III (pp. 169–170)

The Modern Library. New York, New York, USA. 1936

### **Cedering, Siv** 1939–

Swedish-American poet, painter, and sculptor

I have helped him polish the mirrors and lenses of our new telescope. It is the largest in existence. Can you imagine the thrill of turning it to some new corner of the heavens to see something never before seen from the earth?

*Science 84*

Letter from Caroline Herschel (1750–1840)

### **Clerke, Agnes Mary** 1842–1907

Irish astronomer

...access to the nebular heavens can be gained only by making the very most of the little light they send us.

*The System of the Stars* (2nd edition)

Chapter 1 (p. 11)

Adam & Charles Black. London, England. 1905

### **Copeland, Leland S.** 1886–?

American poet and writer

Then outward turn an optic tube  
From some high, lonely hill,  
That we may glance at cosmic nooks  
And marvels rich, until  
The morning glow conceals those realms  
Where precious things distill,  
Far-forth beyond the utmost reach  
Of human hope and will.

All Night with the Stars

*Sky & Telescope*, November, 1949

Many of us find that to leave bright room and cozy chair for the dark world outside is contrary to nature, like a moth flying from the light. As a bather plunges into cold water, so the sky hunter must immerse himself in darkness before he will find it comfortable in the night.... So rich is this nocturnal wonderland that even for smallest telescopes numerous objects await observation. A larger lens or mirror is not an assured benefit. Devotion and patience are as important as light grasp.

All Night with the Stars

*Sky & Telescope*, November, 1949

### **de Grasse Tyson, Neil** 1958–

American astrophysicist and writer

The most famous telescope in modern times is, of course, the Hubble, known to the public primarily through the beautiful, full-color, high-resolution images it has produced of objects in the universe. The problem here is that after viewing such exhibits, you wax poetic about the

beauty of the universe yet are no closer than before to understanding how it all works....

Over the Rainbow

*Natural History*, Volume 110, Number 7, September, 2001 (p. 34)

While much good science has come from the Hubble telescope (including the most reliable measure to date for the expansion rate of the universe), you would never know from media accounts that the foundation of our cosmic knowledge continues to flow primarily from the analysis of spectra and not from looking at pretty pictures.

Over the Rainbow

*Natural History*, Volume 110, Number 7, September, 2001 (p. 34)

### **Dressler, Alan**

American astronomer

To look into space is to look back into time, and telescopes are time machines we can ride nearly all the way back to creation itself.

Observing Galaxies Through Time

*Sky and Telescope*, Volume 82, Number 2, August, 1991 (p. 126)

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The sight of a planet through a telescope is worth all the course on astronomy...

*Ralph Waldo Emerson: Essays and Lectures*

*Essays: Second Series*

New England Reformers (p. 594)

The Library of America. New York, New York, USA. 1983

### **Everett, Edward** 1794–1865

American statesman, educator, and orator

The telescope may be likened to a wondrous cyclopean eye, endued with superhuman power, by which the astronomer extends the reach of his vision to the further heavens, and surveys galaxies and universes compared with which the solar system is but an atom floating in the air.

The Uses of Astronomy, An Oration Delivered at Albany, New York, 28 July 1856 (p. 22)

Ross & Tousey. New York, New York, USA. 1856

### **Faulharer, C.**

No biographical data available

The three principal instruments for the study of the heavenly bodies are the telescope, the spectroscope, and the photographic camera; and since the latter are made useful only as they are attached to the former, it is the telescope which we must still regard as the key to unlock the doors of the universe.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1904)

Construction of Large Telescope Lenses (p. 163)

Government Printing Office. Washington, D.C. 1905

### **Ferris, Timothy** 1944–

American science writer

Telescopes are like musical instruments, in that you get out of them what you put into them.

*Seeing in the Dark*

Appendix A (p. 299)

Simon & Schuster. New York, New York, USA. 2002

**Frost, Robert** 1874–1963

American poet

Man acts more like the poor bear in a cage  
That all day fights a nervous inward rage...  
The toenail click at the shuffle of his feet,  
The telescope at one end of his beat,  
And at the other end the microscope,  
Two instruments of nearly equal hope...

*Complete Poems of Robert Frost*

The Bear

Henry Holt & Company. New York, New York, USA. 1949

He burned his house down for the fire insurance  
And spent the proceeds on a telescope  
To satisfy a lifelong curiosity  
About our place among the infinities.

*Complete Poems of Robert Frost*

The Star Splitter

Henry Holt & Company. New York, New York, USA. 1949

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

O telescope, instrument of much knowledge, more precious than any scepter! Is not he who holds thee in his hand made king and lord of the works of God?

In William H. Jefferys and R. Robert Robbins

*Discovering Astronomy* (p. 174)

John Wiley & Sons, Inc. New York, New York, USA. 1995

All which facts were discovered and observed a few days ago by the help of a telescope devised by me, through God's grace first enlightening my mind.

Translated by Edward Stafford Carlos

*The Sidereal Messenger of Galileo Galilei, and a Part of the Preface to Kepler's Dioptrics*

The Astronomical Messenger (p. 9)

Rivingtons. London, England. 1880

**Gamow, George** 1904–68

Russian-born American physicist

My telescope  
Has dashed your hope;  
Your tenets are refuted.  
Let me be terse:  
Our universe  
Grows daily more diluted!

*Mr. Tompkins in Paperback*

Chapter 6 (p. 63)

At The University Press. Cambridge, England. 1965

**Hankins, Arthur Preston** 1880–1932

No biographical data available

Midnight – with Cole of Spyglass Mountain seated high up on his ladder, his far-seeing blue-gray eye glued to the powerful five-hundred-diameter eye-piece of his telescope. Unnoticeably the refractor followed the planet in its endless flight. The driving clock purred softly, the only sound on Spyglass Mountain – cold and still and fraught with uncanny tensivity.

*Cole of Spyglass Mountain* (p. 302)

Dodd, Mead & Company. New York, New York, USA. 1923

**Hastings, C. S.**

No biographical data available

Let us therefore congratulate the possessors of this noble instrument, wish them God speed in their search after knowledge, while we remind them that although no astronomer can ever make another discovery that will rival that made by the insignificant tube first directed toward the heavens by the Paduan philosopher, yet no mind can weigh the importance of any truth, however trivial in appearance, which may be added to that store which we call "science."

*Annual Report of the Board of Regents of the Smithsonian Institution, 1893*

The History of the Telescope (p. 109)

Government Printing Office. Washington, D.C. 1894

**Herschel, Friedrich Wilhelm**

**(Sir William)** 1738–1822

English astronomer

In the old Telescope's tube we sit,  
And the shades of the past around us flit...

*Herschel at the Cape*

Introduction (p. xix)

University of Texas Press. Austin, Texas, USA. 1969

I will make such telescopes and see such things!

In Grant Allen

*Biographies of Working Men*

Chapter IV (p. 108)

Society for Promoting Christian Knowledge. London, England. 1884

Although my single endeavors should not succeed in a work which seems to require the joint effort of every astronomer, yet so much we may venture to hope that by applying ourselves with all our powers to the improvement of telescopes, which I look upon as yet in their infant state, and turning them with assiduity to the study of the heavens, we shall in time obtain some faint knowledge of, and perhaps be able partly to delineate, the interior construction of the universe.

Account of Some Observations Tending to Investigate the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London,*

Volume 74, 1784 (p. 449)

The power of penetrating into space by telescopes is very different from magnifying power, and ought to be considered separately.

On the Power of Penetrating into Space by Telescopes  
*Philosophical Transactions of the Royal Society of London*,  
 Volume 90, 1800 (p. 49)

...when an object is once discovered by a superior power,  
 an inferior one will suffice to see if afterwards.

Quoted in book review  
*Nature*, February 1, 1883 (p. 310)

### Hogan, James

No biographical data available

Today, everybody remembers Galileo. How many can  
 name the bishops and professors who refused to look  
 through his telescope?

*Mind Matters: Exploring the World of Artificial Intelligence*, (p. 11)  
 Del Ray/Ballantine Books. New York, New York, USA. 1957

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

I was riding on the outside of a stage-coach from London  
 to Windsor, when all at once a picture familiar to me from  
 my New England village childhood came upon me like  
 a reminiscence rather than a revelation. It was a mighty  
 bewilderment of slanted masts and spars and ladders and  
 ropes, from the midst of which a vast tube, looking as if it  
 might be a piece of ordnance such as the revolted angels  
 battered the walls of Heaven with, according to Milton,  
 lifted its muzzle defiantly towards the sky.

*The Poet at the Breakfast-Table*

Chapter VIII (p. 219)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

I love all sights of earth and skies,  
 From flowers that grow to stars that shine;  
 The comet and the penny show,  
 All curious things above, below...  
 But most I love the tube that spies  
 The orbs celestial in their march;  
 That shows the comet as it whisks  
 Its tail across the planet's disk,  
 Or wheels so close against the sun  
 We tremble at the thought of risks  
 Our little spinning ball may run.

*The Complete Poetical Works of Oliver Wendell Holmes*

The Flaneur

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

### Howe, Herbert Alonzo 1858–1926

American astronomer

Ingenuous and powerful instruments have been devised,  
 which reveal wonders otherwise unimagined, and the end  
 is not yet. Each new telescopic giant is expected to win  
 fresh laurels in old fields of endeavor, or to make discov-  
 eries which shall link its name forever with the stars.

*A Study of the Sky*

Chapter I (p. 16)

Charles Scribner's Sons. New York, New York, USA. 1901

### Hubble, Edwin Powell 1889–1953

American astronomer

The exploration of space is an achievement of great  
 telescopes.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1938*  
 The Nature of the Nebulae (p. 137)

Government Printing Office. Washington, D.C. 1939

### Kepler, Johannes 1571–1630

German astronomer

What now, dear reader, shall we make out of our tele-  
 scope? Shall we make a Mercury's magic-wand to cross  
 the liquid ether with, and like Lucian lead a colony to the  
 uninhabited evening star, allured by the sweetness of the  
 place? Or shall we make it a Cupid's arrow which, enter-  
 ing by our eyes, has pierced our inmost mind, and fired  
 us with love of Venus?...  
*Dioptrice*

Preface (p. 86)

O telescope, instrument of much knowledge, more pre-  
 cious than any scepter! Is not he who holds thee in his  
 hand made king and lord of the works of God?

*Dioptrice*

Preface (p. 103)

### Kitchiner, William 1775–1827

English doctor/optician and telescope inventor

Immense telescopes are only about as useful as the enor-  
 mous spectacles which are suspended over the doors of  
 opticians!

In William Sheehan

*Planets and Perception: Telescopic Views and Interpretations*,  
 1609–1909

Chapter 9 (p. 113)

The University of Arizona Press. Tucson, Arizona, USA. 1988

When a Telescope is pointed at a Star, the least Defect in  
 the figure, or adjustment of the metals in a Reflector, or of  
 the object-glass in an Achromatic, immediately stares in  
 your Eye, – the Star not appearing round, but surrounded  
 by false lights, radiating points, and little flitting lumi-  
 nous accompaniments.

They make their appearance in a Periwig, – instead of  
 presenting themselves clean shaved, – or like round Sil-  
 ver Spangles on a bit of Black Cloth.

*The Economy of the Eyes*

Chapter VI (p. 97)

Printed by J. Moyes. London, England. 1825

If I was an Optician, – I think that I would almost as  
 willingly – *Waltz blindfold and barefoot among 9 Red*  
*hot Ploughshares laid at unequal distances from each*  
*other*, – as have All my Telescopes tried by that truly  
 troublesome test a Fixed Star.

*The Economy of the Eyes* Part II

Chapter XVII (p. 153)

Printed for Hurst, Robinson & Co. London, England. 1824

**Lardner, Dionysius** 1793–1859

British physicist and astronomer

What will a telescope do for us in regard to the examination of the heavenly bodies, or indeed of any distant object? It will accomplish this, and nothing more: it will place us at a less distance from the object to which we direct our view; it will enable us to approach it within a certain limit of distance, and to behold it as we should do without a telescope at the lesser distances.

*Popular Lectures on Science and Art*

The Plurality of Worlds (p. 51)

Henry W. Law. New York, New York, USA. 1856

**Longair, Malcolm** 1941–

Scottish astronomer

‘Twas brillig and the slithy toves  
Brought plans of telescopes fair to see.  
The Jabberwock, he clapped his hands  
And said, “That’s just for me.”

*Alice and the Space Telescope*

Chapter 2 (p. 7)

The John Hopkins University Press, Baltimore, Maryland, USA. 1989

**Lovell, Sir Alfred Charles Bernard** 1913–

English astrophysicist

Astronomy has marched forward with the growth in size of its telescopes.

Radio Stars

*Scientific American*, Volume 188, Number 1, January, 1953 (p. 21)**Maunder, Edward Walter** 1851–1928

English astronomer

We have no right to assume, and yet we do habitually assume, that our telescopes reveal to us the ultimate structure of the planet.

The Canals of Mars

*Knowledge*, Number 1, 1894 (p. 251)**Milton, John** 1608–74

English poet

...a spot like which perhaps  
Astronomer in the Sun’s lucent Orbe  
Through his glaz’d Optic Tube yet never saw.

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book III, l. 588–590

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mitchel, Ormsby MacKnight** 1805–62

American astronomer

With the potent aid of this magic instrument [telescope], the astronomer no longer is bound hopelessly to his native earth; without indeed quitting in person its surface, his eyes gifted with superhuman power, ranges the illimitable fields of space. He visits the moon, and finds a world with its lofty mountains and spreading valleys.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*

Lecture I (p. 30)

Baker &amp; Scribner. New York, New York, USA. 1848

**Mitchell, Maria** 1818–89

American astronomer and educator

The tube of Newton’s first telescope...was made from the cover of an old book—a little glass at one end of the tube and a large brain at the other...

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 168)

Macmillan &amp; Company. New York, New York, USA. 1949

Size is not so important as people generally suppose. Nicety and accuracy are what is needed in all scientific work; startling effects by large telescopes and high powers are too suggestive of sensational advertisement.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 178)

Lea &amp; Shepard Publishers. Boston, Massachusetts, USA. 1896

**Molyneux, William** 1656–98

Irish astronomer

‘Tis manifest by Experiments, that the ordinary Power of Man’s Eye extends no farther than perceiving what subtends an Angle of about a Minute, or something less. But when an Eye is armed with a Telescope, it may discern an Angle less than a Second.

*Dioptrica Nova* (p. 243)

Printed for Benjamin Tooke

London, England. 1692

**Morehouse, George Wilkinson** 1840–?

American naturalist

I run to the telescope; my vision is extended a thousand fold; millions more [of stars] come into view, and in the thousand times more distant circle of vision fade gradually until in the outer limits only glimpses can be caught of faint points of light.

*The Wilderness of Worlds*

Preface (p. 4)

Peter Eckler, Publisher. New York, New York, USA. 1898

As far as the telescope can penetrate space, matter exists. Every improvement in the instrument enables us to see clearer the stars already discovered, and brings to the eye faint glimpses of swarms still farther removed.

*The Wilderness of Worlds*

Chapter III (p. 19)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Moulton, Forest Ray** 1872–1952

American astronomer

The eye of the fabled Cyclops was not even prophetic of the great telescope at Mt. Wilson, the pupil of whose eye, so to speak, is 100 inches in diameter.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1927

### Mullaney, James

American astronomy writer, lecturer, and consultant

The telescope in particular need to be regarded as not just another gadget or material possession but a wonderful, magical gift to humankind – a window on creation, a time machine, a spaceship of the mind that enables us to roam the universe in a way that is surely the next best thing to being out there.

Focal Point

*Sky & Telescope*, March, 1990 (p. 244)

### Narrator

There are more stars in the heavens than there are human beings on Earth. Through telescopes men of science constantly search the infinitesimal corners of our solar system seeking new discoveries, hoping to better understand the laws of the Universe.

*When Worlds Collide*

Film (1951)

### Newton, Sir Isaac 1642–1727

English physicist and mathematician

If the theory of making telescopes could at length be fully brought into practice, yet there would be certain bounds beyond which telescopes could not perform. For the air through which we look upon the stars is in a perpetual tremor; as may be seen by the tremulous motion of shadows cast from high towers, and by the twinkling of the fixed stars.... The only remedy is a most serene and quiet air, such as may perhaps be found on the tops of the highest mountains above the gossamer clouds.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book 1, Part 1, Proposition viii, problem 2 (p. 423)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...they (telescopes) cannot be so formed as to take away that confusion of Rays which arises from the Tremors of the Atmosphere. The only Remedy is a most serene and quiet Air, such as may perhaps be found on the tops of the highest Mountains above the grosser Clouds.

*Opticks* (4th edition)

Book I (p. 98)

Printed for William Innys. London, England. 1730

### Noyes, Alfred 1880–1958

English poet

My periwig's askew, my ruffle stained  
With grease from my new telescope!

*The Torch Bearers: Watchers of the Sky*

William Herschel Conducts (p. 231)

Frederick A. Stokes Company. New York, New York, USA. 1922

### Oswalt, Terry D.

No biographical data available

...the viable mix of telescope sizes in astronomy is like that of operating a truck fleet. One must have trucks of all sizes, so as to efficiently match the size of the truck to the need.

*The Future of Small Telescopes in the New Millennium*

Chapter 17 (p. 191)

Kluwer Academic Publishers. Dordrecht, Germany. 2003

### Panek, Richard

No biographical data available

The relationship between the telescope and our understanding of the dimensions of the universe is in many ways the story of modernity. It's the story of how the development of one piece of technology has changed the way we see ourselves and of how the way we see ourselves has changed this piece of technology, each set of changes reinforcing the other over the course of centuries until, in time, we've been able to look back and say with some certainty that the pivotal division between the world we inhabit today and the world of our ancestors was the invention of this instrument.

*Seeing and Believing: How the Telescope Opened Our Eyes and Minds to the Heavens*

Prologue (p. 4)

The Viking Press. New York, New York, USA. 1998

### Peltier, Leslie C. 1900–80

American comet hunter

Old telescopes never die, they are just laid away.

*Starlight Nights*

Chapter 28 (p. 232)

Harper & Row, Publishers. New York, New York, USA. 1965

### Rowan-Robinson, Michael 1942–

English astronomer, astrophysicist, and professor

Once it was the navigators crossing the oceans to find new continents and new creatures, the globe opening up before their eyes, and at the same time the unknown areas, white on the map, shrinking.

Now it is the astronomers' telescopes penetrating the void to find new worlds, voyages of discoveries made with giant metal eyes, seeing light we cannot see.

*Our Universe: An Armchair Guide*

Cosmic Landscape

After Preface

W.H. Freeman & Company. New York, New York, USA. 1990

### Ryder-Smith, Roland

No biographical data available

All night he watches roving worlds go by  
Through tempered glass, his window on the sky  
Feels in his own beat

Of some far mightier heart, and hears  
The mystic concert of the spheres.

Astronomer

*The Scientific Monthly*, Volume 67, Number 4, October, 1948 (p. 253)



**Theil, Rudolph** 1894–1967

No biographical data available

Like snow-flakes, the stars float out of the visual field of large instruments; a mere quiver of the telescope tube can make stars leap away like so many grasshoppers.

*And There Was Light: The Discovery of the Universe*

Triumph of Precision (p. 277)

Alfred A. Knopf. New York, New York, USA. 1967

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Man's eye is the true star-finder, the comet-seeker. No superior telescope to this has been invented.

*The Writings of Henry David Thoreau*

Winter (p. 217)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1887

**Toogood, Hector B.**

No biographical data available

The telescope, an instrument which, if held the right way up, enables us to examine the stars and constellations at close quarters. If held the wrong way up, however, the telescope is of little or no use.

*The Outline of Everything with a Critical Survey of the World's Knowledge*

Chapter VIII (p. 96)

Little, Brown & Company. Boston, Massachusetts, USA. 1923

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935

Russian research scientist

All that which is marvelous, and which we anticipate with such thrill, already exists but we cannot see it because of the remote distances and the limited power of our telescopes...

In Adam Starchild (ed.)

*The Science Fiction of Konstantin Tsiolkovsky*

Dreams of the Earth and Sky (p. 154)

University Press of the Pacific, Inc. Seattle, Washington, USA. 1979

**Vehrenberg, Hans** 1910–91

German astronomer

It is a fundamental human instinct to collect, whether berries and roots in the prehistoric past or knowledge of the universe today. For several decades, my favorite pastime has been to collect celestial objects in photographs. I will never forget the many thousands of hours I have spent with my instruments, working peacefully in my telescope shelter as I listened to good music and dreamed about the infinity of the universe.

*Atlas of Deep Sky Splendors*

Preface

Treugesell-Verlag. Düsseldorf, Germany. 1978

**Verne, Jules** 1828–1905

French novelist

Another cry, this time a perfect howl answered him.... The unfortunate man, imprudently leaning over the metal

tube, had disappeared in the immense telescope.

*Works of Jules Verne*

*A Tour of The Moon*

Chapter XXI (p. 370)

F. Tyler Daniels. New York, New York, USA. 1911

**Vezzoli, Dante**

No biographical data available

Cyclopean eye that sweeps the sky,

Whose silvered iris gathers light

From galaxies that unseen pierce

The silent blanket of the night.

Eye of Palomar

*The Sky*, January, 1940 (p. 8)

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

A curious analogy could be based on the fact that even the hugest telescope has to have an eye-piece no larger than the human eye.

Translated by Peter Winch

*Culture and Value* (p. 17e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wordsworth, William** 1770–1850

English poet

WHAT crowd is this? what have we here! we must not pass it by;

A Telescope upon its frame, and pointed to the sky:

Long is it as a barber's pole, or mast of little boat,

Some little pleasure-skiff, that doth on Thames's waters float.

*The Complete Poetical Works of William Wordsworth*

Star-Gazers

Crowell. New York, New York, USA. 1888

**Zwicky, Fritz** 1898–1974

Swiss astronomer and physicist

Only Galileo and I really knew how to use a small telescope.

In Richard Preston

*First Light*

Part 2 (p. 119)

Random House, Inc. New York, New York, USA. 1996

**TEMPERATURE****Feynman, Richard P.** 1918–88

American theoretical physicist

John and his father go out to look at the stars. John sees two blue stars and a red star. His father sees a green star, a violet star, and two yellow stars. What is the total temperature of the stars seen by John and his father?

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

Judging Books by Their Covers (p. 293)

W.W. Norton & Company, Inc. New York, New York, USA. 1985



**TEMPORAL**

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The things which are temporal arise by their participation in the things which are eternal.

*Process and Reality*  
Fact and Form (p. 40)

**TENSOR**

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

...the tensor calculus that cost Einstein an effort to master is now a regular part of an undergraduate course in the better technical schools. The subject has been so thoroughly emulsified that even an eighteen-year-old can swallow it without regurgitating. But this does not prove that wither his brain or his stomach is stronger than Einstein's was.

*Mathematics: Queen and Servant of Science*  
A Metrical Universe (p. 211)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Benford, Gregory** 1941–  
American physicist and science fiction novelist

There was a blithe certainty that came from first comprehending the full Einstein field equations, arabesques of Greek letters clinging tenuously to the page, a gossamer web. They seemed insubstantial when you first saw them, a string of squiggles. Yet to follow the delicate tensors as they contracted, as the superscripts paired with subscripts, collapsing mathematically into concrete classical entities – potential; mass; forces vectoring in a curved geometry – that was a sublime experience. The iron fist of the real, inside the velvet glove of airy mathematics.

*Timescape*  
Chapter 15 (pp. 175–176)  
Simon & Schuster. New York, New York, USA. 1980

**Bester, Alfred** 1913–87  
American science fiction writer

Tensor, said the Tensor  
Tensor, said the Tensor  
Tension, apprehension,  
And dissension have begun.

*The Demolished Man*  
Chapter iii (p. 48)  
Shasta Publishers. Chicago, Illinois, USA. 1953

**Einstein, Albert** 1879–1955  
German-born physicist

...the energy tensor can be regarded only as a provisional means of representing matter. In reality, matter consists of electrically charged particles...

*The Meaning of Relativity* (p. 82)  
Princeton University Press. Princeton, New Jersey, USA. 1945

...in the case of the equations of gravitation it is the four-dimensionality and the symmetric tensor as expression for the structure of space that, together with the invariance with respect to the continuous transformation group, determine the equations all but completely.

Translated by Paul Arthur Schlipp  
*Albert Einstein: Autobiographical Notes* (p. 85)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1979

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

We want to express physical laws in such a way that it shall be obvious when we are expressing the same law by reference to two different systems of co-ordinates, so that we shall not be misled into supposing we have different laws when we have one law in different words. This is accomplished by the method of tensors.

*The ABC of Relativity*  
Chapter XII (p. 110)  
George Allen & Unwin Ltd. London, England. 1958

**van Dine, S. S.** 1888–1939  
American art critic and author

The tensor is known to all advanced Mathematicians. It is one of the technical expressions used in non-Euclidean geometry; and though it was discovered by Riemann in connection with a concrete problem in physics, it has now become of widespread importance in the mathematics of relativity. It's highly scientific in the abstract sense, and can have no direct bearing on Sprigg's murder.

*The Bishop Murder Case*  
Chapter 9  
Charles Scribner's Sons. New York, New York, USA. 1929

**Weyl, Hermann** 1885–1955  
German mathematician

The conception of tensors is possible owing to the circumstance that the transition from one co-ordinate system to another expresses itself as a linear transformation in the differentials. One here uses the exceedingly fruitful mathematical device of making a problem "linear" by reverting to infinitely small quantities.

Translated by Henry L. Brose  
*Space – Time – Matter*  
Chapter II, Section 13 (p. 104)  
Dover Publications, Inc. New York, New York, USA. 1922

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The idea that physicists would in future have to study the theory of tensors created real panic amongst them following the first announcement that Einstein's predictions had been verified.

In Jean-Pierre Luminet  
*Black Holes* (p. 47)  
Cambridge University Press. New York, New York, USA. 1992

## TERMINOLOGY

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

The last thing an old teacher wants is, as you know full well, a new set of terms for a familiar set of objects. It is hard instructing ancient canine individuals in new devices. It is hard teaching old professors new tricks.

Letter to Dr. Wilder, May 30, 1881

*Proceedings of the American Philosophical Society Held at Philadelphia*, Volume XIX, July 15, 1881 (p. 530)

**Whewell, William** 1794–1866  
English philosopher and historian

Terminology must be conventional, precise, constant; copious in words, and minute in distinctions, according to the needs of the science. The student must understand the terms, directly according to the convention, not through the medium of explanation or comparison.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2) (2nd edition)

Aphorisms Concerning Ideas (p. 460)

John W. Parker. London, England. 1847

## TERMS

**Owen, Richard** 1804–92  
English biologist, comparative anatomist and paleontologist

Terms are the tools of the teacher; and only an inferior hand persists in toiling with a clumsy instrument when a better one lies within his reach.

*On the Anatomy of Vertebrates* (Volume I)

Preface (p. xiii)

Longmans, Green & Co. London, England. 1866

## TERRA INCOGNITA

**Steenstrup, Johannes Japetus Smith**

No biographical data available

I believe that I have given only the first rough outlines of a province of a great *terra incognita* which lies unexplored before us, and the exploration of which promises a return such as we can at present scarcely appreciate.

*On the Alternation of Generations*

Preface (p. 8)

Printed for the Ray Society. London, England. 1845

## TERRESTRIAL

**Dick, Thomas** 1600–80  
Scottish theologian and philosopher

Compared with the splendour, the amplitude, the august motions, and the ideas of infinity which the celestial vault presents, the most resplendent terrestrial scenes sink into

inanity, and appear unworthy of being set in competition with the glories of the sky.

*Celestial Scenery: Or, The Wonders of the Planetary System Displayed*

Introduction (p. 13)

Harper & Brothers Publishers. New York, New York, USA. 1838

## TEST

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Whereas Fever had obscure conditions, and gave him that delightful labour of the imagination which is not mere arbitrariness, but the exercise of disciplined power – combining and constructing with the clearest eye for probabilities and the fullest obedience to knowledge; and then, in yet more energetic alliance with impartial Nature, standing aloof to invent tests by which to try its own work.

*Middlemarch: A Study of Provincial Life* (Volume 1)

Book II (p. 249)

Thomas Nelson & Sons. New York, New York, USA. 1906

## TESTING

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

Examinations are formidable, even to the best prepared, for the greatest fool may ask more than the wisest man can answer.

*Lacon; or Many Things in a Few Words* (p. 170)

William Gowans. New York, New York, USA. 1849

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

It is by testing that we discern fine gold.

*Leonardo da Vinci's Note Books* (p. 60)

Duckworth & Company. London, England. 1906

**Raleigh, Sir Walter** 1552–1618  
Renaissance English courtier and poet

No instrument smaller than the World is fit to measure men and women: Examinations measure Examinees.

*Laughter from a Cloud*

Some Thoughts on Examinations (p. 120)

Constable. London, England. 1923

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Examinations are pure humbug from beginning to end.

*Epigrams: Phrases and Philosophies for the Use of the Young*

Oscariana

A.R. Keller. London, England. 1907

In examinations the foolish ask questions that the wise cannot answer.

*Epigrams: Phrases and Philosophies for the Use of the Young*

Phrases and Philosophies

A.R. Keller. London, England. 1907

**TEXTBOOK****Collie, John Norman** 1859–1942

English chemist

At the present time it is not altogether easy to say on what lines a text-book of Organic Chemistry should be written. To state in the preface that the Author “hopes it will supply a long-felt want” is not always an injudicious method of announcing the Author’s belief in the readers of text-books. For if the “long-felt want” of the public is to have a restatement of all the old facts once more, with nothing new, no critical faculty shown, and an obvious lack of evidence that the book can be used to broaden our outlook on other sciences as well as chemistry, then no doubt the desire of the public for the time being is satisfied.

In Alfred Walter Stewart

*Recent Advances in Organic Chemistry*

Introduction (p. xiii)

Longmans, Green &amp; Co. London, England. 1908

The text-book is rare that stimulates its reader to ask, Why is this so? or, How does this connect with what has been read elsewhere?

In Alfred Walter Stewart

*Recent Advances in Organic Chemistry*

Introduction (p. xiv)

Longmans, Green &amp; Co. London, England. 1908

**Lewis, Exum Percival**

No biographical data available

The student must bear constantly in mind that the matter in a textbook is not Physics. The direct object of his study is nature as we find it in everyday life, supplemented by the laboratory. Everyone of us began his study of Physics before he could read. The text-book is a guide to the use of this material, just as a catalogue is a guide through an art gallery; each is almost indispensable on account of its classification of details, its historical information, and its discussion and criticisms; but neither can take the place of the original subject matter.

*Notes on the Properties of Matter and Heat*

Introductory (p. 4)

Berkeley, California, USA. 1903

**THEOLOGY****Keyser, Cassius Jackson** 1862–1947

American mathematician

...in the mathematical doctrine of Invariance, the realm wherein are sought and found configurations and types of being that, amid the swirl and stress of countless hosts of transformations, remain immutable, and the spirit dwells in contemplation of the serene and eternal reign of the subtle law of Form, it is there that Theology may find, if she will, the clearest conceptions, the noblest symbols,

the most inspiring intimations, the most illuminating illustrations, and the surest guarantees of the object of her teaching and her quest, an Eternal Being, unchanging in the midst of the universal flux.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter XV (p. 312)

Columbia University Press. New York, New York, USA. 1916

**THEOREM****Atiyah, Sir Michael** 1922–

English mathematician

A theorem is never arrived at in the way that logical thought would lead you to believe or that posterity thinks. It is usually much more accidental, some chance discovery in answer to some kind of question. Eventually you can rationalize it and say that this is how it fits. Discoveries never happen as neatly as that. You can rewrite history and make it look much more logical, but actually it happens quite differently.

24th of May, 2004 prior to the Abel prize celebrations

Interview with Michael Atiyah and Isadore Singer

Martin Raussen and Christian Skau are the interviewers

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

How many properties were there of which the compass knew nothing, how many cunning laws lay contained in embryo within an equation, the mysterious nut which must be artistically cracked to extract the rich kernel, the theorem!

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XIII (p. 303)

Dodd, Mead &amp; Co. New York, New York, USA. 1925

**Feynman, Richard P.** 1918–88

American theoretical physicist

We decided that “trivial” means “proved.” So we joked with the mathematicians: “We have a new theorem – that mathematicians can prove only trivial theorems, because every theorem that’s proved is trivial.”

*Surely You’re Joking, Mr. Feynman!: Adventures of a Curious Character*

A Map of a Cat? (p. 70)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1985

**Hamming, Wesley Richard** 1915–98

American mathematician

Some people believe that a theorem is proved when a logically correct proof is given; but some people believe a theorem is proved only when the student sees why it is inevitably true. The author tends to belong to this second school of thought.

*Coding and Information Theory* (p. 155)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1980

**Hofstadter, Douglas R.** 1945–  
American academic

All the limitative Theorems of metamathematics and the theory of computation suggest that once the ability to represent your own structure has reached a certain critical point, that is the kiss of death: it guarantees that you can never represent yourself totally. Gödel's Incompleteness Theorem, Church's Undecidability Theorem, Turing's Halting Theorem, Tarski's Truth Theorem – all have the flavor of some ancient fairy tale which warns you that "To seek self-knowledge is to embark on a journey which...will always be incomplete, cannot be charted on any map, will never halt, cannot be described."

*Gödel, Escher, Bach: An Eternal Golden Braid*

Part II, Chapter XX (p. 697)

Basic Books, Inc. New York, New York, USA. 1979

**Howe, Roger** 1945–  
American mathematician

Everybody knows that mathematics is about Miracles, only mathematicians have a name for them: Theorems.

MAA address, Baltimore, January 9, 1998

**Huxley, Aldous** 1894–1963  
English writer and critic

Too much theorizing, as we all know, is fatal to the soul...

*Tomorrow and Tomorrow and Tomorrow and Other Essays*

The Education of an Amphibian (p. 7)

Harper & Brothers. New York, New York, USA. 1956

**Papert, Seymour** 1928–  
South African mathematician

For what is important when we give children a theorem to use is not that they should memorize it. What matters most is that by growing up with a few very powerful theorems one comes to appreciate how certain ideas can be used as tools to think with over a lifetime. One learns to enjoy and to respect the power of powerful ideas. One learns that the most powerful idea of all is the idea of powerful ideas.

*Mindstorms: Children, Computers and Powerful Ideas*

Chapter 3 (p. 76)

Basic Books, Inc. New York, New York, USA. 1980

**Planck, Max** 1858–1947  
German physicist

...Leibniz's theorem...sets forth fundamentally that of all the worlds that may be created, the actual world is that which contains, besides the unavoidable evil, the maximum good.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Principle of Least Action (p. 71)

Methuen & Company Ltd. London, England. 1925

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

I beg your pardon; I am about to use some technical expressions, but they need not frighten you for you are not obliged to understand them. I shall say, for example, that I have found the demonstration of such a theorem under such circumstances. This theorem will have a barbarous name unfamiliar to many, but that is unimportant; what is of interest for the psychologist is not the theorem but the circumstances...

*The Foundations of Science*

*Science and Method*. Book I

Chapter III (p. 387)

The Science Press. New York, New York, USA. 1913

**Sylvester, James Joseph** 1814–97  
English mathematician

No mathematician now-a-days sets any store on the discovery of isolated theorems, except as affording hints of an unsuspected new sphere of thought, like meteorites detached from some undiscovered planetary orb of speculation.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Notes to the Exeter Association Address (p. 717)

University Press. Cambridge, England. 1904–1912

**Truesdell, Clifford** 1919–2000  
American mathematician, natural philosopher, historian of mathematics

**Noll, Walter**  
Mathematician

Pedantry and sectarianism aside, the aim of theoretical physics is to construct mathematical models such as to enable us, from the use of knowledge gathered in a few observations, to predict by logical processes the outcomes in many other circumstances. Any logically sound theory satisfying this condition is a good theory, whether or not it be derived from "ultimate" or "fundamental" truth. It is as ridiculous to deride continuum physics because it is not obtained from nuclear physics as it would be to reproach it with lack of foundation in the Bible.

*The Non-Linear Field Theories of Mechanics* (2nd edition)

Introduction, Section 2 (p. 4)

Springer-Verlag, Berlin, Germany. 1992

**Veblen, Oswald** 1880–1960  
American mathematician

The abstract mathematical theory has an independent, if lonely existence of its own. But when a sufficient number of its terms are given physical definitions it becomes a part of a vital organism concerning itself at every instant with matters full of human significance. Every theorem can be given the form "if you do so and so, such and such will happen."

Remarks on the Foundation of Geometry  
*Bulletin of the American Mathematical Association*, Volume 31, 1925  
 (p. 135)

## FOURIER

**Kelvin, Lord William Thomson** 1824–1907  
 Scottish engineer, mathematician, and physicist

Fourier's Theorem is not only one of the most beautiful results of modern analysis, but it may be said to furnish an indispensable instrument in the treatment of nearly every recalcitrant question in modern physics.

In E.T. Bell  
*Men of Mathematics* (p. 183)  
 Simon & Schuster. New York, New York, USA. 1937

## THEORIST

**Boltzmann, Ludwig Edward** 1844–1906  
 Austrian physicist

A friend of mine has defined the practical man as one who understands nothing of theory and the theoretician as an enthusiast who understands nothing at all.

*Theoretical Physics and Philosophical Problems. Selected Writings*  
 On the Significance of Theories (p. 33)  
 Reidel Publishing Company. Boston, Massachusetts, USA. 1974

**Cardozo, Benjamin N.** 1870–1938  
 American jurist

The theorist has a hard time to make his way in an ungrateful world. He is supposed to be indifferent to realities; yet his life is spent in the exposure of realities, which, till illuminated by his searchlight, were hidden and unknown.

*The Growth of the Law*  
 Chapter II (p. 21)  
 Yale University Press. New Haven, Connecticut, USA. 1924

**Crick, Francis Harry Compton** 1916–2004  
 English biochemist

[I]t is virtually impossible for a theorist, by thought alone, to arrive at the correct solution to a set of biological problems.... The best a theorist can hope to do is to point an experimentalist in the right direction....

*What Mad Pursuit: A Personal View of Scientific Discovery*  
 Chapter 10 (pp. 109–110)  
 Basic Books, Inc. New York, New York, USA. 1988

Theorists almost always become too fond of their own ideas, often simply by living with them too long. It is difficult to believe that one's cherished theory, which really works rather nicely in some respects, may be completely false.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
 Chapter 13 (p. 141)  
 Basic Books, Inc. New York, New York, USA. 1988

Theorists will often complain that experimentalists ignore their work. Let a theorist produce just one theory of the type sketched above (i.e., one that makes non-obvious verified predictions) and the world will jump to the conclusion (not always true) that he has a special insight into difficult problems.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
 Chapter 13 (p. 142)  
 Basic Books, Inc. New York, New York, USA. 1988

**Einstein, Albert** 1879–1955  
 German-born physicist

...every true theorist is a kind of tamed metaphysicist, no matter how pure a "positivist" he may fancy himself.

On the Generalized Theory of Gravitation  
*Scientific American*, Volume 182, Number 4, April, 1950 (p. 13)

**Lederman, Leon** 1922–  
 American high-energy physicist

The sequence of theorist, experimenter, and discovery has occasionally been compared to the sequence of farmer, pig, truffle. The farmer leads the pig to an area where there might be truffles. The pig searches diligently for the truffles. Finally, he locates one, and just as he is about to devour it, the farmer snatches it away.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
 Chapter 1 (p. 16)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Marshall, Alfred** 1842–1924  
 English economist

...the most reckless and treacherous of all theorists is he who professes to let facts and figures speak for themselves.

In A.C. Pigou (ed.)  
*Memorials of Alfred Marshall*  
 Chapter VI (p. 168)  
 Macmillan & Company Ltd. London, England. 1925

**Spencer-Brown, George** 1923–  
 English mathematician and polymath

A theorem is no more proved by logic and computation than a sonnet is written by grammar and rhetoric, or than a sonata is composed by harmony and counterpoint, or a picture painted by balance and perspective. ...[T]hese forms are, in the final analysis, parasitic on – they have no existence apart from – the creativity of the work itself. Thus the relation of logic to mathematics is seen to be that of an applied science to its pure ground, and all applied science is seen as drawing sustenance from a process of creation with which it can combine to give structure, but which it cannot appropriate.

*Laws of Form*  
 Chapter 12 (p. 102)  
 George Allen & Unwin Ltd. London, England. 1969



**Truesdell, Clifford** 1919–2000

American mathematician, natural philosopher, historian of mathematics

**Noll, Walter**

Mathematician

The task of the theorist is to bring order into the chaos of the phenomena of nature, to invent a language by which a class of these phenomena can be described efficiently and simply.

*The Non-Linear Field Theories of Mechanics* (2nd edition)

Introduction, Section 2 (p. 4)

Berlin: Springer-Verlag, 1992

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Most disgusting are pedantic observers and crotchety theorists; their experiments are petty and complicated, their hypotheses abstract and startling. Such minds luxuriate in terms and obstruct the progress of science, for it is absolutely necessary that sounder men should repeat their experiments and throw some light on the chaos they make. But since there are not many who can do this, affairs are allowed to take their own course, and the results at which such crotchety theorists arrive, are, to a certain extent, valued. And this is not, indeed, a very great crime.

Translated by Otto Wenckstern

*Goethe's Opinions on the World, Mankind, Literature, Science, and Art* (p. 67)

John W. Parker & Son, London, England, 1853

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

A successful theorist should be excessively interested in immediate events, otherwise he is not at all likely to formulate correctly anything about them.

*The Organization of Thought*

*Science*, Volume 44, Number 1134, September 29, 1916 (p. 410)

**THEORY****Adam, George**

No biographical data available

A theory recorded without development work is as the squatting of land whose value increases through extraneous efforts.

*The Solar System: An Astronomical Unit Addenda*

Introduction (p. 10)

John W. Newbegin, Publisher, San Francisco, California, USA, 1911

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

There is a theory which states that if ever anyone discovers exactly what the Universe is for and why it is

here, it will instantly disappear and be replaced by something even more bizarre and inexplicable.

There is another which states that this has already happened.

*The Ultimate Hitchhiker's Guide to the Galaxy*

*The Restaurant at the End of the Universe*

Chapter 1 (p. 148)

Ballantine Books, New York, New York, USA, 2002

**Asimov, Isaac** 1920–92

American writer and biochemist

Theories are not so much wrong as incomplete.

*The Relativity of Wrong*

The Relativity of Wrong (p. 222)

Doubleday & Company, Inc, New York, New York, USA, 1988

Once we learn to expect theories to collapse and to be supplanted by more useful generalizations, the collapsing theory becomes not the gray remnant of a broken today, but the herald of a new and brighter tomorrow.

In Timothy Ferris (ed.)

*The World Treasury of Physics, Astronomy, and Mathematics*

The Nature of Science (p. 783)

Little, Brown & Company, Boston, Massachusetts, USA, 1991

Scientific theories have a tendency to fit the intellectual fashions of the time.

*Asimov on Chemistry*

The Weighting Game (p. 3)

Anchor Press/Doubleday, Garden City, New York, USA, 1974

No matter how many times a theory meets its tests successfully, there can be no certainty that it will not be overthrown by the next observation.

This, then, is a cornerstone of modern natural philosophy. It makes no claim of attaining ultimate truth. In fact, the phrase "ultimate truth" becomes meaningless, because there is no way in which enough observations can be made to make truth certain and, therefore, "ultimate".

*Asimov's New Guide to Science*

Chapter I (p. 13)

Basic Books, Inc, New York, New York, USA, 1984

**Author undetermined**

There are those who make a great framework which is their theory, and into which they fit the facts; and there are those whose theory is like a map of the things, which are placed thereby more within the grasp of our immediate handling. For things are real and existing, and we wander among them and look; and the true spirit of Science recognizes the greatness of things as compared with our views of them, which views are fleeting, and moulded variously according to our vantage-ground.

The Teaching of Science (Second Part)

*The American Educational Monthly*, Volume VII, April, 1870 (p. 140)



**Ayer, Alfred Jules** 1910–89  
English philosopher

There never comes a point where a theory can be said to be true. The most that one can claim for any theory is that it has shared the successes of all its rivals and that it has passed at least one test which they have failed.

*Philosophy in the Twentieth Century*  
Chapter IV (p. 133)  
Random House, Inc. New York, New York, USA. 1982

**Balfour, Arthur James** 1848–1930  
English prime minister

The interdependence of theory and practice cannot be ignored without inflicting injury on both; and he is but a poor friend to either who undervalues their mutual cooperation.

Reflections Suggested by the New Theory of Matter  
*Popular Science Monthly*, Volume 65, Number 6, October, 1904 (p. 495)

**Beadle, George Wells** 1903–89  
American geneticist

It's hard to make a good theory; a theory has to be reasonable, but a fact doesn't.

Quoted in Norman H. Horowitz  
*Biographical Memoirs*  
George Wells Beadle (p. 39)  
National Academies Press. Washington, D.C. 1990

**Berkeley, Edmund C.** 1909–88  
American computer theoretician

The World is more complicated than most of our theories make it out to be.

Right Answers – A Short Guide for Obtaining Them  
*Computers and Automation*, Volume 18, Number 10, September, 1969 (p. 20)

**Bernard, Claude** 1813–78  
French physiologist

A theory is merely a scientific idea controlled by experiment.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section vi (p. 26)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Bernstein, Jeremy** 1929–  
American physicist, educator, and writer

I would insist that any proposal for a radically new theory in physics or in any other science, contain a clear explanation of why the precedent science worked. What new domain of experience is being explored by the new science, and how does it meld with the old?

*Cranks, Quarks, and the Cosmos: Writings on Science*  
Chapter 1 (p. 18)  
Basic Books, Inc. New York, New York, USA. 1993

**Berzelius, Jöns Jacob** 1779–1848  
Swedish chemist

All our theory is but a means of consistently conceptualizing the inward processes of phenomena, and it is pre-summable and adequate when all scientifically known facts can be deduced from it.

In Edward O. Wilson  
*The Diversity of Life*  
Chapter One (p. 8)  
W.W. Norton & Company, Inc. New York, New York, USA. 1992

This mode of conceptualization [theorizing] can...well be false and...is so frequently. Even though, at a certain period in the development of science, it may match the purpose just as well as a true theory. Experience is augmented, facts appear which do not agree with it, and one is forced to go in search of a new mode of conceptualization within which these facts can also be accommodated; and in this manner, no doubt, modes of conceptualization will be altered from age to age, as experience is broadened, and the complete truth may ever be attained.

In Edward O. Wilson  
*The Diversity of Life*  
Chapter One (pp. 8–9)  
W.W. Norton & Company, Inc. New York, New York, USA. 1992

**Bethe, Hans** 1906–2005  
American physicist

Scientific theories are not overthrown; they are expanded, refined, and generalized.

In Victor F. Weisskopf  
*Physics in the Twentieth Century: Selected Essays*  
Forward (p. x)  
The MIT Press. Cambridge, Massachusetts, USA. 1972

**Bigelow, S. Lawrence** 1870–1947  
American physical chemistry professor

Our laws summarize our knowledge, our theories summarize our beliefs.... Laws codify established facts, they are history; theories contain the possibilities of the future. Theories may be considered as knowledge in the state of flux.

*Theoretical and Physical Chemistry*  
Section I, Chapter II (pp. 15–16)  
The Century Company. New York, New York, USA. 1917

**Black, Alexander**  
No biographical data available

Theories are like swords. People sometimes trip over them.

*The Seventh Angel*  
Part V, Chapter VIII (p. 285)  
Harper & Brothers Publishers. New York, New York, USA. 1921

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

...your theory is crazy. The question which divides us is whether it is crazy enough to have a chance of being correct.

In Martin Gardner  
*The Ambidextrous Universe* (p. 280)

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

No theory, however attractive, merits scientific consideration unless it sticks out its neck sufficiently to be disproved by experiment or observation.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1966

Astronomy and the Physical Sciences (p. 263)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

To the nonscientist it must seem strange that, while the history of science appears to be a brilliant success story, from a logical point of view the stress is always on disproof and hence on the failure rather than on the confirmation of theories.

In James R. Newmann

*What is Science?*

Astronomy and Cosmology (p. 84)

Simon & Schuster. New York, New York, USA. 1955

**Born, Max** 1882–1970  
German-born English physicist

The human mind is conservative, and the scientist makes no exception from this rule. He will accept a new theory only if it stands the trial of many experimental tests.

*Les Prix Nobel. The Nobel Prizes in 1954*

Nobel banquet speech for award received in 1954

Nobel Foundation. Stockholm, Sweden. 1955

A theory, to be of any real use to us, must satisfy two tests. In the first place, it must not make use of any ideas which are not confirmed by experiment. Special assumptions must not be dragged in merely to meet some particular difficulty. In the second place, the theory must not only explain all the facts known already, but must also enable us to foresee other facts which were not known before and can be tested by further experiment.

*The Restless Universe*

Chapter I (pp. 5–6)

Dover Publications, Inc. New York, New York, USA. 1951

**Bradbury, Ray** 1920–  
American writer

Theories are invigorating and tonic. Give me an ounce of fact and I will produce you a ton of theory by tea this afternoon.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Foreword (p. x)

Harper & Row, Publishers. New York, New York, USA. 1973

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

But alas for theories that germinate in the minds of men! They wilt in the bright light of advancing knowledge.

*Parade of the Living*

Part I, Chapter I (pp. 6–7)

Coward-McCann, Inc. New York, New York, USA. 1930

**Bridgman, Percy Williams** 1882–1961  
American physicist

Every new theory as it arises believes in the flush of youth that it has the long-sought goal; it sees no limits to its applicability, and believes that at long last it is the fortunate to achieve the “right” answer.

*The Nature of Physical Theory*

Chapter X (p. 136)

Princeton University Press. Princeton, New Jersey, USA. 1936

**British Association for the Advancement of Science**

Great physical theories with their trains of practical consequences, are pre-eminently national objects, whether for glory or utility.

In John Frederick William Herschel

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Meeting, Newcastle, 1838 (p. 109)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

**Browne, Rupert**

No biographical data available

Theories are like men, they may be crushed by scorn or ridicule; yet if they decline to be crushed they will end by being listened to, and by gaining followers.

*Club Cameos*

Finance (p. 201)

Sampson, Low, Marston, Searle & Rivington. London, England. 1879

**Buckland, Francis Trevelyan** 1826–80

English surgeon, zoologist, popular author and natural historian

Your theory is most excellent, and I shall endeavor to collect facts for you with a view to its elucidation.

In Karl Pearson

*The Life, Letters, and Labours of Francis Galton* (Volume 2) (p. 87)

At The University Press. Cambridge, England. No date

**Burgess, William Harvey**

No biographical data available

Theory is like the color of the chameleon, never twice alike, and the men who pretend to know most about it are the most deceived.

*Chronic Disease* (p. 123)

Avondale. Chattanooga, Tennessee, USA. 1907

**Burroughs, Edgar Rice** 1875–1950

American writer

...even theories must have foundations.

*Pirates of Venus*

Chapter Four (p. 44)

University of Nebraska Press. Lincoln, Nebraska, USA. 2001

**Campbell, Norman R.** 1880–1949

English physicist and philosopher

To those who have not the power to think, theory will always be dangerous.

*Physics: The Elements*

Chapter VI (p. 121)

At The University Press. Cambridge, England. 1920

Space and time are the conceptions of theory, not of laws. They are neither necessary nor useful in the statement of the results of any experiment.

Theory and Experiment in Relativity

*Nature*, Volume 106, Number 2677, February 17, 1921 (p. 804)

**Cantor, Georg** 1845–1918

German mathematician

My theory stands as firm as a rock; every arrow directed against it will return quickly to its archer. How do I know this? Because I have studied it from all sides for many years; because I have examined all objections which have ever been made against the infinite numbers; and above all because I have followed its roots, so to speak, to the first infallible cause of all created things.

In Joseph Dauben

*Georg Cantor: His Mathematics and Philosophy of the Infinite*

Chapter 12 (p. 298)

Princeton University Press. Princeton, New Jersey, USA. 1990

**Cassirer, Ernst** 1874–1945

German philosopher

Each theory becomes a Procrustean bed in which the empirical facts are stretched to fit a preconceived pattern.

*An Essay on Man: An Introduction to a Philosophy of Human Culture* (p. 21)

Yale University Press. New Haven, Connecticut, USA. 1944

**Chamberlin, Thomas Chrowder** 1843–1928

American geologist

The moment one has offered an original explanation for a phenomenon which seems satisfactory, that moment affection for his intellectual child springs into existence, and as the explanation grows into a definite theory his parental affections cluster about his offspring and it grows more and more dear to him.... There springs up also unwittingly a pressing of the theory to make it fit the facts and a pressing of the facts to make them fit the theory...

*Journal of Geology*, Volume 5, 1897 (p. 837)

The mind lingers with pleasure upon the facts that fall happily into the embrace of the theory, and feels a natural coldness toward those that seem refractory....

The Method of Multiple Working Hypotheses

*Science*, Volume 148, Number 3671, 7 May, 1965 (p. 755)

**Charlie Chan (Fictional character)**

Theory like mist on eyeglasses. Obscure facts.

*Charlie Chan in Egypt*

Film (1935)

Wilkie Ballou: Your theory's full of holes. It won't hold water! Charlie Chan: Sponge is full of holes. Sponge holds water.

*The Black Camel*

Film (1931)

**Charcot, Jean-Martin** 1825–93

French neurologist

Theory is good, but it doesn't prevent things from existing.

*The Complete Psychological Works of Sigmund Freud* (Volume 3)

Charcot (p. 13)

The Hogarth Press. London, England. 1962

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

A man warmly concerned with any large theories has always a relish for applying them to any triviality.

*The Wisdom of Father Brown*

The Absence of Mr. Glass (p. 16)

Dodd, Mead & Company. New York, New York, USA. 1927

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

Theory...demands a practical test. All its data are derived from observation; and their insecurity becomes less tolerable as it advances nearer to perfection.

*A Popular History of Astronomy During the Nineteenth Century* (3rd edition)

Introduction (p. 3)

Adam & Charles Black. London, England. 1893

**Crichton, Michael** 1942–

American novelist

Most areas of intellectual life have discovered the virtues of speculation, and have embraced them wildly. In academia, speculation is usually dignified as theory.

Why Speculate

Talk, International Leadership Forum, La Jolla, California, April 26, 2002

**Clarke, Arthur C.** 1917–

English science and science fiction writer

"I'd be glad to settle without the theory," remarked Kimball, "if I could even understand what this thing is – or what it's supposed to do."

*The Lost Worlds of 2001*

Chapter 31 (p. 179)

New American Library. New York, New York, USA. 1972

**Collie, John Norman** 1859–1942

English chemist

...in every science which is at all progressive there must arise from time to time conflicts between the older generation of workers and the leaders of the new; for, to those who have grown up along with it, a theory generally becomes invested with a sort of sanctity which is quite out of keeping with its true make-shift character. The longer a theory stands the harder does it become to shake it, and the greater is the tendency of the science to become stereotyped.

In W.A. Stewart

*Recent Advances in Organic Chemistry*

Preface

Longman, Green, & Co. New York, New York, USA. 1909

...if a theory suffices to explain facts discovered after its promulgation, knowledge may be increased; but there is no true progress unless our general outlook is altered. Thus in science we have an alternation of two courses: in the first the aim is the accumulation of facts and yet more facts; while the second is directed towards classifying these facts in the most convenient manner. At irregular intervals some facts are discovered which cannot be fitted into the accepted scheme of arrangement and in order to make room for them the scheme has to be altered and recast into some new form.

In W.A. Stewart

*Recent Advances in Organic Chemistry*

Preface

Longman, Green, & Co. New York, New York, USA. 1909

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

Theory is worth little, unless it can explain its own phenomena, and it must effect this with out contradicting itself; therefore, the facts are sometimes assimilated to the theory, rather than the theory to the facts.

*Lacon; or Many Things in a Few Words* (p. 77)

William Gowans. New York, New York, USA. 1849

Professors in every branch of the sciences prefer their own theories to truth: the reason is, that their theories are private property, but truth is common stock.

*Lacon; or Many Things in a Few Words* (p. 189)

William Gowans. New York, New York, USA. 1849

**Cooper, Leon** 1930–

American physicist

A theory is a well-defined structure that we hope is in correspondence with what we observe. It's an architecture, a cathedral.

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*

The Memory Machine (pp. 114–115)

Alfred A. Knopf. New York, New York, USA. 1991

**Couderc, Paul**

No biographical data available

The only conceptions that succumb are those that pretend to fix the image of a profound reality: true relations among things survive, united to the true new relations in the burgeoning theory. Let us then rejoice at the massacre of old theories because this is the criterion of progress. There is, I think, no ground for fear that nature will undernourish the seekers. Nothing should diminish our enthusiasm for the experimental victories, decisive and definitive, of the past thirty years.

In Lucienne Felix

*The Modern Aspect of Mathematics* (p. 31)

Basic Books, Inc. New York, New York, USA. 1960

**Couper, Archibald Scott** 1831–92

Scottish scientist

The end of chemistry is its theory. The guide in chemical research is a theory. It is therefore of the greatest importance to ascertain whether the theories at present adopted by chemists are adequate to the explanation of chemical phenomena, or are at least based upon the true principles which ought to regulate scientific research.

*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Volume 16, Number 4, 1858

**Crease, Robert P.**

American science historian

**Mann, Charles C.**

American journalist and science writer

[P.A.M.] Dirac said often he was beset by fears when he came up with his new theory.... [H]e soon discovered that his fear was justified. Quantum electrodynamics was indeed a great step forward, but it came at a great price. Dirac had set down the beginnings of the modern theory of electromagnetism – the first solid piece of the standard model – but he had also unwittingly let loose an onslaught of conceptual demons that would change our views of space and matter.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*

Uncertainty and Complementarity (p. 69)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Crick, Francis Harry Compton** 1916–2004

English biochemist

...a theory will always command more attention if it is supported by unexpected evidence, particularly evidence of a different kind.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 10 (p. 115)

Basic Books, Inc. New York, New York, USA. 1988

**Cromer, Alan** 1935–

American physicist and educator

The word theory, as used in the natural sciences, doesn't mean an idea tentatively held for purposes of argument – that we call a hypothesis. Rather, a theory is a set of logically consistent abstract principles that explain a body of concrete facts. It is the logical connections among the principles and the facts that characterize a theory as truth. No one element of a theory...can be changed without creating a logical contradiction that invalidates the entire system. Thus, although it may not be possible to substantiate directly a particular principle in the theory, the principle is validated by the consistency of the entire logical structure.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 7 (p. 137)

Oxford University Press, Inc. New York, New York, USA. 1993

**Croll, James** 1821–90

Scottish scientist

I prefer to use the term “theory,” with the above understood qualification, viz. a theory in its hypothetical stage.

*Stellar Evolution and Its Relations to Geological Time*

Part I (p. 1)

D. Appleton & Co. New York, New York, USA. 1889

### **Cromie, William J.**

No biographical data available

Theories are the right arm of science and present a carefully thought-out picture of what the scientists think happened. The other arm of science is observation, wherein scientists devise experiments and collect data to prove, or disprove, a theory.

*Exploring the Secrets of the Sea*

Chapter I (p. 5)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

### **da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Theory is the general, and practice the soldiers.

Quoted in David Brewster

*The Life of Sir Isaac Newton*

Chapter XVIII (p. 295)

J. & J. Harper. New York, New York, USA. 1833

You must first propound the theory and then explain the practice.

Translated by Maurice Baring

*Thoughts on Art and Life*

Thoughts on Science (p. 142)

The Merrymount Press. Boston, Massachusetts, USA. 1906

### **d’Abro, Abraham**

No biographical data available

...a theory of mathematical physics is not one of pure mathematics. Its aim and its raison d’être are not solely to construct the rational scheme of some possible world, but to construct that particular rational scheme of the particular real world in which we live and breathe. It is for this reason that a theory of mathematical physics, in contradistinction to one of pure mathematics, is constantly subjected to the control of experiment.

*The Evolution of Scientific Thought*

Chapter XXI (p. 215)

Dover Publications, Inc., New York, New York, USA. 1950

### **Dantzig, George Bernard** 1914–2005

American mathematician

The final test of a theory is its capacity to solve the problems which originated it.

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 71)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

### **Darbishire, Arthur Dukinfield** 1879–1915

Statistician

A theory which touches reality at no point cannot be disproved or proved by an appeal to reality.

*An Introduction to a Biology*

Appendix to an Introduction to Biology (p. 105)

Funk & Wagnalls Co. New York, New York, USA. 1917

I see theories as balloons. Their makers inflate them, their admirers over-inflate them; and they generally burst from over-inflation.

*An Introduction to a Biology*

Appendix to an Introduction to Biology (p. 105)

Funk & Wagnalls Co. New York, New York, USA. 1917

### **Dark, K. R.**

No biographical data available

It would be easy to imagine that archaeological theory is daunting, or irrelevant, or both. Theorists often use jargon-laden sentences, quote obscure works, discuss periods and areas distant from those of one’s own interest, and are keen to promote their own views.

*Theoretical Archaeology*

Introduction (p. 1)

Duckworth & Company. London, England. 1995

### **Darwin, Charles Robert** 1809–82

English naturalist

...for without the making of theories I am convinced there would be no observation.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

C. Darwin to C. Lyell, June 1st [1860] (p. 108)

D. Appleton & Company. New York, New York, USA. 1896

Let theory guide your observations, but till your reputation is well established, be sparing in publishing theory. It makes persons doubt your observations.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

Letter 646, Darwin to Scott, June 6, 1863 (p. 323)

D. Appleton & Company. New York, New York, USA. 1903

In October 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The results of this would be the formation of a new species. Here, then I had at last got a theory by which to work.

*Autobiography*

### **Darwin, Sir George Howard** 1845–1912

English astronomer and mathematician

A theory is, then, a necessity for the advance of science, and we may regard it as the branch of a living tree, of which facts are the nourishment.

Address to British Association, Section A

*Nature*, Volume 34, Number 879, September 2, 1886 (p. 420)



**Davies, John Tasman** 1924–  
Chemist

Theories are generalizations and unifications, and as such they cannot logically follow only from our experiences of a few particular events. Indeed we often generalize from a single event, just as a dog does who, having once seen a cat in a certain driveway, looks eagerly around whenever he passes that place in future. Evidently this latter activity is equivalent to testing the theory...that “there is always a cat in that driveway.”

*The Scientific Approach*

Chapter 1 (p. 11)

Academic Press. London, England. 1965

...a theory arises from a leap of the imagination...

*The Scientific Approach*

Chapter 1 (p. 11)

Academic Press. London, England. 1965

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

The basis of this theory is that in nature there is an inherent uncertainty or unpredictability that manifests itself only on an atomic scale. For example, the position of a subatomic particle such as an electron may not be a well-defined concept at all; it should be envisaged as jiggling around in a random sort of a way. Energy, too, becomes a slightly nebulous concept, subject to capricious and unpredictable changes.

*The Edge of Infinity: Where the Universe Came from and How It Will End*

Chapter 4 (p. 90)

Simon & Schuster. New York, New York, USA. 1981

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

If the number of theorems is larger than one can possibly survey, who can be trusted to judge what is “important?” One cannot have survival of the fittest if there is no interaction.

*The Mathematical Experience*

Ulam’s Dilemma (p. 21)

Birkhäuser. Boston, Massachusetts, USA. 1981

**Davy, Sir Humphry** 1778–1829  
English chemist

Theories ought to be made for time, and be considered capable of improvement.

*The Collected Works of Sir Humphry Davy* (Volume 1)

*Memories of the Life of Sir Humphry Davy*

Chapter II (p. 70)

London, England. 1839–1840

**de Fermat, Pierre** 1601–65  
French mathematician

We have found a beautiful and most general proposition, namely, that every integer is either a square, or the sum of two, three or at most four squares. This theorem depends on some of the most recondite mysteries of number, and is not possible to present its proof on the margin of this page.

In Tobias Dantzig

*Number: The Language of Science* (4th edition) (p. 269)

The Macmillan Company. New York, New York, USA. 1954

I have found a very great number of exceedingly beautiful theorems.

In E.T. Bell

*Men of Mathematics* (p. 56)

Simon & Schuster. New York, New York, USA. 1937

**de Grasse Tyson, Neil** 1958–  
American astrophysicist and writer

Scientific evidence in support of a theory sometimes takes you places where your senses have never been. Twentieth-century science has largely been built upon data collected with all manner of tools that enable us to see the universe in decidedly uncommon ways. As a consequence, while we have always required that a theory make mathematical sense, we no longer require that a theory make common sense. We simply demand that it be consistent with the results of observations and experiments....

In Defense of the Big Bang

*Natural History*, Volume 105, Number 12, December, 1996 (p. 76)

A well-constructed theory must explain some of what is not understood, predict previously unknown phenomena, and, to be successful, have its predictions consistently confirmed. Furthermore, skeptics should not hesitate to question every possible assumption, no matter how basic.

In Defense of the Big Bang

*Natural History*, Volume 105, Number 12, December, 1996 (p. 76)

**de La Beche, Henry Thomas** 1796–1855  
English geologist

Theories, no doubt, are useful to a certain extent, for they promote inquiry; and, in the present day, a few facts, at least, must be brought forward to support them. Among the facts so produced, there is always a probability of finding some that are new. The scarcity of the facts known too often gives the theorist a false security, and he hastens to conclusions upon the most meagre data, without reflecting that a small addition to his present very limited stock of knowledge may completely overset his speculations.

*Sections & Views, Illustrative of Geological Phaenomena*

Preface (p. iii)

Treuttel & Wurtz. London, England. 1830

**Dingle, Herbert** 1890–1978  
English astrophysicist



Success in scientific theory is won, not by rigid adherence to the rules of logic, but by bold speculation which dares even to break those rules if by that means new regions of interest may be opened up.

*Through Science to Philosophy*

Part II, Chapter XV (p. 346)

At The Clarendon Press. Oxford, England. 1937

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

I don't mean to deny that the evidence is in some ways very strong in favor of your theory, I only wish to point out that there are other theories possible.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*Adventures of the Norwood Builder* (p. 421)

Wings Books. New York, New York, USA. 1967

One forms provisional theories and waits for time or fuller knowledge to explode them. A bad habit, Mr. Ferguson, but human nature is weak.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

*The Adventure of the Sussex Vampire* (pp. 467–468)

Wings Books. New York, New York, USA. 1967

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

...if the aim of physical theories is to explain experimental laws, theoretical physics is not an autonomous science; it is subordinate to metaphysics.

Translated by Philip P. Wiener

*The Aim and Structure of Physical Theory*

Chapter I (p. 10)

Princeton University Press. Princeton, New Jersey, USA. 1954

A physical theory is not an explanation. It is a system of mathematical propositions, deduced from a small number of principles, which aim...to represent as simply, as completely, and as exactly as possible a group of experimental laws.

*The Aim and Structure of Physical Theory*

Part I, Chapter II (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1954

The sole purpose of physical theory is to provide a representation and classification of experimental laws; the only test permitting us to judge a physical theory and pronounce it good or bad is the comparison between the consequences of this theory and the experimental laws it has to represent and classify.

*The Aim and Structure of Physical Theory*

Part II, Chapter VI (p. 180)

Princeton University Press. Princeton, New Jersey, USA. 1954

Unlike the reduction to absurdity employed by geometers, experimental contradiction does not have the power to transform a physical hypothesis into an indisputable truth; in order to confer this power on it, it would be

necessary to enumerate completely the various hypotheses which may cover a determinate group of phenomena; but the physicist is never sure he has exhausted all the imaginable assumptions. The truth of a physical theory is not decided by heads or tails.

*The Aim and Structure of Physical Theory*

Part II, Chapter VI (p. 190)

Princeton University Press. Princeton, New Jersey, USA. 1954

When several taps of the beak break the shell of an egg from which the chick escapes, a child may imagine that this rigid and immobile mass, similar to the white shells he picks up on the edge of a stream, had suddenly taken life and produced the bird who runs away with a chirp; but just where his childish imagination sees a sudden creation, the naturalist recognizes the last stage of a long development; he thinks back to the first fusion of two microscopic nuclei in order to review next the series of divisions, differentiations, and reabsorptions which, cell by cell, have built up the body of the chick. The ordinary layman judges the birth of [scientific] theories as the child the appearance of the chick.

*The Aim and Structure of Physical Theory*

Part II, Chapter VII (p. 221)

Princeton University Press. Princeton, New Jersey, USA. 1954

Contemplation of a set of experimental laws does not, therefore, suffice to suggest to the physicist what hypotheses he should choose in order to give a theoretical representation of these laws; it is also necessary that the thoughts habitual with those among whom he lives and the tendencies impressed on his own mind by his previous studies come and guide him, and restrict the excessively great latitude left to this day a merely empirical form until circumstances prepare the genius of a physicist to conceive the hypothesis which will organize them into a theory!

*The Aim and Structure of Physical Theory*

Part II, Chapter VII (p. 255)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

Theories are like crutches; to prove that they are good, we must make use of them and walk.

In M. cap.

*The Chemist*

Robert Boyle, a Biographical Study

Volume IV 1857 (p. 327)

**Duschl, Richard Alan** 1951–

American science education professor and researcher

In order to say we have developed a knowledge of science, we must be able to say we have an understanding of the function, structure, and generation of scientific theories.

*Restructuring Science Education: The Importance of Theories and Their*

*Development*

Chapter 6 (p. 96)

Teachers College Press. New York, New York, USA. 1990

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...a reasoned theory is preferable to blind extrapolation.

*The Expanding Universe*

Chapter I, Section IV (p. 18)

The University Press. Cambridge. 1933

There was just one place where the theory did not seem to work properly, and that was – infinity. I think Einstein showed his greatness in the simple and drastic way in which he disposed of difficulties at infinity. He abolished infinity. He slightly altered his equations so as to make space at great distances bend round until it closed up. So that, if in Einstein's space you kept going right on in one direction, you do not get to infinity; you find yourself back at your starting-point again. Since there was no longer any infinity, there could be no difficulties at infinity. Q. E. D.

*The Expanding Universe*

Chapter I, Section V (pp. 21–22)

The University Press. Cambridge. 1933

The relativity theory of physics reduces everything to relations; that is to say, it is structure, not material, which counts. The structure cannot be built up without material; but the nature of the material is of no importance.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (p. 197)

At The University Press. Cambridge, England. 1953

We have found a strange footprint on the shores of the unknown. We have devised profound theories, one after another to account for its origin. At last, we have succeeded in reconstructing the creature that made the footprint. And lo! It is our own.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (p. 201)

At The University Press. Cambridge, England. 1921

It is quite commonly said that scientific theories about the world are neither true nor false but merely convenient or inconvenient.

*The Nature of the Physical World*

Chapter XIII (p. 285)

The University Press. New York, New York, USA. 1929

Scientific theories have blundered in the past; they blunder no doubt today; yet we cannot doubt that along with the error there come gleams of a truth for which the human mind is impelled to strive.

*Science and the Unseen World*

Lecture II (p. 22)

The Macmillan Co. New York, New York, USA. 1929

**Einstein, Albert** 1879–1955

German-born physicist

These fundamental concepts and postulates, which cannot be further reduced logically, form the essential part of a theory, which reason cannot touch. It is the grand object of all theory to make these irreducible elements as simple and as few in number as possible, without having to renounce the adequate representation of any empirical content whatever.

Translated by Alan Harris

*Essays in Science*

On the Method of Theoretical Physics (p. 15)

Philosophical Library. New York, New York, USA. 1934

No fairer destiny could be allotted to any physical theory, than that it should of itself point out the way to the introduction of a more comprehensive theory, in which it lives on as a limiting case.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Part II, Chapter 22 (pp. 98–99)

Pi Press. New York, New York, USA. 2005

Theories are evolved and are expressed in short compass as statements of a large number of individual observations in the form of empirical laws, from which the general laws can be ascertained by comparison. Regarded in this way, the development of a science bears some resemblance to the compilation of a classified catalogue. It is, as it were, a purely empirical enterprise.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Appendix III, The Experimental Confirmation of the General Theory of Relativity

Pi Press. New York, New York, USA. 2005

Of the general theory of relativity you will be convinced, once you have studied it. Therefore I am not going to defend it with a single word.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Letter to A. Sommerfeld, 8 February, 1916 (p. 101)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

Physical theory has two ardent desires, to gather up as far as possible all pertinent phenomena and their connections, and to help us not only to know how Nature is and how her transactions are carried through, but also to reach as far as possible the perhaps utopian and seemingly arrogant aim of knowing why Nature is thus and not otherwise. Here lies the highest satisfaction of a scientific person.

In G. Holton

*Thematic Origins of Scientific Thought*

Chapter 8 (p. 242)

Harvard University Press. Cambridge, Massachusetts, USA. 1973

The scientific theorist is not to be envied. For Nature, or more precisely experiment, is an inexorable and not very friendly judge of his work. It never says "Yes" to a theory. In the most favorable cases it says "Maybe," and in the great majority of cases simply "No." If an experiment

agrees with a theory it means for the latter “Maybe,” and if it does not agree it means “No.” Probably every theory will someday experience its “No” – most theories [do], soon after conception.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Note dated 11 November, 1922 (p. 18)

Princeton University Press. Princeton, New Jersey, USA. 1979

For the creation of a theory the mere collection of recorded phenomena never suffices – there must always be added a free invention of the human mind that attacks the heart of the matter. And: the physicist must not be content with the purely phenomenological considerations that pertain to the phenomenon. Indeed, he should press on to the speculative method, which looks for the underlying pattern.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Lecture at the Berlin Planetarium, 4 October, 1931 (pp. 29–30)

Princeton University Press. Princeton, New Jersey, USA. 1979

If my theory of relativity is proven successful, Germany will claim me as a German and France will declare that I am a citizen of the world. Should my theory prove untrue, France will say that I am a German, and Germany will declare that I am a Jew.

*The Great Quotations*

Address at the Sorbonne (p. 226)

New York Times, 16 February, 1930

A theory is the more impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability.

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 31)

Open Court. La Salle, Illinois, USA. 1979

I have learned something else from the theory of gravitation: no collection of empirical facts however comprehensive can ever lead to the setting up of such complicated equations. A theory can be tested by experience, but there is no way from experience to the construction of a theory. Equations of such complexity as are the equations of the gravitational field can be found only through the discovery of a logically simple mathematical condition that determines the equations completely or almost completely. Once one has obtained those sufficiently strong formal conditions, one requires only little knowledge of facts for the construction of the theory...

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 31)

Open Court. La Salle, Illinois, USA. 1979

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

There are no eternal theories in science. It always happens that some of the facts predicted by a theory are disproved by experiment. Every theory has its period of gradual development and triumph, after which it may experience a rapid decline.

*The Evolution of Physics*

The Two Electric Fluids (p. 77)

Simon & Schuster. New York, New York, USA. 1961

Creating a new theory is not like destroying an old barn and erecting a skyscraper in its place. It is rather like climbing a mountain, gaining new and wider views, discovering unexpected connections between our starting point and its rich environment. But the point from which we started out still exists and can be seen, although it appears smaller and forms a tiny part of our broad view gained by the mastery of the obstacles on our adventurous way up.

*The Evolution of Physics*

The Mechanical Scaffold (pp. 158–159)

Simon & Schuster. New York, New York, USA. 1961

**Elliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

The possession of an original theory which has not yet been assailed must certainly sweetens the temper of a man who is not beforehand ill-natured.

*Impressions of Theophrastus Such*

How We Encourage Research (p. 26)

William Blackwood. London, England. 1879

...it is possible, thank Heaven! to have very erroneous theories and very sublime feelings.

*Adam Bede*

After the Preaching (p. 34)

Charles Scribner's Sons. New York, New York, USA. 1917

**Elliot, Hugh Samuel Roger** 1881–1930

No biographical data available

...only theories that profess to be founded on facts, that can be refuted by facts.

*Modern Science and the Illusions of Professor Bergson*

Preface (p. 2)

Longmans, Green & Co. New York, New York, USA. 1912

**Faraday, Michael** 1791–1867

English physicist and chemist

The world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Five (p. 58)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Feynman, Richard P.** 1918–88  
American theoretical physicist

This is the key of modern science and...the beginning of the true understanding of Nature – this idea to look at the thing, to record the details, and to hope that in the information thus obtained might lie a clue to one or another theoretical interpretation.

*The Character of Physical Law*  
Chapter 1 (p. 15)  
BBC. London, England. 1965

Another thing I must point out is that you cannot prove a vague theory wrong. If the guess that you make is poorly expressed and rather vague, and the method that you use for figuring out the consequences is a little vague – you are not sure, and you say, “I think everything’s right because it’s all due to so and so,...and I can sort of explain how this works”...then you see that this theory is good, because it cannot be proved wrong! Also if the process of computing the consequences is indefinite, then with a little skill any experimental results can be made to look like the expected consequences.

*The Character of Physical Law*  
Chapter 7 (pp. 158–159)  
BBC. London, England. 1965

If someone were to propose that the planets go around the sun because all planet matter has a kind of tendency for movement, a kind of motility, let us call it an “oomph,” this theory could explain a number of other phenomena as well. So this is a good theory, is it not? It is nowhere near as good as the proposition that the planets move around the sun under the influence of a central force which varies exactly inversely as the square of the distance from the center. The second theory is better because it is so specific; it is so obviously unlikely to be the result of chance. It is so definite that the barest error in the movement can show that it is wrong; but the planets could wobble all over the place, and, according to the first theory, you could say, “Well, that is the funny behavior of the oomph.”

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (pp. 19–20)  
Perseus Books. Reading, Massachusetts, USA. 1998

People are always asking for the latest developments in the unification of this theory with that theory, and they don’t give us a chance to tell them anything about what we know pretty well. They always want to know the things we don’t know.

*QED: The Strange Theory Of Light And Matter* (p. 3)

**Fischer, Martin H.** 1879–1962  
German-American physician

Don’t confuse hypothesis and theory. The former is a possible explanation; the latter, the correct one. The establishment of theory is the very purpose of science.

In Howard Fabing and Ray Marr  
*Fischerisms*  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Fresnel, Augustin-Jean** 1788–1827  
French physicist

The assistance to be derived from a good theory is not to be confined to the calculation of the forces when the laws of the phenomena are known. There are certain laws so complicated and so singular, that observation alone, aided by analogy, could never lead to their discovery. To divine these enigmas we must be guided by theoretical ideas founded on a true hypothesis. The theory of luminous vibrations presents this character, and these precious advantages; for to it we owe the discovery of optical laws the most complicated and most difficult to divine.

In Richard Taylor  
*Scientific Memoirs* (Volume 5)  
Memoir on Double Refraction (p. 241)  
London, England. 1837–1853

**Frost, Robert** 1874–1963  
American poet

A theory if you hold it hard enough  
And long enough gets rated as a creed....

*Complete Poems of Robert Frost*  
Etherealizing  
Henry Holt & Company. New York, New York, USA. 1949

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

In order to draw any conclusion...it is prudent to wait until more numerous and exact observations have provided a solid foundation on which we may build a rigorous theory.

In Maurice Crosland  
*Gay-Lussac: Scientist and Bourgeois*  
Chapter 4 (p. 71)  
Cambridge University Press. Cambridge, England. 1978

**George, William H.**  
No biographical data available

Theories come into fashion and theories go out of fashion, but the facts connected with them stay.

*The Scientist in Action: A Scientific Study of His Methods*  
Chapter XII (p. 218)  
Williams & Norgate Ltd. London, England. 1936

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

About binomial theorem I’m teeming with a lot o’ news –  
With many cheerful facts about the square of the hypotenuse.

*The Complete Plays of Gilbert and Sullivan*

*The Pirates of Penzance*

Act I (p. 133)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

### **Ginsparg, Paul**

American physicist

### **Glashow, Sheldon** 1932–

American physicist

The theory of everything may come in its time, but not until we are certain that Nature has exhausted her bag of performable tricks.

Desperately Seeking Superstrings?

*Physics Today*, May, 1986 (p. 7)

### **Glashow, Sheldon L.** 1932–

American physicist

No matter how compelling or elegant it is, a theory of physics must be subjected to experimental verification or it differs little from medieval theology.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 4 (p. 77)

Warner Books. New York, New York, USA. 1988

### **Goddard, Robert H.** 1882–1945

American physicist

In this present age of science, when no problem seems too baffling for the inventor, and no mysterious phenomenon too much in the dark for elucidation by the discoverer, it is surprising that so few fundamental scientific theories can be proved.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted (p. 63)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

### **Goldhaber, Maurice** 1911–

Austrian-American physicist

Antaeus was the strongest person alive, invincible as long as he was in contact with his mother, the earth. Once he lost contact with the earth, he grew weak and was vanquished. Theories in physics are like that. They have to touch the ground for their strength.

In Robert P. Crease and Charles C. Mann

How the Universe Works

*The Atlantic Monthly*, August, 1984 (p. 91)

### **Goodman, Nicholas P.**

No biographical data available

There are no deep theorems – only theorems that we have not understood very well.

Reflections on Bishops Philosophy of Mathematics

*The Mathematical Intelligence*, Volume 5, Number 3, 1983 (p. 63)

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

As the new Darwinian orthodoxy swept through Europe, its most brilliant opponent, the aging embryologist Karl

Ernst von Baer, remarked with bitter irony that every triumphant theory passes through three stages: first it is dismissed as untrue; then it is rejected as contrary to religion; finally, it is accepted as dogma and each scientist claims that he had long appreciated its truth.

*Ever Since Darwin: Reflections in Natural History*

Chapter 20. The Validation of Continental Drift (pp. 161–162)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

I would say usually, theories act as straitjackets to channel observations toward their support, and to forestall data that might refute them. Such theories cannot be rejected from within, for we will not conceptualize the disapproving observations.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 12 (p. 151)

Random House, Inc. New York, New York, USA. 1995

All great theories are expansive, and all notions so rich in scope and implication are underpinned by visions about the nature of things. You may call these visions “philosophy,” or “metaphor,” or “organizing principle,” but one thing they are surely not – they are not simple inductions from observed facts of the natural world.

*Time’s Arrow, Time’s Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 9)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

### **Gratzer, Walter Bruno** 1932–

English science writer

It is also of course difficult to renounce a cherished theory, the product of costly intellectual and emotional investment, and to accept the cost to ambition, reputation and pride of a humiliating retraction. As the economist J. K. Galbraith put it, “faced with the choice between changing one’s mind and proving that there is no need to do so, almost everyone gets busy with the proof.” And so a fatuous optimism triumphs over the caution that must guide all scientists through most of their working lives.

*The Undergrowth of Science: Delusion, Self-Deception and Human Frailty*

Chapter 3 (p. 81)

Oxford University Press, Inc. Oxford, England. 2000

### **Gray, Elisha** 1835–1901

American electrical engineer

A man who is all theory is like “a rudderless ship on a shoreless sea.” All he really knows is that he is afloat, and if he lands at all it is likely to be in an insane asylum.

*Nature’s Miracles; Familiar Talks on Science*

Introduction (p. vii)

Fords, Howard & Hulbert. New York, New York, USA. 1899

### **Greene, Brian** 1963–

American theoretical physicist

One measure of the depth of a physical theory is the extent to which it poses serious challenges to aspects of our worldview that had previously seemed immutable



*The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory*

Chapter 15 (p. 386)

Random House, Inc. New York, New York, USA. 2000

**Gribbin, John** 1946–

British science writer and astronomer

Good theories are the ones that get those predictions right; the best theories enable us to “get right” the calculation of how the Universe came into being and then exploded into its present form. But that doesn’t mean that they convey ultimate truth, or that there “really are” little hard particles rattling around against each other inside the atom. Such truth as there is in any of this work lies in the mathematics; the particle concept is simply a crutch ordinary mortals can use to help them towards an understanding of the mathematical laws.

*The Search of Superstrings, Symmetry, and the Theory of Everything* (pp. 51–52)

Little, Brown & Company. Boston, Massachusetts, USA. 1998

**Grove, William Robert** 1811–96

Judge and physical scientist

The theory consequent upon new facts, whether it be a co-ordination of them with known ones, or the more difficult and dangerous attempt at remodelling the public ideas, is generally enunciated by the discoverers themselves of the facts, or by those to whose authority the world at that period defers; others are not bold enough, or if they be so, are unheeded.

*The Correlation of Physical Forces*

Chapter I (p. 2)

Samuel Highly. London, England. 1850

**Haeckel, Ernst Heinrich Philipp August** 1834–1919

German biologist and philosopher

The value which every scientific theory possesses is measured by the number and importance of the objects which can be explained by it, as well as by the simplicity and universality of the causes which are employed in it as grounds of explanation.

Translated by Edwin Ray Lankester

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition)

Chapter II (p. 25)

D. Appleton & Co. New York, New York, USA. 1892

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

“The results so far obtained are consistent with the view that...” has taken the place of “Thus saith the Lord...” as an introduction to a new theory.

*Possible Worlds and Other Papers*

Chapter XXX (p. 223)

Harper & Brothers. New York, New York, USA. 1928

**Hamilton, Edith** 1868–1963

German-born classicist and educator

Theories that go counter to the facts of human nature are foredoomed.

*The Roman Way*

Comedy’s Mirror

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Hawking, Stephen William** 1942–

English theoretical physicist

...a good theory is characterized by the fact that it makes a number of predictions that could in principle be disproved or falsified by observation.

*A Brief History of Time: The Updated and Expanded Edition*

Chapter 1 (p. 10)

Bantam Books. Toronto, Ontario, Canada. 1988

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Theory always tends to become more abstract as it emerges successfully from the chaos of facts by processes of differentiation and elimination, whereby the essentials and their connections become recognized, while minor effects are seen to be secondary or unessential, and are ignored temporarily, to be explained by additional means.

In J.W. Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. 370)

Dover Publications. New York, New York, USA. 1955

Let them [facts] be digested into theory, however, and brought into mutual harmony, and it is another matter.

Theory is the essence of facts. Without theory scientific knowledge would be only worthy of the madhouse.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 12)

D. van Nostrand Co. New York, New York, USA. 1893

**Heinlein, Robert A.** 1907–88

American science fiction writer

Permit me to say, speaking from experience, all theories are empty.

*Time Enough for Love*

Chapter XIII (p. 390)

G.P. Putnam’s Sons. New York, New York, USA. 1973

Modern theory did not arise from revolutionary ideas which have been, so to speak, introduced into the exact sciences from without. On the contrary, they have forced their way into research which was attempting consistently to carry out the program of classical physics – they arise out of its very nature.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part I, Chapter 3 (p. 67)

Simon & Schuster. New York, New York, USA. 1982

**Heitler, W.** 1904–1981

German theoretical physicist

It is usually the fate of good physical theory that after its initial success, difficulties or limitations of its applicability



become apparent. Eventually it is superseded by a better theory in which some of the difficulties are removed or which has a wider field of application, as the case may be.

*The Quantum Theory of Radiation*

Introduction (p. xi)

At The Clarendon Press. Oxford, England. 1954

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

A philosophical theory does not shoot up like the tall and spiry pine in graceful and unencumbered natural growth, but, like a column built by men, ascends amid extraneous apparatus and shapeless masses of materials...

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Terrestrial Magnetism (p. 67)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

**Hilton, James** 1900–1954

English-born novelist

And I believe that the Binomial Theorem and a Bach Fugue are, in the long run, more important than all the battles of history.

*This Week Magazine*, 1937

**Holt, Michael**

No biographical data available

Nobody knows why, but [the only] scientific theories that really work are the mathematical ones.

*Mathematics in Art*

Chapter 2 (p. 33)

Studio Vista. London, England. 1971

**Horton, Robin**

British anthropologist and philosopher

To say of the traditional African thinker that he is interested in supernatural rather than natural causes makes little more sense...than to say of the physicist that he is interested in nuclear rather than natural causes. In fact, both are making the same use of theory to transcend the limited vision of natural causes provided by common sense.

African Traditional Thought and Western Science

*Africa*, Volume 37, Number 1, 1967 (p. 57)

**Howes, Oscar** 1830–90

American educator

...the fewer the facts, the more numerous the theories.

The Origin of Language

*The Christian Review*, Volume 28 July 1863 (p. 384)

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

It is true that we must not accept a theory on the basis of emotional preference but it is not an emotional preference to attempt to establish a theory that would place us

in a position to obtain a complete understanding of the Universe. The stakes are high, and win or lose, are worth playing for.

*Frontiers of Astronomy*

Epilogue (pp. 354–355)

Harper & Row, Publishers. New York, New York, USA. 1955

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

**Hoyle, Geoffrey** 1942–

English science fiction writer

Be suspicious of a theory if more and more hypotheses are needed to support it as new facts become available, or as new considerations are brought to bear.

*Evolution from Space* (p. 135)

Simon & Schuster. New York, New York, USA. 1982

**Hubble, Edwin Powell** 1889–1953

American astronomer

Many theories are formulated but relatively few endure the tests. The survivors, in general, must be occasionally revised to conform with the growing body of knowledge. The ability to theorize is highly personal; it involves art, imagination, logic, and something more. An outstanding genius may invent a successful new type of theory; first-rate men may follow the lead and develop other theories on the same pattern; less competent minds are embarrassed by the custom of testing predictions.

*The Realm of the Nebulae*

Introduction (p. 5)

Dover Publications, Inc. New York, New York, USA. 1958

No theory is sacred. When a theory fails to meet the test of verified predictions, it is modified to include the larger field, or, vary rarely, it may be abandoned completely.

*The Nature of Science and Other Lectures*

Part I, Experiment and Experience (p. 41)

The Huntington Library. San Marino, California, USA. 1954

**Huggins, Sir William** 1824–1910

English astronomer

A theory which sweeps the astronomical horizon of so many mysteries must not only arouse our profound interest, but claim the respectful consideration of men of science.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

Stellar Evolution in the Light of Recent Research (p. 192)

Government Printing Office. Washington, D.C. 1903

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

But when, in framing a theory of the earth, a geologist shall indulge his fancy in framing, without evidence, that which had preceded the present order of things, he then either misleads himself, or writes a fable for the amusement of his reader.

*The Theory of the Earth* (Volume 1)  
Part I, Chapter III (pp. 280–281)  
Messrs. Cadwell, Junior & Davies. London, England. 1795

A theory which is founded on a new principle, a theory which has to make its way in the public mind by overturning the opinions commonly received by philosophising men, and one which has nothing to recommend it but the truth of its principles, and the view of wisdom or design to which it leads, neither of which may perhaps be perceived by the generality of people, such a theory, I say, must meet with the strongest opposition from the prejudices of the learned, and from the superstition of those who judge not for themselves in forming their notions, but look up to men of science for authority.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter II (p. 201)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

A theory founded on truth, and formed according to the proper rules of science, can ever suffer from a strict examination, by which it would be but the more and more confirmed.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter II (p. 203)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

So far as a theory is formed in the generalization of natural appearances, that theory must be just, although it may not be perfect, as having comprehended every appearance; that is to say, a theory is not perfect until it be founded upon every natural appearance; in which case, those appearances will be explained by the theory.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)  
Chapter III (p. 300)  
H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95  
English biologist

The struggle for existence holds as much in the intellectual as in the physical world. A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

*Collected Essays* (Volume 2)  
*Darwiniana*  
The Coming of Age of “The Origin of Species” (p. 229)  
Macmillan & Company Ltd. London, England. 1904

A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

*Darwiniana*  
Essay VII (p. 229)  
D. Appleton & Co. New York, New York, USA. 1896

**Jacoby, Harold** 1865–1932  
American astronomer

A theory starts life an intellectual pigmy, may develop, if it have the vitality, into a veritable intellectual colossus, and, after it has run its course, may leave behind its

offspring. It is not a cause of reproach but rather of congratulation that the scientific theory of today may be discarded tomorrow, for no theory will be abandoned until a better one has been brought forward to take its place, one which can explain the facts in a way more satisfying to the human mind.

In Columbia University  
*Lectures on Science, Philosophy and Art, 1907–1908*  
Astronomy (p. 29)  
The Columbia University Press. New York, New York, USA. 1909

**James, William** 1842–1910  
American philosopher and psychologist

Theories thus become instruments, not answers to enigmas, in which we can rest. We don’t lie back upon them, we move forward, and, on occasion, make nature over again by their aid.

*Pragmatism: A New Name for Some Old Ways of Thinking*  
Lecture II (p. 53)  
Longmans, Green & Company London, England. 1914

...the classic stages of a theory’s career. First, you know, a new theory is attacked as absurd; then it is admitted to be true, but obvious and insignificant; finally it is seen to be so important that its adversaries claim that they themselves discovered it.

*Pragmatism: A New Name for Some Old Ways of Thinking*  
Lecture VI (p. 198)  
Longmans, Green & Company London, England. 1914

The history of science is strewn with wrecks and ruins of theory – essences and principles, fluids and forces – once fondly clung to, but found to hang together with no facts of sense. And experimental phenomena solicit our belief in vain until such time as we chance to conceive them as of kinds already admitted to exist. What science means by ‘verification’ is no more than this, that no object of conception shall be believed which sooner or later has not some permanent and vivid object of sensations for its *term*.

*The Principles of Psychology* (Volume 2)  
Chapter XXI (p. 301)  
Henry Holt & Co. New York, New York, USA. 1890

**Jastrow, Joseph** 1863–1944  
Polish-born psychologist

Theories without facts or based on uncritically selected facts are vain, and facts without theoretical interpretation, blind.

In Joseph Jastrow (ed.)  
*The Story of Human Error*  
Introduction (p. 33)  
D. Appleton-Century Company, Inc. New York, New York, USA. 1936

**Jevons, William Stanley** 1835–82  
English economist and logician

The fertile discoverer...chooses between many theories, and is never wedded to anyone, unless impartial and repeated comparison has convinced him of its validity.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Chapter XXVI (p. 587)  
Macmillan & Co Ltd. London, England. 1887

**Joos, Georg** 1894–1959  
German physicist

While it is true that theory often sets difficult, if not impossible tasks for the experiment, it does, on the other hand, often lighten the work of the experimenter by disclosing cogent relationships which make possible the indirect determination of inaccessible quantities and thus render difficult measurements unnecessary.

*Theoretical Physics*  
Introduction (p. 1)  
Blackie & Son Ltd. London, England. 1968

**Kasner, Edward** 1878–1955  
American mathematician

Today the mathematician admits the existence and the necessity of many theories, many geometries, each appealing to certain interests, each to be developed by the most appropriate methods; and he realizes that, no matter how large his conceptions and how powerful his methods, they will be replaced before long by others larger and more powerful.

The Present Problems of Geometry  
*Bulletin of the American Mathematical Society*, Volume XI, Number 6, March, 1905 (p. 283)

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

A scientific theory is a tool and not a creed.

In Richard Willstätter  
*From My Life: The Memoirs of Richard Willstätter*  
Chapter 12 (p. 388)  
W.A. Benjamin. New York, New York, USA. 1965

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

For scientific theories are, each and all of them, and they will continue to be, built upon and about notions which, however sublimated, are nevertheless derived from common sense.

*Mathematics* (pp. 5–6)  
Columbia University Press. New York, New York, USA. 1907

**Kitaigorodski, Aleksandr Isaakovich** 1914–  
No biographical data available

A first-rate theory predicts; a second-rate theory forbids and a third-rate theory explains after the event.

Lecture, ICU, Amsterdam, August, 1975

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

The history of cosmic theories...may without exaggeration be called a history of collective obsessions and controlled schizophrenias.

*The Sleepwalkers*  
Preface (p. 15)  
The Macmillan Company. New York, New York, USA. 1966

**Kosso, Peter**  
No biographical data available

Nature acts as *if* our theories about it are true, but that does not mean that nature is as these theories say.

*Appearance and Reality: An Introduction to the Philosophy of Physics*  
Chapter 2 (p. 26)  
Oxford University Press. Oxford, England. 1998

**Kuhn, Thomas S.** 1922–96  
American historian of science

The scientist must...be concerned to understand the world and to extend the precision and scope with which it has been ordered. That commitment must, in turn, lead them to scrutinize, either for themselves or through colleagues, some aspect of nature in great empirical detail. And, if that scrutiny displays pockets of apparent disorder, then these must challenge the scientist to a new refinement of their observational techniques or to a further articulation of their theories.

*The Structure of Scientific Revolutions*  
Chapter IV (p. 42)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

...no theory ever solves all the puzzles with which it is confronted at a given time; nor are the solutions already achieved often perfect.

*The Structure of Scientific Revolutions*  
Chapter XII (p. 146)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

One often hears that successive theories grow ever closer to, or approximate more and more closely to, the truth. Apparently generalizations like that refer not to the puzzle-solutions and the concrete predictions derived from a theory but rather to its ontology, to the match, that is, between the entities with which the theory populates nature and what is “really there.”

*The Structure of Scientific Revolutions*  
Postscript–1969 (p. 206)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

**Lakatos, Imre** 1922–74  
Hungarian-born philosopher

No theory forbids some state of affairs specifiable in advance; it is not that we propose a theory and Nature may shout No. Rather, we propose a maze of theories, and Nature may shout INCONSISTENT.

Criticism and the Methodology of Scientific Research Programmes  
*Proceedings of the Aristotelian Society*, Volume 69, 1968–1969 (p. 162)

Scientists want to make their theories respectable, deserving of the title “science”, that is genuine knowledge. Now the most relevant knowledge in the seventeenth century, when science was born, concerned God, the Devil, Heaven and Hell. If one got one’s conjectures

about matters of divinity wrong, the consequences of one's mistake was eternal damnation.

*The Methodology of Scientific Research Programmes* (p. 2)  
Cambridge University Press. Cambridge, England. 1978

### **Laszlo, E.**

No biographical data available

Ours is a complex world. But human knowledge is finite and circumscribed. "Nature does not come as clean as you can think it," warned Alfred North Whitehead, and went on to propound an extremely clean and elegant cosmology. Since theories, like window panes, are clear only when they are clean, and the world does not come as cleanly as all that, we must know where we perform a clean-up operation.

*The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences*

Chapter 1, Section 2 (p. 13)

George Braziller. New York, New York, USA. 1972

Scientific theories, while simpler than reality, must nevertheless reflect its essential structure. Science then must beware of rejecting the structure for the sake of simplicity; that would be to throw out the baby with the bath water.

*The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences*

Chapter 1, Section 2 (p. 13)

George Braziller. New York, New York, USA. 1972

### **Lauden, Larry** 1945–

American philosopher of science

...the rationale for accepting or rejecting any theory is thus fundamentally based on the idea of problem-solving progress. If one research tradition has solved more important problems than its rivals, then accepting that tradition is rational precisely to the degree that we are aiming to "progress," i.e., to maximize the scope of solved problems. In other words, the choice of one tradition over its rivals is a progressive (and thus a rational) choice precisely to the extent that the chosen tradition is a better problem solver than its rivals.

*Progress and Its Problems: Toward a Theory of Scientific Growth*

Chapter Three (p. 109)

University of California Press. Berkeley, California, USA. 1977

### **Lederman, Leon** 1922–

American high-energy physicist

...a comment on the word "theory," which lends itself to popular misconceptions. "That's your theory" is a popular sneer. Or "That's only a theory." Our fault for sloppy use. The quantum theory and the Newtonian theory are well-established, well-verified components of our world view. They are not in doubt. It's a matter of derivation. Once upon a time it was Newton's (as yet unverified) "theory." Then it was verified, but the name stuck. "Newton's theory" it will always be. On the other hand,

superstrings and GUTs are speculative efforts to extend current understanding, building on what we know.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 9 (p. 389)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

The better theories are verifiable. Once upon a time that was the sine qua non of any theory. Nowadays, addressing events at the Big Bang, we face, perhaps for the first time, a situation in which a theory may never be experimentally tested.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 9 (p. 389)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### **Lewontin, Richard C.** 1929–

American evolutionary geneticist and philosopher of science

Theory generally should not be an attempt to say how the world is. Rather, it is an attempt to construct the logical relations that arise from various assumptions about the world.

In E. Mayr and W.B. Provine (eds.)

*The Evolutionary Synthesis*

Part One, Chapter 1

Theoretical Population Genetics in the Evolutionary Synthesis (p. 65)

Harvard University Press. Cambridge, Massachusetts, USA. 1980

It is not always appreciated that the problem of theory building is a constant interaction between constructing laws and finding an appropriate set of descriptive state variables such that laws can be constructed.

*The Genetic Basis of Evolutionary Change*

Chapter 1 (p. 8)

Columbia University Press. New York, New York, USA. 1974

...we cannot go out and describe the world in any old way we please and then sit back and demand that an explanatory and predictive theory be built on that description.

*The Genetic Basis of Evolutionary Change*

Chapter 1 (p. 8)

Columbia University Press. New York, New York, USA. 1974

### **Libes, Antoine** 1752–1832

French physicist

Let us add a word in favor of theories, which certain physicists still dare to present as invincible obstacles to the discovery of truth. It is incontestable that experience and observation ought to serve as the basis of our physical knowledge. But without the help of theory the most well-certified experiments, the most numerous observations will be only isolated facts in the hands of the physicist, isolated facts which cannot serve for the advancement of physics. The man of genius must seize upon these scattered links and bring them together skillfully to form a continuous chain. This continuity constitutes the theory, which alone can give us a glimpse of the relations which bind the facts to one another and of their dependence on the causes which have produced them.

In Russell McCormach (ed.)  
*Historical Studies in the Physical Sciences* (Volume 4)  
 In Robert H. Silliman  
 Fresnel and the Emergence of Physics as a Discipline (p. 143)  
 Princeton University Press. Princeton, New Jersey, USA. 1974

**Lichtenberg, Georg Christoph** 1742–99  
 German physicist and satirical writer

This whole theory is good for nothing except disputing about.

*Lichtenberg: Aphorisms & Letters*  
 Aphorisms (p. 57)  
 Jonathan Cape. London, England. 1969

**Lindley, David** 1956–  
 English astrophysicist and author

Theoretical physicists can invent theories in which the speed of light is not an absolute limit, but those theories do not correspond to the world we inhabit. The speed of light does not have to be finite, but in our world, as distinct from all the imaginary worlds a mathematician might invent, it is. Some things in the end can be determined only empirically, by looking at the world and figuring out how it works.

*The End of Physics: The Myth of a Unified Theory*  
 Prologue (p. 6)  
 Basic Books, Inc. New York, New York, USA. 1993

Ultimately, theories must be useful and accurate, and in that sense it does not matter whether they were arrived at through piercing insight or blind luck.

*The End of Physics: The Myth of a Unified Theory*  
 Prologue (p. 10)  
 Basic Books, Inc. New York, New York, USA. 1993

**Lodge, Sir Oliver** 1851–1940  
 English physicist

A physical theory cannot take the whole universe into account; but if it is to be complete enough to be satisfactory, and to make trustworthy predictions, it must take all relevant factors into account.

Contributions to a British Association Discussion on the Evolution of the Universe  
*Nature*, Supplement, October 24, 1931 (p. 722)

**Mach, Ernst** 1838–1916  
 Austrian physicist and philosopher

The object of natural science is the connection of phenomena; but the theories are like dry leaves which fall away when they have long ceased to be the lungs of the tree of science.

*History and Root of the Principle of the Conservation of Energy*  
 Chapter IV (p. 74)  
 The Open Court Publishing Company. Chicago, Illinois, USA. 1911

...theories are like dry leaves which fall away when they have long ceased to be the lungs of the tree of science.  
 Translated by Philip E.B. Jourdain

*History and Root of the Principle of the Conservation of Energy*  
 Chapter IV (p. 74)  
 The Open Court Publishing Co. Chicago, Illinois, USA. 1911

...theories are abstractions, which, while placing in relief what is important in *certain determinate* cases, neglect almost necessarily, or even disguise, what is important in other cases.

Translated by Cora May Williams  
*Contributions to the Analysis of the Sensations*  
 Appendix I (p. 186)  
 The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Maimonides, Moses** 1135–1204  
 Spanish-born philosopher, jurist, and physician

Man knows only these poor mathematical theories about the heavens, and only God knows the real motions of the heavens and their causes.

In Phillip Frank  
*Modern Science and its Philosophy*  
 Chapter 13 (p. 222)  
 Harvard University Press, Cambridge, England. 1952

**Malthus, Thomas Robert** 1766–1834  
 English economist

Each pursues his own theory, little solicitous to correct or improve it by an attention to what is advanced by his opponents.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today, 1961*  
*Essays on the Principle of Population* (p. 473)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1961

**Matthew, William Diller** 1871–1930  
 Canadian-American paleontologist

Many a false theory gets crystallized by time and absorbed into the body of scientific doctrine through lack of adequate criticism when it is formulated.

Supplementary Note  
*Climate and Evolution* (Volume 1) (p. 159)  
 Special Publications of the New York Academy of Sciences. December, 1950

**Maxwell, James Clerk** 1831–79  
 Scottish physicist

In every human pursuit there are two courses – one, that which in its lowest form is called the useful, and has for its ultimate object the extension of knowledge, the dominion over Nature, and the welfare of mankind. The objects of the second course are entirely self-contained. Theories are elaborated for theories' sake, difficulties are sought out and treasured as such, and no argument is to be considered perfect unless it lands the reasoner at the point from which he started.

In Lewis Campbell and William Garnett  
*The Life of James Clerk Maxwell*  
 Appendix A (p. 346)  
 Macmillan & Co Ltd. London, England. 1884



**Mayes, Jr., Harlan**

No biographical data available

Theory, glamorous mother of the drudge experiment.

In Eric M. Rogers

*Physics for the Inquiring Mind*

Chapter 40 (p. 648)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Mayo, John**

No biographical data available

This theory of the learned author is certainly very ingenious, but I am not sure that it is in the same degree in accordance with truth.

*Medico-Physical Works*

Fourth Treatise

Chapter I (p. 231)

The Alembic Club. Edinburgh, Scotland. 1907

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Scientific theories...begin as imaginative constructions. They begin, if you like, as stories, and the purpose of the critical or rectifying episode in scientific reasoning is precisely to find out whether or not these stories are about real life.

*Pluto's Republic*

Science and Literature, Section 4 (p. 53)

Oxford University Press, Inc. Oxford, England. 1982

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

...for a professor must have a theory, as a dog must have fleas.

*Prejudices: First Series*

Criticism of Criticism of Criticism (p. 12)

Alfred A. Knopf. New York, New York, USA. 1923

**Merezhkovskii, Konstantine** 1855–1921

Russian biologist

The Germans compare German science to a lighthouse. I would as well, but then to a lighthouse without sacred fire to light up the world. The Germans carry stones to construct a solid base without which there would be no lighthouse, and in this task no other nation surpasses them. But, it is left for others to arrive and light the fire. Now, without fire, there is no lighthouse.

In Jan Sapp

*Evolution by Association: A History of Symbiosis*

Chapter 4 (p. 56)

Oxford University Press, Inc. New York, New York, USA. 1994

**Millikan, Robert Andrews** 1868–1953

American physicist

Almost every new theory is built like a great mediaeval cathedral, through the addition by many builders of many different elements, one adding a little here and another a

little there so that to the eye of a distant observer in the clouds the whole structure seems to move forward in a practically continuous way.

The Significance of Radium

*Science (New Series)*, Volume 54, Number 1383, July 1, 1921 (p. 2)

**Neumann, John von** 1903–57

Hungarian-American mathematician

It must be emphasized that it is not a question of accepting the correct theory and rejecting the false one. It is a matter of accepting that theory which shows greater formal adaptability for a correct extension. This is a formalistic esthetic criterion, with a highly opportunistic flavor.

*Collected Works (Volume 6)*

Method in the Physical Sciences (p. 498)

Pergamon Press. New York, New York, USA. 1961–1963

**Newell, A.**

No biographical data available

Working with theories is not like skeet shooting, where theories are lofted up and bang, they are shot down with a falsification bullet, and that's the end of that theory. Theories are more like graduate students – once admitted you try hard to avoid flunking them out, it being much better for them and for the world if they can become long-term contributors to society.

*Unified Theories of Cognition*

Introduction (p. 14)

Harvard University Press. Cambridge, Massachusetts, USA. 1990

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

It is certainly not the least charm of a theory that it is refutable...

*Beyond Good and Evil*

Chapter I, 18 (pp. 18–19)

The Modern Library. New York, New York, USA. 1917

**Nizer, Louis** 1902–94

English-born American lawyer

The argument seemed sound enough, but when a theory collides with a fact, the result is a tragedy.

*My Life in Court* (p. 433)

Doubleday & Company, Inc. New York, New York, USA. 1961

**Nordmann, Charles**

Astronomer

A theory is either true or false, whether the nose of its author has the aquiline contour of the nose of the children of Sem, or the flattened shape of that of the children of Cham, or the straightness of that of the children of Japhet.

Translated by Joseph McCabe

*Einstein And The Universe: A Popular Exposition of The Famous Theory*

Chapter I (p. 3)

Henry Holt & Co. New York, New York, USA. 1922



**Novalis (Friederich von Hardenberg)** 1772–1801  
German poet

Theories are like fishing: it is only by casting into unknown waters that you may catch something.

In Jean-Pierre Luminet

*Black Holes* (p. 1)

Cambridge University Press. New York, New York, USA. 1992

**Oman, John** 1860–1939  
English Presbyterian theologian

To refuse to consider any possibility is merely the old habit of making theory the measure of reality.

*The Natural and the Supernatural*

Chapter XV (p. 269)

The Macmillan Company. New York, New York, USA. 1931

**Oppenheimer, James Robert** 1904–67  
American theoretical physicist

The theory of our modern technical [era] shows that nothing is as practical as theory.

*Reflex*, July 1977

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

A theory can't be right if it can't also be wrong.

*The Dreams of Reason*

Chapter 8 (p. 174)

Simon & Schuster. New York, New York, USA. 1988

**Papoulis, Athanasios** 1921–2002  
Greek-American engineer and applied mathematician

Scientific theories deal with concepts, never with reality. All theoretical results are derived from certain axioms by deductive logic. In physical sciences the theories are so formulated as to correspond in some useful sense to the real world, whatever that may mean. However, this correspondence is approximate, and the physical justification of all theoretical conclusions is based on some form of inductive reasoning.

*Probability, Random Variables, and Stochastic Processes*

Chapter 1 (p. 3)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1965

**Parkhurst, C. K.**  
No biographical data available

A theory is like a new vessel, upon which we prefer not to take passage until it has made its trial trip.

Work as an Educating Power

*The Magazine of American History with Notes and Queries*, Volume 13, Number 4, April, 1885 (p. 355)

**Parsons, Talcott** 1902–79  
American sociologist

Theory not only formulates what we know but also tells us what we want to know, that is, the questions to which an answer is needed.

*The Structure of Social Action*

Part I, Chapter I (p. 9)

The Free Press. Glencoe, Illinois, USA. 1949

**Pasteur, Louis** 1822–95  
French chemist

Without theory, practice is but routine born of habit. Theory alone can bring forth and develop the spirit of invention.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter I (p. 11)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

The characteristic of a true theory is its fruitfulness.

In Emile Duclaux

*Pasteur: The History of a Mind*

Aphorisms and Ideals of Pasteur (p. 343)

W.B. Saunders Co. Philadelphia, Pennsylvania, USA. 1920

**Petit, Jean-Pierre** 1937–  
French astrophysicist

Sir, please believe me, it's the first time this has ever happened. Have another try, don't get upset. You know our Theorems are GUARANTEED.

*Euclid Rules OK?* (p. 11)

John Murray Ltd. London, England. 1982

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

A theory is never more unfairly dealt with, than when those parts are separated which were meant to support one another, and each left to stand or fall by itself.

*Illustrations of the Huttonian Theory of the Earth*

Section 303 (p. 340)

Dover Publications, Inc. New York, New York, USA. 1964

The want of theory, then, does not secure the candor of an observer, and it may very much diminish his skill. The discipline that seems best calculated to promote both is a thorough knowledge of the methods of inductive investigation; an acquaintance with the history of physical discovery; and the careful study of those sciences in which the rules of philosophizing have been most successfully applied.

*Illustrations of the Huttonian Theory of the Earth*

Note XXVI, 459 (p. 528)

Dover Publications, Inc. New York, New York, USA. 1964

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

It is not sufficient for a theory to affirm no false relations; it must not hide true relations.

*The Foundations of Science*

*Science and Hypothesis*, Part IV

Chapter X (p. 145)

The Science Press. New York, New York, USA. 1913

At the first blush it seems to us that theories last only a day and that ruins upon ruins accumulate.... But if we

look more closely, we see that what thus succumb are the theories properly so called, those which pretend to teach us what things are. But there is in them something which usually survives. If one of them taught us a true relation, this relation is definitively acquired, and it will be found again under a new disguise in the other theories which will successively come to reign in place of the old.

*The Foundations of Science*

*The Value of Science, Science and Reality* (p. 351)

The Science Press. New York, New York, USA. 1913

Scientific theories are like empires, they are not certain of the morrow.

The New Mechanics

*The Monist*, Volume XXIII, Number 3, July, 1913 (p. 385)

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Never let yourself be goaded into taking seriously problems about words and their meanings. What must be taken seriously are questions of fact, and assertions about facts: theories and hypotheses; the problems they solve; and the problems they raise.

*Unended Quest: An Intellectual Autobiography*

Chapter 7 (p. 19)

Open Court Publishing Company. La Salle, Illinois, USA. 1976

As with our children, so with our theories, and ultimately with all the work we do: our products become largely independent of their makers. We may gain more knowledge from our children or from our theories than we ever imparted to them.

*Unended Quest: An Intellectual Autobiography*

Chapter 40 (p. 196)

Open Court Publishing Company. La Salle, Illinois, USA. 1976

...scientific theories, if they are not falsified, forever remain hypotheses or conjectures.

*Unended Quest: An Intellectual Autobiography*

Chapter 16 (p. 79)

Open Court Publishing Company. La Salle, Illinois, USA. 1976

The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to a man – whether it is a musical theme, or a dramatic conflict, or a scientific theory – may be of great interest to empirical psychology; but it is irrelevant to the logical analysis of scientific knowledge.

*The Logic of Scientific Discovery*

Part I, Chapter I, Section 2 (p. 31)

Basic Books, Inc. New York, New York, USA. 1959

Theories are nets cast to catch what we call “the world”: to rationalize, to explain, and to master it. We endeavor to make the mesh ever finer and finer.

*The Logic of Scientific Discovery*

Part II, Chapter III (p. 59)

Basic Books, Inc. New York, New York, USA. 1959

Scientific theories are not the digest of observations, but they are inventions – conjectures boldly put forward for trial, to be eliminated if they clashed with observations; with observations which were rarely accidental, but as a rule undertaken with the definite intention of testing a theory by obtaining, if possible, a decisive refutation.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter I, Section IV (p. 46)

Harper & Row, Publishers. New York, New York, USA. 1963

...our critical examinations of our theories lead us to attempts to test and to overthrow them; and these lead us further to experiments and observations of a kind which nobody would ever have dreamed of without the stimulus and guidance both of our theories and of our criticisms of them. For indeed, the most interesting experiments and observations were carefully designed in order to test our theories, especially our new theories.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10, Section I (pp. 215–216)

Harper & Row, Publishers. New York, New York, USA. 1963

We have no reason to regard the new theory as better than the old theory – to believe that it is nearer to the truth – until we have derived from the new theory new predictions which were unobtainable from the old theory (the phases of Venus...) and until we have found that these new predictions were successful.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10 (p. 246)

Harper & Row, Publishers. New York, New York, USA. 1963

...a high probability cannot be one of the aims of science. For the scientist is most interested in theories with a high content. He does not care for highly probable trivialities but for bold and severely testable (and severely tested) hypotheses. If (as Carnap tells us) a high degree of confirmation is one of the things we aim at in science, then degree of confirmation cannot be identified with probability. ...if high probability were an aim of science, then scientists should say as little as possible, and preferably utter tautologies only. But their aim is to “advance” science, that is to add to its content. Yet this means lowering its probability. And in view of the high content of universal laws, it is [not] surprising to find that their probability is zero...

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 11, Section VI (p. 286)

Harper & Row, Publishers. New York, New York, USA. 1963

The dogmatic attitude of sticking to a theory as long as possible is of considerable significance. Without it we could never find out what is in a theory – we should give the theory up before we had real opportunity of finding out its strength; and in consequence no theory would ever be able to play its role of bringing order into the world, of preparing us for future events, of drawing our attention to events we should otherwise never observe.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 15, fn 1 (p. 312)  
Harper & Row, Publishers. New York, New York, USA. 1963

Every “good” scientific theory is one which forbids certain things to happen; the more a theory forbids, the better it is.

In C.A. Mace (ed.)  
*British Philosophy in the Mid-Century*  
Philosophy of Science: A Personal Report I (p. 159)  
George Allen & Unwin Ltd. London, England. 1957

**Pratchett, Terry** 1948–  
English author

...theories, diverse as they are, have two things in common. They explain the observed facts, and they are completely and utterly wrong.

*The Light Fantastic* (p. 165)  
Colin Smythe. Gerrards Cross, England. 1986

**Preston, Thomas** 1860–1900  
Irish scientist

Without a theory all our knowledge of nature would be reduced to a mere inventory of the results of observation. Every scientific theory must be regarded as an effort of the human mind to grasp the truth, and as long as it is consistent with the facts, it forms a chain by which they are linked together and woven into harmony.

*The Theory of Heat* (2nd edition)  
Preface to the First Edition (p. vi)  
Macmillan & Co Ltd. London, England. 1904

**Priestley, J. B.**  
No biographical data available

A first encounter with any grand fantastic theory, not political or economic, delights me.

*Delight*  
Fantastic Theories (p. 52)  
William Heinemann. London, England. 1949

**Quimby, Phineas Parkhurst** 1802–66  
American spiritualist and healer

Talking about a theory is like talking about a science we do not understand; it contains no wisdom.

*The Quimby Manuscripts Showing the Discovery of Spiritual Healing*  
Chapter XIV (p. 184)  
Thomas Y. Crowell Co. New York, New York, USA. 1921

**Raup, David Malcolm** 1933–  
American geophysicist and paleontologist

[A] new theory is guilty until proven innocent, and the pre-existing theory is innocent until proven guilty.... Continental drift was guilty until proven innocent.

*The Nemesis Affair: A Story of the Death of the Dinosaurs and the Ways of Science*  
Chapter 12 (pp. 195, 205)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Reiser, Anton** 1628–86  
German Lutherischer theologian

Our experience and observations alone never lead to finalities. Theory, however, creates reliable roads over which we may pursue our journeys through the world of observations.

In Bernard Jaffe  
*New World of Chemistry*  
Chapter 11 (p. 133)  
Silver, Burdett & Company. New York, New York, USA. 1935

**Richards, Dickinson W.** 1895–1973  
American physician and physiologist

The problems are the ones that we have always known. The little gods are still with us, under different names. There is conformity: of technique, leading to repetition; of language, encouraging if not imposing conformity of thought. There is popularity: it is so easy to ride along on an already surging tide; to plant more seed in an already well-ploughed field; so hard to drive a new furrow into stony ground. There is laxness: the disregard of small errors, of deviations, of the unexpected response; the easy worship of the smooth curve. There is also fear: the fear of speculation; the overprotective fear of being wrong. We are forgetful of the curious and wayward dialectic of science, whereby a well-constructed theory even if it is wrong, can bring a signal advance.

*Transactions of the Association of American Physicians*, Volume 75, 1962 (p. 1)

**Richards, Herbert Maule** 1871–1928  
No biographical data available

A theory which starts life an intellectual pigmy, may develop, if it have the vitality, into a veritable intellectual colossus, and, after it has run its course, may leave behind its offspring.

Botany  
*Torreyia*, Volume 8, Number 5, May, 1908 (p. 99)

**Richet, Charles** 1850–1935  
French physiologist

I often recall to my students the history of Don Quixote, who, having constructed a helmet of cardboard and wood, wished to prove its solidity. Alas, the poor helmet flew to bits when his own good sword struck it. Then the knight, no whit discouraged, made a new and stronger helmet. He raised his sword.

*The Natural History of a Savant*  
Chapter II (p. 17)  
J.M. Dent & Sons Ltd. London, England. 1927

**Ritchie, Arthur David** 1891–1967  
Scottish philosopher and science history writer

There is nothing in the world as ephemeral as scientific theory, nothing so musty and ancient as old scientific theory.

*Scientific Method: An Inquiry into the Character and Validity of Natural Law*

Chapter I (p. 14)

Kegan Paul, Trench, Trubner & Co., Ltd. London, England. 1923

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

A theory is worthless without good supporting data.

*Encyclopedia of Thoughts*

Aphorisms 2410

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Pringsheim, Alfred** 1850–1941

German mathematician

Theorems are not to mathematics what successful courses are to a meal. The nutritional analogy is misleading.

In Philip J. Davis and Reuben Hersh

*The Mathematical Experience*

Introduction (pp. xviii–xix)

Birkhäuser. Boston, Massachusetts, USA. 1981

**Rothman, Tony** 1953–

American cosmologist

**Sudarshan, George** 1931–

Indian physicist

The everyday usage of “theory” is for an idea whose outcome is as yet undetermined, a conjecture, or for an idea contrary to evidence. But scientists use the word in exactly the opposite sense. [In science] “theory”...refers only to a collection of hypotheses and predictions that is amenable to experimental test, preferably one that has been successfully tested. It has everything to do with the facts.

*Doubt and Certainty: The Celebrated Academy: Debates on Science,*

*Mysticism, Reality, in General on the Knowable and Unknowable*

First Debate (p. 2)

Perseus Books. Reading, Massachusetts. USA. 1998

It is not difficult to calculate that if one inflated the world to keep up with the current rate of population growth, then after 2598 years the earth would be expanding at the speed of light. The growth of science is proceeding even faster. Several years ago, in physics at least, we crossed the point at which the expected lifetime of a theory became less than the lead time for publication in the average scientific journal. Consequently, most theories are born dead on arrival and journals have become useless, except as historical documents.

*A Physicist on Madison Avenue*

Chapter 8 (p. 118)

Princeton University Press. Princeton, New Jersey, USA. 1991

A theory is accepted only when the last of its opponents dies off. The Copernican Revolution was a great shift in mankind’s thinking, but did not take place overnight.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 1 (p. 15)

Ballantine Books. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970

British philosopher, logician, and social reformer

...it is only theory that makes men completely incautious.

*Unpopular Essays*

Ideas that Have Harmed Mankind (p. 210)

George Allen & Unwin Ltd. London, England. 1950

**Sabatier, Paul** 1854–1941

French chemist

Theories cannot claim to be indestructible. They are only the plough which the ploughman uses to draw his furrow and which he has every right to discard for another one, of improved design, after the harvest.

*Nobel Lectures, Chemistry 1901–1921*

The Method of Direct Hydrogenation by Catalysis

Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

Theory helps us to bear our ignorance of facts.

*The Sense of Beauty*

Part III, Section 30 (p. 125)

Transaction Publishers. New Brunswick, New Jersey, USA. 2000

...theory – when we use the word for a schema of things’ relations and not for contemplation of them in their detail and fulness – is an expedient to cover ignorance and remedy confusion.

*The Life of Reason; Or, The Phases of Human Progress*

Chapter II (p. 47)

Charles Scribner’s Sons. New York, New York, USA. 1906

**Sayers, Dorothy L.** 1893–1957

English novelist and essayist

Very dangerous things, theories.

*The Unpleasantness at the Bellona Club*

Chapter 4 (p. 27)

HarperPaperback. New York, New York, USA. 1995

**Schegel, Richard**

No biographical data available

We must accept, I think, that there is an inherent limitation in the structure of science that prevents a scientific theory from ever giving us an adequate total explanation of the universe. Always, there is a base in nature (or, correspondingly, a set of assumptions in theory) which cannot be explained by reference to some yet more fundamental property. This feature of science has been commented on by many writers in the philosophy of science; and, certainly the limitation is a point of difference between science and those religious or metaphysical

systems in which there is an attempt to present a doctrine that gives answers for all ultimate questions.

*Completeness in Science*

Chapter 14, Section 2 (p. 252)

Appleton-Century-Crofts. New York, New York, USA. 1967

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

It is the business of theories to forecast “facts”, and of facts to form points of departure for theories, which again, when verified by the new facts to which they have successfully led, will extend the borders of knowledge.

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (p. 275)

At The Clarendon Press. Oxford, England. 1917

**Schön, Donald A.** 1930–97

American philosopher of practice and learning theory

...there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is a swampy lowland where situations are confusing “messes” incapable of technical solution. ...[I]n the swamp are the problems of greatest human concern.

*The Reflective Practitioner: How Professionals Think in Action* (p. 42)

Aldershot Press. Avebury, England. 1983

**Schramm, David N.** 1945–97

American astrophysicist

**McKee, Christopher F.** 1942–

American astrophysicist

When theory runs too far ahead of what can be measured, a field becomes more philosophy than science.

*Astronomy in the Mind and the Lab*

*Sky and Telescope*, Volume 82, Number 4, October, 1991 (p. 352)

**Seeger, Raymond J.**

No biographical data available

It is noteworthy that the etymological root of the word theatre is the same as that of the word theory, namely a view. A theory offers us a better view.

*Journal of the Washington Academy of Sciences*, Volume 36, 1946

(p. 286)

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

The weakness of the man who, when his theory works out into a flagrant contradiction of the facts, concludes “so much the worse for the facts: let them be altered,” instead of “so much the worse for my theory.”

A Degenerate’s View of Nordau

*Liberty*, July 27, 1895

**Silver, Brian L.**

Israeli professor of physical chemistry

Some see the fragility of scientific theory as an indication of a basic inability of science to explain the universe. But scientific change is almost always accompanied by an increase in our ability to rationalize and predict the course of nature. Newton could explain far more than Aristotle, Einstein far more than Newton. Science frequently stumbles, but it gets up and carries on. The road is long.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

Facts may be regarded as indisputable; theories are not.

*The Ascent of Science*

Part I, Chapter 2 (p. 19)

Solomon Press Book. New York, New York, USA. 1998

**Skolimowski, Henryk** 1930–

Polish philosopher

Theories, like old soldiers, fade away rather than being killed on the scientific battlefield.

In A.J. Ayala (ed.)

*Studies in the Philosophy of Biology: Reduction and Related Problems*

Problems of Rationality in Biology (p. 217)

Macmillan & Company Ltd. London, England. 1974

**Slater, John C.** 1900–76

American physicist and theoretical chemist

A theoretical physicist in these days asks just one thing of his theories: if he uses them to calculate the outcome of an experiment, the theoretical prediction must agree, within limits, with the result of the experiment. He does not ordinarily argue about philosophical implications of his theory. Almost his only recent contribution to philosophy has been the operational idea, which is essentially only a different way of phrasing the statement I have just made, that the one and only thing to be done with a theory is to predict the outcome of an experiment. As a physicist, I find myself very well satisfied with this attitude.

*Electrodynamics of Ponderable Bodies*

*Journal of the Franklin Institute*, Volume 225, Number 3, March, 1938

(pp. 277–287)

Questions about a theory which do not affect its ability to predict experimental results correctly seem to me quibbles about words, rather than anything more substantial, and I am quite content to leave such questions to those who derive some satisfaction from them.

*Electrodynamics of Ponderable Bodies*

*Journal of the Franklin Institute*, Volume 225, Number 3, March, 1938

(pp. 277–287)

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

The scientist does not abandon a theory because it has inconsistencies any more than he divorces his wife because she has inconsistencies.



*Easy Lesson in Einstein: A Discussion of the More Intelligible Features of the Theory of Relativity*  
Scientific Versus Legal Laws (p. 106)  
Harcourt, Brace & Company. New York, New York, USA. 1920

**Soddy, Frederick** 1877–1956  
English chemist

It is wonderful how accommodating a true theory is to new truth, apparently of a diametrically opposite character, and this not in any sense of mere ingenuity of explanation, but in a manner that arrests the investigator, and is his sign that he is on safe ground.

*The Interpretation of Radium and the Structure of the Atom*  
Chapter I (p. 6)  
J. Murray. London, England. 1909

**Stenger, Victor J.** 1935–  
American physicist

The fact that a theory may eventually test wrong does not detract from its original merit as a worthy try. On the other hand, if an idea is poorly formulated, often because the terms used are not clearly defined, then how can we even test it? ... We cannot determine that gibberish is anything but gibberish.

*Physics and Psychics: The Search for a World Beyond the Senses*  
Chapter 3 (p. 58)  
Prometheus Books. Buffalo, New York, USA. 1990

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

It is better to emit a scream in the shape of a theory than to be entirely insensible to the jars and incongruities of life and take everything as it comes in a forlorn stupidity.

*Virginibus Puerisque and Familiar Studies of Men and Books*  
Crabbed Age and Youth (p. 42)  
J.M. Dent & Sons Ltd. London, England. No date

**Stewart, Alfred Walter** 1880–1947  
British chemist

...in every science which is at all progressive there must arise from time to time conflicts between the older generation of workers and the leaders of the new; for, to those who have grown up along with it, a theory generally becomes invested with a sort of sanctity which is quite out of keeping with its true make-shift character. The longer a theory stands the harder does it become to shake it, and the greater is the tendency of the science to become stereotyped.

*Recent Advances in Organic Chemistry*  
Chapter I (p. 1)  
Longmans, Green & Co. London, England. 1908

**Stillman, J. D. B.**  
American physician

...your theory is like an Irishman's wheelbarrow loaded with dirt: it is supported on one wheel – the rest you carry.

Concerning the Late Earthquake  
*The Overland Monthly*, Volume 1 November, 1868 (p. 495)

**Sussmann, Hector** 1946–  
Argentinean-American mathematician

A mark of a good theory is that it proves even the most trivial results.

Gelfand Workshop  
Rutgers University, February 11, 2002

**Swann, William Francis Gray** 1884–1962  
English physicist

In speaking of theories being discarded and superseded by others, we must not think of the discarded ones as useless. The situation is not one where we are to think of a certain theory as right and all the other wrong. In a sense, different theories are like different languages for describing the same phenomena. The English language may be more suitable – more powerful for the purposes of the science of chemistry than the French language. It may have a greater richness of word content; but to say that one is right and the other wrong is utter nonsense.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1928)  
Three Centuries of Natural Philosophy (pp. 246–247)  
Government Printing Office. Washington, D.C. 1929

**Swanwick, Michael** 1950–  
American science fiction author

...once the data is in, the theory has to follow along meekly.

*Gravity's Angels*  
Ginungagap (p. 302)  
Frog. Ltd. Berkeley, California, USA. 2001

**Synge, John L.** 1897–1995  
Irish mathematician and physicist

A well built theory has three merits: (i) it has an aesthetic appeal, (ii) it is comparatively easy to understand, and (iii), if its postulates are clearly stated, it may be taken out of its original physical context and applied in another.

*The Hamiltonian Method and Its Application to Water Waves*  
*Proceedings of the Irish Academy*, Volume 63, Section A, Number 1, May, 1962 (p. 1)

**Teall, Sir J. J. Harris** 1849–1924  
British geologist

It is only when a theory has proved its usefulness as a coordinator of fact that it becomes worthy of the dignity of publication. It may be true or false, most likely the latter; but if it coordinates more facts than any other it is at any rate useful and may be conveniently retained until replaced by a better.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1902  
The Evolution of Petrological Ideas (p. 289)  
Government Printing Office. Washington, D.C. 1903



**Thomson, Sir Joseph John** 1856–1940  
English physicist

If his [Einstein's] theory is right, it makes us take an entirely new view of gravitation. If it is sustained that Einstein's reasoning holds good – and it has sustained two very severe tests in connection with the perihelion of Mercury and the present eclipse – then it is the result of one of the highest achievements of human thought. The weak point in the theory is the great difficulty in expressing it. It would seem that no one can understand the new law of gravitation without a thorough knowledge of the theory of invariants and of the calculus of variations.

In Edwin Emery Slosson  
*Easy Lessons in Einstein*  
Easy Lessons in Einstein (p. 3)  
Harcourt, Brace & Howe. New York, New York, USA. 1920

**Tilden, Sir William Augustus** 1842–1926  
English chemist

A good theory is one which almost always leads to further discovery, but no theory, however justifiable, can be regarded as final.

*Introduction to the Study of Chemical Philosophy*  
10th Introduction (pp. 3–4)  
Longmans, Green & Co. London, England. 1901

**Tolstoy, Leo** 1828–1910  
Russian writer

Pfuehl was one of those theorists who so love their theory that they forget its aim, – its application to practice; out of love for the theory he despised all practice, and did not want to hear a word about it. He really took delight in a failure, because such a failure, due to departures in practice from the theory, only proved to him the justice of his theory.

Translated by Leo Wiener  
*The Complete Works of Count Tolstoy* (Volume 3)  
*War and Peace* (Volume 2)  
Part 9, Chapter X (pp. 64–65)  
Colonial Press. New York, New York, USA. 1904

**Toulmin, Stephen** 1922–  
English philosopher

It is part of the art of the sciences, which has to be picked up in the course of the scientist's training, to recognize the situations in which any particular theory or principle can be applied to, and when it will cease to hold.

*The Philosophy of Science: An Introduction*  
Chapter III (pp. 92–93)  
Harper & Row, Publishers. New York, New York, USA. 1960

**Turner, Michael S.**  
American astrophysicist

If all you have are observations, that's botany. If all you have is theory, that's philosophy.  
In John Hogan

Universal Truths  
*Scientific American*, Volume 264, Number 4, October, 1990 (p. 117)

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

...the trouble about arguments is, they ain't nothing but theories, after all, and theories don't prove nothing, they only give you a place to rest on, a spell, when you are tuckered out butting around and around trying to find out something there ain't no way to find out.... There's another trouble about theories: there's always a hole in them somewheres, sure, if you look close enough.

*Tom Sawyer Abroad; Tom Sawyer, Detective and Other Stories, etc., etc.*  
Tom Sawyer Abroad  
Chapter IX (p. 70)  
Harper & Brothers. New York, New York, USA. 1902

**Tyndall, John** 1820–93  
Irish-born English physicist

Scientific theories sometimes float like rumours in the air before they receive complete expression.

*Fragments of Science* (Volume 2)  
Chapter XIV (p. 338)  
D. Appleton & Co. New York, New York, USA. 1915

A favorite theory – the desire to establish or avoid a certain result – can so warp the mind as to destroy its power of estimating facts.

*Fragments of Science for Unscientific People*  
Chapter III (p. 54)  
D. Appleton & Co. New York, New York, USA. 1875

**van Fraassen, Bas C. -** 1941  
Dutch-born philosopher

Science aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true.

*The Scientific Image*  
Chapter 2, section 1. 1 (p. 8)  
Clarendon Press. Oxford, England. 1990

...the success of current scientific theories is no miracle. It is not even surprising to the scientific (Darwinist) mind. For any scientific theory is born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive – the ones which in fact latched on to the actual regularities in nature.

*The Scientific Image*  
Chapter 2, Section 7 (p. 40)  
Clarendon Press. Oxford, England. 1980

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright and natural philosopher

No phenomenon can be explained in and of itself; only many comprehended together, methodically arranged, in the end yield something that could be regarded as theory.

In Karl J. Fink  
*Goethe's History of Science*  
 Chapter 2 (p. 26)  
 Cambridge University Press. Cambridge, England. 1991

Dear friend, all theory is grey  
 And green the golden tree of life.

In *Great Books of the Western World* (Volume 47)  
*Faust*  
 The First Part  
 Faust's Study (2), I. 2038–2039  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Theory is of no use in itself; but only in so far as it helps us to believe in the coherency of phenomena.

In John Stuart Blackie  
*The Wisdom of Goethe*  
 Philosophy, Metaphysics, Logic, Truth and Science (p. 162)  
 William Blackwood & Sons. Edinburgh, Scotland. 1883

An old foundation is worthy of all respect, but it must not take from us the right to build afresh wherever we will.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
 536 (p. 188)  
 The Macmillan Co. New York, New York, USA. 1906

Theories are usually the over-hasty efforts of an impatient understanding that would gladly be rid of phenomena, and so puts in their place pictures, notions, nay, often mere words.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
 520 (p. 184)  
 The Macmillan Co. New York, New York, USA. 1906

The supreme achievement would be to see that stating a fact is starting a theory.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
 #557 (p. 194)  
 The Macmillan Co. New York, New York, USA. 1906

**von Liebig, Justus** 1803–73  
 German organic chemist

Every theory which urges men to labour and research, which excites acuteness and sustains perseverance, is a gain to science; for it is labour and research which lead to discoveries.

In John Blyth  
*Familiar Letters on Chemistry* (4th edition)  
 Letter III (p. 53)  
 Walton & Maberly. London, England. 1859

**Waddington, Conrad Hal** 1905–75  
 British biologist and paleontologist

A scientific theory cannot remain a mere structure within the world of logic, but must have implications for action and that in two different ways. In the first place, it must involve the consequence that if you do so and so, such and such results will follow. That is to say it must give,

or at least offer the possibility of controlling the process; and secondly – and this is a point not so often mentioned by those who discuss the nature of scientific theories – its value is quite dependent on its power of suggesting the next step in scientific advance.

*The Nature of Life*  
 Chapter I (pp. 11–12)  
 Harper & Row, Publishers. New York, New York, USA. 1960

**Weinberg, Steven** 1933–  
 American nuclear physicist

This is often the way it is in physics – our mistake is not that we take our theories too seriously, but that we do not take them seriously enough.

*The First Three Minutes*  
 Chapter VI (p. 131)  
 Basic Books, Inc. New York, New York, USA. 1988

Our theories are very esoteric – necessarily so, because we are forced to develop these theories using a language, the language of mathematics, that has not become part of the general equipment of the educated public. Physicists generally do not like the fact that our theories are so esoteric. On the other hand, I have occasionally heard artists talk proudly about their work being accessible only to a band of cognoscenti and justify this attitude by quoting the example of physical theories like general relativity that also can be understood only by initiates. Artists like physicists may not always be able to make themselves understood by the general public, but esotericism for its own sake is just silly.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
 Chapter VI (p. 150)  
 Pantheon Books. New York, New York, USA. 1992

**Weiss, John**  
 No biographical data available

The theory that can absorb the greatest number of facts, and persist in doing so, generation after generation, through all changes of opinion and of detail, is the one that must rule all observation.

*American Religion*  
 Chapter I (p. 25)  
 Roberts Brothers. Boston, Massachusetts, USA. 1871

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

Very simple was my explanation, and plausible enough – as most wrong theories are!

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today* 1971  
*The Time Machine*  
 Chapter Four (p. 468)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whewell, William** 1794–1866  
 English philosopher and historian

...there is a mask of theory over the whole face of nature...

*The Philosophy of the Inductive Sciences Founded upon Their History*  
(Volume 1)

Part I, Book I, Chapter II, sect. 10 (p. 42)  
John W. Parker. London, England. 1847

The tendencies of our speculative nature, carrying us onwards in pursuit of symmetry and rule, and thus producing all true theories, perpetually show their vigour by overshooting the mark. They obtain something, by aiming at much more. They detect the order and connexion which exist, by conceiving imaginary relations of order and connexion which have no existence. Real discoveries are thus mixed with baseless assumptions; profound sagacity is combined with fanciful conjecture ...

*The Philosophy of the Inductive Sciences, Founded Upon Their History*  
(2nd edition)

Book XI, Chapter V (p. 55)  
John W. Parker. London, England. 1867

It is a test of true theories not only to account for, but to predict phenomena.

*The Philosophy of the Inductive Sciences Founded upon Their History*  
(Volume 2)

Aphorisms, Aphorisms Concerning Science, XII (p. 468)  
John W. Parker. London, England. 1847

The distinction of Fact and Theory is only relative. Events and phenomena, considered as particulars which may be colligated by Induction, are Facts; considered as generalities already obtained by colligation of other Facts, they are Theories.

*The Philosophy of the Inductive Sciences: Founded Upon Their History*  
(Volume 2) (2nd edition)

Aphorisms Concerning Ideas (p. 471)  
John W. Parker. London, England. 1847

### **Williams, Richard**

No biographical data available

...a scientist without a theory is like a preacher without a text – not much good.

Notes on the St. Erth Beds

*Journal*, Volume 12, 1891–1892 (p. 21)

### **Winchell, Alexander** 1824–91

American geologist

When a great theory has grown into existence, and the general assent of competent judges has converted a sublime conception from the state of a provisional hypothesis to the position of a strengthening doctrine, there is unusual interest in glancing over the progress of science and noting the actual steps by which the guess became theory, and the theory, doctrine.

*World-Life or Comparative Geology*

Part IV (p. 550)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

### **White, Henry S.**

No biographical data available

The accepted truths of today, even the commonplace truths of any science, were the doubtful or the novel theories of yesterday.

*Bulletin of the American Mathematical Society*, Volume 15, 1909 (p. 325)

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

On the absolute theory, bare space and bare time are such very odd existences, half something and half nothing.

The Idealistic Interpretations of Einstein's Theory

*Proceedings of the Aristotelian Society*, N.S. Volume 22, Part III, (p. 131)

...to come very near a true theory and to grasp its precise application are two very different things.

*The Organization of Thought*

Chapter VI (p. 127)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

### **Wilson, Edward O.** 1929–

American biologist and author

Nothing in science – nothing in life, for that matter, makes sense without theory. It is our nature to put all knowledge into context in order to tell a story, and to re-create the world by this means. ...We are enchanted by the beauty of the natural world. Our eye is caught by the dazzling visual patterns of polar star trails, for example, and the choreography of chromosomes in dividing root tip cells of plant. Both disclose processes that are also vital to our lives. In unprocessed form, however, without theoretical frameworks of heliocentric astronomy and Mendelian heredity, they are no more than beautiful patterns of light.

*Consilience: The Unity of Knowledge* (p. 58)

Alfred A. Knopf. New York, New York, USA. 1998

### **Wisdom, John O.**

No biographical data available

Sometimes [the word theory] is used for a hypothesis, sometimes for a confirmed hypothesis; sometimes for a train of thought; sometimes for a wild guess at some fact, or for a reasoned claim of what some fact is – or even for a philosophical speculation.

*Foundations of Inference in Natural Sciences*

Chapter III (p. 33)

Methuen & Company Ltd. London, England. 1952

### **Woodbridge, Frederick James Eugene** 1867–1940

American philosopher

It is a theory of nature, that system of things which allows a plant to grow, an animal to graze, and a man to think, fully as much as it allows the sun to be eclipsed or bodies to be in motion or at rest.

*Aristotle's Vision of Nature*

Chapter III (p. 49)

Columbia University Press. New York, New York, USA. 1965

### **Woodger, Joseph Henry** 1894–1981

English biologist

Theoretical statements, it is clear, cannot be verified because we can never know whether they are true. All we can do is to go on testing their consequences until an observation record turns up which contradicts them. Then we have the choice of two courses: we can say that the theoretical statement is false and reject it; or we can assume that we have been mistaken in our observation and retain the theoretical statements.

*Biology and Language*

Lecture II (p. 57)

At The University Press. Cambridge, England. 1952

### **Wurtz, Charles Adolphe** 1817–84

French organic chemist

The triumph of a theory is to embrace the greatest number and the greatest variety of facts.

*A History of Chemical Theory from the Age of Lavoisier to the Present Time*

Lavoisier

I (p. 7)

Macmillan & Company Ltd. London, England. 1869

### **Wyndham, John** 1903–69

English science fiction writer

...I do refuse to accept a bad theory simply on the grounds that there is not a better [one]...

*The Midwich Cuckoos*

Chapter Twenty (p. 221)

M. Joseph. London, England. 1977

### **Ziman, John M.** 1925–2005

British physicist

The verb “to theorize” is now conjugated as follows: “I built a model; you formulated a hypothesis; he made a conjecture.”

*Reliable Knowledge*

Chapter 2 (fn 20, p. 22)

Cambridge University Press. Cambridge, England. 1978

...the sooner we all face up to the fact that theory and practice are indissoluble, and that there is no contradiction between the qualities of usefulness and beauty, the better.

Growth and Spread of Science

*Nature*, Volume 221, Number 5180, February 8, 1969 (p. 521)

...a significant fraction of the ordinary scientific literature in any field is concerned with essentially irrational theories put forward by a few well-established scholars who have lost touch with reality.

Some Pathologies of the Scientific Life

*Nature*, Volume 227, 5 September, 1970

## THEORY, STANDARD

### **Glashow, Sheldon L.** 1932–

American physicist

Physics of the past century has been characterized by frequent great but unanticipated experimental discoveries. If the standard theory is correct, this age has come to an end. Only a few important particles remain to be discovered, and many of their properties are alleged to be known in advance. Surely this is not the way things will be, for Nature must still have some surprises in store for us.

In C.H. Lai

*Selected Papers on Gauge Theory of Weak and Electromagnetic Interactions*

Towards a Unified Theory: Threads in a Tapestry (p. 23)

World Scientific Publishing Co. Singapore, Malaysia. 1981

## THEORY-MAKING

### **de La Beche, Henry Thomas** 1796–1855

English geologist

One very reprehensible mode of theory-making consists, after honest deductions from a few facts have been made, in torturing other facts to suit the end proposed, in omitting some, and in making use of any authority that may lend assistance to the object desired; while all those which militate against it are carefully put on one side or doubted.

*Sections & Views, Illustrative of Geological Phaenomena*

Preface (p. iv)

Treuttel & Wurtz. London, England. 1830

## THEORY OF FUNCTIONS

### **Keyser, Cassius Jackson** 1862–1947

American mathematician

The Modern Theory of Functions – that stateliest of all the pure creations of the human intellect.

In Columbia University

*Lectures on Science, Philosophy and Art 1907–1908* (p. 16)

New York, New York, USA. 1908

### **Volterra, Vito** 1860–1940

Italian mathematician

The theory that has had the greatest development in recent times is without any doubt the theory of functions.

In Stanley Gudder

*A Mathematical Journey* (p. 32)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

## THERMODYNAMICS

### **Allen, Woody** 1935–

American film director and actor

It's the Second Law of Thermodynamics – sooner or later everything turns to shit. That's my phrasing, not the Encyclopedia Britannica's.

*Husbands and Wives*

Film (1992)

**Atkins, Peter William** 1940–

English physical chemist and writer

Everything is driven by motiveless, purposeless decay.

*The Creation*

Chapter 2 (p. 23)

W.H. Freeman. San Francisco, California, USA. 1981

**Barnett, Lincoln Kinnear** 1909–79

American science writer

Although it is true that the amount of matter in the universe is perpetually changing, the change appears to be mainly in one direction – toward dissolution. The sun is slowly but surely burning out, the stars are dying embers, and everywhere the cosmos heart is turning to cold; matter is dissolving into radiation, and energy is being dissipated into empty space. “The universe is thus progressing toward an ultimate ‘heat death’ or, as it is technically defined, a condition of maximum entropy” [quoting Einstein].... And there is no way of avoiding this destiny.

[T]he fateful principle known as the Second Law of Thermodynamics, which stands today as the principal pillar of classical physics left intact by the march of science, proclaims that the fundamental processes of nature are irreversible. Nature moves only one way.

*The Universe and Dr. Einstein*

Chapter 14 (p. 99)

William Sloane Associates. New York, New York, USA. 1948

**Blum, Harold** 1899–?

No biographical data available

No matter how carefully we examine the energetics of living systems we find no evidence of defeat of thermodynamic principles.

*Time's Arrow and Evolution*

Princeton University Press. Princeton, New Jersey, USA. 1951

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

The old thermodynamics... is to statistical thermodynamics what classical mechanics is to quantum mechanics.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 9 (p. 107)

Harper & Row, Publishers. New York, New York, USA. 1971

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

General thermodynamics proceeds from the fact that, as far as we can tell from our experience up to now, all natural processes are irreversible. Hence according to the principles of phenomenology, the general thermodynamics of the second law is formulated in such a way that the unconditional irreversibility of all natural processes is asserted as a so-called axiom.

Translated by Stephen G. Brush

*Lectures on Gas Theory* (pp. 444–445)

University of California Press. Berkeley, California, USA. 1964

The Second Law can never be proved mathematically by means of the equations of dynamics alone.

On Certain Questions of the Theory of Gases

*Nature*, Volume 51, 1895 (p. 413)

**Bridgman, Percy Williams** 1882–1961

American physicist

...the laws of thermodynamics have a different feel from most of the other laws of the physicist...they smell more of their human origin.

*The Nature of Thermodynamics*

Chapter I (p. 3)

Harvard University Press. Cambridge, Massachusetts, USA. 1941

**Cardenal, Ernesto** 1925–

Nicaraguan poet and Roman Catholic priest

The second law of thermodynamics!:  
energy is indestructible in quantity  
but continually changes in form.

And it always runs down like water.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 3, Autumn Fugue (p. 29)

Curbstone Press. Willimantic, Connecticut, USA. 1993

**Dickerson, Richard E.**

American molecular biologist

It is possible to know thermodynamics without understanding it...

*Molecular Thermodynamics*

Chapter 7 (p. 387)

W.A. Benjamin. New York, New York, USA. 1969

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The law of entropy always increases – the Second Law of Thermodynamics – holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equation – then so much the worse for Maxwell's equations. If it is found to be contradicted by observation – well, these experimentalists do bungle things sometimes. But if your theory is found to be against the Second Law of Thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.

*The Nature of the Physical World*

Chapter IV (p. 74)

The Macmillan Company. New York, New York, USA. 1930

**Epstein, P. S.** 1883–1966

German-born physicist

Thermodynamics deals with systems which, in addition to mechanical and electromagnetic parameters, are described by a specifically thermal one, namely, the temperature or some equivalent of it. Thermodynamics is essentially a science about the conditions of equilibrium



of systems and about the processes which can go on in states little different from the state of equilibrium.

*Textbook of Thermodynamics*

Chapter I (p. 2)

John Wiley & Sons, Inc. New York, New York, USA. 1937

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

In doing a problem involving a given mass of some substance, the condition of the substance at any moment can be described by telling what its temperature is and what its volume is. If we know the temperature and volume of a substance, and that the pressure is some function of the temperature and volume, then we know the internal energy. One could say, “I do not want to do it that way. Tell me the temperature and the pressure and I will tell you the volume. I can think of the volume as a function of temperature and pressure, and so on.” That is why thermodynamics is hard, because everyone uses a different approach. If we could only sit down once and decide on our variables, and stick to them, it would be fairly easy.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 44–5 (p. 44–9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Hoffmann, Roald** 1937–

Polish-born American chemist

My second law, your second law, ordains that local order, structure in space and time, be crafted in ever-so-losing contention with proximal disorder in this neat but getting messier universe.

*The Metamict State*

The Devil Teaches Thermodynamics (p. 3)

University of Central Florida Press. Orlando, Florida, USA. 1987

**Hogan, Graig J.**

No biographical data available

Everything that happens in the universe consists of the same basic stuff, “mass-energy,” transfigured in space and time from one form into another.

*The Little Book of the Big Bang: A Cosmic Primer* (p. 25)

Copernicus. New York, New York, USA. 1998

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects.

On the Dynamical Theory of Heat, with Numerical Results Deduced

from Mr. Joule’s Equivalent of a Thermal Unit, and M. Regnault’s Observations on Steam

*Transactions of the Royal Society of Edinburgh*, March, 1851

**Lewis, Gilbert Newton** 1875–1946

American chemist

**Randall, Merle** 1888–1950

American chemist

The fascination of a growing science lies in the work of the pioneers at the very borderland of the unknown, but to reach this frontier one must pass over well traveled roads; of these one of the safest and surest is the broad highway of thermodynamics.

Revised by Kenneth S. Pitzer and Leo Brewer

*Thermodynamics* (p. x)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1961

The second law of thermodynamics not only is a principle of wide reaching scope and application, but also is one which has never failed to satisfy the severest test of experiment. The numerous quantitative relations derived from this law have been subjected to more and more accurate experimental investigation without the detection of the slightest inaccuracy.

*Thermodynamics* (p. 87)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1961

**Maxwell, James Clerk** 1831–79

Scottish physicist

I do not think...that the perfect identity which we observe between different portions [of molecules] of the same kind of matter can be explained on the statistical principle of the stability of the averages of large numbers of quantities each of which may differ from the mean. For if of the molecules of some substance such as hydrogen, some were of slightly greater mass than others, we have the means of producing a separation between molecules of different masses, and in this way we should be able to produce two kinds of hydrogen, one of which would be somewhat denser than the other. As this cannot be done, we must admit that the equality which we assert to exist between the molecules of hydrogen applies to each individual molecule, and not merely to the average of groups of millions of molecules.

*Theory of Heat*

Limitation of the Second Law of Thermodynamics (p. 309)

Longmans, Green & Company. London, England. 1871

**Meixner, J.** 1908–94

German theoretical physicist

A careful study of the thermodynamics of electrical networks has given considerable insight into these problems and also produced a very interesting result: the non-existence of a unique entropy value in a state which is obtained during an irreversible process.... I would say,



I have done away with entropy. The next step might be to let us also do away with temperature.

In Edward B. Stuart, Benjamin Gal-Or and Alan J. Brainard (eds.)  
*A Critical Review of Thermodynamics: The Proceedings of the International Symposium*  
University of Pittsburgh. Pittsburgh, Pennsylvania, April 7–8, 1969

**Morowitz, Harold J.** 1927–

American biophysicist

The use of thermodynamics in biology has a long history rich in confusion...

*Beginnings of Cellular Life: Metabolism Recapitulates Biogenesis*  
Chapter 6 (p. 69)  
Yale University Press. New Haven, Connecticut, USA. 1992

**Pippard, A. B.** 1920–

English physicist

It may be objected by some that I have concentrated too much on the dry bones [of thermodynamic theory], and too little on the flesh which clothes them, but I would ask such critics to concede at least that the bones have an austere beauty of their own.

*Classical Thermodynamics*  
Preface (p. vii)  
Cambridge University Press. Cambridge, England. 1966

**Reiss, H.**

No biographical data available

...the almost certain truth [is] that nobody (authors included) understands thermodynamics completely. The writing of a book therefore becomes a kind of catharsis in which the author exorcises his own demon of incomprehension and prevents it from occupying the soul of another.

*Methods of Thermodynamics*  
Preface (p. vii)  
Blaisdell Publishing Company. New York, New York, USA. 1965

Almost all books on thermodynamics contain some errors which are not purely typographical.

*Methods of Thermodynamics*  
Preface (p. ix)  
Blaisdell Publishing Company. New York, New York, USA. 1965

**Ross, John** 1920–

American physical chemist

I have written that there are no known violations of the second law of thermodynamics (*Chemical and Engineering News*, July 27, 1980). Unfortunately I have been intentionally misinterpreted by creationists who say that this quote proves that evolution is impossible. This is nonsense: evolution is in no way a violation of the second law.

Letter to Carl Gaither  
19 June, 2007

**Seifert, H. S.** 1911–77

American aeronautics and astronautics scientist

The first and second laws of thermodynamics are of course known to us as well as the Ten Commandments, and probably obeyed more consistently.

Can We Decrease Our Entropy?  
*American Scientist*, Summer, June, 1961 (p. 124A)

**Sommerfeld, Arnold** 1868–1951

German physicist

The science of thermodynamics introduces a new concept, that of temperature.

*Thermodynamics and Statistical Mechanics, Lectures on Theoretical Physics* (Volume 1)  
Translated by J. Kestin (p. 1)  
Academic Press. New York, New York, USA. 1956

**Stenger, Victor J.** 1935–

American physicist

Scientists speak of the Law of Inertia or the Second Law of Thermodynamics as if some great legislature in the sky once met and set down rules to govern the universe.

*Not by Design*  
Chapter 1 (p. 14)  
Prometheus Books. Buffalo, New York, USA. 1988

**Truesdell, Clifford** 1919–2000

American mathematician, natural philosopher, historian of mathematics

Every physicist knows exactly what the first and the second law mean, but...no two physicists agree about them.

In Mario Bunge (ed.)  
*Delaware Seminar in the Foundations of Physics*  
Foundations of Continuum Mechanics (p. 37)

...thermodynamics is the kingdom of deltas.

*The Tragicomical History of Thermodynamics*  
Chapter 1 (p. 1)  
Springer-Verlag. New York, New York, USA. 1980

## SECOND LAW

**Klein, Joseph Frederic** 1849–1918

Engineer

The outcome of the whole study of irreversibility results in the briefly stated law: "There exists in Nature a quantity which clianges always in the same sense in all natural processes."

This boldly asserts the essential one-sidedness of Nature. The proposition stated in this general form may be correct or incorrect; but whichever it may be it will remain so independently of human experimental skill.

*Physical Significance of Entropy Or of the Second Law* (p. 37)  
D. van Nostrand Co. New York, New York, USA. 1910

**Planck, Max** 1858–1947

German physicist

The gist of the second law [of thermodynamics] has nothing to do with experiment; the law asserts briefly that

*there exists in nature a quantity which changes always in the same sense in all natural processes.* The proposition stated in this general form may be correct or incorrect; but whichever it may be, it will remain so, irrespective of whether thinking and measuring beings exist on the earth or not, and whether or not, assuming they do exist, they are able to measure the details of physical or chemical processes more accurately by one, two, or a hundred decimal places than we can. The limitations of the law, if any, must lie in the same province as its essential idea, in the observed Nature, and not in the Observer. That man's experience is called upon in the deduction of the law is of no consequence; for that is, in fact, our only way of arriving at a knowledge of natural law. But the law once discovered must receive recognition of its independence, at least in so far as Natural Law can be said to exist independent of Mind. Should anyone deny this, he would have to deny the possibility of natural science.

Translated by Alexander Ogg

*Treatise on Thermodynamics*

Part III, Chapter II (p. 106)

Longmans, Green & Co. London, England. 1926

## THERMOMETER

**Fahrenheit, Daniel Gabriel** 1686–1736

German physicist

It then came into my mind what that most careful observer of natural phenomena had written about the correction of the barometer; for he had observed that the height of the column of mercury in the barometer was a little (though sensibly enough) altered by the varying temperature of the mercury. From this I gathered that a thermometer might perhaps be constructed with mercury, which would not be so hard to construct, and by the use of which it might be possible to carry out the experiment which I so greatly desired to try.

Experimenta Circa Gradum Caloris Liqueorum Nonnullorum Ebullitionum Instituta

*Philosophical Transactions of the Royal Society of London*, Volume 33, Number 1, 1724

## THING

**Browning, Robert** 1812–89

English poet

We find that great things are made of little things ...

*The Complete Poetic and Dramatic Works of Robert Browning* (Volume 1)

Mr. Sludge "The Medium" (p. 618)

The Macmillan Co. New York, New York, USA. 1899

**James T. Kirk (Fictional character)**

James T. Kirk: Bones, there's a thing out there.

Leonard McCoy: Why is any object we don't understand always called a thing?

*Star Trek – The Motion Picture*

The film (2001)

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

We seek not to know the precise measure of anything; we only understand the limits of a thing, in knowing what it is not, either on the one side or the other.

Part I, Chapter IV

*The Theory of the Earth*

*Transactions of the Royal Society of Edinburgh*, Volume I, Part II 1788 (p. 298)

**Parkhurst, C. K.**

No biographical data available

Things never lie in the books exactly as they do in the facts and in the field.

Work as an Educating Power

*The Magazine of American History with Notes and Queries*, Volume 13, Number 4, April, 1885 (p. 356)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Things have been, says the legal mind, and so we are here. The creative mind says we are here because things have yet to be.

*The Discovery of the Future*

The Discovery of the Future (p. 7)

B.W. Huesch. New York, New York, USA. 1914

## THINK

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Let it be our first duty to teach thinking, and then what to think about.

In John Payne Collier

*Seven Lectures on Shakespeare and Milton*

The First Lecture (p. 7)

Chapman & Hall, Ltd. London, England. 1856

Some persons have contended that mathematics ought to be taught by making the illustrations obvious to the senses. Nothing can be more absurd or injurious: it ought to be our never-ceasing effort to make people think, not feel; and it is very much owing to this mistake that, to those who do not think, and have not been made to think Shakespeare has been found so difficult of comprehension.

In John Payne Collier

*Seven Lectures on Shakespeare and Milton*

The Second Lecture (p. 23)

Chapman & Hall, Ltd. London, England. 1856

**Hansberry, Lorraine** 1930–65

African American playwright and author

Never be afraid to sit awhile and think.

*A Raisin In The Sun*, (p. 137)

Random House, Inc. New York, New York, USA. 1958

**Lowell, James Russell** 1819–91

American poet, critic, essayist, editor, and diplomat

Whatever we have dared to think, That dare we also say.

In John Pickering

*The Working Man's Political Economy*

Lines

Thomas Varney. Cincinnati, Ohio, USA. 1847

**Maartens, Willie**

South African poet

To be able to think rationally (or scientifically) is like having money; it is very useful and it will solve many of your problems, but it will not solve all of your problems and cannot buy everything – some things are not for sale or do not have a price.

*Mapping Reality: A Critical Perspective on Science and Religion*

Chapter 18 (p. 396)

Universe, Inc. New York, New York, USA. 2006

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

A great university has a dual function, to teach and to think.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter VII (p. 126)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

## THINK TANK

**Chargaff, Erwin** 1905–2002

Austrian biochemist

When the so-called think tanks began to replace the thought processes of human beings, I called them the aseptic tanks.

*Heraclitean Fire: Sketches from a Life before Nature*

White Blood, Red Snow (p. 5)

Rockerfeller University Press. New York, New York, USA. 1978

## THINKING

**Asimov, Isaac** 1920–92

American author and biochemist

Many adults, whether consciously or unconsciously, find it beneath their adult dignity to do anything as childish as read a book, think a thought, or get an idea. Adults are rarely embarrassed at having forgotten what little algebra or geography they once learned.

*The Roving Mind*

His Own Particular Drummer

Prometheus Books. Buffalo, New York, New York, USA. 1983

**Burroughs, John** 1837–1921

American naturalist and essayist

Thinking is like catching pigeons with a net. You may pull your rope never so quick sometimes and catch nothing but a feather.

*The Heart of Burroughs's Journals*

May 15, 1857 (p. 9)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Some scientists work so hard there is no time left for serious thinking.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Basic Books, Inc. New York, New York, USA. 1988

**Cromer, Alan** 1935–

American physicist and educator

Scientific thinking, which is analytic and objective, goes against the grain of traditional human thinking, which is associative and subjective.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 1 (pp. 1–2)

Oxford University Press, Inc. New York, New York, USA. 1993

**Dewey, John** 1859–1952

American philosopher and educator

The first distinguishing characteristic of thinking is facing the facts – inquiry, minute and extensive scrutinizing, observation.

*Reconstruction in Philosophy*

Chapter VI (p. 140)

Beacon Press. Boston, Massachusetts, USA. 1920

Intelligent thinking means an increment of freedom in action – an emancipation from chance and fatality. “Thought” represents the suggestion of a way of response that is different from that which would have been followed if intelligent observation had not effected an inference as to the future.

*Reconstruction in Philosophy*

Chapter VI (p. 144)

Beacon Press. Boston, Massachusetts, USA. 1920

**Edison, Thomas** 1847–1931

American inventor

I am going to have a sign put up all over my plant, reading “There is no expedient to which a man will not resort to avoid the real labor of thinking.”

In Dogbert D. Runes (ed.)

*The Diary and Sundry Observations of Thomas Alva Edison*

Chapter XXIX (p. 167)

Philosophical Library. New York, New York, USA. 1948

**Einstein, Albert** 1879–1955

German-born physicist

Thinking for its own sake, as in music! When I have no special problem to occupy my mind, I love to reconstruct

proofs of mathematical and physical theorems that have long been known to me. There is no goal in this, merely an opportunity to indulge in the pleasant occupation of thinking.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter from Spring 1918 (p. 17)

Princeton University Press. Princeton, New Jersey, USA. 1979

### **Harrington, John W.** 1918–

American naturalist

We cannot see without thinking; we cannot think without seeing.

*Dance of the Continents*

Epilogue (p. 232)

J.P. Tarcher. Los Angeles, California, USA. 1983

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...one extreme is the idea of an objective world, pursuing its regular course in space and time, independently of any kind of observing subject; this has been the guiding image from modern science. At the other extreme is the idea of a subject, mystically experiencing the unity of the world and no longer confronted by an object or by any objective world; this has been the guiding image of Asian mysticism. Our thinking moves somewhere in the middle, between these two limiting conceptions; we should maintain the tension resulting from these opposites.

*Across the Frontiers*

Chapter XVI (p. 227)

Harper & Row, Publishers. New York, New York, USA. 1974

### **Keyser, Cassius Jackson** 1862–1947

American mathematician

...most of the thinking done in the world in a given day, whether done by men in the street or by farmers or factory-hands or administrators or historians or physicians or lawyers or jurists or statesmen or philosophers or men of letters or students of natural science or even mathematicians (when not strictly employed in their own subject), comes far short of the demands and standards of rigorous thinking.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter I (p. 6)

Columbia University Press. New York, New York, USA. 1916

### **Rothman, Tony** 1953–

American cosmologist

### **Sudarshan, George** 1931–

Indian physicist

...one result of unimaginative, mechanistic thinking was that societies eventually ceased to burn people at the stake for witchcraft.

*Doubt and Certainty: The Celebrated Academy: Debates on Science,*

*Mysticism, Reality, in General on the Knowable and Unknowable*

Fourth Debates (p. 74)

Perseus Books. Reading, Massachusetts, USA. 1998

### **Sagan, Carl** 1934–96

American astronomer and science writer

The scientific way of thinking is at once imaginative and disciplined. This is central to its success. Science invites us to let the facts in, even when they don't conform to our preconceptions. It counsels us to carry alternative hypotheses in our heads and see which best fit the facts. It urges on us a delicate balance between no-holds-barred openness to new ideas, however heretical, and the most rigorous skeptical scrutiny of everything – new ideas and established wisdom. This kind of thinking is also an essential tool for a democracy in an age of change.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 27)

Random House, Inc. New York, New York, USA. 1995

### **Steiner, Rudolf** 1861–1925

Austrian philosopher and scientist

In thinking, we have that element given us which welds our separate individuality into one whole with the cosmos.

*The Philosophy of Freedom: The Basis for a Modern World Conception*

Chapter 5 (p. 70)

Rudolf Steiner Press. London, England. 1999

### **Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Thinking is the most unhealthy thing in the world, and people die of it just as they die of any other disease.

*Intentions*

The Decay of Lying (p. 5)

Brentano's. New York, New York, USA. 1905

## THOUGHT

### **Baldwin, J. Mark**

**American philosopher and psychologist** 1861–1934

We do not scatter our thoughts as widely as possible in order to increase the chances of getting a true one; on the contrary, we call the man who produces the most thought-variations a "scatter-brain," and expect nothing inventive from him... we succeed in thinking well by thinking hard; we get the valuable thought-variations by concentrating attention upon the body of related [data] which we already have; we discover new relations among the data of experience by running over and over the links and couplings of the appreciative systems with which our minds are already filled.

On Selective Thinking

*The Psychological Review*, Volume 5, Number 1, 1889 (p. 4)

**Betz, William**

No biographical data available

All human thought moves in three great spheres, namely, Nature, Man, God.

*Proceedings of the Tenth Annual Conference*

Graphic Methods in Elementary Algebra (p. 102)

New York State Science Teachers Association. Bulletin 375 June, 1906

**Brewster, George**

No biographical data available

...thoughts may be *novel* and *important*, and have entamped upon them the characteristics of immutable truth, and yet, if they be not expressed so as to be *intelligible*, they might just as well not be expressed at all.

*A New Philosophy of Matter; Showing the Identity of All the Imponderables* (3rd edition)

Chapter I (p. 20)

Edward H. Fletcher. New York, New York, USA. 1858

**Burroughs, John** 1837–1921

American naturalist and essayist

It is only by surprise, by a sudden instantaneous movement of the mind, that we can get an objective view of our own thoughts, as Puss, if she succeeds at all, does by a sudden twist and outreaching before her whole body is fully in motion. The mind can at best get but a mere glance at its own workings. Our own thoughts, like woodcock, are always rising to take flight when we seen them.

*The Heart of Burroughs's Journals*

July 4, 1859 (p. 18)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

**Byron, George Gordon, 6th Baron Byron** 1788–1824

English Romantic poet and satirist

The power of Thought; – the magic of the Mind!

*The Complete Poetical Works of Byron*

The Corsair

Canto I, Stanza 8

Houghton Mifflin. Boston, Massachusetts, USA. 1933

**Carlyle, Thomas** 1795–1881

English historian and essayist

Thought once awakened does not again slumber.

*On Heroes and Hero Worship*

Lecture I (p. 24)

John B. Alden, Publisher. New York, New York, USA. 1887

And what is that Science, which the scientific head alone, were it screwed off, and (like the Doctor's in the Arabian Tale) set in a basin to keep it alive, could prosecute without a heart, but one other of the mechanical and menial handicrafts, for which the Scientific Head (having a Soul in it) is too noble an organ? I mean that Thought without Reverence is barren, perhaps poisonous; at best, dies like cookery with the day that called it forth; does not live, like

sowing, in successive tilts and wider-spreading harvests, bringing food and plenteous increase to all Time.

*Sartor Resartus*

Chapter X (pp. 50–51)

J.M. Dent & Sons. London, England. 1908

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

We know nothing of what may lie beyond. Thought may wander into the void, but observation cannot follow. And where its faithful escort halts, positive science comes to a standstill.

*Problems in Astrophysics*

Chapter XL! (p. 538)

Adam & Charles Black. London, England. 1903

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

Thoughts are timid things. They are frightened away by noise and they make none themselves. They flutter as silently as do owls on soft-edged wings.

*The Endless Adventure*

Sanctuaries (p. 176)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Davy, Sir Humphry** 1778–1829

English chemist

My real, my working existence is among the objects of scientific research. Common amusements and enjoyments are necessary to me only as dreams to interrupt the flow of thoughts too nearly analogous to enlighten and vivify.

In Sir William Ramsay

*Essays Biographical and Chemical*

The Great London Chemists

Section II (pp. 47–48)

Archibald Constable & Company Ltd. London, England. 1908

**Douglas, A. Vibert** 1894–1988

Canadian astronomer

Guided by some of the great thinkers of today, our thoughts have traversed aeons of time, contemplating some of the changes taking place with majestic deliberation throughout the vastness of space. "Time rolls his ceaseless course." A million million years suffice for the birth of a star and its early development; a few hundred thousand years will tell the tale of the life of mankind upon this planet; and as for man, an individual man, the years of his life are three score years and ten, and yet such is the power of a great mind that, despite the brevity of its allotted span, it can wrestle with the problems of nature and learn something at least of the immensities of space and time.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1925*

Time and Space (p. 155)

Government Printing Office. Washington, D.C. 1926



**Editor**

Thought must stand on scientific ground and follow a scientific line; if it is diverted it must be at angles which accord with the logic of nature.

Accuracy

*Chemical News and Journal of Industrial Science*, Volume XIX, Number 574, January 1, 1869 (p. 1)

**Einstein, Albert** 1879–1955

German-born physicist

Scientific thought is a development of pre-scientific thought.

Translated by Alan Harris

*Essays in Science*

The Problem of Space, Ether, and the Field in Physics (p. 61)

Philosophical Library. New York, New York, USA. 1934

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1896

Polish physicist

Human thought creates an ever-changing picture of the universe.

*The Evolution of Physics*

The First Clew (p. 9)

Simon & Schuster. New York, New York, USA. 1936

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Look sharply after your thoughts. They come unlooked for, like a new bird seen on your trees, and, if you turn to your usual task, disappear; and you shall never find that perception again; never, I say – but perhaps years, ages, and I know not what events and worlds may lie between you and its return!

*Journals of Ralph Waldo Emerson 1864–1876*

October, 1872 (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The crystal sphere of thought is as concentric as the geological structure of the globe. As our soils and rocks lie in strata, concentric strata, so do all men's thinkings run laterally, never vertically.

*Ralph Waldo Emerson: Essays and Lectures*

The Method of Nature (p. 117)

The Library of America. New York, New York, USA. 1983

In every work of genius we recognize our own rejected thoughts; they come back to us with a certain alienated majesty.

*Essays: First Series*

Essay II (p. 48)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 1885

Thought dissolves the material universe by carrying the mind up into a sphere where all is plastic.

*The Conduct of Life*

Fate (p. 28)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

A man should learn to detect and watch that gleam of light which flashes across his mind from within, more than the lustre of the firmament of bards and sages. Yet he dismisses without notice his thought, because it is his. In every work of genius we recognise our own rejected thoughts: they come back to us with a certain alienated majesty.

*Essays, Lectures, and Orations*

Self-Reliance (p. 23)

William S. Orr & Co. London, England. 1848

**Everett, Charles Carroll** 1829–1900

American theologian

It is the nature of thought to manifest itself. It is not lifeless like the stone; it is germinant. It cannot be repressed or hidden. Not merely does it develop itself according to the laws of its own nature, that is, as thought; like the sprouting seed, it shows itself above the soil in which it springs. Words and acts are its inevitable expression. Thought runs through all the framework of our outward life, as the nerves run through the body, forming a separate system, yet giving life to all.

*The Science of Thought*

Thought and Logic in General (p. 3)

De Wolfe, Fiske & Co. Boston, Massachusetts, USA. 1890

**Haldane, J. S. (John Scott)** 1860–1936

Scottish physiologist

...scientific thought does not involve physical realism...

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*

Lecture III, The Deeper Meaning of Berkeley's Reasoning (p. 120)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Heine, Heinrich** 1797–1856

German journalist, essayist

Thought is invisible nature – nature is visible thought.

Translated by Simon Alder Stern

*Scintillations from the Prose Works of Heinrich Heine*

Miscellaneous (p. 170)

Henry Holt & Co. New York, New York, USA. 1873

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...when new groups of phenomena compel changes in the pattern of thought...even the most eminent of physicists find immense difficulties. For the demand for change in the thought pattern may engender the feeling that the ground is to be pulled from under one's feet.... I believe that the difficulties at this point can hardly be overestimated. Once one has experienced the desperation with which clever and conciliatory men of science react to the demand for a change in the thought pattern, one can only be amazed that such revolutions in science have actually been possible at all.

In Robert M. Augros & George N. Stanciu

*The New Story of Science: Mind and the Universe*

Chapter III (p. 45)

Bantam Books, Inc. New York, New York, USA. December, 1986



**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

From desire ariseth the thought of some means we have seen produce the like of that which we aim at; and from the thought of that, the thought of means to that mean; and so continually till we come to some beginning within our own power.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Chapter III (p. 53)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

A thought is often original, though you have uttered it a hundred times.

*The Autocrat of the Breakfast-Table*

Chapter I (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

...little-minded people's thoughts move in such small circles that five minutes' conversation gives you an arc long enough to determine their whole curve. An arc in the movement of a large intellect does not sensibly differ from a straight line.

*The Autocrat of the Breakfast-Table*

Chapter I (p. 10)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

The daily home of his thought is in illimitable space, hovering between the two eternities.

*The Poet at the Breakfast Table*

Chapter II (p. 56)

J.M. Dent & Co. London, England. 1906

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

A man is not idle, because he is absorbed in thought.

Translated by Charles E. Wilbour

*Les Misérables*

Rosette, Chapter VII (p. 134)

Carleton. New York, New York, USA. 1884

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

It is not given to man to know what things are truly in themselves, but only what those things are in his thought.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section IV (p. 187)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

We have but to enlarge our thoughts with regard to things past by attending to what we see at present, and we shall understand many things which to a more contracted view appear to be in nature insulated or without a proper cause ...

*Theory of the Earth: With Proofs and Illustrations* (Volume 2)

Chapter VII (p. 212)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95

English biologist

Our thoughts may be delusive, but they cannot be fictitious. As thoughts, they are real and existent, and the cleverest deceiver cannot make them otherwise.

*Method and Results: Essays*

Descartes' Discourse on Method (p. 172)

D. Appleton & Co. New York, New York, USA. 1898

**Jefferies, Richard** 1848–87

English naturalist and author

There is an immense ocean over which the mind can sail, upon which the vessel of thought has not yet been launched. I hope to launch it.

*The Story of My Heart*

Chapter III (p. 54)

Longmans, Green & Co. London, England. 1901

**Jespen, G. L.**

No biographical data available

Habits of thought in the tradition of a science are not readily changed; it is not easy to deviate from the customary channels of accumulated experience in the conventionalized subjects.

In G.L. Jespen, E. Mayr, and G.G. Simpson (eds.)

*Genetics, Paleontology and Evolution*

Foreword (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Jevons, William Stanley** 1835–82

English economist and logician

At the base of all thought and science must lie the laws which express the very nature and conditions of the discriminating and identifying powers of mind. These are the so-called Fundamental Laws of Thought, usually stated as follows: –

1. The Law of Identity. *Whatever is, is.*
2. The Law of Contradiction. *A thing cannot both be and not be.*
3. The Law of Duality. *A thing must either be or not be.*

*The Principles of Science: A Treatise on Logic and Scientific Method*

Introduction (p. 5)

The Macmillan Co. New York, New York, USA. 1887

Our thoughts cannot be the criterion of truth, for we often have to acknowledge mistakes in arguments of moderate complexity, and we sometimes only discover our mistakes by collision between our expectations and the events of objective nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*

(2nd edition)

Chapter I (p. 7)

Macmillan & Co Ltd. London, England. 1877

**Keynes, John Maynard** 1883–1946  
British economist

Anyone who has ever attempted pure scientific or philosophical thought knows how one can hold a problem momentarily in one's mind and apply all one's powers of concentration to piercing through it, and how it will dissolve and escape and you find what you are surveying is a blank.

*Essays in Biography*  
Newton the Man (p. 312)  
Horizon Press, Inc. New York, New York, USA. 1951

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Transcending the flux of the sensuous universe, there exists a stable world of pure thought, a divinely ordered world of ideas, accessible to man, free from the mad dance of time, infinite and eternal.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Human Significance of Mathematics (p. 58)  
Columbia University Press. New York, New York, USA. 1916

To think right – that is no characteristic striving of a class of men. It is a common aspiration. Only, the stuff of thought is mostly intractable, formless, like some milky way waiting to be analysed into distinct star-forms of definite ideas. All thought aspires towards the character and condition of mathematics.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter VI (p. 134)  
Columbia University Press. New York, New York, USA. 1916

...the stuff of thought is mostly intractable, formless, like some milky way waiting to be analysed into distinct star-forms of definite ideas.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Universe and Beyond (p. 134)  
Columbia University Press. New York, New York, USA. 1916

**Lewis, Alonzo Norton**  
No biographical data available

Thought begets thought A fact, on the other hand, has not the power of propagating itself. Thought is like grain, or seed, capable of reproducing its kind a hundred-fold. Facts are like flour – the intellectual grain has been ground down and bolted all ready for immediate consumption; and yet, by this very process, rendered incapable of propagating itself.

The Teacher's Work  
*Connecticut Common School Journal*, N.S. Volume IX, Number 11,  
November, 1862 (p. 331)

**Lowell, Abbott Lawrence** 1856–1943  
American educator

Man cannot set a limit to his thought... Man cannot conceive of a boundary to space, or a time that began

and will end because he cannot fetter the processes of his own mind... [H]e was made for infinite conceptions of which he is to partake.... Only at infinity can the vision be finished and the end complete.

*Fact and Visions*  
June 19, 1927 (p. 134, 135)  
Harvard University Press. Cambridge, Massachusetts, USA. 1944

**Ludmerer, Kenneth M.** 1947–  
American physician and professor of medicine and history

Critical thinking, in short, offers the way to keep science and technology in harness.

*Learning to Heal: The Development of American Medical Education*  
Chapter 14 (p. 280)  
Basic Books, Inc. New York, New York, USA. 1985

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

...everyone who has felt the pangs of sleepless nights spent in thought, at first fruitless, but in the end successful. No thought in such struggles was thought in vain; each one, even the most insignificant, nay, even the erroneous thought, that which apparently was the least productive, served to prepare the way for those that afterwards bore fruit. And as in the thought of the individual naught is in vain, so, also, it is in that of humanity.

*Popular Scientific Lectures* (2nd edition)  
The Velocity of Light (p. 65)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Martin, Charles-Noël** 1923–  
French physicist

It is always extremely difficult to express thoughts. Words and phrases are so many fretters by which our spirit is bound. Words are mere symbols of reality, and the written word is not more than a one-dimensional flow across the two-dimensional page of a three-dimensional book.

Translated by A.J. Pomerans  
*The Role of Perception in Science*  
Chapter 1 (p. 15)  
Hutchinson of London. London, England. 1963

**Maxwell, James Clerk** 1831–79  
Scottish physicist

...who will lead...into that still more hidden and dimmer region where Thought weds Fact, where the mental operation of the mathematician and the physical action of the molecules are seen in their true relation? Does not the way to it pass through the very den of the metaphysician, strewn with the remains of former explorers, and abhorred by every man of science?

*Report for the Fortieth Meeting of the British Association for the Advancement of Science*  
Mathematics and Physics (p. 2)  
John Murray. London, England. 1871

**McCormick, Leander Hamilton** 1859–1934  
American author, inventor and scientist

The manner in which thought flits from subject to subject is suggestive of the humming bird passing from flower to flower, ever active, ever moving, and ceaselessly busy.

*Characterology*

Chapter XXVI (p. 594)

Rand McNally & Co. Chicago, Illinois, USA. 1920

There is a thought which connects every human being with the infinite.

*Characterology*

Chapter XXVI (p. 597)

Rand McNally & Co. Chicago, Illinois, USA. 1920

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

Nowadays we all give too much thought to the material blessings or evils that science has brought with it, and too little to its power to liberate us from the confinements of ignorance and superstition.

*The Art of the Soluble* (p. 15)

Harper & Row Publishers. New York, New York, USA. 1967

**Merz, John Theodore** 1840–1922  
German-born British chemist, historian, and, industrialist

Thought, and thought alone, be it as a principle the only of action or as the medium of after-contemplation, is principle, capable of arranging and connecting, of combining what is isolated, of moving that which is stagnant, of propelling that which is stationary. Take away thought, and monotony becomes the order,

*A History of European Thought in the Nineteenth Century* (Volume 1)

Introduction (p. 2)

William Blackwood & Sons. Edinburgh, Scotland. 1907

**Moore, H. P.**

No biographical data

...today, there are many guardians of culture who are more shocked at a misspelled word (even in our quite unsystematic English spelling) than at a hazily expressed thought.

*Engineering Culture*

*Science*, Volume 73, Number 1881, January 16, 1931 (p. 51)

**Murray, William John**

No biographical data available

Without thought the forces of nature would be as inoperative to benefit mankind as water would be powerless to produce steam without fire.

*The Realm of Reality*

Chapter VI (p. 69)

The Divine Science Publishing Association. 1922

**Nash, John F.** 1928–  
American mathematician

Rationality of thought imposes a limit on a person's concept of his relation to the cosmos.

*Les Prix Nobel. The Nobel Prizes in 1994*

Autobiography

Nobel Foundation. Stockholm, Sweden. 1995

**Planck, Max** 1858–1947  
German physicist

Is there something in the nature of man, some inner realm, that science cannot touch? ...Or to speak more concretely, is there a point at which the causal line of thought ceases and beyond which science cannot go?

*Where Is Science Going?*

Chapter V (p. 160)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Richardson, David Lester** 1801–65  
Poet and writer

Thoughts unexpressed, imprisoned in a solitary brain, are short-lived, and limited in their utility. Thoughts unembodied in words are ghost-like and impalpable, and haunt but one human brain. Thoughts of dumb men are smothered in their dark and silent cradles.

*Literary Chit-Chat*

Chapter X (p. 85)

P.S. D'Rozario and Co. Calcutta, India. 1848

**Roux, Joseph** 1725–93  
French hydrographer

"Thoughts" are fruits; words are leaves. Let us strip off the leaves! let us strip off the leaves! in order that thought, thus exposed to the light, may gain strength, beauty, and flavor.

*Meditations of a Parish Priest: Thoughts*

Prelude (p. 1)

Thomas Y. Crowell & Co. New York, New York, USA. 1886

To put forth thoughts – therein lies my consolation, my delight, my life. I too would exclaim, in another sense, "I think, therefore I am!"

*Meditations of a Parish Priest: Thoughts*

Prelude (p. 1)

Thomas Y. Crowell & Co. New York, New York, USA. 1886

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Flout 'em and scout 'em

And scout 'em and flout 'em;

Thought is free.

*In Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*The Tempest*

Act III, Scene ii, l. 130–133

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sime, James** 1843–95  
No biographical data available

Whatever helps to lift man's thoughts above the little-nesses of life and time is a distinct gain to the human race, altogether irrespective of the uses to which, in course of time, it may be applied.

*William Herschel and His Work*

Chapter VIII (p. 128)

T.&T. Clark. Edinburgh, Scotland. 1900

**Tyndall, John** 1820–93

Irish-born English physicist

The profoundest minds know best that Nature's ways are not at all times their ways, and that the brightest flashes in the world of thought are incomplete until they have been proved to have their counterparts in the world of fact.

*Fragments of Science for Unscientific People*

Chapter VI (p. 111)

D. Appleton & Co. New York, New York, USA. 1871

**Valéry, Paul** 1871–1945

French poet and critic

Thought is bisexual; it both inseminates and conceives itself.

Translated by Stuart Gilbert

*The Collected Works of Paul Valéry* (Volume 14)

*Analects*

Literature (p. 95)

Princeton University Press. Princeton, New Jersey, USA. 1979

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Much confusion in science, and in everything else, arises from this, that men who have no capacity for thought will presume to theorise, because they cannot see that mere stores of *knowledge*, however vast, in themselves give no capacity for *thinking*.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 159)

William Blackwood & Sons. Edinburgh, Scotland. 1883

All truly wise thoughts have been thought already thousands of times; but to make them truly ours, we must think them over again honestly, till they take firm root in our personal experience.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 171)

William Blackwood & Sons. Edinburgh, Scotland. 1883

**Weil, Simone** 1909–43

French philosopher and mystic

Our science is like a store filled with the most subtle intellectual devices for solving the most complex problems, and yet we are almost incapable of applying the elementary principles of rational thought.

In George Andrew Panichas (ed.)

*The Simone Weil Reader*

The Power of Words (p. 271)

**Whewell, William** 1794–1866

English philosopher and historian

At every step, [man] must try the value of the advances he has made in thought, by applying his thoughts to things. The Explication of Conceptions must be carried on with a perpetual reference to the Colligation of Facts.

*The Philosophy of the Inductive Sciences, Founded Upon Their History*

(Volume 2)

Book XIII, Chapter IV (p. 379)

John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...the first man who noticed the analogy between a group of seven fishes and a group of seven days made a notable advance in the history of thought.

*Science and the Modern World*

Chapter II (p. 30)

The Macmillan Company. New York, New York, USA. 1929

The history of thought is largely concerned with the records of clear-headed men insisting that they at least have discovered some clear, adequately expressed, indubitable truths. If clear-headed men throughout the ages would only agree with each other, we might cease to be puzzled. Alas, that is a comfort that is denied to us.

*Essays in Science and Philosophy*

Harvard: The Future (p. 211)

Philosophical Library. New York, New York, USA. 1947

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Thoughts rise to the surface slowly, like bubbles. (Sometimes it's as though you could see a thought, an idea, as an indistinct point far away on the horizon; and then it often approaches with astonishing swiftness.)

Translated by Peter Winch

*Culture and Value* (p. 63e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

## THOUGHT, DEVELOPMENT OF

**Rodwell, George Farrer** 1843–1905

No biographical data available

Step by step we cross great eras in the development of thought; there is no sudden gigantic stride; a theory proceeds by slow evolution until it dominates or is destroyed.

Theory of Phlogiston

*Philosophical Magazine*, Volume XXXV, January, 1868 (pp. 28–29)

## THOUGHT-ELEMENT

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

There should be no need to emphasize, in this century of radio sets and electronic devices, that many dreams may be assemblages of thought-elements that convey no information whatsoever: that they may be just noise.

*The Art of the Soluble* (pp. 87–88)

Harper & Row Publishers. New York, New York, USA. 1967

## THOUGHTS

### Editor

If we wish to know the history of our own thoughts we trace them back in our minds, and if we wish to know how the world learned to think we must look to the ages which preceded the building of our ideas.... There is a richness in these early thoughts because they have a tint of the eastern sun which never fades, and we shall admire their brightness whilst time lasts, or until that day when the poet comes who shall exhaust in his writings the delight which children have in the fields and the sunshine.

Accuracy

*Chemical News and Journal of Industrial Science*, Volume XIX, Number 574, January 1, 1869 (p. 1)

## THOUGHTS, LIMITS OF

**Langer, Susanne Katherina Knauth** 1895–1985

American philosopher

The limits of thought are not so much set from outside, by the fullness or poverty of experiences that meet the mind, as from within, by the power of conception, the wealth of formulative notions with which the mind meets experiences.

*Philosophy in a New Key: A Study in the Symbolism of Reason, Rite, and Art*

Chapter 1 (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

## THRILL

**Margenau, Henry** 1901–97

American physicist

...the greatest thrill for a scientist comes not when he has demonstrated a conjecture to be valid but when a departure from expectations convinces him that an accepted theory is wrong.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 2 (p. 19)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1950

## THUNDERBOLT

**Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

The thunderbolts were imprisoned in crucible crystal-line ore,

And locked in the laughing ocean, and shut in the shining shore,

And lulled in the light of evening, and hushed in gentle grain

And unimpered lilies imperiled with quiet rain.

*White Lightning*

Cover page

Covici-McGee. Chicago, Illinois, USA. 1923

## TIDAL BORE

**Adam, John A.**

No biographical data

What is a bore? The answer will vary depending on whether one is at a cocktail party...or the Bay of Fundy in Nova Scotia.

*Mathematics in Nature: Modeling Patterns in the Natural World*

Chapter Nine (p. 194)

Princeton University Press. Princeton, New Jersey, USA. 2003

## TIDE

**Bolland, Richard**

No biographical data available

The great Master of Philosophy drowned himself because he could not apprehend the Cause of Tydes; but his Example cannot be so prevalent with all, as to put a Period to other Mens Inquiries into the Subject.

*A Draught of the Streights of Gibraltar*

Publisher undetermined. 1732

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

It does not take long to realize that, instead of clocks, the tides beat out the measure of the marsh and shore, and that all you see, plant and animal, must adapt to the periodic changes of water level.

*The Endless Adventure*

The Sand Dunes and Salt Marshes in November (p. 62)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Defant, Albert** 1884–1974

Austrian meteorologist and oceanographer

The tides are the heartbeat of the ocean, a pulse that can be felt all over the world.

*Ebb and Flow: The Tides of Earth, Air, and Water*

Chapter 1 (p. 9)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1958

**Dickens, Charles** 1812–70

English novelist

Time and tide will wait for no man saith the adage. But all men have to wait for time and tide.



*The Life and Adventures of Martin Chuzzlewit* (Volume 1)  
Chapter X (p. 169)  
Bernhard Tauchnitz. Leipzig, Germany. 1844

### Harrington, Thomas

No biographical data available

The benefit which God designed for man by the Tides in giving a perpetual motion to the Waters was to prevent their corrupting, and thereby breeding any infection that might arise from too long a stagnation of them.

*Science Improved; or the Theory of the Universe*  
Section III (p. 18)  
Printed for the Author. London, England. 1774

### Kelvin, Lord William Thomson 1824–1907

Scottish engineer, mathematician, and physicist

The subject on which I have to speak this evening is the tides, and at the outset I feel in a curiously difficult position. If I were asked to tell what I mean by the Tides I should feel it exceedingly difficult to answer the question. The tides have something to do with motion of the sea. Rise and fall of the sea is sometimes called a tide; but I see, in the Admiralty Chart of the Firth of Clyde, the whole space between Ailsa Craig and the Ayrshire coast marked “very little tide here.” Now, we find there a good ten feet rise and fall, and yet we are authoritatively told there is very little tide. The truth is, the word “tide” as used by sailors at sea means horizontal motion of the water; but when used by landmen or sailors in port, it means vertical motion of the water.

Lecture

The British Association at the Southampton Meeting, Friday, August 25, 1882

### Tennyson, Alfred (Lord) 1809–92

English poet

A still salt pool, locked in with bars of sand,  
Left on the shore; that hears all night  
The plunging seas draw backward from the land  
Their moon-led waters white.

*The Works of Tennyson*

The Palace of Art

The Macmillan Co. New York, New York, USA. 1913

### Wallis, John

No biographical data available

The sea’s ebbing and flowing has so great a connexion with the moon’s motion, that all philosophers have attributed much of its cause to the moon, which either by some occult quality, or particular influence which it has on moist bodies, or by some magnetic virtue, drawing the water towards it, which should therefore make the water highest where the moon is vertical, or by its gravity and pressure downwards upon the terraqueous globe, which should make it lowest, where the moon is vertical, or by whatever other means, has so great an influence on, or

at least connexion with, the sea’s flux and reflux, that it would seem very unreasonable to separate the consideration of the moon’s motion from that of the sea ...

In Richard Phillips

*Readings in Natural Philosophy; Or, A Popular Display of the Wonders of Nature*

Flux and Reflux of the Sea (p. 8)

Printed for Horatio Phillips. London, England. 1828

### Young, Charles Augustus 1834–1908

American astronomer

...the statical theory [of tides] becomes utterly unsatisfactory in regard to what actually takes place, and it is necessary to depend almost entirely upon the results of observation, using the theory merely as a guide in the discussion of the observations.

*A Text-book of General Astronomy for Colleges and Scientific Schools*

Chapter XXII (p. 307)

Ginn & Co. Boston, Massachusetts, USA. 1898

## TIME

### Adams, George 1750–95

English instrument maker

Nothing can be more shocking to reason than eternal time; infinite divisibility is not less absurd.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXIV (p. 12)

Printed by R. Hindmarsh. London, England. 1794

### Alexander, Samuel 1859–1938

Australian-born British philosopher

Time is the mind of Space, and Space the body of Time.

*Space, Time, and Deity: The Gifford Lectures at Glasgow, 1916–1918*

Volume 2

Chapter II (p. 38)

Macmillan & Co. Ltd. London, England. 1920

### Aristotle 384 BCE–322 BCE

Greek philosopher

...time is “number of movement in respect to the before and after”, and is continuous since it is an attribute of what is continuous.

In *Great Books of the Western World* (Volume 8)

*Physics*

Book IV, Chapter 11 (p. 300)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Aurelius Antoninus, Marcus 121–180

Roman emperor

Time is like a river made up of the events which happen, and a violent stream; for as soon as a thing has been seen, it is carried away, and another comes in its place, and this will be carried away too.

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, #43 (p. 267)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**Babbage, Charles** 1792–1871  
English mathematician

Time and change are great, only with reference to the faculties of the beings which note them. The insect of an hour, fluttering, during its transient existence, in an atmosphere of perfume, would attribute unchanging duration to the beautiful flowers of the cistus, whose petals cover the dewy grass but a few hours after it has received the lifeless body of the gnat.

*The Ninth Bridgewater Treatise* (2nd edition)  
Chapter VII (pp. 87–88)  
London, England. 1838

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...time is the greatest innovator...

In Fred Allison Howe (ed.)  
*The Essays or Counsels*  
Civil and Moral, XXIV, Of Innovations (p. 75)

...time, which is the author of authors, be not deprived of his due, which is, further and further to discover truth.

In *Great Books of the Western World* (Volume 30)  
*Advancement of Learning*  
First Book, Chapter IV, Section 12  
Section IV, 12 (p. 15)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barnett, Lincoln Kinnear** 1909–79  
American science writer

Time itself will come to an end. For entropy points the direction of time. Entropy is the measure of randomness. When all system and order in the universe have vanished, when randomness is at its maximum, and entropy cannot be increased, when there is no longer any sequence of cause and effect, in short when the universe has run down, there will be no direction to time – there will be no time.

*The Universe and Dr. Einstein*  
Chapter 14 (p. 100)  
William Sloane Associates. New York, New York, USA. 1948

**Barrow, Isaac** 1630–77  
English clergyman and mathematician

Because Mathematicians frequently make use of Time, they ought to have a distinct idea of the meaning of that Word, otherwise they are Quacks...

In Paul Davies  
*About Time: Einstein's Unfinished Revolution*  
Header (p. 183)  
Simon & Schuster. New York, New York, USA. 1995

**Bergson, Henri** 1859–1941  
French philosopher

Wherever anything lives, there is, open somewhere, a register in which time is being inscribed.

Translated by Arthur Mitchell

*Creative Evolution*  
Chapter I (p. 17)  
The Modern Library. New York, New York, USA. 1944

Time is an invention or it is nothing at all. But of time-invention physics can take no account.... Modern physics...rests altogether on a substitution of time-length for time-invention.

Translated by Arthur Mitchell  
*Creative Evolution*  
Chapter IV (p. 361)  
The Modern Library. New York, New York, USA. 1944

**Blake, William** 1757–1827  
English poet, painter, and engraver

I see the Past, Present, and Future existing all at once before me.

*The Complete Poetry and Prose of William Blake*  
Jerusalem, l. 15  
University of California Press. Berkeley, California, USA. 1982

**Bohm, David** 1917–92  
American physicist

Eternity can be affected by what happens in time.

Quoted by Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 91)  
Routledge & Kegan Paul. London, England. 1986

But the puzzle is, what happened before time began?

Quoted by Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 199)  
Routledge & Kegan Paul. London, England. 1986

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

Time must never be thought of as pre-existing in any sense; it is a manufactured quantity.

In Paul Davies  
*About Time: Einstein's Unfinished Revolution*  
Header (p. 21)  
Simon & Schuster. New York, New York, USA. 1995

**Borges, Jorge Luis** 1899–1986  
Argentine writer

Our destiny...is not frightful because it is unreal; it is frightful because it is irreversible and ironbound. Time is the substance of which I am made. Time is a river which sweeps me along, but I am the river; it is a tiger which mangles me, but I am the tiger; it is a fire which consumes me, but I am the fire. The world, unfortunately, is real; I unfortunately, am Borges.

Translated by Anthony Kerrigan, Alastair Reid and others  
*A Personal Anthology*  
A New Refutation of Time (p. 64)  
Grove Press. New York, New York, USA. 1967

...he believed in an infinite series of times, a growing, dizzying web of divergent, convergent, and parallel times. That fabric of times that approach one another,

fork, are snipped off, or are simply unknown for centuries, contains all possibilities. In most of those times, we do not exist; in some, you exist but I do not; in others, I do and you do not; in others still, we both do. In this one, which the favouring hand of chance has dealt me, you have come to my home; in another, when you come through my garden you find me dead; in another, I say these same words, but I am an error, a ghost.

In Donald A. Yates & James E. Irby (eds.)

*Labyrinths: Short Stories & Other Writings*

The Garden of Forking Paths (p. 28)

A New Direction Book. New York, New York, USA. 1964

### **Borland, Hal** 1900–78

American writer

Forget that second-ticking clock.

Time is the seed

Waiting to fly from the milkweed pod.

Time is the speed

Of a dragonfly.

Time is the rabbit's desperate scut.

Time's dimensions are hidden in rocks,

In wind and rain, but never in clocks.

*Borland Country*

Foreword (p. 5)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

### **Bradbury, Ray** 1920–

American writer

There was a smell of Time in the air tonight. He smiled and turned the fancy in his mind. There was a thought. What did Time smell like? Like dust and clocks and people. And if you wondered what Time sounded like it sounded like water running in a dark cave and voices crying and dirt dropping down upon hollow box lids, and rain. And, going further, what it looked like a silent film in an ancient theater, one hundred billion faces falling like those New Year balloons, down and down into nothing. That was how Time smelled and looked and sounded. And tonight...tonight you could almost touch Time.

*The Martian Chronicles*

### **Bridgman, Percy Williams** 1882–1961

American physicist

But in no case is there any question of time flowing backward, and in fact the concept of backward flow of time seems absolutely meaningless.... If it were found that the entropy of the universe were decreasing, would one say that time was flowing backward, or would one say that it was a law of nature that entropy decreases with time?

*Reflections of a Physicist*

Chapter 8 (p. 165)

Philosophical Library. New York, New York, USA. 1950

It seems to me that in any operational view of the meaning of natural concepts the notion of time must be used as

a primitive concept, which cannot be analysed but must be accepted, so that it is meaningless to speak of a reversal of the direction of time.

*Reflections of a Physicist*

Chapter 8 (p. 165)

Philosophical Library. New York, New York, USA. 1950

### **Brillouin, Léon** 1889–1969

French physicist

...one of the most important features about time is its irreversibility. Time flows on and never comes back. When the physicist is confronted with this fact he is greatly disturbed. All the laws of physics in their elementary forms are reversible.

In Walter Buckley and Anatol Rapaport (eds.)

*Modern Systems Research for the Behavioral Scientist: A Sourcebook*

Life, Thermodynamics, and Cybernetics (p. 150)

Aldine Publishing Company. Chicago, Illinois, USA. 1968

### **Browne, Sir Thomas** 1605–82

English author and physician

Time which antiquates antiquities, and hat an art to make dust of all things.

*Hydriotophia*

Chapter V (p. 69)

Printed for Hen. Brome. London, England. 1658

### **Carlyle, Thomas** 1795–1881

English historian and essayist

That great mystery of Time, were there no other; the illimitable, silent, never-resting thing called Time, rolling, rushing on, swift, silent, like an all-embracing ocean-tide, on which we and all the Universe swim like exhalations, like apparitions which are, and then are not....

*On Heroes and Hero Worship*

Lecture I (p. 12)

John B. Alden, Publisher. New York, New York, USA. 1887

...no hammer in the Horologe of Time peals through the universe when there is a change from Era to Era. Men understand not what is among their hands...

*Critical and Miscellaneous*

Death and Goethe (p. 343)

Phillips, Samson & Co. Boston, Massachusetts, USA. 1855

### **Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Alice sighed wearily. "I think you might do something better with the time," she said, "than wasting it in asking riddles with no answers."

"If you knew Time as well as I do," said the Hatter, "you wouldn't talk about wasting *it*. It's *him*." "I don't know what you mean," said Alice.

"Of course you don't!" the Hatter said, tossing his head contemptuously. "I dare say you never even spoke to Time!"

"Perhaps not," Alice cautiously replied: "but I know I have

to beat time when I learn music.”

“Ah! That accounts for it,” said the Hatter. “He won’t stand beating. Now, if you only kept on good terms with him, he’d do almost anything you liked with the clock. For instance, suppose it were nine o’clock in the morning, just time to begin lessons: you’d only have to whisper a hint to Time, and round goes the clock in a twinkling! Half-past one, time for dinner!”

“I only wish it was,” the March Hare said to itself in a whisper.)

“That would be grand, certainly,” said Alice thoughtfully: “but then – I shouldn’t be hungry for it, you know.”

“Not at first, perhaps,” said the Hatter: “but you could keep it to half-past one as long as you liked.”

*Alice’s adventures in Wonderland*

A Mad Tea-party (p. 101)

Macmillan & Co Ltd. London, England. 1869

### Charlie Chan (Fictional character)

Time and analysis will tell.

*Charlie Chan in Reno*

Film (1939)

### Chaucer, Geoffrey 1343–1400

English poet

The tyme, that may not sojourne  
But goth, and never may retourne,  
As water that down runneth ay,  
But never drope retourne may;  
Ther may no-thing as tyme endure,  
Metal, nor erthely creature;  
For alle thing it fret, and shal:  
The tyme eek, that chaungeth al,  
And all doth waxe and fostred be,  
And alle thing destroyeth he.

*The Poetical Works of Geoffrey Chaucer* (Volume 4)

The Romaunt of the Rose

William Pickering. London, England. 1843

### Christianson, Gale E.

No biographical data available

Historical time is a tricky thing; it flows at an ever accelerating speed, like a river approaching a great waterfall. We must soon learn to cope with the awesome power given to us by the heirs of Copernicus or our species, and all others on the planet, are doomed to a painful and purposeless extinction. Were this to happen, only the stars would remain; and what are the stars, after all, without the eyes of man to gaze upon them or the human mind to contemplate the vastness of their wonders?

*This Wild Abyss: The Story of the Men Who Made Modern Astronomy*

Chapter 9 (p. 434)

The Free Press. New York, New York, USA. 1978

### Clemence, G. M.

No biographical data available

The measurement of time is essentially a process of counting.

Time and Its Measurement

*American Scientist*, Volume 40, Number 2, April, 1952 (p. 261)

### Cleugh, Mary F.

Psychologist

It cannot be too often emphasized that physics is concerned with the measurement of time, rather than with the essentially metaphysical question as to its nature.... We must not believe that physical theories can ultimately solve the metaphysical problems that time raises.

*Time and Its Importance in Modern Thought*

Chapter II (p. 51)

Methuen & Company Ltd. London, England. 1937

### Corben, Herbert Charles 1914–

Physicist

Time! It has been measured and mismeasured, used wisely and wasted; it has enslaved some and enriched others, and, except for those effects that are described by the theory of relativity, it has resisted all attempts to advance or delay it.

*The Struggle to Understand*

Chapter I (p. 17)

Prometheus Books. Buffalo, New York, USA. 1991

### Cummings, Ray 1887–1957

American science fiction writer

This same Space; the spread of this lawn...what would it be in another hundred years? Or a thousand? This little Space, from the Beginning to the End so crowded with events and only Time to hold them apart.

*The Shadow Girl*

Gerald G. Swan. London, England. 1946

“Time,” said George, “why I can give you a definition of time. It’s what keeps everything from happening at once.”

*The Man Who Mastered Time*

Chapter I (p. 1)

A.L. Burt Company. New York, New York, USA. 1929

### da Vinci, Leonardo 1452–1519

Italian High Renaissance painter and inventor

In rivers, the water that you touch is the last of what has passed and the first of that which comes: so with time present.

In Edward McCurdy

*Leonardo da Vinci’s Note-books*

Book I: Life (p. 51)

Duckworth & Co. London, England. 1906

O Time, thou that consumest all things! O envious age, thou destroyest all things and devourest all things with the hard teeth of the years, little by little, in slow death!

In Edward McCurdy

*Leonardo da Vinci's Note-books*

Book I: Life (p. 52)

Duckworth & Co. London, England. 1906

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Relativity physics has shifted the moving present out from the superstructure of the universe, into the minds of human beings, where it belongs.

*The Physics of Time Asymmetry* (p. 2)

University of California Press. Berkeley, California, USA. 1976

Until we have a firm understanding of the flow of time, or incontrovertible evidence that it is indeed an illusion, then we will not know who we are, or what part we are playing in the great cosmic drama.

*About Time: Einstein's Unfinished Revolution*

Chapter 13 (p. 278)

Simon & Schuster. 1996

**Davis, Philip J.** 1923–

American mathematician

**Hersh, Reuben** 1927–

American mathematician

Time, that mysterious something, that flow, that relation, that mediator, that arena for event, envelops us and confounds us all.

*Descartes' Dream: The World According to Mathematics*

Chapter IV

Of Time and Mathematics (p. 189)

Harcourt Brace Jovanovich. San Diego, California, USA. 1986

...we still cannot say what time is; we cannot agree whether there is one time or many times, cannot even agree whether time is an essential ingredient of the universe or whether it is the grand illusion of the human intellect.

*Descartes' Dream: The World According to Mathematics*

Chapter IV

Of Time and Mathematics (p. 189)

Harcourt Brace Jovanovich. San Diego, California, USA. 1986

**Dewey, John** 1859–1952

American philosopher and educator

Time and memory are true artists; they remold reality nearer to the heart's desire.

*Reconstruction in Philosophy*

Chapter V (p. 104)

Beacon Press. Boston, Massachusetts, USA. 1920

**Davy, Sir Humphry** 1778–1829

English chemist

Time...which purifies, and as it were sanctifies the mind, destroys and brings into utter decay the body; and, even in nature, its influence seems always degrading. She is represented by the poets as eternal in her youth, but amongst these ruins she appears to me eternal in her age,

and here no traces of renovation appear in the ancient of days.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the First (p. 25)

Cassell & Co., Ltd. London, England. 1889

**Dickens, Charles** 1812–70

English novelist

To speak of Time – the venerable figure not incommoded with drapery, with forelock, scythe, and hour glass (the sands forever running), with wings, and foot forever poised upon the march. *Tempus fugit*. I will be bold at once and dissent from the wise old saw. Time does not fly. He has no wings, no poised foot, no power of locomotion. Time is, and was, and will be, the same – unchanged, unchangeable, immutable.

Time and the Hour

*Household Words*, Volume 5, Number 144, December 25, 1852 (p. 357)

Don't make of time an ogre, pitilessly devouring his children as the Virgil and Homer men would make you believe he does. Take him as he is; calm, tranquil, unmoved by the course of centuries, and ages, and years. Take him as a decent, sober citizen, sleeping calmly in his well-worn nightcap, while the sun (the real mover, the real essence of mobility) is forever getting up with many a yawn and shrug before he rises, or going to bed with many a sigh of lassitude and weariness.

Time and the Hour

*Household Words*, Volume 5, Number 144, December 25, 1852 (p. 357)

Take Time as a midge slung high and dry, and steady as a rock over a boiling, bubbling, crashing, Niagara of a waterfall beneath. Perfectly inert and stationary is this old myth. He does not measure us. He wants us not. He never interferes with us. We want him; we measure him; we interfere with him.

Time and the Hour

*Household Words*, Volume 5, Number 144, December 25, 1852 (p. 357)

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

Time is the continuous loop, the snakeskin with scales endlessly overlapping without beginning or end, or time is an ascending spiral if you will, like a child's toy Slinky.

*Pilgrim at Tinker Creek*

Chapter 5 (p. 76)

Harper's Magazine Press. New York, New York, USA. 1974

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Whatever may be time *de jure*, the Astronomer Royal's time is time *de facto*. His time permeates every corner of physics.

*The Nature of the Physical World*

Chapter III (p. 36)

The Macmillan Company. New York, New York, USA. 1930

It is inconceivable that we are the heirs of an infinite time of preparation; it is not less inconceivable that there was once a moment with no moment preceding it.

*The Nature of the Physical World*

Chapter IV (p. 83)

Ann Arbor Paperbacks. Ann Arbor, Michigan, USA. 1958

In any attempt to bridge the domains of experience belonging to the spiritual and physical sides of our nature, time occupies the key position.

*The Nature of the Physical World*

Chapter V (p. 91)

The Macmillan Company. New York, New York, USA. 1930

The great thing about time is that it goes on.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 25)

Simon & Schuster. New York, New York, USA. 1995

The philosopher discusses the significance of time; the astronomer measures time. The astronomer goes confidently about his business and does not think of asking the philosopher what exactly is this thing he is supposed to be measuring; nor does the philosopher always stop to consider whether time in his speculations is identical with the time which the world humbly accepts from the astronomer. In these circumstances it is not surprising that some confusion should have arisen.

The Relativity of Time

*Nature*, Volume CVI, Number 2677, February 17, 1921 (p. 802)

Our minds are immediately aware of a "flight of time" without the intervention of external senses.

*The Mathematical Theory of Relativity*

Chapter I (p. 24)

At the University Press. Cambridge, England. 1923

**Einstein, Albert** 1879–1955

German-born physicist

Till now it was believed that time and space existed by themselves, even if there was nothing – no Sun, no Earth, no stars – while now we know that time and space are not the vessel for the Universe, but could not exist at all if there were no contents, namely, no Sun, no Earth, and other celestial bodies.

*New York Times*, April 4, 1921

The distinction between past, present and future is only an illusion, even if a stubborn one.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 70)

Simon & Schuster. New York, New York, USA. 1995

Michele [Besso] has left this strange world just before me. This is of no importance. For us convinced physicists the distinction between past, present and future is an illusion, although a persistent one.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 283)

Random House, Inc. New York, New York, USA. 1991

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Men can do nothing without the make-believe of a beginning. Even Science, the strict measurer, is obliged to start with a make-believe unit, and must fix on a point in the stars' unceasing journey when his sidereal clock shall pretend that time is Nought. His less accurate grandmother Poetry has always been understood to start in the middle; but on reflection it appears that her proceeding is not very different from his; since Science, too, reckons backward as well as forward, divides his unit into billions, and with his clock-finger at Nought really sets off in medias res. No retrospect will take us to the true beginning; and whether our prologue be in heaven or on earth, it is but a fraction of that all-presupposing fact with which our story sets out.

*Daniel Deronda*

Book I, Chapter I (p. 5)

A.L. Burt Company. New York, New York, USA. 18??

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

Time present and time past

Are both perhaps present in time future,

And time future contained in time past.

*The Collected Poems and Plays 1909–1950*

Burnt Norton (p. 117)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Ford, John** 1586–1640  
English poet and dramatist

He hath shook hands with time...

*The Dramatic Works of John Ford* (Volume 1)

*The Broken Heart*

John Murray. London, England. 1831

**Fraser, Julius Thomas**  
No biographical data available

The resulting dichotomy between time felt and time understood is a hallmark of scientific-industrial civilization, a sort of collective schizophrenia.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 283)

Random House, Inc. New York, New York, USA. 1991

**Froude, James Anthony** 1818–94  
English historian and biographer

Time has no relation to Being, conceived mathematically; it would be absurd to speak of circles or triangles as any older today than they were at the beginning of the world.



*Short Studies on Great Subjects* (Volume 1)  
Spinoza (p. 359)  
Longmans, Green & Company. London, England. 1879

### **Gale, Richard M.**

No biographical data available

...“time” is indefinable...due to the fact that temporal notions are implicitly involved in all of the basic concepts by means of which we think and talk about the world.

*The Language of Time*  
Part One, Chapter I (p. 5)  
Humanities Press. New York, New York, USA. 1968

### **Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

It is difficult to withstand a suspicion that the three dimensions of space and the fourth dimension of time may be four independent variables of a system that is neither space nor time, but something else wholly unconceived by us. Our present enigma as to how a First Cause could itself have been brought into existence – how the tortoise of the fable, that bears the elephant that bears the world, is itself supported, – may be wholly due to our necessary mistranslation of the four or more variables of the universe, limited by inherent conditions, into the three unlimited variables of Space and the one of Time.

*Inquiries into Human Faculty and Its Development*  
The Observed Order of Events (p. 196)  
AMS Press. New York, New York, USA. 1973

### **Gardner, Earl Stanley** 1889–1970

American author

Time is really nothing but a huge circle. You divide a circle of three hundred and sixty degrees into twenty-four hours, and you get fifteen degrees of arc that is the equivalent of each hour.

*The Case of the Buried Clock* (p. 82)  
Grosset & Dunlap. New York, New York, USA. 1943

### **Haughton, Samuel** 1821–97

Irish scientific writer

The infinite time of the geologists is in the past; and most of their speculations regarding this subject seem to imply the absolute infinity of time, as if the human imagination was unable to grasp the period of time requisite for the formation of a few inches of sand or feet of mud, and its subsequent consolidation into rock.

*Manual of Geology*  
Lecture IV (p. 80)  
Longmans, Green, Reader, and Dyer. London, England. 1866

### **Hawking, Stephen William** 1942–

English theoretical physicist

Imaginary time is another direction of time, one that is at right angles to ordinary, real time. We could get away from this one-dimensional, linelike behavior of time....

Ordinary time would be a derived concept we invent for psychological reasons. We invent ordinary time so that we can describe the universe as a succession of events in time, rather than as a static picture, like a surface map of the earth.... Time is just like another direction in space.  
*Playboy*, Interview, April, 1990

### **Heraclitus** ca. 540 BCE–ca. 475 BCE

Greek philosopher

Time is like a river flowing endlessly through the universe.

In Franzo H. Crawford  
*Introduction to the Science of Physics*  
Chapter 10 (p. 160)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1968

### **Høeg, Peter** 1957–

Danish author

Time refuses to be simplified or reduced. You cannot say that it is only found in the mind or only in the universe, that it runs only in one direction, or in everyone imaginable. That it exists only in biological substructure, or is only a social convention. It is all of these things.

*Borderliners*  
Chapter Seven (p. 259)  
Farrar, Straus & Giroux. New York, New York, USA. 1994

### **Housman, A. E. (Alfred Edward)** 1859–1936

English poet, scholar, and satirist

Three minutes' thought would suffice to find this out; but thought is irksome and three minutes is a long time.

*Selected Prose*  
Chapter II, Section 3 (p. 56)  
At The University Press. Cambridge, England. 1961

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If there is one thing we can be sure enough of in physics it is that all time exists with equal reality.

*October the First Is Too Late*  
Chapter Six (p. 75)  
Harper & Row, Publishers. New York, New York, USA. 1966

### **Hubble, Edwin Powell** 1889–1953

American astronomer

Past time is finite, future time is infinite.

*The Observational Approach to Cosmology* (p. 62)  
The Clarendon Press. Oxford, England. 1937

### **Hurley, Patrick M.** 1912–2000

British geophysicist

How majestic are those broad reaches of time! Looking into an abyss, one senses the gigantic form of the void only in comparison to one's own minute stature. It is almost incomprehensible that only a few billion years ago our galaxy was born in a gigantic bomb-flash of



nuclear energy. What an inspiring picture of the process of creation! But awesome and inspiring as it is to contemplate this mighty spectacle, the true reward is not to be found in whether our calculations are correct, give or take a few million years; it lies in the discoveries, in the advancement of human knowledge and philosophy that are the inevitable products of scientific search for law in nature.

*How Old Is the Earth?*

Chapter VI (p. 152)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1959

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Time, which measures everything in our idea, and is often deficient to our schemes, is to nature endless and as nothing; it cannot limit that by which alone it had existence; and, as the natural course of time, which to us seems infinite, cannot be bounded by any operation that may have an end, the progress of things upon this globe, that is, the course of nature, cannot be limited by time, which must proceed in a continual succession.

*Theory of the Earth: With Proofs and Illustrations*

Chapter I, Section I (p. 15)

*Transactions of the Royal Society of Edinburgh*

The Theory of the Earth

Volume 1 1788

Though the continuance of time may do much in those operations which are extremely slow, where no change, to our observation, had appeared to take place, yet, where it is not in the nature of things to produce the change in question, the unlimited course of time would be no more effectual, than the moment by which we measure events in our observations.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section II (p. 43)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Huxley, Thomas Henry** 1825–95

English biologist

Biology takes her time from geology. The only reason we have for believing in the slow rate of the change in living forms is the fact that they persist through a series of deposits which, geology informs us, have taken a long while to make. If the geological clock is wrong, all the naturalist will have to do is to modify his notions of the rapidity of change accordingly.

*Quarterly Journal of the Geological Society London*, Volume 25 (p. xxxviii)

**Jammer, Max** 1915–

Israeli physicist and philosopher

Time in general is to duration as place is to expansion.

*An Essay Concerning Human Understanding* (Volume 1)

Chapter XIV (p. 261)

At The Clarendon Press. Oxford, England. 1894

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...time figures as the mortar which binds the bricks of matter together...

*The Mysterious Universe*

Chapter V (p. 144)

The Macmillan Company. New York, New York, USA. 1932

...time leaves its mark, its wrinkles and its grey hairs, on the stars, so that we can guess their ages tolerable well, and the evidence is all in favor of stellar lives, not of thousands of millions, but of millions of millions, of years.

*The Universe Around Us*

Chapter I (p. 78)

The Macmillan Company. New York, New York, USA. 1929

**Kant, Immanuel** 1724–1804

German philosopher

Time is not an empirical conception. For neither coexistence nor succession would be perceived by us, if the representation of time did not exist as a foundation a priori. Without this presupposition we could not represent to ourselves that things exist together at one and the same time, or at different times, that is, contemporaneously, or in succession.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

First Part, Of Time, Metaphysical Exposition of this Conception, 5

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Krauss, Lawrence M.** 1954–

American theoretical physicist

The possibilities of space travel beckon us every time we gaze up at the stars, yet we seem to be permanent captives in the present. The question that motivates not only dramatic license but a surprising amount of modern theoretical physics research can be simply put: Are we or are we not prisoners on a cosmic temporal freight train that cannot jump the tracks?

*The Physics of Star Trek*

Chapter Two (p. 13)

HarperPerennial. New York, New York, USA. 1995

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

Time is insignificant and never a difficulty for Nature. It is always at her disposal and represents an unlimited power with which she accomplishes her greatest and smallest tasks.

Translated by Albert V. Carozzi

*Hydrogeology*

Chapter 3 (p. 61)

University of Illinois Press. Urbana, Illinois, USA. 1964

Oh, how very ancient the earth is!

Translated by Albert V. Carozzi

*Hydrogeology*

Chapter 3 (p. 75)

University of Illinois Press. Urbana, Illinois, USA. 1964

**Lapworth, Charles** 1842–1920

English geologist

Far be it from me to suggest that geologists should be reckless in their drafts upon the bank of Time; but nothing whatever is gained, and very much is lost, by persistent niggardliness in this direction.

*Proceedings of the Geological Society of London*, Volume 59, 1903 (p. lxxii)

The concept of the vastness of space has been familiar to mankind for untold ages, and has grown and expanded with the growth of the race. The concept of the immensity of time has entered so little into the intellectual development of mankind as a whole, and in its grander aspects so recently, that the race is as yet incapable of adequately grasping it.

The Relations of Geology

*Scottish Geographical Magazine*, Volume XIX, Number 8, August, 1902 (p. 396)**Lightman, Alan** 1948–

American physicist, novelist, and essayist

There is a place where time stands still...illuminated by only the most feeble red light, for light is diminished to almost nothing at the center of time, its vibrations slowed to echoes in vast canyons, its intensity reduced to the faint glow of fireflies.

*Einstein's Dreams*

14 May, 1905 (p. 70, 72–73)

Pantheon Books. New York, New York, USA. 1993

**Lodge, Sir Oliver** 1851–1940

English physicist

Our fundamental standard of time is the period of the earth's rotation – the length of the day. The earth is our one standard clock: all time is expressed in terms of it, and if it began to go wrong, or if it did not go with perfect uniformity, it would seem a most difficult thing to discover its error, and a most puzzling piece of knowledge to utilize when found.

*Pioneers of Science*

Lecture XVIII (p. 384)

Macmillan &amp; Co Ltd. London, England. 1905

**Lyell, Sir Charles** 1797–1875

English geologist

Such views of the immensity of past time, like those unfolded by the Newtonian philosophy in regard to space, were too vast to awaken ideas of sublimity unmingled with a painful sense of our incapacity to conceive a plan of such infinite extent. Worlds are seen beyond worlds immeasurably distant from each other, and beyond them all innumerable other systems are faintly traced on the confines of the visible universe.

*Principles of Geology* (Volume 1)

Chapter IV (p. 63)

John Murray. London, England. 1830

...until we habituate ourselves to contemplate the possibility of an indefinite lapse of time having been comprised within each of the modern periods of earth's history, we shall be in danger of forming most erroneous and partial views of geology.

*Principles of Geology* (Volume 3)

Chapter VIII (p. 97)

John Murray. London, England. 1830

In vain do we aspire to assign limits to the works of creation in space, whether we examine the starry heavens, or that world of minute animalcules which is revealed to us by the microscope. We are prepared, therefore, to find that in time also the confines of the universe lie beyond the reach of mortal ken.

*Principles of Geology* (Volume 3)

Concluding Remarks (p. 384)

John Murray. London, England. 1830

**Mann, Thomas** 1875–1955

German-born American novelist

Time has no division to mark its passage, there is never a thunder-storm or blare of trumpets to announce the beginning of a new month or year. Even when a new century begins it is only we mortals who ring bells and fire off pistols.

*The Magic Mountain*

Chapter V

Whims of Mercurius (p. 225)

Alfred A. Knopf. New York, New York, USA. 1966

**Mason, Rick**

No biographical data available

With a bit of a mind slip  
You're in for a time slip  
And nothing can ever be the same.

*Time Warp*

Dance song

*The Rocky Horror Picture Show*

Film (1975)

**Mehlberg, Henry** 1904–79

Polish-American philosopher of science

It seems to me that it would be either a miracle or an unbelievable coincidence if all the major scientific theories...somehow managed to co-operate with each other so as to conceal time's arrow from us. There would be neither a miracle nor an unbelievable coincidence in the concealment of time's arrow from us only if there were nothing to conceal – that is, if time had no arrows.

In Robert S. Cohen (ed.)

*Time, Causality, and the Quantum Theory* (Volume 1) (p. 207)

Reidel. Dordrecht, Netherland. 1980

**Milton, John** 1608–74  
English poet

Fly envious Time, till thou run out thy race...

*The Complete Poetical Works of John Milton*

On Time, l. 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1924

**Misner, Charles W.**  
American physicist

**Thorne, Kip S.** 1940–  
American theoretical physicist

Time is defined so that motion looks simple.

In Charles W. Misner et al.

*Gravitation*

Part I, Chapter 1 (p. 23)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Morehouse, George Wilkinson** 1840–?  
American naturalist

Space is infinite, and time is eternal. There could have been no beginning, and there can never be an end. Today is as much a day of beginning, or of ending, as any other day that may be selected in the past or future.

*The Wilderness of Worlds*

Chapter II (p. 15)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Morris, Richard** 1939–2003  
American physicist and science writer

Though science has not yet probed all the depths of the subject of time, it at least knows what we should be asking about the subject. Knowing what to ask is often the most significant step on the road to understanding.

*Time's Arrow: Scientific Attitudes Toward Time*

Chapter 12 (p. 218)

Simon & Schuster. New York, New York, USA. 1985

**Nabokov, Vladimir Vladimirovich** 1899–1977  
Russian-born American novelist

Pure Time, Perceptual Time, Tangible Time, Time free of content, context, and running commentary – this is my time and theme. All the rest is numerical symbol or some aspect of Space. The texture of Space is not that of Time, and the piebald four-dimensional sport bred by relativists is a quadruped with one leg replaced by the ghost of a leg. My time is also Motionless Time (we shall presently dispose of “flowing” time, water-clock time, water-closet time).

*Ada or Ardor: A Family Chronicle*

Part Four (p. 539)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external.

*Mathematical Principles of Natural Philosophy*

Definitions, Scholium I

E.P. Dutton & Company. New York, New York, USA. 1922

**Nietzsche, Friedrich Wilhelm** 1844–1900  
German philosopher

This all took a long time or a short time. For, properly speaking, for such things there is *no* time on earth.

Translated by Alexander Tille

*Thus Spake Zarathustra*

The Sign (p. 477)

The Macmillan Co. New York, New York, USA. 1896

**Penrose, Roger** 1931–  
English mathematical physicist

...our present picture of physical reality, particularly in relation to the nature of time, is due for a grand shake-up – even greater, perhaps, than that which has already been provided by present-day relativity and quantum mechanics.

*The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*

Chapter 8 (p. 371)

Oxford University Press, Inc. Oxford, England. 1989

**Palgrave, Francis** 1788–1861  
English historian

Few similes possess such truth as that most trite one – *the Stream of Time* – or rather the simile is the abstract idea of Time, presented to our sensuous perceptions, in the only form intelligible to the human mind.

*The History of Normandy and of England* (Volume 1)

Chapter I (p. 1)

John W. Parker & Son. London, England. 1851

The events appearing to us consecutive, are essentially consentaneous: indistinct and transient disclosures of the decree, foredoomed before all Time, and not to be fulfilled until Time shall pass away: dim glimpses of the changeless sky, caught between the vaporous margins of the driving clouds.

*The History of Normandy and of England* (Volume 1)

Chapter I (p. 2)

John W. Parker & Son. London, England. 1851

**Pirsig, Robert M.** 1928–  
American writer

The past cannot remember the past. The future can't generate the future. The cutting edge of this instant right here and now is always nothing less than the totality of everything there is.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*

Part III, Chapter 24 (p. 283)

William Morrow & Company, Inc. New York, New York, USA. 1974

**Plato** 428 BCE–347 BCE  
Greek philosopher

...The creator...sought to make the universe eternal, so far as might be. Now the nature of the ideal being was everlasting, but to bestow this attribute in its fullness upon a creature was impossible. Wherefore he resolved to have a moving image of eternity, and when he set in order the heaven, he made this image eternal but moving according to number, while eternity itself rests in unity, and this image we call time.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 37 (p. 450)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Time, then, and the heaven came into being at the same instant in order that, having been created together, if ever there was to be a dissolution of them, they might be dissolved together.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 38 (p. 451)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

The mind seemed to grow giddy by looking so far into the abyss of time.

Biographical Account of the Late James Hutton, F.R.S.

*Transactions of the Royal Society of Edinburgh*, Volume V, Part III, 1805 (p. 73)

### **Plotinus** ca. 205–270

Egyptian-Roman philosopher

Time at first – in reality before that “first” was produced by desire of succession – Time lay, though not yet as Time, in the Authentic Existent together with the Cosmos itself; the Cosmos also was merged in the Authentic and motionless within it.

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Third Ennead VII. 11 (p. 126)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The origin of Time, clearly, is to be traced to the first stir of the Soul’s tendency towards the production of the sensible Universe with the consecutive act ensuing. This is how “Time” – as we read – “came into Being simultaneously with” this All: the Soul begot at once the Universe and Time; in that activity of the Soul this Universe sprang into being; the activity is Time, the Universe is the content of Time.

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Third Ennead VII. 11 (p. 127)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Poinsot, Louis** 1777–1859

French mathematician and physicist

If anyone asked me to define time, I should reply: “Do you know what it is that you speak of?” If he said “Yes,” I should answer, “Very well, let us talk about it.” If he said “No,” I should answer, “Very well, let us talk about something else.”

In William Maddock Bayliss

*Principles of General Physiology* (3rd edition)

Preface (p. xvii)

Longmans, Green & Company. London, England. 1920

### **Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

The irreversibility [of time] is the mechanism that brings order out of chaos.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 283)

Random House, Inc. New York, New York, USA. 1991

Time is creation. The future is just not there.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 321)

Random House, Inc. New York, New York, USA. 1991

### **Putnam, H.**

No biographical data available

I do not believe that there are any longer any philosophical problems about Time; there is only the physical problem of determining the exact physical geometry of the four-dimensional continuum that we inhabit.

Time and Physical Geometry

*Journal of Philosophy*, Volume 64, April, 1967

### **Reichenbach, Hans** 1891–1953

German philosopher of science

There is no other way to solve the problem of time than the way through physics.... If time is objective the physicist must have discovered the fact. If there is Becoming, the physicist must know it.... If there is a solution to the philosophical problem of time, it is written down in the equations of mathematical physics.

*The Direction of Time* (p. 16)

University of California Press. Berkeley, California, USA. 1956

### **Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Indolence watches the tooth of Time with careless eye and nerveless hand.

*The Poetry of Architecture: Cottage, Villa, Etc.*

The Cottage (p. 28)

John Wiley & Sons. New York, New York, USA. 1877

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...to realise the unimportance of time is the gate of wisdom.

*Our Knowledge of the External World*

Lecture VI (p. 167)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1891

It is poetic imagination, not science, which presents Time as despotic lord of the world, with all the irresponsible frivolity of a child.

*Mysticism and Logic: And Other Essays*  
Chapter I (p. 3)  
Longmans, Green & Co. London, England. 1919

...there is some sense – easier to feel than to state – in which time is an unimportant and superficial characteristic of reality. Past and future must be acknowledged to be as real as the present, and a certain emancipation from slavery to time is essential to philosophic thought.

*Mysticism and Logic and Other Essays*  
Chapter I, Section III (p. 21)  
Longmans, Green & Company London, England. 1925

### **Saint Augustine of Hippo** 354–430

Theologian and doctor of the Church

Time is like a river made up of events which happen, and its current is strong; no sooner does anything appear than it is swept away.

In Paul Davies  
*Other Worlds: A Portrait of Nature in Rebellion, Space, Superspace, and the Quantum Universe*  
Chapter 10 (p. 186)  
Simon & Schuster, New York, New York, USA. 1980

...all time past to be driven away by time to come; and all time to come, to follow upon the past; and that all both past and to come, is made up, and flows out of that which is always present? Who now shall so hold fast this heart of man, that it may stand, and see, how that eternity ever still standing, gives the word of command to the times past or to come, itself being neither past nor to come?

*St. Augustine's Confessions* (Volume 2)  
Book XI, XI (p. 233)  
William Heinemann, London, England. 1912

For what is time? Who is able easily and briefly to explain that? Who is so much as in thought to comprehend it, so as to express himself concerning it? And yet what in our usual discourse do we more familiarly and knowingly make mention of than time? And surely we understand it well enough, when we speak of it: we understand it also, when in speaking with another we hear it named.

*St. Augustine's Confessions* (Volume 2)  
Book XI, XIV (p. 237, 239)  
William Heinemann, London, England. 1912

What is time then? If nobody asks me, I know: but if I were desirous to explain it to one that should ask me, plainly I know not.

*St. Augustine's Confessions* (Volume 2)  
Book XI, XIV (p. 237, 239)  
William Heinemann, London, England. 1912

...if nothing were coming, there should be no time to come: and if nothing were, there should now be no present time. These two times therefore, past and to come, in what sort are they, seeing the past is now no longer, and that to come is not yet? As for the present, should it always be present and never pass into times past, verily it should not be time but eternity.

*St. Augustine's Confessions* (Volume 2)  
Book XI, XIV (p. 239)  
William Heinemann, London, England. 1912

Clear now it is and plain, that neither things to come, nor things past, are. Nor do we properly say, there be three times, past, present, and to come; but perchance it might be properly said, there be three times: a present time of past things; a present time of present things; and a present time of future things.... The present time of past things is our memory; the present time of present things is our sight; the present time of future things our expectation.

*St. Augustine's Confessions* (Volume 2)  
Book XI, XX (p. 253)  
William Heinemann, London, England. 1912

### **Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

The essence of nowness runs like a fire along the fuse of time.

*Realms of Being*  
Chapter IX (p. 491)  
Cooper-Square Publishers, Inc. New York, New York, USA. 1972

### **Schiller, Friedrich** 1759–1805

German poet, philosopher, historian, and dramatist

Time irrevocably flies, towards changeless eternity...

*The Poems of Schiller*  
The Unchangeable (p. 305)  
H. Holt & Co. New York, New York, USA. 1902

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

Unless hours were cups of sack, and minutes capons, and clocks the tongues of bawds, and dials the signs of leaping-houses, and the blessed sun himself a fair hot wench in flame-colour'd taffeta, I see no reason why thou shouldst be so superfluous to demand the time of the day.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
*The First Part of King Henry the Fourth*  
Act I, Scene ii, l. 7–10  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There are many events in the womb of time which will be delivered.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)



*Othello, The Moor of Venice*

Act I, Scene iii, l. 376

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

What seekest thou else

In the dark backward and abysm of time?

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*The Tempest*

Act VI, Scene ii, l. 50

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Silesius, Angelus** 1624–77

German poet

Do not compute eternity

as light-year after year

One step across

that line called Time

Eternity is here.

*The Book of Angelus Silesius*

Of Time and Eternity (p. 42)

Alfred A. Knopf. New York, New York, USA. 1976

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

She is settling fast? said the First Lieutenant as he returned from shaving.

“Fast, Mr. Spoker?” asked the Captain. “The expression is a strange one, for Time (if you will think of it) is only relative.”

*Fables*

The Sinking Ship

Charles Scribner’s Sons. New York, New York, USA. 1923

**Suess, Eduard** 1831–1914

Austrian geologist

The astronomer, in order to render conceivable the immensity of celestial space, points to the parallelism of the stellar rays or to the white clouds of the Milky Way. There is no such means of comparison by which we can illustrate directly the great length of cosmic periods, and we do not even possess a unit with which such periods might be measured. The distance in space of many stars from the earth has been determined; for the distance in time of the latest strand-line on Capri or the last shell-bed on Tromsø, we cannot suggest an estimate even in approximate figures.

*The Face of the Earth* (Volume 2)

Part III, Chapter XIV (p. 556)

At The Clarendon Press. Oxford, England. 1906

We hold the organic remains of the remote past in our hand and consider their physical structure, but we know not what interval of time separates their epoch from our own; they are like those celestial bodies without parallax, which inform us of their physical constitution by their spectrum, but furnish no clue to their distance. As Rama looks out

upon the Ocean, its limits mingling and uniting with heaven on the horizon, and as he ponders whether a path might not be built into the Immeasurable, so we look over the Ocean of time, but nowhere do we see signs of a shore.

*The Face of the Earth* (Volume 2)

Part III, Chapter XIV (p. 556)

At The Clarendon Press. Oxford, England. 1906

**Swinburne, Algernon Charles** 1837–1909

English poet

Before the beginning of years

There came to the making of man

Time, with a gift of tears ...

*The Poems of Algernon Charles Swinburne* (Volume 4)

Atlanta in Calydon (p. 258)

Chatto & Windus. London, England. 1905

**Swinburne, Richard** 1943–

English philosopher

It would be an error to suppose that if the universe is infinitely old, and each state of the universe at each instant of time has a complete explanation which is a scientific explanation in terms of a previous state of the universe and natural laws (and so God is not invoked), that the existence of the universe throughout infinite time has a complete explanation, or even a full explanation. It has not. It has neither. It is totally inexplicable.

*The Existence of God*

Chapter 7 (p. 122)

At the Clarendon Press. Oxford, England. 1979

**Schwinger, Julian** 1918–94

American theoretical physicist

Time appears in quantum mechanics as a continuous parameter which represents an abstraction of the dynamical role of the measurement apparatus.

*Nobel Lectures, Physics 1963–1970*

Relativistic Quantum Field Theory (p. 142)

Elsevier Publishing Co. Amsterdam, The Netherlands. 1972

## The X-Files

SCULLY: No, wait a minute. You’re saying that, that time disappeared. Time can’t just disappear, it’s, it’s, it’s a universal invariant!

MULDER: Not in this zip code.

*Pilot*

Television program

Season 1 (1993)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Time is but the stream I go a-fishin in.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter II (p. 155)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893



**Tuttle, Hudson** 1836–1910  
American spiritualist

Thousands of years are, in the chronometer of nature, one stroke of the pendulum – a moment.

In Ludwig Buchner

*Force and Matter*

Chapter IX (p. 56)

Trubner & Company. London, England. 1864

**Urey, Harold Clayton** 1893–1981  
American chemist

However, the evolution from inanimate systems of biochemical compounds, e.g., the proteins, carbohydrates, enzymes and many others, of the intricate systems of reactions characteristic of living organisms, and the truly remarkable ability of molecules to reproduce themselves seems to those most expert in the field to be almost impossible. Thus a time from the beginning of photosynthesis of two billion years may help to accept the hypothesis of the spontaneous generation of life.

On the Early Chemical History of the Earth and the Origin of Life  
*Proceedings of the National Academy of Science*, Volume 38, 1952 (p. 362)

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

Time is flying – flying never to return.

In Paul Davies

*Other Worlds: A Portrait of Nature in Rebellion, Space, Superspace, and the Quantum Universe*

Chapter 10 (p. 186)

Simon & Schuster. New York, New York, USA. 1980

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

Physico-Mechanical laws are, as it were, the telescopes of our spiritual eyes which can penetrate into the deepest night of time, past and to come.

In Alexander Winchell

*World-Life or Comparative Geology*

Part II, Chapter IV (p. 451)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**Vyasa** ca. 3100 BCE

Vedic and Puranic scribe

Time does not sleep when all things sleep,  
Only Time stands straight when all things fall.

Is, was, and shall be are Time's Children.

Is, was, and shall be are Time's Children.

*The Mahabharata of Vyasa*

The Beginning (p. 65)

Publisher undetermined

**Weil, Simone** 1909–43  
French philosopher and mystic

Time is an image of eternity, but it is also a substitute for eternity.

*Gravity and Grace*

Renunciation of Time (p. 18)

Routledge & Kegan Paul. London, England. 1952

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

“Can an instantaneous cube exist?”

“Don't follow you,” said Filby.

“Can a cube that does not last for any time at all, have a real existence?”

Filby became pensive. “Clearly,” the Time Traveler proceeded, “any real body must have extension in four directions: it must have Length, Breadth, Thickness, and – Duration.... There are really four dimensions, three which we call the three planes of Space and a fourth, Time. There is, however, a tendency to draw an unreal distinction between the former three dimensions and the latter, because it happens that our consciousness moves intermittently in one direction along the latter from the beginning to the end of our lives.”

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today* 1971

*The Time Machine*, Chapter 1

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

There is no difference between Time and any of the three dimensions of Space except that our consciousness moves along it.

*Seven Science Fiction Novels of H. G. Wells*

*The Time Machine*

Chapter 1 (p. 4)

Dover Publications, Inc. New York, New York, USA. 1934

**Wheeler, John Archibald** 1911–  
American theoretical physicist and educator

Should we be prepared to see someday a new structure for the foundations of physics that does away with time?

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 178)

Simon & Schuster. New York, New York, USA. 1995

Time is nature's way to keep everything from happening at once.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 236)

Simon & Schuster. New York, New York, USA. 1995

Time ends. That is the lesson of the “big bang.” It is also the lesson of the black hole.

The Lesson of the Black Hole

*Proceedings of the American Philosophical Society*, Volume 125, 25

Of all the obstacles to a thoroughly penetrating account of existence, none looms up more dismayingly than “time.” Explain time? Not without explaining existence. Explain existence? Not without explaining time. To uncover the deep and hidden connection between time and existence,

to close on itself our quartet of questions, is a task for the future.

Hermann Weyl and the Unity of Knowledge  
*American Scientist*, Volume 74, July–August, 1986 (p. 374)

**White, Henry Kirke** 1785–1806  
English poet

...it is fearful then  
To steer the mind in deadly solitude  
Up the vague stream of probability  
To wind the mighty secrets of the past  
And turn the key of time.

*Poetical Works*

Time

Bell & Daldy. London, England. 1870

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Apart from time there is no meaning for purpose, hope, fear, energy. If there be no historic process, then everything is what it is, namely, a mere fact. Life and motion are lost.

*Modes of Thought*

Chapter II, Lecture Five (p. 139)

The Macmillan Company. New York, New York, USA. 1938

Time and space express the universe as including the essence of transition and the success of achievement. The transition is real, and the achievement is real. The difficulty is for language to express one of them without explaining away the other.

*Modes of Thought*

Chapter II, Lecture Five (pp. 139–140)

The Macmillan Company. New York, New York, USA. 1938

It is impossible to meditate on time and the mystery of the creative process of nature without an overwhelming emotion at the limitations of human intelligence.

*The Concept of Nature*

Chapter III (p. 73)

At The University Press. Cambridge, England. 1920

**Whitrow, G. J.** 1912–2000  
English mathematician, cosmologist, and science historian

The basic objection to attempts to deduce the unidirectional nature of time from concepts such as entropy is that they are attempts to reduce a more fundamental concept to a less fundamental one.

*The Natural Philosophy of Time* (2nd edition)

Chapter 7 (p. 338)

Clarendon Press. Oxford, England. 1980

...the history of natural philosophy is characterized by the interplay of two rival philosophies of time – one aiming at its “elimination” and the other based on the belief that it is fundamental and irreducible.

*The Natural Philosophy of Time* (2nd edition)

Chapter 7 (p. 370)

Clarendon Press. Oxford, England. 1980

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

What Eddington says about “the direction of time” and the law of entropy comes to this: time would change its direction if men should start walking backwards one day. Of course you can call it that if you like; but then you should be clear in your mind that you have said no more than that people have changed the direction they walk in.

Translated by Peter Winch

*Culture and Value* (p. 18e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wordsworth, William** 1770–1850  
English poet

...the unimaginable touch of time ...

*The Complete Poetical Works of William Wordsworth*

Ecclesiastical Sonnets, XXXIV

Thomas Y. Crowell Co. New York, New York, USA. 1894

**Yeats, William Butler** 1865–1939  
Irish poet and playwright

Time drops in decay,

Like a candle burnt out.

*The Collected Poems of W.B. Yeats*

The Moods (p. 54)

The Macmillan Company. New York, New York, USA. 1956

**Zebrowski, George** 1945–  
Polish-American science fiction writer

Time is a relationship that we have with the rest of the universe; or more accurately, we are one of the clocks, measuring one kind of time. Animals and aliens may measure it differently. We may even be able to change our way of marking time one day, and open up new realms of experience, in which a day today will be a million years.  
*OMNI Magazine*, 1994

## TIME AND SPACE

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

Time and space are fragments of the Infinite for the use of finite creatures.

Translated by Mrs. Humphry Ward

*Amiel's Journal*

November 16, 1864 (p. 101)

Macmillan & Company Ltd. London, England. 1921

**Poincaré, Jules Henri** 1854–1912  
French mathematician and theoretical astronomer

...time and space.... It is not nature which imposes them upon us, it is we who impose them upon nature because we find them convenient.

Translated by George Bruce Halsted  
*The Value of Science*  
 Introduction (p. 13)  
 The Science Press. New York, New York, USA. 1907

## TIME TRAVEL

**Allen, Elizabeth Akers** 1832–1911  
 Journalist and poet

Backward, turn backward, O Time, in your flight.  
 Make me a child again just for to-night.  
*Rock Me to Sleep, Mother*  
 Rock Me to Sleep, Mother (p. 11)  
 Estes & Lauriat. Boston, Massachusetts, USA. 1883

**Bester, Alfred** 1913–87  
 American science fiction writer

“We’re like millions of strands of spaghetti in the same pot. No time traveler can ever meet another time traveler in the past or the future. Each of us must travel up or down his own strand alone.”  
 “But we’re meeting each other now.”  
 “We’re no longer time travelers, Henry. We’ve become the spaghetti sauce.”  
*Starlight: The Great Short Fiction of Alfred Bester*  
 The Man Who Murdered Mohammed (p. 100)  
 Doubleday & Company, Inc. Garden City, New York, USA. 1976

**Clarke, Arthur C.** 1917–  
 English science and science fiction writer

The most convincing argument against time travel is the remarkable scarcity of time travelers. However unpleasant our age may appear to the future, surely one would expect scholars and students to visit us, if such a thing were possible at all. Though they might try to disguise themselves, accidents would be bound to happen – just as they would if we went back to Imperial Rome with cameras and tape-recorders concealed under our nylon togas.  
*Profiles of the Future: An Inquiry into the Limits of the Possible*  
 Chapter 11 (p. 132)  
 Harper & Row, Publishers. New York, New York, USA. 1973

**Kaku, Michio** 1947–  
 Japanese-American theoretical physicist

...imagine the chaos that would arise if time machines were as common as automobiles, with tens of millions of them commercially available. Havoc would soon break loose, tearing at the fabric of our universe. Millions of people would go back in time to meddle with their own past and the past of others, rewriting history in the process.... It would be impossible to take a simple census to see how many people there were at any given time.  
*Hyperspace : A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension*  
 Chapter 11 (p. 234)  
 Oxford University Press, Inc. New York, New York, USA. 1995

**Krauss, Lawrence M.** 1954–  
 American theoretical physicist

While everyone of us is a time traveler, the cosmic pathos that elevates human history to the level of tragedy arises precisely because we seem doomed to travel in only one direction – into the future.  
*The Physics of Star Trek*  
 Chapter Two (p. 13)  
 Harp Perennial Publishers. New York, New York, USA. 1995

**Schickel, Richard**  
 American film critic

Time travel is the thinking person’s UFO, an improbability that nevertheless resonates with mysterious and sometimes marvelous possibilities.  
 Review  
 Back to the Future, Part II  
*Time*, December 4, 1989

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

Man...can go up against gravitation in a balloon, and why should he not hope that ultimately he may be able to stop or accelerate his drift along the Time-Dimension, or even turn about and travel the other way.  
*The Great Ideas Today* 1971  
*The Time Machine*  
 Chapter One (p. 451)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

I’m afraid I cannot convey the peculiar sensations of time traveling. They are excessively unpleasant.  
 In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today* 1971  
*The Time Machine*  
 Chapter Three (p. 458)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

## TOMB

**Carter, Howard** 1874–1939  
 English archaeologist and Egyptologist

**Mace, Arthur Cruttenden** 1874–1928  
 Egyptologist

...as my eyes grew accustomed to the light, details of the room within emerged slowly from the mist, strange animals, statues, and gold – everywhere the glint of gold. For the moment – an eternity it must have seemed to the others standing by – I was struck dumb with amazement, and when Lord Carnarvon, unable to stand the suspense any longer, inquired anxiously, “Can you see anything?” it was all I could do to get out the words, “Yes, wonderful things.”  
*The Discovery of the Tomb of Tutankhamen*  
 Chapter V (p. 35)  
 Sphere Books. London, England. 1972

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

Why, oh why, wasn't the tomb left intact as it was found, where it was found? The garden of the Florence museum is vastly instructive, if you want object-lessons about the Etruscans. But who wants object lessons about vanished races? What one wants is a contact. The Etruscans are not a theory or a thesis. If they are anything, they are an *experience*.

*D.H. Lawrence and Italy*

*Etruscan Places*

Volterra, Chapter V (p. 114)

Penguin Classics. New York, New York, USA. 1997

## TOOL

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

A tool is but the extension of a man's hand, and a machine is but a complex tool. He that invents a machine augments the power of a man and the well-being of mankind.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

Historical Background (p. 340)

Centennial of Engineering. Chicago, Illinois. 1952

**Bergson, Henri** 1859–1941  
French philosopher

Science has equipped man in less than fifty years with more tools than he had made during the thousands of years he had lived on earth. Each new machine being for man a new organ – an artificial organ – his body became suddenly and prodigiously increased in size, without his soul being at the same time able to dilate to the dimensions of his body.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

Historical Background (p. 343)

Centennial of Engineering. Chicago, Illinois. 1952

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Man is a Tool-using Animal. Weak in himself, and of small stature, he stands on a basis, at most for the flattest-soled, of some half square foot, insecurely enough; Has to straddle out his legs, lest the very wind supplant him. Feeblest of bipeds! Three quintals are a crushing load for him; the steer of the meadow tosses him aloft like a waste rag. Nevertheless he can use Tools: with these the granite mountain melts into light dust before him, seas are his smooth highway, winds and fire his unwearying steeds. Nowhere do you find him without Tools; without Tools he is nothing, with Tools he is all.

*Sartor Resartus*

Book I, Chapter V (pp. 35–36)  
Ginn & Company. Boston, Massachusetts, USA. 1897

## TOOTHACHE

**Burns, Robert** 1759–96  
English author

My curse upon your venom'd stang,  
That shoots my tortur'd gooms alang,  
An' thro' my lug gies monie a twang  
Wi' gnawing vengeance,  
Tearing my nerves wi' bitter pang,  
Like racking engines!

*The Poems and Songs of Robert Burns* (Volume 2)

Address to the Toothache, Stanza I

Clarendon Press. Oxford, England. 1968

**Busch, Wilhelm** 1832–1908  
German cartoonist, painter, and poet

A toothache, not to be perverse,  
Is an unmitigated curse...

*German Satirical Writings*

The Poet Thwarted (p. 161)

Continuum. New York, New York, USA. 1984

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“Do I look very pale?” said Tweedledum, coming up to have his helmet tied on. (He called it a helmet, though it certainly looked much more like a saucepan.)

“Well – yes – a little”, Alice replied gently.

“I'm very brave generally”, he went on in a low voice: “only today I happen to have a headache.”

“And I've got a toothache!” said Tweedledee, who had overheard the remark. I'm far worse than you!”

*The Complete Works of Lewis Carroll*

*Through the Looking-Glass*

Chapter IV (p. 193)

The Modern Library. New York, New York, USA. 1936

**Collins, John** 1742–1808  
No biographical data available

Maria one Morning was smitten full sore,  
With the Tooth-ache's unmerciful Pang;  
And she vow'd, if she liv'd to the Age of Five-score,  
That she still should remember the Fang.

*Scripscrapologia*

Excuse for Oblivion, l. 1–4

Published by the author. Birmingham, England. 1804

**Fuller, Thomas** 1608–61  
English clergyman and author

The tongue is ever turning to the aching tooth.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings.*

*Ancient and Modern, Foreign and British*

No. 4796

Printed for Thomas & Joseph Allman. London, England. 1816

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

Roll on, thou ball, roll on!  
Through pathless realms of Space  
Roll on!  
What though I'm in a sorry case?  
What though I cannot meet my bills?  
What though I suffer toothache's ills?  
What though I swallow countless pills?

In Helen and Lewis Melville  
*An Anthology of Humorous Verse*  
To the Terrestrial Globe  
Dodd, Mead & Company New York, New York, USA. 1924

**Heath-Stubbs, John** 1918–2006  
English critic, anthologist, translator, and poet

Venerable Mother Toothache  
Climb down from the white battlements,  
Stop twisting in your yellow fingers  
The fourfold rope of nerves.

*Collected Poems 1943–1987*  
A Charm Against the Toothache (p. 312)  
Carcaret Press Ltd. Manchester, England. 1988

**Herbert, George** 1593–1633  
Welsh poet, orator and priest

Music helps not the toothache.  
*The Works of George Herbert in Prose and Verse*  
Jacula Prudentum (p. 459)  
John Wurtele Lovell. New York, New York, USA. 1881

**Hood, Thomas** 1582–98  
English poet and editor

One tooth he had with many fangs,  
That shot at once as man pangs,  
It had an universal sting;  
One tough of that ecstatic stump  
Could jerk his limbs, and make him jump,  
Just like a puppet on a string.

*The Complete Poetical Works of Thomas Hood*  
A True Story  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**James, Henry** 1843–1916  
American novelist

He might have been a fine young man with a bad tooth-  
ache; with the first even of his life. What ailed him above  
all, she felt, was that trouble was new to him...

*The Spoils of Poynton*  
Chapter 8 (p. 102)  
New Directions Houghton Mifflin Company. Norfolk, Connecticut,  
USA, 1924

**Josselyn, John** 1630–75  
English gentleman

...for the Toothache I have found the following medicine  
very available, Brimstone and Gunpowder compounded  
with butter; rub the mandible with it, the outside being  
first warm'd.

*Two Voyages to New-England*  
The Second Voyage (pp. 128–129)

**Mather, Cotton** 1663–1728  
American minister and religious writer

O Man, Since the Hardest and Strongest Things thou hast  
about thee, are so fast Consuming; Do not imagine that  
that rest of thy Body will remain Long Unconsumed, or  
that any Bones of thy Body shall not soon Moulder into  
Dust.

*The Angel of Bethesda*  
Capsula XI (p. 63)  
American Antiquarian Society and Barre Publishers. Barre, Massachu-  
setts, USA. 1972

a Thigh-bone of a Toad, applied unto an aking Tooth,  
rarely fails of easing the Pain.

*The Angel of Bethesda*  
Capsula XI (p. 64)  
American Antiquarian Society and Barre Publishers. Barre, Massachu-  
setts, USA. 1972

**Melville, Herman** 1819–91  
American novelist

Another [sailor] has the toothache: the carpenter out  
pincers, and clapping one hand upon his bench bids  
him be seated there; but the poor fellow unmanageably  
winces under the uncompleted operation; whirling round  
the handle of his wooden vice, the carpenter signs him  
to clap his jaw in that, if he would have him draw the  
tooth.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 107 (p. 344)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## Proverb

The tooth-ache is more ease,  
than to deale with ill people.

In George Herbert  
*Outlandish Proverbs*  
#558  
Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ray, John** 1627–1705  
English naturalist

Who hath aching teeth hath ill tenants.  
*A Complete Collection of English Proverbs* (p. 26)  
Printed for G. Cowie. London, England. 1813

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

For there was never yet philosopher  
That could endure the toothache patiently.

In *Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)*Much Ado About Nothing*

Act V, Scene i, l. 35–36

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He that sleeps feels not the toothache.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)*Cymbeline*

Act V, Scene iv, l. 177

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

The man with toothache thinks everyone happy whose  
teeth are sound.

*The Revolutionist's Handbook & Pocket Companion*

Maxims for Revolutionists, Greatness (p. 56)

Publisher undetermined. USA. 1962

**TRACK****Defoe, Daniel** 1660–1731

English pamphleteer, journalist, and novelist

...there was exactly the print of a foot, toes, heel and  
every part of a foot; how it came thither, I knew not, nor  
could I in the least imagine...

*Robinson Crusoe* (p. 113)

Dodd, Mead &amp; Company. New York, New York, USA. 1946

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“Not a bird my dear Roxton – not a bird?”

“A beast?”

“No; a reptile – a dinosaur. Nothing else could have left  
such a track.”

*The Lost World*

Chapter X (p. 168)

The Colonial Press, Clinton, Massachusetts, USA. 1959

**Melville, Herman** 1819–91

American novelist

That turnpike earth! – that common highway all over  
dented with the marks of...heels and hoofs.

In *Great Books of the Western World* (Volume 48)*Moby Dick*

Chapter 13 (p. 44)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mills, Enos A.** 1870–1922

Naturalist, writer and nature guide

The tracks and records in the snow which I read in  
passing made something of a daily newspaper for me.  
They told much of the news of the wilds.

In William H. Carr

*The Stir of Nature*

Chapter Three (p. 37)

Oxford University Press, Inc. New York, New York, USA. 1930

**TRACKING****Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children's writer, and playwright

“Hallo” said Piglet, “What are you doing?”

“Tracking something” said Winnie-the Pooh very mys-  
teriously.

“Tracking what?” said Piglet, coming closer.

“That’s just what I ask myself. I ask myself, What?”

*The Complete Tales & Poems of Winnie-the-Pooh**Winnie-the-Pooh*, Winnie-the-Pooh, Pooh and Piglet Go Hunting and

Nearly Catch a Woozle (p. 34)

Dutton Children's Books. New York, New York, USA. 2001

**TRADITION****Huxley, Thomas Henry** 1825–95

English biologist

Ancient traditions, when tested by the severe processes  
of modern investigation, commonly enough fade away  
into mere dreams: but it is singular how often the dream  
turns out to have been a half-waking one, presaging a  
reality.

*Evidence as to Man's Place in Nature*

Chapter I (p. 9)

D. Appleton &amp; Company. New York, New York, USA. 1873

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

It would have been good, if Bacon had not poured the  
child out with the bath water, if he had seen the value of  
existing tradition and had advanced this point of view,  
if he would have known how to value and to make use  
of existing experiences, rather than in his style to refer  
to that which is indeterminable and infinite. He knew of  
Gilbert's work on magnetism, for example, but seemed  
to have no idea of the monumental worth which already  
existed in this discovery.

In Karl J. Fink

*Goethe's History of Science*

Chapter 6 (p. 75)

Cambridge University Press. Cambridge, England. 1991

**TRANSCENDENTAL****Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist



In general, the mathematics required is more or less of the character sometimes termed transcendental. This is a grandiloquent word, suggestive of something beyond human capacity to find out; a word to frighten timid people into believing that it is all speculation, and therefore unsound.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 1)

D. van Nostrand Co. New York, New York, USA. 1893

## TRANSISTOR

**Landauer, Rolf** 1927–99

German-American physicist

An ordinary transistor circuit is like a door.... You slam it open, you slam it shut. You don't have to have a delicate regard for the amount of force you use when you push it one way or the other. These quantum systems are not like that. Quantum computers don't use just an open door or a shut door. Both the open door and the shut door are present simultaneously. The problems all relate to the fact that the process is not perfect. It doesn't do exactly what you want it to do.

In Tim Folger

The Best Computer in All Possible Worlds

*Discover Magazine*, October, 1995

## TRANSIT OF VENUS

**Halley, Edmond** 1656–1742

English astronomer and mathematician

I could wish...that many observations of this famous phenomenon [transit of Venus] might be taken by different persons at separate places, both that we might arrive at a greater degree of certainty by their agreement, and also lest any single observer should be deprived by the intervention of clouds, of a sight which I know not whether any man living in this or the next age will ever see again, and on which depends the certain and adequate solution of a problem the most noble, and at any other times not to be attained to. I recommend it therefore again and again, to those curious astronomers who, when I am dead, will have an opportunity of observing these things, that they would remember this my admonition, and diligently apply themselves with all their might in making this observation; and I earnestly wish them all imaginable success; in the first place that they may not by the unseasonable obscurity of a cloudy sky, be deprived of this most desirable sight, and then, that having ascertained with more exactness the magnitudes of the planetary orbits, it may redound to their immortal fame and glory.

In R. A. Proctor

Past and Coming Transits of Venus

*The Cornhill Magazine*, Volume 31, January, 1875 (p. 96)

**Harkness, William** 1837–1903

Astronomer

We are now on the eve of the second transit of a pair, after which there will be no other till the twenty-first century of our era has dawned upon the earth, and the June flowers are blooming in 2004. When the last transit season occurred the intellectual world was awakening from the slumber of ages, and that wondrous scientific activity which led to our present advanced knowledge was just beginning. What will be the state of science when the next transit season arrives God only knows. Not even our children's children will live to take part in the astronomy of that day.

On the Transit of Venus

*Nature* Volume XXVII, November 30, 1882 (p. 114)

**Horrocks, Jeremiah** 1618–41

English astronomer

I then beheld a most agreeable spectacle – the object of my sanguine wishes – a spot of unusual magnitude, and of a perfectly circular shape, which had already fully entered upon the sun's disc on the left, so that the limbs of the sun and Venus perfectly coincided. Not doubting that this was really the shadow of the planet, I immediately applied myself sedulously to observe it.

In R. A. Proctor

Past and Coming Transits of Venus

*The Cornhill Magazine*, Volume 31, January, 1875 (p. 94)

...he [William Crabtree] at once began to observe, and was gratified by beholding the pleasing spectacle of Venus upon the sun's disc. Rapt in contemplation, he stood for some time motionless, scarcely trusting his own senses, through excess of joy; for we astronomers have, as it were, a womanish disposition, and are overjoyed with trifles, and such small matters as scarcely make an impression upon others; a susceptibility which those who will may deride with impunity, even in my own presence; and if it gratify them I too will join in the merriment.

In R. A. Proctor

Past and Coming Transits of Venus

*The Cornhill Magazine*, Volume 31, January, 1875 (pp. 94–95)

But America! Venus! what riches dost thou squander on unworthy regions which attempt to repay such favours with gold, the paltry product of their mines. Let these barbarians keep their precious metals to themselves, the incentives to evil which we are content to do without. These rude people would indeed ask from us too much should they deprive us of all those celestial riches [transit of Venus], the use of which they are not able to comprehend

In Arundell Blount Whatton

*Memoir of the Life and Labors of the Rev. Jeremiah Horrox*

Chapter III (p. 134)

Wertheim, MacIntosh & Hunt. London, England. 1859

Come then, ye renowned astronomers of our own times!  
Behold here a noble reward, – Venus promises Urania,  
fairer than any Helen, to him who shall happily win her.

In Arundell Blount Whatton

*Memoir of the Life and Labors of the Rev. Jeremiah Horrox*

Chapter X (p. 164)

Wertheim, MacIntosh & Hunt. London, England. 1859

**Paine, Thomas** 1737–1809

Anglo-American political theorist and writer

I have one plain answer to give, which is, that man knows how to calculate an eclipse, and also how to calculate to a minute of time when the planet Venus, in making her revolutions around the sun will come in a straight line between our earth and the sun.... As, therefore, man could not be able to do these things if he did not understand the solar system, and the manner in which the revolutions of the several planets or worlds are performed, the fact of calculating an eclipse, or a transit of Venus, is a proof in point that the knowledge exists; and as to a few thousand, or even a few million miles, more or less, it makes scarcely any sensible difference in such immense distances.

*Age of Reason* Part I

Part First (p. 55)

Peter Eckler New York, New York, USA. 1892

**Proctor, Richard Anthony** 1837–88

English astronomer

I think the astronomers of the first years of the twenty first century, looking back over the long transit-less period which will then have passed, will understand the anxiety of astronomers in our own time to utilize to the full whatever opportunities the coming transits may afford...; and I venture to hope...they will not be disposed to judge over harshly what some in our own day may have regarded as an excess of zeal.

*Transits of Venus, a Popular Account* (p. 231)

Longmans, Green & Company. London, England. 1882

American humorist and critic

## TRANSLUCENT

**Thomson, Sir John Arthur** 1861–1933

Scottish naturalist

When we work long at a thing and come to know it up and down, in and out, through and through, it becomes in quite a remarkable way translucent.

*Introduction to Science*

Chapter I (p. 27)

Henry Holt & Co. New York, New York, USA. 1911

## TRANSMUTATION

**Fermi, Enrico** 1901–54

Italian-born American physicist

Although the problem of transmuting chemical elements into each other is much older than a satisfactory definition of the very concept of chemical element, it is well known that the first and most important step towards its solution was made only nineteen years ago by the late Lord Rutherford, who started the method of the nuclear bombardments.

Nobel Lecture (physics) December 12, 1938

Artificial Radioactivity Produced by Neutron Bombardment, (p. 414)

## TRANSPARENT

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

I shall never forget that dawn, and the strange horror of seeing that my hands had become as clouded glass, and watching them grow clearer and thinner as the day went by, until at last I could see the sickly disorder of my room through them, though I closed my transparent eyelids. My limbs became glassy, the bones and arteries faded, vanished, and the little white nerves went last.

*The Invisible Man*

Chapter XX (pp. 181–182)

Harper & Brothers Publishers. New York, New York, USA. 1897

## TREATMENT

**Bigelow, Jacob** 1787–1879

American Physician

...we [physicians] should not allow him [the patient] to be tormented with useless and annoying applications, in a disease of settled destiny. It should be remembered that all cases are susceptible of errors of commission, as well as of omission, and that by an excessive application of the means of art, we may frustrate the intentions of nature, when they are salutary, or embitter the approach of death when it is inevitable.

*Nature in Disease, Illustrated in Various Discourses and Essays*

On Self-limited Diseases (p. 35)

Ticknor & Fields. Boston, Massachusetts, USA. 1854

**Lewis, Sir Thomas** 1881–1945

No biographical data available

A method which depends for its success upon a supposedly unusual sensitiveness of touch or of hearing, is a method whose clinical scope is admittedly limited, whose scope in science is almost negligible.

*The Mechanism and Graphic Registration of the Heart Beat*

Preface (p. vi)

Shaw & Sons. London, England. 1920

**Mayo, Charles Horace** 1865–1939

American physician

Long ago I learned from my father to put old people to bed only for as short a time as was absolutely necessary,

for they like a foundered horse, if they got down it was difficult for them to get up, and their strength ebbed away very rapidly while in bed.

In Fredrick A. Willis

*Aphorisms of Dr. Charles Horace Mayo (1865–1939) and Dr. William James Mayo (1861–1939)* (p. 7)

Mayo Foundation. Rochester, Minnesota, USA. 1990

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

In science the treatment is nothing, and all the effect lies in the discovery.

*Conversations of Goethe With Eckermann and Soret*

Tues., Dec. 30 (p. 47)

George Bell & Sons. London, England. 1883

## TREATMENT, MEDICAL

**Born-Volber, A. J.**

No biographical data available

The first step in treatment is to change the conditions which produced the disease.

In Albert Abrams

*Man and His Poisons*

Chapter X (p. 220)

E.B. Treat & Co. New York, New York, USA. 1906

## TREE OF LIFE

**Mason, Frances**

No biographical data available

Evolution does not move in a straight course, symbolized by the links in a chain; the tree is the symbol of nature's plan of creation. The trunk represents the main course of life through the ages; the branches are the great groups of plants and animals that have appeared during the growth of the tree; the plants and animals now living are the green twigs at the tips of the branches. In the evolution of forms there are no offshoots leading from one branch to another; the branches start from below and diverge as they grow, each branch maintaining its own course.

In Frances Mason

*Creation by Evolution*

Frontispiece (p. ii)

The Macmillan Company. New York, New York, USA. 1928

## TREE RINGS

**Burroughs, John** 1837–1921

American naturalist and writer

An old tree, unlike an old person, as long as it lives at all, always has a young streak, or rather ring, in it. It wears a girdle of perpetual youth.

*Studies in Nature and Literature*

Bird Life in an Old Apple Tree (p. 38)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Douglas, Andrew Ellicott** 1867–1962

American astronomer

By translating the story told by tree rings, we have pushed back the horizons of history in the United States for nearly eight centuries before Columbus reached the shores of the New World...

The Secret of the Southwest Solved by Talkative Tree Rings

*National Geographic*, Volume 56, Number 6, 1929 (p. 737)

**Leopold, Aldo** 1886–1948

American naturalist

We sensed that these two piles of sawdust were something more than wood: that they were the integrated transect of a century; that our saw was biting its way, stroke by stroke, decade by decade, into the chronology of a lifetime, written in concentric annual rings of oak.

*A Sand County Almanac, with Essays on Conservation from Round River*

Part I, February (p. 10)

Sierra Club. San Francisco, California, USA. 1970

## TRIAL AND ERROR

**Born, Max** 1882–1970

German-born English physicist

...I believe that there is no philosophical highroad in science, with epistemological signposts. No, we are in a jungle and find our way by trial and error, building our road behind us as we proceed. We do not find signposts at crossroads, but our own scouts erect them, to help the rest.

*Experiment and Theory in Physics* (p. 44)

Cambridge University Press. Cambridge, England. 1944

## TRIANGLE

**Abbott, Edwin A.** 1838–1926

English schoolmaster and theologian

The birth of a True Equilateral Triangle from Isosceles parents is the subject of rejoicing in our country for many furlongs round. After a strict examination conducted by the Sanitary and Social Board, the infant, if certified as Regular, is with solemn ceremonial admitted into the class of Equilaterals.

*Flatland: A Romance of Many Dimensions*

Part I, Section 3 (p. 21)

Little, Brown & Co. Boston, Massachusetts, USA. 1899

**Beckett, Samuel** 1906–89

Irish playwright

...do not despair. Remember there is no triangle, however obtuse, but the circumference of some circle passes through its wretched vertices.

*The Collected Works of Samuel Beckett  
Murphy*  
Chapter 10 (p. 213)  
Grover Press, Inc., New York, New York, USA. 1970

**Buchanan, Scott** 1895–1968  
American educator and philosopher

The triangle is an obsession to geometers and the rest of the world may be grateful to the geometer for cultivating such a neurosis.

*Poetry and Mathematics*  
Chapter II (p. 56)  
The University of Chicago Press. Cambridge, England. 1975

**Crelle, August** 1780–1856  
German civil engineer and mathematician

It is indeed wonderful that so simple a figure as the triangle is so inexhaustible in properties. How many as yet unknown properties of other figures may there not be?"  
*Sammlung mathematischer Aufsätze und Bemerkungen* (Volume 1) (p. 176)  
Maurer, Berlin, Germany. 1821

## TRIGONOMETRY

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

A straight liner is straight  
And a square mile is flat:  
But you learn in trigonometrics a trick worth two of that.

*The Collected Poems of G.K. Chesterton*  
Songs of Education, V, The Higher Mathematics (p. 97)

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Trigonometry contains *the science of continually undulating magnitude*: meaning magnitude which becomes alternately greater and less, without any termination to succession of increase and decrease.

*Trigonometry and Double Algebra*  
Book I, Chapter I (p. 1)  
Printed for Taylor, Walton & Mayberly. London, England. 1849

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

When my old tutor used to give me an exercise in trigonometry, it always took the shape of measuring heights.

*Memoirs of Sherlock Holmes*  
Adventure V, The Musgrave Ritual (p. 106)  
Harper & Brothers Publishers. New York, New York, USA. 1903

**Howell, Scott** 1959–  
American conservative political consultant

As long as schools continue to teach trigonometry and algebra, there will always be a moment of silence, and indeed prayer, in our public schools.

On why he sees no need to formalize a moment of silence in Utah schools

**Philips, J. D.**  
No biographical data available

The notion that anyone other than a scientist will ever use even the most elementary trigonometry or algebra is laughable. Imagine the absurdity of being in a car or on a plane when suddenly the need arises to solve a quadratic equation or to graph a trigonometric function. But this is precisely the scenario that the traditional defense has coerced us into accepting as realistic. Clearly this is absurd. And so is our complicity.

Mathematics as an Aesthetic Discipline  
*Humanistic Mathematics Network Journal*, Number 12, October, 1995

**Tait, Peter Guthrie** 1831–1901  
Scottish physicist and mathematician

Perhaps to the student there is no part of elementary mathematics so repulsive as is spherical trigonometry.

*Scientific Papers* (Volume 2)  
Quaternions (p. 453)  
At the University Press. Cambridge, England. 1900

## TRILOBITE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The eye of the Trilobite tells us that the sun shone on the old beach where he lived; for there is nothing in nature without a purpose; and when so complicated an organ was made to receive the light, there must have been light to enter it.

*Geological Sketches*  
Chapter II (pp. 31–32)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1886

**Conrad, Timothy** 1803–77  
American geologist and malacologist

The race of man shall perish, but the eyes  
Of trilobites eternal be in stone,  
And seem to stare about in mild surprise  
At changes greater than they have yet known.

*A Geological Vision and Other Poems*  
Murphy & Bechtel. Trenton, New Jersey, USA. 1871

**Darwin, Charles Robert** 1809–82  
English naturalist

For instance, I cannot doubt that all the Silurian trilobites have descended from some one crustacean, which must have lived long before the Silurian age, and which probably differed greatly from any known animal.

*On the Origin of Species*  
Chapter IX (p. 275)  
Grant Richards. London, England. 1902

**Howell, G. K.**

No biographical data available

Thou man of hammer and the disreputable trilobite I have some what to say unto thee. The hammer is an honest instrument that advertises what it does when it smashes – but for the trilobite ah what shall I say? I say that an animal that used 20 000 eyes must have been essentially a sneak! – not the one to meet a foe squarely but one that would be peeking around in all directions out of some if its headlights to be ready to run at the first sign of an adversary.

In Ellis L. Yochelson

*Charles Doolittle Walcott, Paleontologist*

Letter to Walcott, October 31, 1879 (p. 118)

The Kent State University Press. Kent, Ohio, USA. 1998

And then you never know how to class [a trilobite] – he wasn't a mollusk or a fish, and he wasn't a bird nor again an honest square reptile like the gay alligator. And he wasn't an Englishman – well perhaps you don't have Pinafore out among the Utes and the prairie dogs.

In Ellis L. Yochelson

*Charles Doolittle Walcott, Paleontologist*

Letter to Walcott, October 31, 1879 (p. 118)

The Kent State University Press. Kent, Ohio, USA. 1998

**Levi-Setti, Riccardo**

No biographical data available

Trilobites tell me of ancient marine shores teeming with budding life, when silence was only broken by the wind, the breaking of the waves, or by the thunder of storms and volcanoes. The struggle for survival already had its toll in the seas, but only natural laws and events determined the fate of evolving life forms. No footprints were to be found on those shores, as life had not yet conquered land. Genocide had not been invented as yet, and the threat to life on Earth resided only with the comets and asteroids.

*Trilobites*

Preface (p. vii)

The University of Chicago Press. Chicago, Illinois, USA. 1993

All fossils are, in a way, time capsules that can transport our imagination to unseen shores, lost in the sea of eons that preceded us. The time of trilobites is unimaginably far away, and yet, with relatively little effort, we can dig out these messengers of our past and hold them in our hand. And, if we learn the language, we can read the message.

*Trilobites*

Preface (p. vii)

The University of Chicago Press. Chicago, Illinois, USA. 1993

**Newman, Joseph S.** 1892–1960

American poet

A million years ago, or six...perhaps as much as seven, When rhizopods were spewing forth the chalky cliffs of Devon,

Upon a cool and mossy rock, beneath a bed of sedum,  
A trilobite named Annie lived in trilobitish freedom.

*Poems for Penguins and Other Lyrical Lapses*

The Trilobite

Greenburg. New York, New York, USA. 1941

**TROGLODYTE****Burroughs, John** 1837–1921

American naturalist and essayist

...there is enough of the troglodyte in most persons to make them love the rocks and the caves and ledges that the air and the rains have carved out of them.

*The Writings of John Burroughs* (Volume 19)

Chapter II (p. 40)

Houghton, Mifflin. Boston, Massachusetts, USA. 1916

**TROPICAL****Darwin, Charles Galton** 1809–82

English naturalist

Epithet after epithet was found too weak to convey to those who have not visited the intertropical regions, the sensation of delight which the mind experiences.... The land is one great wild, untidy, luxuriant hothouse, made by Nature for herself ...

*The Voyage of the Beagle*

Chapter XXI (p. 523)

P.F. Collier & Son. New York, New York, USA. 1909

**TROPICS****Wallace, Alfred Russel** 1820–1913

English humanist, naturalist, and geographer

The luxuriance and beauty of Tropical Nature is a well-worn theme, and there is little new to say about it. The traveler and the naturalist have combined to praise, and not unfrequently to exaggerate the charms of tropical life – its heat and light, its superb vegetable forms, its brilliant tints of flower and bird and insect.

*Tropical Nature, and Other Essays*

Preface (p. vii)

Macmillan & Company Ltd. London, England. 1878

**TRUTH****Abbey, Edward** 1927–89

American environmentalist and nature writer

...I am sometimes forced to the conclusion that the whole truth is not always represented in certain of the orthodox attitudes. The intuitions of a lover are not always to be trusted; but neither are those of the loveless.



In Joseph Wood Krutch  
*The Great Chain of Life*  
 Prologue (p. xi)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1957

**Adams, George** 1750–95  
 English instrument maker

You should, therefore, set out in the search of truth as of a stranger, not in search of arguments to support as of a stranger, not in search of arguments to support your own opinions, and endeavor to maintain your mind in a state of equilibrium, an indifference for everything but known and well attested truth, totally regardless of the place from whence it comes, or that to which it tends...

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
 Lecture II (p. 28)  
 Printed by R. Hindmarsh. London, England. 1794

Truth, though destined to be the guide of man, is not bestowed with an unconditional profusion; but is hidden in darkness, and involved in difficulties; intended, like all the other gifts of heaven, to be fought and cultivated by all the different powers and exertions of human reason.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
 Lecture II (p. 62)  
 Printed by R. Hindmarsh. London, England. 1794

**Amiel, Henri-Frédéric** 1821–81  
 Swiss philosopher, poet, and critic

...it is truth alone – scientific, established, proved, and rational truth – which is capable of satisfying nowadays the awakened minds of all classes. We may still say perhaps, ‘faith governs the world,’ – but the faith of the present is no longer in revelation or in the priest – it is in reason and in science.

Translated by Humphry Ward  
*Amiel's Journal: The Journal Intime of Henri-Frédéric Amiel* (Volume 2)  
 15th November, 1876 (pp. 212–213)  
 McGraw-Hill Book Co., Inc. New York, New York, USA. 1894

**Angier, Natalie** 1958–  
 Writer and science journalist

...if there is any lesson I have learned in my years of following science, it is that nothing is as it seems. Instead, things are as they seem plus the details you are just beginning to notice. New truths rarely overturn old ones, they simply add nuanced brushstrokes to the portrait.

*The Beauty of the Beastly: New Views on the Nature of Life*  
 Introduction (p. xiii)  
 Houghton Mifflin & Co. Boston, Massachusetts, USA. 1995

**Arbuthnot, John** 1667–1735  
 Scottish mathematician and physician

Truth is the same thing to Understanding, as Music to the Ear, and Beauty to the Eye.

*An Essay on the Usefulness of Mathematical Learning* (3rd edition) (p. 5)  
 Printed for J. Barrett  
 London, England. 1745

**Aristotle** 384 BCE–322 BCE  
 Greek philosopher

The investigation of the truth is in one way hard, in another easy. An indication of this is found in the fact that no one is able to attain the truth adequately, while, on the other hand, we do not collectively fail, but everyone says something true about the nature of things, and while individually we contribute little or nothing to the truth, by the union of all a considerable amount is amassed. Therefore, since the truth seems to be like the proverbial door, which no one can fail to hit, in this respect it must be easy, but the fact that we can have a whole truth and not the particular part we aim at shows the difficulty of it.

In *Great Books of the Western World* (Volume 8)  
*Metaphysics*  
 Book II, Chapter I (p. 511)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Aronowitz, Stanley** 1933–  
 American sociologist, labor/union advocate, and writer

The power of science consists, in the first place, in its conflation of knowledge and truth. Devising a method of proving the validity of propositions about objects taken as external to the knower has become identical with what we mean by truth.

*Science as Power: Discourse and Ideology in Modern Society*  
 Preface (p. vii)  
 University of Minnesota Press. Minneapolis, Minnesota, USA. 1988

**Avedon, Richard** 1923–2004  
 American photographer

The moment an emotion or fact is transformed into a photograph it is no longer fact but an opinion. There is no such thing as inaccuracy in a photograph. All photographs are accurate. None of them is the truth.

*The Chronicle of Higher Education*, July 10, 1991, (p. B2)

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

The human understanding resembles not a dry light, but admits a tincture of the will and passions, which generate their own system accordingly; for man always believes more readily that which he prefers.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 49 (p. 111)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

For myself, I found that I was fitted for nothing so well as for the study of Truth; as having a mind nimble and versatile enough to catch the resemblances of things (which is the chief point), and at the same time steady enough to fix and distinguish their subtler differences; as being gifted by nature with desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to



reconsider, carefulness to dispose and set in order; and as being a man that neither affects what is new nor admires what is old, and that hates every kind of imposture. So I thought my nature had a kind of familiarity and relationship with Truth.

In James Spedding

*The Letters and the Life of Francis Bacon Including All His Occasional Works*

Chapter III, Section 3 (p. 85)

Longmans, Green, Reader & Dyer. London, England. 1868

There are and can exist but two ways of investigating and discovering truth. The one hurries on rapidly from the senses and particulars to the most general axioms; and from them as principles and their supposed indisputable truth derives and discovers the intermediate axioms. This is the way now in use. The other constructs its axioms from the senses and particulars, by ascending continually and gradually, till it finally arrives at the most general axioms, which is the true but unattempted way.

*Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book (p. 108)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Balfour, Arthur James** 1848–1930

British prime minister

It is not by mere accumulation of material, nor even by a plant-like development, that our beliefs grow less inadequate to the truths which they strive to represent. Rather we are like one who is perpetually engaged in altering some ancient dwelling in order to satisfy new-born needs. The ground-plan of it is being perpetually modified. We build here; we pull down there. One part is kept in repair, another part is suffered to decay. And even those portions of the structure which may in themselves appear quite unchanged, stand in such new relations to the rest, and are put to such different uses, that they would scarce be recognized by their original designer.

*The Foundations of Belief*

Appendix, Section I (p. 350)

Longmans, Green & Company. London, England. 1912

### **Barfield, Owen** 1898–1997

British philosopher, critic, and anthroposophist

It was not simply a new theory of the nature of the celestial movements that was feared, but a new theory of the nature of theory; namely, that, if a hypothesis saves all the appearances, it is identical with truth.

*Saving the Appearances: A Study in Idolatry*

Chapter VII (pp. 50–51)

Faber & Faber Ltd. London, England. 1957

### **Beaumont, William** 1785–1853

American army surgeon

Truth, like beauty, when “unadorned, is adorned the most”; and in prosecuting these experiments and inquiries, I believe I have been guided by its light.

In William Osler

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Army Surgeon (p. 113)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

### **Becker, Ernest** 1925–74

Canadian anthropologist

The man of knowledge in our time is bowed under a burden he never imagined he would ever have: the overproduction of truth that cannot be consumed. For centuries man lived in the belief that truth was slim and elusive and that once he found it the troubles of mankind would be over. And here we are in the closing of the 20th century, choking on truth.

*The Denial of Death*

Preface (p. x)

The Free Press. New York, New York, USA. 1973

### **Bernard, Claude** 1813–78

French physiologist

It seems, indeed, a necessary weakness of our mind to be able to reach truth only across a multitude of errors and obstacles.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter I, Section ii (p. 170)

Henry Schuman, Inc. New York, New York, USA. 1927

Men of science, then, do not seek for the pleasure of seeking; they seek the truth to possess it, and they possess it already within the limits in the present state of the sciences. But men of science must not halt on the road; they must climb ever higher and strive toward perfection; they must always seek, as long as they see anything to be found.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 222)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Blake, William** 1757–1827

English poet, painter, and engraver

God forbid that Truth should be Confined to Mathematical Demonstration. He who does not know Truth at sight is unworthy of Her Notice.

In Edwin John Ellis

*The Real Blake: A Portrait Biography*

Chapter XXXII (p. 393)

Chatto & Windus. London, England. 1907

### **Bohm, David** 1917–92

American physicist

The notion of absolute truth is...is shown to be in poor correspondence with the actual development of science.... [S]cientific truths are better regarded as relationships holding in some limited domain...

*The Special Theory of Relativity*

Preface (p. x)

Routledge. London, England. 1996

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Truth lies in the abyss.

In Gerald Holton

*Scientific Optimism and Societal Concerns*

A Note of the Psychology of Scientists (p. 83)

Publisher undetermined

The opposite of a correct statement is a false statement.  
But the opposite of a profound truth may well be another  
profound truth.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 8 (p. 102)

Harper & Row, Publishers. New York, New York, USA. 1971

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

...the search for truth is the most noble aim of science,  
and there are no degrees between truth and error; the  
insignificance and smallness of a phenomenon will per-  
haps diminish its practical interest, but not its scientific  
value.

*Space and Time*

Introduction (p. 14)

Dover Publications. New York, New York, USA. 1960

**Born, Max** 1882–1970  
German-born English physicist

Truth is what the scientist aims at. He finds nothing at  
rest, nothing enduring, in the universe. Not everything is  
knowable, still less is predictable. But the mind of man is  
capable of grasping and understanding at least a part of  
Creation; amid the flight of phenomena stands the immu-  
table pole of law.

*The Restless Universe*

Chapter V (p. 278)

Dover Publications, Inc. New York, New York, USA. 1951

My optimistic enthusiasm about the disinterested search  
for truth has been severely shaken....

*The Restless Universe*

Postscript (p. 279)

Dover Publications, Inc. New York, New York, USA. 1951

**Brewster, David** 1781–1868  
Scottish scientist, inventor and writer

Truth, however, like all moral powers, can neither be  
checked nor extinguished. When compressed, it but reacts  
the more. It crushes where it cannot expand, – it burns  
where it is not allowed to shine. Human when originally  
divulged, it becomes divine when finally established. At  
first, the breath of a sage – at last it is the edict of a god.

*More Worlds Than One: The Creed of the Philosopher and the Hope of  
the Christian*

Chapter III (pp. 47–48)

Chatto & Windus. London, England. 1876

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Truth in science is like Everest, an ordering of the facts.

*Science and Human Values*

The Sense of Human Dignity (p. 52)

Harper & Row, Publishers. New York, New York, USA. 1965

We cannot define truth in science until we move from  
fact to law. And within the body of laws in turn, what  
impresses us as truth is the orderly coherence of the  
pieces. They fit together like the characters of a great  
novel, or like the words of a poem. Indeed, we should  
keep that last analogy by us always, for science is a  
language, and like a language it defines its parts by the  
way they make up a meaning. Every word in a sentence  
has some uncertainty of definition, and yet the sentence  
defines its own meaning and that of its words conclu-  
sively. It is the internal unity and coherence of science  
which gives it truth, and which makes it a better system  
of prediction than any less orderly language.

*The Common Sense of Science*

Chapter VIII, Section 5 (p. 131)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Brown, John** 1810–82  
Scottish physician and author

You may come to the chest of knowledge. It is shut, it  
is bolted, but...you have the key; put it in steadily and  
home. But what is the key? It is the love of truth; neither  
more or less; no other key opens it; no false one, however  
cunning can pick that lock; no assault of hammer, how-  
ever stout, can force it open; but with its own key, a little  
child may open it; often does open it.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 28)

Macmillan & Company Ltd. London, England. 1918

**Buchner, Ludwig** 1824–99  
German physician and philosopher

If these pages may venture to claim any merit or char-  
acteristic, it is that of representing a determination not  
to shrink with dismal horror from the simple if unavoid-  
able consequences of an unprejudiced contemplation of  
nature from the standpoint of empirical philosophy, but  
to admit the truth regardless of what may follow. We can-  
not make things different from what they *are*, and noth-  
ing seems to us more preposterous than the attempts of  
some distinguished naturalists at introducing *orthodoxy*  
into natural science. We do not pretend to bring forward  
anything absolutely new or anything that had never been  
heard of before. Similar views and views cognate to ours  
have been taught in *all* ages, and some of them were laid  
down by the oldest Greek and Indian Philosophers, but  
their groundwork, which is necessarily empirical, could

only be supplied by the progress of natural science in the present century.

*Force and Matter: Or, Principles of the Natural Order of the Universe*

Preface to the First Edition (pp. xix-xx)

Asher & Co. London, England. 1884

**Burroughs, John** 1837–1921

American naturalist and essayist

Ask what is the truth in mathematics, and the answer is easy: two and two make four; a straight line is the shortest distance between two points; the angles of a triangle are equal to two right angles, etc. Ask what is the truth in science, and the answer comes as promptly, though here the field is as yet only fairly entered upon;...the truth is whatever you can convince yourself is true.

*The Writings of John Burroughs* (Volume 17)

Chapter X (p. 167)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

**Burroughs, William S.** 1914–97

American writer

...truth is used to vitalize a statement rather than devitalize it. Truth implies more than a simple statement of fact. "I don't have any whisky," may be a fact but it is not a truth.

*The Adding Machine*

On Coincidence

Arcade Publishing. New York, New York, USA. 1991

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

It is a great truth of science that every ending is a beginning, that each question answered leads to new problems to solve, that each opportunity grasped and utilized engenders fresh and greater opportunities.

In Helen Wright

*Palomar: The World's Largest Telescope*

Dedication of the Hale Telescope (p. 183)

The Macmillan Company. New York, New York, USA. 1952

**Calvin, Melvin** 1911–97

American biochemist

The true student will seek evidence to establish fact rather than confirm his own concept of truth, for truth exists whether it is discovered or not.

*Chemical Evolution*

Chapter 11 (p. 252)

Oregon State System of Higher Education. Eugene, Oregon, USA. 1961

**Carmichael, Robert Daniel** 1879–1967

American mathematician

He who discovers a fact or makes known a new law or adds a novel beauty to truth in any way makes everyone of us his debtor. How beautiful upon the highway are the feet of him who comes bringing in his hands the gift of a new truth to mankind.

*The Logic of Discovery*

Chapter IX (p. 273)

The Open Court Publishing. Chicago, Illinois, USA. 1930

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Most other Sciences [but not mathematics] are in a state of constant flux – the precious truths of one generation being smiled at as paradoxes by the second generation, and contemptuously swept away as childish nonsense by the third.

*Curiosa Mathematica* Part I (3rd edition)

Introduction (p. xv)

Macmillan & Co Ltd. London, England. 1890

**Chandler, Raymond Thornton** 1888–1959

American novelist

There are two kinds of truth: the truth that lights the way and the truth that warms the heart. The first of these is science, and the second is art.... With art science would be as useless as a pair of high forceps in the hands of a plumber. Without science art would become a crude mess of folklore and emotional quackery.

*The Notebooks of Raymond Chandler*

Great Thought (p. 7)

Ecco Press. New York, New York, USA. 1976

**Chargaff, Erwin** 1905–2002

Austrian biochemist

...I prefer the search for the truth to its possession.

*Serious Questions*

Knowledge Industry (p. 111)

Birkhäuser. Boston, Massachusetts, USA. 1986

**Charlie Chan (Fictional character)**

Truth, like football, receive many kicks before reaching goal.

*Charlie Chan at the Olympics*

Film (1937)

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Faiths come and go, but Truth abides. Out there among the stars lie such truths as we may understand, whether we learn them by our own efforts, or from the strange teachers who are waiting for us along the infinite road on which our feet are now irrevocably set.

*The Challenge of the Spaceship*

Of Space and the Spirit (p. 212)

Harper & Brothers. New York, New York, USA. 1959

**Cole, William** 1530–1600

English man of letters

Whoever attempts to erect a building, should take care that the foundation be securely laid; so also in our inquiries after truth, all our proceedings should be founded upon just and incontrovertible grounds.

*Philosophical Remarks on the Theory of Comets, a Dissertation on the Nature and Properties of Light*

Introduction (p. xi)

B.J. Holdsworth. London, England. 1823

**Compton, Arthur H.** 1892–1962

American physicist

The truths that science teaches are of common interest the world over. The language of science is universal, and is a powerful force in bringing the peoples of the world closer together. We are all acquainted with the sharp divisions which religions draw between men. In science there are no such divisions: all peoples worship at the shrine of truth.

*Les Prix Nobel. The Nobel Prizes in 1927*

Nobel banquet speech for award received in 1927

Nobel Foundation. Stockholm, Sweden. 1928

**Cornforth, John W.** 1917–2004

English organic chemist

In a world where it is so easy to neglect, deny, corrupt and suppress the truth, the scientist may find his discipline severe. For him, truth is so seldom the sudden light that shows new order and beauty; more often, truth is the uncharted rock that sinks his ship in the dark.

In Wilhelm Odelberg

*Les Prix Nobel en 1975*

John Cornforth's speech at the Nobel Banquet, December 10, 1975

Nobel Foundation

Stockholm, Sweden. 1976

**D'Alembert, Jean Le Rond** 1717–83

French mathematician

Geometrical truths are in a way asymptotes to physical truths, that is to say, the latter approach the former indefinitely near without ever reaching them exactly.

In Alphonse Rebière

*Mathématiques et Mathématiciens: Pensées et Curiosités* (p. 10)

**Darwin, Charles Robert** 1809–82

English naturalist

The truth will not penetrate a preoccupied mind.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 222, Darwin to Hooker, July 28, 1868 (p. 305)

D. Appleton & Company. New York, New York, USA. 1903

**Davy, Sir Humphry** 1778–1829

English chemist

To explain nature and the laws instituted by the Author of nature and to apply the phenomena presented in the external world to useful purposes are the great ends of physical investigation, and these ends can only be obtained by the exertion of all the faculties of the mind. And the imagination, the memory, and the reason are

perhaps equally essential to the development of great and important truths.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Lecture Four (p. 58)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

Truth enters so naturally into the mind, that when we learn anything for the first time, it appears as if we only remembered the thing learned, or exerted the faculty of our memory.

*Conversations on the Plurality of Worlds*

The Second Evening (p. 70)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...in order to seek truth, it is necessary once in the course of our life, to doubt, as far as possible, of all things.

As we were at one time children, and as we formed various judgments regarding the objects presented to our senses, when as yet we had not the entire use of our reason, numerous prejudices stand in the way of our arriving at the knowledge of truth; and of these it seems impossible for us to rid ourselves, unless we undertake, once in our lifetime, to doubt of all those things in which we may discover even the smallest suspicion of uncertainty.

Translated by John Veitch

*The Principles of Philosophy*

Section I

Publisher undetermined

...we must believe that all the sciences are so interconnected, that it is much easier to study them all together than to isolate one from all the others. If, therefore, anyone wishes to search out the truth of things in serious earnest, he ought not to select one special science; for all the sciences are cojoined with each other and interdependent....

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule 1 (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Dewey, John** 1859–1952

American philosopher and educator

There is but one sure road of access to truth – the road of cooperative inquiry operating by means of observation, experiment, record, and controlled reflection.

*Common Faith*

Chapter II (p. 32)

Yale University Press. New Haven, Connecticut, USA. 1934

**Drake, Daniel** 1785–1852  
American physician

The love of pleasure and the love of science may coexist, but cannot be indulged at the same time; though in fact they are seldom united. A student should draw his pleasures from the discovery of truth, and find his amusements in the beauties and wonders of nature. He should seek for recreation not debauchery

*Physician to the West* (p. 298)

University Press of Kentucky. Lexington, Kentucky, USA. 1970

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

Truth is so beautiful that it deserves every effort a man can bestow to attain it; it is so fruitful that it carries along with it its own recompense. By keeping the end in view, without occupying ourselves with particulars, we find the ordinary details of prosperity and riches fall into their proper places.

In Faraday Lectures

*Lectures Delivered Before the Chemical Society*

The First Faraday Lecture (p. 3)

The Chemical Society. London, England. 1928

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

An addition to knowledge is won at the expense of an addition to ignorance. It is hard to empty the well of Truth with a leaky bucket.

*The Nature of the Physical World*

Chapter X (p. 229)

The Macmillan Company. New York, New York, USA. 1930

Accidental truth of a conclusion is no compensation for erroneous deduction.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter I (p. 29)

At The University Press. Cambridge, England. 1921

We seek the truth; but if some voice told us that a few years more would see the end of our journey, that the clouds of uncertainty would be dispersed, and that we should perceive the whole truth about the physical universe, the tidings would be by no means joyful. In science as in religion the truth shines ahead as a beacon showing us the path; we do not ask to attain it; it is better far that we be permitted to seek.

*Science and the Unseen World*

Lecture II (p. 23)

The Macmillan Co. New York, New York, USA. 1929

**Einstein, Albert** 1879–1955  
German-born physicist

Truth is what stands the test of experience.

In Philipp Frank

*Relativity – A Richer Truth*

The Laws of Science and the Laws of Ethics (p. 10)

Jonathan Cape. London, England. 1951

The search for truth is more precious than its possession.  
*The American Mathematical Monthly*, Volume 100, Number 3, March, 1993 (p. 254)

As for the search for truth, I know from my own painful searching, with its many blind alleys, how hard it is to take a reliable step, be it ever so small, towards the understanding of that which is truly significant.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 13 February, 1934 (p. 18)

Princeton University Press. Princeton, New Jersey, USA. 1979

It is the most beautiful reward for one who has striven his whole life to grasp some little bit of truth if he sees that other men have real understanding of and pleasure with his work.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 9 December, 1952 (p. 29)

Princeton University Press. Princeton, New Jersey, USA. 1979

I want to know how God created this world. I am not interested in this or that phenomenon, in the spectrum of this or that element. I want to know His thoughts, the rest are details.

In Ronald W. Clark

*Einstein: The Life and Times*

Part One, Chapter 1 (p. 19)

The World Publishing Company. New York, New York, USA. 1971

But the years of searching in the dark for a truth that one feels, but cannot express; the intense desire and the alternations of confidence and misgiving, until one breaks through to clarity and understanding, are only known to him who has himself experienced them.

In Ronald W. Clark

*Einstein: The Life and Times*

Part Five, Chapter 21 (p. 590)

The World Publishing Company. New York, New York, USA. 1971

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Approximate truth is the only truth attainable, but at least one must strive for that, and not wade off into arbitrary falsehood.

*The George Eliot Letters* (Volume 4) (p. 43)

Yale University Press. New Haven, Connecticut, USA. 1954–1978

**Errera, Leo** 1858–1905  
Belgian botanist

Truth is on a curve whose asymptote our spirit follows eternally.

In J.A. Thomson

*Introduction to Science*

Chapter V (p. 125)

Williams & Norgate Ltd. London, England. 1916



**Esquivel, Laura** 1951?–  
Mexican novelist

Anything could be true or false, depending on whether one believed it.

*Like Water for Chocolate*

July (p. 127)

Doubleday & Company, Inc. New York, New York, USA. 1989

**Everett, Edward** 1794–1865  
American statesman, educator, and orator

In the pure mathematics we contemplate absolute truths, which existed in the Divine Mind before the morning stars sang together, and which will continue to exist there, when the last of their radiant host shall have fallen from heaven.

In E.T. Bell

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 21)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

There are truths and groups of truths, which seem to bind all creation, – the flower of the field, the stars of the sky, and the marvellous frame of man in bonds of strange analogy, – of which it lifts the soul from earth to heaven to catch a glimpse, as of a golden thread woven in the great loom of Providence through the mystic tissue of the Universe.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

An Address (p. 76)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

Amid the ruins that surround me, one strip of wall remains standing, immovable upon its solid base: my passion for scientific truth.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter I (p. 12)

Dodd, Mead & Co. New York, New York, USA. 1925

... what rouses my enthusiasm is the process that sets the truth before us. We start from a brilliantly lighted spot and gradually get deeper and deeper in the darkness, which, in its turn, becomes self-illuminated by kindling new lights for a higher ascent. This progressive march of the known toward the unknown, this conscientious lantern lighting what follows by the rays of what comes before: that was my real business.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 288)

Dodd, Mead & Co. New York, New York, USA. 1925

**Feynman, Richard P.** 1918–88  
American theoretical physicist

We've learned from experience that the truth will come out. Other experimenters will repeat your experiment and

find out whether you were wrong or right. Nature's phenomena will agree or they'll disagree with your theory. And, although you may gain some temporary fame and excitement, you will not gain a good reputation as a scientist if you haven't tried to be very careful in this kind of work. And it's this type of integrity, this kind of care not to fool yourself, that is missing to a large extent in much of the research in cargo cult science.

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character* (Caltech commencement address, 1974) *Cargo Cult Science* (p. 342)  
W.W. Norton & Company, Inc. New York, New York, USA. 1985

It is possible to know when you are right way ahead of checking all the consequences. You can recognize truth by its beauty and simplicity.

*The Character of Physical Law*

Chapter 7 (p. 171)

BBC. London, England. 1965

...there is nothing more exciting than the truth, the pay dirt of the scientist, discovered by his painstaking efforts.

*The Meaning of It All*

Chapter I (pp. 12–13)

Perseus Books. Reading, Massachusetts, USA. 1998

**Forbes, David** 1809–68  
Scottish physicist

However long truth may remain dormant, it must eventually assert itself in science as in all other matters ...

*The Depths of the Sea*

*Nature*, Volume 1, November 25, 1869 (p. 101)

**Forbes, Edward** 1815–54  
English naturalist

The highest aim of man is the discovery of the Truth; the search after Truth is his noblest occupation. It is more; it is his duty. Every step onwards we take in science and learning, tells us how nearly all sciences are connected. There is a deep philosophy in that connection yet undeveloped; a philosophy of the utmost moment to man: let us seek it out.

In George Wilson and Archibald Geikie

*Memoir of Edward Forbes* (p. 195)

Macmillan & Co Ltd. London, England. 1861

**Foster, Sir Michael** 1836–1907  
English physiologist

...the truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more exacting. Man, unscientific man, is often content with 'the near!' and 'the almost.' Nature never is.

Address by the President of the British Association for the Advancement of Science

*Science*, N.S. Volume X, Number 249, October 6, 1899 (p. 476)

...the seeker after truth must himself be truthful, truthful with the truthfulness of Nature. For the truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more



exacting. Man, unscientific man, is often content with 'the nearly 'and' the almost.' Nature never is.

*Report of the Sixty-ninth Meeting of the British Association for the Advancement of Science*

President's Address (p. 16)

John Murray. London, England. 1900

### **Fourcroy, Antoine-François** 1755–1809

French chemist

The general truths in any science are continually multiplied, as its perfection advances, and its means of investigation are improved. Such has been the fortune of chemistry.

Translated by R. Heron

*Elements of Chemistry and Natural History* (Volume 1)

Advertisement (p. 1)

Printed for G. Mudie & Son. Edinburgh, Scotland. 1796

### **Frederick the Great** 1712–86

German king

The greatest and noblest pleasure which men can have in this world is to discover new truths; and the next is to shake off old prejudices.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 2)

Chapter 47 (p. 729)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

### **Galilei, Galileo** 1564–1642

Italian physicist and astronomer

Two truths cannot contradict one another.

Translated by Stillman Drake

*Discoveries and Opinions of Galileo*

Letter to Madame Christina of Lorraine (p. 186)

Doubleday & Company, Inc. New York, New York, USA. 1957

### **Galilei, Vincenzo** 1520–1591

Father of Galileo Galilei

It appears to me that they who in proof of any assertion rely simply on the weight of authority, without adducing any argument in support of it, act very absurdly. I, on the contrary, wish to be allowed freely to question and freely to answer you without any sort of adulation, as well becomes those who are in search of truth.

In John Joseph Fahie

*Galileo*

Chapter I (p. 3)

John Murray. London, England. 1903

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

In the Theory of Numbers it happens rather frequently that, by some unexpected luck, the most elegant new truths spring up by induction.

In G. Polya

*Induction and Analogy in Mathematics* (Volume 1)

Chapter IV (p. 59)

Princeton University Press. Princeton, New Jersey, USA. 1954

### **Gore, George** 1826–1909

English electrochemist

The deepest truths require still deeper truths to explain them.

*The Art of Scientific Discovery*

Chapter III (p. 26)

Longmans, Green & Company. London, England. 1878

We cannot intelligently love that which we cannot form an idea of, nor discover that which we cannot discriminate when it is present; and if we cannot discriminate truth, we cannot intelligently love it, nor can we discover it.

*The Art of Scientific Discovery*

Part II, Chapter 24 (p. 290)

Longmans, Green & Co. London, England. 1878

Any man who wishes to discover new truth must be content usually to confine his search to one subject at a time. The selection of a good subject of examination is a difficult problem; the difficulty usually arises not from scarcity of subjects, but from the impracticability of determining which is the most suitable one. An investigator cannot, to any great degree, pick and choose discoveries, but must, to a large extent, be content to accept those he can find.

*The Art of Scientific Discovery*

Part IV, Chapter XXXVIII (p. 372)

Longmans, Green & Co. London, England. 1878

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

I am a strong advocate of the general argument that "truth" as preached by scientists often turns out to be no more than prejudice inspired by prevailing social and political beliefs. I have devoted several columns to this theme because I believe that it helps to 'demystify' the practice of science by showing its similarity to all creative activity.

In Laurie R. Godfrey

*Scientists Confront Creationism*

Darwin's Untimely Burial – Again!

W.W. Norton & Co. New York, New York, USA. 1984

### **Gray, George W.**

American free lance science writer

No truth is sacrosanct. No belief is too generally accepted, too well established by experiment, to escape the challenge of doubt. And no doubt is too radical to receive a hearing if it is seriously proposed.

*The Riddle of Our Reddening Skies*

*Harper's Monthly Magazine*, July 1937 (p. 169)

### **Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

In the pursuit of truth the man of science spends his days; and for the defense of truth he is prepared to stand against the world.

*Discovery; or, The Spirit and Service of Science*  
Chapter II (p. 24)  
Macmillan & Company Ltd. London, England. 1918

A truthful mind is necessary for the discovery of truth in Nature.

*Discovery; or, The Spirit and Service of Science*  
Chapter II (p. 25)  
Macmillan & Company Ltd. London, England. 1918

The grand, and indeed only, character of truth is its capability of enduring the test of human experience, and coming unchanged out of every possible form of fair discussion.

*Discovery, Or, The Spirit and Service of Science*  
Chapter VII (p. 166)  
Macmillan & Co Ltd. London, England. 1916

**Haeckel, Ernst Heinrich Philipp August** 1834–1919  
German biologist and philosopher

Without prejudice and without fear, philosophy would tear the mantle from “the veiled statue of Sais,” and attain a full vision of the truth.

*The Wonders of Life: A Popular Study of Biological Philosophy*  
Chapter I (p. 1)  
Harper & Brothers Publishers. New York, New York, USA. 1905

**Hall, Asaph** 1829–1907  
American astronomer

When men are striving for the discovery of truth in its various manifestations, they learn that it is by correcting the mistakes of preceding investigators that progress is made, and they have charity for criticism. Hence persecution for difference of opinion becomes an absurdity. The labors of scientific men are forming a great body of doctrine that can be appealed to with confidence in all countries. Such labors bring people together, and tend to break down national barriers and restrictions. The scientific creed is constantly growing and expanding, and we have no fears, but rejoice at its growth. We need no consistory of bishops, nor synod of ministers, to tell us what to believe. Everything is open to investigation and criticism.

*Proceedings of the American Association for the Advancement of Science*  
The Science of Astronomy  
1903 (p. 322)

**Halmos, Paul R.** 1916–2006  
Hungarian-born American mathematician

The joy of suddenly learning a former secret and the joy of suddenly discovering a hitherto unknown truth are the same to me – both have the flash of enlightenment, the almost incredibly enhanced vision, and the ecstasy and euphoria of released tension.

*I Want to Be a Mathematician*  
Chapter 1 (p. 3)  
Springer-Verlag. New York, New York, USA. 1985

**Hamerton, Philip Gilbert** 1834–94  
English artist and art critic

The deepest truths require still deeper truths to explain them.

*The Intellectual Life*  
Part I, Chapter III (p. 26)  
Little, Brown & Co. Boston, Massachusetts, USA. 1901

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

We do not dwell in the Palace of Truth. But, as was mentioned to me not long since, “There is a time coming when all things shall be found out.” I am not so sanguine myself, believing that the well in which Truth is said to reside is really a bottomless pit.

*Electromagnetic Theory*  
Chapter I, Volume 1 (p. 1)  
“The Electrician” printing & publishing company. London, England. 1894–1912

**Heinlein, Robert A.** 1907–88  
American science fiction writer

The hardest part about gaining any new idea is sweeping out the false idea occupying that niche. As long as that niche is occupied, evidence and proof and logical demonstration get nowhere. But once the niche is emptied of the wrong idea that has been filling it – once you can honestly say, “I don’t know,” then it becomes possible to get at the truth.

*The Cat Who Walks Through Walls: A Comedy of Manners*  
Chapter XVIII (p. 230)  
G.P. Putnam’s Sons. New York, New York, USA. 1985

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

It is only when we are wandering and lost in the mazes of particulars, or entangled in fruitless attempts to work our way downwards in the thorny paths of applications, to which our reasoning powers are incompetent, that nature appears complicated: – the moment we contemplate it as it is, and attain a position from which we can take a commanding view, though but of a small part of its plan, we never fail to recognise that sublime simplicity on which the mind rests satisfied that it has attained the truth.

*The Cabinet of Natural Philosophy*  
Part III, Chapter VI, Section 393 (pp. 360–361)  
Longman, Rees, Orme, Brown & Green. London, England. 1831

**Holbach, Paul Henri Thiry** 1723–89  
French philosopher

Let us then discover it [truth] to mortals – let us exhibit its charms – let us shed its effulgence over the darkened road; it is the only mode by which man can become disgusted with that disgraceful superstition which leads him into error, and which but too often usurps his homage by treacherously covering itself with the mask of truth – its

lustre can wound none but those enemies to the human race whose power is bottomed solely on the ignorance, on the darkness in which they have in almost every climate contrived to involve the mind of man.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World* (Volume 1)

Author's Preface (p. 3)

J.P. Mendum. Boston, Massachusetts, USA. 1889

Truth is invariable – it is requisite to man – it can never harm him – his very necessities, sooner or later, make him sensible of this; oblige him to acknowledge it.

Translated by H.D. Robinson

*The System of Nature, Or, Laws of the Moral and Physical World* (Volume 1)

Author's Preface (p. 3)

J.P. Mendum. Boston, Massachusetts, USA. 1889

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Every probability – and most of our common, working beliefs are probabilities – is provided with buffers at both ends, which break the force of opposite opinions clashing against it; but scientific certainty has no spring in it, no courtesy, no possibility of yielding. All this must react on the minds which handle these forms of truth.

*The Autocrat of the Breakfast-Table*

Chapter III (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

### **Huxley, Aldous** 1894–1963

English writer and critic

Science is the only way we have of shoving truth down the reluctant throat.

*Literature and Science*

Chapter 27 (p. 79)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Huxley, Thomas Henry** 1825–95

English biologist

Ecclesiasticism in science is only unfaithfulness to truth.

*Collected Essays* (Volume 2)

*Darwiniana*

Mr. Darwin's Critics (p. 149)

Macmillan & Company Ltd. London, England. 1904

The scientific spirit is of more value than its products, and irrationally held truths may be more harmful than reasoned errors.

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of "The Origin of Species" (p. 229)

Macmillan & Company Ltd. London, England. 1904

History warns us, however, that it is the customary fate of new truths to begin as heresies and to end as superstitions....

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of "The Origin of Species" (p. 229)

Macmillan & Company Ltd. London, England. 1904

Science has fulfilled her function when she has ascertained and enunciated truth....

*Collected Essays* (Volume 7)

*Man's Place in Nature, On the Relations of Man to the Lower Animals* (p. 151)

Macmillan & Company Ltd. London, England. 1904

*Magna est veritas et praevalabit!* Truth is great, certainly, but, considering her greatness, it is curious what a long time she is apt to take about prevailing.

*Man's Place in Nature and Other Anthropological Essays*

Preface (pp. ix–x)

D. Appleton & Company. New York, New York, USA. 1896

But to those whose life is spent, to use Newton's noble words, in picking up here a pebble and there a pebble on the shores of the great ocean of truth – who watch, day by day, the slow but sure advance of that mighty tide, bearing on its bosom the thousand treasures wherewith man ennobles and beautifies life: – it would be laughable, if it were not so sad, to see the little Canutes of the hour enthroned in solemn state, bidding that great wave to stay, and threatening to check it beneficent progress.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter II (p. 77)

D. Appleton & Company. New York, New York, USA. 1896

### **Inge, William Ralph** 1860–1954

English religious leader and writer

Every truth is a shadow, except the last; but every truth is a substance in its own place, though it be but a shadow in another place; and the shadow is a true shadow, as the substance is a true substance.

*Proceedings of the Aristotelian Society*, 1918–1919 (p. 272)

### **Jeffers, Robinson** 1887–1962

American poet

The mathematicians and physics men  
Have their mythology; they work alongside the truth,  
Never touching it; their equations are false  
But the things work. Or, when gross error appears,  
They invent new ones; they drop the theory of waves  
In universal ether and imagine curved space.

*The Beginning and the End and Other Poems*

The Great Wound (p. 11)

Random House, Inc. New York, New York, USA. 1963

### **Jennings, Herbert Spencer** 1868–1947

American zoologist

If the truth is what one is seeking, one cannot reject it because someone else has recognized it or spoken it.

*The Universe and Life*

Chapter I (p. 2)

Yale University Press. New Haven, Connecticut, USA. 1933

**Jones, Raymond F.** 1915–94  
American writer

...in the statistical world you can multiply ignorance by a constant and get truth.

*The Non-Statistical Man* (p. 58)  
Belmont Books, New York, New York, USA. 1964

**Jonson, Ben** 1573?–1637  
English dramatist and poet

If in some things I dissent from others, whose wit, industry, diligence, and judgment I look up at and admire, let me not therefore hear presently of ingratitude and rashness. For I thank those that have taught me, and ever will; but yet dare not think the scope of their labour and inquiry was to envy their posterity what they also could add and find out.... If I err, pardon me....

*Timber; or Discoveries Made upon Man and Matter*  
Explorata; or, Discoveries (p. 7)  
Ginn & Company. Boston, Massachusetts, USA. 1892

**Kepler, Johannes** 1571–1630  
German astronomer

The very truth, and the nature of things, though repudiated and ordered into exile, sneaked in again through the back door, to be received by me under an unwonted guise.

Translated by William H. Donahue  
*New Astronomy*  
Part IV, 58 (p. 575)  
At The University Press. Cambridge, England. 1992

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The universal impermanence of things, the inevitableness of decay, the mocking frustration of deepest yearnings and fondest dreams, all this has been keenly realized wherever men and women have had seeing eyes or been even a little touched with the malady of meditation, and everywhere in the literature of power is heard the cry of the mournful truth.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Human Significance of Mathematics (p. 46)  
Columbia University Press. New York, New York, USA. 1916

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

Man is condemned to exhaust all possible errors when he examines any set of facts before he recognises the truth.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter V (p. 57)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

...both individual and public reason, when they find themselves exposed to any alteration, usually set up so great an obstacle to it, that it is often harder to secure the recognition of a truth than it is to discover it.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter VIII (p. 404)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

Induction, analogy, hypotheses founded upon facts and rectified continually by new observations, a happy tact given by nature and strengthened by numerous comparisons of its indications with experience, such are the principal means for arriving at truth.

*A Philosophical Essay on Probabilities*  
Chapter XVII (p. 176)  
Dover Publications, Inc. New York, New York, USA. 1951

**Lawson, Alfred William** 1869–1954  
American baseball player, popular philosopher and economist

Education is the science of knowing TRUTH. Miseducation is the art of absorbing FALSITY. TRUTH is that which is, not that which ain't. FALSITY is that which ain't, not that which is.

In Martin Gardner  
*Fads and Fallacies in the Name of Science*  
Chapter 6 (p. 76)  
Dover Publications, Inc., New York, New York, USA. 1957

**Le Bon, Gustave** 1841–1931  
French social psychologist, author, and amateur physicist

Science has promised us truth – an understanding of such relationships as our minds can grasp; it has never promised us either peace or happiness.

*La Psychologie des Foules*  
Introduction

**Lepper, George Henry**  
No biographical data available

Natural truth exists independently of both human wishes and opinions, and cannot be settled one way or the other by a plebiscite, or even by a council of the wisest of one's own generation.

*From Nebula to Nebula*  
Introduction (p. 15)  
Privately printed. Pittsburgh, Pennsylvania, USA. 1917

**Levy, Hyman** 1889–1975  
British mathematician and social activist

Truth is a dangerous word to incorporate within the vocabulary of science. It drags with it, in its train, ideas of permanence and immutability that are foreign to the spirit of a study that is essentially an historically changing movement, and that relies so much on practical examination within restricted circumstances....

*The Universe of Science*  
Chapter V (p. 206)  
The Century Company. New York, New York, USA. 1933

Truth is an absolute notion that science, which is not concerned with any such permanency, had better leave alone.

*The Universe of Science*

Chapter V (p. 207)

The Century Company. New York, New York, USA. 1933

**Lewis, Gilbert Newton** 1875–1946

American chemist

The theory that there is an ultimate truth, although very generally held by mankind, does not seem useful to science except in the sense of a horizon toward which we may proceed, rather than a point which may be reached.

*The Anatomy of Science*

Chapter I (p. 7)

Yale University Press. New Haven, Connecticut, USA. 1926

**Libby, Walter** 1867–1955

American science historian

The untrained mind, reliant on so-called facts and distrustful of mere theory, inclines to think of truth as fixed rather than progressive, static rather than dynamic. It longs for certainty and repose, and has little patience for any authority that does not claim absolute infallibility.

*An Introduction to the History of Science*

Chapter XVIII (p. 245)

Houghton Mifflin & Co. New York, New York, USA. 1917

**Locke, John** 1632–1704

English philosopher and political theorist

...truth, like gold, is not the less so for being newly brought out of the mine. It is trial and examination must give it price, and not any antique fashion: and though it be not yet current by the public stamp, yet it may, for all that, be as old as nature, and is certainly not the less genuine.

*An Essay Concerning Human Understanding*

Dedication (p. iii)

Printed for Thomas Tegg. London, England. 1841

Truth scarcely ever yet carried it by vote any where at its first appearance; new opinions are always suspected, and usually opposed, without any other reason, but because they are not already common.

*An Essay Concerning Human Understanding*

Dedication (p. iii)

Printed for Thomas Tegg. London, England. 1841

**Lodge, Sir Oliver** 1851–1940

English physicist

The direct aim of Science is Truth, and the temptation of its devotees is to concentrate too narrowly on this one aim and lose sight of the wealth of existence which gives all the meaning and value to bare fact, thus gaining but a purblind view of the universe, in spite of a large accumulation of knowledge which is accurate as far as it goes, but so incomplete as regards the totality of things as to be liable to mislead.

In J. Arthur Thomson

*The Outline of Science* (Volume 4)

Chapter XXIV (p. 1077)

G.P. Putnam's Sons. New York, New York, USA. 1937

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Truth suffers herself to be won. She flirts at times disgracefully. Above all, she is determined to be merited, and has naught but contempt for the man who will win her too quickly.

*Popular Scientific Lectures*

On the Causes of Harmony (p. 45)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

The inquirer seeks the truth. I do not know if the truth seeks the inquirer. But were that so, then the history of science would vividly remind us of that classical rendezvous, so often immortalized by painters and poets. A high garden wall. At the right a youth, at the left a maiden. The youth sighs, the maiden sighs! Both wait. Neither dreams how near the other is.

*Popular Scientific Lectures*

On the Causes of Harmony (p. 45)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Only when Truth is in exceptionally good spirits does she bestow upon her wooer a glance of encouragement. For, thinks Truth, if I do not do something, in the end the fellow will not seek me at all.

*Popular Scientific Lectures*

On the Causes of Harmony (pp. 45–46)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The truth is not in nature waiting to declare itself, and we cannot know a priori which observations are relevant and which are not; every discovery, every enlargement of the understanding begins as an imaginative preconception of what the truth might be. This imaginative preconception – a “hypothesis” – arises by a process as easy or as difficult to understand as any other creative act of mind; it is a brainwave, an inspired guess, the product of a blaze of insight. It comes, anyway, from within and cannot be arrived at by the exercise of any known calculus of discovery.

*Advice to a Young Scientist*

Chapter 11 (p. 84)

Basic Books, Inc. New York, New York, USA. 1979

**Millikan, Robert Andrews** 1868–1953

American physicist

...in science, truth once discovered always remains truth.

*Science and the New Civilization*

Chapter III (p. 76)

Charles Scribner's Sons. New York, New York, USA. 1930



**Morehouse, George Wilkinson** 1840–?  
American naturalist

The more difficult and important the question, the broader, freer, and more careful and thorough should be our study. The honest seeker after the truth gives all sides a hearing, and welcomes every addition to his mental equipment.

*The Wilderness of Worlds*

Preface (p. 3)

Peter Eckler, Publisher. New York, New York, USA. 1898

Truth courts light; but error shuns and deprecates impartial inquiry. The more difficult and important the question, the broader, freer, and more careful and thorough should be our study. The honest seeker after the truth gives all sides a hearing, and welcomes every addition to his mental equipment.

*The Wilderness of Worlds*

Preface (p. 7)

Peter Eckler, Publisher. New York, New York, USA. 1898

...some men, who, actuated by the love of truth for its own sake, are forever prospecting along the borders of the unknown.

*The Wilderness of Worlds*

Chapter I (p. 11)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Moulton, Forest Ray** 1872–1952  
American astronomer

Many a chemist, physicist, biologist, psychologist, and historian, as well as monk, has had as his first and only love The Truth, and as it his greatest reward the approval of his own conscience.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1927

Science does not bow down before precedent nor custom nor dogma; it exalts the truth and honestly seeks it.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 4)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

Truth is the offspring of silence and unbroken meditation.

Attributed to Newton

Source unknown

I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

In David Brewster

*Memoirs of the Life, Writings and Discoveries of Sir Isaac Newton*

(Volume 2)

Chapter 27 (p. 407)

Hamilton, Adams & Company. London, England. 1855

**Nietzsche, Friedrich Wilhelm** 1844–1900  
German philosopher

It is good to express a thing twice right at the outset and so to give it a right foot and also a left foot. Truth can surely stand on one leg, but with two, it will be able to walk and get around.

*The Wanderer and His Shadow*

Aphorism 13

1880

**Orlans, Harold** 1912–  
American education researcher

A profession which seeks the truth must consider whether silence about motives and restraint in expression serve, on balance, to enhance or suppress it.

Neutrality and Advocacy in Policy Research

*Policy Sciences*, Volume 6, 1975

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

A distressing feature in the life which you are about to enter, a feature which will press hardly upon the finer spirits among you and ruffle their equanimity, is the uncertainty which pertains not alone to our science and art, but to the very hopes and fears which make us men. In seeking absolute truth we aim at the unattainable, and must be content with finding broken portions.

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*

Chapter I (p. 7)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1905

Truth has been well called the daughter of Time, and even in anatomy, which is a science in a state of fact, the point of view changes with successive generations.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 84)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The truth is the best you can get with your best endeavor, the best that the best men accept – with this you must learn to be satisfied, retaining at the same time with due humility an earnest desire for an ever larger portion.

*Selected Writings of Sir William Osler*

Chapter 11 (p. 172)

Oress. London, England. 1951

**Ostwald, Carl Wilhelm Wolfgang** 1853–1932  
Latvian-born German chemist

No matter where an unprejudiced search after truth may lead an investigator; if his work is that of an honest scientist it must and will finally turn out to be for the benefit of mankind.

Translated by Thomas Seltzer

*Individuality and Immortality*

Individuality and Immortality (p. 3)

Houghton, Mifflin & Co. Boston, Massachusetts, USA. 1906



**Pagels, Heinz R.** 1939–88  
American physicist and science writer

The only touchstone for empirical truth is experiment and observation.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Four, Chapter 1 (p. 355)  
Simon & Schuster. New York, New York, USA. 1985

**Pascal, Blaise** 1623–62  
French mathematician and physicist

We may have three main objects in the study of truth: first, to find it when we are seeking it; second, to demonstrate it after we have found it; third, to distinguish it from error by examining it.

In *Great Books of the Western World* (Volume 33)  
*Scientific Treatises*  
On Geometrical Demonstration (p. 430)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95  
French chemist

Truth, Sir, is a great coquette. She will not be won by too much passion. Indifference is often more successful with her. She escapes when apparently caught, but she yields readily if patiently waited for. She reveals herself when one is about to abandon the hope of possessing her; but she is inexorable when one affirms her, that is when loves her with too much fervor.

In Rene Dubos  
*Louis Pasteur: Free Lance of Science*  
Chapter XIV (p. 389)  
Little, Brown & Company. Boston, Massachusetts, USA. 1950

If I have sometimes disturbed the peace of our Academic meetings by somewhat too lively discussions, it is because I have passionately defended the truth.

In Percy Frankland  
*Pasteur*  
Chapter XVI (p. 216)  
Cassell & Co., Ltd. London, England. 1901

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

...truths, on the average, have a greater tendency to get believed than falsities have. Were it otherwise, considering that there are myriads of false hypotheses to account for any given phenomenon, against one sole true one (or if you will have it so, against every true one), the first step towards genuine knowledge must have been next door to a miracle.

*The Collected Works of Charles Sanders Peirce* (Volume 5)  
*Pragmatism and Pragmaticism* (p. 431)

**Penrose, Roger** 1931–  
English mathematical physicist

Scientists do not invent truth – they discover it.  
In John Horgan

Quantum Consciousness  
*Scientific American*, Volume 261, Number 5, November, 1989 (p. 32)

**Phillips, J.**  
No biographical data available

Ours is no coasting voyage by the sunny shores of some well-havened bay; we steer across the undiscovered oceans of truth, with compasses in need of correction, under the canopy of cloud and darkness which involves the origin of things.

Presidential address  
*Quarterly Journal of the Geological Society*, Volume 15, 1859 (p. lxi)

**Pirsig, Robert M.** 1928–  
American writer

It was a puzzling thing. The truth knocks on the door and you say, “Go away, I’m looking for the truth,” and so it goes away. Puzzling.

*Zen and the Art of Motorcycle Maintenance: An Autobiography* (p. 5)  
Bantam Books. New York, New York, USA. 1984

**Planck, Max** 1858–1947  
German physicist

Conscientiousness and truth are as necessary in research in pure science as in practical life.

*A Survey of Physical Theory*  
Dynamical Laws and Statistical Laws  
Methuen & Company Ltd. London, England. 1925

If we seek a foundation for the edifice of exact science which is capable of withstanding every criticism, we must first of all tone down our demands considerably. We must not expect to succeed at a stroke, by one single lucky idea, in hitting on an axiom of universal validity, to permit us to develop, with exact methods, a complete scientific structure. We must be satisfied initially to discover some form of truth which no skepticism can attack. In other words, we must set our sights not on what we would like to know, but first on what we do not know with certainty.

*Scientific Autobiography and Other Papers*  
The Meaning and Limits of Exact Science, Part I (p. 84)  
Philosophical Library. New York, New York, USA. 1949

...“to believe” means “to recognize as a truth,” and the knowledge of nature, continually advancing on incontestably safe tracks, has made it utterly impossible for a person possessing some training in natural science to recognize as founded on truth the many reports of extraordinary occurrences contradicting the laws of nature, of miracles which are still commonly regarded as essential supports and confirmations of religious doctrines, and which formerly used to be accepted as facts pure and simple, without doubt or criticism.

*Scientific Autobiography and Other Papers*  
Religion and Natural Science, Part I (p. 154)  
Philosophical Library. New York, New York, USA. 1949

It is not the possession of truth, but the success which attends the seeking after it, that enriches the seeker and brings happiness to him.

In H.A. Ross

*Elihu Root Lectures of Carnegie Institution of Washington on the Influence of Science and Research on Current Thought*  
The Nature of Progress in Science (p. 14)  
Washington, D.C. 1945

...the whole strenuous intellectual work of an industrious research worker would appear, after all, in vain and hopeless, if he were not occasionally through some striking facts to find that he had, at the end of his all criss-cross journeys, at last accomplished at least one step which was conclusively nearer the truth.

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1918 (p. 407)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

### **Poe, Edgar Allan** 1809–49

American short story writer

Truth is not always in a well. In fact, as regards the more important knowledge, I do believe that she is invariably superficial. The depth lies in the valleys where we seek her, and not upon the mountain-tops where she is found.

*Complete Tales and Poems of Edgar Allan Poe*

The Murders in the Rue Morgue (p. 153)

The Modern Library. New York, New York, USA. 1965

### **Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

The scientist is accustomed to conquer truth only by degrees; for him all certainty should be bought by long hesitations, by perpetually feeling his way. He suspects what comes too easily, and accepts it only after submitting it to numerous and diverse proofs.

In James Byrnie Shaw

Henri Poincaré as an Investigator

*The Popular Science Monthly*, Volume 82, Number 3, March, 1913 (p. 211)

The search for truth should be the goal of our activities; it is the sole end worthy of them. Doubtless we should first bend our efforts to assuage human suffering, but why? Not to suffer is a negative ideal more surely attained by the annihilation of the world. If we wish more and more to free man from material cares, it is that he may be able to employ the liberty obtained in the study and contemplation of truth.

Translated by George Bruce Halsted

*The Value of Science*

Introduction (p. 11)

The Science Press. New York, New York, USA. 1907

...sometimes truth frightens us. And in fact we know that it is sometimes deceptive, that it is a phantom never showing itself for a moment except to ceaselessly flee, that it must be pursued further and ever further without ever being attained.

Translated by George Bruce Halsted

*The Value of Science*

Introduction (p. 11)

The Science Press. New York, New York, USA. 1907

...truth should not be feared, for it alone is beautiful.

*The Value of Science*

Introduction (p. 11)

The Science Press. New York, New York, USA. 1907

...we know that it [truth] is sometimes deceptive, that it is a phantom never showing itself for a moment except to ceaselessly flee, that it must be pursued further find ever further without ever being attained.

*The Value of Science*

*Popular Science Monthly*, Volume 69, Number 3, September, 1906 (p. 193)

### **Priestley, Joseph** 1733–1804

English theologian and scientist

When I...compare my last discoveries relating to the constitution of the atmosphere with the first, I see the closest and easiest connexion in the world between them, so as to wonder that I should not have been led immediately from the one to the other. That this was not the case, I attribute to the force of prejudice, which unknown to ourselves, biases not only our judgments, properly so called, but even the perception of our senses: for we may take a maxim so strongly for granted, that the plainest evidence of sense will not entirely change, and often hardly modify, our persuasions; and the more ingenious a man is, the more effectually he is entangled in his errors; ...his ingenuity only helping him to deceive himself, by evading the force of truth.

In F.W. Gibbs

*Joseph Priestley: Adventurer in Science and Champion of Truth*

Chapter 9 (p. 119)

Thomas Nelson & Sons Ltd. London, England. 1965

### **Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

Such supreme joy and satisfaction makes all other pleasures appear as pale sensations and compensates the scientist for the hard, constant, analytical work, like child-birth labor involved in achieving a new truth.

In E.H. Craigie and W.C. Gibson

*The World of Ramón y Cajal With Selections from His Nonscientific Writings* (p. 191)

Charles C. Thomas. La Salle, Indiana, USA. 1968

### **Reichenbach, Hans** 1891–1953

German philosopher of science

He who searches for truth must not appease his urge by giving himself up to the narcotic of belief.

In Ruth Renya

*The Philosophy of Matter in the Atomic Era: A New Approach to the Philosophy of Science* (p. 16)

Asia Publishing House. Bombay, India. 1962

**Renan, Ernest** 1823–92  
French philosopher and Orientalist

Science has no enemies save those who consider truth as useless and making no difference, and those who granting to truth its priceless value profess to get at it by other roads than those of criticism and rational investigation.

*The Future of Science*

Chapter IV (p. 68)

Roberts Brothers. Boston, Massachusetts, USA. 1893

The simplest schoolboy is now familiar with truths for which Archimedes would have sacrificed his life.

In L.I. Ponomarev

*The Quantum Dice* (p. 34)

Institute of Physics Publishing. Bristol, England. 1993

**Rey, Jean** 1583–1645  
French physician and chemist

Behold now this truth, whose brilliance strikes the eye, which I have drawn from the deepest dungeons of obscurity. This it is to which the path has been hitherto inaccessible. This it is which has distressed with toil so many learned men, who, wishing to know it, have striven to clear the difficulties which held it encircled. Cardan, Scaliger, Fachsius, Cxsalpinus, Libavius, have curiously sought it, but never perceived it. Others may be on its quest, but vainly if they fail to follow the road which I first of all have made clear and royal: all others being but thorny footpaths and inextricable byways which lead never to the goal. The labour has been mine; may the profit be to the reader, and to God alone the glory.

*Essays of Jean Rey, Doctor of Medicine*

Conclusion (p. 54)

William F. Clay. Edinburgh, Scotland. 1895

**Richet, Charles** 1850–1935  
French physiologist

Truth, the goddess, the sovereign, the all-powerful, who will freeze with terror those who jeer at her!

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter II (p. 25)

J.M. Dent & Sons Ltd. London, England. 1927

...if you would discover a new truth, do not seek to know what use will be made of it.

*The Natural History of a Savant*

Chapter XII (p. 133)

J.M. Dent & Sons Ltd. London, England. 1927

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

Science speaks the language of universal truth.

*Encyclopedia of Thoughts*

Aphorisms 961

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Rousseau, Jean-Jacques** 1712–78  
Swiss-French philosopher

I only know that truth is in the things, and not in my mind which judges of them, and that the less there is of mine in the judgment I form, the surer I am of attaining the truth...

*Emilius* (Volume 2)

The Third Book (p. 21)

Printed for John Nourse and Paul Vaillant. London, England. 1763

**Rowland, Henry Augustus** 1848–1901  
American physicist

The ordinary crude mind has only two compartments, one for truth and one for error; indeed the contents of the two compartments are sadly mixed in most cases: the ideal scientific mind, however, has an infinite number. Each theory or law is in its proper compartment indicating the probability of its truth. As a new fact arrives the scientist changes it from one compartment to another so as, if possible, to always keep it in its proper relation to truth and error.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aims of the Physicist (p. 676)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

When a man tells you that he knows the exact truth about anything, you are safe in inferring that he is an inexact man.

*The Scientific Outlook*

Characteristics of Scientific Method (p. 65)

George Allen & Unwin Ltd. London, England. 1931

Science thus encourages abandonment of the search for absolute truth, and the substitution of what may be called “technical” truth, which belongs to any theory that can be successfully employed in inventions or in predicting the future. “Technical” truth is a matter of degree: a theory from which more successful inventions and predictions spring is truer than one which gives rise to fewer.

*Religion and Science*

Grounds of Conflict (p. 15)

Henry Holt & Company. New York, New York, USA. 1935

**Sagan, Carl** 1934–96  
American astronomer and science writer

The truth may be puzzling. It may take some work to grapple with. It may be counterintuitive. It may contradict deeply held prejudices. It may not be consonant with what we desperately want to be true. But our preferences do not determine what’s true.

Wonder and Skepticism

*Skeptical Inquirer*, Volume 19, Issue 1, January-February, 1995

We have a method, and that method helps us to reach not absolute truth, only asymptotic approaches to the truth – never there, just closer and closer, always finding vast new oceans of undiscovered possibilities.

Wonder and Skepticism

*Skeptical Inquirer*, Volume 19, Issue 1, January–February, 1995

### Sattler, R.

No biographical data available

Modern philosophy of science has gone far beyond the naive belief that science reveals the truth. Even if it could, we would have no means of proving it. Certainty seems unattainable. All scientific statements remain open to doubt... We cannot reach the absolute at least as far as science is concerned; we have to content ourselves with the relative.

*Biophilosophy*

Chapter 1 (p. 41)

Springer-Verlag, Berlin, Germany. 1986

### Sendivogius, Michael 1566–1636

Polish alchemist and inventor

There is abundance of knowledge, yet but little Truth known. The generality of our knowledge is as Castles in the Air, or groundless Fancies.

*A New Light of Alchymy*

To the Reader

Printed by A. Clark. London, England. 1674

### Shaw, George Bernard 1856–1950

Irish comic dramatist and literary critic

RIDGEON: The buried truth germinates and breaks through to the light.

*The Doctor's Dilemma*

Act V (p. 114)

Brentano's. New York, New York, USA. 1920

### Shepherd, Linda Jean

American biochemist

...the "truth" has many faces, depending upon the perspective of the observer.

*Lifting the Veil: The Feminine Face of Science*

Chapter 6 (p. 153)

Shambhala. Boston, Massachusetts, USA. 1993

### Smuts, Jan Christiaan 1870–1950

South African statesman, military leader, and holistic philosopher

Truth is a whole, and the truth of physics will be found to link on and to be but part of that larger truth which is the nature and the character of the universe.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 718)

### Spencer-Brown, George 1923–

English mathematician and polymath

To arrive at the simplest truth, as Newton knew and practiced, requires years of contemplation. Not activity.

Not reasoning. Not calculating. Not busy behavior of any kind. Not reading. Not talking. Not making an effort. Not thinking. Simply bearing in mind what it is one needs to know. And yet those with the courage to tread this path to real discovery are not only offered practically no guidance on how to do so, they are actively discouraged and have to set about it in secret, pretending meanwhile to be diligently engaged in the frantic diversions and to conform with the deadening personal opinions which are continually being thrust upon them.

*Laws of Form*

Appendix I (p. 110)

George Allen & Unwin Ltd. London, England. 1969

### Teilhard de Chardin, Pierre 1881–1955

French Jesuit, paleontologist, and biologist

We are given to boasting of our age being an age of science.... Yet though we may exalt research and derive enormous benefits from it, with what pettiness of spirit, poverty of means and general haphazardness do we pursue truth in the world today! [W]e leave it to grow as best it can, hardly tending it, like those wild plants whose fruits are plucked by primitive peoples in their forests.

*The Phenomenon of Man*

Book Four, Chapter III, Section 2 (p. 278, 278, 279)

Harper & Brothers. New York, New York, USA. 1959

### Thomson, Sir George Paget 1892–1975

English physicist

Science is essentially a search for truth.

*The Inspiration of Science*

Introduction (p. 1)

Oxford University Press, Inc. London, England. 1961

### Thurston, William Paul 1946–

American mathematician

There is great power in truth and sincerity. The mathematics community has tremendous reserves of human potential energy. If we are lean and hungry, we are likely to use our energy. If we are honest, it is likely to be effective...

In D. Albers, G. Alexanderson and C. Reid

*More Mathematical People: Contemporary Conversations* (p. 334)

Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

### Tischner, August

No biographical data available

I doubt that you look in science for nothing but truth, and admit, that theory is but an attempt to explain inexorable, great Nature, and that theory can serve but for a resting-point, a point of departure for further explorations, and that science, if raised to dogma, is brought to a standstill, and any further success is rendered impossible.

*The Fixed Idea of Astronomical Theory* (p. 7)

Gustav Fock. Leipzig, Germany. 1885

### Tolstoy, Leo 1828–1910

Russian writer

Some mathematician, I believe, has said that true pleasure lies not in the discovery of truth, but in the search for it.

*Anna Karenina*

Part II, Chapter XIV (p. 192)

Barnes & Noble Books. New York, New York, USA. 2003

**Toynbee, Arnold J.** 1852–83

English historian

The Truth apprehended by the Subconscious Psyche finds natural expression in Poetry; The Truth apprehended by the Intellect finds natural expression in science....

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 6 (p. 115)

The New American Library, Inc. New York, New York, USA. 1967

**Trollope, Anthony** 1815–82

English novelist

There are certain statements which, though they are false as hell, must be treated as though they were true gospel.

*The Eustace Diamond* (Volume 2)

Chapter LXXVIII (p. 353)

Oxford University Press, Inc. London, England. 1973

**Tyndall, John** 1820–93

Irish-born English physicist

Truth is often of a dual character, taking the form of a magnet with two poles; and many of the differences which agitate the thinking part of mankind are to be traced to the exclusiveness with which partisan reasoners dwell upon one-half of the duality in forgetfulness of the other.

*Fragments of Science for Unscientific People*

Chapter VI (p. 112)

D. Appleton & Co. New York, New York, USA. 1875

### Uzor (Fictional character)

Truth will flourish in fantasy only to wither and die in what you call reality.

*The Mummy's Curse*

Film (1944)

**Vaihinger, Hans** 1852–1933

German philosopher

We have repeatedly insisted...that the boundary between truth and error is not a rigid one, and we were able ultimately to demonstrate that what we generally call truth, namely a conceptual world coinciding with the external world, is merely the most expedient error.

*The Philosophy of "As If"*

Part I, Chapter XXIV (p. 108)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1925

**van Leeuwenhoek, Antony** 1632–1723

Dutch biology researcher and microscope developer

As I aim at nothing but Truth, and so far as in me lieth, to point out Mistakes that may have crept into certain

Matters; I hope that in so doing those I chance to censure will not take it ill: and if they would expose any Errors in my own Discoveries, I'd esteem it an Encouragement toward the Attaining of a nicer Accuracy.

*Antony van Leeuwenhoek and His "Little Animals"*

Envoy: Leeuwenhoek's Place in Protozoology and Bacteriology (p. 387)

John Bale, Sons & Danielsson Ltd. London, England. 1932

**van Dyke, John Charles** 1856–1932

American art historian and critic

...reality is one thing, the appearance quite another thing; but why are not both of them truthful?

*The Desert*

Chapter VII (p. 109)

Charles Scribner's Sons. New York, New York, USA. 1930

**von Ebner-Eschenbach, Marie** 1830–1916

Austrian novelist

The simplest and most familiar truth seems new and wonderful the instant we ourselves experience it for the first time.

Translated by Annis Lee Wister

*Aphorisms*

Number 18

J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

To a new truth there is nothing more hurtful than an old error.

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#549 (p. 192)

The Macmillan Co. New York, New York, USA. 1906

**von Hoffman, A. W.**

No biographical data available

Whenever one of your chemical friends, full of enthusiasm, exhibits and explains to you his newly-discovered compound, you will not cool his noble ardour by asking him that most terrible of all questions, "What is its use? Will your compound bleach or dye? Will it shave? May it be used as a substitute for leather?" Let him quietly go on with his work. The dye, the leather, will make their appearance in due time. Let him, I repeat, perform his task. Let him indulge in the pursuit of truth – of truth pure and simple – of truth not for the sake of Mauve – let him pursue truth for the sake of truth.

Quoted in Richard Arman Gregory

*Discovery, Or, The Spirit and Service of Science*

Chapter IX (p. 251)

Macmillan & Co Ltd. London, England. 1916

**von Liebig, Justus** 1803–73

German organic chemist

There is only one path to the truth, crossed by a thousand crooked paths, at each of which credulity stands to point the way. Truth has its rights, which cannot be infringed



with impunity: it has its signs, by which every unprejudiced man recognises it.

*Familiar Letters on Chemistry*

Letter XXIV (p. 320)

Walton & Maberly. London, England. 1859

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

Truth is born into this world only with pangs and tribulations, and every fresh truth is received unwillingly. To expect the world to receive a new truth, or even an old truth, without challenging it, is to look for one of those miracles which do not occur.

In an interview/obituary by W.B. Northrop

*The Outlook* (New York), Volume 105, 1913 (p. 622)

**Wegener, Alfred** 1880–1930

German climatologist and geophysicist

Scientists still do not appear to understand sufficiently that all earth sciences must contribute evidence toward unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combing all this evidence. . . . It is only by combing the information furnished by all the earth sciences that we can hope to determine “truth” here, that is to say, to find the picture that sets out all the known facts in the best arrangement and that therefore has the highest degree of probability.

Translated by John Biram

*The Origin of Continents and Oceans* (4th edition)

Foreword (p. vii)

Dover Publications, Inc. New York, New York, USA. 1966

**Weil, Simone** 1909–43

French philosopher and mystic

Truth is a radiant manifestation of reality.

Translated by Arthur Wills

*The Need for Roots: Prelude to a Declaration of Duties Toward Mankind*

Part III (p. 253)

The Beacon Press. Boston, Massachusetts, USA. 1952

**Weinberg, Steven** 1933–

American nuclear physicist

We search for universal truths about nature and when we find them, we show that they can be deduced from deeper truths.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Prologue (p. 6)

Pantheon Books. New York, New York, USA. 1992

**Weyl, Hermann** 1885–1955

German mathematician

We are not very pleased when we are forced to accept a mathematical truth by virtue of a complicated chain of formal conclusions and computations, which we traverse

blindly, link by link, feeling our way by touch. We want first an overview of the aim and of the road; we want to understand the idea of the proof, the deeper context.

In Abe Shenitzer

Part II. Topology and Abstract Algebra as Two Roads of Mathematical Comprehension

*The American Mathematical Monthly*, Volume 102, Number 7, August–September, 1995 (p. 646)

By the mental process of thinking we try to ascertain truth; it is our mind's effort to bring about its own enlightenment by evidence.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

The Unity of Knowledge (p. 68)

Mathematical Association of America. Washington, D.C. 2004

**Whewell, William** 1794–1866

English philosopher and historian

Experience must always consist of a limited number of observations; and however numerous these may be, they can show nothing with regard to the infinite number of cases in which the experiment has not been made. . . .

[T]ruths can only be known to be general, not universal, if they depend upon experience alone. Experience cannot bestow that universality which she herself cannot have, nor that necessity of which she has no comprehension.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 1)

Part I, Book I, Chapter V, Article 1, Article 2 (pp. 63, 64)

John W. Parker. London, England. 1847

The Logic of Induction is the Criterion of Truth inferred from Facts, as the Logic of Deduction is the Criterion of Truth deduced from necessary Principles.

*The Philosophy of the Inductive Sciences: Founded Upon Their History* (Volume 2) (2nd edition)

Aphorisms Concerning Ideas (p. 470)

John W. Parker. London, England. 1847

**Whipple, George H.** 1878–1976

American pathologist

Any investigator is indeed fortunate who can contribute a tiny stone to the great edifice which we call scientific truth.

*Les Prix Nobel. The Nobel Prizes in 1934*

Nobel banquet speech for award received in 1934

Nobel Foundation. Stockholm, Sweden. 1935

That grand unselfish love of truth, and joy in its discovery, by whomsoever made, which characterize the true seeker and seer of science and creative art, alone can keep the mind alive and alert, alone can make the possession of truth a means of elevating and purifying the man.

*Character and Characteristic Men*

Chapter III (pp. 84–85)

James R. Osgood & Co. Boston, Massachusetts, USA. 1877



**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

...what is truth? In matters of religion, it is simply the opinion that has survived. In matters of science, it is the ultimate sensation. In matters of art, it is one's last mood.

*Intentions*

The Critic As Artist (p. 188)

Brentano's. New York, New York, USA. 1905

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

JACK: ... That, my dear Algy, is the whole truth, pure and simple.

ALGERNON – The truth is rarely pure and never simple.

*The Importance of Being Earnest*

Act I (p. 13 )

Walter H. Baker Company. Boston, Massachusetts, USA. 19—

It is a terrible thing for a man to find out suddenly that all his life he has been speaking nothing but the truth.

In John D. Barrow

*The World Within the World* (p. 260)

Clarendon Press. Oxford, England. 1988

**Wilder, Burt Green** 1841–1925

American zoologist, neurologist, and composer

Life is too short to spend in digging for Truth with a long-handled shovel when a trowel will serve the purpose; nor is it becoming that any nation, however wise and great, should ask all the rest to take their intellectual food with chop-sticks of its peculiar pattern.

A Partial Revision of Anatomical Nomenclature

*Science*, March 29, 1881 (p. 124)**Wilkins, Bishop John** 1614–72

Co-founder of the Royal Society

That the strangeness of this opinion is no sufficient reason why it should be rejected, because other certain truths have been formerly esteemed ridiculous, and great absurdities entertained by common consent.

*The Discovery of a World in the Moone* (p. 1)

Printed by E. Griffin. England. 1638

**Wilson, Edward O.** 1929–

American biologist and author

...if history and science have taught us anything, it is that passion and desire are not the same as truth. The human mind evolved to believe in the gods. It did not evolve to believe in biology. Acceptance of the supernatural conveyed a great advantage throughout prehistory, when the brain was evolving. Thus it is in sharp contrast to biology, which was developed as a product of the modern age and is not underwritten by genetic algorithms. The uncomfortable truth is that the two beliefs are not factually compatible. As a result those who hunger for both

intellectual and religious truth will never acquire both in full measure.

*Consilience: The Unity of Knowledge*

Chapter 11 (p. 262)

Alfred A. Knopf. New York, New York, USA. 1998

**Wright, Chauncey** 1830–75

American philosopher of science

We receive the truths of science by compulsion. Nothing but ignorance is able to resist them.

In Edward H. Madden (ed.)

*The Philosophical Writings of Chauncey Wright*

The Philosophy of Herbert Spencer (p. 23)

The Liberal Arts Press. New York, New York, USA. 1958

Truth is eternal, of course, but whether there are some truths which are not facts or some facts which are not truths may be left to the logicians, and other former inhabitants of the fanes of science, discredited dwellers in the temples of truth.

The Evanesence of Facts

*The Popular Science Monthly The Popular Science Monthly*, Volume 86, Number 2, 1915 (p. 182)**Yates, James A.**

No biographical data available

As each brick or stone is of service in a building, so a place will be found for every truth wrested from nature.

The Value of the Work of the Scientist to Humanity (p. 31)

*Transactions of the Kansas Academy of Science*, Volume 21, PRT I,

State Printing Office. Topeka, Kansas, USA. 1908

**TUNNELING****Drinker, Henry** 1850–1937

A barbarous people may, perhaps, develop a high degree of perfection in the mere art of open-air building, where stone can be piled on stone, and rafter fitted to rafter, in the light of day; but it takes the energy, knowledge, experience, and skill of an educated and trained class of men to cope with the unknown dangers of the dark depths that are to be invaded by the tunnel-man.

In Henry Drinker

*Tunneling, Explosive Compounds, and Rock Drilling* (p. 32)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1878

**TURBULENCE****Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

The next great era of awakening of human intellect may well produce a method of understanding the

qualitative content of equations. Today we cannot. Today we cannot see that the water flow equations contain such things as the barber pole structure of turbulence that one sees between rotating cylinders. Today we cannot see whether Schrödinger's equation contains frogs, musical composers, or morality – or whether it does not.

*The Feynman Lectures on Physics* (Volume 2)

Chapter 41 (p. 41–12)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

### **Lamb, Sir Horace** 1848–1934

English applied mathematician

It remains to call attention to the chief outstanding difficulty of our subject [turbulent motion].

*Hydrodynamics*

Chapter VI, section 365 (p. 663)

Dover Publications, Inc. Mineola, New York, USA. 1945

### **Saffman, P. G.**

No biographical data available

...we should not altogether neglect the possibility that there is no such thing as “turbulence.” That is to say, it is not meaningful to talk of the properties of a turbulent flow independently of the physical situation in which it arises. In searching for a theory of turbulence, we are perhaps looking for a chimera.

In H. Fiedler (ed.)

*Structure and Mechanisms of Turbulence* (Volume 2)

Problems and Progress in the Theory of Turbulence (p. 276)

Springer-Verlag. Berlin, Germany. 1978

## TWILIGHT

### **Flammarion, Camille** 1842–1925

French astronomer and writer

What greater delight can be conceived, on a fine spring evening, at the hour when the crescent moon is shining in the West amid the last glimmer of twilight, than the contemplation of that grand and silent spectacle of the stars stepping forth in sequence in the vast Heavens? All sounds of life die out upon the earth, the last notes of the sleepy birds have sunk away, the Angelus of the church hard by has rung the close of day. But if life is arrested around us, we may seek it in the Heavens. These incandescing orbs are so many points of interrogation suspended above our heads in the inaccessible depths of space.... Gradually they multiply.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 1)

D. Appleton & Co. New York, New York, USA. 1915

## TYOPOLOGY

### **Bordes, Francois** 1919–81

French scientist, geologist, and archaeologist

One has to see a great number of implements, classify them, see them again several times, before one acquires a “typological eye.”

On Old and New Concepts of Typology

*Current Anthropology*, Volume 13, Number 1 (p. 141)

### **Brögger, A. W.**

No biographical data available

The proud edifice of chronology built on a foundation of typology is a dangerous mirage.

*Kulturgeschichte des Norwegischen Altertums* (p. 14)

### **Hawksworth, D. L.**

No biographical data available

The Purpose of typification is to fix permanently the application of names of all ranks governed by the Code so as to preclude the possibility of the same name being used in different senses; i.e., for different plants.

*Mycologist's Handbook: An Introduction to the Principles of Taxonomy and Nomenclature in the Fungi and Lichens* (p. 127)

Commonwealth Mycological Institute. Kew, England. 1974

### **Krieger, A.**

In speaking of “types” did the author follow any philosophy of typology, or – as is so common – did he merely devise still another “typology” for his own convenience.

Epistemology and Archaeological Theory, Comment on Lowther

*Current Anthropology*, Volume 3, 1963 (p. 506)

### **Malmer, Mats P.**

No biographical data available

Archaeology is directed at the general, it aims to depict the important features of existence for groups of people in prehistoric times. It is clear, therefore, that typology is the central method in archaeology: the study of types and their associations. This central archaeological concept is the type. If typology were not the central and unifying factor, all other methods and subsidiary sciences would fall hopelessly apart, and archaeology as a science would cease to exist.... There can be no typology without types, no archaeology without typology.

*Acta Archaeologica Lundensis*

*Jungneolithische Studien*, Number 2 (pp. 880–881)

### **Reed, T. D.**

No biographical data available

Towards the end of the last century those strange new gods Typology and Chronology, Athanasian in their

relationship, arose and the archaeologists bowed down and worshipped them.... The younger archaeologist of today is a sad, wise, disillusioned, and almost human being.

*The Battle for Britain in the 5th Century: An Essay in Dark Age History* (pp. 5–6)

**Taylor, Walter W.** 1913–97

American archaeologist

It is possible to type automobiles on the basis of the length of the scratches in their paint, to classify sand tempered potsherds on the number of sand grains in each, or to group together all chipped stone points which have side notches. It would be possible, but the pertinent question is “So what?”

*A Study of Archeology*

Part II, Chapter 5 (p. 127)

Southern Illinois University Press. Carbondale, Illinois, USA. 1967

**Tucker, Albert W.**

No biographical data available

On one occasion during World War II...Lefschetz and I and Oskar Zariski...traveled into New York together on the train. Lefschetz and Zariski were talking about a certain paper, which had recently appeared in algebraic geometry, which they thought was a very good paper. Lefschetz remarked that he wasn't sure if he would classify the paper as algebra or topology.... So Zariski, to tease Lefschetz a bit, asked, “How do you draw the line between algebra and topology?” Quick as a flash, Lefschetz came back with, “Well, if it's just turning the crank, it's algebra, but if it's got an idea in it, it's topology!”

Solomon Lefschetz, *A Reminiscence*

*Two-Year Coll. Math. J.*, Volume 14 (June, 1983) (p. 227)

## U

### UFO

#### **Bramley, William**

American author

An in-depth study of the UFO phenomenon reveals that it does not offer a happy little romp through the titillating unknown. The UFO appears more and more to be one of the grimmest realities ever confronted by the human race.

*The Gods of Eden*

Avon Books. New York, New York, USA. 1989

#### **Fort, Charles** 1874–1932

American writer

Unknown, luminous things, or beings, have often been seen, sometimes close to this earth, and sometimes high in the sky. It may be that some of them were living things that occasionally come from somewhere else in our existence, but that others were lights on vessels of explorers, or voyagers, from somewhere else.

*Lo!*

Chapter 10 (p. 123)

Claude Kendall. New York, New York, USA. 1931

#### **Sagan, Carl** 1934–96

American astronomer and science writer

UFOs: The reliable cases are uninteresting and the interesting cases are unreliable.

*Other Worlds* (p. 114)

Bantam Books. New York, New York, USA. 1975

After I give lectures – on almost any subject – I am often asked, “Do you believe in UFOs?.” I’m always struck by how the question is phrased, the suggestion that this is a matter of belief and not evidence. I’m almost never asked, “How good is the evidence that UFOs are alien spaceships?”

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 3 (p. 82)

Random House, Inc. New York, New York, USA. 1995

### FLYING SAUCERS

#### **Feynman, Richard P.** 1918–88

American theoretical physicist

“Listen, I mean that from my knowledge of the world that I see around me, I think that it is much more likely that the reports of flying saucers are the results of the known irrational characteristics of terrestrial intelligence than of the unknown rational efforts of extra-terrestrial intelligence.” It is just more likely, that is all. It is a good guess. And we always try to guess the most likely explanation,

keeping in the back of the mind the fact that if it does not work we must discuss the other possibilities.

*The Character of Physical Law*

Chapter 7 (p. 166)

BBC. London, England. 1965

### UNATTAINABLE

#### **Hamerton, Philip Gilbert** 1834–94

English artist and art critic

It is useless to search for that which cannot exist.

*The Intellectual Life*

Part I, Chapter II (p. 15)

Little, Brown & Co. Boston, Massachusetts, USA. 1901

### UNCERTAIN

#### **Whately, Richard** 1787–1863

English theologian

Nothing can be in itself uncertain; it is we that are uncertain.

In Elizabeth Jane Whatley

*Miscellaneous Remains from the Commonplace Book of Richard*

*Whately, D.D.*

Apothegm 40 (p. 4)

Longman, Green, Longman, Roberts & Green. London, England. 1865

### UNCERTAINTY

#### **Buffalo Springfield** 1966–67

American folk rock group

There’s something happening here,

What it is ain’t exactly clear.

*The Best of Buffalo Springfield*

For What It’s Worth

Electra CD. 1969

#### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

In fact, our ordinary description of nature, and the idea of exact laws, rests on the assumption that it is possible to observe the phenomena without appreciably influencing them.

*The Physical Principles of the Quantum Theory*

Translated by Carl Eckhart and Frank C. Hoyt (p. 62)

The University of Chicago Press. Chicago, Illinois, USA. 1930

#### **Hooke, Robert** 1635–1703

English physicist

Thus all the uncertainty, and mistakes of humane actions, proceed either from the narrowness and wandering of our *Senses*, from the slipperiness or delusion of our *Memory*, from the confinement or rashness of our *Understanding*, so that ’tis no wonder, that our power over natural causes

and effects is so slowly improv'd, seeing we are not only to contend with the obscurity and *difficulty of the things* whereon we work and think, but even the *forces of our own minds* conspire to betray us.

*Extracts from Micrographia*

Extracts from the Preface (p. 7)

University of Chicago Press. Chicago, Illinois, USA. 1906

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If matters still seem very uncertain it must always be remembered that clearly sign-posted roads are not to be expected at a pioneering frontier.

*Frontiers of Astronomy*

Chapter Nineteen (p. 341)

Harper & Row, Publishers. New York, New York, USA. 1955

**Latham, Peter Mere** 1789–1875

English physician

Where reasoning begins, there begins uncertainty; and on this account the highest and the best things in the world are all uncertain...

*Lectures on Subjects Connected With Clinical Medicine*

Lecture II (p. 41)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Pagels, Heinz R.** 1939–88

American physicist and science writer

Space looks empty only because this great creation and destruction of all the quanta takes place over such short times and distances.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 8 (p. 274)

Simon & Schuster. New York, New York, USA. 1982

**Professor Hubert J. Farnsworth**  
(Fictional character)

Announcer [on loudspeaker]: And it's a dead heat! They're checking the electron microscope. And the winner is... [A man holds up a "3" in a window.]...number 3, in a quantum finish.

Farnsworth: No fair! You changed the outcome by measuring it.

*Futurama*

Luck of the Fryrish

Aired 11 March, 2001

**Vincenti, Walter G.** 1917–

American aeronautical engineer

In the end, decreasing uncertainty in the growth of knowledge in a technology comes, I suggest, mainly from the increase in scope and precision (that is, the decrease in unsureness) in the vicarious means of selection. Just as expanding scope tends, as we saw, to widen the field that can be overtly searched, so also the increase in both scope and precision sharpens the ability to weed out variations

that won't work in the real environment. Blindness in the variations may by the same token even increase – engineers have freedom to be increasingly blind in their trial variations as their means of vicarious selection become more reliable. One sees engineers today, for example, using computer models to explore a much wider field of possibilities than they were able to select from just a decade ago.

*What Engineers Know and How They Know It: Analytical Studies from Aeronautical History*

Chapter 8 (p. 250)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1990

**Ziman, John M.** 1925–

British physicist

Many philosophers have now sadly come to the conclusion that there is no ultimate procedure which will wring the last drops of uncertainty from what scientists call their knowledge.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 1 (p. 5)

Cambridge University Press. Cambridge, England. 1968

## UNCERTAINTY PRINCIPLE

**Stoppard, Tom** 1937–

Czech-born English playwright

An electron can be here or there at the same moment. You can choose. It can go from here to there without going in between; it can pass through two doors at the same time, or from one door to another by a path which is there for all to see until someone looks, and then the act of looking has made it take a different path.

[An electron's] movements cannot be anticipated because it has no reasons. It defeats surveillance because when you know what it's doing you can't be certain where it is, and when you know where it is you can't be certain what it's doing: Heisenberg's uncertainty principle; and this is not because you're not looking carefully enough, it is because there is no such thing as an electron with a definite position and a definite momentum; you fix one, you lose the other, and it's all done without tricks, it's the real world, it is awake.

*Tom Stoppard: Plays*

Hapgood, Act I, Scene 5 (p. 544)

Faber & Faber. London, England. 1999

## UNCHANGING

**Chown, Marcus**

English writer

Like shipwrecked mariners clinging to the rocks in a wild sea, to make sense of the world we search desperately for things that are unchanging.

*The Quantum Zoo*

Chapter 7 (p. 102)

Joseph Henry Press. Washington, D.C. 2006

## UNDERSTAND

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

“...we are calling him an example of a Spontaneous Para-Causal Meteorological Phenomenon.” “Can you tell us what that means?” “I’m not altogether sure. Let’s be straight here. If we find something we can’t understand we like to call it something you can’t understand, or indeed pronounce.

*So Long, and Thanks for All the Fish*

Chapter 33 (p. 170)

Harmony Books. New York, New York, USA. 1984

**Adams, John** 1735–1826

26th president of the USA

It has been long, very long, a settled opinion in my mind, that there is now, never will be, and never was but one being who can understand the universe.

*The Works of John Adams, Second President of the United States*

(Volume 10)

Letter from John Adams to Thomas Jefferson (p. 69)

Little, Brown & Co. Boston, Massachusetts, USA. 1856

**Blackwood, Algernon** 1869–1951

English author

To trace the unfamiliar to the familiar...is to understand.

*Incredible Adventures*

The Damned, Chapter IV (p. 165)

The Macmillan Co. New York, New York, USA. 1914

**Bojowald, Martin** 1973–

German physicist

...what good does all scientific progress do if it cannot be communicated? Do we really understand the world if we cannot explain it without the requirement of long, demanding studies?

*Once Before Time: A Whole Story of the Universe*

Preface (p. vii)

Alfred A. Knopf. New York, New York, USA. 2010

**Burroughs, John** 1837–1921

American naturalist and essayist

The infinitely little and infinitely vast alike baffle the understanding,...

*Under The Apple Tree*

Scientific Faith Once More (p. 161)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1916

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“It’s very good jam,” said the Queen. “Well, I don’t want any today, at any rate.” “You couldn’t have it if you did want it,” the Queen said. “The rule is, jam tomorrow and

jam yesterday – but never jam today.” “It must come sometimes to ‘jam today,’ Alice objected.”

“No, it can’t,” said the Queen. “It’s jam every other day; today isn’t any other day, you know.” “I don’t understand you,” said Alice. “It’s dreadfully confusing!”

*Alice in Wonderland*

*Through the Looking Glass*

Chapter V (p. 149)

Lothrop Publishing Co. Boston, Massachusetts, USA. 1898

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

It is very good for a man to talk about what he does not understand; as long as he understands that he does not understand it.

*A Handful of Authors: Essays of Books and Writers*

Louisa Alcott (p. 163)

Sheed & Ward. New York, New York, USA. 1953

**Daumal, René** 1908–44

French surrealist writer

I know everything, but I don’t understand any of it

Translated by David Coward and E. A. Lovatt

*A Night of Serious Drinking*

Part II, 27 (p. 68)

Shambhala. Boulder, Colorado, USA. 1979

**Dr. Lao (Fictional character)**

Whatever men do not understand they find unconvincing.

*The Seven Faces of Dr. Lao*

Film (1964)

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

I am seized with astonishment, for I understand!

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 278)

Dodd, Mead & Co. New York, New York, USA. 1915

You understand, because you succeed in making another understand.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter XII (p. 285)

Dodd, Mead & Co. New York, New York, USA. 1925

**Feynman, Richard P.** 1918–88

American theoretical physicist

Trying to understand the way nature works involves a most terrible test of human reasoning ability. It involves subtle trickery, beautiful tightropes of logic on which one has to walk in order not to make a mistake in predicting what will happen.

*The Meaning of It All*

Chapter I (p. 15)

Addison-Wesley. Reading, Massachusetts, USA. 1998



**Flammarion, Camille** 1842–1925

French astronomer and writer

Attempt to understand it! As well might the ant attempt to drink the ocean!

Translated by J. Ellard Gore

*Popular Astronomy: A General Description of the Heavens*

Book III, Chapter III (p. 247)

Chatto &amp; Windus. London, England. 1894

I have ears only for hearing you...and intelligence only for trying to understand you. Speak, then, fearlessly and directly, and design to describe the impressions, unknown to me...

Translated by S.R. Crocker

*Stories of Infinity*

First Story (p. 6)

Robert Brothers. Boston, Massachusetts, USA. 1873

**Hooke, Robert** 1635–1703

English physician

...nothing is so well understood or apprehended, as when it is represented under some sensible Form...

In Harry Woolf (ed.)

*The Posthumous Works of Robert Hooke*

Lectures of Light, Section VII (p. 141)

Johnson Reprint Corporation. New York, New York, USA. 1969

**L'Engle, Madeleine** 1918–2007

American writer

... just because we don't understand doesn't mean that the explanation doesn't exist.

*A Wrinkle in Time*

Chapter 3 (p. 46)

Dell Publishing Co. New York, New York, USA. 1962

**Lodge, Sir Oliver** 1851–1940

English physicist

To suppose that we know and understand the universe, to suppose that we have grasped its main outlines, that we realise pretty completely not only what is in it, but the still more stupendous problem of what is not and cannot be in it...

*Man and the Universe*

Section III, Chapter IX (p. 198)

Methuen &amp; Co. London, England. 1908

**Mivart, St. George Jackson** 1827–1900

English biologist

To know anything whatever, is to know that it is distinct from something else.

*The Groundwork of Science; A Study of Epistemology*

Chapter II (p. 18)

G.P. Putnam's Sons. New York, New York, USA. 1898

**National Research Council (U.S.)**

To understand how things work is to see how, within environmental constraints and the limitations of wisdom, better to accommodate nature to man and man to nature.

*Physics in Perspective* (Volume 1)

Chapter 2 (p. 14)

National Academy of Sciences. Washington, D.C. 1972

It can be a gigantic step from an understanding of the parts to an understanding of the whole.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 60)

National Academy of Sciences. Washington, D.C. 1972

**Neumann, John von** 1903–57

Hungarian-American mathematician

A discussion of the nature of any intellectual effort is difficult *per se* – at any rate, more difficult than the mere exercise of that particular intellectual effort. It is harder to understand the mechanism of an airplane, and the theories of the forces which lift and which propel it, than merely to ride in it, to be elevated and transported by it or even to steer it. It is exceptional that one should be able to acquire the understanding of a process without having previously acquired a deep familiarity with running it, with using it, before one has assimilated it in an instinctive and empirical way.

In Raymond George Ayoub

*Musings of the Masters: An Anthology of Mathematical Reflections*

The Mathematician (p. 172)

Mathematical Association of America. Washington, D.C. 2004

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

We ourselves, and with each other by our converse, can create, not an architecture of global scope, but an immense, intricate network of intimacy, illumination, and understanding.

The Growth of Science and the Structure of Society

*Daedalus*, Winter, 1958**Sagan, Carl** 1934–96

American astronomer and author

We go about our daily lives understanding almost nothing of the world. We give little thought to the machinery that generates the sunlight that makes life possible, to the gravity that glues us to an Earth that would otherwise send us spinning off into space, or to the atoms of which we are made and on whose stability we fundamentally depend. Except for children (who don't know enough not to ask the important questions), few of us spend much time wondering why nature is the way it is; where the cosmos came from, or whether it was always here; if time

will one day flow backward and effects precede causes; or whether there are ultimate limits to what humans can know.

In Stephen Hawking  
*A Brief History of Time*  
Introduction (p. ix)  
Bantam Books. New York, New York, USA. 1990

**Tyndall, John** 1820–93  
Irish-born English physicist

Man never has been and he never will be satisfied with the operations and products of the understanding alone; hence physical science cannot cover all the demands of his nature.

*Fragments of Science: A Series of Detached Essays, Addresses, and Reviews* (Volume 2)  
Chapter 9 (p. 141)  
D. Appleton & Co. New York, New York, USA. 1896

**Valéry, Paul** 1871–1945  
French poet and critic

A very dangerous state of mind: thinking one understands.  
Translated by Stuart Gilbert  
*The Collected Works of Paul Valéry* (Volume 14)  
*Analects*  
Odds and Ends (p. 35)  
Princeton University Press. Princeton, New Jersey, USA. 1979

**von Ebner-Eschenbach, Marie** 1830–1916  
Austrian novelist

They understand but little who understand only what can be explained.

Translated by Annis Lee Wister  
*Aphorisms*  
Number 3  
J.B. Lippincott & Co. Philadelphia, Pennsylvania, USA. 1883

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

I have often been told, on the occasion of the publication of some important scientific work, that ‘whatever there is true in it is not new, and what is new is not true.’ This means in plain language: ‘we understand what we know, but that which we ought to know, we do not understand.’

Translated by Otto Wenckstern  
*Goethe’s Opinions on the World, Mankind, Literature, Science, and Art*  
(p. 34)  
John W. Parker & Son. London, England. 1853

Whatever you cannot understand, you cannot possess.  
*Goethe’s Opinions on the World, Mankind, Literature, Science, and Art*  
(p. 113)  
John W. Parker & Son. London, England. 1853

To understand that the sky is everywhere blue, we need not go round the world.

In John Stuart Blackie  
*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 153)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

...every educated man who tries to understand the forces at work in the world in which he is living...must have some interest in that peculiar kind of mental labour, which works and acts in the sciences in question.

In Harvard Classics  
*Scientific Papers* (Volume 30)  
*On the Conservation of Force* (p. 181)  
P.F. Collier & Son. New York, New York, USA. 1910

**Westfall, Richard S.** 1924–96  
American academic, biographer, and historian of science

Enthusiasm is not necessarily equivalent to understanding.

In Harry Woolf (ed.)  
*The Posthumous Works of Robert Hooke*  
Introduction (p. ix)  
Johnson Reprint Corporation. New York, New York, USA. 1969

**Zinsser, Hans** 1878–1940  
US bacteriologist

...it is dangerous when a great man is too easily half-understood.

*Rats, Lice and History*  
Chapter 1 (p. 4)  
Little, Brown & Company. Boston, Massachusetts, USA. 1965

## UNDERSTANDING

**Arnott, Neil** 1788–1874  
Scottish physician

...no man can understand a subject of which he does not carry a distinct outline in his mind...

*Elements of Physics, or, Natural Philosophy, General and Medical Synopsis* (p. 4)  
Printed for Thomas & George Underwood. London, England. 1827

**Atiyah, Sir Michael** 1922–  
English mathematician

...it is hard to communicate understanding because that is something you get by living with a problem for a long time. You study it, perhaps for years, you get the feel of it and it is in your bones. You can’t convey that to anybody else. Having studied the problem for five years you may be able to present it in such a way that it would take somebody else less time to get to that point than it took you, but if they haven’t struggled with the problem and seen all the pitfalls, then they haven’t really understood it.

An Interview with Michael Atiya  
*The Mathematical Intelligencer*, Volume 6, Number 1, 1984 (p. 17)

### Author undetermined

The rabbi spoke three times. The first talk was brilliant; clear and simple. I understood every word. The second was even better; deep and subtle. I didn't understand much, but the rabbi understood all of it. The third was by far the finest; a great and unforgettable experience. I understood nothing, and the rabbi himself didn't understand much either.

In Aage Petersen  
The Philosophy of Niels Bohr  
*Bulletin of the Atomic Scientists*, Volume 19, Number 7, September, 1963 (p. 8)

I understand the material. I just can't do the problems.  
*The Physics Teacher*, Volume 6, Number 9, December, 1968

**Bach, Richard** 1936–  
American writer

Don't believe what your eyes are telling you. All they show is limitation. Look with your understanding, find out what you already know, and you'll see the way...  
*Jonathan Livingston Seagull*  
Part III (p. 92)  
The Macmillan Co. New York, New York, USA. 1970

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The eye of the understanding is like the eye of the sense: for as you may see great objects through small crannies or levels; so you may see great axioms of nature through small and contemptible instances.  
*The Works of Francis Bacon* (Volume 1)  
*Sylva Sylvarum*  
Century I, 91 (p. 278)  
Printed for C. & J. Rivington. London, England. 1826

...it is the peculiar and perpetual error of the human understanding to be more moved and excited by affirmatives than negatives, whereas it ought duly and regularly to be impartial; nay, in establishing any true axiom the negative instance is the most powerful.  
*Advancement of Learning and Novum Organum*  
*Novum Organum*  
#46 (p. 321)  
Colonial Press. New York, New York, USA. 1899

The human understanding is like a false mirror, which, receiving rays irregularly, distorts and discolors the nature of things by mingling its own nature with it.  
*In Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 48 (p. 110)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barbour, Julian** 1937–  
English physicist

...the higher we climb, the more comprehensive the view. Each new vantage point yields a better understanding

of the interconnection of things. What is more, gradual accumulation of understanding is punctuated by sudden and startling enlargements of the horizon, as when we reach the brow of a hill and see things never conceived of in the ascent. Once we have found our bearings in the new landscape, our path to the most recently attained summit is laid bare and takes its honourable place in the new world.

*The End of Time: The Next Revolution in Physics*  
Part 1, Chapter 1 (p. 13)  
Weidenfield & Nicolson. London, England. 1999

**Becker, Carl Lotus** 1873–1945  
American historian

We really haven't time to stand amazed, either at the starry firmament above or the Freudian complexes within us. The multiplicity of things to manipulate and make use of so fully engage our attention that we have neither the leisure nor the inclination to seek a rational explanation of the force that makes them function so efficiently.  
*The Heavenly City of the Eighteenth Century Philosophers*  
Chapter I (pp. 23–24)  
Yale University Press. New Haven, Connecticut, USA. 1932

**Bergaust, Erik**  
No biographical data available

Someday in the very, very distant future earthlings may learn to understand the universe...  
*Wernher von Braun*  
Are Flying Saucers Real? (p. 547)  
National Space Institute. Washington, D.C. 1976

**Bergman, Torbern Olaf** 1735–84  
Swedish chemist and naturalist

A scientist strives to understand the work of Nature. But with our insufficient talents as scientists, we do not hit upon the truth all at once. We must content ourselves with tracking it down, enveloped in considerable darkness, which leads us to make new mistakes and errors. By diligent examination, we may at length little by little peel off the thickest layers, but we seldom get the core quite free, so that finally we have to be satisfied with a little incomplete knowledge.  
In J.A. Schuffe  
*Chymia*  
Torbern Bergman, Earth Scientist (Volume 12), 1967  
Lecture to the Royal Swedish Academy of Science  
May 23, 1764 (p. 78)  
University of Pennsylvania Press. Philadelphia, Pennsylvania, USA. 1948–1967

**Berkeley, George** 1685–1753  
Irish prelate and metaphysical philosopher

PHILONOUS: I am not for imposing any sense on your words: you are at liberty to explain them as you please. Only, I beseech you, make me understand something by them.

*Three Dialogues Between Hylas and Philonous*

First Dialogue (p. 40)

The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1954

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

The enthusiasm, the exuberance, that properly accompanies the great achievements of science, the thrill of at last beginning to understand nature and the universe about us, in all their awesome magnificence, continues to lead many men all over the world, especially young men, on to this new materialism.

*Science Is Not Enough*

Chapter II (pp. 19–20)

William Morrow &amp; Company, Inc. New York, New York, USA. 1967

**Chu, Steven** 1948–

American physicist

You want to try to put something that you learn in your own language, so that it's no longer something that's merely memorized but something you transfer from your head to your gut – you simplify it and put it in your own language to the point where it seems almost obvious and intuitive. It's only when you understand your science in this very obvious, intuitive way that you have a chance of thinking of something new.

Interview

*American Scientist*, Volume 86, January–February, 1998 (p. 25)**Cole, K. C.** 1946–

American science writer

...the need to go to the moon or smash atoms is on a par with the need to have natural history museums: Science provides a handle on who we are and how we fit into the scheme of things. Understanding our place in the sun requires an understanding of the sun's place in the solar system, the cycles of the sky, the nature of the elements, and the improbabilities of life. If what we learn leaves us a little stunned by our limitations and potentials, so be it. Science gives us a sense of scale and a sense of limits, an appreciation for perspective and a tolerance for ambiguity.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Introduction (p. 11)

Harcourt Brace &amp; Co. Orlando, Florida, USA. 1999

**Conrad, Joseph** 1857–1924

Polish-born English novelist

Things and men have always a certain sense, a certain side by which they must be got hold of if one wants to obtain a solid grasp and a perfect command.

*Under Western Eyes*

Section 10 (p. 304)

Harper &amp; Brothers Publishers. New York, New York, USA. 1911

**Cortázar, Julio** 1914–84

Argentinean novelist and short story writer

It had been some time since Gregorovius had given up the illusion of understanding things, but at any rate, he still wanted misunderstanding to have some sort of order, some reason about them.

Translated by Gregory Rabassa

*Hopscotch*

Chapter 31 (p. 179)

Pantheon Books. New York, New York, USA. 1966

**Dahlberg, Edward** 1900–77

American novelist and essayist

It takes a long time to understand nothing.

*Reasons of the Heart*

On Wisdom and Folly

Horizon Press, Inc. New York, New York, USA. 1965

**Davy, Sir Humphry** 1778–1829

English chemist

To me there never has been a higher source of honour or distinction than that connected with advances in science. I have not possessed enough of the eagle in my character to make a direct flight to the loftiest altitudes in the social world, and I certainly never endeavored to reach those heights by using the creeping powers of the reptile who, in ascending, generally chooses the dirtiest path, because it is the easiest.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 157)

Cassell &amp; Co., Ltd. London, England. 1889

**de Quincey, Thomas** 1785–1859

English author

He trembles at the abyss into which his bodily eyes look down, or look up; not knowing that abyss to be, but by an instinct written in his prophetic heart feeling it to be, boding it to be, fearing it to be, and sometimes hoping it to be, the mirror to a mightier abyss that will one day be expanded in himself.

*The Works of Thomas de Quincey*

System of the Heavens as Revealed by Lord Rosse's Telescope (p. 176)

Adam &amp; Charles Black. Edinburgh, Scotland. 1871

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

ADSO: “But how does it happen,” I said with admiration, “that you were able to solve the mystery of the library looking at it from the outside, and you were unable to solve it when you were inside?”

WILLIAM OF BASKERVILLE: “Thus God knows the world, because He conceived it in His mind, as if from the outside, before it was created, and we do not know its rule, because we live inside it, having found it already made.”

Translated by William Weaver

*The Name of the Rose*

Vespers (p. 218)

Harcourt Brace Jovonovich. San Diego, California, USA. 1983

**Einstein, Albert** 1879–1955  
German-born physicist

The hardest thing to understand is why we understand anything at all.

In Morton Wagman

*Cognitive Science and Concepts of Mind* (p. 103)  
Praeger. New York, New York, USA. 1991

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

The scientist reading the book of nature... must find the solution for himself, for he cannot, as impatient readers of other stories often do, turn to the end of the book. In our case the reader is also the investigator, seeking to explain, at least in part, the relation of events to their rich context. To obtain even a partial solution the scientist must collect the unordered facts available and make them coherent and understandable by creative thought.

*The Evolution of Physics*

The Great Mystery (pp. 4–5)

Simon & Schuster. New York, New York, USA. 1961

With the help of physical theories we try to find our way through the maze of observed facts, to order and understand the world of our sense impressions.

*The Evolution of Physics*

Physics and Reality (p. 296)

Simon & Schuster. New York, New York, USA. 1961

**Ferguson, Marilyn** 1938–  
American writer

Real progress in understanding nature is rarely incremental. All important advances are sudden intuitions, new principles, new ways of seeing. We have not fully recognized this process of leaping ahead, however, in part because textbooks tend to tame revolutions, whether cultural or scientific. They describe the advances as if they had been logical in their day, not at all shocking.

*The Aquarian Conspiracy: Personal and Social Transformation in the 1980s*

Chapter 1 (p. 28)

J.P. Tarcher, Inc. Los Angeles, California, USA. 1980

**Ferris, Timothy** 1944–  
American science writer

We might eventually obtain some sort of bedrock understanding of cosmic structure, but we will never understand the universe in detail; it is just too big and varied for that. If we possessed an atlas of our galaxy that devoted but a single page to each star system in the Milky Way (so that the sun and all its planets were crammed in on one page), that atlas would run to more than ten

million volumes of ten thousand pages each. It would take a library the size of Harvard's to house the atlas, and merely to flip through it, at the rate of a page per second, would require over ten thousand years.

*Coming of Age in the Milky Way*

Chapter 20 (p. 383)

William Morrow & Company, Inc. New York, New York, USA. 1988

**Feynman, Richard P.** 1918–88  
American theoretical physicist

What I cannot create I do not understand.

In James Gleick

*Genius: The Life and Science of Richard Feynman*

Epilogue (p. 437)

Pantheon Books. New York, New York, USA. 1992

I would like to be rather more special, and I would like to be understood in an honest way rather than in a vague way.

*The Character of Physical Law*

Chapter 1 (p. 13)

BBC. London, England. 1965

One does not, by knowing all the physical laws as we know them today, immediately obtain an understanding of anything much.

*The Character of Physical Law*

Chapter 5 (p. 122)

BBC. London, England. 1965

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

We proceed in step-by-step discussion from inference to inference, whereas He conceives through mere intuition. Thus in order to gain insight into some of the properties of the circle, of which it possesses infinitely many, we begin with one of the simplest; we take it for a definition and proceed from it by means of inference to a second property, from this to a third, and hence a fourth, and so on. The divine intellect, on the other hand, grasps the essence of a circle *senza temporaneo discorso* and thus apprehends the infinite array of the properties.

*Opere* (VII)

Dialogo (p. 129)

SAGREDO: My brain already reels. My mind, like a cloud momentarily illuminated by a lightning-flash, is for an instant filled with an unusual light, which now beckons to me and which now suddenly mingles and obscures strange, crude ideas.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 132)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The vain presumption of understanding everything can have no other basis than never understanding anything. For anyone who had experienced just once the perfect understanding of one single thing, and had truly tasted



how knowledge is accomplished, would recognize that infinity of other truths of which he understands nothing.

Translated by Stillman Drake

*The Two Chief World Systems*

First Day (p. 101)

University of California Press. Berkeley, California, USA. 1953

### **Hawking, Stephen William** 1942–

English theoretical physicist

...there may be no ultimate theory, and even if there is, we may not find it. But it is surely better to strive for a complete understanding than to despair of the human mind.

*Black Holes and Baby Universes and Other Essays*

Preface (p. ix)

Bantam Books. New York, New York, USA. 1993

### **Hazlitt, William Carew** 1834–1913

English bibliographer

...in what we really understand, we reason but little.

*The Collected Works of William Hazlitt*

*On the Conduct of Life* (p. 430)

McClure, Phillips & Company. New York, New York, USA. 1904

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Even for a physicist the description in plain language will be a criterion of the degree of understanding that has been reached.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter X (p. 168)

Harper & Row, Publishers. New York, New York, USA. 1958

Whenever we proceed from the known into the unknown we may hope to understand, but we may have to learn at the same time a new meaning of the word “understanding.”

*Physics and Philosophy: The Revolution in Modern Science*

Chapter XI (p. 201)

Harper & Row, Publishers. New York, New York, USA. 1962

The exact sciences also start from the assumption that in the end it will always be possible to understand nature, even in every new field of experience, but that we may make no a priori assumptions about the meaning of the word understand.

In Heinrich O. Proskauer

*The Rediscovery of Color: Goethe Versus Newton Today*

Preface (p. ix)

Anthroposophic Press. Spring Valley, New York, USA. 1986

...as facts and knowledge accumulate, the claim of the scientist to an understanding of the world in a certain sense diminishes.

*Wandlungen in der Grundlagen der Naturwissenschaft*

Zur Geschichte der physikalischen NaturerklSrung (p. 28)

### **Hoffman, Roald** 1937–

Polish-born applied theoretical chemist and writer

In principle one could go ahead and calculate each molecule.... [H]owever...even if the results were in excellent agreement with experiment, the resultant predictability would not necessarily imply understanding. True understanding implies a knowledge of the various physical factors, the mix of different physical mechanisms, that go into making an observable.

*Interaction of Orbitals Through Space and Through Bonds*

*Accounts of Chemical Research*, Volume 4, Number 1, 1971 (p. 1)

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

A moment's insight is sometimes worth a life's experience.

*The Professor at the Breakfast-Table*

Chapter X (p. 301)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The man who voyages strange seas must of necessity be a little unsure of himself. It is the man with the flashy air of knowing everything, who is always on the ball, always with it, that we should beware of.

*Of Men and Galaxies*

Motives and Aims of the Scientist (pp. 24–25)

University of Washington Press. Seattle, Washington, USA. 1964

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

...a man may be a fine genius, and yet understand nothing of an art which he has not studied.

*Notre-Dame de Paris*

Book III, Chapter 2 (p. 126)

J.M. Dent & Sons Ltd. London, England. 1910

### **Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

If anyone is resolved to find fault with it, let him first be sure he understands it.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the First, Arguments for the Truth of It (p. 13)

Printed for T. Childe. London, England. 1698

### **Jefferies, Richard** 1848–87

English naturalist and author

Let me have wider feelings, more extended sympathies, let me feel with all living things, rejoice and praise with them. Let me have deeper knowledge, a nearer insight, a more reverent conception. Let me see the mystery of life the secret of the sap as it rises in the tree the secret of the blood as it courses through the vein. Reveal the broad earth and the ends of it make the majestic ocean open to the eye down to its inmost recesses.

*The Hills and the Vale*

Nature and Eternity (p. 296)

Duckworth & Co. London, England. 1909



**Juster, Norton** 1929–  
American architect and author

Milo tried very hard to understand all the things he'd been told, and all the things he'd seen, and, as he spoke, one curious thing still bothered him. "Why is it," he said quietly, "that quite often even the things which are correct just don't seem to be right?"

*The Phantom Tollbooth*

Chapter 16 (p. 198)

Alfred A. Knopf. New York, New York, USA. 1989

**Kaufmann, William J., III** 1942–94  
American astronomer

We shall speak of things we cannot understand. We shall discuss concepts we cannot grasp. We shall examine processes we cannot comprehend.

*Stars and Nebulas*

Chapter I (p. 4)

W.H. Freeman & Company. San Francisco, California, USA. 1978

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Some people say they cannot understand a million million. Those people cannot understand that twice two makes four. That is the way I put it to people who talk to me about the incomprehensibility of such large numbers. I say finitude is incomprehensible, the infinite in the universe is comprehensible.

Wave Theory of Light

*Journal of the Franklin Institute*, Volume 118, November, 1884

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Intelligibility is alike the first and the last demand of the understanding.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter V (p.101)

Columbia University Press. New York, New York, USA. 1916

**Le Guin, Ursula K.** 1929–  
American writer of science fiction and fantasy

If the human creatures will not understand Relativity, very well; but they must understand Relatedness.

*The Wind's Twelve Quarters*

Direction of the Road (p. 223)

Harper & Rowe, Publishers, New York, New York, USA; 1975

**Lec, Stanislaw** 1909–66  
Polish poet and aphorist

Some like to understand what they believe in. Others like to believe in what they understand.

*Unkempt Thoughts* (p. 159)

St. Martin's Press. New York, New York, USA. 1962

**Locke, John** 1632–1704  
English philosopher and political theorist

... understanding, like the eye, judging of objects only by its own sight, cannot but be pleased with what it discovers, having less regret for what has escaped it, because it is unknown.

*An Essay Concerning Human Understanding*

Epistle to the Reader (p. v)

Printed for Thomas Tegg. London, England. 1841

**Pascal, Blaise** 1623–62  
French mathematician and physicist

We naturally believe ourselves far more capable of reaching the centre of things than of embracing their circumference. The visible extent of the world visibly exceeds us, but as we exceed little things, we think ourselves more capable of knowing them.

*Thoughts*

Section II (p. 28)

P.F. Collier & Son. New York, New York, USA. 1910

**Oppenheimer, Frank** 1912–85  
American physicist

Understanding is a lot like sex. It's got a practical purpose, but that's not why people do it normally.

In K.C. Cole

*The Universe and the Teacup: The Mathematics of Truth and Beauty*

Chapter 1 (p. 5)

Harcourt Brace & Company. New York, New York, USA. 1998

**Ortega y Gasset, José** 1883–1955  
Spanish philosopher

To be surprised, to wonder, is to begin to understand.

*The Revolt of the Masses*

Chapter I (p. 12)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

To understand the old writers one must see as they saw. Feel as they felt, believe as they believed – and this is hard, indeed impossible! We may get near them by asking the Spirit of the Age in which they lived to enter in and dwell with us, but it does not always come.... Each generation has its own problems to face, look at truth from a special focus, and does not see quite the same outlines as any other.

*The Evolution of Medicine*

Chapter VI (p. 218)

Yale University Press. New Haven, Connecticut, USA. 1922

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

The attempt to understand the origin of the universe is the greatest challenge confronting the physical sciences. Armed with the new concepts, scientists are rising to meet that challenge, although they know that success may be far away. Yet when the origin of the universe is

understood, it will open a new vision that is beautiful, wonderful and filled with the mystery of existence. It will be our intellectual gift to our progeny and our tribute to the scientific heroes who began this great adventure of the human mind, never to see it completed.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part One, Chapter 7 (p. 156)  
Simon & Schuster. New York, New York, USA. 1985

**Palade, George E.** 1912–2008  
Russian-born American cell biologist

For a scientist, it is a unique experience to live through a period in which his field of endeavor comes to bloom – to be witness to those rare moments when the dawn of understanding finally descends upon what appeared to be confusion only a while ago – to listen to the sound of darkness crumbling.

*Les Prix Nobel. The Nobel Prizes in 1974*  
Nobel banquet speech for award received in 1974  
Nobel Foundation. Stockholm, Sweden. 1975

**Polanyi, Michael** 1891–1976  
Hungarian-born English scientist, philosopher, and social scientist

We have a solid tangible object before us.... But we do not know what it is. Then let a team of physicists and chemists inspect the object. Let them be equipped with all the physics and chemistry ever to be known, but let their technological outlook be that of the stone age. Or, if we cannot disregard the practical incompatibility of these two assumptions, let us agree that in their investigations they shall not refer to any operational principles. They will describe the clock precisely in every particular, and in addition, they will predict all its possible future configurations. Yet they will never be able to tell us that it is a clock. The complete knowledge of a machine as an object tells us nothing about it as a machine.

*Personal Knowledge*  
Chapter 11, Section 2 (p. 330)  
Harper & Row, Publishers. New York, New York, USA. 1962

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

...the activity of understanding is, essentially, the same as that of all problem solving.

*Objective Knowledge: An Evolutionary Approach*  
Chapter 4 (p. 166)  
Clarendon Press. Oxford, England. 1972

...only a man who understands science (that is scientific problems) can understand its history.... [O]nly a man who has some real understanding of its history (the history of its problem situations) can understand science.

*Objective Knowledge: An Evolutionary Approach*  
On the Theory of the Objective Mind (p. 185)  
Oxford University Press, Inc. Oxford, England. 1979

Bohr...thought of understanding in terms of pictures and models – in terms of a kind of visualization. This was

too narrow, I felt; and in time I developed an entirely different view. According to this view what matters is the understanding not of pictures but of the logical force of a theory: its explanatory power, its relation to the relevant problems and to other theories.

*Unended Quest: An Intellectual Autobiography*  
Chapter 18 (p. 93)  
Open Court Publishing Company. La Salle, Illinois, USA. 1976

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

Scientific understanding...is an essential step to our finding a home for ourselves in the universe. Through understanding the universe, we become at home in it. In a certain sense we have made this universe out of human concepts and human discoveries. It ceases to be a lonely place, because we can to some extent actually navigate in it.

In A.A. Warner, Dean Morse, and T.E. Cooney (eds.)  
*The Environment of Change*  
The Revolution in Science (p. 49)  
Columbia University Press. New York, New York, USA. 1969

**Ramsay, Sir William** 1852–1916  
English chemist

I trust we have not wearied you in giving some account of our attempts to see the invisible, touch the intangible, and weigh the imponderable.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1912*  
Measurements of Infinitesimal Quantities of Substances (p. 229)  
Government Printing Office. Washington, D.C. 1913

**Recorde, Robert** 1510?–58  
English mathematician and writer

I see in the heaven marvelous motions; and in the reste of the worlde straunge transmutations, and therefore desire muche to know what the worlde is, and what are the principall partes of it, and also how all these strange sightes doo come.

*The Castle of Knowledge*  
The First Treatise (p. 3)  
Imprinted by R. Wolfe. London, England. 1556

**Sagan, Carl** 1934–96  
American astronomer and science writer

We go about our daily lives understanding almost nothing of the world. We give little thought to the machinery that generates the sunlight that makes life possible, to the gravity that glues us to an Earth that would otherwise send us spinning off into space, or to the atoms of which we are made and on whose stability we fundamentally depend. Except for children (who don't know enough not to ask the important questions), few of us spend much time wondering why nature is the way it is; where the cosmos came from, or whether it was always here; if time will one day flow backward and effects precede causes;

or whether there are ultimate limits to what humans can know.

In Stephen W. Hawking

*A Brief History of Time: From the Big Bang to Black Holes*

Introduction (p. ix)

Bantam Books. Toronto, Ontario, Canada. 1988

If you know something only qualitatively, you know it no more than vaguely. If you know it quantitatively – grasping some numerical measure that distinguishes it from an infinite number of other possibilities – you are beginning to know it deeply.

*Billions & Billions: Thoughts on Life and Death at the Brink of the Millennium*

Chapter 2 (p. 21)

Random House, Inc. New York, New York, USA. 1997

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

Next to nature there is nothing more wonderful than man's gradual understanding of it.

*The History of Science and the New Humanism*

Chapter I (p. 44)

H. Holt & Co. New York, New York, USA. 1931

**Stewart, Ian** 1945–

English mathematician and science writer

A person who insists on understanding every tiny step before going on to the next is liable to concentrate so much on looking at his feet that he fails to realize he is walking in the wrong direction.

*Concepts of Modern Mathematics*

Chapter 20 (p. 286)

Dover Publications, Inc. New York, New York, USA. 1995

**Swift, Jonathan** 1667–1745

Irish-born English writer

...where I am not understood, it shall be concluded, that something very useful and profound is couched underneath...

*Gulliver's Travels, the Tale of a Tub, Battle of the Books, Etc.*

*Tale of a Tub*, the Preface (p. 403)

Oxford University Press, Inc. London, England. 1929

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

What is called understanding is often no more than a state where one has become familiar with what one does not understand.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 30 (p. 218)

The Free Press. New York, New York, USA. 1987

**Walker, Kenneth** 1882–1966

Physician

It may be said that all understanding of the universe comes from the combined action of two faculties in us,

the power to register impressions and the capacity to reason and reflect on them.

*Meaning and Purpose*

Chapter II (p. 18)

Jonathan Cape. London, England. 1944

**Welch, Lew** 1926–71?

American Beat poet

Step out onto the Planet. Draw a circle a hundred feet round. Inside the circle are 300 things nobody understands, and maybe nobody's ever really seen. How many can you find?

*Hermit Poems*

Step Out Onto the Planet

Four Seasons Foundation. San Francisco, California, USA. 1965

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Telling someone something he does not understand is pointless, even if you add that he will not be able to understand it.

Translated by Peter Winch

*Culture and Value* (p. 7e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Woodbridge, Frederick James Eugene** 1867–1940

American philosopher

We understand a thing when we have discovered what it can do in relation to other things. In different relations it acts differently, but in every case with a definiteness in accord with its property. Its operation in specific cases is a specific operation which nonetheless illustrates its proper action.

*Nature and Mind: Selected Essays of Frederick J.E. Woodbridge* (p. 257)

Columbia University Press. New York, New York, USA. 1937

**Wiggins, Grant P.**

No biographical data available

Understanding is something different than technical prowess; understanding emerges when we are required to reflect upon achievement, to verify or criticize – thus to rethink and relearn – what we know.... Understanding involves questioning ... the assumptions upon which prior learning is based.

*Assessing Student Performance: Exploring the Purpose and Limits of Testing*

Chapter 2 (p. 38)

Jossey-Bass, Inc. San Francisco, California, USA. 1993

## UNDERSTOOD

**Brewster, George**

No biographical data available

Aim to be understood instead of displaying ostentation...

*A New Philosophy of Matter, Showing the Identity of All the Imponderables* (3rd edition)  
Chapter 1 (p. 21)  
Edward H. Fletcher. New York, New York, USA. 1858

## UNEXPECTED

**Heraclitus** 540 BCE–480 BCE  
Greek philosopher

If one does not expect the unexpected one will not find it out, since it is not to be searched out, and difficult to compass.

In G.S. Kirk and J.E. Raven  
*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*  
Fragment 213 (p. 195)  
At the University Press. Cambridge, England. 1963

**Raymo, Chet** 1936–  
American physicist and science writer

Delight in the unexpected is part of the lifeblood of science. Almost alone among belief systems, science welcomes the disturbingly new.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 15 (p. 138)  
The Viking Press. New York, New York, USA. 1991

**Selye, Hans** 1907–82  
Austrian endocrinologist

...“peripheral vision”: the ability not only to look straight at what you want to see, but also to watch continually, through the corner of your eye, for the unexpected. I believe this to be one of the greatest gifts a scientist can have. Usually we concentrate so much upon what we intend to examine that other things cannot reach our consciousness, even if they are far more important. This is particularly true of things so different from the commonplace that they seem improbable. Yet, only the improbable is really worthy of attention! If the unexpected is nevertheless found to be true, the observation usually represents a great step forward.

*From Dream to Discovery: On Being a Scientist*  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

## UNFATHOMABLE

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

The further knowledge advances, the nearer we come to the unfathomable: the more we know how to use our knowledge, the better we see that the unfathomable is of no practical use.

Translated by Thomas Bailey Saunders  
*The Maxims and Reflections of Goethe*  
#576 (p. 200)  
The Macmillan Co. New York, New York, USA. 1906

## UNIFIED FIELD THEORY

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

Ranged against GUTs, however, is the fact that there is no unique theory, and the unification scale is so remote there is no prospect whatever that it will become accessible to direct experimentation. How, then, are we to discriminate between rival theories? If the GUTs describe a world so small and so energetic that we can never observe it, has not physics degenerated to pure philosophy? Are we not in the same position as Democritus and the other Greek philosophers who mused endlessly about the shapes and properties of atoms without any hope of ever observing them?

*Superforce: The Search for a Grand Unified Theory of Nature*  
Chapter 8 (p. 135)  
Simon & Schuster. New York, New York, USA. 1984

**Hawking, Stephen William** 1942–  
English theoretical physicist

The discovery of a complete unified theory, therefore, may not aid the survival of our species. It may not even affect our life-style. But ever since the dawn of civilization, people have not been content to see events as unconnected and inexplicable. They have craved an understanding of the underlying order in the world. Today we still yearn to know why we are here and where we came from. Humanity’s deepest desire for knowledge is justification enough for our continuing quest. And our goal is nothing less than a complete description of the universe we live in.

*A Brief History of Time: From The Big Bang to Black Holes*  
Chapter 2 (p. 13)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

**Thompson, Jennifer**  
American author

To a physicist, finally discovering the unified field theory is like being a child left in the middle of a toy store. Far from the end, it is only a beginning.

*Beyond Einstein: The Cosmic Quest for the Theory of the Universe*  
Chapter 11 (p. 204)  
Bantam Books. Toronto, Ontario, Canada. 1987

## UNIFORM

**Stanley, Ferdinando (Lord Derby)** 1559–94  
English literary patron

When you find uniformity, or something which closely approximates to uniformity, it is impossible not to be impressed with the permanence and steadiness of the laws which regulate our existence.

In Albert Leffingwell  
*Illegitimacy, and The Influence of Seasons Upon Conduct*  
 Appendix II (p. 146)  
 Swan Sonnenschein & Co. London, England. 1892

## UNIFORMITARIANISM

**Gould, Stephen Jay** 1941–2002  
 American paleontologist and evolutionary biologist

Is uniformitarianism necessary?  
 Is Uniformitarianism Necessary?  
*Journal of Science*, Volume 263, 1965 (p. 223)

**Huxley, Thomas Henry** 1825–95  
 English biologist

Uniformitarianism, on the other hand, has with equal justice [to Catastrophism] insisted upon a practically unlimited bank of time, ready to discount any quantity of hypothetical paper. It has kept before our eyes the power of the infinitely little, time being granted, and has compelled us to exhaust known causes, before flying to the unknown.

*Lay Sermons, Addresses and Reviews*  
 Chapter XI (p. 242)  
 Macmillan & Co Ltd. London, England. 1874

**Lapworth, Charles** 1842–1920  
 English geologist

Uniformity and Evolution are one.  
*Report of the British Association for the Advancement of Science (1892)*  
 Presidential Address to the Geology Section (p. 707)

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

...what is surprising in physics is not the existence of general laws, but their extreme simplicity. It is not the uniformity of nature that should surprise us, for, by sufficient analytic ingenuity any conceivable course of nature might be shown to exhibit uniformity. What should surprise us is the fact that the uniformity is simple enough for us to be able to discover it. But it is just this characteristic of simplicity which it would be fallacious to generalize, for it is obvious that simplicity has been a part of cause of their discovery, and can, therefore, give no ground for the supposition that other undiscovered laws are equally simple.

*Scientific Method in Philosophy*  
 Section I (p. 8)  
 At The Clarendon Press. Oxford, England. 1914

## UNIFORMITY

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

It is not the uniformity of nature that should surprise us, for, by sufficient analytic ingenuity, any conceivable

course of nature might be shown to exhibit uniformity. What should surprise us is the fact that the uniformity is simple enough for us to be able to discover it.

*Mysticism and Logic: And Other Essays*  
 Chapter VI (p. 102)  
 Longmans, Green & Co. London, England. 1919

**Wren, Sir Christopher** 1632–1723  
 English designer, astronomer, and geometer

Views contrary to beauty are deformity, or a defect of uniformity: and plainness, which is the excess of uniformity: variety makes the mean.

In Society for the Diffusion of Useful Knowledge  
*Lives of Eminent Persons*  
 Sir Christopher Wren (p. 30)  
 Baldwin & Cradock. London, England. 1833

## UNIQUENESS

**Doyle, Sir Arthur Conan** 1859–1930  
 Scottish writer

As a rule, when I have heard some slight indication of the course of events, I am able to guide myself by the thousands of other similar cases which occur to my memory. In the present instance I am forced to admit that the facts are, to the best of my belief, unique.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
*The Red-Headed League* (p. 419)  
 Wings Books. New York, New York, USA. 1967

**Simon, Herbert Alexander** 1916–2001  
 American social scientist

The definition of man's uniqueness has always formed the kernel of his cosmological and ethical systems. With Copernicus and Galileo, he ceased to be the species located at the centre of the universe, attended by sun and stars. With Darwin, he ceased to be the species created and specially endowed by God with soul and reason. With Freud he ceased to be the species whose behavior was – potentially – governable by rational mind. As we begin to produce mechanisms that think and learn, he has ceased to be the species uniquely capable of complex, intelligent manipulation of his environment.

What Computers Mean for Man and Society  
*Science*, Volume 195, Number 4283, March 18, 1977 (p. 190)

## UNITS

**Lodge, Sir Oliver** 1851–1940  
 English physicist

Changing the units does not affect the velocity of light. Whether you say light travels at 186,000 miles a second or whether you say it is so many inches an hour makes no difference to the velocity. An algebraic symbol ought



to represent the thing itself, not a mere number of units. Altering the numerical specifications – which is what you do by altering units – means no difference to the thing itself.

Royal Astronomical Society

*Monthly Notices*, Volume 80, 1919 (p. 107)

## UNITY

### Gray, Jeremy

English mathematician

Mathematicians often speak of the unity of their subject, whether to praise it or lament its passing.

*Linear Differential Equations and Group Theory from Riemann to Poincare* (2nd edition)

Introduction to the First Edition (p. xv)

Birkhäuser. Boston, Massachusetts, USA. 1985

...the unity of mathematics...is often invoked in a rather imprecise way...

*Linear Differential Equations and Group Theory from Riemann to Poincare* (2nd edition)

Introduction to the First Edition (p. xix)

Birkhäuser. Boston, Massachusetts, USA. 1985

## UNIVERSAL LAWS

### National Research Council (U.S.)

Some aspects of nature are neither universal nor permanent – the shape of Cape Cod or even a spiral arm of a galaxy. But the forces that created both Cape Cod and the spiral arm of stars and dust obey universal laws. Discovering that has enabled man to understand more of what goes on in his universe.

*Physics in Perspective* (Volume 1)

Chapter 3 (p. 55)

National Academy of Sciences. Washington, D.C. 1972

## UNIVERSE

### Adams, Douglas 1952–2001

English author, comic radio dramatist, and musician

For a long period of time there was much speculation and controversy about where the so-called “missing matter” of the Universe had got to. All over the Galaxy the science departments of all the major universities were acquiring more and elaborate equipment to probe and search the hearts of distant galaxies, and then the very center and the very edges of the whole Universe, but when eventually it was tracked down it turned out in fact to be all the stuff which the equipment had been packed in.

*The Ultimate Hitchhiker’s Guide to the Galaxy*

*Mostly Harmless*

Chapter 17 (p. 756)

Ballantine Books. New York, New York, USA. 2002

The Universe, as has been observed before, is an unsettlingly big place, a fact which for the sake of a quiet life most people tend to ignore.

*The Ultimate Hitchhiker’s Guide to the Galaxy*

*The Restaurant at the End of the Universe*

Chapter 10 (p. 194)

Ballantine Books. New York, New York, USA. 2002

If the Universe came to an end every time there was some uncertainty about what happened in it, it would never have got beyond the first picosecond. And many of course don’t. It’s like the human body, you see. A few cuts and bruises here and there don’t hurt it. Not even major surgery if it’s done properly. Paradoxes are just the scar tissue. Time and space heal themselves up around them and people remember a version of events which makes as much sense as they require it to make.

*Dirk Gently’s Holistic Detective Agency*

Chapter 32 (p. 283)

Simon & Schuster. New York, New York, USA. 1988

### Alfven, Hannes 1908–95

Swedish physicist

I have never thought that you can get the extremely clumpy, heterogeneous universe we have today from a smooth and homogenous one dominated by gravitation.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 42)

Random House, Inc. New York, New York, USA. 1991

### Amaldi, Ginestra Giovane

Italian physicist

Our imagination has roamed far and wide through distant reaches of the Universe. Understandably, we may have become dazed by the immense dimensions of space and the enormous sizes of some of its occupants.

*Our World and the Universe Around Us* (Volume 1)

First Steps into Space (p. 124)

Abradale Press. New York, New York, USA. 1966

### Apfel, Necia H. 1930–

American astronomer

### Hynek, J. Allen 1910–86

American astronomer

It is hard for us today to assimilate all the new ideas that are being suggested in response to the new information we have. We must remember that our picture of the universe is based not only on our scientific knowledge but also on our culture and our philosophy. What new discoveries lie ahead no one can say. There may well be civilizations in other parts of our galaxy or in other galaxies that have already accomplished much of what lies ahead for mankind. Others may just be beginning. The universe clearly presents an unending challenge.

*Architecture of the Universe*



Chapter 21 (p. 453)  
The Benjamin/Cummings Publishing Company, Inc. Menlo Park,  
California, USA. 1979

**Asimov, Isaac** 1920–92  
American author and biochemist

However glorious and vast the unimaginable depths of  
the universe, we cannot remain lost in its glories forever.

*Asimov's New Guide to Science*

Chapter 3 (p. 95)

Basic Books, Inc. New York, New York, USA. 1984

**Atkins, Peter William** 1940–  
English physical chemist and writer

My aim is to argue that the universe can come into exist-  
ence without intervention, and that there is no need to  
invoke the idea of a Supreme Being in one of its numer-  
ous manifestations.

*The Creation*

Preface

W.H. Freeman. San Francisco, California, USA. 1981

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

Either it is a well-arranged universe or a chaos huddled  
together, but still a universe. But can a certain order sub-  
sist in thee, and disorder in the All?

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, #27 (p. 266)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Author undetermined

On scientific grounds our most passionate appeal to the  
universe is like trying to make a dumb animal speak.

The Reconstruction of Belief

*The Living Age*, Volume ccxlv, Number 3179, June 10, 1905 (p. 655)

**Bacon, Leonard** 1887–1954  
American poet and critic

Eddington's universe goes phut.

Richard Tolman's can open and shut.

Eddington's bursts without grace or tact,

But Tolman's swells and perhaps may contract.

*Rhyme and Punishment*

Richard Tolman's Universe

Farrar & Rinehart, Inc. New York, New York, USA. 1936

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

For the fabric of this universe is like a labyrinth to the  
contemplative mind, where doubtful paths, deceitful imi-  
tations of things and their signs, winding and intricate  
folds and knots of nature everywhere present themselves,  
and a way must constantly be made through the forests  
of experience and particular natures, with the aid of the

uncertain light of the senses, shining and disappearing  
by fits.

In Basil Montague

*The Works of Francis Bacon* (Volume 3)

*The Great Instauration*, Preface (p. 336)

Parry & McMillan. Philadelphia, Pennsylvania, USA. 1859

**Bagehot, Walter** 1826–77  
English journalist

Taken as a whole, the universe is absurd. There seems an  
unalterable contradiction between the human mind and  
its employments.

*Literary Studies* (Volume 1) (p. 36)

J.M. Dent & Sons Limited. London, England. 1951

We are startled to find a universe we did not expect.

*Literary Studies* (Volume 2) (p. 403)

J.M. Dent & Sons Limited. London, England. 1951

**Banks, Sir Joseph** 1743–1820  
English naturalist

...the treasures of the heavens are well known to be inex-  
haustible...

In Charles Richard Weld (ed.)

*A History of the Royal Society, With Memoirs of the Presidents*

Volume 2

Chapter V (p. 149)

John W. Parker. London, England. 1848

**Barbellion, Wilhelm Nero Pilate** 1889–1919  
English author

This great bully of a universe overwhelms me. The stars  
make me cower. I am intimidated by the immensity sur-  
rounding my own littleness.

*The Journal of a Disappointed Man*

March 2, 1917 (p. 283)

George H. Doran Company. New York, New York, USA. 1919

**Barth, John** 1930–  
American writer

All the scientists hope to do is describe the universe math-  
ematically, predict it, and maybe control it. The philoso-  
pher, by contrast, seems unbecomingly ambitious: He  
wants to understand the universe; to get behind phenom-  
ena and operation and solve the logically prior riddles of  
being, knowledge, and value. But the artist, and in particu-  
lar the novelist, in his essence wishes neither to explain  
nor to control nor to understand the universe. He wants  
to make one of his own, and may even aspire to make it  
more orderly, meaningful, beautiful, and interesting than  
the one God turned out. What's more, in the opinion of  
many readers of literature, he sometimes succeeds.

*The Friday Book: Essays and Other Nonfiction*

How to Make a Universe (p. 17)

G.P. Putnam's Sons. New York, New York, USA. 1984

**Bergson, Henri** 1859–1941  
French philosopher

The universe is not made, but is being made continually.  
It is growing, perhaps indefinitely....

Translated by Arthur Mitchell

*Creative Evolution*

Chapter III (p. 255)

The Modern Library. New York, New York, USA. 1944

**Bloch, Arthur** 1948–

American humorist

The universe is simmering down, like a giant stew left to cook for four billion years. Sooner or later we won't be able to tell the carrots from the onions.

In John D. Barrow

*The World Within the World* (p. 221)

Clarendon Press. Oxford, England. 1988

**Blount, Sir Thomas Pope** 1649–97

English author

Whoever surveys the curious fabric of the universe can never imagine, that so noble a structure should be fram'd for no other use, than barely for mankind to live and breathe in. It was certainly the design of the great Architect, that his creatures should afford not only necessaries and accommodations to our animal part, but also instructions to our intellectual.

*A Natural History*

Preface

Printed for R. Bentley. London, England. 1693

**Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

It may seem rash indeed to draw conclusions valid for the whole universe from what we can see from the small corner to which we are confined. Who knows that the whole visible universe is not like a drop of water at the surface of the earth? Inhabitants of that drop of water, as small relative to it as we are relative to the Milky Way, could not possibly imagine that beside the drop of water there might be a piece of iron or a living tissue, in which the properties of matter are entirely different.

*Space and Time*

Note IV (p. 227)

Dover Publications. New York, New York, USA. 1960

**Born, Max** 1882–1970

German-born English physicist

We have sought for firm ground and found none. The deeper we penetrate, the more restless becomes the universe; all is rushing about and vibrating in a wild dance.

*The Restless Universe*

Chapter V (p. 277)

Dover Publications, Inc. New York, New York, USA. 1951

**Bove, Ben**

No biographical data available

The universe lies before us. What we know about it today is merely the steppingstone to a greater, deeper understanding.

*The Milky Way Galaxy*

Chapter 10 (p. 201)

Holt, Rinehart & Winston. New York, New York, USA. 1961

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

...man is the only animal who can face with a thought, a dream, and a smile the mystery and the madness and the terrible beauty of the universe.

*Autobiography of Earth*

Chapter XII, Section III (p. 347)

Coward-McCann, Inc. New York, New York, USA. 1935

**Browne, J. Stark**

No biographical data available

And we, listening to this wonderful music of the spheres, are filled with emotions of the deepest humility and awe, but at the same time with a great pride in the achievements of the mind of man in wrestling from the dark universe about us some of its long-hidden secrets.

*The Rationalist Annual*

The Number and Distances of the Stars, 1931 (p. 66)

**Bruno, Giordano** 1548–1600

Italian philosopher and pantheist

The center of the universe is everywhere, and the circumference nowhere.

In Joseph Silk

*The Big Bang* (p. 84)

W.H. Freeman & Company. San Francisco, California, USA. 1980

The universe is then one, infinite, immobile.... It is not capable of comprehension and therefore is endless and limitless, and to that extent infinite and indeterminable, and consequently immobile.

Translated by Jack Lindsay

*Cause, Principle, and Unity*

Fifth Dialogue (p. 135)

International Publishers. New York, New York, USA. 1962

**Burritt, Elijah H.** 1794–1838

American astronomer

Beyond these are other suns, giving light and life to other systems, not a thousand, or two thousand merely, but multiplied without end, and ranged all around us, at immense distances from each other, attended by ten thousand times ten thousand worlds, all in rapid motion; yet calm, regular and harmonious – all space seems to be illuminated, and every particle of light a world.... And yet all this vast assemblages of suns and worlds may bear no greater proportion to what lies beyond the utmost boundaries of human vision, than a drop of water to the ocean.

*The Geography of the Heavens*

Chapter XVI (p. 153)

Huntington & Savage, Mason & Law. New York, New York, USA. 1850

**Burroughs, John** 1837–1921

American naturalist and essayist

...the universe, considered as a machine, however scientific it may be, has neither value to the spirit nor charm to the imagination.

*Indoor Studies*

Chapter II (p. 64)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

One thing we may affirm about the universe – it is logical; the conclusion always follows from the premise.

*Studies in Nature and Literature*

The Devine Soil (p. 69)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1908

### **Burroughs, William S.** 1914–97

American writer

This is a war universe. War all the time. That is its nature. There may be other universes based on all sorts of other principles, but ours seems to be based on war and games.

The War Universe

*Grand Street* 37, Volume Ten, Number 1, 1991 (p. 95)

### **Bush, Vannevar** 1890–1974

American electrical engineer and physicist

In no other discipline...do men confront mystery and challenge of the order of that which looms down on the astronomers in the long watches of the night. The astronomer knows at first hand...how slight is our earth, how slight and fleeting are mankind.... But more than that, he senses...the majesty which resides in the mind of man because that mind seeks in all its slightness to see, to learn, to understand at least some part of the mysterious majesty of the universe.

In James Mullaney

Some Noted Dreamers Tell of the Skies' Spell

*Science Digest*, June, 1978 (p. 41)

### **Calder, Alexander** 1898–1976

American kinetic sculptor

The universe is real but you can't see it. You have to imagine it.

In Katharine Kuh

*The Artist's Voice: Talks with Seventeen Artists*

Josef Albers (p. 14)

Da Capo Press Edition. Cambridge, Massachusetts, USA. 2000

### **Camus, Albert** 1913–60

French novelist, essayist, and playwright

...I laid my heart open to the benign indifference of the universe.

*The Outsider*

Part II, Chapter V (p. 127)

H. Hamilton. London, England. 1946

### **Campbell, Reginald John** 1867–1956

English Congregationalist

The mysterious universe is always calling, and, in some form or other, we are always answering.

*The New Theology*

Chapter II (p. 16)

The Macmillan Co. New York, New York, USA. 1907

### **Campbell, William Wallace** 1862–1938

American astronomer

He who would explore the universe should begin by knowing his immediate surroundings.

In Astronomical Society of the Pacific

*The Adolfo Stahl Lectures in Astronomy*

The Solar System

Stanford University Press. San Francisco, California, USA. 1919

### **Card, Orson Scott** 1951–

Science fiction writer

Give the universe a push, and you don't know which dominoes will fall. There are always a few you never thought were connected.

*Ender's Shadow*

Chapter 22 (p. 342)

TOR. New York, New York, USA. 1999

### **Carlyle, Thomas** 1795–1881

English historian and essayist

Margaret Fuller: I accept the Universe.

Thomas Carlyle: Gad! she'd better!

In D.A. Wilson

*Carlyle on Cromwell and Others*

Looking Round, Margaret Fuller Has to Listen (pp. 349–350)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1925

I don't pretend to understand the Universe – it's a great deal bigger than I am.

In D.A. Wilson and D.W. MacArthur

*Carlyle in Old Age (1865–1881)* (p. 177)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1934

### **Carpenter, Edward** 1844–1929

English socialist poet and socialist philosopher

...nothing is more certain than that worlds on worlds, and spheres on spheres, stretch behind and beyond the actually seen.

*The Drama of Love and Death: A Study of Human Evolution and Transfiguration*

Chapter VII (p. 113)

Mitchell Kennerley, New York, New York, USA. 1912

### **Cayton, Elizabeth**

Actress

Our universe is vast, full of wonders. We'll explore, find strange new worlds, together.

*Slave Girls from Beyond Infinity*

Film (1987)

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

But perhaps the universe is suspended on the tooth of some monster.

*Note-Book of Anton Chekhov* (p. 20)  
B.W. Huebsch, Inc. New York, New York, USA. 1921

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

There is no reason to assume that the universe has the slightest interest in intelligence – or even in life. Both may be random accidental by-products of its operations like the beautiful patterns on a butterfly’s wings. The insect would fly just as well without them....

*The Lost Worlds of 2001*  
Chapter 16 (p. 109)  
New American Library. New York, New York, USA. 1972

Every thoughtful man has often asked himself: Is our race the only intelligence in the universe, or are there other, perhaps far higher, forms of life elsewhere? There can be few questions more important than this, for upon its outcome may depend all philosophy – yes, and all religion, too.

Lecture  
St Martin’s Technical School on Charing Cross Road, October 5, 1946

The universe: a device contrived for the perpetual astonishment of astronomers.

In Clifford A. Pickover  
*Keys to Infinity*  
Chapter 5 (p. 41)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

Many and strange are the universes that drift like bubbles in the foam of the river of time.

*The Collected Stories of Arthur C. Clarke*  
The Wall of Darkness (p. 104)  
Tom Doherty Associates. New York, New York, USA. 2001

...the universe has no purpose and no plan...

*The Collected Stories of Arthur C. Clarke*  
The Star (p. 521)  
Tom Doherty Associates. New York, New York, USA. 2001

...the universes...drift like bubbles in the foam upon the River of Time.

The Wall of Darkness  
*Super Science Stories*, July 1949

When the first rocket lands on our satellite, the romantic writers will have lost the Moon, but it will be a small sacrifice, for the Universe will still remain as their playground.

*The Exploration of Space*  
Chapter 1 (p. 8)  
Harper & Brothers Publishers. New York, New York, USA. 1951

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

Progress, then, is the law of the universe. From its present state we can obscurely argue a “has been” and a “shall be.”

*The System of the Stars*  
Chapter XXV (p. 397)  
Longmans, Green & Co. London, England. 1890

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

It surely is not impossible that to some infinitely superior being the whole universe may be as one plain, the distance between planet and planet being only as the pores in a grain of sand, and the spaces between system and system no greater than the intervals between one grain and the grain adjacent.

*The Table Talk and Omniana of Samuel Taylor Coleridge*  
Omniana  
The Universe (p. 415)  
George Bell & Sons. London, England. 1884

**Conger, George Perrigo** 1884–1960  
American philosopher

The universe as revealed in modern days and ways is so overwhelming that mind needs some other title than that of self-appointed legislator for it. Mind must register before it can regulate.

*A World of Epitomizations: A Study in the Philosophy of the Sciences*  
Introduction to Division Two (pp. 345–346)  
Princeton University Press. Princeton, New Jersey, USA. 1931

**Conklin, Edwin Grant** 1863–1952  
American zoologist

Reason and consciousness have disclosed to man a vast and mysterious universe, in which there are stupendous forces and processes which he but dimly apprehends and the meaning and purpose of which he cannot understand.

*The Direction of Human Evolution*  
art III, Chapter I (p. 162)  
Charles Scribner’s Sons. New York, New York, USA. 1922

**Cook, Peter** 1937–95  
English comedian

I am very interested in the Universe – I am specializing in the Universe and all that surrounds it.

*Beyond the Fringe*  
Disc 2, Sitting on the Bench  
EMI International. 1996

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

But they say that beyond the heavens there isn’t anybody or place or void or anything at all; and accordingly it is not possible for the heavens to move outward: in that case it is rather surprising that something can be held together by nothing. But if the heavens were infinite and were finite only with respect to a hollow space inside, then it will be said with more truth that there is nothing of heaven, since anything which occupied any space would be in them, but the heavens will remain immobile. For movement is the most powerful reason wherewith they try to conclude that the universe is finite.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*  
Book One, Chapter 8 (p. 519)  
Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Crane, Stephen** 1871–1900  
American writer

A man said to the universe:

“Sir I exist!”

“However,” replied the universe,

“The fact has not created in me

A sense of obligation.”

*The Collected Poems of Stephen Crane*

War Is Kind (p. 101)

Alfred A. Knopf. New York, New York, USA. 1965

**Croswell, Ken**

American astronomer and author

Is it mere coincidence that the universe happens to possess just those properties which allow part of it to be alive? Some people say yes; it was simply good luck that the universe was born with the particular characteristics that it has. Others say no; our universe is only one of many universes.... Still others, of a more spiritual persuasion, see the universe's remarkable offspring as a sign that an intelligent creator wrote a tremendous symphony whose melodies the stars, galaxies, and planets now play with beauty and precision.... Whatever the case, and vast and complex though the universe is, its most astonishing features are two of the simplest: it exists, and so do we.

*Planet Quest: The Epic Discovery of Alien Solar Systems*

Chapter 12 (p. 247)

Oxford University Press, Inc. Oxford, England. 1997

**Crowley, Aleister** 1875–1947

British occultist and writer

It sometimes strikes me that the whole of science is a piece of impudence; that nature can afford to ignore our impertinent interference. If our monkey mischief should ever reach the point of blowing up the earth by decomposing an atom, and even annihilated the sun himself, I cannot really suppose that the universe would turn a hair.

*The Confessions of Aleister Crowley: An Autohagiography*

Part One, Chapter 14 (p. 128)

Arkana. London, England. 1989

I have never grown out of the infantile belief that the universe was made for me to suck.

*The Confessions of Aleister Crowley: An Autobiography*

Part Three, Chapter 54 (p. 460)

Arkana. London, England. 1989

**D'Alembert, Jean Le Rond** 1717–83

French mathematician

To someone who could grasp the universe from a unified standpoint, the entire creation would appear as a unique truth and necessity.

In Charles W. Misner et al.

*Gravitation*

Part X, Chapter 44 (p. 1218)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Dampier, Sir William Cecil** 1867–1952

English scientific writer

Confronted with the mystery of the Universe, we are driven to ask if the model our minds have framed at all corresponds with the reality; if, indeed, there be any reality behind the image.

*The Recent Development of Physical Science*

Chapter I (p. 12)

P. Blackiston's Sons & Co. Philadelphia, Pennsylvania, USA. 1904

**Dantzig, Tobias** 1884–1956

Russian mathematician

...has the universe an existence *per se* or does it exist only in the mind of man? To the man of science, the acceptance of the one hypothesis or the other is not at all a question of “to be or not to be”; for from the standpoint of logic either hypothesis is tenable, and from the standpoint of experience neither is demonstrable. So the choice will forever remain a matter of expediency and convenience. The man of science will act *as if* this world were an absolute whole controlled by laws independent of his own thoughts or acts; but whenever he discovers a law of striking simplicity or one of sweeping universality or one which points to a perfect harmony in the cosmos, he will be wise to wonder what rôle his mind has played in the discovery, and whether the beautiful image he sees in the pool of eternity reveals the nature of this eternity, or is but a reflection of his own mind.

*Number, the Language of Science*

Chapter Eleven (p. 233)

The Macmillan Co. New York, New York, USA. 1954

**Darling, David** 1953–

British astronomer and science writer

In giving birth to us, the universe has performed its most astonishing creative act. Out of a hot, dense melee of subatomic particles...it has fashioned intelligence and consciousness.... Somehow the anarchy of genesis has given way to exquisite, intricate order, so that now there are portions of the universe that can reflect upon themselves....

*Equations of Eternity: Speculations on Consciousness, Meaning, and the Mathematical Rules that Orchestrate the Cosmos*

Introduction (p. xiii)

Hyperion. New York, New York, USA. 1993

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Mathematics and beauty are the foundation stones of the universe. No one who has studied the forces of nature can doubt that the world about us is a manifestation of something very, very clever indeed.



*The Forces of Nature* (2nd edition)  
Conclusion (p. 167)  
Cambridge University Press. Cambridge, England. 1983

If there is a purpose to the universe, and it achieves that purpose, then the universe must end, for its continued existence would be gratuitous and pointless. Conversely, if the universe endures forever, it is hard to imagine that there is any ultimate purpose to the universe at all. So cosmic death may be the price that has to be paid for cosmic success. Perhaps the most that we can hope for is that the purpose of the universe becomes known to our descendants before the end of the last three minutes.

*The Last Three Minutes: Conjectures about the Ultimate Fate of the Universe*

Chapter 11 (p. 155)  
Basic Books, Inc. New York, New York, USA. 1994

### Davis, Watson

The most wide-flung task in the universe is the exploration of the universe itself.

*The Advance of Science*  
Chapter 1 (p. 1)  
Doubleday, Dorian & Co. Garden City, New York, USA. 1934

### Davy, Sir Humphry 1778–1829

English chemist

...we cannot be too grateful for that wonderful constitution of the external universe, by which it is rendered an inexhaustible source of interest to the inexhaustible human mind...

In John Davy (ed.)  
*Memoirs of the Life of Sir Humphry Davy* (Volume 1)  
Chapter III (p. 217)  
Longman, Rees, Orme, Brown, Green & Longman London, England. 1836

It is contrary to the usual order of things, that events so harmonious as those of the system of the world, should depend on such diversified agents as are supposed to exist in our artificial arrangements; and there is reason to anticipate a great reduction in the number of uncompounded bodies, and to expect that the analogies of nature will be found conformable to the refined operations of art. The more the phenomena of the universe are studied, the more distinct their connection appears, and the more simple their causes, the more magnificent their design, and the more wonderful the wisdom and power of their Author.

In J. Davy  
*The Collected Works of Sir Humphry Davy* (Volume 4)  
Historical View of the Progress of Chemistry (p. 42)  
Smith, Elder & Co. London, England. 1840

### Dawkins, Richard 1941–

British ethologist, evolutionary biologist, and popular science writer

I believe that an orderly universe, one indifferent to human preoccupations, in which everything has an explanation even if we still have a long way to go before we

find it, is a more beautiful, more wonderful place than a universe tricked out with capricious, ad hoc magic.

*Unweaving the Rainbow: Science, Delusion and The Appetite for Wonder*

Preface (p. xi)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

### Day, Clarence S. 1874–1935

American writer

Is it possible that our race may be an accident, in a meaningless universe, living its brief life uncared for, on this dark, cooling star: but so – and all the more – what marvelous creatures we are! What fairy story, what tale from the Arabian Nights of the Jinns, is a hundredth part as wonderful as this story of simians! It is so much more heartening, too, than the tales we invent. A universe capable of giving birth to so many accidents is – blind or not – a good world to live in, a promising universe.

*This Simian World*

Chapter XIX (p. 91)  
Alfred A. Knopf. New York, New York, USA. 1941

### de Coulevain, Pierre 1853–1927

French writer

...everywhere throughout the whole Universe, everything is linked together...

Translated by Alys Hallard  
*The Heart of Life*  
Chapter VI (p. 401)  
E.P. Dutton & Company, Inc. London, England. 1912

### de Fontenelle, Bernard le Bovier 1657–1757

French author

How vast then! And beyond all reckoning, and beyond all mensuration must the spaces of the universe be!

*Conversations on the Plurality of Worlds*  
The Fifth Evening (p. 151, fn)  
Printed for Peter Wilson. Dublin, Ireland. 1761

...I see the universe so large...that I know not where I am, or what will become of me.

*Conversations on the Plurality of Worlds*  
The Fifth Evening (p. 151)  
Printed for Peter Wilson. Dublin, Ireland. 1761

...the universe is but a watch on a larger scale; all its motions depending on determined laws and mutual relation of its parts.

*Conversations on the Plurality of Worlds*  
The First Evening (p. 10)  
Printed for Peter Wilson. Dublin, Ireland. 1761

...when the heavens appeared to me as a little blue vault, stuck with stars, methought the universe was too straight and close, I was almost stifled for want of air; but now, it is enlarged in height and breadth, and a thousand and a thousand vortexes taken in, I begin to breathe with more freedom, and think the universe to be incomparably more magnificent than it was before.



*Conversations on the Plurality of Worlds*  
The Fifth Evening (pp. 151–152)  
Printed for Peter Wilson. Dublin, Ireland. 1761

**de Morgan, Augustus** 1806–71  
English mathematician and logician

We divide the visible universe into earth and heavens, just as an insect who is bred in a tree would, if it could, speak of the things within its knowledge as consisting of its native branch and all the rest of the forest.

*The Globes, Celestial and Terrestrial*  
Introduction (p. 1)  
Malby & Co. London, England. 1845

**de Sitter, Willem** 1872–1934  
Dutch mathematician, physicist, and astronomer

Our conception of the structure of the Universe bears all the marks of a transitory structure. Our theories are decidedly in a state of continuous and just now very rapid evolution.

In J.H.F. Umbgrove  
*The Pulse of the Earth*  
Chapter I (p. 1)  
Martinus Nijhoff. The Hague, Netherlands. 1947

After all, the universe is an hypothesis, like the atom, and must be allowed the freedom to have properties and to do things which would be contradictory and impossible for a fine material structure.... The conclusions derived about the expanding universe depend on the assumed homogeneity and isotropy – i.e., on the hypothesis that the observed finite material density and expansion of our neighbourhood are not local phenomena, but properties of the “universe”. It is not inconceivable that this hypothesis may at some future stage of the development of science have to be given up, or modified, or at least differently interpreted.

*Kosmos* (p. 133)  
Harvard University Press. Cambridge, Massachusetts, USA. 1932

**de Vries, Peter** 1910–93  
American editor and novelist

The universe is like a safe to which there is a combination but the combination is locked up in the safe.

*Let Me Count the Ways*  
Chapter Twenty-Two (p. 307)  
Little, Brown & Company. Boston, Massachusetts, USA. 1965

**Dee, John** 1527–1609  
English mathematician and occultist

The entire universe is like a lyre tuned by some excellent artificer, whose strings are separate species of the universal whole.

Translated by Wayne Schumaker  
*John Dee on Astronomy*  
XI (p. 127)  
University of California Press. Berkeley, California, USA. 1978

**DeLillo, Don** 1936–  
American novelist

It’s the size of things that worries people. No reason for the universe to be so large.

*Ratner’s Star*  
Vintage Contemporaries. Toronto, Ontario, Canada. 1976

**Deutsch, Karl W.** 1912–92  
Czech-born American international political scientist

Any universe uneven enough to sustain the life of a flat-worm should perhaps be uneven enough to be eventually known by man.

Mechanism, Organism, and Society: Some Models in Natural and Social Science  
*Philosophy of Science*, Volume 18, Number 3, July, 1951 (p. 231)

**Dewar, Redcote**  
No biographical data available

The universe thus unrolls before our eyes as a magnificently coloured and gaily caparisoned pageant of things great and small, transient and durable, yet beginningless and endless; for into the eternal past it rolls never more to be seen, and out of the eternal present it unwinds, full-blown and complete, the same yesterday, today, and forever.

*From Matter to Man: A New Theory of the Universe*  
Chapter XIX (p. 288)  
Chapman & Hall, Ltd. London, England. 1898

**Dickens, Charles** 1812–70  
English novelist

No; we cannot figure to ourselves such a final limit to the extent of the universe, such a ring-fence enclosing all things created. It is far easier both to grant and to understand that space *must* be infinitely extendable.

The Universe  
*All the Year Round: A Weekly Journal*, Volume 2, June 5 to November 27, 1869 (p. 10)

**Digges, Thomas** 1546–95  
English mathematician and astronomer

This orb of stars, infinitely up extendeth...garnished with perpetual shining glorious lights innumerable, far exceeding our sun both in quantity and quality...wonderful & incomprehensible huge frame of God’s work...we live on a dark and obscure *Terrestrial Star*, where, wandering as strangers, we lead, in a short space of time, a life harassed by varied fortunes.”

*Perfect Description of the Celestial Orbs*  
Publisher undetermined

**Dillard, Annie** 1945–  
American poet, essayist, novelist, and writing teacher

The universe was not made in jest but in solemn incomprehensible earnest.

*Pilgrim at Tinker Creek*

Chapter 15 (p. 270)

Harper's Magazine Press. New York, New York, USA. 1974

**du Prel, Karl** 1839–99

German hypnosis researcher

The universe as a totality is without cause, without origin, without end.

In Ludwig Buchner

*Force and Matter* (p. 11)

Truth Seeker. New York, New York, USA. 1950

**Duke of Argyll (George Douglas**

**Campbell)** 1823–1900

English statesman and writer on science, religion, and politics

The System of Nature in which we live impresses itself on the mind as one System. It is under this impression that we speak of it as the Universe.

*The Unity of Nature*

Chapter I (p. 1)

G.P. Putnam's Sons. New York, New York, USA. 1885

**Dyson, Freeman J.** 1923–

American physicist and educator

As a working hypothesis to explain the riddle of our existence, I propose that our universe is the most interesting of all possible universes, and our fate as human beings is to make it so.

*Infinite in All Directions*

Preface (p. vii)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

I have found a universe growing without limit in richness and complexity, a universe of life surviving forever and making itself known to its neighbors across unimaginable gulfs of space and time. Whether the details of my calculations turn out to be correct or not, there are good scientific reasons for taking seriously the possibility that life and intelligence can succeed in molding this universe of ours to their own purposes.

*Infinite in All Directions*

Part One, Chapter Six (p. 117)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

The hypothesis is that the universe is constructed according to a principle of maximum diversity. The principle of maximum diversity operates both at the physical and at the mental level. It says that the laws of nature and the initial conditions are such as to make the universe as interesting as possible. As a result, life is possible but not too easy. Always when things are dull, something new turns up to challenge us and to stop us from settling into a rut. Examples of things which make life difficult are all around us: comet impacts, ice ages, weapons, plagues, nuclear fission, computers, sex, sin and death. Not all challenges can be overcome, and so we have tragedy. Maximum diversity often leads to maximum stress. In the end we survive, but only by the skin of our teeth.

*Infinite in All Directions*

Part Two, Chapter Seventeen (p. 298)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

As we look out into the Universe and identify the many accidents of physics and astronomy that have worked together to our benefit, it almost seems as if the Universe must in some sense have known that we were coming.

In John D. Barrow and Frank J. Tipler

*The Anthropic Cosmological Principle*

Chapter 5.5 (p. 318)

Clarendon Press. Oxford, England. 1986

I do not feel like an alien in this universe. The more I examine the universe and study the details of its architecture, the more evidence I find that the universe in some sense must have known that we were coming.

*Disturbing the Universe*

Chapter 23 (p. 250)

Basic Books, Inc. New York, New York, USA. 1979

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The unanimity with which the galaxies are running away looks almost as though they had a pointed aversion to us. We wonder why we should be shunned as though our system were a plague spot in the universe.

*The Expanding Universe*

Chapter I, Section III (p. 12)

The University Press. Cambridge. 1933

Meanwhile the knowledge that has been attained shows only the more plainly how much there is to learn. The perplexities of today foreshadow the discoveries of the future. If we have still to leave the stellar universe a region of hidden mystery, yet it seems as though, in our exploration, we have been able to glimpse the outline of some vast combination which unites even the farthest stars into an organised system.

*Stellar Movements and the Structure of the Universe*

Chapter XII (p. 261)

Macmillan & Company Ltd. London, England. 1914

I would feel more content that the universe should accomplish some great scheme of evolution and, having achieved whatever may be achieved, lapse back into chaotic changelessness, than its purpose should be banalised by continual repetition. I am an Evolutionist, not a Multiplicationist. It seems rather stupid to keep doing the same thing over and over again.

*The Nature of the Physical World*

Chapter IV (p. 86)

The Macmillan Company. New York, New York, USA. 1930

Looking back through the long past we picture the beginning of the world – a primeval chaos which time has fashioned into the universe that we know. Its vastness appalls the mind; space boundless though not infinite, according to the strange doctrine of science.

*Science and the Unseen World*

Lecture I (p. 11)

The Macmillan Co. New York, New York, USA. 1929

If we have still to leave the stellar universe a region of hidden mystery, yet it seems as though, in our exploration, we have been able to glimpse the outline of some vast combination which unites even the farthest stars into an organised system.

*Stellar Movements and the Structure of the Universe*  
Chapter XII (p. 261)  
Macmillan & Co Ltd. London, England. 1914

...the theory of the expanding universe is in some respects so preposterous that we naturally hesitate to commit ourselves to it. It contains elements apparently so incredible that I feel almost an indignation that anyone should believe in it – except myself.

*The Expanding Universe*  
Chapter III, Section IV (pp. 86–87)  
At the University Press. Cambridge, England. 1952

### Editorial

It is obvious that we must regard the universe as extending infinitely, forever, in every direction; or that we must regard it as not so extending. Both possibilities go beyond us.

Einstein's Finite Universe  
*Scientific American*, Volume 124, Number 11, March 12, 1921 (p. 202)

**Ehrmann, Max** 1872–1945  
American lawyer and writer

You are a child of the universe, no less than the trees and the stars; you have a right to be here. And whether or not it is clear to you, no doubt the universe is unfolding as it should.

*Desiderata*  
Published by author. 1927

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

Do I dare

Disturb the universe?

In a minute there is time

For decisions and revisions which a minute will reverse.

*The Collected Poems and Plays 1909–1950*  
The Love Song of J. Alfred Prufrock (p. 5)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Elliot, Hugh** 1752–1830  
British diplomat and adventurer

No sign of purpose can be detected in any part of the vast universe disclosed by our most powerful telescopes.

*Modern Science and Materialism* (p. 39)  
Longmans, Green & Company. 1919

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Philosophically considered, the universe is composed of Nature and the Soul.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*  
Introduction (p. 8)  
The Library of America. New York, New York, USA. 1983

We are taught by great actions that the universe is the property of every individual in it.

*Ralph Waldo Emerson: Essays and Lectures*  
*Nature: Addresses, and Lectures*  
Beauty (p. 16)  
The Library of America. New York, New York, USA. 1983

Everything in the universe goes by indirection. There are no straight lines.

*The Complete Works of Ralph Waldo Emerson (Volume 7)*  
*Society and Solitude*  
Works and Days (p. 181)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

...the universe does not jest with us, but is in earnest...

*Letters and Social Aims*  
Poetry and Imagination (p. 3)  
James R. Osgood & Company. Boston, Massachusetts, USA. 1876

There are no fixtures in nature. The universe is fluid and volatile. Permanence is but a word of degrees. Our globe seen by God, is a transparent law, not a mass of facts. The law dissolves the fact, and holds it fluid.

*Essays, Orations and Lectures*  
Circles (p. 173)  
William Tegg & Co. London, England. 1848

**Engard, Charles J.**  
American botanist

We accept the universe as far as we know it, but we do not attempt to explain why it exists. It is difficult enough to understand how!

In Johann Wolfgang von Goethe, Bertha Mueller, and Charles J. Engard  
*Goethe's Botanical Writings*  
Introduction (p. 14)  
University of Hawaii Press. Honolulu, Hawaii, USA. 1952

**Estling, Ralph**  
No biographical data available

There is no question about there being design in the Universe. The question is whether this design is imposed from the Outside or whether it is inherent in the physical laws governing the Universe. The next question is, of course, who or what made these physical laws.

*The Skeptical Inquirer*, Spring 1993

I do not know what, if anything, the Universe has in its mind, but I am quite, quite sure that, whatever it has in its mind, it is not at all like what we have in ours. And, considering what most of us have in ours, it is just as well.

*The Skeptical Inquirer*, Spring 1993

**Euler, Leonhard** 1707–83  
Swiss mathematician and physicist

For since the fabric of the universe is most perfect and the work of a most wise Creator, nothing at all takes

place in the universe in which some rule of maximum or minimum does not appear.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 573)  
Oxford University Press, Inc. New York, New York, USA. 1972

**Ferris, Timothy** 1944–

American science writer

There could be more life out there than we've ever imagined – for if the universe has taught us anything, it is that reality is richer and more resourceful than our wildest dreams.

*Life Beyond Earth*

The Ice Zone (p. 116)

Simon & Schuster. New York, New York, USA. 2000

We live in a changing universe, and few things are changing faster than our conception of it.

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 11)

Simon & Schuster. New York, New York, USA. 1996

**Feynman, Richard P.** 1918–88

American theoretical physicist

This universe has been described by many, but it just goes on, with its edge as unknown as the bottom of the bottomless sea of the other ideas – just as mysterious, just as awe-inspiring, and just as incomplete as the poetic pictures that came before.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 10)

Perseus Books. Reading, Massachusetts, USA. 1998

Is no one inspired by our present picture of the universe? The value of science remains unsung by singers: you are reduced to sharing not a song or poem, but an evening lecture about it. This is not yet a scientific age.

*What Do You Care What Other People Think?*

The Value of Science (p. 244)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

A poet once said, “The whole universe is in a glass of wine.” We will probably never know in what sense he meant that, for poets do not write to be understood.... How vivid is the claret, pressing its existence into the consciousness that watches it! If our small minds, for some convenience, divide this glass of wine, this universe, into parts – physics, biology, geology, astronomy, psychology, and so on – remember that nature does not know it! So let us put it all back together, not forgetting

ultimately what it is for. Let it give us one more final pleasure: drink it and forget it all!

*The Feynman Lectures on Physics* (Volume 1)

Chapter 3-7 (p. 3-10)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Field, Edward** 1924–

American poet

Look, friend, at this universe

With its spiral clusters of stars

Flying out all over space

Like bedsprings suddenly bursting free;

*New and Selected Poems from the Book of My Life*

From Stand Up, Friend, with Me (1963) Prologue

**Flammarion, Camille** 1842–1925

French astronomer and author

May we conclude, then, that in these successive endings the universe will one day become an immense and dark tomb. No: otherwise it would already have become so during a past eternity. There is in nature something else besides blind matter; an intellectual law of progress governs the whole creation; the forces which rule the universe cannot remain inactive. The stars will rise from their ashes. The collision of ancient wrecks causes new flames to burst forth, and the transformation of motion into heat creates nebulae and worlds. Universal death shall never reign.

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter VII (p. 80)

Chatto & Windus. London, England. 1894

When the last human eyelid closes here below, and our globe – after having been for so long the abode of life with its passions, its labour, its pleasures and its pains, its loves and its hatred, its religious and political expectations and all its vain finalities – is enshrouded in the winding-sheet of a profound night, when the extinct sun wakes no more; well, then – then, as today, the universe will be as complete, the stars will continue to shine in the sky, other suns will illuminate other worlds, other springs will bring round the bloom of flowers and the illusions of youth, other mornings and other evenings will follow in succession, and the universe will move on as at present; for creation is developed in infinity and eternity.

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter VI (p. 164)

Chatto & Windus. London, England. 1894

What pleasures await us in the study of the Universe! Nothing could speak more eloquently to our heart and intellect!

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Introduction (p. 13)

D. Appleton & Co. New York, New York, USA. 1915

**France, Anatole (Jean Jacques Brousson)** 1844–1924  
French writer

The universe which science reveals to us is a dispiriting monotony. All the suns are drops of fire and all the planets are drops of mud.

In Stanley L. Jacki  
*Creator*  
Chapter Two (p. 26)  
Scottish Academic Press. Edinburgh, Scotland. 1980

If desire lends a grace to whatsoever be the object of it, then the desire of the unknown makes beautiful the Universe.

*My Friend's Book*  
Chapter XI (p. 159)  
Dodd, Mead & Company. New York, New York, USA. 1924

**Frayn, Michael** 1933–  
English dramatist

The complexity of the universe is beyond expression in any possible notation. Lift up your eyes. Not even what you see before you can ever be fully expressed. Close your eyes. Not even what you see now.

*Constructions*  
No. 1  
Wildwood House. London, England. 1974

**Friedman, Herbert** 1916–2000  
American space scientist and astrophysicist

It is impossible for any sensitive person to look at a star-filled sky without being stirred by thoughts of creation and eternity. The mystery of the origin and destiny of the universe haunts us throughout our lives.

*The Amazing Universe*  
Chapter VII (p. 166)  
National Geographic Society. 1975

**Fritsch, Harald** 1943–  
German theoretical physicist

The universe is more than merely an accretion of electrons, quarks, and galaxies, more than space and time. The complex, interrelated world of the earth which created us is part of it. It is our duty not only to ourselves to preserve this world. The universe itself imposes this task on us.

*The Creation of Matter: The Universe from Beginning to End*  
Chapter 17 (p. 282)  
Basic Books, Inc. New York, New York, USA. 1984

**Frost, Robert** 1874–1963  
American poet

The Universe is but the Thing of Things  
The things but balls all going round in rings  
Some of them mighty huge, some mighty tiny  
All of them radiant and might shiny.

*Complete Poems of Robert Frost*  
Accidentally on Purpose  
Henry Holt & Company. New York, New York, USA. 1949

...all reasoning is in a circle. At least that's why the universe is round.

*Complete Poems of Robert Frost*  
Build the Soil  
Henry Holt & Company. New York, New York, USA. 1949

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

No one will be able to read the great book of the Universe if he does not understand its language which is that of mathematics.

In A. Zee  
*Fearful Symmetry*  
Chapter 9 (p. 122)  
Macmillan Publishing Company. New York, New York, USA. 1986

Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it.

Translated by Stillman Drake  
*Discoveries and Opinions of Galileo*  
The Assayer (pp. 237–238)  
Doubleday & Company, Inc. New York, New York, USA. 1957

I should think that anyone who considered it more reasonable for the whole universe to move in order to let the Earth remain fixed would be more irrational than one who should climb to the top of a cupola just to get a view of the city and its environs, and then demand that the whole countryside should revolve around him so that he would not have to take the trouble to turn his head.

*Dialogues Concerning the Two Chief World Systems*  
Second Day (p. 115)  
University of California Press. Berkeley, California, USA. 1967

**Gaarder, Jostein** 1952–  
Norwegian intellectual

It is enough to hold a stone in your hand. The universe would have been equally incomprehensible if it had only consisted of that one stone the size of an orange. The question would be just as impenetrable: Where did this stone come from.

Translated by Paulette Møller  
*Sophie's World: A Novel about the History of Philosophy*  
The Big Bang (p. 389)  
Farrar, Straus & Giroux. New York, New York, USA. 1994

The universe has no timeless geography. The universe is a happening.

Translated by Paulette Møller  
*Sophie's World: A Novel about the History of Philosophy*  
The Big Bang (p. 393)  
Farrar, Straus & Giroux. New York, New York, USA. 1994



**Gamow, George** 1904–68  
Russian-born American physicist

Shall we consider the universe as extending into infinity and conclude that bigger and better telescopes will always reveal to the inquiring eye of an astronomer new and hitherto unexplored regions of space, or must we believe, on the contrary, that the universe occupies some very big but nevertheless finite volume, and is, at least in principle, explorable down to the last star?

*One Two Three...Infinity: Facts and Speculations of Science*  
Part IV, Chapter X (p. 294)  
The Viking Press. New York, New York, USA. 1947

**Giacconi, Riccardo** 1931–  
Italian-born American astrophysicist

The universe is popping all over the place.  
*NY Times*, May 8, 1984

**Giraudoux, Jean** 1882–1944  
French novelist, playwright, and essayist

COUNTESS: I know perfectly well that at this moment the whole universe is listening to us – and that every word we say echoes to the remotest star.

English adaptation by Maurice Valency  
*The Madwoman of Chaillot*  
Act Two (p. 94)  
Random House, Inc. New York, New York, USA. 1947

**Gleiser, Marcello** 1959–  
Brazilian-born physicist and astronomer

Our planet is not in a special place in the solar system, our Sun is not in a special place in our galaxy and our galaxy is not in a special place in the Universe.

*The Dancing Universe*  
Chapter 9 (p. 274)  
The Penguin Group. New York, New York, USA. 1997

**Guth, Alan** 1947–  
American physicist

The universe may be the ultimate free lunch.  
In P.C.W. Davies (ed.)  
*The New Physics*  
The Inflationary Universe (p. 54)  
Cambridge University Press. Cambridge, England. 1989

**Guth, Alan** 1947–  
American physicist

**Steinhardt, Paul**  
American physicist

The inflationary model of the universe provides a possible mechanism by which the observed universe could have evolved from an infinitesimal region. It is then tempting to go one step further and speculate that the entire universe evolved from literally nothing.

The Inflationary Universe  
*Scientific American*, Volume 250, Number 5, May, 1984 (p. 128)

**Guyau, Jean-Marie** 1854–88  
French philosopher and poet

To explain the universe by hydrogen is like explaining it by the sun and the planets.

*The Non-religion of the Future: A Sociological Study*  
Part Third, Chapter V (p. 489)  
Henry Holt & Co. New York, New York, USA. 1897

**Halacy, Jr., D. S.**  
No biographical data available

Our universe operates not at the whims of those who live in it, but by inexorable natural laws.

*They Gave Their Names to Science*  
Prologue (p. 9)  
G.P. Putnam's Sons. New York, New York, USA. 1967

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

...the universe is not only queerer than we suppose but it is queerer than we can suppose.

*Possible Worlds and Other Papers*  
Chapter XXXIV (p. 298)  
Harper & Brothers Publishers. New York, New York, USA. 1928

The conclusion forced upon me in the course of a life devoted to natural science is that the universe as it is assumed to be in physical science is a spiritual universe in which spiritual values count for everything.

*The Sciences and Philosophy* (p. 260)  
Doubleday & Co., Inc. New York, New York, USA. 1929

**Hale, George Ellery** 1868–1938  
American astronomer

It is a far cry from the facile imaginings of the philosopher to the rigorous demonstrations of exact science, and the true structure of the universe is not yet known.

*Beyond the Milky Way*  
Beyond the Milky Way (p. 100)  
Charles Scribner's Sons. New York, New York, USA. 1926

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

'Imaginary' universes are so much more beautiful than this stupidly constructed 'real' one; and most of the finest products of an applied mathematician's fancy must be rejected, as soon as they have been created, for the brutal but sufficient reason that they do not fit the facts.

*A Mathematician's Apology*  
Section 26 (p. 135)  
Cambridge University Press. Cambridge, England. 1967

**Harrison, Edward Robert**  
Cosmologist

What determines the design of a universe; is it the Universe, God, fortuity, or the human mind?



*Masks of the Universe*

Chapter 1 (p. 5)

Macmillan Publishing Company. New York, New York, USA. 1985

We cannot doubt the existence of an ultimate reality. It is the Universe forever masked. We are part of an aspect of it, and the masks figured by us are the Universe observing and understanding itself from a human point of view. When we doubt the Universe we doubt ourselves. The Universe thinks, therefore it is.

*Masks of the Universe*

Chapter I (p. 14)

Macmillan Publishing Company. New York, New York, USA. 1985

The universe consists only of atoms and the void: all else is opinion and illusion.

*Masks of the Universe*

Chapter 4 (p. 55)

Macmillan Publishing Company. New York, New York, USA. 1985

We do not know what sets limits to the Great Chain of hierarchical structures, nor do we know what unifies it. We are clueless as to why atoms exist and why the Universe is structured the way it is. Of course, if the Universe were structured in any other way, we would not be here asking these pertinent questions; or so we are told. But I am a heretic and inclined to think the other way: without us this Universe would not be here.

## A Twinkle in the Eye of the Universe

*Quarterly Journal of the Royal Astronomical Society*, Volume 25, Number 4, December, 1984 (p. 428)

From the outset we must decide whether to use Universe or universe. This in not so trivial a matter as it might seem. We know of only one planet called Earth; similarly, we know of only one Universe. Surely then the proper word is Universe?

*Cosmology: The Science of the Universe*

Chapter 1 (p. 10)

Cambridge University Press. Cambridge, England. 1981

**Haught, James A.**

No biographical data available

The universe is a vast, amazing, seething dynamo which has no discernable purpose except to keep on churning. From quarks to quasars, it's alive with incredible power. But it seems utterly indifferent to any moral laws. It destroys as blindly as it nurtures.

*2000 Years of Disbelief: Famous People with The Courage to Doubt*

Afterthought (p. 324)

Prometheus Books. Amherst, New York, USA. 1996

**Hawking, Stephen William** 1942–

English theoretical physicist

There ought to be something very special about the boundary conditions of the universe and what can be more special than the condition that there is no boundary.

In John D. Barrow and Frank J. Tipler

*The Anthropic Cosmological Principle*

Chapter 6.15 (p. 444)

Clarendon Press. Oxford, England. 1986

...we do not know what is happening at the moment farther away in the universe: the light that we see from distant galaxies left them millions of years ago and in the case of the most distant object that we have seen, the light left some eight thousand million years ago. Thus, when we look at the universe, we are seeing it as it was in the past.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 2 (p. 28)

Bantam Books. Toronto, Ontario, Canada. 1988

We see the universe the way it is because we exist.

*A Brief History of Time: The Updated and Expanded Edition*

Chapter 8 (p. 128)

Bantam Books. Toronto, Ontario, Canada. 1988

Even if there is only one possible unified theory, it is just a set of rules and equations. What is it that breathes fire into the equations and makes a universe for them to describe? The usual approach of science of constructing a mathematical model cannot answer the questions of why there should be a universe for the model to describe. Why does the universe go to all the bother of existing?

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 11 (p. 174)

Bantam Books. Toronto, Ontario, Canada. 1988

I do not agree with the view that the universe is a mystery, something that one can have intuition about but never fully analyze or comprehend.

*Black Holes and Baby Universes and Other Essays*

Preface (p. viii)

Bantam Books. New York, New York, USA. 1993

I think the universe is completely self-contained. It doesn't have any beginning or end, it doesn't have any creation or destruction.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 89)

Routledge &amp; Kegan Paul. London, England. 1986

**Hawkins, Michael** 1942–

British astrophysicist

The stars and galaxies that fill our view as we survey the depths of the Universe are really just a froth delineating the massive, dark unseen structures beneath.

*Hunting Down the Universe: The Missing Mass, Primordial Black Holes, and Other Dark Matters*

Chapter 13 (p. 183)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1997

**Hayflick, Leonard** 1928–

American microbiologist

Everything in the universe ages, including the universe.

In Nancy Shute

*U.S. News and World Report*, 18/25 August, 1997 (p. 57)

**Haynes, Margaret**

No biographical data available

The universe is just a bowl of spaghetti.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 49)

Random House, Inc. New York, New York, USA. 1991

**Heinlein, Robert A.** 1907–88

American science fiction writer

Tomorrow I will seven eagles see, a great comet will appear, and voices will speak from whirlwinds foretelling monstrous and fearful things – This Universe never did make sense; I suspect that it was built on government contract.

*The Number of the Beast*

Chapter II (p. 19)

Fawcett Columbine Books. New York, New York, USA. 1980

No storyteller has ever been able to dream up anything as fantastically unlikely as what really does happen in this mad universe.

*Time Enough for Love*

Prelude, Chapter II (p. 51)

G.P. Putnam's Sons. New York, New York, USA. 1973

A zygote is a gamete's way of producing more gametes. This may be the purpose of the universe.

*Time Enough for Love*

Intermission (p. 262)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Henderson, Archibald** 1877–1933

American mathematician and writer

We are doomed to dwell within a finite universe a thousand million times greater than the region now accessible to astronomical observation. Our glances are confined forever within this giant – this all too minute – monad.

*The Size of the Universe**Science*, Volume 58, Number 1497, 7 September, 1923 (p. 172)**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...after dilating his thoughts to comprehend the grandeur of those ideas his calculations have called up, and exhausting his imagination and the powers of his language to devise similes and metaphors illustrative of the immensity of the scale on which his universe is constructed, he shrinks back to his native sphere, he finds it, in comparison, a mere point; so lost – even in the minute system to which it belongs – as to be invisible and unsuspected from some of its principal and remoter members.

*Outlines of Astronomy: By Sir John F. W. Herschel*

Introduction (p. 23)

American Home Library Co. New York, New York, USA. 1902

**Hickok, Laurens Perseus** 1798–1888

No biographical data available

There must somewhere be a position from whence it may clearly be seen, that the universe has laws which are necessarily determined by immutable and eternal principles. Nothing in nature, and equally so not nature itself, can be made intelligible except as it has been subjected to rational principle, and such principle must both have been, and been made controlling, in the very origination of nature, or nature must forever be without meaning or end.

*Rational Cosmology: Or, The Eternal Principles and the Necessary Laws of the Universe*

Preface (p. 3)

D. Appleton &amp; Co. New York, New York, USA. 1858

**Hinshelwood, Sir Cyril** 1897–1967

English chemist

To some men knowledge of the universe has been an end possessing in itself a value that is absolute: to others it has seemed a means of useful application.

*The Structure of Physical Chemistry*

Chapter I (p. 2)

Clarendon Press. Oxford, England. 1951

**Hogan, John**

No biographical data

...cosmologists – and the rest of us – may have to forego attempts at understanding the universe and simply marvel at its infinite complexity and strangeness.

Universal Truths

*Scientific American*, Volume 263, Number 4, October, 1990 (p. 117)**Holmes, John Haynes** 1879–1964

American clergyman

The universe is not hostile, nor yet is it friendly. It is simply indifferent.

*A Sensible Man's View of Religion*

Is the Universe Friendly? (p. 39)

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

There is a coherent plan in the universe, though I don't know what it's a plan for.

*Wired*, 2/98 (p. 174)

...if there is one important result that comes out of our inquiry into the nature of the Universe it is this: when by patient inquiry we learn the answer to any problem, we always find, both as a whole and in detail, that the answer thus revealed is finer in concept and design than anything we could ever have arrived at by a random guess.

*The Nature of the Universe*

Chapter 7 (p. 140)

The University Press. Cambridge. 1933

Perhaps the most majestic feature of our whole existence is that while our intelligences are powerful enough to penetrate deeply into the evaluation of this quite incredible Universe, we still have not the smallest clue to our own fate.

*The Nature of the Universe*  
Chapter 7 (p. 142)  
The University Press. Cambridge. 1933

The Universe is everything; both living and inanimate things; both atoms and galaxies; and if the spiritual exists as well as the material, of spiritual things also; and if there is a Heaven and a Hell, of Heaven and Hell too; for by its very nature the Universe is the totality of all things.

*Frontiers of Astronomy*  
Chapter Eighteen (p. 304)  
Harper & Row, Publishers. New York, New York, USA. 1955

**Hubble, Edwin Powell** 1889–1953  
American astronomer

We find them smaller and fainter, in constantly increasing numbers, and we know that we are reaching out into space, further and ever further, until, with the faintest nebulae that can be detected with the greatest telescope, we arrive at the frontiers of the known universe.

In Joseph Silk  
*The Big Bang* (p. 26)  
W.H. Freeman & Company. San Francisco, California, USA. 1980

...equipped with his five senses, man explores the universe around him and calls the adventure science.

*The Nature of Science and Other Lectures*  
Part I, The Nature of Science (p. 6)  
The Huntington Library. San Marino, California, USA. 1954

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

What a wonderful and amazing Scheme have we here of the magnificent Vastness of the Universe! So many Suns, so many Earths...!

*The Celestial Worlds Discover'd; or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
Kosmotheoros (p. 222)  
Printed for T. Childe. London, England. 1698

**Inge, William Ralph** 1860–1954  
English religious leader and author

If the universe is running down like a clock, the clock must have been wound up at a date which we could name if we knew it. The world, if it is to have an end in time, must have had a beginning in time.

*God and the Astronomers*  
Chapter 3 (p. 48)  
W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Ingelow, Jean** 1820–97  
English poet and novelist

Fair world! these puzzled souls of ours grow weak  
With beating their bruised wings against the rim  
That bounds their utmost flying, when they seek The distant and the dim.

Contentment comes not therefrom; still there lies  
An outer distance when the first is hailed;

And still forever yawns before our eyes  
An utmost – that is veiled.

*Poems*  
13th Honours (p. 24)  
Longmans, Green & Co. London, England. 1867

**Ionides, Stephen A.**  
No biographical data available

**Ionides, Margaret L.**  
No biographical data available

Today we regard the universe as utterly indifferent, a vast expanse into which we have wandered, perhaps by accident, perhaps by divine providence. We are not at all necessary to it, but we know that it is necessary to us, and we must learn its rules if we are to survive.

*Stars and Men*  
Chapter XVII (p. 393)  
Bobbs-Merrill. Indianapolis, Indiana, USA. 1939

**Ionesco, Eugene** 1912–94  
French playwright

...the universe seems to me infinitely strange and foreign. At such a moment I gaze upon it with a mixture of anguish and euphoria; separate from the universe, as though placed at a certain distance outside it; I look and I see pictures, creatures that move in a kind of timeless time and spaceless space, emitting sounds that are a kind of language I no longer understand or ever register.

*Notes and Counter Notes: Writing on the Theatre*  
Part II, Interviews, Brief Notes for Radio (p. 136)

**James, William** 1842–1910  
American philosopher and psychologist

Whatever universe a professor believes in must at any rate be a universe that lends itself to lengthy discourse. A universe definable in two sentences is something for which the professorial intellect has no use. No faith in anything of that cheap kind!

*Pragmatism: A New Name for Some Old Ways of Thinking*  
Lecture I (p. 4)  
Longmans, Green & Company. London, England. 1914

**Jastrow, Robert** 1925–  
American space scientist

Theologians generally are delighted with the proof that the Universe had a beginning, but astronomers are curiously upset. Their reactions provide an interesting demonstration of the response of the scientific mind – supposedly a very objective mind – when evidence uncovered by science itself leads to a conflict with the articles of faith in our profession. It turns out that the scientist behaves the way the rest of us do when our beliefs are in conflict with the evidence. We become irritated, we pretend the conflict does not exist, or we paper it over with meaningless phrases.

*God and the Astronomers*

Epilogue (p. 117)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

Thus, the facts indicate that the Universe will expand forever. We still come across pieces of mass here and there in the Universe, and someday we may find the missing matter, but the consensus at the moment is that it will not be found. According to the available evidence, the end will come in darkness.

*God and the Astronomers*

Epilogue (p. 123)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The universe cannot go on forever as it now is, and neither can it have existed in its present condition from all eternity.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*

The New Outlook in Cosmogony (p. 155)

Government Printing Office. Washington, D.C. 1928

If the universe is a universe of thought then its creations must have been an act of thought.

*The Mysterious Universe*

Into The Deep Waters (pp. 133–134)

Cambridge University Press. Cambridge, England. 1930

The Universe can be best pictured, although still very imperfectly and inadequately, as consisting of pure thought, the thought of what, for want of a wider word, we must describe as a mathematical thinker.

*The Mysterious Universe*

Chapter V (p. 136)

The Macmillan Company. New York, New York, USA. 1932

The universe begins to look more like a great thought than a machine.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2)

Q.3 (p. 632)

Simon & Schuster. New York, New York, USA. 1987

The physical universe never has any choice – it must inevitably move along a single road to a predestined end.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 701)

The universe consists in the main not of stars but of desolate emptiness – inconceivably vast stretches of desert space in which the presence of a star is a rare and exceptional event.... The stars move blindly through space, and the players in the stellar blind-man's-buff are so few and far between that the chance of encountering another star is almost negligible.

*The Universe Around Us*

Chapter I (pp. 84–85)

The Macmillan Company. New York, New York, USA. 1929

Every star is continually radiating energy away into space, and we have no knowledge of any appreciable part of this radiation coming back or of the stars replenishing their sources of energy in any way. The universe is running down like a clock which no one winds up.

*Annual Report of the Board of Regents of the Smithsonian Institution (1926)*

Cosmogony (p. 155)

Government Printing Office. Washington, D.C. 1927

### **Jeffers, Robinson** 1887–1962

American poet

It seemed to Barclay the cloud broke and he saw the stars,

Those of this swarm were many, but beyond them universe past universe

Flared to infinity, no end conceivable. Alien, alien, alien universes.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

The Women at Point Sur (p. 312)

Stanford University Press. Stanford, California, USA. 1988

The learned astronomer

Analyzing the light of most remote star-swirls

Has found them – or a trick of distance deludes his prism – All at incredible speeds fleeing outward from ours.

I thought, no doubt they are fleeing the contagion

Of consciousness that infects this corner of space.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 2)

Margrave (p. 161)

Stanford University Press. Stanford, California, USA. 1988

The universe expands and contracts like a great heart.

It is expanding, the farthest nebulae

Rush with the speed of light into empty space.

*The Beginning and the End and Other Poems*

The Great Explosion (p. 3)

Random House, Inc. New York, New York, USA. 1963

### **Jennings, Herbert Spencer** 1868–1947

American zoologist

...the universe is not “a mere clockwork mechanical wonder swinging in a vast vacuum,” but is a system that, in the course of time, comes to life.

*The Universe and Life*

Chapter II (p. 33)

Yale University Press. New Haven, Connecticut, USA. 1941

### **Jevons, William Stanley** 1835–82

English economist and logician

Were this indeed a Chaotic Universe, the powers of mind employed in science would be useless to us.

*The Principles of Science: A Treatise on Logic and Scientific Method* (2nd edition)

Chapter I (p. 2)

Macmillan & Co Ltd. London, England. 1877

...the Universe in which we dwell is not the result of chance, and where chance seems to work it is our own deficient faculties which prevent us from recognising the operation of Law and of Design.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Introduction (p. 2)  
Macmillan & Co Ltd. London, England. 1887

**Joad, Cyril Edwin Mitchinson** 1891–1953  
English philosopher and broadcasting personality

When the scientist leaves his laboratory and speculates about the universe as a whole, the resultant conclusions are apt to tell us more about the scientist than about the universe.

*Philosophical Aspects of Modern Science*  
Chapter XI (p. 339)  
George Allen & Unwin Ltd. London, England. 1939

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

The fact that our universe, like Appleworld, is curved in an unseen dimension beyond our spatial comprehension has been experimentally verified. These experiments, performed on the path of light beams, shows that starlight is bent as it moves across the universe.

*Hyperspace: A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension*  
Chapter 1 (p. 17)  
Oxford University Press, Inc. New York, New York, USA. 1995

**Kant, Immanuel** 1724–1804  
German philosopher

If the grandeur of a planetary world in which the earth, as a grain of sand, is scarcely perceived, fills the understanding with wonder, with what astonishment are we transported when we behold the infinite multitude of worlds and systems which fill the extension of the Milky Way! But how is this astonishment increased, when we become aware of the fact that all these immense orders of star-worlds again form but one of a number whose termination we do not know, and which perhaps, like the former, is a system inconceivably vast – and yet again but one member in a new combination of members! We see the first members of a progressive relationship of worlds and systems; and the first part of this infinite progression enables us already to recognise what must be conjectured of the whole. There is here no end but an abyss of a real immensity, in presence of which all the capability of human conception sinks exhausted.

*Kant's Cosmogony as in His Essay on the Retardation of the Rotation of the Earth*  
Chapter II, First Part (pp. 64–65)  
James Maclehose & Co. Glasgow, Scotland. 1900

**Kepler, Johannes** 1571–1630  
German astronomer

This very cogitation carries with it I don't know what secret, hidden horror; indeed one finds oneself wandering in this immensity to which are denied limits and centre and therefore also all determinate places.

In Alexander Koyre  
*From the Closed World to the Infinite Universe*  
Chapter III (p. 61)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1968

The diversity of the phenomena of Nature is so great, and the treasures hidden in the heavens so rich, precisely in order that the human mind shall never be lacking in fresh nourishment.

*Mysterium Cosmographicum*  
Original Dedication (p. 55)

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Depend upon it, the universe will never really be understood unless it may be sometime resolved into an ordered multiplicity and made to own itself an everlasting drama of the calculus.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Mathematical Emancipations: Dimensionality and Hyperspace (p. 101)  
Columbia University Press. New York, New York, USA. 1925

**Kirshner, Robert P.** 1949–  
American astrophysicist

If Copernicus taught us the lesson that we are not at the center of things, our present picture of the universe rubs it in.

*The Extravagant Universe*  
Chapter 11 (p. 259)  
Princeton University Press. Princeton, New Jersey, USA. 2002

Although the Universe is under no obligation to make sense, students in pursuit of the Ph.D. are.

Exploding Stars and the Expanding Universe  
*Quarterly Journal of the Royal Astronomical Society*, Volume 32,  
Number 3, September, 1991 (p. 240)

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

There are no longer any absolute directions in space. The universe has lost its core. It no longer has a heart, but a thousand hearts.

*The Sleepwalkers*  
Part Three, Chapter II, Section 6 (p. 217)  
The Macmillan Company. New York, New York, USA. 1966

In my youth I regarded the universe as an open book, printed in the language of physical equations, whereas now it appears to me as a text written in invisible ink, of which in our rare moments of grace we are able to decipher a small fragment.

*Bricks to Babel*  
Epilogue (pp. 682–683)  
Random House, Inc. New York, New York, USA. 1980



**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

There are many beautiful and wondrous things to see in the universe, and to discover them we simply have to gaze into the dark night sky.

*Blind Watchers of the Sky*

Chapter One (p. 1)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1996

Whether our cosmological view of the universe is right or wrong, or just incomplete, we were brave enough to confront our ignorance and look. We looked with all our might, and with boldness and imagination managed to see a little bit farther than our predecessors. We were not proud of our blindness, but neither were we ashamed of it or intimidated by it, for we chose to look for the light of truth fully cognizant of our blindness.

*Blind Watchers of the Sky*

Chapter Ten (p. 282)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1996

**Komarov, Victor G.**

No biographical data available

The universe is an inexhaustible source of knowledge. But the more we know the deeper we realize the extent of what is yet unknown and the greater the probability of stunning discoveries.

Translated by N. Kittell

*This Fascinating Astronomy* (p. 299)

MIR Publishers, Moscow, Russia. 1985

**Krauss, Lawrence M.** 1954–

American theoretical physicist

There is a maxim about the universe which I always tell my students: That which is not explicitly forbidden is guaranteed to occur. Or, as Data said in the episode “Parallels,” referring to the laws of quantum mechanics, “All things which can occur, do occur.”

*The Physics of Star Trek*

Chapter Two (p. 16)

Harp Perennial Publishers, New York, New York, USA. 1995

**Kunitz, Stanley** 1905–2006

American poet

I see lines of your spectrum shifting red,  
The Universe expanding, thinning out,  
Our worlds flying, oh flying, fast apart.

*The Collected Poems*

The Science of the Night (p. 88)

W.W. Norton & Company, Inc. New York, New York, USA. 2000

**Kunz, F. L.**

No biographical data available

The whole universe is one mathematical and harmonic expression, made up of finite representations of the infinite.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 139)

Routledge & Kegan Paul, London, England. 1986

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

...the firmament must be more enduring than things on our earth and the empires of the world.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Twentieth Letter (p. 193)

Science History Publications, New York, New York, USA. 1976

**Lao Tzu** fl. 6th century BCE

Chinese philosopher and father of Taoism

Something mysteriously formed,

Born before heaven and earth.

In the silence and the void,

Standing alone and unchanging,

Ever present and in motion.

Translated by Gia-Fu Feng and Jane English

*Tao Te Ching*

Twenty-five

Alfred A. Knopf, New York, New York, USA. 1974

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

The universe is dead for us, and how is it to come to life again? “Knowledge” has killed the sun, making it a ball of gas, with spots; “knowledge” has killed the moon, it is a dead little earth pitted with extinct craters as with small-pox...

*Lady Chatterley’s Lover*

A Propos of ‘Lady Chately’s Lover’ (p. 331)

Penguin Books, London, England. 1994

**Lederman, Leon** 1922–

American high-energy physicist

We hope to explain the entire universe in a single, simple formula that you can wear on your T-shirt.

In Richard Wolkomir article

Quark City

*OMNI Magazine*, February, 1984 (p. 41)

**Lemaître, Abbé Georges** 1894–1966

Belgian astronomer and cosmologist

Our universe bears the marks of youth and we can hope to reconstruct its story. The documents at our disposal are not buried in the piles of bricks carved by the Babylonians; our library does not risk being destroyed by fire; it is in space, admirably empty, where light waves are preserved better than sound is conserved on the wax of phonograph discs.

*The Primeval Atom*

Chapter II (p. 75)

D. van Nostrand Company, Inc. New York, New York, USA. 1950



**Lerner, Eric J.** 1947–  
American popular science book

A universe of unlimited progress from an infinite past to an infinite future makes sense when society is advancing. But when that advance halts, when the idea of progress is mocked by the century of Verdun, Auschwitz, and Hiroshima, when the prospect of human betterment is dim, we should not be surprised that the decaying cosmos again rises to dominance.

*The Big Bang Never Happened*

Part One, Chapter 4 (p. 115)

Time Books. New York, New York, USA. 1991

**Lloyd, Seth** 1950–  
American engineer

I wanted to get a handle on why the universe is so complex.... Or at any rate why there seems to be so much information processing going on. You can look at life and almost all the things – well, all the things – that we see going on around us in terms of information processing. You could say that life is an example of information being processed in the service of getting a free lunch out of your environment. A typical event in evolution, for example, is some organism suddenly, by a mutation, being able to produce an enzyme that allows it to digest something it couldn't get at before. The free lunch is there, but in order to get it, you've got to be able to process information.

In Tim Folger

The Best Computer in All Possible Worlds

*Discover Magazine*, October, 1995

**Lodge, Sir Oliver** 1851–1940  
English physicist

The Universe is huge and awful every way, we might so easily be crushed by it; we need the help of every agency available, and if we had no helpers we should stand a poor chance. The loneliness of it when we leave the planet would be appalling; sometimes even here the loneliness is great.

In James Edward Hand

*Ideals of Science & Faith*

A Physicist's Approach (p. 48)

Longmans, Green & Co. New York, New York, USA. 1904

**Longfellow, Henry Wadsworth** 1807–82  
American poet

The Universe as an immeasurable wheel  
Turning for evermore

In the rapid and rushing river of Time.

*The Poetical Works of Henry Wadsworth Longfellow*

Rain in Summer

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

...the existing universe is bounded in none of its dimensions; for then it must have an outside.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book One, l. 958 (p. 12)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The universe is like a machine in which the motion of certain parts is determined by that of others, only nothing is determined about the motion of the whole machine.

*History and Root of the Principle of the Conservation of Energy*

Chapter IV (p. 62)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

**Maclaurin, Colin** 1838–1916  
Scottish mathematician

We can perceive no bounds of the vast expanse, in which natural causes operate, and fix no limit, or termination, to the universe. The objects we commonly call great, vanish, when we contemplate the vast body of the earth. The terraqueous globe itself is lost in the solar system; the sun itself dwindles into a star; Saturn's vast orbit, and all the orbits of the comets, crowd into a point, when viewed from numberless places between the earth and the nearest fixed stars.

*An Account of Sir Isaac Newton's Philosophical Discoveries*

Chapter I Section 5

London, England. 1748

**Maeterlinck, Maurice** 1862–1949  
Belgian playwright and poet

However far the telescope... may penetrate, what it would disclose to us would always be the same island, the same bubble, even when it touches the ultimate spiral nebulae; and this island or this bubble of which the surface is millions or billions of light years, is only a point in the ocean of the All.

Translated by K. S. Shelvankar

*The Supreme Law*

Chapter VII (p. 145)

E.P. Dutton & Company, Inc. New York, New York, USA. 1935

**Marden, Orison Swett** 1850–1924  
American writer

The universe is one great kindergarten for man. Everything that exists has brought with it its own peculiar lesson. The mountain teaches stability and grandeur; the ocean immensity and change. Forests, lakes, and rivers, clouds and winds, stars and flowers, stupendous glaciers and crystal snowflakes – every form of animate or inanimate existence, leaves its impress upon the soul of man.

*Rising in the World: Or, Architects of Fate*

Chapter XXIV (pp. 424–425)

The Success Co. Cooper Union, New York, USA. 1897

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

do not tell me said warty bliggens that there is not a  
purpose in the universe  
the thought is blasphemy

*the lives and times of archy & mehitabel*  
warty bliggens, the toad (p. 56)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

the men of science are talking about the size and shape  
of the universe

again i thought i had settled that for them years ago  
it is as big as you think it is and it is spherical in shape

*the lives and times of archy & mehitabel*  
why the earth is round (p. 284)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

you write so many things  
about me that are not true  
complained the universe  
there are so many things  
about you which you seem to be  
unconscious of yourself said archy  
contain a number of things  
which i am trying to forget  
rejoined the universe  
such as what asked archy  
such as cockroaches and poets  
replied the universe

*the lives and times of archy & mehitabel*  
poets (p. 289)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Martin, Geoffrey**  
Chemist

... worlds come and go, attracting new atoms out of lim-  
itless space or dispersing their own particles; thus the  
universe is in a state of flux in every part. All things are  
fading or growing like clouds in a summer's sky.

*Triumphs & Wonders of Modern Chemistry*  
Chapter 2 (p. 12)

D. van Nostrand. New York, New York, USA. 1911

**Massey, Raymond** 1896–1983  
Canadian-born American actor

It is this, or that – all the universe, or nothing. Which  
shall it be... Which shall it be?

*Things to Come*  
Film (1936)

**Masson, David**  
No biographical data available

Erst, space was nebulous.  
It whirled and in the whirl, the nebulous milk  
Broke into rifts and curdled into orbs –  
Whirled and still curdled, till the azure rifts  
Severed and shored vast systems, all of orbs.  
In Alexander Winchell

*World-Life or Comparative Geology*  
Part II, Chapter I (p. 145)  
S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**McAleer, Neil** 1942–  
American science writer

If science ever knows for certain the fate of the Universe,  
what will this tell us? It will tell us the ultimate fate of  
the atoms that now make up our living bodies and brains,  
the same atoms that allow us to exist and struggle to give  
meaning to the Universe and to our brief lives.

*The Mind-Boggling Universe*  
Chapter 6 (p. 239)

Doubleday & Company, Inc. Garden City, New York, USA. 1957

**Melville, Herman** 1819–91  
American novelist

It's too late to make any improvements now. The universe  
is finished; the copestone is set on, and the chips were  
carted off a million years ago.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 2 (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There is no place but the universe; no limit but the limit-  
less; no bottom but the bottomless.

*Mardi and a Voyage Thither*

Chapter CXLIII (p. 460)

Northwestern University Press. Evanston, Illinois, USA. 1970

**Minto, Walter**  
No biographical data available

This immense, beautiful, and varied universe is a book  
written by the finger of Omnipotence and raises the  
admiration of every attentive beholder.

In John Archibald Wheeler

*At Home in the Universe*

The Spirit of Collegueship at Princeton (p. 89)

The American Institute of Physics. Woodbury, New York, USA. 1994

**Mitchel, Ormsby MacKnight** 1805–62  
American astronomer

Man having obtained the mastery over his own system,  
boldly wings his flight to the star-lit vault, and resolves to  
number its countless millions, to circumscribe its limit-  
less extent, to fathom its infinite depth, to fix the centre  
about which this innumerable host is wheeling its silent  
and mysterious round.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great  
Discoveries and Theories of Modern Astronomy*

Lecture I (p. 34)

Baker & Scribner. New York, New York, USA. 1848

**Moore, Benjamin** 1745–1816  
Episcopal writer and professor of rhetoric

The mystery of life is often spoken of as if it were the  
crowning mystery of all things, and indeed it has its

wonderful secrets like all the natural phenomena of the world. But the riddle of the universe lies much deeper than life.

*The Origin and Nature of Life*

Chapter I

Henry Holt & Co. New York, New York, USA.

**Morehouse, George Wilkinson** 1840–?

American naturalist

How grand, complete and sublime are the works and workings of nature. We stand with bowed heads, entranced and speechless in the presence of the Universe. Held in its all-embracing arms, we are of it – one and inseparable.

*The Wilderness of Worlds*

Preface (p. 8)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Morris, Richard** 1939–2003

American physicist and science writer

How is it that common elements such as carbon, nitrogen, and oxygen happened to have just the right kind of atomic structure that they needed to combine to make the molecules upon which life depends? It is almost as though the universe had been consciously designed.

*The Fate of the Universe*

Chapter 8 (pp. 154–155)

Playboy Press. New York, New York, USA. 1982

**Muir, John** 1838–1914

American naturalist

When we try to pick out anything by itself, we find it hitched to everything else in the universe.

*My First Summer in the Sierra*

July 27 (p. 211)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The clearest way into the Universe is through a forest wilderness.

*The Wilderness World of John Muir*

The Philosophy of John Muir (p. 312)

Houghton, Mifflin & Company. Boston, Massachusetts, USA. 2001

How hard to realize that every camp of men or beast has this glorious starry firmament for a roof! In such places standing alone on the mountaintop it is easy to realize that whatever special nests we make of leaves and moss like marmots and birds, or tents or piled stone we all dwell in a house of one room the world with the firmament for its roof and are sailing the celestial spaces without leaving any track.

*The Wilderness World of John Muir*

The Philosophy of John Muir (p. 312)

Houghton, Mifflin & Company. Boston, Massachusetts, USA. 2001

...when we contemplate the whole globe as one great dewdrop, striped and dotted with continents and islands, flying through space with other stars all singing and

shining together as one, the whole universe appears as an infinite storm of beauty.

*Travels in Alaska*

Chapter I (p. 5)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1915

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being.

A Heavenly Master governs all the world as Sovereign of the universe. We are astonished at Him by reason of His perfection, we honor Him and fall down before Him because of His unlimited power. From blind physical necessity, which is always and everywhere the same, no variety adhering to time and place could evolve, and all variety of created objects which represent order and life in the universe could happen only by the willful reasoning of its original Creator, Whom I call the Lord God.

Translated by Andrew Motte

*Newton's Principia: The Mathematical Principles of Natural Philosophy*

General Scholium

Daniel Adee. New York, New York, USA. 1848

...since Space is divisible in infinitum, and Matter is not necessarily in all places, it may be also allow'd that God is able to create Particles of Matter of several Sizes and Figures, and in several Proportions to Space, and perhaps of different Densities and Forces, and thereby to vary the Laws of Nature, and make Worlds of several sort in several Parts of the Universe.

In *Great Books of the Western World* (Volume 34)

*Optics*

Query 31

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Munroe, J.**

No biographical data available

The universe may be silent and dark where there is no mind and sense; but it springs into light and music wherever there is an eye and an ear.

Science and the Sense of Beauty

*The Journal of Science, and Annals of Astronomy, Biology, Geology,*

Volume IV (Third series), April, 1882 (p. 206)

**Newcomb, Simon** 1835–1909

Canadian-American astronomer

The farther we advance in knowledge, the clearer it becomes that the bodies which are scattered through the celestial spaces are not completely independent existences, but have, with all their infinite diversity, many attributes in common.

*Side-Lights on Astronomy and Kindred Fields of Popular Science*

Chapter XIX (p. 299)

Harper & Brothers Publishers. New York, New York, USA. 1906

The problem of the structure and duration of the universe is the most far-reaching with which the mind has to deal. Its solution may be regarded as the ultimate object of stellar astronomy, the possibility of reaching which has occupied the minds of thinkers since the beginning of civilisation.

*The Stars: A Study of the Universe*

Chapter XIV (p. 226)

G.P. Putnam's Sons. New York, New York, USA. 1901

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

If the universe may be conceived as a definite quantity of energy, as a definite number of centers of energy – and every other concept remains indefinite and therefore useless – it follows therefore that the universe must go through a calculable number of combinations in the great game of chance which constitutes its existence. In infinity, at some moment or other, every possible combination must once have been realized; not only this, but it must have been realized an infinite number of times.

*Complete Works*

Volume IX (p. 430)

Foulis. Edinburgh, Scotland. 1913

**Noyes, Alfred** 1880–1958

English poet

This universe exists, and by that one impossible fact Declares itself a miracle.

*The Torch Bearers: Watchers of The Sky*

Newton, VII (p. 226)

Frederick A. Stokes Company Publishers. New York, New York, USA. 1922

**Oates, Joyce Carol** 1938–

American writer

Nothing is accidental in the universe – this is one of my Laws of Physics – except the entire universe itself, which is Pure Accident, pure divinity.

*Do What You Will*

The Summing Up: Meredith Dawe

Random House, Inc. New York, New York, USA. 1982

**Pagels, Heinz R.** 1939–88

American physicist and science writer

...the universe contains the record of its past the way that sedimentary layers of rock contain the geological record of the earth's past.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 2 (p. 24)

Simon & Schuster. New York, New York, USA. 1985

**Parker, Barry**

Canadian science writer

Looking into the dark night sky we feel a tingle of excitement as we are overcome by its grandeur and beauty.

Each point of light we see is the image of a star, an image of light that may have left the star long before we were born. The universe is vast beyond imagination – almost terrifying in its intensity and complexity.

*Einstein's Dream: The Search for a Unified Theory of the Universe*

Chapter 1 (p. 1)

Plenum Press. New York, New York, USA. 1986

**Pascal, Blaise** 1623–62

French mathematician and physicist

[The Universe] is an infinite sphere, the centre of which is everywhere, the circumference nowhere.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section II, 72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The spaces of the universe enfold me and swallow me up like a speck; but I, by the power of thought, may comprehend the universe.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section VI, 348

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95

French chemist

The universe is asymmetrical; for, if the whole of the bodies which compose the solar system moving with their individual movements were placed before a glass, the image in the glass could not be superimposed upon the reality.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter IV (p. 111)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Pearson, Karl** 1857–1936

English mathematician

The universe is a variable quantity, which depends upon the keenness and structure of our organs of sense, and upon the fineness of our powers and instruments of observation.

*The Grammar of Science* (2nd edition)

Chapter I (p. 15)

Adam & Charles Black. London, England. 1900

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

There is no certainty vouchsafed us in the vast testimony of Nature that the universe was designed for man, nor yet for any purpose, even the bleak purpose of symmetry. The courageous thinker must look the inimical aspects of his environment in the face, and accept the stern fact that the universe is hostile and deadly to him save for a very narrow zone where it permits him, for a few eons, to exist.

*An Almanac for Moderns*

March Twenty-Ninth (p. 11)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Penzias, Arno** 1933–

German-American mathematical physicist

Either we've seen the birth of the universe, or we've seen a pile of pigeon shit.

In Roylston Roberts

*Serendipity: Accidental Discoveries in Science*

John Wiley & Sons, Inc. New York, New York, USA. 1989

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The universe ought to be presumed too vast to have any character.

*Chance, Love, and Logic: Philosophical Essays* (p. 127)

University of Nebraska Press. Lincoln, Nebraska, USA. 1998

**Plato** 428 BCE–347 BCE

Greek philosopher

Time and the heavens came into being at the same instant, in order that, if they were ever to dissolve, they might be dissolved together. Such was the mind and thought of God in the creation of time.

In James Jeans

*The Mysterious Universe*

Chapter V (p. 182)

The Macmillan Company. New York, New York, USA. 1932

...had we never seen the stars, and the sun, and the heaven, none of the words which we have spoken about the universe would ever have been uttered.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 47 (p. 455)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49

American short story writer

I design to speak of the Physical, Metaphysical and Mathematical – of the Material and Spiritual The Universe is a plot of God.

*Eureka*

Line 7 (p. 120)

Geo. P. Putnam. New York, New York, USA. 1848

Universe: – of its Essence, its Origin, its Creation, its Present Condition and its Destiny.

*Eureka*

Line 9 (p. 7)

Geo. P. Putnam. New York, New York, USA. 1848

Telescopic observations, guided by the laws of perspective, enable us to understand that the perceptible Universe exists as a roughly spherical cluster of clusters irregularly disposed.

*Eureka*

Line 16 (p. 96)

Geo. P. Putnam. New York, New York, USA. 1848

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

The universe is still dead, but it already has the capacity of coming to life.

In Freeman Dyson

*Personal Knowledge*

Chapter 13, Section 7 (p. 404)

Harper & Row, Publishers. New York, New York, USA. 1962

**Pope, Alexander** 1688–1744

English poet

Order is Heav'n's first law.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle IV, l. 49

Houghton Mifflin Company. New York, New York, USA. 1903

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

I certainly think we are only living in the prehistory of the understanding of our universe.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 199)

Routledge & Kegan Paul. London, England. 1986

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

The scientist does not defy the universe. He accepts it. It is his dish to savor, his realm to explore; it is his adventure and never-ending delight. It is complaisant and elusive but never dull. It is wonderful both in the small and in the large. In short, its exploration is the highest occupation for a gentleman.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 4 (p. 104)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

As long as the brain is a mystery, the universe will also be a mystery.

In Victor Cohn

Charting the Soul's Frail Dwelling-House

*The Washington Post*, September 5, 1982, Final Edition (p. A1)

**Rand, Ayn**

Russian-born American novelist and philosopher

I know not if this earth on which I stand is the core of the universe or if it is but a speck of dust lost in eternity.

*Anthem*

Chapter XI (p. 95)

E.P. Dutton & Company. New York, New York, USA. 1995

**Raymo, Chet** 1936–

American physicist and science writer

Give me the ninety-two elements and I'll give you a universe. Ubiquitous hydrogen. Standoffish helium, Spooky boron. No-nonsense carbon. Promiscuous oxygen.



Faithful iron. Mysterious phosphorous. Exotic xenon.  
Brash tin. Slippery mercury. Heavy-footed lead.

*The Soul of The Night*

Chapter 7 (p. 65)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1985

**Reade, Winwood** 1838–75

English philosopher and historian

The universe is anonymous; it is published under secondary laws; these at least we are able to investigate, and in these perhaps we may find a partial solution of the great problem.

*The Martyrdom of Man*

Chapter IV (p. 465)

E.P. Dutton & Company. New York, New York, 1926

**Reed, Ishmael** 1938–

American poet, essayist, and writer

The universe is a spiraling Big Band in a polka-dotted speak-easy, effectively generating new lights everyone-night stand.

In A. Zee

*An Old Man's Toy: Gravity at Work and Play in Einstein's Universe*

Chapter 8 (p. 123)

The Macmillan Company. New York, New York, USA. 1989

**Rees, Martin John** 1942–

15th Astronomer Royal of England

...the more we study the Universe, the more we're aware that there's a mystery lying behind it.

BBC News interview

January 24, 2002

**Reichenbach, Hans** 1891–1953

German philosopher of science

Instead of asking for a cause of the universe, the scientist can ask only for the cause of the present state of the universe; and his task will consist in pushing farther and farther back the date from which he is able to account for the universe in terms of laws of nature.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 208)

University of California Press. Berkeley, California, USA. 1951

**Remsen, Ira** 1846–1927

American chemist

The universe is inexhaustible, and its mysteries are inexplicable. We may and must strive to learn all we can, but we cannot hope to learn all. We are finite; the mysteries we are dealing with are infinite.

The Age of Science

*Science*, New Series, Volume 20, Number 407, July 15, 1904 (p. 73)

**Renard, Maurice** 1875–1939

French writer

Man, peeping at the Universe through only a few tiny windows – his senses – catches mere glimpses of the

world around him. He would do well to brace himself against unexpected surprises from the vast unknown; from that immeasurable sector of reality that has remained a closed book.

In Charles Noël Martin

*The Role of Perception in Science* (p. 7)

Hutchinson of London. London, England. 1963

**Rey, Jean** 1583–1645

French physician and chemist

There is no power in nature which from nothing could have made the universe, and none which could reduce the universe to nothing:

*Essays of Jean Rey*

Essay IV (p. 11)

William F. Glay. Edinburgh, Scotland 1895

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

...the origin of the material universe presents a problem which neither the vagaries of the ancients nor the speculations of the moderns have been able to solve in a satisfactory manner.

*Nature and Culture*

Chapter 1 (p. 7)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**Richards, Theodore William** 1868–1928

American chemist

The mystery that enshrouds the ultimate nature of the physical universe has always stimulated the curiosity to the thinking man.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1911*

(Faraday Lecture) The Fundamental Properties of the Elements (p. 100)

Government Printing Office. Washington, D.C. 1912

Both infinity and eternity are beyond our mental grasp. We know that we cannot hope to understand all the wonders of the universe; but, nevertheless, we may be full of hope for the future. Step by step we gain in knowledge, and with each step we acquire better opportunity for improving the lot of mankind and for illuminating the dark places of our philosophy of nature.

*Annual Report of the Board of Regents of the Smithsonian Institution (1916)*

Ideals of Chemical Investigation (pp. 222–223)

Government Printing Office. Washington, D.C. 1917

**Rindler, Wolfgang**

Physicist and author

Modern scientific man has largely lost his sense of awe in the Universe. He is confident that given sufficient intelligence, perseverance, time, and money, he can understand all there is beyond the stars.

In M. Taube

*Evolution of Matter and Energy*

Chapter 2 (p. 18)

Springer-Verlag. New York, New York, USA. 1985



**Rothman, Tony** 1953–  
American cosmologist

When confronted with the order and beauty of the universe and the strange coincidences of nature, it's very tempting to take the leap of faith from science into religion. I am sure many physicists want to. I only wish they would admit it.

In J.L. Casti

*Paradigms Lost: Images of Man in the Mirror of Science*

Chapter 7 (pp. 482–483)

William Morrow & Company, Inc., New York, New York, USA. 1989

**Rubin, Vera** 1928–  
American astronomer

The joy and fun of understanding the universe we bequeath to our grandchildren – and to their grandchildren. With over 90% of the matter in the universe still to play with, even the sky will not be the limit.

In Marcia Bartusiak

*The Woman Who Spins the Stars*

*Discover*, October, 1990 (p. 94)

**Ruderman, M. A.**  
No biographical data available

**Rosenfeld, A. H.**  
No biographical data available

We are peeling an onion layer by layer, each layer uncovering in a sense another universe, unexpected, complicated, and – as we understand more – strangely beautiful.

An Explanatory Statement on Elementary Particle Physics

*American Scientist*, Volume 48, June, 1960, Number 2 (p. 210)

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

So far as scientific evidence goes, the universe has crawled by slow stages to a somewhat pitiful result on this earth, and is going to crawl by still more pitiful stages to a condition of universal death.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Has Religion Made Useful Contributions to Civilization (p. 32)

Watts. London, England. 1927

The Universe may have a purpose, but nothing that we know suggests that, if so, this purpose has any similarity to ours.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Do We Survive Death? (p. 92)

Watts. London, England. 1927

All the labors of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system; and the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins.

In George Smoot

*Wrinkles in Time*

Chapter 4 (p. 69)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Sagan, Carl** 1934–96  
American astronomer and science writer

We might have lived in a Universe in which nothing could be understood by a few simple laws, in which Nature was complex beyond our abilities to understand, in which laws that apply on Earth are invalid on Mars, or in a distant quasar. But the evidence – not the preconceptions, the evidence – proves otherwise. Luckily for us, we live in a Universe in which much can be “reduced” to a small number of comparatively simple laws of Nature. Otherwise we might have lacked the intellectual capacity and grasp to comprehend the world.

*The Demon-Haunted World: Science As a Candle in the Dark*

Chapter 15 (pp. 273–274)

Random House, Inc. New York, New York, USA. 1995

The universe is not required to be in perfect harmony with human ambition.

But the fact that some geniuses were laughed at does not imply that all who are laughed at are geniuses. They laughed at Columbus, they laughed at Fulton, they laughed at the Wright brothers. But they also laughed at Bozo the Clown.

*Cosmos*

Chapter II (p. 31)

Random House, Inc. New York, New York, USA. 1980

A universe in which everything is known would be static and dull, as boring as the heaven of some weak-minded theologians. A Universe that is unknowable is no fit place for a thinking being.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 18)

Random House, Inc. New York, New York, USA. 1979

A religion old or new, that stressed the magnificence of the universe as revealed by modern science, might be able to draw forth reserves of reverence and awe hardly tapped by the conventional faiths. Sooner or later, such a religion will emerge.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 4 (p. 52)

Random House, Inc. New York, New York, USA. 1994

**Sagan, Carl** 1934–96  
American astronomer and author

**Druyan, Ann** 1949–  
American author and television producer

The Universe is lavish beyond imagining.

*Shadows of Forgotten Ancestors: A Search for Who We Are*

Chapter 1 (p. 13)

Random House, Inc. New York, New York, USA. 1992

**Sandage, Allan** 1926–  
American astronomer

The present universe is something like the old professor nearing retirement with his brilliant future behind him.

In G. Borner

*The Early Universe*

Chapter 3 (p. 90)

Springer-Verlag, Berlin, Germany. 1988

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952  
Spanish-born American philosopher

The universe, as far as we can observe it, is a wonderful and immense engine; its extent, its order, its beauty, its cruelty, make it alike impressive. If we dramatize its life and conceive its spirit, we are filled with wonder, terror, and amusement, so magnificent is that spirit, so prolific, inexorable, grammatical and dull.

In Logan Pearsall Smith

*Little Essays Drawn from the Writings of George Santayana*

Piety (p. 85)

Books for Libraries Press, Freeport, New York, USA. 1967

**Schiller, Ferdinand Canning Scott** 1759–1805  
German poet, dramatist, and philosopher

The universe is one of God's thoughts.

*Essays: Aesthetical and Philosophical*

Letter 4: Theosophy of Julius

**Shelley, Percy Bysshe** 1792–1822  
English poet

Its easier to suppose that the universe has existed from all eternity than to conceive a Being beyond its limits capable of creating it.

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab

Houghton Mifflin Company, Boston, Massachusetts, USA. 1901

Below lay stretched the boundless universe!

*The Complete Poetical Works of Percy Bysshe Shelley*

The Daemon of the World Part I, The Daemon and the Spirit

1241

Houghton Mifflin Company, Boston, Massachusetts, USA. 1901

**Siegel, Eli** 1902–78  
American philosopher, poet, critic, and founder of Aesthetic Realism

The universe is Why, How, and What, in any order, and all at once.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #69 (p. 28)

Definition Press. New York, New York, USA. 1972

The weight of the universe is at one with all its space.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #70 (p. 28)

Definition Press. New York, New York, USA. 1972

The universe, being clever, has given scientists trouble.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #71 (p. 28)  
Definition Press. New York, New York, USA. 1972

**Silk, Joseph** 1942–  
American astronomer and physicist

The development of human awareness of the Universe evolved from the geocentric cosmology of the ancient world via the heliocentric cosmology of the Renaissance and the egocentric cosmology of the nineteenth century, to the ultimate destination of the Big-Bang theory of the expanding Universe.

*Cosmic Enigmas*

Cosmologists and Their Myths (p. 3)

AIP Press. Woodbury, New York, USA. 1994

**Smith, Logan Pearsall** 1865–1946  
American author

I woke this morning...into the well-known, often-discussed, but, to my mind, as yet unexplained Universe.

*Trivia*

Book 1, To-Day (p. 4)

Doubleday, Page & Company. Garden City, New York, USA. 1917

**Smuts, Jan Christiaan** 1870–1950  
South African statesman, military leader, and holistic philosopher

Truth, beauty, goodness, and love are as much structures of the evolutionary universe as the sun and the earth and the moon.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 718)

**Spenser, Edmund** 1552–99  
English poet

Why then should witless man so much misween,  
That nothing is, but that which he hath seene?

What if in the Moones faire shining speheare?

What if in every other starre unseene,

Of other worldes he happily should heare?

That nothing is, but that which he hath seene?

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book the Second, Introduction

Houghton Mifflin Company, Boston, Massachusetts, USA. 1908

**Stern, S. Alan**  
American planetary scientist and author

The place we call our Universe is, for the most part, cold and dark and all but endless. It is the emptiest of empties. It is old, and yet very young. It contains much that is dead, and yet much that is alive, forever reinventing itself, and sometimes inventing something wholly new.

In S. Alan Stern (ed.)

*Our Universe: The Thrill of Extragalactic Exploration as Told by Leading Experts*

The Frontier Universe: At the Edge of the Night (p. 1)

Cambridge University Press. Cambridge, England. 2001

**Sullivan, Walter** 1918–96  
American science journalist

We do know enough already, however, to believe that no myth or legend could be as rich in beauty, wonder, and awe as the full reality of the universe that is our home.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Walter Sullivan (p. 127)

Harper & Row, Publishers. New York, New York, USA. 1973

**Swann, William Francis Gray** 1884–1962  
Anglo-American physicist

There is one great work of art; it is the universe. Ye men of letters find the imprints of its majesty in your sense of the beauty of words. Ye men of song find it in the harmony of sweet sounds. Ye painters feel it in the design of beautiful forms, and in the blending of rich soft colors do your souls mount on high to bask in the brilliance of nature's sunshine. Ye lovers are conscious of its beauties in forms ye can but ill define. Ye men of science find it in the rich harmonies of nature's mathematical design.

*The Architecture of the Universe*

Chapter XII (p. 424)

The Macmillan Company. New York, New York, USA. 1934

**Swimme, Brian** 1950–  
American mathematical cosmologist

I am convinced that the story of the universe that has come out of three centuries of modern scientific work will be recognized as a supreme human achievement, the scientific enterprise's central gift to humanity, a revelation having a status equal to that of the great religious revelations of the past.

In Connie Barlow (ed.)

*Evolution Extended: Biological Debates on the Meaning of Life*

The MIT Press. Cambridge, Massachusetts, USA. 1994

**Talbot, Michael** 1953–92  
American physicist

...we have to begin to view the universe as ultimately constituted not of matter and energy, but of pure information.

*Beyond the Quantum*

Chapter 6 (p. 155)

The Macmillan Company. New York, New York, USA. 1986

**Teller, Woolsey** 1890–1954  
Essayist

...the picture of the universe presented by astronomy is one of dismal stretches of time and space and unparalleled desolation. In the eternal abyss of space – bleak, cold, and dark – there are no signs of a Cosmic Consciousness.

*The Atheism of Astronomy*

Chapter VI (p. 120)

Arno Press & The New York Times. New York, New York, USA. 1972

**Tennyson, Alfred (Lord)** 1809–92  
English poet

This truth within thy mind rehearse,  
That in a boundless universe  
Is boundless better, boundless worse.

*Alfred Tennyson's Poetical Works*

The Two Voices, Stanza 9

Oxford University Press, Inc. London, England. 1953

**Thompson, Francis** 1859–1907  
English writer

The universe is his box of toys. He dabbles his fingers in the day-fall. He is gold-dusty with tumbling amidst the stars. He makes bright mischief with the moon. The meteors nuzzle their noses in his hand.

*The Works of Francis Thompson*

Shelley (p. 18)

Burns & Oats. London, England. 1913

**Thomson, Sir John Arthur** 1861–1933  
Scottish naturalist

The picture of the Universe which the astronomer offers to us is imperfect; the lines he traces are often faint and uncertain. There are many problems which have been solved, there are just as many about which there is doubt, and notwithstanding our great increase in knowledge, there remain just as many which are entirely unsolved.

In John Arthur Thomson

*The Outline of Science: A Plain Story Simply Told*

Chapter I (p. 9)

G.P. Putnam's Sons. New York, New York, USA. 1922

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The universe is wider than our views of it.

*The Writings of Henry David Thoreau* (Volume 2)

*Walden*

Chapter XVIII (p. 493)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

...the universe is not rough-hewn, but perfect in its details.

*The Writings of Henry David Thoreau* (Volume 9)

*Natural History of Massachusetts* (p. 132)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Toynbee, Arnold J.** 1852–83  
English historian

Huddled together in our little earth we gaze with frightened eyes into the dark universe.

*Toynbee's Industrial Revolution*

Notes and Jottings (p. 256)

A.M. Kelley. New York, New York, USA. 1969

**Trimble, V.**  
No biographical data available

Those of us who are not directly involved in the fray can only suppose that the universe is open ( $W < 1$ ) on Wednesday,

Friday, and Sunday and closed ( $W > 1$ ) on Thursday, Saturday, and Monday. (Tuesday is choir practice.)

Dark Matter in the Universe: Where, What, and Why?  
*Contemporary Physics*, Volume 29, 1988 (p. 389)

### Turner, Michael S.

American astrophysicist

The progress made in our understanding of the universe during the twentieth century is nothing short of stunning.

A Sober Assessment of Cosmology at the New Millennium  
*Publications of the Astronomical Society of the Pacific*, Volume 113, 2001 (p. 653)

### Tyron, E. P.

No biographical data available

If it is true that our Universe has a zero net value for all conserved quantities, then it may simply be a fluctuation of the vacuum of some larger space in which our Universe is imbedded. In answer to the question of why it happened, I offer the modest proposal that our Universe is simply one of those things which happen from time to time.

Is the Universe a Vacuum Fluctuation?

*Nature*, Volume 246, Number 5433, December 14, 1973 (p. 397)

### van Vleck, Edward B. 1863–1943

American mathematician

The stupendous size of the universe hushes thought itself.

Address at the Dedication of the van Vleck Observatory  
*Popular Astronomy*, Volume XXIV, Number 7, August-September, 1916 (p. 418)

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

Man is not born to solve the problems of the universe, but to find out where the problems begin, and then to take his stand within the limits of the intelligible.

In Louis Berman

*Exploring the Cosmos*

Chapter 16 (p. 351)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

### Warden, Jack 1920–2006

American character actor

[The universe] is all random, radiating aimlessly out of nothing and eventually vanishing forever. The universe, all space, all time, it's just a temporary convulsion. And I get paid to prove it.

*September*

Film (1987)

### Weil, Simone 1909–43

French philosopher and mystic

Two forces rule the universe: light and gravity.

Translated by Arthur Wills

*Gravity and Grace*

Gravity and Grace (p. 45)

G.P. Putnam's Sons. New York, New York, USA. 1952

### Weinberg, Steven 1933–

American nuclear physicist

...the urge to trace the history of the universe back to its beginning is irresistible.

*The First Three Minutes*

Chapter I (p. 4)

Basic Books, Inc. New York, New York, USA. 1988

It is very hard to realize that this all is just a tiny part of an overwhelmingly hostile universe. It is even harder to realize that this present universe has evolved from an unspeakably unfamiliar early condition, and faces a further extinction of endless cold or intolerable heat. The more the universe seems comprehensible, the more it also seems pointless.

*The First Three Minutes*

Epilogue (p. 154)

Basic Books, Inc. New York, New York, USA. 1988

The effort to understand the universe is one of the very few things that lifts human life a little above the level of farce, and gives it some of the grace of tragedy.

*The First Three Minutes*

Epilogue (p. 155)

Basic Books, Inc. New York, New York, USA. 1988

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

Few people realise the immensity of vacancy in which the dust of the material universe swims.

*Seven Science Fiction Novels of H. G. Wells*

*The War of the Worlds*

Chapter the First (p. 312)

Dover Publications, Inc. New York, New York, USA. 1934

### Wharton, Edith 1862–1937

American novelist

...she had never been able to understand the laws of a universe which was so ready to leave her out of its calculations.

*The House of Mirth*

Book I, Chapter III (p. 42)

Charles Scribner's Sons. New York, New York, USA. 1919

### Wheeler, John Archibald 1911–

American theoretical physicist and educator

We will first understand how simple the universe is when we recognize how strange it is.

From the Big Bang to the Big Crunch

*Cosmic Search Magazine*, Volume 1, Number 4, Fall, 1979

The Universe is a self-excited circuit.

In Freeman Dyson

*Infinite in All Direction*

Part I, Chapter Three (p. 53)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

...this is our universe, our museum of wonder and beauty, our cathedral...

*A Journey into Gravity and Spacetime*

Opening

Scientific American Library. New York, New York, USA. 1990

**Wheeler, John Archibald** 1911–

American theoretical physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

A model universe that is closed, that obeys Einstein's geometrodynamics law, and that contains a nowhere negative density of mass-energy, inevitably develops a singularity. No one sees any escape from the density of mass-energy rising without limit. A computing machine calculating ahead step by step the dynamical evolution of the geometry comes to the point where it cannot go on. Smoke, figuratively speaking, starts to pour out of the computer. Yet physics, surely continues to go on if for no other reason than this: Physics is by definition that which does go on its eternal way despite all the shadowy changes in the surface of reality.

*Gravitation*

Part X, Chapter 44 (p. 1196)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Whewell, William** 1794–1866

English philosopher and historian

The constitution of the universe, so far as it can be clearly apprehended by our intellect, thus assumes a shape involving an assemblage of mathematical propositions: certain algebraical formulae, and the knowledge when and how to apply them, constitute the last step of the physical science to which we can attain.

*Astronomy and General Physics*

Chapter V (p. 18)

Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Praised be the fathomless universe

For life and joy and for objects and knowledge curious...

*Complete Poetry and Collected Prose*

Memories of President Lincoln, Stanza 14

The Library of America. New York, New York, USA. 1982

The whole theory of the universe is directed unerringly to one single individual – namely to you.

*Complete Poetry and Collected Prose*

*Leaves of Grass*

By Blue Ontario's Shore, Stanza 15

The Library of America. New York, New York, USA. 1982

The world, the race, the soul –

Space and time, the universes

All bound as is befitting each – all

Surely going somewhere.

*Complete Poems and Collected Prose*

Going Somewhere

The Library of America. New York, New York, USA. 1982

**Wiechert, Emil** 1861–1928

Prussian geophysicist

The universe is infinite in all directions.

In Freeman Dyson

*Infinite in All Directions*

Part One, Chapter Three (p. 53)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Young, Louise B.**

American science writer

The universe is unfinished, not just in the limited sense of an incompletely realized plan but in the much deeper sense of a creation that is a living reality of the present. A masterpiece of artistic unity and integrated Form, infused with meaning, is taking shape as time goes by. But its ultimate nature cannot be visualized, its total significance grasped, until the final lines are written.

*The Unfinished Universe*

Conclusion (pp. 205, 208)

Simon & Schuster. New York, New York, USA. 1986

**Zebrowski, George** 1945–

Polish-American science fiction writer

The rationality of our universe is best suggested by the fact that we can discover more about it from any starting point, as if it were a fabric that will unravel from any thread.

Is Science Rational?

*OMNI Magazine*, June, 1994 (p. 50)

In a perfectly rational universe, infinities turn back on themselves...

Is Science Rational?

*OMNI Magazine*, June, 1994 (p. 50)

## UNIVERSE AND COSMOGENESIS

**Ackerman, Diane** 1948–

American writer

Fifteen billion years ago, when the Universe

let rip and, in disciplined panic,

Creation spewed mazy star-treacle and resin,

shrinking balls of debut fire smoldered

and glitched.

*The Planets: A Cosmic Pastoral*

Neptune, IV (p. 129)

William Morrow & Company, Inc. New York, New York, USA. 1976

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

In the beginning the universe was created. This made a lot of people very angry and has been widely regarded as a bad move. Many races believe that it was created by some sort of god, though the Jatravartid people of Viltvodle VI believe that the entire Universe was in fact sneezed out of the nose of a being called the Great Green Arkleseizure.



*The Ultimate Hitchhiker's Guide to the Galaxy*  
The Restaurant at the End of the Universe  
Chapter 1 (p. 149)  
Ballantine Books. New York, New York, USA. 2002

### Author undetermined

In the beginning there was nothing... which exploded.  
Source undetermined

**Barrow, John D.** 1952–  
English theoretical physicist

One day we may be able to say something about the origins of our own cosmic neighborhood. But we can never know the origins of the universe. The deepest secrets are the ones that keep themselves.

*The Origin of the Universe*  
Chapter 8 (p. 137)  
Basic Books, Inc. New York, New York, USA. 1994

The most extreme example of this direct observation of the past arises from our understanding of what occurred in the Universe during the brief interval of time between one second and three minutes after it began its present state of expansion from some unknown state that we usually call the “beginning of the Universe” (although it may have been nothing of the sort). Our mathematical theory allows us to determine the ambient conditions of the Universe during those first few minutes of cosmic history from what we observe at present, some fifteen billion years later.

*Pi in the Sky*  
Chapter 6 (p. 269)  
Back Bay Books. 1993

**Bowyer, Stuart** 1934–  
American astrophysicist

Ultimately, the origin of the universe is, and always will be, a mystery.

In Henry Margenau and Roy Abraham Varghese (eds.)  
*Cosmos, Bios, Theos*  
Chapter 2 (p. 32)  
Open Court. La Salle, Illinois, USA. 1992

**Cardenal, Ernesto** 1925–  
Nicaraguan poet and Roman Catholic priest

In the beginning there was nothing  
neither space  
nor time.

The entire universe concentrated  
in the space of the nucleus of an atom,  
and before that even less,  
much less than a proton,  
and even less still,  
an infinitely dense mathematical point.

Translated by John Lyons  
*Cosmic Canticle*  
Cantigua 1, Big Bang (p. 11)  
Curbstone Press. Willimantic, Connecticut, USA. 1993

**Egyptian Myth** ca. 2500 B.C.

In the beginning, only the ocean existed, upon which there appeared an egg. Out of the egg came the sun-god and from himself he begat four children: Shu and Tefnut, Keb and Nut. All these, with their father, lay upon the ocean of chaos. Then Shu and Tefnut thrust themselves between Keb and Nut. They planted their feet upon Keb and raised Nut on high so that Keb became the earth and Nut the heavens.

In Eric J. Lerner  
*The Big Bang Never Happened*  
Chapter 2 (p. 58)  
Random House, Inc. New York, New York, USA. 1991

**Flaubert, Gustave** 1821–90  
French novelist

SMARH: How vast creation is! I see the planets rise, I see the fiery stars driven along.... Space opens out as I rise, worlds revolve around me, and I am the center of this bustling creation.

*Early Writings*  
Smarh (p. 216)  
University of Nebraska Press. Lincoln, Nebraska, USA. 1991

**Gamow, George** 1904–68  
Russian-born American physicist

Before we can discuss the basic problem of the origin of our universe, we must ask ourselves whether such a discussion is necessary.

*The Creation of the Universe*  
Chapter 1 (p. 6)  
The Viking Press. New York, New York, USA. 1952

In the beginning God created radiation and ylem. And ylem was without shape or number, and the nucleons were rushing madly over the face of the deep.

*My World Line: An Informal Autobiography*  
Chapter 6 (p. 127)  
The Viking Press. New York, New York, USA. 1979

**Hawkins, Gerald S.** 1928–2003  
English archaeoastronomer

In the beginning.... A scientist cannot continue this sentence with absolute certainty. It would be like asking a child to give an account of his birth or a description of his conception.

In *Reader's Digest*  
Marvels and Mysteries of the World Around Us  
Earth's Ancient Drama (p. 10)  
The Reader's Digest Association. Pleasantville, New York, USA. 1972

**Hein, Robert**  
No biographical data available

The first world the cosmic colossus created with a word:  
One lightning word from the golden lips of Truth  
And electric earth condensed on a creamy cloud,  
Adorned with a necklace of blue-gold stars and a chain



Of peppermint planets in the amphitheater of space.

*Quest of the Singing Tree*

The Larger Creation, Creation of the Earth

H. Harrison. New York, New York, USA. 1938

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Without continuous creation, the Universe must evolve toward a dead state in which all the matter is condensed into a vast number of dead stars.

*The Nature of the Universe*

Chapter 6 (pp. 131–132)

The University Press. Cambridge. 1933

**Kipling, Rudyard** 1865–1936

British writer and poet

Before the High and Far-Off Times, O my Best Beloved, came the Time of the Very Beginnings; and that was in the days when the Eldest Magician was getting Things ready. First he got the Earth ready; then he got the Sun ready; and then he told all the Animals that they could come out and play.

*Just So Stories*

The Crab that Played with the Sea (p. 171)

Doubleday & Company, Inc. Garden City, New York, USA. 1952

**Marquesas Islanders**

In the beginning there was nothing. There arose a swelling, a ferment, a black fire, a spinning vortices, a bubbling, a swallowing – there arose a whole series of pairs of props, posts, or piles, large and small, long and short, crooked and bent, decayed and rotten. Similarly there arose pairs of roots, large and small, long and short, and so forth; there arose countless and infinitely many supports. Above all, there now arose the ground, the foundation, the hard rock, there arose the space for light, there arose rocks of different sorts.

In John A. Wood

*Meteorites and the Origin of Planets*

Creation Myth (p. v)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Reeves, Hubert** 1932–

Canadian astrophysicist

In the beginning was the absolute rule of the flame: The universe was in limbo. Then after countless eras, the fires slowly abated like the sea at the outgoing tide. Matter awoke and organized itself; the flame gave way to music.

*Atoms of Silence*

Introduction (p. 5)

The MIT Press. Cambridge, Massachusetts. USA. 1984

**Sagan, Carl** 1934–96

American astronomer and science writer

If the general picture of an expanding universe and a Big Bang is correct, we must then confront still more difficult

questions. What were conditions like at the time of the Big Bang? What happened before that? Was there a tiny universe, devoid of all matter, and then the matter suddenly created from nothing? How does that happen? In many cultures it is customary to answer that God created the universe out of nothing. But this is mere temporizing. If we wish courageously to pursue the question, we must of course ask next where God comes from. And if we decide this to be unanswerable, why not save a step and decide that the origin of the universe is an unanswerable question. Or, if we say that God has always existed, why not save a step and conclude that the universe has always existed?

*Cosmos*

Chapter X (p. 257)

Random House, Inc. New York, New York, USA. 1980

**Singh, Jagjit** 1919–2002

Indian mathematician and science writer

In the beginning there was neither heaven nor earth, And there was neither space nor time. And the Earth, the Sun, the Stars, the Galaxies and the whole universe were confined within a small volume like the bottled genie of the Arabian Nights. And then God said, “Go!” And straight way the Galaxies rushed out of their prison, scattering in all directions, and they have continued to run away from one another ever since, afraid lest some cosmic Hand should gather them again and put them back in the bottle (which is not bigger than a pin-point). And they shall continue to scatter thus till they fade from each other’s ken – and thus, for each other, cease to exist at all.

*Mathematical Ideas: Their Nature and Use*

Space and Time (pp. 209–210)

Hutchinson & Company Ltd. London, England. 1972

**Smoot, George** 1945–

American experimental astrophysicist

The question of “the beginning” is as inescapable for cosmologists as it is for theologians.

*Wrinkles in Time*

Chapter 9 (p. 189)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Spenser, Edmund** 1552–99

English poet

Through knowledge we behold the world’s creation,  
How in his cradle first he fostered was;  
And judge of Natures cunning operation,  
How things she formed of a formless mass.

*The Complete Poetical Works of Edmund Spenser*

The Tears of the Muses, l. 499–502

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Sturluson, Snorri** 1179–1241  
Icelandic writer

Erst was the age when nothing was:  
Nor sand nor sea, nor chilling stream-waves;  
Earth was not found, nor Ether – Heaven,  
– A Yawning Gap, but grass was none.

*The Prose Edda*

Here Begins the Beguiling of Gylfi (p. 16)  
The American-Scandinavian Foundation. New York, New York, USA.  
1916

### Sufi Creation Myth

I was a hidden treasure and desired to be known: there-  
fore I created the creation in order to be known.

In George Smoot

*Wrinkles in Time*

Chapter 1 (p. 1)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Tagore, Rabindranath** 1861–1941  
Indian poet and philosopher

It seems to me that, perhaps, creation is not fettered by  
rules,

That all the hubbub, meeting and mingling are blind hap-  
penings of fate.

Translated by Indu Dutt

*Our Universe* (p. 75)

Jaico Publishing House. Bombay, India. 1969

### The Bible (King James Version)

In the beginning God created the heaven and the earth.  
Genesis 1:1

**Townes, Charles H.** 1915–  
American inventor of the laser

I do not understand how the scientific approach alone,  
as separated from a religious approach, can explain an  
origin of all things. It is true that physicists hope to look  
behind the “big bang,” and possibly to explain the origin  
of our universe as, for example, a type of fluctuation. But  
then, of what is it a fluctuation and how did this in turn  
begin to exist? In my view the question of origin seems  
always left unanswered if we explore from a scientific  
view alone.

In Henry Margenau and Roy Abraham Varghese (eds.)

*Cosmos, Bios, Theos*

Chapter 25 (p. 123)

Open Court. La Salle, Illinois, USA. 1992

**Updike, John** 1932–

American novelist, short story writer, and poet

By computation, they all must have begun at one place  
about five billion years ago; all the billions and trillions  
and quadrillions squared and squared again of tons of  
matter in the universe were compressed into a ball at the  
maximum possible density, the density within the nucleus

of the atom; one cubic centimeter of this primeval egg  
weighed two hundred and fifty tons.

*The Centaur*

Chapter I (p. 38)

Alfred A. Knopf. New York, New York, USA. 1995

**Weinberg, Steven** 1933–  
American nuclear physicist

...the urge to trace the history of the universe back to  
the beginnings is irresistible. From the start of modern  
science in the sixteenth and seventeenth centuries, physi-  
cists and astronomers have returned again and again to  
the problem of the origin of the universe.

*The First Three Minutes*

Chapter I (p. 4)

Basic Books, Inc. New York, New York, USA. 1988

**Wilmot, John (Second Earl of Rochester)** 1647–80  
English libertine and satirical and bawdy poet

E'er time and place were, time and place were not,  
When Primitive Nothing something straight begot,  
Then all proceeded from the great united – What.

*Collected Works of John Wilmot Earl of Rochester*

Upon Nothing

The Nonesuch Press. London, England. 1926

### Zuni Creation Myth

In the beginning of things Awonawilona was alone. There  
was nothing beside him in the whole of time. Everywhere  
there was black darkness and void. Then Awonawilona  
conceived in himself the thought, and the thought took  
shape and got out into space and through this stepped out  
into the void, into outer space, and from them came nebu-  
lae of growths and mists, full of power and growth.

In Raymond van Over

*Sun Songs*

Zuni Creation Myths

Cosmic Creation (p. 23)

New American Library. New York, New York, USA. 1980

## UNIVERSE AND GOD

**Alighieri, Dante** 1265–1321  
Italian poet and writer

...the entire universe is naught else than a footprint of  
divine goodness.

*The De Monarchia of Dante Alighieri*

Book I, Chapter VIII (p. 26)

Houghton Mifflin & Co. New York, New York, USA. 1904

**Barber, Margaret Fairless** 1869–1901  
English Christian writer

There are, I take it, two master-keys to the secrets of the  
universe, viewed *sub specie aeternitatis*, the Incarnation  
of God, and the Personality of Man...

*The Roadmender*

At The White Gate (p. 197)  
Thomas B. Mosher. Portland, Maine, USA. 1905

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Then sawest thou that this fair Universe, were it in the meanest province thereof, is in very deed the star-domed City of God; that through every star, through every grass-blade, and to most through every Living Soul, the glory of a present God still beams.

In Archibald Macnechan  
*Sartor Resartus*  
Book III (p. 240)  
Ginn & Co. Boston, Massachusetts, USA. 1896

**Clutton-Brock, Arthur** 1868–1924  
Essayist and journalist

So long as we see the universe in the relation of use to ourselves, it remains cold, indifferent, meaningless to us; but when we see it in relation to God, sharing the life which is God, but sharing it even more imperfectly than ourselves, then the process of nature is no longer a meaningless intimidating mechanism, but pathetic and forgivable to us even as we are to ourselves.

*Essays on Religion*  
Introduction (pp. xx–xxi)  
Books for Libraries Press. Freeport, New York, USA. 1969

**Lewis, C. S. (Clive Staples)** 1898–1963  
British author, scholar, and popular theologian

If the universe is so bad, or even half so bad, how on earth did human beings ever come to attribute it to the activity of a wise and good Creator?

*The Problem of Pain*  
Introduction (p. 3)  
HarperCollins. New York, New York, USA. 2001

**Parker, Theodore** 1810–60  
American Transcendentalist

The power of nature is God; the universe, broad and deep and high, a handful of dust, which God enchants. He is the mysterious magic that possesses the world...

*A Discourse of Matters Pertaining to Religion*  
Book I, Chapter V (p. 76)  
American Unitarian Association. Boston, Massachusetts, USA. 1907

**Trine, Ralph Waldo** 1866–1958  
Philosopher

The great central fact of the universe is that Spirit of Infinite Life and Power that is behind., all, that animates all, that manifests itself in – and through all; that self-existent principle of life from which all has come, and not only from which all has come...

*In Tune With the Infinite: Or, Fullness of Peace, Power, and Plenty*  
Chapter II (p. 11)  
George Bell & Sons. London, England. 1905

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

The contemplation of the architecture of the universe in the infinitely great and infinitely little of which it is composed, leads us inevitably to the conclusion that at the bottom of the whole an idea lies, according to which God in nature, and nature in God from eternity to eternity, works and shapes forth all things.

In John Stuart Blackie  
*The Wisdom of Goethe*  
Nature – Natural History (p. 181)  
William Blackwood & Sons. Edinburgh, Scotland. 1883

## UNIVERSE, CITIZENS OF

**Herrick, Charles Judson** 1868–1960  
American neurologist

We are citizens of the universe. This universe is dynamic and intrinsically creative at all levels of organization. This native creativity is amplified in the domain of organic evolution and glorified when aware of itself in human purposive planning. The sublimity of this conception of man's place in nature commands our reverence and our utmost effort to meet the demands imposed upon us by that nature which is our alma mater.

*The Evolution of Human Nature*  
Epilogue: The Unknown God (p. 466)  
University of Texas Press. Austin, Texas, USA. 1956

## UNIVERSE, DEATH OF

**Balfour, Arthur James** 1848–1930  
English prime minister

...the energies of our system will decay, the glory of the sun will be dimmed, and the earth, tideless and inert, will no longer tolerate the race which has for a moment disturbed its solitude. Man will go down into the pit, and all his thoughts will perish.

*The Foundations of Belief*  
Part I, Chapter I, Section III (p. 33)  
Longmans, Green & Company. London, England. 1912

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

I had a dream, which was not all a dream.  
The bright sun was extinguish'd, and the stars  
Did wander darkling in the eternal space,  
Rayless, and pathless, and the icy earth  
Swung blind and blackening in the moonless air.

*The Complete Poetical Works of Byron*  
Miscellaneous Poems, Darkness  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

Many billions of years will elapse before the smallest, youngest stars complete their nuclear burning and shrink into white dwarfs. But with slow, agonizing finality perpetual night will surely fall.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*  
Chapter 5 (p. 50)  
Basic Books, Inc. New York, New York, USA. 1994

A universe that came from nothing in the big bang will disappear into nothing at the big crunch. Its glorious few zillion years of existence not even a memory.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*  
Chapter 9 (p. 123)  
Basic Books, Inc. New York, New York, USA. 1994

**Dyson, Freeman J.** 1923–  
American physicist and educator

Since the universe is on a one-way slide toward a state of final death in which energy is maximally degraded, how does it manage, like King Charles, to take such an unconsciously long time a-dying.

Energy in the Universe  
*Scientific American*, Volume 224, Number 3, 1971 (p. 52)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

...the universe will finally become a ball of radiation, becoming more and more rarified and passing into longer and longer wave-lengths. The longest waves of radiation are Hertzian waves of the kind used in broadcasting. About every 1500 million years this ball of radio waves will double in diameter; and it will go on expanding in geometrical progression forever. Perhaps then I may describe the end of the physical world as – one stupendous broadcast.

*New Pathways in Science*  
Chapter III, Section VI (p. 71)  
The Macmillan Company. New York, New York, USA. 1935

In the beginning was vastness, solitude and the deepest night. Darkness was upon the face of the deep, for as yet there was no light.

*Science and the Unseen World*  
Lecture I (p. 12)  
The Macmillan Co. New York, New York, USA. 1929

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

This is the way the world ends  
Not with a bang but a whimper.

*The Collected Poems and Plays 1909–1950*  
The Hollow Men (p. 59)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Frost, Robert** 1874–1963  
American poet

Some say the world will end in fire,  
Some say in ice.  
From what I've tasted of desire  
I hold with those who favor fire.  
But if it had to perish twice,  
I think I know enough of hate  
To say that for destruction ice  
Is also great  
And would suffice.

*Complete Poems of Robert Frost*  
Fire and Ice  
Henry Holt & Company. New York, New York, USA. 1949

**Gamow, George** 1904–68  
Russian-born American physicist

Galaxies are ever spinnik,  
Stars will burn to final sparrk,  
Till our universe is thinnink  
And is lifeless, cold and darrk.

*Mr. Tompkins in Paperback*  
Chapter 6 (p. 60)  
At The University Press. Cambridge, England. 1965

**Gribbin, John** 1946–  
British science writer and astronomer

“Big Crunch” is...an ugly term which hardly seems appropriate for so important an event as the end of the universe. But there is no convention as yet for a label of the moment of destruction at the end of time, and I am free to borrow the term “omega point.”

*The Omega Point: The Search for the Missing Mass and the Ultimate Fate of the Universe*  
Introduction (p. 2)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

The stars begin to fade like guttering candles and are snuffed out one by one. Out of the depths of space the great celestial cities, the galaxies, cluttered with the memorabilia of ages, are gradually dying. Tens of billions of years pass in the growing darkness. Occasional flickers of light pierce the fall of cosmic night, and spurts of activity delay the sentence of a universe condemned to become a galactic graveyard.

*Cosmology: The Science of the Universe*  
Chapter 18 (p. 360)  
Cambridge University Press. Cambridge, England. 1981

**Hawking, Stephen William** 1942–  
English theoretical physicist

The present evidence therefore suggests that the universe will probably expand forever, but all we can really be sure of is that even if the universe is going to recollapse,

it won't do so for at least another ten thousand million years, since it has already been expanding for at least that long. This should not unduly worry us: by that time, unless we have colonized beyond the Solar System, mankind would long since have died out, extinguished along with our sun!

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 3 (p. 46)

Bantam Books, Toronto, Ontario, Canada. 1988

**James, William** 1842–1910

American philosopher and psychologist

Though the ultimate state of the universe may be its vital and psychical extinction, there is nothing in physics to interfere with the hypothesis that the penultimate state might be the millennium – in other words a state in which a minimum of difference of energy-level might have its exchanges so skillfully canalised that a maximum of happy and virtuous consciousness would be the only result. In short, the last expiring pulsation of the universe's life might be, "I am so happy and perfect that I can stand it no longer."

Letter to Henry Adams dated June, 17, 1910

*The Atlantic Monthly*, September, 1920 (p. 316)

**Jastrow, Robert** 1925–

American space scientist

Within the isolated galaxies, the old stars burn out one by one, and fewer and fewer new stars are formed to replace them. Stars are the source of the energy by which all beings live. When the light of the last star is extinguished, the Universe fades into darkness, and all life comes to an end.

*God and the Astronomers*

Epilogue (p. 117)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Everything points with overwhelming force to a definite event, or series of events, of creation at some time or times, not infinitely remote. The universe cannot have originated by chance out of its present ingredients, and neither can it have been always the same as now. For in either of these events no atoms would be left save such as are incapable of dissolving into radiation; there would be neither sunlight nor starlight but only a cool glow of radiation uniformly diffused through space. This is, indeed, so far as present-day science can see, the final end towards which all creation moves, and at which it must at last arrive.

*Eos or the Wider Aspects of Cosmogony* (p. 55)

Kegan Paul, Trench, Trubner & Company, Ltd. London, England. 1931

**Jeffers, Robinson** 1887–1962

American poet

For man will be blotted out, the blithe earth die, the brave sun

Die blind and blacken to the heart...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

To the Stone-Cutters (p. 5)

Stanford University Press. Stanford, California, USA. 1988

I seem to have stood a long time and watched the stars pass.

They also shall perish I believe.

Here today, gone tomorrow, desperate wee galaxies

Scattering themselves and shining their substance away

Like a passionate thought. It is very well ordered.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 2)

Margrave (p. 171)

Stanford University Press. Stanford, California, USA. 1988

Time will come no doubt

When the sun too shall die; the planets will freeze, and the air on them; frozen gases, white flakes of air

Will be the dust: which no wind will ever stir: this very dust in dim starlight glistening

Is dead wind, the white corpse of wind.

Also the galaxy will die; the glitter of the Milky Way, our universe, all the stars that have names are dead.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 261)

Stanford University Press. Stanford, California, USA. 1988

It will contract, the immense navies of stars and galaxies, Dust-clouds and nebulae

Are recalled home, they crush against each other in one harbor, they stick in one lump.

*The Beginning and the End and Other Poems*

The Great Explosion (p. 3)

Random House, Inc. New York, New York, USA. 1963

**Joyce, James** 1882–1941

Irish expatriate writer and poet

Gasballs spinning about, crossing each other, passing. Same old dingdong always. Gas, then solid, then world, then cold, then dead shell drifting around, frozen rock like that pineapple rock. The moon.

*Ulysses* (p. 164)

Random House, Inc. New York, New York, USA. 1946

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

And so someday,

The mighty ramparts of the mighty universe

Ringed round with hostile force,

Will yield and face decay and come crumbling to ruin.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 33)

Simon & Schuster. New York, New York, USA. 1995



**MacLeish, Archibald** 1892–1982  
American poet and Librarian of Congress

And there, there overhead, there, there hung over  
Those thousands of white faces, those dazed eyes,  
There in the starless dark the poise, the hover,  
There with vast wings across the canceled skies,  
There in the sudden blackness the black pall  
Of nothing, nothing, nothing – nothing at all.

*Collected Poems 1917–1952*

The End of the World

Houghton Mifflin Company, Boston, Massachusetts, USA. 1952

**Nicholson, Norman** 1914–87  
English poet

And if the universe  
Reversed and showed  
The colour of its money;  
If now observable light  
Flowed inward, and the skies snowed  
A blizzard of galaxies,  
The lens of night would burn  
Brighter than the focused sun,  
And man turn blinded  
With white-hot darkness in his eyes.

*The Pot Geranium*

The Expanding Universe (p. 212)

Faber & Faber Ltd. London, England. 1994

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...in the vast death of the solar system, and the whole temple of Man's achievements must inevitable be buried beneath all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction debris of a universe in ruins – all these things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand. Only within the scaffolding of these truths, only on the firm foundation of unyielding despair, can the soul's habitation henceforth be safely built.

*Mysticism and Logic: And Other Essays*

Chapter III (pp. 47–48)

Longmans, Green & Co. London, England. 1919

**Swinburne, Algernon Charles** 1837–1909  
English poet

Then star nor sun shall waken,  
Nor any change of light;  
Nor sound of waters shaken,  
Nor any sound or sight: ...  
Only the sleep eternal  
In an eternal night.

In Richard Henry Stoddard (ed.)

*The Poems of Algernon Charles Swinburne*

The Garden of Proserpine

Thomas Y. Crowell & Co. New York, New York, USA. 1884

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

There will be a time when the day will be as long as a year is now, and the cooling sun, shorn of its beams, will hang motionless in the heavens.

*The Outline of History* (Volume 1)

Book 1, Chapter I, Section 3 (p. 15)

Garden City Books, Garden City, New York, USA. 1961

...a steady twilight brooded over the Earth.... All traces of the moon had vanished. The circling of the stars, growing slower and slower, had given place to creeping points of light...the sun, red and very large, halted motionless upon the horizon, a vast dome glowing with a dull heat.... The rocks about me were of a harsh reddish colour, and all the traces of life that I could see at first was the intensely green vegetation...the same rich green that one sees on forest moss or on the lichen in caves: plants which like these grow in a perpetual twilight.... I cannot convey the sense of abominable desolation that hung over the world.

*The Great Ideas Today* 1971

*The Time Machine*

Chapter Eleven (p. 497)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Yeats, William Butler** 1865–1939  
Irish poet and playwright

When shall the stars be blown about the sky,  
Like the sparks blown out of a smithy, and die?

*The Collected Poems of W.B. Yeats*

The Secret Rose (p. 67)

The Macmillan Company, New York, New York, USA. 1956

## UNIVERSE, EVOLUTION

**Barrell, Joseph** 1869–1919  
American geologist

The logic of all branches of science points to the existence of some system of evolution of the universe, its complete nature hidden in the vastnesses of time and space, but nevertheless developed in accordance with Nature's laws.

In Joseph Barrell and Charles Schuchert

*The Evolution of the Earth and Its Inhabitants*

Introduction (p. 1)

Yale University Press, New Haven, Connecticut, USA. 1919

## UNIVERSE, EXPANDING

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We walk the stage of life, performers of a drama for the benefit of the cosmic spectator. As the scenes proceed he notices that the actors are growing smaller and the action



quicker. When the last act opens the curtain rises on midget actors rushing through their parts at frantic speed. Smaller and smaller. Faster and faster. One last microscopic blur of intense agitation. And then nothing.

*The Expanding Universe*

Chapter III, Section VI (pp. 91–92)

At the University Press. Cambridge, England. 1952

## UNIVERSE, LIMIT OF

**Henderson, Archibald** 1877–1963

Mathematician

If a voyager of the skies travel deep into the interstellar spaces, past the great blue helium stars of Orion, past Betelgeuse and Antares, beyond the white variable Cepheids, the gaseous red and yellow giant-stars, the faintest of the super-nebulæ, “lying like silver snails in the garden of the stars” but whirling in fiery spirals in the dim void of remoter space – will he ever reach any limit to the universe?

Is the Universe Finite?

*American Mathematical Monthly*, Volume 32 1925 (p. 215)

## UNIVERSITY

**Babbage, Charles** 1792–1871

English mathematician

A young man passes from our public schools to the universities, ignorant almost of the elements of every branch of useful knowledge...

*Reflections on the Decline of Science in England, And on Some of Its Causes*

Chapter I (p. 3)

Printed for B. Fellowes. London, England. 1830

**Branford, Victor**

No biographical data available

The university is, in a sense, the cathedral – a somewhat truncated one doubtless – of the American city, and every citizen is unhappy until his city gets what he conceives to be its full complement of culture, in the possession of a university.

*Science and Citizenship*

Section VIII (p. 20)

George Allen. London, England. 1906

**Cooke, Josiah Parsons** 1827–94

American chemist

The time has passed when we can afford to limit the work of our higher institutions of learning to teaching knowledge already acquired. Henceforth the investigation of unsolved problems, and the discovery of new truth, should be one of the main objects at our American universities, and no cost grudged which is required to

maintain at them the most active minds, in every branch of knowledge which the country can be stimulated to produce.

*Scientific Culture: And Other Essays* (2nd edition)

Scientific Culture (p. 25)

D. Appleton & Co. New York, New York, USA. 1855

The university should be the center of scientific investigation and literary culture, the nursery of lofty aspirations and noble thoughts, and thus should become the soul of the higher life of the nation.

*Scientific Culture: And Other Essays* (2nd edition)

The Nobility of Knowledge (p. 49)

D. Appleton & Co. New York, New York, USA. 1855

**Everett, Edward** 1794–1865

Whig Party politician

Universities have been wittily compared to vessels at anchor in the stream of time, serving little purpose but to show with what rapidity independent Research moves down the current.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

An Address (p. 79)

Little, Brown & Co. Boston, Massachusetts, USA. 1857

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Unlike man the individual, a university is, like man the race, immortal.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Chapter X (p. 202)

Columbia University Press. New York, New York, USA. 1916

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

...a university rightly and inherently is a place where the individual man can form new syntheses, where the accidents of friendship and associations can open a man's eyes to a part of science or art which he had not known before, where parts of human life, remote and probably superficially incompatible, can find in men their harmony and their synthesis.

*The Open Mind*

Prospects in the Arts and Sciences (p. 142)

Simon & Schuster. New York, New York, USA. 1955

## UNIVERSITY PRINTING PRESS

**Cornford, Francis M.** 1874–1943

English academic

University printing presses exist, and are subsidised by the Government for the purpose of producing books which no one can read; and they are true to their high calling.

*Microcosmographia Academica*

The Principles of Government, of Discipline (Including Religion), and of Sound Learning

Bowes & Bowes, Publishers. Cambridge, England. 1908

## UNKNOWABLE

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

Penetrating so many secrets, we cease to believe in the unknowable. But there it sits nevertheless, calmly licking its chops.

*Minority Report*  
#304 (p. 241)

Alfred A. Knopf. New York, New York, USA. 1956

**Pearson, Karl** 1857–1936  
English mathematician

...the business of the scientist is to know, and therefore he will not lightly assent to throwing anything into the unknowable...

*The Grammar of Science* (2nd edition)  
Chapter III (p. 102)

Adam & Charles Black. London, England. 1900

## UNKNOWN

**Asimov, Isaac** 1920–92  
American author and biochemist

If it is exciting to probe the unknown and shed light on what was dark before, then more and more excitement surely lies ahead of us.

*The Universe*  
Chapter 19 (p. 294)

Walker & Company. New York, New York, USA. 1966

**Auvaiyaar** ca. 9th century  
Tamil sage and poetess

What is known is a handful; the unknown is as vast as the universe.

Attributed

*The Physics Teacher*, Volume 15, Number 9, December, 1977 (p. 544)

**Berry, Wendell** 1934–  
American man of letters

...though we pretend otherwise, the unknown increases with the known.

*The Unforeseen Wilderness: Kentucky's Red River Gorge*  
Chapter Five (p. 77)

The University of Kentucky Press. Lexington, Kentucky, USA. 1971

**Carlson, A. J.** 1875–1956  
Swedish-American physiologist

We recognize the unknown but not the unknowable.

Science and the Supernatural

*Science*, Volume 73, Number 1887, February 27, 1931 (p. 221)

When we know that we don't know, that is itself an achievement, for then the field is cleared of the confusing and obstructing rubbish of tradition, and we are free to use all our ingenuity and imagination in contriving methods to find out.

Science and the Supernatural

*Science*, Volume 73, Number 1887, February 27, 1931 (p. 221)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

I have always oscillated between the brightness of reality and the darkness of the unknowable.

*Heraclitean Fire: Sketches from a Life before Nature*  
Part I

The Silence of the Heavens (p. 55)

Rockefeller University Press. New York, New York, USA. 1978

**Charles, John**  
American planetary geologist

We want to research what we call the "known unknowns"... This will reduce total risk in the face of the unknown unknowns, the true surprises....

In James Olberg

Red Planet Blues

*Popular Science*, July 2003 (p. 64)

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

The unknown, it is true, is indefinitely vast, and the rays of light which we can project into its darkness penetrate but a short way.

*Problems in Astrophysics*

Preface (p. vii)

Adam & Charles Black. London, England. 1903

...such a region of inquiry...where we feel that at every step the Unknown may merge into the Unknowable, has a particular and an illimitable fascination.

*Problems in Astrophysics*

Chapter XL (p. 537)

Adam & Charles Black. London, England. 1903

**Crookes, Sir William** 1832–1919  
English chemist and physicist

We are on the track and are not daunted, and fain would we enter the mysterious region which ignorance tickets 'Unknown.'

*Report of the Fifty-sixth Meeting of the British Association for the Advancement of Science*

Presidential Address (p. 560)

John Murray. London, England. 1887

## David Reed (Fictional character)

The unknown always seems unbelievable...

*Creature from the Black Lagoon*

Film (1954)

**Davy, Sir Humphry** 1778–1829  
English chemist

It has justly been said that the greater the circle of light, the greater the boundary of darkness by which it is surrounded.

*Consolations in Travel: Or, The Last Days of a Philosopher*

Dialogue the Fifth (p. 170)

Cassell & Co., Ltd. London, England. 1889

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Something unknown is doing we don't know what...

*The Nature of the Physical World*

Chapter XIII (p. 291)

The Macmillan Company. New York, New York, USA. 1930

**Farmer, Philip José** 1918–

American science fiction and fantasy writer

Some of you have asked why we should set out for a goal that lies we know not how far away or that might not even exist. I will tell you that we are setting sail because the Unknown exists and we would make it the Known. That's all!

*To Your Scattered Bodies Go*

Chapter 13 (p. 98)

Berkley Publishing Corporation. New York, New York, USA. 1971

**Feynman, Richard P.** 1918–88

American theoretical physicist

If we want to solve a problem that we have never solved before, we must leave the door to the unknown ajar – ajar only.

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 4 (p. 115)

Perseus Books. Cambridge, Massachusetts, USA. 2000

**Flammarion, Camille** 1842–1925

French astronomer and writer

The Known is an infinitesimal island in the midst of the vast ocean of the Unknown.

Translated by Frances Alice Welby

*Astronomy for Amateurs*

Chapter XII (p. 320)

D. Appleton & Co. New York, New York, USA. 1915

**Harvey, Moses** 1820–1901

Irish clergyman, essayist, and naturalist

Behind all that is known stretch the vast realms of the unknown.

Science and Religion

*The Maritime Monthly*, Volume II, November, 1873 (p. 479)

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

If there be something which cannot be reduced to a quantity, or more generally to a definite function, no matter how complex and involved, of any number of other quantities which can be measured (either actually, or in imagination), then that something cannot be accurately reasoned about, because it is in part unknown. Not unknown in the sense in which a quantity is said to be unknown in algebra, when it is virtually known because

virtually expressible in terms of known quantities, but literally unknown by the absence of sufficient quantitative connection with the known.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 10)

D. van Nostrand Co. New York, New York, USA. 1893

The unknown is not necessarily unknowable; fresh knowns may make the former unknowns become also known.

*Electromagnetic Theory* (Volume 1)

Chapter I (p. 10)

D. van Nostrand Co. New York, New York, USA. 1893

**Hinshelwood, Sir Cyril** 1897–1967

English chemist

...as the chart of the unknown becomes filled in, judgment of the most profitable course to follow changes. Mysterious inlets may prove dead ends or may open into vast seas.

Science and Scientists

*Supplement to Nature*, Volume 207, Number 5001, 4 September, 1965

(p. 1057)

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Grasping your head between your hands, you strive to see and to know. You are at the window opening into the unknown. On all sides the deep layers of effects and causes, heaped one behind the other, wrap you with mist.

Translated by Melville Best Anderson

*William Shakespeare*

Part Second, Book V, Chapter I (p. 175)

A.C. McClurg & Co. Chicago, Illinois, USA. 1887

**Huxley, Aldous** 1894–1963

English writer and critic

Cheerfully...let us advance together, men of letters and men of science, further and further into the ever-expanding regions of the unknown.

*Literature and Science*

Chapter 38 (p. 118)

Harper & Row, Publishers. New York, New York, USA. 1963

**Huxley, Thomas Henry** 1825–95

English biologist

The known is finite, the unknown infinite; intellectually we stand on an islet in the midst of an illimitable ocean of inexplicability. Our business in every generation is to reclaim a little more land.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter XIV (p. 557)

D. Appleton & Company. New York, New York, USA. 1896

**Kennedy, John F.** 1917–63

26th president of the USA

Despite the striking fact that most of the scientists that the world has ever known are alive and working today, despite the fact that this Nation's own scientific manpower is doubling every 12 years in a rate of growth more than three times that of our population as a whole, despite that, the vast stretches of the unknown and the unanswered and the unfinished still far outstrip our collective comprehension.

Address at Rice University  
Houston, Texas  
September 12, 1962

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

...to be indefinable is not to be unknowable and not to be unknown.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter VI (p. 125)  
Columbia University Press. New York, New York, USA. 1916

**Kingsley, Charles** 1819–75  
English clergyman and author

Always try to explain the unknown by the known. If you meet something which you have not seen before, then think of the thing most like it, which you have seen before; and try if that which you know explains the one will not explain the other also.

*Scientific Lectures and Essays*  
Chapter I (p. 31)  
Macmillan & Co Ltd. London, England. 1893

**Leiber, Jr., Fritz** 1910–92  
American writer of science fiction and horror

Science has only increased the area of the unknown. And if there is a god, her name is Mystery.

*Our Lady of Darkness* (p. 44)  
Berkley Publishing Corp. New York, New York, USA. 1977

**Lindbergh, Charles A.** 1902–74  
American aviator

Whether outwardly or inwardly, whether in space or in time, the farther we penetrate the unknown, the vaster and more marvelous it becomes.

*Autobiography of Values*  
Chapter Fifteen (p. 402)  
Harcourt Brace Jovanovich. New York, New York, USA. 1967

**Locke, John** 1632–1704  
English philosopher and political theorist

For the understanding, like the eye, judging of objects only by its own sight, cannot but be pleased with what it discovers, having less regret for what has escaped it, because it is unknown.

In *Great Books of the Western World* (Volume 35)  
*Concerning Human Understanding*  
Epistle to the Reader (p. 87)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**London, Jack** 1876–1916  
American author

He had caught a glimpse of the apparently illimitable vistas of knowledge.... In the alchemy of his brain, trigonometry and mathematics and the whole field of knowledge which they betokened were transmuted into so much landscape. The vistas he saw were vistas of green foliage and forest glades, all softly luminous or shot through with flashing lights. In the distance, detail was veiled and blurred by a purple haze, but behind this purple haze, he knew, was the glamour of the unknown...

*Martin Eden*  
Chapter II (pp. 19–20)  
The Review of Review's Co. New York, New York, USA. 1916

**Melville, Herman** 1819–91  
American novelist

...I am tormented with an everlasting itch for things remote. I love to sail the forbidden seas...

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter I (p. 4)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

Penetrating so many secrets, we cease to believe in the unknowable. But there it sits nevertheless, calmly licking its chops.

*Minority Report: H.L. Mencken's Notebooks*  
No. 364 (p. 241)  
Alfred A. Knopf. New York, New York, USA. 1956

**Mitchel, Ormsby MacKnight** 1805–62  
American astronomer

...the twilight of the known flings its feeble light into the domain of the unknown; and we are permitted to gather some idea, not of all that remains to be done, but of that which must be first accomplished.

*The Orbs of Heaven, or, The Planetary and Stellar Worlds*  
Lecture I (pp. 15–16)  
Office of the National Illustrated Library. London, England. 1851

We stand on the dim confines of the unknown. All behind us is clear and bright and perfect, all before us is shrouded in gloom and darkness and doubt.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Lecture I (p. 36)  
Baker & Scribner. New York, New York, USA. 1848

...the twilight of the known flings its feeble light into the domain of the unknown, and we are permitted to gather some idea, not of all that remains to be done, but of that which must first be accomplished.

*The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy*  
Lecture I (p. 36)  
Baker & Scribner. New York, New York, USA. 1848

**More, Louis Trenchard**

American educator

After centuries of effort, the ocean of the unknown lies before us unexplored.

*The Limitations of Science*

Chapter VII (p. 261)

Henry Holt & Co. New York, New York, USA. 1915

**Morehouse, George Wilkinson** 1840–?

American naturalist

There are always some men, who, actuated by the love of truth for its own sake, are forever prospecting along the borders of the unknown.

*The Wilderness of Worlds*

Chapter I (p. 10)

Peter Eckler, Publisher. New York, New York, USA. 1898

As the dread of the unknown weighs less and less heavily upon us, the known becomes more enjoyable.

*The Wilderness of Worlds*

Chapter I (p. 11)

Peter Eckler, Publisher. New York, New York, USA. 1898

**Nansen, Fridtjof** 1861–1930

Norwegian explorer, scientist, and diplomat

...the limits of the unknown had to recede step by step before the ever-increasing yearning after light and knowledge of the human mind...

*Farthest North* (Volume 1)

Chapter I (pp. 1–2)

Harper & Brothers Publishers. New York, New York, USA. 1898

**Nicholson, Norman** 1914–87

English poet

No man has seen it; nor the lensed eye  
That pin-points week by week the same patch of sky  
Records even a blur across its pupil. Only  
The errantry of Saturn, the wry  
Retarding of Uranus, speak  
Of the pull beyond the pattern:  
The unknown is shown  
Only by a bend in the known.

In Neil Curry (ed.)

*Norman Nicholson Collected Works*

The Undiscovered Planet (p. 211)

Faber & Faber Ltd. London, England. 1994

**Nietzsche, Friedrich Wilhelm** 1844–1900

German philosopher

To trace something unknown back to something known is alleviating, soothing, gratifying and gives moreover a feeling of power, Danger, disquiet, anxiety attend the unknown – the first instinct is to eliminate these distressing states. First principle: any explanation is better than none....

In Alexander Tille (ed.), Thomas Common (trans.)

*The Works of Friedrich Nietzsche* (Volume 11)

*Twilight of the Idols*, The Four Great Errors, Section 5 (p. 138)

Henry & Company. London, England. 1896

**Oppenheimer, James Robert** 1904–67

American theoretical physicist

The problem of doing justice to the implicit, the imponderable and the unknown is always with us in science, it is with us in the most trivial of personal affairs, and it is one of the great problems of all forms of art.

In Lincoln Barnett

*Writing on Life: Sixteen Close-Ups*

Physicist Oppenheimer (p. 358)

William Sloane Associates, Publishers. New York, New York, USA. 1951

**Pinter, Harold** 1930–

English absurdist playwright

In other words, apart from the known and the unknown, what else is there?

*The Homecoming*

Act Two (p. 52)

Methuen & Company Ltd. London, England. 1966

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

With the beginning of direct exploration of the solar system and promise; in fact science derives its sustenance from the unknown; all the good things have come from that inexhaustible realm.

Faith in Science

*The Atlantic Monthly*, Volume 187, Number 1, January, 1951 (p. 28)

**Rice, Harvey** 1800–91

American lawyer and newspaper publisher

In modern methods of logic, we reason from cause to effect, from the known to the unknown; but, in attempting to penetrate the region of the unknown, we are often left without a reliable guide.

*Nature and Culture*

Chapter I (p. 7)

Lee & Shepard. Boston, Massachusetts, USA. 1875

**Rumsfeld, Donald** 1932–

American businessman, politician, and secretary of state

...as we know, there are known knowns. There are things we know we know. We also know there are known unknowns. That is to say we know there are some things we do not know. But there are also unknown unknowns, the ones we don't know we don't know.

Department of Defense News Briefing

February 12, 2002

**Service, Robert William** 1874–1958

Canadian poet and novelist

Let us probe the silent places,  
let us seek what luck betides us;  
Let us journey to a lonely land I know.

There's a whisper on the night-wind,  
there's a star agleam to guide us,  
And the Wild is calling, calling...let us go.

*The Complete Poems of Robert Frost*

The Call of the Wild

Stanza 5

Dodd, Mead & Company. New York, New York, USA. 1940

**Singer, June** 1920–2004

American Gnostic

As knowledge proceeds with spiraling movement to penetrate the vast universe of black mystery, one is continually astonished to discover that at the outer limit of awareness where science interfaces with the unknown, there is nothing but a growing edge, where knowledge and ignorance meet. The more one learns, the more one discovers the increasing magnitude of the unknown, as anyone who has tried to do “exhaustive” research knows very well!

*Androgyny: Toward a New Theory of Sexuality* (p. 59)

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**Vernon, A. G.**

No biographical data available

It is the successful, or even the unsuccessful, pursuit of truth which gives happiness to each generation of scientific men, and not the value of the truth itself – the energy, the doing, not the thing done. If a time could arrive when all was known, when there could not be a new investigation or experiment, our keenest pleasure would be at an end. We may therefore feel happy in the thought of how much is still unknown.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 28)

Macmillan & Company Ltd. London, England. 1918

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

Scientists know that research merely discloses parts of the infinite unknown. Paradoxically, the enticing, helpful “unknown” increases as men continue to subtract from it. Progress in every line of experimental science follows the same law. The apparently narrow path gradually expands into unlimited, unexplored territory.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*

The Vacuum – There's Something in It (p. 194)

Government Printing Office. Washington, D.C. 1925

## UNKNOWN QUANTITY

### Author undetermined

Among the Unknown Quantities assembled at Court, there was none of more brilliant promise than the hero of our tale. Young x was descended from a family of Symbols,

which abstractly considered as the representatives of a mathematical truth, could have had no beginning: but without venturing on such dangerous metaphysics as speculations on this point would lead to, it is sufficient to know that our hero's ancestors had been people of consideration ever since the discovery of algebra; ever since the light of reason pierced the obscuring fog banks and touched the cliffs of that continent where the disciples of science will forever wander as in a paradise.

The Symbol of Darkness

*The Knickerbocker*, Volume 34, Number 3, September, 1849 (p. 214)

## UNNOTICED

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Not invisible, but unnoticed, Watson. You did not know where to look, and so you missed all that was important.

*The Adventures of Sherlock Holmes*

A Case of Identity (p. 66)

*The Strand Magazine*

Harper & Brothers Publishers. New York, New York, USA. 1892

## UNSCIENTIFIC

**James, William** 1842–1910

American philosopher and psychologist

Fondness for the word ‘scientist’ is one of the notes by which you may know its votaries; and its [science's] short way of killing any opinion that it disbelieves in is to call it ‘unscientific.’

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living, IV (p. 53)

Longmans, Green & Co. New York, New York, USA. 1899

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...cowardice is unscientific; for there cannot be a science of ignorance. There may be a science of bravery, for that advances; but a retreat is rarely well conducted; if it is, then is it an orderly advance in the face of circumstances.

*Excursions*

Natural History of Massachusetts (p. 40)

Thomas Y. Crowell Co. New York, New York, USA. 1913

## UNSCIENTIFIC MAN

**Foster, Sir Michael** 1836–1907

English physiologist

Man, unscientific man is often content with “the nearly” and “the almost.” Nature never is. It is not her way to call the same, two things which differ, though the difference may be measured by less than the thousandth of



a milligramme or of a millimetre, or by any other like standard of minuteness.

Presidential Address

*The Chemical News and Journal of Industrial Science*, Volume LXXX, Number 2077, September 15, 1899 (p. 130)

## UNTRUE

**Topsell, Edward** 1572–1625

English cleric

But for my part, which write the English story, I acknowledge that no man must looke for that at my hands, which I have not received from some other: for I would bee unwilling to write anything untrue, or uncertaine out of mine owne invention; and truth on every part is so deare unto mee, that I will not lie to bring any man in love and admiration with God and his works, for God needeth not the lies of men: To conclude, therefore, this Praeface, as the beast is strange, and never seene in our countrey, so my eyesight cannot adde anything to the description; therefore harken unto that which I have observed out of other writers

In John Ashton

*Curious Creatures in Zoology*

The Rhinoceros (p. 99)

John C. Nimmo. London, England. 1890

## UREA

**Wöhler, Friedrich** 1800–82

German chemist

The fact that in the union of these substances they appear to change their nature, and give rise to a new body, drew my attention anew to the subject, and research gave the unexpected result that by the combination of cyanic acid with ammonia, urea is formed, a fact that is more noteworthy inasmuch as it furnishes an example of the artificial production of an organic, indeed a so-called animal substance, from inorganic material.

In Henry M. Leicester and Herbert S. Klickstein

*A Source Book in Chemistry: 1400–1900*

Friedrich Wöhler (p. 310)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

## URINANALYSIS

**Addis, Thomas** 1881–1949

English-American physician

When the patient dies the kidneys may go to the pathologist, but while he lives the urine is ours. It can provide us day by day, month by month, and year by year, with a serial story of the major events going on within the kidney.

*Glomerular Nephritis: Diagnosis and Treatment* (p. 2)

The Macmillan Company. New York, New York, USA. 1948

**Harington, John** 1561–1612

English inventor of flush toilet

He called for his urinal and having made water in it, he cast it, & viewed it (as Physicians do) a prettie while; at last he swore soberly, he saw nothing in that man's water, but that he might live.

*The Metamorphosis of Aiax: A New Discourse of a Stale Subject*

1596

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

FALSTAFF: What says the Doctor to my water?

PAGE: He said, Sir, the water itself was good healthy water; but, for the party that owned it, he might have more diseases than he knows for.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

*The Second Part of King Henry the Fourth*

Act I, Scene ii, l. 1–4

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## URINE

**Dinesen, Isak** 1885–1962

Danish author

What is man, when you come to think upon him, but a minutely set, ingenious machine for turning with infinite artfulness, the red wine of Shiraz into urine?

*Seven Gothic Tales*

The Dreamers

Modern Library

New York, New York, USA. 1961

## USE

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

Nothing is without its use in this world, though it may occasionally be difficult to discover that use.

*Properties of Matter* (2nd edition)

Preface (p. viii)

Adam & Charles Black. Edinburgh, Scotland. 1890

## USELESS

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

What a master a man would be in his own subject if he taught nothing useless!

Translated by Thomas Bailey Saunders

*The Maxims and Reflections of Goethe*

#562 (p. 196)

The Macmillan Co. New York, New York, USA. 1906

**UTILITARIAN**

**Everett, Edward** 1794–1865  
Whig Party politician

it would be a grievous wrong to mathematical, as indeed to any science, to rest its importance mainly on a utilitarian basis. The great truths with which it deals, are clothed with an austere grandeur, far above all purposes of immediate convenience or profit. It is in them that our limited understandings approach nearest to the conception of that absolute and infinite, toward which in most other things they aspire in vain.

*Inauguration of Washington University at Saint Louis, Missouri. April 23, 1857*

Mr. Everett's Inaugural Address on Academic Education (p. 91)  
Little, Brown & Co. Boston, Massachusetts, USA. 1857

**UTILITY**

**Teale, Edwin Way** 1899–1980  
American naturalist

The difference between utility and utility plus beauty is the difference between telephone wires and the spider web.

*Circle of Seasons* (p. 184)

Dodd, Mead & Company. New York, New York, USA. 1987

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

Whoever, in the pursuit of science, seeks after immediate practical utility, may generally rest assured that he will seek in vain.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

First Series

On the Relation of Natural Science to General Science (p. 29)

D. Appleton & Co. New York, New York, USA. 1897

**Whittaker, James Thomas**

No biographical data available

Nothing so dampens enthusiasm, so hampers progress, as doubt of the utility of the work.

*Physiology*

Lecture I (p. 4)

Chancy R. Murry. Cincinnati, Ohio, USA. 1879

## V

### VACCINATION

**Jeffers, Robinson** 1887–1962  
American poet

They take horses  
And give them sicknesses through hollow needles, their  
blood saves babies: I am here on the mountain making  
Antitoxin for all the happy towns and farms...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

A Redeemer (p. 407)

Stanford University Press. Stanford, California, USA. 1988

**Jenner, Edward** 1749–1823  
English scientist

My opinion of vaccination is precisely as it was when  
I first promulgated the discovery. It is not in the least  
strengthened by any event that has happened, for it  
gain no strength; it is not in the least weakened, for if  
the failures you speak of had not happened, the truth of  
my assertions respecting those coincidences which occa-  
sioned them would not have been made out.

In John Baron

*The Life of Edward Jenner* (Volume 2)

Chapter IX (p. 311)

Henry Colburn. London, England. 1838

### VACUUM

**Bacon, Roger** 1214–92  
English philosopher, scientist, and friar

For vacuum rightly conceived of is merely a mathemati-  
cal quantity extended in the three dimensions, existing  
per se without heat and cold, soft and hard, rare and  
dense, and without any natural quality, merely occupying  
space, as the philosophers maintained before Aristotle,  
not only within the heavens, but beyond.

*Opus Majus* (Volume 2)

Part Five, Ninth Distinction, Chapter II (p. 485)

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

...but what God has bin pleas'd to place beyond the  
Region of the Stars, is as much above our Knowledge, as  
it is our Habitation.

Or what if beyond such a determinate space he has left  
an infinite Vacuum; to show, how inconsiderable is all  
that he has made is, to what his Power could, had he so  
pleas'd, have produc'd?

*The Celestial Worlds Discover'd; or, Conjectures Concerning the  
Planetary Worlds, Their Inhabitants and Productions*

Book the Second (p. 156)  
Printed for T. Childe. London, England. 1698

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

he i said is afraid of a vacuum  
what is there in a vacuum to make one afraid said the flea  
there is nothing in it i said  
and that is what makes one afraid to contemplate it  
a person can t think of a place with nothing at all in it  
without going nutty  
and if he tries to think that nothing is something after all  
he gets nuttier

*the lives and times of archy & mehitabel*

the merry flea (p. 45)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Morris, Richard** 1939–2003  
American physicist and science writer

In modern physics, there is no such thing as “nothing.”  
Even in a perfect vacuum, pairs of virtual particles are  
constantly being created and destroyed. The existence of  
these particles is no mathematical fiction. Though they  
cannot be directly observed, the effects they create are  
quite real. The assumption that they exist leads to predic-  
tions that have been confirmed by experiment to a high  
degree of accuracy.

*The Edges of Science*

Chapter II (p. 25)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

Once our minds accept the mutability of matter and the  
new idea of the vacuum, we can speculate on the origin  
of the biggest thing we know – the universe. Maybe the  
universe itself sprang into existence out of nothingness –  
a gigantic vacuum fluctuation which we know today as  
the big bang. Remarkably, the laws of modern physics  
allow for this possibility.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 8 (p. 278)

Simon & Schuster. New York, New York, USA. 1982

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Because...you have believed from childhood that a box  
was empty when you saw nothing in it, you have believed  
in the possibility of a vacuum.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section II, 82

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Rey, Jean** 1583–1645  
French physician and chemist

...in the bounds of nature, a vacuum, which is nothing, can find no place. There is no power in nature which from nothing could have made the universe, and none which could reduce the universe to nothing: that requires the same virtue.

*Essays of Jean Rey*

Essay IV (p. 11)

William F. Clay. Edinburgh, Scotland. 1895

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

You cannot have first space and then things to put into it, any more than you can have first a grin and then a Cheshire cat to fit on to it.

In Sir Arthur Stanley Eddington

*New Pathways in Science*

Chapter II, Section VI (p. 48)

The Macmillan Company. New York, New York, USA. 1935

**Williams, Tennessee** 1911–83

American playwright

...a vacuum is a hell of a lot better than some of the stuff that nature replaces it with.

*Cat on a Hot Tin Roof*

Act 2

A New Directions Book. New York, New York, USA. 1975

**VALLEY**

**Austin, Mary Hunter** 1868–1934

American writer

...valleys are the sunken places of the earth, cañons are scored out by the glacier ploughs of God.

*The Land of Little Rain*

The Streets of the Mountains (p. 183)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1903

**King, Thomas Starr** 1824–64

American Unitarian clergyman

less it not one of the rich rewards of a long visit in any valley, to be able to drive directly to the seats which Nature has fixed along her picture-gallery, for studying leisurely, to the best advantage, her masterpieces of drawing, her most fascinating combinations of sublimity and loveliness, and the most mystic touches of her pencils of light, that edge the “mountain gloom” with “mountain glory?”

*The White Hills: Their Legends, Landscape, and Poetry*

The Four Balleys (p. 9)

Crosby & Ainsworth. Boston, Massachusetts, USA. 1866

**VALUE**

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

The values by which we are to survive are not rules for just and unjust conduct, but are those illuminations in whose light justice and injustice, good and evil, means and ends are seen in fearful sharpness of outline.

*Science and Human Values*

The Sense of Human Dignity (p. 73)

Harper & Row, Publishers. New York, New York, USA. 1965

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

If a new result has value it is when, by binding together long-known elements, until now scattered and appearing unrelated to each other, it suddenly brings order where there reigned apparent disorder.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 126)

Government Printing Office. Washington, D.C. 1910

**VAN ALLEN BELT**

**Kennedy, John F.** 1917–63

26th president of the USA

I know there's been disturbance about the van Allen belt, but van Allen says it's not going to affect the belt, and it's his! [Laughter]

*The President's News Conference*

May 9. 1962

**Ray, Ernest**

American physicist

Space is radioactive!

In Wallace Cloud (ed.)

James van Allen Tells What Space Is Really Like

*Popular Science*, April 1963 (p. 75)

**VANISH**

**Browning, Robert** 1812–89

English poet

Suddenly, as rare things will, it vanished.

In William J. Rolfe and Heloise Edwina Hersey

*Select Poems of Robert Browning*

One Word More

**VARIABILITY**

**Hill, Austin Bradford** 1897–1991

English epidemiologist

The variability of human beings in their illnesses and their reactions to them is a fundamental reason *for* the planned clinical trial and not *against* it.

*Principles of Medical Statistics* (9th edition) (p. 13)

Oxford University Press. New York, New York, USA. 1971

**VARIABLE**

**Fort, Charles** 1874–1932  
American writer

There can be no real science where there are indeterminate variables, but every variable is, in finer terms, indeterminate, or irregular, if only to have the appearance of being in Intermediateness is to express regularity unattained.

*The Book of the Damned*

Chapter III (p. 25)

Boni & Liveright. New York, New York, USA. 1919

**VARIANCE**

**Boring, Edwin Garrigues** 1886–1968  
American psychologist

McDougall's freedom was my variance. McDougall hoped that variance would always be found in specifying the laws of behavior, for there freedom might still persist. I hoped then – less wise than I think I am now (it was 31 years ago) – that science would keep pressing variance towards zero as a limit. At any rate this general fact emerges from this example: freedom, when you believe it is operating, always resides in an area of ignorance. If there is a known law, you do not have freedom.

When Is Human Behavior Predetermined

*The Scientific Monthly*, Volume 84, 1957 (p. 190)

**Cooley, Charles Horton** 1864–1929  
American sociologist

It is clear that one who attempts to study precisely things that are changing must have a great deal to do with measures of change.

Observations on the Measure of Change

*Journal of the American Statistical Association*, New Series, Number 21, March, 1893

**Crichton, Michael** 1942–  
American novelist

The computer informed her that three spaces accounted for eighty-one percent of variance.

*The Terminal Man*

Chapter 6 (p. 47)

Alfred A. Knopf. New York, New York, USA. 1972

**VARIATION**

**Darwin, Charles Robert** 1809–82  
English naturalist

Many laws regulate variation, some few of which can be dimly seen.... I will here only allude to what may be called correlated variation. Important changes in the embryo or larva will probably entail changes in the mature animal.... Breeders believe that long limbs are almost always

accompanied by an elongated head...cats which are entirely white and have blue eyes are generally deaf.... [I]t appears that white sheep and pigs are injured by certain plants whilst dark-colored individuals escape....

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter I (p. 11)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...individuals of the same species often present, as is known to everyone, great differences of structure, independently of variation, as in the two sexes of various animals, in the two or three castes of sterile females or workers amongst insects, and in the immature and larval states of many of the lower animals.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter II (p. 25)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the number of intermediate varieties, which must have formerly existed, [must] be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and gravest objection which can be urged against the theory.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter X (p. 152)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The mind cannot possibly grasp the full meaning of the term of even a million years; it cannot add up and perceive the full effects of many slight variations, accumulated during an almost infinite number of generations.

*The Origin of Species by Means of Natural Selection* Volume 2

Chapter XV (p. 295)

John Murray. London, England. 1888

But at present, after drawing up a rough copy on this subject, my conclusion is that external conditions do extremely little, except in causing mere variability. This mere variability (causing the child not closely to resemble the parent) I look at as very different from the formation of a marked variety or new species.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

C. Darwin to J.D. Hooker, November 23rd [1856] (p. 445)

D. Appleton & Company. New York, New York, USA. 1896

**Fieller, E. C.**

American statistician

Before the inherent variability of the test-animals was appreciated, assays were sometimes carried out on as few as three rabbits: as one pharmacologist put it, those were the happy days.

The Biological Standardization of Insulin

*Supplement to the Journal of the Royal Statistical Society*, Volume 7,

Number 1, 1940–41 (p. 3)

**Harvey, William** 1578–1657  
English physician

...to me the form of the egg has never appeared to have aught to do with the engenderment of the chick, but to be a mere accident; and to this conclusion I come the rather when I see the diversities in the shapes of the eggs of different hens.

In *Great Books of the Western World* (Volume 28)  
*Anatomical Exercises on the Generation of Animals*  
Exercise 59 (p. 462)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hume, David** 1711–76  
Scottish philosopher and historian

Nothing so like as eggs; yet no one, on account of this appearing similarity, expects the same taste and relish in all of them.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
Section IV, Part II (p. 462)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Thomas Henry** 1825–95  
English biologist

The student of anatomy is perfectly well aware that there is not a single organ of the human body the structure of which does not vary, to a greater or less extent, in different individuals.

*Man's Place in Nature and Other Anthropological Essays*  
Chapter III (p. 185)  
D. Appleton & Company. New York, New York, USA. 1896

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

...there are never in nature two beings which are exactly alike...

*Philosophical Papers and Letters* (Volume 2)  
Monadology, 9 (p. 1044)  
The University of Chicago Press. Chicago, Illinois, USA. 1956

**Pallister, William Hales** 1877–1946  
Canadian physician

What shall we say of a plot of ground  
Planted in similar seed,  
Where thousands of similar plants are found  
But one is a new type indeed;  
When dissimilar comes from similar,  
And freedom has its hour,  
When the scion is not as ancestors are,  
What is this latent power?

*Poems of Science*  
De Ipsa Natura, Variation (p. 213)  
Playford Press. New York, New York, USA. 1931

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

The endless variety in the world has not been created by law. It is not the nature of uniformity to originate variation, nor of law to beget circumstance.

*Collected Papers* (Volume 6)  
Chapter 6, Section 2 (p. 373)  
Harvard University Press. Cambridge, Massachusetts, USA. 1960

**Tippett, L. C.**  
English statistician

Variation is, of course, an important characteristic of populations that individuals cannot have.... A thousand exactly similar steel bearing balls (if such were possible) would be no more than one ball multiplied one thousand times. It is the quality of variation that makes it difficult at first to carry in mind a population in its complexity.

*The World of Mathematics* (Volume 3)  
Sampling and Standard Error (p. 1480)  
Simon & Schuster. New York, New York, USA. 1956

**Waddington, Conrad Hal** 1905–75  
British biologist and paleontologist

To suppose that the evolution of the wonderfully adapted biological mechanisms has depended only on a selection out of a haphazard set of variations, each produced by blind chance, is like suggesting that if we went on throwing bricks together into heaps, we should eventually be able to choose ourselves the most desirable house.

*The Listener*, 13 February, 1952

**Wheeler, William Morton** 1865–1937  
American entomologist

Since no two events are identical, every atom, molecule, organism, personality, and society is an emergent and, at least to some extent, a novelty.

Emergent Evolution of the Social  
*Proceedings of the Sixth International Congress of Philosophers*, Cambridge, Massachusetts, USA, 1926.

**Ricklefs, R.**  
No biographical data available

Variation in the environment is a fact of life for all plants and animals, except perhaps for inhabitants of the abyssal depths of the sea.

*Ecology* (2nd edition) (p. 159)  
Chiron Press. New York, New York, USA

## VARIETIES

**Wallace, Alfred Russel** 1820–1913  
English humanist, naturalist, and geographer

One of the strongest arguments which have been adduced to prove the original and permanent distinctness of species is, that *varieties* produced in a state of domesticity are more or less unstable, and often have a tendency, if left to themselves, to return to the normal form of the



parent species; and this instability is considered to be a distinctive peculiarity of all varieties, even of those occurring among wild animals in a state of nature, and to constitute a provision for preserving unchanged the originally created distinct species.

*Contributions to the Theory of Natural Selection* (2nd edition)

Chapter II (p. 26)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1871

...there is a tendency in nature to the continued progression of certain classes of varieties further and further from the original type – a progression to which there appears no reason to assign any definite limits ...

*Contributions to the Theory of Natural Selection* (2nd edition)

Chapter II (p. 43)

McGraw-Hill Book Co., Inc. New York, New York, USA. 1871

## VARIETY

**Cowper, William** 1731–1800

English poet

Variety's the very spice of life,  
That gives it all its flavor.

*The Poetical Works of William Cowper*

The Task, Book II (The Timepiece), l. 606

John W. Lovell Company. New York, New York, USA. No date

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Unanimity of opinion may be fitting for a church, for the frightened or greedy victims of some (ancient, or modern) myth, or for the weak and willing followers of some tyrant. Variety of opinion is necessary for objective knowledge. And a method that encourages variety is also the only method that is comparable with a humanitarian outlook.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 3 (p. 46)

Verso. London, England. 1978

**Wren, Sir Christopher** 1632–1723

English designer, astronomer, and geometer

In things to be seen at once much variety makes confusion, another vice of beauty. In things that are not seen at once, and have no respect one to another, great variety is commendable, provided this variety transgress not the rules of *optics* and *geometry*.

*Lives of Eminent Persons*

Sir Christopher Wren (p. 30)

Baldwin & Cradock. London, England. 1833

Variety of uniformities makes complete beauty. Uniformities are best tempered, as rhymes in poetry, alternately, or sometimes with more variety, as in stanzas.

*Lives of Eminent Persons*

Sir Christopher Wren (p. 30)

Baldwin & Cradock. London, England. 1833

## VECTOR

**Gibbs, J. Willard** 1839–1903

American mathematician

If I wished to attract the student of any of these sciences to an algebra for vectors, I should tell him that the fundamental notions of this algebra were exactly those with which he was daily conversant.... In fact, I should tell him that the notions which we use in vector analysis are those which he who reads between the lines will meet on every page of the great masters of analysis, or of those who have probed deepest the secrets of nature...

*Nature*, Volume 47, Number 1220, March, 1893 (p. 464)

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Quaternions came from Hamilton...and have been an unmixed evil to those who have touched them in any way. Vector is a useless survival...and has never been of the slightest use to any creature.

In Jerrold E. Marsden and Anthony J. Tromba

*Vector Calculus*

Chapter 1 (p. 1)

W.H. Freeman & Company. New York, New York, USA. 2003

**Warren, Robert Penn** 1905–89

American writer and critic

What if angry vectors veer  
Round your sleeping head, and form.  
There's never need to fear  
Violence of the poor world's abstract storm.

*Poems*

Lullaby: Smile in Sleep

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1998

## VECTOR ANALYSIS

**Gibbs, J. Willard** 1839–1903

American mathematician

If I wished to attract the student of any of these sciences to an algebra for vectors, I should tell him that the fundamental notions of this algebra were exactly those with which he was daily conversant.... In fact, I should tell him that the notions which we use in vector analysis are those which he who reads between the lines will meet on every page of the great masters of analysis, or of those who have probed the deepest secrets of nature.

Quaternions and the Algebra of Vectors

*Nature*, Volume 47, Number 1220, 16 March, 1893 (p. 464)

The numerical description of a vector requires three numbers, but nothing prevents us from using a single number for its symbolical designation. An algebra or analytical method in which a single letter or other expression is

used to specify a vector may be called a vector algebra or vector analysis.

*Elements of Vector Analysis Arranged for the Use of Students in Physics*, 1881

## VEGETABLE

### Hawks, Ellison

No biographical data available

Great as have been the victories of the human intelligence over the forces of the vegetable world, the problems solved seem only to point the way to further questions that yet await solution. As in all other sciences, the more we learn, the wider does the path open out, so that we see ever more before us.

*Pioneers of Plant Study*

Preface (p. v)

The Shelton Press. 1928

### Phillips, Henry 1779–1840

English banker

The vegetable world presents an almost infinite variety of objects, calculated not only to supply our numerous wants, but to gratify the senses, to delight the most refined taste, and to elevate the mind to the God of Nature.

*History of Cultivated Vegetables* (Volume 1) (2nd edition)

Introduction (p. 2)

Henry Colburn & Co. London, England. 1822

## VEGETABLE LIFE

### von Humboldt, Alexander 1769–1859

German naturalist and explorer

Without entering on the difficult question of spontaneous motion, or, in other words, on the difference between vegetable and animal life, we would remark that if Nature had endowed us with microscopic powers of vision, and the integuments of plants had been rendered perfectly transparent to our eyes, the vegetable world would present a very different aspect from the apparent immobility and repose in which it is now manifested to our senses. The interior portion of the cellular structure of their organs is incessantly animated by the most varied currents, ...rotating, ascending and descending, ramifying, and ever changing their direction. ... If to these manifold currents and gyratory movements we add the phenomena of endosmosis, nutrition, and growth, we shall have some idea of those forces which are ever active amid the apparent repose of vegetable life.

Translated by E.C. Otte

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1) (p. 341)

D. Appleton & Co. New York, New York, USA. 1850

## VEGETARIAN

### Hutchison, Sir Robert Grieve 1871–1960

English radiologist

Don't scrape your insides with much roughage as it is more likely to do harm than good. Vegetarianism is harmless enough though it is apt to fill a man with wind and self-righteousness.

Address

British Medical Association, Winnipeg, Canada, 1930

## VEGETATION

### Carson, Rachel 1907–64

American marine biologist and author

The earth's vegetation is a part of the web of life in which there are intimate and essential relations between plants and the earth, between plants and other plants, between plants and animals, and we must learn to respect that fine and fragile web if there is to be anything left for the next generation.

*Silent Spring*

Chapter 6 (p. 64)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

### White, Gilbert 1720–93

English naturalist and cleric

Vegetation is highly worthy of our attention; and in itself is of the utmost consequence to mankind, and productive of many of the greatest comforts and elegancies of life.

*The Natural History of Selborne*

Letter XL (p. 192)

Robert M. McBride & Company. New York, New York, USA. 1925

## VENOM

### Bunyan, John 1628–88

English Christian writer and preacher

SPIDER: My venom's good for something, since God made it.

*The Complete works of John Bunyan*

The Sinner and the Spider

Bradley, Garretson & Co. Philadelphia, Pennsylvania, USA. 1872

### Roberts, Charles, D.

The stinging fire of it [ant stings] ran like lightning all over her arms and body. With a piercing scream she sprang away from the tree and began tearing and beating frantically at her body with both hands. She was covered with furious ants – the great, red, stinging ants whose venom is like drops of liquid flame.

On the Face of the Waters

*Cosmopolitan*, Volume LIX, Number 5, October, 1915 (p. 648)

## VERMIN OF THE SKIES

**Moulton, Forest Ray** 1872–1952  
American astronomer

I have heard the great geologist Suess, a man of the widest interests and richest imagination, describe a certain astronomer as “one of those who busy themselves with those vermin of the skies – minor planets and comets.”

The Progress of mathematical Astronomy  
*Popular Astronomy*, Volume 24, Number 9, November, 1916 (p. 555)

## VERNAL EQUINOX

**Cuppy, Will** 1884–1929  
American humorist and critic

Among things you might be thinking about today is the vernal equinox – it’s March 21, you know. The vernal equinox is the point at which the sun apparently crosses the celestial equator toward the north, or you can say it is the moment at which this occurs, or you can simply say: “Hooray! Spring is here!” Exactly why the sun does this on March 21 is a long story.

*How to Get from January to December*  
March 21 (p. 61)  
Holt. New York, New York, USA. 1951

## VERNIER

**Langley, Samuel Pierpoint** 1834–1906  
American astronomer and aviation pioneer

That little Vernier, on whose slender lines  
The midnight taper trembles as it shines,  
Tells through the mist where dazzled Mercury burns,  
And marks the point where Uranus returns.

*The New Astronomy*  
Chapter I (p. 3)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1889

## VERTEBRATE

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

...if the vertebrates differ markedly from one another in their organisation, it is because nature only started to carry out her plan in their respect with the fishes; that she made further advances with the reptiles; that she carried it still nearer perfection with the birds, and that finally she only attained the end with the most perfect mammals.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter VI (p. 81)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

## VIBRATE

**Rowland, Henry Augustus** 1848–1901  
American physicist

Something vibrates.

*The Physical Papers of Henry Augustus Rowland*  
The Roentgen Ray, and its Relation to Physics (p. 586)  
The Johns Hopkins Press. Baltimore, Maryland, USA. 1902

## VIBRATION

**Tuttle, Hudson** 1836–1910  
American spiritualist

There is no breath of air so gentle, no wave breaking on the sands, but the vibrations of these movements run through all space.

In Ludwig Buchner  
*Force and Matter*  
Chapter III (p. 16)  
Trubner & Company. London, England. 1864

## VIEW

**Dewey, John** 1859–1952  
American philosopher and educator

It is not truly realistic or scientific to take short views, to sacrifice the future to immediate pressure, to ignore facts and forces that are disagreeable and to magnify the enduring quality of whatever falls in with immediate desire. It is false that the evils of the situation arise from absence of ideals; they spring from wrong ideals.

*Reconstruction in Philosophy*  
Chapter V (p. 130)  
Beacon Press. Boston, Massachusetts, USA. 1920

## VIEWPOINT

**Hobbs, William Herbert** 1864–1952  
American geologist

Experience has shown that whenever a new and more advanced viewpoint has been gained to take the place of an earlier one, and its superiority has come to be acknowledged, the tendency has always been to sketch in from that one standpoint even the more distant objects, rather than to move forward to new and independent positions.

*Characteristics of Existing Glaciers*  
Introduction (p. 1)  
The Macmillan Co. New York, New York, USA. 1911

## VIEWS

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Nothing is quite so practical, in the sense of being effectual and influential, as the views men hold, consciously or unconsciously, regarding the great locus of their lives and their cosmic home.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
The Walls of the World (p. 83)  
Columbia University Press. New York, New York, USA. 1916

## VIRTUAL PARTICLES

### Gilmore, Robert

No biographical data available

‘What *is* forbidden had better be done pretty quickly.’

This is the rule followed by the virtual particles.

*Alice in Quantum Land*

Chapter 6 (p. 95)

Springer-Verlag. New York, New York, USA. 1955

## VIRUS

### Author undetermined

A virus is a Latin word translated by doctors to mean ‘Your guess is as good as mine.’

Source undetermined

### Cudmore, Lorraine Lee

American cell biologist

All living things need their instruction manual (even non-living things like viruses) and that is all they need, carried in one very small suitcase.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 8)

New York Times Book Company. New York, New York, USA. 1977

### Newman, Michael

No biographical data available

Observe this virus: think how small

Its arsenal, and yet how loud its call;

It took my cell, now takes your cell,

And when it leaves will take our genes as well.

*The Sciences*

Cloned Poem, 1982

### Thomas, Lewis 1913–93

American physician and biologist

We live in a dancing matrix of viruses; they dart, rather like bees, from organism to organism, from plant to insect to mammal to me and back again, and into the sea, tugging along pieces of this genome, strings of genes from that, transplanting grafts of DNA, passing around heredity as though at a great party. They may be a mechanism for keeping new, mutant kinds of DNA in the widest circulation among us. If this is true, the odd virus disease on which we must focus so much of our attention in medicine, may be looked on as an accident, something dropped.

*The Lives of a Cell: Notes of a Biology Watcher*

The Lives of a Cell (p. 5)

The Viking Press. New York, New York, USA. 1974

## VISION

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

*Microscopes and telescopes*, properly considered, put our human eyes out of their natural, healthy, and profitable point of view.

In John Stuart Blackie

*The Wisdom of Goethe*

Philosophy, Metaphysics, Logic, Truth and Science (p. 161)

William Blackwood & Sons. Edinburgh, Scotland. 1883

## VITALITY

### Bergson, Henri 1859–1941

French philosopher

A very small element of a curve is very near being a straight line. And the smaller it is, the nearer. In the limit, it may be termed a part of the curve or a part of the straight line, as you please, for in each of its points a curve coincides with its tangent. So likewise “vitality” is tangent, at any and every point, to physical and chemical forces; but such points are, as a fact, only views taken by a mind which imagines stops at various moments of the movement that generates the curve. In reality, life is no more made of physico-chemical elements than a curve is composed of straight lines.

Translated by Arthur Mitchell

*Creative evolution*

Chapter I (p. 31)

Henry Holt & Co. New York, New York, USA. 1913

### Burroughs, John 1837–1921

American naturalist and writer

Biological science has hunted the secret of vitality like a detective, and it has done some famous work; but it has not yet unraveled the mystery.

*The Breath of Life*

Chapter IV (p. 76)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

## VITAMIN

### Drummond, Jack Cecil 1891–1952

English biochemist

The suggestion is now advanced that the final “-e” [of Funk’s “vitamine”] be dropped, so that the resulting word Vitamin is acceptable under the standard scheme of nomenclature adopted by the Chemical Society.... It is recommended that the somewhat cumbersome nomenclature introduced by McCollum (Fat-soluble A, Water-soluble B),

be dropped, and that the substances be spoken of as Vitamin A, B, C, etc.

The Nomenclature of the So-Called Accessory Food Factors (Vitamins)  
*Biochemical Journal*, Volume 14, 1920

## VIVISECTION

**Shaw, George Bernard** 1856–1950

Irish playwright

If the medical profession were to outdo the Anti-Vivisection Societies in a general professional protest against the practice and principles of the vivisectors, every doctor in the kingdom would gain substantially by the immense relief and reconciliation which would follow such a re-assurance of the humanity of the doctor.

*The Doctor's Dilemma*

Preface (p. 36)

Penguin Books. Baltimore, Maryland, USA. 1954

## VOCABULARY

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

To interrupt one's own researches in order to follow those of another is a scientific pleasure which most experts delegate to their assistants. Consequently, the confusion of tongues increases as the square of the number of talkers, until only ever more select coteries of narrow specialists really understand the refinements of their esoteric vocabularies.

*The Development of Mathematics* (p. 510)

## VOID

**Blake, William** 1757–1827

English poet, painter, and engraver

For the Chaotic Voids outside of the Stars are measured by The Stars...

*The Complete Poetry and Prose of William Blake*

Milton

Book the Second

University of California Press. Berkeley, California, USA. 1982

**Pagels, Heinz R.** 1939–88

American physicist and science writer

The nothingness “before” the creation of the universe is the most complete void that we can imagine – no space, time, or matter existed. It is a world without place, without duration or eternity, without number – it is what mathematicians call “the empty set.” Yet this unthinkable void converts itself into the plenum of existence – a necessary consequence of physical laws. Where are these laws written into that void? What “tells” the void that is pregnant with a possible universe? It would seem that

even the void is subject to law, a logic that exists prior to space and time.

*Perfect Symmetry: The Search for the Beginning of Time*

Part Three, Chapter 5 (p. 347)

Simon & Schuster. New York, New York, USA. 1985

**Thomson, James** 1700–48

Scottish poet

With what an awful, world-revolving power,  
Were first the unwieldy planets launched along  
The illimitable void! There  
to remain

Amidst the flux of many  
thousand years,

That oft has swept the toiling race of men,  
And all their labored monuments, away.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 206)

Birkhäuser. Boston, Massachusetts, USA. 1987

## VOLATILITY

**Bowen, Norman L.** 1887–1956

Canadian geologist

To many petrologists a volatile component is exactly like a Maxwell demon; it does just what one may wish it to do.

*The Evolution of the Igneous Rocks*

Chapter XVI (p. 282)

Dover Publication, Inc., New York, New York, USA. 1956

## VOLCANO

**Anderson, Tempest** 1846–1913

British ophthalmic surgeon

Very few branches of science still remain available for the amateur of limited leisure. Electricity, Chemistry, Bacteriology, most branches of Geology and Mineralogy, have all led to results of highest economic value, and they are cultivated by a large body of professional men subsidized by Colleges or by the Government. They are in a position to give their whole time to their work, and their results are so voluminous that to keep abreast of the literature of any single branch would occupy more than the entire leisure of most men, yet this is a necessary preliminary to any attempt at original work. I was consequently led to seek some branch of Science which gave no prospect of pecuniary return, and I determined on Volcanology, which had the additional advantage of offering exercise in the open air, and in districts often remote and picturesque.

*Volcanic Studies in Many Lands*

Preface (p. ix)

John Murray. London, England. 1917



**Anidoho, Kofi** 1947–

Ghanaian poet

Our Earth survives recurring furies  
of her stomach pains and quakes  
From the bleeding anger of her wounds  
volcanic ash becomes the hope  
that gives rebirth to abundance of seedtimes.

*Earthchild, with Brain Surgery: Poems*

The Homing Call of Earth

Woeli Publishing Services. 1985

**Author undetermined**

Just as the dairy-maid believes the moon to be a great cheese, so the astronomer fancies our globe a condensed nebula; the chemist, an oxydized ball of aluminium and potassium; the mineralogist, a prodigious crystal – “one entire chrysolite”; and the zoologist, an enormous animal – a thing of life and heat, with volcanoes for nostrils, lava for blood, and earthquakes for pulsations.

Principles of Geology: Being an Inquiry How Far the Former Changes of the Earth's Surface Are Preferable to Causes Now in Operation

*London Quarterly Reviews*, Volume LIII, April, 1835 (p. 217)

Among the many wonderful works of God, none exhibits so much of awful grandeur as an active volcano.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Preface

T. Nelson. London, England. 1890

For the clouds that overhang an active volcano during an eruption of its vapours are, in reality, thunderclouds highly charged with electricity. They accordingly produce what Baron Humboldt calls the volcanic storm. It includes all the most terrible of atmospheric phenomena – lightnings of extraordinary vividness; thunders that peal and reverberate as if they would rend the echoes asunder; torrents of rain that pour down upon the mountain and its neighborhood, hissing like thousands of serpents when they fall on the glowing lava-torrent; and whirlwinds that sweep the volcanic ashes round and round in vast eddies, and before whose violence no man of mortal mould is able for a moment to stand.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter I

T. Nelson. London, England. 1890

A volcano is a mountain that is busted and squirts out stuff.

In C. Judson Herrick

*The Evolution of Human Nature*

Chapter Five (p. 57)

University of Texas Press. Austin, Texas, USA. 1956

Since the small hours of this morning lava from Vesuvius has been slowly eating its way through this village. It is a slow, deliberate process. In the darkness of the night the

flames, the incandescent glow from the rolling masses of lava, and above all the great lambent red tongue on the mountain side overhanging all, make it indescribably awesome.... We were watching the lava preparing to swallow a house which still bore somewhat unnecessarily in the circumstances the Fascist slogan ‘*Viva pericolosamente*’ (Live dangerously). Presently the house collapsed. As the dust-cloud subsided a mongrel collie suddenly emerged from the masses of plaster. It shook itself and dashed to safety. It had lived up to Mussolini's injunction.

In the Track of the Lava: Stricken Villages on Vesuvius'

*The Times*, March, 21, 1944 (p. 3)

The ocean conveys an idea of power; but not in the same sense or degree with which the volcano, which hurls great masses of rock, amidst fire and smoke, to the utmost range of human vision, and makes the solid earth tremble over the area of an entire province with its deep reverberations. Imagination must be wanting in the people to whom such a spectacle does not appeal with singular force, and on whose minds it does not leave a profound impression.

The Volcanoes of Central America

*Harper's New Monthly Magazine*, Volume 19, Number 114 (p. 739)

Two agencies of the most opposite character have apparently been, at all times, acting on the crust of the earth to change its form, or add to the surface of the dry land – the volcano and the insect! – the one the most sudden and violent imaginable, producing in a short time the most astonishing effects; the other gradual, silent, and imperceptible, yet leaving the most stupendous monuments of its activity. The volcano has thrown up a mountain in a single night; there is an instance, too, on record, where a mountain has quite as suddenly disappeared, destroying itself in its own violent combustion, and breaking up with repeated and terrific explosions. On the other hand, besides what has been long known of the works of the coral insect, the microscope has revealed to us that huge cliffs have been constructed of the minute fossil shells of animalculae.

Physical Geography

*Blackwood's Edinburgh Magazine*, Volume 66, Number 408, October, 1849 (pp. 465–466)**Bonney, Thomas George** 1833–1923

English geologist

Were it not that Nature sometimes supplies new material, there would be little excuse for another book on Volcanoes.

*Volcanoes: Their Structure and Significance*

Preface (p. v)

John Murray. London, England. 1899

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist



Volcanoes are personalities that resist classification.

*Autobiography of Earth*

Chapter VII (p. 211)

Coward-McCann, Inc. New York, New York, USA. 1935

**Burnet, Thomas** 1635–1715

English cleric and scientist

There is nothing certainly more terrible in all Nature than Fiery Mountains, to those that live within the view or noise of them; but it is not easier for us, who never see them nor heard them, to represent to ourselves with such just and lively imaginations as shall excite us in the same passions, and the same horror as they would excite, if present to our senses.

*The Sacred Theory of the Earth* (2nd edition)

Book III, Chapter VII (p. 272)

Printed by R. Norton. London. 1691

**Cassius Dio** 150–235

Roman senator and historian

Thus day was turned into night and light into darkness. Some thought that the Giants were rising again in revolt (for at this time also many of their forms could be discerned in the smoke and, moreover, a sound as of trumpets was heard), while others believed that the whole universe was being resolved into chaos or fire.

*Dio's Roman History*

Epitome of Book LXXVI (p. 211)

Heinemann. London, England. 1914–27

**Cloos, Hans** 1885–1951

German geologist

Giant smoking volcanoes stand in a row like the pipes of a cosmic organ through which the mighty breath of the earth blows its roaring music.

*Conversation with the Earth*

Prologue (p. 5)

Routledge & Kegan Paul. London, England. 1954

**Conway, Sir William Martin** 1856–1937

English art critic, politician, and mountaineer

...with what a bold brush volcanoes can stain a whole landscape...

*Mountain Memories: A Pilgrimage of Romance*

Chapter XVI (p. 168)

Cassell & Co. London, England. 1920

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

This day, as I fly, the lava world is calm. There is something surprising in the tranquility of this deserted landscape where once a thousand volcanoes boomed to each other in their great subterranean organs and spat forth their fire. I fly over a world mute and abandoned, strewn with black glaciers.

*Wind, Sand and Stars*

Chapter 5, Section I (pp. 99–100)

Reynal & Hitchcock. New York, New York, USA. 1939

He carefully cleaned out his active volcanoes. He possessed two active volcanoes; and they were very convenient for heating his breakfast in the morning. He also had one volcano that was extinct. But, as he said, "One never knows!" So he cleaned out the extinct volcano, too. If they are well cleaned out, volcanoes burn slowly and steadily, without any eruptions. Volcanic eruptions are like fires in a chimney.

Translated by Katherine Woods

*The Little Prince*

Chapter IX (p. 32)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Decker, Robert** 1927–2005

American volcanologist

**Decker, Barbara**

American science writer

Volcanoes assail the senses. They are beautiful in repose and awesome in eruption; they hiss and roar, they smell of brimstone. Their heat warms, their fires consume; they are the homes of gods and goddesses.

Volcanoes are described in words and pictures, but they must be experienced to be known. Their roots reach deep inside the Earth; their products are scattered in the sky. Understanding volcanoes is an unconquered challenge.

*Volcanoes* (3rd edition)

Preface (p. vii)

W.H. Freeman & Company. San Francisco, California, USA. 1981

Volcanoes are nature's forges and stills where the elements of the Earth, both rare and common, are moved and sorted.

*Volcanoes* (3rd edition)

Chapter 13 (p. 168)

W.H. Freeman & Company. San Francisco, California, USA. 1981

**Francis, Peter** 1944–99

English volcanologist

If mountains can have personalities, then volcanoes are schizophrenic – they have split personalities. For most of their life, they are dormant, and one tends to think of them as graceful unsweeping cones, delicately capped with snow, dreaming serenely over the cherry-blossom-draped landscapes of calendars and travel posters. Sometimes, perhaps not very often during their lifetimes, volcanoes erupt and present a wholly different character. Convolute eruption clouds tower above them, raining hot ashes on the helpless humans who live on their flanks, and glowing tongues of liquid rock ooze inexorably downwards, engulfing the flimsy structures which stand in their way.

*Volcanoes: A Planetary Perspective*

Chapter 1 (p. 13)

Penguin Books Ltd. Middlesex, England. 1976

**Guterson, David** 1956–

American writer

"Everything up here is crumbling," he said. "Erosion city or something."

Basalt lava,” Christine said.  
 “Old volcanoes.”  
 “Very old volcanoes.”  
 “Like fifty million years.”  
 “Even older.”

*East of the Mountains*

Chapter Two (pp. 37–38)

Harcourt Brace & Company. New York, New York, USA. 1999

**Herschel, Sir John Frederick William** 1792–1871  
 English astronomer and chemist

Everyone knows that a volcano is a mountain that vomits out fire, and smoke, and cinders, and melted lava, and sulphur, and steam, and gases, and all kinds of horrible things ...

*Familiar Lectures on Scientific Subjects*

Lecture I (p. 1)

George Routledge & Sons. New York, New York, USA. 1871

**Hunt, Leigh** 1784–1859  
 English author, poet, and editor

Did Aetna [a volcano] exist before the human race? Was it, for ages, a great lonely earth monster, sitting by the sea with its rugged woody shoulders and ghastly crown; now silent and quiet for centuries, like a basking giant – now roaring to the antediluvian solitudes, vomiting forth fire and smoke, driveling with lava, then silent again as before – alternately destroying and nourishing the transitory races of analogous gigantic creatures, mammoths, and mastodons, which preceded nobler humanity?

*A Jar of Honey From Mount Hybla* (p. 36)

Smith, Elder & Co. London, England. 1897

**Hutton, James** 1726–97  
 Scottish geologist, chemist, and naturalist

Volcanoes are natural to the globe, as general operations; but we are not to consider nature as having a burning mountain for an end in her intention, or as a principal purpose in the general system of this world.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section III (p. 145)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

A volcano is not made on purpose to frighten superstitious people into fits of piety and devotion, nor to overwhelm devoted cities with destruction; a volcano should be considered as a spiracle to the subterranean furnace, in order to prevent the unnecessary elevation of land, and fatal effects of earthquakes; and we may rest assured, that they, in general, wisely answer the end of their intention, without being in themselves an end, for which nature had exerted such amazing power and excellent contrivance.

*Theory of the Earth: With Proofs and Illustrations* (Volume 1)

Chapter I, Section III (p. 146)

H.R. Engelmann & Weldon & Wesley. Weinheim, Germany. 1959

**Judd, John Wesley** 1840–1916  
 British geologist

[Volcanoes] are just...holes in the earth’s crust...by means of which a communication is kept up between the surface and the interior of our globe.

*Volcanoes: What They Are And What They Teach*

Chapter I (p. 2)

D. Appleton & Co. New York, New York, USA. 1881

**Kircher, Athanasius** 1601?–80  
 German Jesuit scholar

That there are Subterraneous Conservatories, and Treasuries of Fire (even as well, as there are of Water, and Air, &c.) and vast Abysses, and bottomless Gulphs in the Bowels and very Entrals of the Earth, stored therewith, no sober Philosopher can deny; If he do but consider the prodigious Vulcano’s, or fire-belching Mountains; the eruptions of sulphurous fires not only out of the Earth, but also out of the very Sea; the multitude and variety of hot Baths everywhere occurring. And that they have their source and birth-place, not in the Air, not in the Water; nay, nor as the Vulgar perswade themselves, not at the bottom of the Mountains; but in the very in-most privy-Chambers, and retiring places of the Earth, is as reasonable to think; And there Vulcan, as it were, to have his Elaboratories, Shops, and Forges in the profoundest Bowels of Nature.

*The Vulcano’s, or, Burning and Fire-vomiting Mountains, Famous in the World* (p. 1)

John Allen. London, England. 1669

**Krafft, Katia** 1942–91  
 French volcanologist and photographer

I would always like to be near craters, drunk with fire, gas, my face burned by the heat. ... It’s not that I flirt with my death, but at this point I don’t care about it, because there is the pleasure of approaching the beast and not knowing if he is going to catch you.

In Stanley Williams and Fen Montaigne

*Surviving Galeras*

Chapter 6 (p. 101)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2001

**Lowry, Malcolm** 1909–57  
 English novelist

...it was in eruption, yet no, it wasn’t the volcano, the world itself was bursting, bursting into black spouts of villages catapulted into space with himself falling through it all, through the blazing of ten million bodies, falling...

*Under the Volcano*

Chapter XII (p. 375)

Penguin Books, USA. New York, New York, USA. 1971

**McBirney, Alexander R.** 1924–  
 American geologist and founder of Center for Volcanology

The progress that volcanology has made since ancient scholars explained the lavas of Vesuvius and Etna as products of combustion and subterranean storms is more

apparent than real. The sad fact is that we desperately need a coherent and demonstrable theory on volcanism. Why do volcanoes erupt? The only honest answer is that we do not have the vaguest idea.

In Katia Krafft

*Volcanoes: Earths Awakening* (p. 4)

Hamond World Atlas Corporation. 1916

**Michener, James A.** 1907?–97

American novelist

For nearly forty million years the first island struggled in the bosom of the sea, endeavoring to be born as observable land. For nearly forty million submerged years its subterranean volcano hissed and...spewed forth rock, but it remained nevertheless hidden beneath the dark waters of the restless sea...a small climbing pretentious thing of no consequence.

*Hawaii*

Chapter I (p. 5)

Random House, Inc. New York, New York, USA. 1959

**Miller, Hugh** 1802–56

Scottish geologist and theologian

The billows fall back in boiling eddies; the solid strata are upheaved into a flat dome, crusted with corals and shells; it cracks, it severs, a dark gulf yawns suddenly in the midst; a dense strongly variegated cloud of mingled smoke and steam arises black as midnight in its central volumes, but chequered, where the boiling waves hiss at its edge, with wreaths of white....

*Sketch-Book of Popular Geology*

Lecture Third (p. 109)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

And over the roar of waves or the rush of tides we may hear the growling of a subterranean thunder, that now dies away in low deep mutterings, and no, ere some fresh earthquake-shock tern – pests the sea, bellows wildly from the abyss.

*Sketch-Book of Popular Geology*

Lecture Third (p. 109)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Morton, Ron L.**

No biographical data available

Why are we humans drawn to volcanoes like kids to a haunted house, like mice to a cheese-baited trap?

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 2 (p. 35)

Plenum Press. New York, New York, USA. 1996

**Muir, John** 1838–1914

American naturalist

Like gigantic geysers, spouting hot stone instead of hot water, they work and sleep, and we have no sure means of knowing whether they are only sleeping or dead.

*Steep Trails*

Chapter III (p. 56)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Noonan, Dominic A.**

No biographical data available

Now volcanoes are like women, lad, There are no two the same; Though underneath each crest and breast, There burns the self-same flame.

*Alaska: The Land of Now* (p. 105)

Publisher undetermined

Seattle, Washington, USA. 1921

**Ovid** 43 BCE–17 AD

Roman poet

Near Troezen, ruled by Pittheus, there is a hill, high and treeless, which once was a perfectly level plane, but now a hill; for (horrible to relate) the wild forces of the winds, shut up in dark regions underground, seeking an outlet for their flowing and striving vainly to obtain a freer space, since there was no chink in all their prison through which their breath could go, puffed out and stretched the ground, just as when one inflates a bladder with his breath, or the skin of a horned goat. That swelling in the ground remained, has still the appearance of a high hill, and has hardened as the years went by.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 2)

Chapter XV (pp. 385–387)

William Heinemann. London, England. 1916

**Peattie, Roderick** 1891–1955

Geographer and romanticist

Fuji is benign. Its serenity gives it a place in Japanese philosophy. It is sacred and it is the most common motive of Japanese art. Etna, if one is a dualist, is a devil rather than a divinity. It is a force for evil whose boiling arms of lava reach out fiendishly toward the villages.

*Mountain Geography*

Introduction (p. 4)

Harvard University Press. Cambridge, Massachusetts, USA. 1936

**Perry, Lilla Cabot** 1848–1933

American poet

Forgive me not! Hate me and I shall know  
Some of love's fire still burns in your breast!  
Forgiveness finds its home in hearts at rest,  
On dead volcanoes only lies the snow.

*Ode to Volcanoes and the Living Earth*

**Scrope, George Poulett** 1797–1876

English geologist and political economist

The action of a Volcano, in its simplest and most general form, may be described as, the rise of earthy substances in a liquefied state and at a high temperature (Lava,) from beneath the outer crust of the earth; accompanied by

prodigious volumes of elastic fluids, which, appearing to be evolved from the interior of the mass, burst upwards with violent successive detonations, scattering into the air, to a considerable height, numerous fragments, still in a liquid state, of the lava, through which they tear their way, together with shattered blocks of the solid pre-existing rocks, which obstructed their expansion.

*Considerations on Volcanos*

Chapter I, Section 1 (pp. 1–2)

Printed by W. Phillips. London, England. 1825

### **Shelley, Percy Bysshe** 1792–1822

English poet

Nature's most secret steps

He like her shadow has pursued, where'er

The red volcano overcanopies

Its fields of snow and pinnacles of ice

With burning smoke.

*The Complete Poetical Works of Percy Bysshe Shelley*

Alastor

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### **Shindler, Tom**

Musician

Those lovely white snow peaks, those rulers of mountains,

Who knows what secrets they keep?

But when they look like forever, just stop and remember

The Giants are only asleep.

*The Giants Are Only Asleep*

Source undetermined

### **Sontag, Susan** 1933–2004

American critic and writer

It's the mouth of a volcano. Yes, mouth; and lava tongue. A body, a monstrous living body, both male and female. It emits, ejects. It is also an interior, an abyss. Something alive, that can die. Something inert that becomes agitated, now and then. Existing only intermittently. A constant menace. If predictable, usually not predicted. Capricious, untamable, malodorous. Is that what's meant by the primitive? Nevado del Ruiz, Mount Saint Helens, La Soufrière. Mount Pelée, Krakatoa, Tambora. The slumbering giant that wakes. The lumbering giant who turns his attentions to you. King Kong. Vomiting destruction, and then sinking back to somnolence.

*The Volcano Lover: A Romance* (pp. 5–6)

Jonathan Cape Co. London, England. 1992

### **Tazieff, Haroun** 1914–98

Polish-born French volcanologist

In all ages volcanoes have frightened, fascinated and attracted man, because what they hold is at once terrifying, splendid, and mysterious.

*Craters of Fire*

Chapter XVIII (p. 209)

Hamish Hamilton. London, England. 1952

### **Tennyson, Alfred (Lord)** 1809–92

English poet

Fires that shook me once, but now to silent ashes fallen away.

Cold upon the dead volcano sleeps the gleam of dying day.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Sixty Years After, Stanza 21

Oxford University Press, Inc. London, England. 1953

Had the fierce ashes of some fiery Peak

Been hurled so high they ranged round the World,

For day by day through many a blood-red eve

The wrathful sunset glared.

*Alfred Tennyson's Poetical Works*

St. Telemachus

Oxford University Press, Inc. London, England. 1953

### **Thompson, Dick**

American science journalist

Volcanoes are magnificent primordial beasts. They are geology's living dinosaurs.

*Volcano Cowboys: The Rocky Evolution of a Dangerous Science*

Introduction (p. 1)

St. Martin's Press. New York, New York, USA. 2000

### **Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Here was a yawning pit upon whose floor the armies of Russia could camp, and have room to spare...over a mile square of it was ringed and streaked and striped with a thousand branching streams of liquid and gorgeously brilliant fire! Occasionally the molten lava flowing under the superincumbent crust broke through – split a dazzling streak, from five hundred to a thousand feet long, like a sudden flash of lightning, and then acre after acre of the cold lava parted into fragments, turned up edgewise like cakes of ice when a great river breaks up, plunged downwards, and were swallowed in the crimson cauldron.

*Roughing It* (Volume 2)

Chapter XXXIII (pp. 296, 298, 299)

Harper & Brothers Publishers. New York, New York, USA. 1899

### **Verne, Jules** 1828–1905

French novelist

Above our heads, not more than 500 feet away, was the crater of the volcano. Every quarter of an hour there came flying from it a tall column of flames mixed with pumice-stone, ashes, and lava, together with a deafening explosion. I felt the whole mountain heave every time it breathed, sending out, like a whale, fire and air through its enormous blowholes. Below, on a steep slope, layers of eruptive material could be seen extending 700 or 800 feet down, meaning that the volcano couldn't be more than 2,000 feet high. Its base was

hidden by a real basket of green trees, amongst which I distinguished olive and fig trees, plus vines laden with purple grapes.

It didn't look much like the Arctic, I had to admit.

Translated by William Butcher

*Journey to the Centre of the Earth* (p. 210)

Oxford University Press. Oxford, England. 1992

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

There is an isle hard by Sicania's coast.  
That rises, and Aeolian Lipare,  
With smoking rocks precipitous, where beneath  
Thunders a cave, and Aetna's vaults, scooped out  
By Cyclopean forges; the strong strokes  
Of anvils to the ear bring echoing groans;  
Hisses the steel ore through its hollow depths,  
And from its furnaces pants fire – the home  
of Vulcan, and Vulcania the land's name.

In *Great Books of the Western World* (Volume 13)

*The Aeneid*

Book VIII, l. 416–424 (p. 270)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## VOLCANOLOGIST

**Tazieff, Haroun** 1914–98

Polish-born French volcanologist

Studying dormant volcanoes is of no more profit to the volcanologist who is attempting to make forecasts than is the study of healthy people for the practicing physician.

In Stanley Williams and Fen Montaigne

*Surviving Galeras*

Chapter 6 (p. 101)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2001

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

I found the reddest-faced set of men I almost ever saw. In the strong light every countenance glowed like red-hot iron, every shoulder was suffused with crimson and shaded rearward into dingy, shapeless obscurity! The place below looked like the infernal regions and these men like half-cooked devils just come up on furlough. The smell of sulphur is strong, but not unpleasant to a sinner.

*Mark Twain's Letters from Hawaii*

Volcano House, June 3rd – Midnight (p. 294)

The University Press of Hawaii. Honolulu, Hawaii, USA. 1975

## VOLUME

**Avogadro, Amedeo** 1776–1856

Italian chemist

It must then be admitted that very simple relations also exist between the volumes of gaseous substances and the numbers of simple or compound molecules which form them. The first hypothesis to present itself in this connection, and apparently even the only admissible one, is the supposition that the number of integral molecules in any gases is always the same for equal volumes, or always proportional to the volumes.

Essay on a Manner of Determining the Relative Masses of the Elementary Molecules of Bodies, and the Proportions in Which They Enter into These Compounds

*Journal de Physique de Chimie d'histoire Naturelle et des Artes,*

Volume 73, 1811

**Shenstone, W. A.** 1850–1908

American science teacher and silica glass-blowing inventor

Avogadro's hypothesis affords a bridge by which we can pass from large volumes of gases, which we can handle, to the minuter molecules, which individually are invisible and intangible.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 5 (p. 73)

Longmans. London, England. 1967



## W

### WARNING

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesmen, soldier, and author

The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to its close. In its place we are entering a period of consequences.

In Al Gore

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (pp. 101–102)

From a 1936 speech to citizens of Great Britain  
Rodale. New York, New York, USA. 2006

### WATER

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

Water, water, water.... There is no shortage of water in the desert but [in] exactly the right amount, a perfect ratio of water to rock, of water to sand, insuring that wide, free, open, generous spacing among plants and animals, homes and towns and cities, which makes the arid West so different from any other part of the nation. There is no lack of water here, unless you try to establish a city where no city should be.

*Desert Solitaire*

Water (pp. 144–145)

Ballantine Books. New York, New York, USA. 1968

### Advertisement

Water means power...water means raw materials...water means the life of the maritime nations. Still – man is ignorant of the mysteries of the oceans...he is only beginning to search the depths.

Advertisement by Defense Systems Division, General Motors Corporation  
*Scientific American*, Volume 264, Number 5, April, 1961 (p. 15)

**Bangs, Richard** 1950–  
Adventure writer

...of all our planet's activities – geological movements, the reproduction and decay of biota, and even the disruptive propensities of certain species (elephants and humans come to mind) – no force is greater than the hydrologic cycle.

*Rivergods: Exploring the World's Great Wild Rivers*

Introduction (p. xiii)

Sierra Club Books. San Francisco, California, USA. 1958

**Ball, Philip** 1962–  
English science writer

We call our home Earth – but Water would be more apt.

*Life's Matrix*

Chapter 2 (p. 22)

Farrar, Straus & Giroux. New York, New York, USA. 1999

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

I shall invite you to observe with me, that clouds, rain, hail, snow, froth, and ice, may be but water, having its parts varied as to their size and distance in respect to each other, and as to motion and rest.

*The Sceptical Chymist*

The Sixth Part (p. 203)

J.M. Dent & Sons. London, England. 1911

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

The history of the land has been written very largely in water.

*Autobiography of Earth*

Chapter III (p. 72)

Coward-McCann, Inc. New York, New York, USA. 1935

**Bucke, Charles** 1781–1846  
English writer

Without rocks or mountains no country can be sublime; without water no landscape can be perfectly beautiful.

*On the Beauties, Harmonies, and Sublimities of Nature*

River (p. 19)

Harper & Brothers Publishers. New York, New York, USA. 1841

**Buckley, Arabella B.** 1840–1929  
English naturalist and science writer

We are going to spend an hour today in following a drop of water on its travels. If I dip my finger in this basin of water and lift it up again, I bring with it a small glistening drop out of the water below and hold it before you. Tell me, have you any idea where this drop has been? What changes it has undergone, and what work it has been doing during all the long ages water has lain on the face of the earth?

*The Fairy-Land of Science*

Lecture IV (pp. 95–96)

D. Appleton & Company. New York, New York, USA. 1899

**Burke, Edmund** 1729–97  
English statesman and philosopher

Water, when simple is insipid, inodorous, colorless, and smooth; it is found, when not cold, to be a great resolver of spasms, and lubricator of the fibers; this power it probably owes to its smoothness.

*On the Sublime and the Beautiful*

Part IV, Section XXI (p. 166)

Cassell & Company Ltd. London, England. 1887

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Water is frozen steam, and ice frozen water.



*The Note-Books of Samuel Butler* (Volume 1)  
1874–1883 (p. 74)  
University Press of America, Inc. Lanham, Maryland, USA. 1984

### Charlie Chan (Fictional Character)

Drop of plain water on thirsty tongue more precious than gold in purse.

*Charlie Chan in Egypt*  
Film (1935)

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Water, water, everywhere,  
And all the boards did shrink;  
Water, water, everywhere,  
Nor any drop to drink.

*The Rime of the Ancient Mariner and Other Poems*  
Rime of the Ancient Mariner, Part II, l. 114–118  
Little Leather Library Corporation. New York, New York, USA. 1915

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

Water is friendly to man. The ocean, a part of Nature farthest removed in the unchangeableness and majesty of its might from the spirit of mankind, has ever been a friend to the enterprising nations of the earth. And of all the elements this is the one to which men have always been prone to trust themselves, as if its immensity held a reward as vast as itself.

*The Mirror of the Sea*  
Chapter XXX (p. 101)  
Doubleday, Page & Co. Garden City, New York, USA. 1924

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The water wears away the mountains and fills up the valleys, and if it had the power it would reduce the earth to a perfect sphere.

Translated by Edward MacCurdy  
*The Notebooks of Leonardo da Vinci* (Volume 1)  
Physical Geography (p. 317)  
George Braziller. New York, New York, USA. 1958

If a drop of water falls into the sea when it is calm, it must of necessity be that the whole surface of the sea is raised imperceptibly, seeing that water cannot be compressed within itself, like air.

*Leonardo da Vinci's Note Books* (p. 101)  
Duckworth & Company. London, England. 1906

Water is the driver of nature.

Translated by Maurice Baring  
*Thoughts on Art and Life*  
Thoughts on Science (p. 164)  
The Merrymount Press. Boston, Massachusetts, USA. 1906

**Dalton, John** 1766–1844  
English chemist and physicist

When we consider the very important part which the two elements of hydrogen and oxygen seem to perform in the arrangement of chemical compounds, we are inclined to wonder that no more than one compound of these two elements themselves should be found.

In Henry Enfield Roscoe  
*John Dalton and the Rise of Modern Chemistry*  
Chapter VI (p. 139)  
The Macmillan Co. New York, New York, USA. 1895

**Davy, Sir Humphry** 1778–1829  
English chemist

...I have come to [the] conclusion...that water is the basis of all the gases, and that oxygen, hydrogen, nitrogen, ammonia, nitrous acid, &c., are merely electrical forms of water....

*Fragmentary Remains*  
Chapter IV  
Letter to T.A. Knight (p. 129)  
John Churchill. London, England. 1858

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

Water, thou hast no taste, no color, no odor; canst not be defined, art relished while ever mysterious. Not necessary to life, but rather life itself, thou fillest us with a gratification that exceeds the delight of the senses.

*Wind, Sand and Stars*  
Chapter 8 (p. 234)  
Reynal & Hitchcock. New York, New York, USA. 1939

**Earle, Sylvia Alice** 1935–  
American oceanographer and education advocate

It doesn't matter where on Earth you live, everyone is utterly dependent on the existence of that lovely, living saltwater soup. There's plenty of water in the universe without life, but nowhere is there life without water.

*Sea Change: A Message of the Oceans*  
Introduction (p. xii)  
G.P. Putnam's Sons. New York, New York, USA. 1995

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

If there is magic on this planet, it is contained in water.

*The Immense Journey*  
The Flow of the River (p. 15)  
Vintage Books. New York, New York, USA. 1957

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Water...transports vast boulders of rock in its iceberg a thousand miles. But its far greater power depends on its talent of becoming little, and entering the smallest holes and pores. By this agency, carrying in solution elements needful to every plant, the vegetable world exists.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)  
*Society and Solitude*  
 Chapter VI (p. 146)  
 Houghton Mifflin Company, Boston, Massachusetts, USA. 1904

**Esar, Evan** 1899–1995  
 American humorist

A beautiful blonde is chemically three-fourths water, but what lovely surface tension.  
*20,000 Quips and Quotes* (p. 127)  
 Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Franks, Felix**  
 English chemist and water researcher

Of all known liquids, water is probably the most studied and least understood....  
*Water: A Comprehensive Treatise*  
 Introduction – Water, the Unique Chemical (p. 18)  
 Plenum Press. New York, New York, USA. 1972–82

**Herbert, Sir Alan** 1890–1971  
 English novelist, playwright, poet, and politician

The rain is plenteous but, by God's decree,  
 Only a third is meant for you and me;  
 Two-thirds are taken by the growing things  
 Or vanish Heavenward on vapour's wings:  
 Nor does it mathematically fall  
 With social equity on one and all.  
 The population's habit is to grow  
 In every region where the water's low:  
 Nature is blamed for failings that are Man's,  
 And well-run rivers have to change their plans.  
*Water*  
 Source undetermined

**Hugo, Victor** 1802–85  
 French author, lyric poet, and dramatist

The water is supple because it is incompressible. It glides away from under the effort. Borne down on one side, it escapes on the other. It is thus that the water becomes a wave. The wave is its liberty.  
 Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
 Part II, Book Third, Chapter II (p. 402)  
 The Heritage Press. New York, New York, USA. 1961

**Hutton, W.**  
 No biographical data available

With water our choicest bread is mixed, and life makes part of the composition of our favourite beverage. By water the beasts of the field, and the fowls of the air, quench their thirst; and by means of it the lofty cedar of Lebanon derives its nutriment, as well as the tender herb that creepeth against the wall ...  
*The Book of Nature Laid Open, in a Popular Survey of the Phenomena and Constitution of the Universe*  
 Chapter III (p. 18)  
 J. Milligan. Georgetown, District of Columbia. 1822

**Huxley, Thomas Henry** 1825–95  
 English biologist

... we live in the hope and the faith that, by the advance of molecular physics, we shall by and by be able to see our way as clearly from the constituents of water to the properties of water, as we are now able to deduce the operations of a watch from the form of its parts and the manner in which they are put together.  
*Collected Essays* (Volume 1)  
*Method and Result*  
 On the Physical Basis of Life (p. 152)  
 Macmillan & Company Ltd. London, England. 1904

**Lawrence, D. H. (David Herbert)** 1885–1930  
 English writer

Water is H<sub>2</sub>O, hydrogen two parts, oxygen one, but there is also a third thing, that makes water, and nobody knows what that is.  
*Pansies*  
 The Third Thing  
 Martin Secker. London, England. 1930

**Lavoisier, Antoine Laurent** 1743–94  
 French chemist

I find myself confronted with the task of settling by decisive experiments a question of interest in physics, namely, whether water can be changed into earth, as was thought by the old philosophers, and still is thought by some chemists of the day.  
 Quoted in William Allan Hamor  
*The Science-history of the Universe* (Volume 4)  
 Chapter IX (p. 161)  
 The Current Literature Publishing Co. New York, New York, USA. 1909

**Lawrence, D. H. (David Herbert)** 1885–1930  
 English writer

Water is H<sub>2</sub>O, hydrogen two parts, oxygen one, but there is also a third thing, that makes it water and nobody knows what that is.  
*Complete Poems*  
 The Third thing  
 Penguin Books. London, England. 1993

**Le Févre, Nicholas** 1615–79  
 French chemist

That insipid liquor which commonly is called Water, hath by the Chymists the name of Phlegm given unto it, when it is separated from all other Mixture...  
*A Complete Body of Chymistry*  
 Part I  
 Chapter III, Section II (p. 22)  
 Printed for O. Pullyn. London, England. 1640

**Lean, Vincent Stuckey**

Water is the eye of a landscape.  
*Lean's Collectanea* (Volume 4) (p. 175)  
 J.W. Arrowsmith. Bristol, England. 1904

**McKay, Christopher**

American planetary scientist

If some alien called me up [and said]..., “Hello, this is Alpha, and we want to know what kind of life you have,” – I’d say, waterbased.... Earth organisms figure out how to make do without almost anything else. The single nonnegotiable thing life requires is water.

Interview

*OMNI Magazine*, July 1992 (p. 66)**Norse, Elliot A.**

American marine conservation biologist

In every glass of water we drink, some of the water has already passed through fishes, trees, bacteria, worms in the soil, and many other organisms, including people.... Living systems cleanse water and make it fit, among other things, for human consumption.

In R.J. Hoage (ed.)

*Animal Extinctions: What Everyone Should Know*

The Value of Animal and Plant Species for Agriculture, Medicine, and Industry (p. 62)

Smithsonian Institution Press. Washington, D.C. 1985

**Muir, Matthew Moncrieff Pattison** 1848–1931

English chemist

...pure water is never found in nature: one may even say that no man has ever seen or handled absolutely pure water; it is an ideal substance, to which some specimens of highly purified water have nearly approached.

*The Story of the Chemical Elements*

Chapter III (p. 39)

George Newness. London, England. 1901

**Orczy, Emmuska** 1865–1947

Hungarian-born British novelist

It is only when we are very happy that we can bear to gaze merrily upon the vast and limitless expanse of water, rolling on and on with such persistent, irritating monotony, to the accompaniment of our thoughts, whether grave or gay. When they are gay, the waves echo their gaiety; but when they are sad, then every breaker, as it rolls, seems to bring additional sadness, and to speak to us of hopelessness and of the pettiness of all our joys.

*The Scarlet Pimpernel*

Chapter XXI (p. 176)

**Overstreet, Harry Allen** 1875–1970

American social psychologist and civic awareness advocate

Water, however, is not simply the sum of hydrogen and oxygen. It is something qualitatively new, something that cannot be found by the most searching examination of the gas, hydrogen, nor of the gas, oxygen. No amount of previous knowledge of the atomic structure of hydrogen and oxygen could, apparently, give a knowledge of this peculiar fluid that results from combining the two gasses.

*The Enduring Quest*

Chapter IV (p. 59)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1931

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541

Swiss alchemist and mystic

Water was the matrix of the world and all its creatures.... Just as the noblest and most delicate colours arise from this black, foul earth, so various creatures sprang forth from the primordial substance that was only formless filth in the beginning. Behold the element of water in its undifferentiated state! And then see how all the metals, all the stones, all the glittering rubies, shining carbuncles, crystals, gold, and silver are derived from it; who could have recognized all these things in water ...

In Jolande Jacobi

*Paracelsus*

Chapter I (pp. 13, 15)

Princeton University Press. Princeton, New Jersey, USA. 1995

**Pindar, Paean IX**

No biographical data available

Best of all things is water ...

Translated by Dawson W. Turner

*The Odes of Pindar*

First Olympian Ode (p. 9)

**Po, Huang**

No biographical data available

To gaze upon a drop of water is to behold the nature of all the waters of the universe.

*The Zen Teaching of Huang Po*

The Wan Ling Record, 37 (p. 108)

Buddhist Society. 1977

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Of all inorganic substances, acting in their own proper nature, and without assistance or combination, water is the most wonderful.

*The True and the Beautiful in Nature, Art, Morals, and Religion* (p. 60)

John Wiley &amp; Sons. New York, New York, USA. 1872

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

A drop of water is not immortal; it can be resolved into oxygen and hydrogen. If, therefore, a drop of water were to maintain that it had a quality of aqueousness which would survive its dissolution we should be inclined to be skeptical.

*What I Believe*

Chapter I (p. 6)

E.P. Dutton &amp; Company. New York, New York, USA. 1925

**Snicket, Lemony (Daniel Handler)** 1970–

American writer

After a great deal of time examining oceans, investigating rainstorms, and staring very hard at several drinking fountains, the scientists of the world developed a theory regarding how water is distributed around our planet, which they have named the “water cycle.” The water cycle consists of three key phenomena – evaporation, precipitation, and collection – and all of them are equally boring.

*A Series of Unfortunate Events. Book the Eleventh: The Grim Grotto*  
HarperCollins Publishers. New York, New York, USA. 2004

**Step, Edward** 1855–1931

No biographical data available

One of the principal occupations of civilised man may be said to consist in making clean water dirty; and one of the greatest operations of Nature is to make the dirty water clean and pure again.

*By the Deep Sea: A Popular Introduction to the Wild Life of the British Shores*

Chapter I (p. 13)

Jarrol & Sons. London, England. 1896

**Strauss, Maurice B.** 1904–74

No biographical data available

In the beginning the abundance of the sea

Led to profligacy.

The ascent through the brackish waters of the estuary

To the salt-poor lakes and ponds

Made immense demands

Upon the glands.

Salt must be saved, water is free.

In the never-ending struggle for security,

Man’s chiefest enemy.

According to the bard of Stratford on the Avon,

The banks were climbed and life established on dry land

Making the incredible demand

Upon another gland

That water, too, be saved.

*Body Water in Man: The Acquisition and Maintenance of the Body Fluids*

Salt and Water

Chapter XII (p. 238)

Little, Brown & Company. Boston, Massachusetts, USA. 1957

**Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

The tooth of running water is very sharp.

*The Physical Geography of the Sea*

Chapter XIV (p. 321)

Harper & Brothers. New York, New York, USA. 1855

**van Helmont, Jean-Baptista** 1579–1644

Flemish chemist

That all plants immediately and substantially stem from the element water alone I have learnt from the following experiment. I took an earthen vessel in which I placed two

hundred pounds of earth dried in an oven, and watered with rain water. I planted in it the stem of a willow tree weighing five pounds. Five years later it had developed a tree weighing one hundred and sixty-nine pounds and three ounces. Nothing but rain (or distilled water) had been added. The large vessel was placed in earth and covered by an iron lid with a tin-surface that was pierced with many holes. I have not weighed the leaves that came off in the four autumn seasons. Finally I dried the earth in the vessel again and found the same two hundred pounds of it diminished by about two ounces. Hence one hundred and sixty-four pounds of wood, bark and roots had come up from water alone.

In William H. Brock

*The Norton History of Chemistry*

Introduction (p. xxi)

W.W. Norton & Company, Inc. New York, New York, USA. 1933

**Walton, Izaak** 1593–1683

English writer

And an ingenious Spaniard says that rivers and the inhabitants of the watery element were made for wise men to contemplate, and fools to pass by without consideration...for you may note, that the waters are Nature’s storehouse, in which she locks up her wonders.

*The Complete Angler*

First Day, Chapter I (pp. 31, 34)

T.N. Foulis. London, England. 1913

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

I am not deeply versed in physical science, but there are certain things about water that fill me with wonder and amaze.

*The Undying Fire*

Chapter 4 (p. 111)

The Macmillan Co. New York, New York, USA. 1919

## WATERSHED

**Leopold, Aldo** 1886–1948

American naturalist

... the watershed work of the future belongs quite as much to the forester as to the hydrographer and engineer.

In Susan L. Flader and J. Baird Callicott

*The River of the Mother of God*

Grass, Brush, Timber, and Fire in Southern Arizona (p. 122)

The University of Wisconsin Press

Madison, Wisconsin, USA. 1991

## WAVE

**Burroughs, John** 1837–1921

American naturalist and essayist

On the beach [at Ocean Grove] the waves at times come wallowing ashore like a great flock of sheep; they break

far out, and then comes that rushing line of tossing, leaping, woolly heads and shoulders; they are not steeds, but a wild mob of woolly-headed sheep.

*The Heart of Burroughs's Journals*

Oct. 3, 1885 (p. 125)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

The wave blossoms when it breaks.

*The Heart of Burroughs's Journals*

November 23, 1920 (p. 328)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1928

### Crew, Henry

American physicist

To the mathematician the problems of wave-motion offer a field for his highest power of analysis; to the physicist they suggest experiments demanding all the skill at his disposal; to the engineer and to those who go down to the sea in ships these problems are matters of life and death, while to the poet and the artist they are "the sea dancing to its own music."

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 24 (p. 327)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

Thou canst not wave thy staff in air,  
Or dip thy paddle in the lake,  
But it carves the bow of beauty there,  
And the ripples in rhymes the oar forsake.

*Poems* (Volume 9)

Woodnotes, II (p. 53)

Houghton Mifflin Co. Boston, Massachusetts, USA.

### Feynman, Richard P. 1918–88

American theoretical physicist

There are the rushing waves...mountains of molecules  
each stupidly minding its own business...trillions apart...  
yet forming white surf in unison.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out*

The Value of Science (p. 144)

Perseus Books. Cambridge, Massachusetts, USA. 1999

### Maury, Matthew Fontaine 1806–73

American astronomer, astrophysicist, historian, and oceanographer

The billows there lift themselves up in long ridges with deep hollows between them. They run high and fast, tossing their white caps aloft in the air, looking like the green hills of a rolling prairie capped with snow, and chasing each other in sport. Still their march is stately and their roll majestic.

*The Physical Geography of the Sea: and its Meteorology*

The Winds, 845 (p. 292)

Sampson Low, Son & Co. London, England. 1857

### Morton, Ron L.

No biographical data available

A wave wants nothing more from life than to roll on, free and easy, across the ocean blue. When land gets in its way, there is only one thing for a good wave to do – give up the carefree life and go to work. Work for a wave means to move, crumble, erode, smash, gouge, submerge, and maim the land.

*Music of the Earth: Volcanoes, Earthquakes, and Other Geological Wonders*

Chapter 8 (pp. 210–211)

Plenum Press. New York, New York, USA. 1996

### Thomson, Sir George Paget 1892–1975

British physicist

The wind catches the filaments and the spider is carried where the filaments take it. In much the same way the point which represents the energy of the electron is guided by the waves which surround it, and extend possibly to an indefinite distance in all directions. If the waves pass over an obstacle like an atom their direction is modified and the modification is transmitted back to the electron and enables it to guide its path in accordance with the distribution of matter which it finds around it.

*The Atom*

Chapter VII (p. 110)

Oxford University Press, Inc. London, England. 1956

## WAVE MECHANICS

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

Schrödinger's wave-mechanics is not a physical theory, but a dodge – and a very good dodge too.

*The Nature of the Physical World*

Chapter X (p. 219)

The Macmillan Company. New York, New York, USA. 1930

### Gamow, George 1904–68

Russian-born American physicist

In wave mechanics there are no impenetrable barriers, ... as the British physicist R.H. Fowler [also] put it after my lecture on that subject at the Royal Society of London...

*My World Line: An Informal Autobiography*

Chapter 3 (p. 60)

The Viking Press. New York, New York, USA. 1979

### Gardner, Willard

No biographical data available

The dancing, vanishing, fuzzy pygmies are indeed fantastic people, but the dancing, vanishing, wavy, evasive electrons, positrons, neutrons, and photons, may prove to be quite the ordinary fundamental entities.

*The Scientist's Concept of the Physical World*

First Annual Faculty Research Lecture (p. 18)

Delivered at Utah State Agricultural College, April 22, 1942



**WAVE-PARTICLE DUALITY**

**Glashow, Sheldon L.** 1932–  
American physicist

One quantum notion that mystifies the novice is the wave-particle duality. Does light consist of a beam of particles or is it a wave phenomenon? the question is hundreds of years old. Newton thought light was probably a stream of particles. Maxwell seemed to answer the problem decisively by showing light to be an electromagnetic wave. Yet Einstein in 1905, demonstrated that under some circumstances light behaves as if it were a beam of discrete particles, which are now called photons.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*  
Chapter 3 (p. 51)  
Warner Books. New York, New York, USA. 1988

**WEAPON**

**Amis, Martin** 1949–  
English writer

Nuclear weapons...are remarkable artifacts. They derive their power from an equation: when a pound of uranium-235 is fissioned, the "liberated mass" within its 1,132,000,000,000,000,000,000,000 atoms is multiplied by the speed of light squared – with the explosive force, that is to say, of 186,000 miles per second times 186,000 miles per second. Their size, their power, has no theoretical limit. They are biblical in their anger.

*Einstein's Monsters*  
Introduction: Thinkability (p. 8)  
Jonathan Cape Ltd. London, England. 1987

**WEATHER****Author Undetermined**

A remark about the weather is like the move P to K4 in chess; it has become the established way of beginning a conversation and it holds its ground for the same reason, that no better opening has been discovered.

Talk About the Weather  
*The Independent*, Volume 75, Number 3372, July 17, 1913 (p. 126)

When the air is soft and warm  
And the sun's aglow, Get your trusty overshoes, It's pretty sure to snow.

When the sky is overcast  
And the wind is high, You want to take precautions 'gainst A sunstroke by and by.

The weather's easy to foretell In moments such as these;  
It's sure to rain or snow or thaw, Or get red hot or freeze.  
In Jennie Day Haines

*Weather Opinions*  
Prelude  
Paul Elder & Co. San Francisco, California, USA. 1907

**Blair, Thomas Arthur**  
No biographical data available

They [mathematicians] are hitching the weather to the engine of a formula, measuring it with the yardstick of an equation, and weighing it in the balances of a co-efficient.

The Mathematician, The Farmer and the Weather  
*The Scientific Monthly*, Volume 11, Number 4, October, 1920 (p. 353)

**Cox, Marcelene**  
No biographical data available

Weather means more when you have a garden. There's nothing like listening to a shower and thinking how it is soaking in around your green beans.

*Ladies Home Journal*, 1944

**Eggleston, Edward** 1837–1902  
American clergyman, novelist, and historian

"It is a beautiful day," said Whittaker....  
"Yes, nice day," growled Adams, "but a weather-breeder."

*ROXY*  
Chapter XIII (p. 112)  
Charles Scribner's Sons. New York, New York, USA. 1903

**Einstein, Albert** 1879–1955  
German-born physicist

...when the number of factors coming into play in a phenomenological complex become too large scientific method in most cases fail us. One need only think of the weather, in which case prediction even for a few days ahead is impossible. Nevertheless no one doubts that we are confronted with a causal connection whose causal components are in the main known to us. Occurrences in this domain are beyond the reach of exact prediction because of the variety of factors in operation, not because of any lack of order in nature.

*Out of My Later Years*  
Science and Religion, II (p. 28)  
Kensington Press. New York, New York, USA. 1956

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

A warm day in December is a memory of October; a warm day in February is a dream of April. Their character is unmistakable; we cannot help going back in imagination with the one, and forward with the other.

*Pages from an Old Volume of Life: A Collection of Essays*  
The Seasons (p. 135)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1883

**Hopfield, John** 1933–  
American physicist and neural scientist



You might understand how a few gas molecules interact with one another, but you wouldn't imagine that putting millions of them together would get you weather.

In T.I. Sanders

*Weather: A User's Guide to the Atmosphere*

Chapter 1 (p. 1)

Icarus Press. South Bend, Indiana, USA. 1985

**Jerome, Jerome K.** 1859–1927

English author

...who wants to be foretold the weather? It is bad enough when it comes, without our having the misery of knowing about it beforehand.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 5 (p. 65)

Collins. London, England. 1957

**Martin, Edward Sandford** 1856–1939

Editor

We all know about the rheumatic people whose bones ache and whose tempers creak for days before a storm. When the storm finally breaks, they limber up at once and feel better; but something in the preliminary airs – waves of ether, electrical disturbances, one cross-grained atmospheric influence or another – rasps their nerves and strains their powers of self-control. And it is observed that these preliminary distresses come oftentimes in weather that to the eye makes an excellent appearance. Fine-looking days may be full of crotchets and cross words, and rainy ones be temperamentally amiable.

*In a New Century*

The Habits of the Sea (p. 326)

Charles Scribner's Sons. New York, New York, USA. 1908

**Webster, Henry Kitchell**

No biographical data available

**Merwin, Samuel** 1874–1936

American playwright and author

Hilda's eye, roaming over the folded newspaper, fell on the weather forecast.

"Fair to-morrow," she said, "and colder."

"That doesn't stand for much. They said the same thing yesterday. It's a worse gamble than wheat."

*Calumet "K"*

Chapter XV (p. 297)

Gossett & Dunlap. New York, New York, USA. 1901

**Mitchell, Margaret** 1900–49

American author

You can always tell the weather by the sunsets.

*Gone With the Wind*

Part One, Chapter I (p. 7)

The Macmillan Company. New York, New York, USA. 1936

**Smith, F. Hopkins** 1838–1918

American author

Work is the universal topic; the weather is too serious a subject to chatter about lightly.

*The Tides of Barnegat*

Chapter XVIII (p. 334)

Charles Scribner's Sons. New York, New York, USA. 1906

**Temple, Sir William** 1628–99

English statesman and essayist

But, with all this, our country must be confessed to be, what a great foreign physician called it, the region of spleen; which may arise a good deal from the great uncertainty and many sudden changes of our weather in all seasons of the year: and how much these affect the heads and hearts, especially of the finest tempers, is hard to be believed by men whose thoughts are not turned to such speculations ...

*Essays* (Volume 1)

Essay 1 (p. 41)

John Sharpe. London, England. 1821

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Who watched the forms of the clouds over this part of the earth a thousand years ago? Who watches them today?

*The Journal of Henry David Thoreau* (Volume 13)

December 13. P.M. (p. 23)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

**Wright, Mabel Osgood** 1859–1934

American author

How we are all more or less creatures of Sun, Shadow, and Imagination, impressed or depressed by weather!

*The Garden of a Commuter's Wife*

Chapter VII (p. 111)

The Macmillan Co. New York, New York, USA. 1905

## CLIMATE CHANGE

### American Geophysical Union

...There is no known geologic precedent for the transfer of carbon from the Earth's crust to atmospheric carbon dioxide in quantities comparable to the burning of fossil fuels without simultaneous changes in other parts of the carbon cycle and climate system. This close coupling between atmospheric carbon dioxide and climate suggests that a change in one would in all likelihood be accompanied by a change in the other.

Climate Change and Greenhouse Gases, American Geophysical Union Report, 1999

Quoted in David Hafemeister

*Physics of Societal Issues. Calculations on National Security, Environment, and Energy* (p. 199)

Springer. New York, New York, USA. 2007

**Crichton, Michael** 1942–

American novelist

[I]n this elastic anything-goes world where science – or non-science – is the hand maiden of questionable public policy, we arrive at last at global warming. It is not my purpose here to rehash the details of this most magnificent of the demons haunting the world. I would just remind you of the now-familiar pattern by which these things are established. Evidentiary uncertainties are glossed over in the unseemly rush for an overarching policy, and for grants to support the policy by delivering findings that are desired by the patron. Next, the isolation of those scientists who won't get with the program, and the characterization of those scientists as outsiders and "skeptics" in quotation marks – suspect individuals with suspect motives, industry flunkies, reactionaries, or simply anti-environmental nut-cases. In short order, debate ends, even though prominent scientists are uncomfortable about how things are being done.

Lecture

Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

**Gore, Al** 1948–

45th vice-president of the USA and environmentalist

...the more we understand about climate change, the more it looks as if [the United States] may be the real culprit. The United States emits about a quarter of the world's greenhouse gases, while the entire continent of Africa is culpable for only about 5% of it. ...We helped manufacture the suffering in Africa, and we have a moral obligation to try to fix it.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 117)

Rodale. New York, New York, USA. 2006

The age-old rhythm of the Earth's seasons – summer, fall, winter, and spring – is...changing as some parts of the world heat up more rapidly than others.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 152)

Rodale. New York, New York, USA. 2006

Climate does naturally change. By studying tree rings, lake sediments, ice cores, and other natural features that provide a record of past climates, scientists know that changes in climate, including abrupt changes, have occurred throughout history. But these changes all took place with natural variations in carbon dioxide levels that were smaller than the ones we are now causing. Cores taken from deep in the ice of Antarctica show that carbon dioxide levels are higher now than they have been at any time in the last 650,000 years, which means we are outside the realm of natural climate variation. More CO<sub>2</sub> in the atmosphere means warming temperatures.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 312)

Rodale. New York, New York, USA. 2006

**Hafemeister, David** 1934–

American physicist

Few scientists debate the fact that Earth is getting warmer. Seventeen of the eighteen warmest years in the 20th century occurred after 1980. The IPCC determined that Earth's surface temperature rose 0.6°C (±0.2°C) during the 20th century. Half this increase occurred since the mid-1970s to reach the highest temperatures in a millennium.

*Physics of Societal Issues. Calculations on National Security, Environment, and Energy* (p. 197)

Springer. New York, New York, USA. 2007

Until alternate energy becomes competitive, natural gas and coal will be the bridging fuels that will supply portable energy as petroleum becomes expensive and less plentiful. And the burning of fossil fuels will probably double CO<sub>2</sub> levels during the next century, causing an unknown amount of climate change.

*Physics of Societal Issues. Calculations on National Security, Environment, and Energy* (pp. 249–250)

Springer. New York, New York, USA. 2007

## Intergovernmental Panel on Climate Change (IPCC)

It is *very likely* that heat waves will be more intense, more frequent and longer lasting in a future warmer climate. Cold episodes are projected to decrease significantly in a future warmer climate. Almost everywhere, daily minimum temperatures are projected to increase faster than daily maximum temperatures, leading to a decrease in diurnal temperature range. Decreases in frost days are projected to occur almost everywhere in the middle and high latitudes, with a comparable increase in growing season length.

In S. Solomon, D. Qin, et al. (eds.)

*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

Cambridge University Press. Cambridge, UK, and New York, New York, USA.

If greenhouse gas concentrations could be reduced, global temperatures would begin to decrease within a decade, although sea level would continue to rise due to thermal expansion for at least another century.

In S. Solomon, D. Qin, et al. (eds.)

*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

Cambridge University Press. Cambridge, UK, and New York, New York, USA.

**Jevons, William Stanley** 1835–82

English economist and logician

Climate, indeed, is a subject upon which the most extravagant and unreasonable statements are made. Not only do

many men, even of much scientific information, imagine that within the short scope of their own recollection they can detect a permanent change in weather or some phenomenon, which would involve a connected change over all the regions of the earth, but they even assert that man's muscular strength and mental ingenuity can affect such changes. The clearing away of trees they say will render a climate dry; extensive reservoirs of water may increase the moistures of the atmosphere.

*Waugh's Australian Almanac, for 1859*

Some Data Concerning the Climate of Australia and New Zealand (p. 79)  
Sydney, Australia. 1859

**Sagan, Carl** 1934–96

American astronomer and science writer

The inadvertent side effects of technology can challenge the environment on which our very lives depend. That means that we must understand science and technology; we must anticipate long-term consequences in a very clever way – not just the bottom line on the profit-and-loss column for the corporation for this year, but the consequences for the nation and the species 10, 20, 50, 100 years in the future.

Wonder and Skepticism

*Skeptical Inquirer*, Jan/Feb 1995 (p. 24)

**Stewart, R. W.** d. 2005

Canadian oceanographer

...one can imagine a gambler's die lying on the floor of a truck running over a rough road; the die is stable on any of its six faces so that in spite of bounding and vibration the same face usually remains up – until a particularly big bump jars it so that it lands with a different face up, whereupon it is stable in its new position.... Perhaps in recent years we have been bouncing along with, say, a four showing. Perhaps 200 years ago the die flipped over to three for a moment, then flipped back to four. It could one day jounce over to a snake eye and bring in a new ice age!

The Atmosphere and the Ocean

*Scientific American*, Volume 221, Number 3, September, 1969 (p. 86)

**Weiner, Jonathan** 1953–

American fiction and non-fiction writer

It is amazing that chemicals measured in parts per million, billion, trillion, should matter to a planet. Yet, together with carbon dioxide, all these trace gases will shape Earth's next one hundred years and beyond. We are turning up the planet's thermostat a little more each year, committing the planet to a higher and higher temperature.

*The Next One Hundred Years*

Chapter 4 (p. 51)

Bantam Books. New York, New York, USA. 1990

**Wohlforth, Charles** 1963–

American journalist and writer

Choosing shorts or long underwear on a particular day is about weather; the ratio of shorts to long underwear in the drawer is about climate.

*The Whale and the Supercomputer: On the Northern Front of Climate Change*  
Chapter 6 (p. 150)

North Point Press. New York, New York, USA. 2004

**CLOUD**

**Bach, Richard** 1936–

American writer

A cloud does not know why it moves in just such a direction and at such a speed, it feels an impulsion.... this is the place to go now. But the sky knows the reason and the patterns behind all clouds, and you will know, too, when you lift yourself high enough to see beyond horizons.

*Illusions: The Adventures of a Reluctant Messiah* (p. 119)

**Hamerton, Philip Gilbert** 1834–94

English artist and art critic

They [clouds] come to the dullest and dreariest of scenes like the splendid cortege of an Oriental sovereign who traverses some miserable village.

*Landscape*

Chapter XXXVIII (p. 421)

Roberts Brothers. Boston, Massachusetts, USA. 1885

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

When scattered clouds are resting on the bosoms of hills, it seems as if one might climb into the heavenly region, earth being so intermixed with sky, and gradually transformed into it.

*The Works of Nathaniel Hawthorne* Volume 9

*American Note-Books*

January 4, 1839 (p. 208)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1914

**Lowell, James Russell** 1819–91

American poet, critic, essayist, editor, and diplomat

Nature is always kind enough to give even her clouds a humorous lining.

*My Study Windows*

Thoreau (p. 195)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1899

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

...clouds are so opaque that, however delicate they may be, you never see one through another. Six feet depth of them, at a little distance, will wholly veil the darkest mountain edge.... And this opacity is, nevertheless, obtained without destroying the gift they have of letting broken light through them, so that, between us and the sun, they may become golden fleeces, and float as fields of light.

*Modern Painters* (Volume 5)  
Part VII, Chapter 2 (p. 119)  
John Wiley & Sons. New York, New York, USA. 1879

## FOG

### Cohen, J. B.

No biographical data available

Town fog is mist made white by Nature and painted any tint from yellow to black by her children; born of the air of particles of pure and transparent water, it is contaminated by man with every imaginable abomination. That is town fog.

*Annual Report of the Board of Regents of the Smithsonian Institution*  
The Air of Towns, Lecture 3 (p. 368)  
US Government Printing Office. Washington, D.C. 1896

## HAIL

### Pliny (C. Plinius Secundus) 23–79

Roman savant and author

Hail is formed of Rain, congealed into Ice: and Snow of the same Humour grown together, but not so hard. Frost is made of Dew frozen. In Winter Snows fall, and not Hail. It hailleth oftener in the Daytime than in the Night; yet Hail sooner melteth by far than Snow.

*Pliny's Natural History. In Thirty-seven Books*  
Book II, Chapter LX (p. 98)  
Printed for the Club by G. Barclay. London, England. 1847–1849

## HOAR-FROST

### Hamerton, Philip Gilbert 1834–94

English artist and art critic

The beauty of hoar-frost is nothing by itself, nothing on naked rock or mountain, nothing in the streets of the city, and out at sea it is visible only on the ship's cordage, if by accident it may whiten it for awhile. But on sylvan landscape it settles like a fairy decoration. No human work is delicate enough to be compared with such delicacy as this, no human artificer in silver or in ivory ever wrought such visible magic as these millions of tiny spears that thrust out points of unimaginable fineness from the lightest spray's utmost extremity. The perfect beauty of this adornment is visible only on tree-branches, and most visible on the thinnest and lightest; on the dark thin twigs of the birch, that bend under the weight of a robin, or on the slender long sprays of the bird-cherry tree, that the little birds love so well.

*The Sylvan Year: Leaves from the Note Book of Raoul Dubois*  
Chapter XI (p. 54)  
Robert Brothers. Boston, Massachusetts, USA. 1886

## HURRICANE

### Blount, Sir Thomas Pope 1649–97

English author

Hurricanes by some are call'd HURRACANOS, and by others, ORANCAN. In some of the CARIBBE ISLANDS the Word HURRICA signifies the DEVIL, where the Tempest took its Name, it being commonly call'd in Latine TEMPESTAS DIABOLICA.

*A Natural History*  
Observations Concerning Hurricanes (p. 416)  
Printed for R. Bentley. London, England. 1693

## ICE STORM

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

...in America the ice-storm is an event. And it is not an event which one is careless about. When it comes, the news flies from room to room in the house, there are bangings on the doors, and shoutings, "The ice-storm! the ice-storm!" and even the laziest sleepers throw off the covers and join the rush for the windows.

*Following the Equator* (Volume 2)  
Chapter XXIII (p. 277)  
Harper & Brothers. New York, New York, USA. 1899

...the Taj has had no rival among the temples and palaces of men, none that even remotely approached it – it was man's architectural ice-storm.

*Following the Equator* (Volume 2)  
Chapter XXIII (p. 277)  
Harper & Brothers. New York, New York, USA. 1899

It occurs to me now that I have never seen the ice-storm put upon canvas, and have not heard that any painter has tried to do it. I wonder why that is. Is it that paint cannot counterfeit the intense blaze of a sun-flooded jewel?

*Following the Equator* (Volume 2)  
Chapter XXIII (p. 279)  
Harper & Brothers. New York, New York, USA. 1899

## LIGHTNING

### Brīhādaranyaka Upanishad

The lightning is like yawning; the shaking of the members is like the rolling of the thunder; the passing of urine is like the rain of the clouds ...

Translated by Edward Röer  
*The Brīhād Aranyaka Upanishad* Column 2, Part 2  
First Chapter (p. 10)  
Society for the Resurrection of Indian Literature. Calcutta, India. 1908

**Huxley, Thomas Henry** 1825–95  
English biologist

The lightning was the angel of the Lord; but it has pleased Providence, in these modern times, that science should make it the humble messenger of man, and we know that every flash that simmers about the horizon on a summer's evening is determined by ascertainable conditions, and that its direction and brightness might, if our knowledge of these were great enough, have been calculated.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 59)

Macmillan & Company Ltd. London, England. 1904

**Muir, John** 1838–1914  
American naturalist

If you are not very strong, try to climb Electric Peak when a big bossy, well-charged thunder-cloud is on it, to breathe the ozone set free, and get yourself kindly shaken and shocked. You are sure to be lost in wonder and praise, and every hair of your head will stand up and hum and sing like an enthusiastic congregation.

*Our National Parks*

Chapter II (p. 59)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

It is a curious fact that all the very old Sequoias have lost their heads by lightning. All things come to him who waits. But of all living things Sequoia is perhaps the only one able to wait long enough to make sure of being struck by lightning. Thousands of years it stands ready and waiting, offering its head to every passing cloud as if inviting its fate, praying for heaven's fire as a blessing; and when at last the old head is off, another of the same shape immediately begins to grow on.

*Our National Parks*

Chapter IX (p. 277)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## SNOW

### Author Undetermined

While watching the snow fall, you can almost fancy that the flakes are white blossoms shaken from a land of flowers that lies somewhere above the sky; those that touch the river are gone in an instant, while some, as they fall slantways, unite together before they touch the earth. Science has seized upon and pictured the fantastic shapes the falling snow-flakes assume, and they are 'beautiful exceedingly.

In Robert Chambers

*The Book of Days* (Volume 1)

January (p. 17)

W. & R. Chambers. London, England. 1864

**Bentley, W. A.** 1865–1931  
American amateur snowflake photographer

Besides combining her greatest skill and artistry in the production of snowflakes, Nature generously fashions the most beautiful specimens on a very thin plane so that they are specially adapted for photomicrographical study.

Photographing Snowflakes

*Popular Mechanics Magazine*, Volume 37, 1922 (p. 309)

**Burroughs, John** 1837–1921  
American naturalist and essayist

For so gentle and on the whole so beneficent an element, the snow asserts itself very proudly. It takes the world quickly and entirely to itself. It makes no concessions or compromises, but rules despotically. It baffles and bewilders the eye, and it returns the sun glare for glare. Its coming in our winter climate is the hand of mercy to the earth and to everything in its bosom, but it is a barrier and an embargo to everything that moves above.

*Writings of John Burroughs* Volume 5

*Pepacton*

Chapter VIII (p. 233)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1909

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Out of the bosom of the Air,  
Out of the cloud-folds of her garments shaken,  
Over the woodlands brown and bare  
Over the harvest-fields forsaken,  
Silent and soft and slow  
Descends the snow.

*The Poetical Works of Henry Wadsworth Longfellow*

Snow-Flakes

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Macmillan, Hugh** 1833–1903  
Scottish minister

It [snow] makes a spiritual world of this dull, dark earth of ours; and the fields that seemed fit only for the growth of man's food, and the tread of weary feet in the common labours of life – covered with its white immaculate carpet – look like a celestial floor on which white-winged angels on lofty errands of mercy might alight from the kindred heavens.

*Two Worlds Are Ours*

Chapter XVII (p. 270)

Macmillan & Company Ltd. London, England. 1880

The line of mountain snow on the blue verge of the horizon is the most exquisite of all sculpture.

*Two Worlds Are Ours*

Chapter XVII (p. 271)

Macmillan & Company Ltd. London, England. 1880

The snow-crystals are the blossoms of inorganic nature. . . . A wreath of snow is thus, indeed, a bank of flowers; and we little think, when walking over its cold and barren surface, that we are treading down at every step a tiny garden.



*Two Worlds Are Ours*  
Chapter XVII (p. 273)  
Macmillan & Company Ltd. London, England. 1880

**Muir, John** 1838–1914  
American naturalist

To lie out alone in the mountains of a still night and be touched by the first of these small silent messengers from the sky is a memorable experience, and the fineness of that touch none will forget.

*Steep Trails*  
Chapter IV (p. 75)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

The fertile clouds, descending, glide about and hover in brooding silence, as if thoughtfully examining the forests and streams with reference to the work before them...

*Our National Parks*  
Chapter VIII (p. 249)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Small flakes or single crystals appear, glinting and swirling in zigzags and spirals; and soon the thronging feathery masses fill the sky and make darkness like night, hurrying wandering mountaineers to their winter quarters.

*Our National Parks*  
Chapter VIII (p. 249)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The faint lisp of snowflakes as they alight is one of the smallest sounds mortal can hear.

*Our National Parks*  
Chapter IX (p. 274)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

How full of creative genius is the air in which these are generated! I should hardly admire them more if real stars fell and lodged on my coat.

In Bradford Torrey and Francis H. Allen (eds.)  
*The Journal of Henry D. Thoreau* (Volume 8)  
January 5, 1856 (p. 87)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1949

Rain ! whose soft architectural hands have power to cut stones, and chisel to shapes of grandeur the very mountains, as no artist could ever do !

In William Drysdale (ed.)  
*Proverbs from Plymouth Pulpit*  
Nature (p. 10)  
D. Appleton & Co. New York, New York, USA. 1887

## STORM

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

An earthquake, a landslide, an avalanche, overtake a man incidentally, as it were – without passion. A furious

gale attacks him like a personal enemy, tries to grasp his limbs, fastens upon his mind, seeks to rout his very spirit out of him.

*Typhoon*  
Chapter X (p. 77)  
Doubleday, Page & Company. Garden City, New York, USA. 1920

**Muir, John** 1838–1914  
American naturalist

Even the storms are friendly and seem to regard you as a brother, their beauty and tremendous fateful earnestness charming alike.

*Our National Parks*  
Chapter IV (p. 99)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## THUNDERSTORM

**Crawford, F. Marion**

The bravest and coolest men have felt their hearts beating faster just before facing cold steel or going into battle, and almost all of them have felt something else too, which has nothing to do with the heart, and which I can only compare to what many women suffer from when there is going to be a thunderstorm – an indescribable physical restlessness and bodily irritation which makes it irksome to stay long in one position and impossible to think consecutively and reasonably about ordinary matters.

Fair Margaret  
*Munsey's Magazine*, Volume XXXIV, Number 4, January, 1906 (p. 510)

## TORNADO

**Aristotle** 440 BCE–322 BCE  
Greek philosopher

It [the tornado] moves things by its wind in the direction in which it is blowing in a straight line, and whirls round by its circular motion and forcibly snatches up whatever it meets.

*Great Books of the Western World* Volume 8  
*Meteorology*  
Book II, I (p. 475)  
Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1952

**Finley, John P.**  
No biographical data available

Ignorance of our surroundings is a most unfortunate plea for those who stubbornly fail to heed the warnings of science. Thousands of people comfort themselves with the thought that as they have escaped in the past, so will they always remain free from danger; but a knowledge of the tornado, and the necessary precautions to be taken for purposes of safety, should be as common and familiar to the people living in tornado districts as a knowledge of the ordinary methods of extinguishing fire.



*Tornadoes*

Tornadoes (pp. 8–9)

The Insurance Monitor. New York, New York, USA. 1887

**Fort, Charles** 1874–1932

American writer

The tornado came wriggling, jumping, whirling like a great green snake, darting out a score of glistening fangs.

*The Book of the Damned*

Chapter XVII (p. 224)

Boni &amp; Liveright. New York, New York, USA. 1919

**WHIRLWIND****Fort, Charles** 1874–1932

American writer

A whirlwind runs amok, and is filled with confusions ...

*Lo!*

Chapter 1 (p. 17)

Claude Kendall. New York, New York, USA. 1931

**WIND****Chandler, Raymond Thornton** 1888–1959

American novelist

Those hot dry Santa Anas [winds] that come down through the mountain passes and curl your hair and make your nerves jump and your skin itch. On nights like that every booze party ends in a fight. Meek little wives feel the edge of the carving knife and study their husbands' necks. Anything can happen.

*Red Wind: A Collection of Short Stories*

Red Wind (p. 11)

World Publishing Co. Cleveland, Ohio, USA. 1946

**Conrad, Joseph** 1857–1924

Polish-born English novelist

It was something formidable and swift, like the sudden smashing of a Vial of Wrath. It seemed to explode all around the ship with an overpowering concussion and a rush of great waters, as if an immense dam had been blown up to windward. It destroyed at once the organised life of the ship by its shattering effect. In an instant the men lost touch of each other. This is the disintegrating power of a great wind. It isolates one from one's kind. An earthquake, a landslip, an avalanche, overtake a man incidentally, as it were – without passion. A furious gale attacks him like a personal enemy, tries to grasp his limbs, fastens upon his mind, seeks to rout the very spirit out of him.

*Typhoon*

Chapter X (p. 77)

Doubleday, Page &amp; Company. Garden City, New York, USA. 1920

The olive hue of hurricane clouds presents an aspect peculiarly appalling. The inky, ragged wrack, flying before a nor'west wind, makes you dizzy with its headlong speed that depicts the rush of the invisible air. A hard sou'wester startles you with its close horizon and its low, gray sky, as if the world were a dungeon wherein there is no rest for body or soul. And there are black-squalls, white-squalls, thunder-squalls, and unexpected gusts that come without a single sign in the sky; and of each kind no one of them resembles another.

*The Mirror of the Sea*

The Character of the Foe (p. 131)

Doubleday, Page &amp; Co. New York, New York, USA. 1916

**Dalton, John** 1766–1844

English chemist and physicist

Winds have ever been considered, with reason, as having a principal share in producing changes of weather, and therefore they demand a particular regard in meteorology.

*Meteorological Observations and Essays* (2nd edition)

Essay Second (p. 81)

Printed by Harrison &amp; Crosfield. Manchester, England. 1834

**Dickens, Charles** 1812–70

English novelist

...a wailing, rushing sound, which shook the walls as though a giant's hand were on them; then a hoarse roar as if the sea had risen; then such a whirl and tumult that the air seemed mad; and then, with a lengthened howl, the waves of wind swept on...

*Barnaby Rudge*

Chapter 33 (p. 172)

George Routledge &amp; Sons. London, England. 1884

**The Bible (King James Version)**

The wind bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh, and whither it goeth...

*John 3:8***Longfellow, Henry Wadsworth** 1807–82

American poet

Through woods and mountain passes

The winds, like anthems, roll.

*The Poetical Works of Henry Wadsworth Longfellow*

Midnight Mass for the Dying Year

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

Properly to appreciate the various offices which the winds and the waves perform, we must regard nature as a whole, for all the departments thereof are intimately connected. If we attempt to study in one of them, we often find ourselves tracing clews which lead us off insensibly into

others, and, before we are aware, we discover ourselves exploring the chambers of some other department.

*The Physical Geography of the Sea*

Chapter X (p. 181)

Harper & Brothers. New York, New York, USA. 1855

‘Tis a noble and herioc thing, the wind! whoever conquered it? In every fight it has the last and bitterest blow. Run tilting at it, and you but run through it.

*Moby Dick*

Chapter CXXXV (p. 523)

The St. Botolph Society. Boston Massachusetts, USA. 1892

### Peattie, Donald Culross 1898–1964

American botanist, naturalist, and author

The oldest voice in the world is the wind. When you see it fitfully turning the blades of a mill lazily to draw water, you think of it as an unreliable servant of man. But in truth it is one of our masters, obedient only to the lord sun and the whirling of the great globe itself.

*Weather: A National Journal* (p. 24)

Weldon Owen Pty Ltd. Sydney, Australia. 1996

### Poynting, John Henry 1852–1914

English physicist

Compare, for instance, the accuracy with which we can describe and foretell the path of a planet with our ignorance of the movements of the atmosphere as dependent on the heat of the sun. The planet keeps to the astronomer’s timetable, but the wind still bloweth almost where it listeth.

Address to the British Association

*Chemical News and Journal of Industrial Science*, Volume 80, Number 2079, September 29, 1899 (p. 156)

### Tyndall, John 1820–93

Irish-born English physicist

...the Italian wind, gliding over the crest of the Matterhorn, is as firmly ruled as the earth in its orbital revolution round the sun ...

*Fragments of Science* (Volume 2)

Chapter I (p. 9)

P.F. Collier & Son. New York, New York, USA. 1905

## WEATHER-FORECAST

### Jerome, Jerome K. 1859–1927

English author

I do think that of all the silly, irritating tomfoolishness by which we are plagued, this “weather-forecast” fraud is about the most aggravating. It “forecasts” precisely what happened yesterday or the day before, and precisely the opposite of what is going to happen today.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 5 (p. 61)

Collins. London, England. 1957

## WEIGHT

### da Vinci, Leonardo 1452–1519

Italian High Renaissance painter and inventor

Weight, pressure, and accidental movement together with resistance are the four accidental powers in which all the visible works of mortals have their existence and their end.

*Leonardo da Vinci’s Note Books* (p. 55)

Duckworth & Company. London, England. 1906

### Rey, Jean 1583–1645

French physician and chemist

I retrace my steps, and affirm that the examination of weights which is made by the balance differs greatly from that which is made by the reason. The latter is only employed by the judicious: the former can be practiced by the veriest clown.

*Essays of Jean Rey*

Essay VIII (p. 17)

William F. Clay. Edinburgh, Scotland. 1895

### Woolcombe, Walter George

No biographical data available

We can no more lock up forces in a box than Pandora could imprison Hope in a casket, so that it is incorrect to talk of a *box of weights* – the correct term being a *box of masses*.

*Practical Work in General Physics for Use in Schools and Colleges*

Units of Measurements (p. 3)

At The Clarendon Press. Oxford, England. 1894

## WEIGHTLESSNESS

### Verne, Jules 1828–1905

French novelist

Fancy has depicted men without reflection, others without shadow. But here reality, by the neutralizations of attractive forces, produced men in whom nothing had any weight, and who weighed nothing themselves.

*From the Earth to the Moon, and Round the Moon*

Chapter VIII (p. 228)

A.L. Burt Company. New York, New York, USA. 1890

## WETLANDS

### Beebe, William 1877–1962

American ornithologist

The marsh, to him who enters it in a receptive mood, holds, besides mosquitoes and stagnation – melody, the mystery of unknown waters, and the sweetness of Nature undisturbed by man.

*The Log of the Sun*

Night Music of the Swamp (p. 172)

Henry Holt and Company. New York, New York, USA. 1906

**Lanier, Sidney** 1842–81

American writer and musician

Ye marshes, how candid and simple and nothing-with-  
holding and free

Ye publish yourselves to the sky and offer yourselves to  
the sea!

In Goodridge Bliss Roberts

*Younger American Poets, 1830–1890*

The Marshes of Glynn

Griffith, Farran, Okeden & Welsh. London, England. 1891

**WHIRLPOOL****Author Undetermined**

When two or several currents meet each other, or cross at  
angles, violent circular motions of the sea are produced,  
which attract everything coming within their vortex, and  
whirling it round in decreasing gyrations, finally engulf  
it in their bosoms. These motions of the sea are called  
*whirlpools*.

*Ocean Scenes: Or, The perils and Beauties of the Deep*

Properties of the Sea (p. 480)

Leavitt & Allen. New York, New York, USA. 1854

**Poe, Edgar Allan** 1809–49

American short story writer

I became possessed with the keenest curiosity about  
the whirl itself. I positively felt a wish to explore its  
depths, even at the sacrifice I was going to make; and  
my principal grief was that I should never be able to  
tell my old companions on shore about the mysteries  
I should see.

In H. Beaver (ed.)

*The Science Fiction of Edgar Allan Poe*

A Descent into the Maelstrom (p. 83)

Penguin Books. Hammondsorth, England. 1976

**Verne, Jules** 1828–1903

French novelist

The maelstrom ! Could a more dreadful word in a more  
dreadful situation have sounded in our ears! We were  
then upon the dangerous coast of Norway. Was the Nau-  
tilus being drawn into this gulf at the moment our boat  
was going to leave its sides? We knew that at the tide the  
pent-up waters between the islands of Ferroe and Lof-  
foden rush with irresistible violence, forming a whirlpool  
from which no vessel ever escapes. From every point of  
the horizon enormous waves were meeting, forming a  
gulf justly called the “Navel of the Ocean,” whose power  
of attraction extends to a distance of twelve miles. There,  
not only vessels, but whales, are sacrificed, as well as  
white bears from the northern regions.

*20,000 Leagues Under the Sea* (p. 301)

Geo. M. Smith & Co. Boston, Massachusetts, USA. 1875

**WHITE DWARF****Updike, John** 1932–

American novelist, short story writer, and poet

You offer cheer to tiny Man

‘Mid galaxies Gargantuan

A little pill in endless night,

An antidote to cosmic fright.

White Dwarf

Source undetermined

**WHY****Poynting, John Henry** 1852–1914

English physicist

On the purely physical or descriptive view, the idea of  
cause is quite out of place. In description we are solely  
concerned with the “how” of things, and their “why” we  
purposely leave out of account.

Address to the British Association

*Chemical News and Journal of Industrial Science*, Volume 80, Number  
2079, September 29, 1899 (p. 155)

**WILD LIFE****Hornaday, William Temple** 1854–1937

American naturalist

It is time for all men to be told in the plainest terms that  
there never has existed, anywhere in historic times, a vol-  
ume of wild life so great that civilized man could not  
quickly exterminate it by his methods of destruction.

*Our Vanishing Wild Life: Its Extermination and Preservation*

Chapter I (p. 6)

Charles Scribner’s Sons. New York, New York, USA. 1913

**WILDERNESS****Abbey, Edward** 1927–89

American environmentalist and nature writer

We would guard and defend and save it [wilderness]  
as a place for all who wish to discover the nearly lost  
pleasures of adventure, adventure not only in the phys-  
ical sense, but also mental, spiritual, moral, aesthetic, and  
intellectual adventure. A place for the free.

*The Journey Home: Some Words in Defense of the American West*

Chapter 8 (p. 88)

E.P. Dutton & Company. New York, New York, USA. 1977

Come on in. The earth, like the sun, like the air, belongs  
to everyone – and to no one.

*The Journey Home: Some Words in Defense of the American West*

Chapter 8 (p. 88)

E.P. Dutton & Company. New York, New York, USA. 1977

On this great river [the Colorado River] one could glide forever – and here we discover the definition of bliss, salvation, Heaven, all the old Mediterranean dreams: a journey from wonder to wonder, drifting through eternity into ever deeper, always changing grandeur, through beauty continually surpassing itself: the ultimate Homeric voyage.

*The Journey Home: Some Words in Defense of the American West*  
Chapter 17 (p. 201)  
E.P. Dutton & Company. New York, New York, USA. 1977

The idea of wilderness needs no defense. It only needs more defenders.

*The Journey Home: Some Words in Defense of the American West*  
Chapter 21 (p. 223)  
E.P. Dutton & Company. New York, New York, USA. 1977

Now I can do no more than offer one final prayer to the young, to the bold, to the angry, to the questioning, to the lost. Beyond the wall of the unreal city, beyond the security fences topped with barbed wire and razor wire, beyond the asphalt belting of the superhighways, beyond the cemented banksides of our temporarily stopped and mutilated rivers, beyond the rage of lies that poisons the air, there is another world waiting for you. It is the old true world of the deserts, the mountains, the forests, the islands, the shores, the open plains. Go there. Be there. Walk gently and quietly deep within it.

*Beyond the Wall*  
Author's Introduction (p. xvi)  
Ballantine Books. New York, New York, USA. 1968

But the love of wilderness is more than a hunger for what is always beyond reach; it is also an expression of loyalty to the earth, the earth which bore us and sustains us, the only home we shall ever know, the only paradise we ever need – if only we had the eyes to see.

*Desert Solitaire*  
Down the River (p. 190)  
Ballantine Books. New York, New York, USA. 1968

How difficult to imagine this place without a human presence; how necessary. I am almost prepared to believe that this sweet virginal primitive land will be grateful for my departure and the absence of the tourists, will breathe metaphorically a collective sigh of relief – like a whisper of wind – when we are all and finally gone and the place and its creations can return to their ancient procedures unobserved and undisturbed by the busy, anxious, brooding consciousness of man. Grateful for our departure? One more expression of human vanity. The finest quality of this stone, these plants and animals, this desert landscape is the indifference manifest to our presence, our absence, our coming, our staying or our going. Whether we live or die is a matter of absolutely no concern whatsoever to the desert.

*Desert Solitaire*  
Bedrock and Paradox (p. 300)  
Ballantine Books. New York, New York, USA. 1968

It is my fear that if we allow the freedom of the hills, and the last of the wilderness to be taken from us, then the very idea of freedom may die with it.

*Down the River*  
Part II, Chapter 8 (p. 121)  
E.P. Dutton & Company. New York, New York, USA. 1982

**Berry, Wendell** 1934–  
American essayist, poet, critic, and farmer

There does exist a possibility that we can live more or less in harmony with our native wilderness; I am betting my life that such a harmony is possible. But I do not believe that it can be achieved simply or easily or that it can ever be perfect, and I am certain that it can never be made, once and for all, but it is the forever unfinished lifework of our species.

*The Land of Harmony*  
Preserving Wilderness (pp. 138–139)  
Five Seasons Press. Hereford, England. 1987

This wilderness, the universe, is somewhat hospitable to us, but it is also absolutely dangerous to us (it is going to kill us, sooner or later), and we are absolutely dependent upon it.

*The Land of Harmony*  
Preserving Wilderness (pp. 138–139)  
Five Seasons Press. Hereford, England. 1987

We live in a wilderness, in which we and our works occupy a tiny space and play a tiny part. We exist under its dispensation and by its tolerance.

*The Land of Harmony*  
Preserving Wilderness (pp. 138–139)  
Five Seasons Press. Hereford, England. 1987

**Brower, David** 1912–2000  
American environmentalist

My feeling is we need to save wilderness for its own sake, for the mysterious and complex knowledge it has within it. Thoreau was right when he said, “In wilderness is the preservation of the world.”

In Jonathan White  
*Talking on the Water*  
Sierra Club Books. San Francisco, California, USA. 1994

...we need boundaries around cities, not around wilderness.

*Let the Mountains Talk, Let the Rivers Run*  
Chapter 5 (p. 43)  
HarperCollins Publishers. New York, New York, USA. 1995

**Carr, William H.** 1902–85  
American desert environmentalist and writer

I am thankful for the wild spaces that are yet untouched. May they not decrease in size and number!

*The Stir of Nature*  
Chapter Eight (p. 116)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

Man has now succeeded in humanizing most of the earth's surface but paradoxically, he is developing simultaneously a cult for wilderness. After having been for so long frightened by the primeval forest, he has come to realize that its eerie light evokes in him a mood of wonder that cannot be experienced in an orchard or a garden.

Humanizing the Earth  
*Science*, Volume 179, Number 4075, February 23, 1973 (p. 772)

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

The world, I have come to believe, is a very queer place, but we have been part of this queerness for so long that we tend to take it for granted. We rush to and from like Mad Hatters upon our peculiar errands, all the time imagining our surroundings to be dull and ourselves quite ordinary creatures. Actually, there is nothing in the world to encourage this idea, but such is the mind of man, and this is why he finds it necessary from time to time to send emissaries into the wilderness in the hope of learning of great events.

*The Star Thrower*  
The Judgment of the Birds (p. 27)  
Times Books. New York, New York, USA. 1978

**Gerould, Katherine Fullerton** 1879–1944  
American writer

The wilderness is a good place to cry in; the echoes are magnificent.

*Modes and Morals*  
The Extirpation of Culture (p. 67)  
Charles Scribner's Sons. New York, New York, USA. 1920

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

I can easily understand why, for most naturalists, the highest form of beauty, inspiration, and moral value might be imputed to increasingly rare patches of true wilderness – that is, to parcels of nature devoid of any human presence, either in current person or by previous incursion.

*Leonardo's Mountain of Clams and the Diet of Worms*  
Introduction (p. 1)  
Harmon Brown. New York, New York, USA. 1998

**Hopkins, Frederick Gowland** 1844–89  
English biochemist

What would the world be, once bereft  
Of wet and of wilderness? Let them be left,  
O let them be left, wilderness and wet;  
Long live the weeds and the wilderness yet.

In W.H. Gardner and N.H. MacKenzie (eds.)  
*The Poems of Gerard Manley Hopkins*  
Inversnaid, Stanza 4  
Oxford University Press, Inc. London, England. 1930

**Hubbard, Henry Vincent** 1875–1947  
American landscape architect

**Kimball, Theodora** 1887–1935  
American librarian

A possession of inestimable value to mankind, which was once so common that it went unheeded, is now becoming in our country so rare that we are beginning to appreciate its preciousness; and the responsibility rests upon us, especially upon our landscape architects, as it has never rested upon any generation of men before, to see to it that the scattered remnants of natural character and natural beauty, which we still have left to us, are preserved for the recreation and inspiration of the generations to come.

*An Introduction to the Study of Landscape Design*  
Chapter V (p. 74)  
The Macmillan Co. New York, New York, USA. 1917

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

The Wilderness and the idea of wilderness is one of the permanent homes of the human spirit.

*Grand Canyon: Today and All Its Yesterday*  
William Sloane Associates, Publishers. New York, New York, USA. 1958

**Leopold, Aldo** 1886–1948  
American naturalist

Shall we now exterminate this thing [wilderness] that made us Americans?

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
Wilderness as a Form of Land Use (p. 137)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

All wilderness areas, no matter how small or imperfect, have a large value to land-science. The important thing is to realize that recreation is not their only or even their principal utility. In fact, the boundary between recreation and science, like the boundaries between park and forest, animal and plant, tame and wild, exists only in the imperfections of the human mind.

In Susan L. Flader and J. Baird Callicott  
*The River of the Mother of God*  
Wilderness as a Land Laboratory (p. 289)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1991

**Lindbergh, Charles A.** 1902–74  
American aviator

In wilderness I sense the miracle of life, and behind it our scientific accomplishments fade to trivia.

The Wisdom of Wilderness  
*Life*, Volume 63, Number 25, December 22, 1967 (p. 10)

**Safina, Carl** 1955–  
Ecologist

I am drawn to the wild not because it is wild but because it is sensible, logical, ordered, stable, resilient.

Wild Comfort  
*Audubon*, January, 2002



**WILDLIFE**

**Borland, Hal** 1900–78  
American writer

The newcomer to the country will find the first signs of “wild life” in his own house. Even before he explores the dooryard he can sharpen his eyes indoors. He may be surprised at the outsiders who want to share that house with him.

*Beyond Your Doorstep: A Handbook to the Country*  
Chapter 1 (p. 1)  
Alfred A. Knopf. New York, New York, USA. 1962

**Hornaday, William Temple** 1854–1937  
American naturalist

And yet the game of North America does not belong wholly and exclusively to the men who kill! The other ninety-seven per cent of the People have vested rights in it.... Posterity has claims upon it that no man can ignore.... A continent without wild life is like a forest with no leaves on the trees.

*Our Vanishing Wild Life*  
Preface (p. ix)  
C. Scribner’s Sons. New York, New York, USA. 1913

**Myers, Norman** 1934–  
British environmentalist

Without knowing it, we utilize hundreds of products each day that owe their origin to wild animals and plants. Indeed our welfare is intimately tied up with the welfare of wild-life. Well may conservationists proclaim that by saving the lives of wild species, we may be saving our own.

*A Wealth of Wild Species: Storehouse for Human Welfare*  
Wild Species (p. 3)  
Westview Press. Boulder, Colorado. 1983

**Prince Philip (Phillip Mountbatten), Duke of Edinburgh** 1921–  
British naturalist

Miners used to take a canary around the coal mines to warn them when the air was so foul that the canary died. This is the importance of wildlife to us; because if wild-life dies it is our turn next. If any part of the life of this planet is threatened, all is threatened. If you say “not interested” to wildlife conservation then you are signing your own death warrant.

*The Times (London)*, May 17, 1988

**WILDNESS**

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

In wildness is the preservation of the world.

Walking  
*The Atlantic Monthly*, Volume 9, Number 56, June, 1862 (p. 665)

There is in my nature, methinks, a singular yearning toward all wildness.

*A Week on the Concord and Merrimack Rivers*  
Sunday (p. 36)  
Charles Scribner’s Sons. New York, New York, USA. 1921

We need the tonic of wildness – to wade sometimes in marshes where the bittern and the meadow-hen lurk, and hear the booming of the snipe; to smell the whispering sedge where only some wilder and more solitary fowl builds her nest, and the mink crawls with its belly close to the ground. At the same time that we are earnest to explore and learn all things, we require that all things be mysterious and unexplorable, that land and sea be infinitely wild, unsurveyed and unfathomed by us because unfathomable.

*Walden or Life in the Woods* (p. 350)  
Houghton Mifflin & Co. New York, New York, USA. 1910

**WIND**

**Jefferies, Richard** 1848–87  
English nature writer

As the wind, wandering over the sea, lakes from each wave an invisible portion, and brings to those on shore the ethereal essence of ocean, so the air lingering among the woods and hedges – green waves arid billows – became full of fine atoms of summer.

*The Pageant of Summer*  
*Eclectic Magazine of Foreign Literature, Science, and Art*,  
Volume XXXVIII, Number 2, August, 1883 (p. 146)

**WISDOM**

**Abelard, Peter** 1079–1142  
French scholastic philosopher

...The first key to wisdom, assiduous and frequent questioning.... By doubting we come to inquiry; by inquiry we perceive the truth ...

In Frederick Denison Maurice  
*Mediaeval Philosophy, Or, A Treatise of Moral and Metaphysical Philosophy from the Fifth to the Fourteenth Century*  
Chapter 1 (p. 138)  
Macmillan & Company Ltd. London, England. 1870

**Aquinas, St. Thomas** 1227?–74  
Dominican philosopher and theologian

Wisdom is a kind of science in so far as it has that which is common to all the sciences, namely, to demonstrate conclusions from principles. But since it has something proper to itself above the other sciences, in so far, that is, as it judges of them all, not only as to their conclusions, but also as to their first principles, therefore it is a more perfect virtue than science.

*Summa Theologica*  
I–II, 57, 2



**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Again, we do not regard any of the senses as wisdom; yet surely these give us the most authoritative knowledge of particulars. But they do not tell us the “why” of anything – e.g., why fire is hot; they only say that it is hot.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book I, Chapter 1 (pp. 499–500)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Wisdom was not born with us, nor will it perish when we descend into the shadows with a regretful backward glance that other eyes than ours are already lit by the dawn of a new and truer mathematics.

*The Queen of the Sciences*

Chapter X (p. 138)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

**Berrill, Norman John** 1903–96

English-born American biologist

Wisdom, the highest product of the human mind, comes late; the young are rarely wise and are not expected to be.

*Man's Emerging Mind*

Chapter I (p. 14)

Dodd, Mead & Company. New York, New York, USA. 1955

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

Wizdum iz like duks eggs – if yu git them, yu hav got tew sarch for them.

*Josh Billings' Wit and Humor*

The Cursid Musketo (p. 101)

George Routledge & Sons. London, England. 1874

**Born, Max** 1882–1970

German-born English physicist

...many scientists are not philosophically minded and have hitherto shown much skill and ingenuity but little wisdom.

*Natural Philosophy of Cause and Chance*

Introduction (p. 2)

Clarendon Press. Oxford, England. 1949

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

There are also the old men, whose days of vigorous building are done, whose eyes are too dim to see the details of the arch or the needed form of its keystone, but who have built a wall here and there, and lived long in the edifice; who have learned to love it and who have even grasped a suggestion of its ultimate meaning; and who sit in the shade and encourage the young men.

*Endless Horizons*

Chapter 17 (p. 181)

Public Affairs Press. Washington, D.C. 1946

**Campbell, Donald T.** 1916–96

American evolutionary philosopher and social scientist

In going beyond what is already known, one cannot but go blindly. If one can go wisely, this indicates already achieved wisdom of some general sort.

In Paul Arthur Schlipp (ed.)

*The Philosophy of Karl R. Popper*

Evolutionary Epistemology (p. 422)

Open Court. La Salle, Illinois, USA. 1974

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Knowledge and wisdom are far from being communicating vessels, and the level of one has no bearing on that of the other.

*Heraclitean Fire: Sketches from a Life before Nature* (p. 110)

The Rockefeller University Press. New York, New York, USA. 1978

**Charlie Chan (Fictional Character)**

Dividing line between folly and wisdom very faint in dark tomb.

*Charlie Chan in Panama*

Film (1940)

**Collingwood, Robin George** 1889–1943

English historian and philosopher

A man ceases to be a beginner in any given science and becomes a master in that science when he has learned that...he is going to be a beginner all his life.

*The New Leviathan; or, Man, Society, Civilization and Barbarism*

Part I, Chapter I, aphorism I. 46 (p. 3)

At The Clarendon Press. Oxford, England. 1942

**Davies, Robertson** 1913–95

Canadian novelist

Knowledge may enable you to memorize the whole of Gray's Anatomy and Osler's Principles and Practice of Medicine, but only wisdom can teach you what to do with what you have learned.

*The Merry Heart*

Chapter 5 (p. 105)

McClelland & Stewart. Toronto, Ontario, Canada. 1996

Knowledge and Wisdom and they are not the same, because Knowledge is what you are taught, but Wisdom is what you bring to it.

*The Cunning Man* (p. 167)

McClelland & Stewart. Toronto, Ontario, Canada. 1994

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...human wisdom...always remains one and the same, however applied to different subjects, and suffers no more differentiation proceeding from them than the light

of the sun experiences from the variety of things which it illumines....

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule 1 (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

Learn as much as you can, but remember that wisdom is more than a mere accumulation of facts. No one hires a man because he knows the encyclopedia by heart.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Nine (p. 108)

Duell, Sloan & Pearce. New York, New York, USA. 1947

Wisdom, if inarticulate, is as impotent as loud-mouthed stupidity.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Nine (p. 112)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Galbraith, John Kenneth** 1908–2006

Canadian-American economist

The enemy of the conventional wisdom is not ideas but the march of events.

*The Essential Galbraith*

The Concept of the Conventional Wisdom (p. 24)

Houghton Mifflin & Co. Boston, Massachusetts, USA. 2001

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The love of truth is the beginning and end of wisdom.

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 27)

Macmillan & Company Ltd. London, England. 1918

**Kingsley, Charles** 1819–75

English clergyman and author

Wise men know that their business is to examine what is, and not to settle what is not.

*The Water-Babies*

Chapter II (p. 62)

Dodd, Mead & Company. New York, New York, USA. 1910

**Latham, Peter Mere** 1789–1875

English physician

Knowledge and wisdom, far from being one, Have oft-times no connection. Knowledge dwells In heads replete with thoughts of other men; Wisdom in minds attentive to their own.

*Lectures on Subjects Connected With Clinical Medicine*

Lecture I (p. 20)

Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

To know how not to know might well be the last word of wisdom.

Translated by Maurice Maeterlinck

In Jean-Henri Fabre

*The Life of the Spider*

Preface (p. 35)

Dodd, Mead & Co. New York, New York, USA. 1913

**Milton, John** 1608–74

English poet

...to know

That which before us lies in daily life

Is the prime Wisdom...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VIII, l. 192–194

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Narby, Jeremy**

Swiss-born anthropologist and author

...wisdom requires not only the investigation of many things, but the contemplation of the mystery.

*The Cosmic Serpent: DNA and the Origins of Knowledge*

Chapter 11 (p. 162)

Tarcher/Putnam. New York, New York, USA. 1998

**Ørsted, Hans Christian** 1777–1851

Danish physicist and chemist

...nothing but the conviction that our love of knowledge is an endeavor after a true reality, and that it is true life, and true harmony, can give you a genuine, enthusiastic love of wisdom. The conviction that when you diffuse knowledge you are instrumental in the consolidation of God's kingdom on earth, can alone give you a true and unalloyed desire to lead those around you towards a higher light and higher knowledge.

This, my young friends, is the important vocation for which you have begun to educate yourselves. Continue your endeavors with holy seriousness, and you will become capable of participating in a joy which the world cannot bestow, and your works will be a blessing to your Fatherland; yes, and will confer a benefit on the whole human race.

Translated by Leonora & Joanna B. Horner

*The Soul in Nature: With Supplementary Contributions*

The Cultivation of Science Considered as an Exercise of Religion (p. 142)

Henry G. Bohn. London, England. 1852

**Procter, Bryan Waller** 1787–1874

English poet

...he who can draw a joy

From rocks, or woods, or weeds, or things

That seem all mute, and does it – is wise.

*The Poetical Works of Barry Cornwall*

A Haunted Stream

Henry Colburn & Company London, England. 1822

**Rowland, Henry Augustus** 1848–1901

American physicist

The holy flame of wisdom burns brightly in a scientific mind and its rays are diffused for the benefit of mankind.

*Discovery, Or. The Spirit and Service of Science*

Chapter III (p. 50)

Macmillan & Co Ltd. London, England. 1916

### The Bible (King James Version)

... I gave my heart to seek and search out by wisdom concerning all things that are done under heaven: this sore travail hath God given to the sons of man to be exercised therewith.

Ecclesiastes 1:13

For in much wisdom is much grief: and he that increaseth knowledge increaseth sorrow.

Ecclesiastes 1:18

**Tolstoy, Leo** 1828–1910

Russian writer

The highest wisdom is established, not on reason alone, not on those worldly sciences, physics, history, chemistry, and the like, on which intellectual knowledge stumbles. The highest wisdom is one. The highest wisdom has one science, the science of the All, the universal science which explains all creation, and the place which man occupies in it.

Translated by Nathan Haskell Dole

*War and Peace* (Volume 2)

Part Second, Chapter II (p. 73)

Thomas Y. Crowell & Co. New York, New York, USA. 1889

### WISE MEN

**Kingsley, Charles** 1819–75

English clergyman and author

...remember the wise; for they have laboured, and you are entering into their labours. Every lesson which you learn in school, all knowledge which raises you above the savage or the profligate – who is but a savage dressed in civilized garments – has been made possible to you by the wise. Every doctrine of theology, every maxim of morals, every rule of grammar, every process of mathematics, every law of physical science, every fact of history or of geography, which you are taught here, is a voice from beyond the tomb. Either the knowledge itself, or other knowledge which led to it, is an heirloom to you from men whose bodies are now mouldering in the dust, but whose spirits live forever before God, and whose works follow them, going on, generation after generation, upon the path which they trod while they were upon

earth, the path of usefulness, as lights to the steps of youth and ignorance.

*Discipline, and Other Sermons*

The Temple of Wisdom (p. 15)

Macmillan & Co Ltd. London, England. 1899

### WONDER

#### Author Undetermined

Many other creatures look up into the night-time sky and see the stars, but we stare at them, wonder how many there are, wonder how far away they are, wonder how they got there, wonder what they are made of, wonder – indeed – why they are there at all.

*Fragments of Reality*

Chapter 1 (p. 6)

Cambridge University Press. Cambridge, England. 1997

**Carson, Rachel** 1907–64

American marine biologist and author

If a child is to keep alive his inborn sense of wonder without any such gift from the fairies, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in.

*The Sense of Wonder* (p. 41)

HarperCollins. New York, New York, USA. 1998

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

The world will never starve for want of wonders; but only for want of wonder.

*Tremendous Trifles*

Tremendous Trifles, I

Dodd, Mead & Company New York, New York, USA. 1909

**Cole, William** 1530–1600

English man of letters

When we contemplate the works of creation in the construction of the planetary system, and the stupendous parts of the universe, we are struck with admiration at their magnitude; so, when we descend the scale of nature, and contemplate the minutiae of material objects, we discover an equal harmony and beauty in their disposition, and are equally lost in wonder.

*Philosophical Remarks on the Theory of Comets, a Dissertation on the Nature and Properties of Light*

Conclusion (p. 93)

B.J. Holdsworth. London, England. 1823

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

The feeling of awed wonder that science can give us is one of the highest experiences of which the human psyche is capable. It is a deep aesthetic passion to rank with the finest that music and poetry can deliver. It is truly one of the things that makes life worth living and it

does so, if anything, more effectively if it convinces us that the time we have for living it is finite.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Preface (p. x)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1998

The fact that we slowly apprehend our world, rather than suddenly discover it, should not subtract from its wonder.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 1 (p. 5)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1998

The mystic is content to bask in the wonder and revel in a mystery that we were not “meant” to understand. The scientist feels the same wonder but is restless, not content; recognizes the mystery as profound, then adds, “But we’re working on it.”

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 2 (p. 17)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1998

We have an appetite for wonder, a poetic appetite, which real science ought to be feeding but which is being hijacked, often for monetary gain, by purveyors of superstition, the paranormal and astrology.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 6 (p. 114)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1998

I believe that astrologers, for instance, are playing on – misusing, abusing – our sense of wonder. I mean when they hijack the constellations, and employ sub-poetic language like the moon moving into the fifth house of Aquarius. Real astronomy is the rightful proprietor of the stars and their wonder. Astrology gets in the way, even subverts and debauches the wonder.

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12th, 1996

There is an appetite for wonder, and isn’t true science well qualified to feed it?

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12th, 1996

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

I do not wonder at a snow-flake, a shell, a summer landscape, or the glory of the stars; but at the necessity of beauty under which the universe lies; that all is and must be pictorial; that the rainbow and the curve of the horizon and the arch of the blue vault are only results from the organism of the eye.

*The Conduct of Life*  
Fate (p. 48)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1904

Men love to wonder, and that is the seed of our science ...

*Society and Solitude*  
Work and Days (p. 152)  
Houghton Mifflin Co. Boston, Massachusetts, USA. 1899

### **Gardner, Martin** 1914–

American writer and mathematics games editor

...almost all scientists believe that as their knowledge increases, their sense of wonder also grows. The scientist sees a flower, said physicist John Tyndall, “with a wonder superadded.”

*Science vs. Beauty?*  
*Skeptical Inquirer*, March 1, 1995

### **Guiducci, Mario** 1585–1646

Italian follower of and ghost writer for Galileo Galilei

When new or rarely seen things awaken in our minds more wonder than those which are common and ordinary, our desire to learn their causes should be aroused accordingly, and with it our wish to put to test those things reported to us by others or supplied by our own minds.

*Discourse on the Comets*  
Discourse on the Comet (p. 2)  
Published by the author. Florence, Italy. 1619

### **Hardy, Thomas** 1840–1928

English poet and regional novelist

Until a person has thought out the stars and their inter-spaces, he has hardly learnt that there are things more terrible than monsters of shape, namely, monsters of magnitude without known shape. Such monsters are the voids and waste places of the sky.

*Two on a Tower*  
Chapter IV (p. 34)  
Harper & Brothers, Publishers. New York, New York, USA. No date

### **Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Accustomed to trace the operation of general causes, and the exemplification of general laws, in circumstances where the uninformed and unenquiring eye perceives neither novelty nor beauty, [the scientist and natural philosopher] walks in the midst of wonders.

*A Preliminary Discourse on the Study of Natural Philosophy*  
Part I, Chapter I, Section 10 (p. 15)  
Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

### **Hunt, Leigh** 1784–1859

English author, poet, and editor

...no wonder is greater than any other wonder: and, if once explained, ceases to be a wonder.

*Table Talk*  
Wonder Never Ceases (p. 52)  
Smith, Elder & Co. London, England. 1902

### **Jacobi, Henri**

No biographical data available

Wonder is only the daughter of Ignorance ...

In William Hamilton  
*Discussions on Philosophy and Literature, Education and University Reform*  
On the Study of Mathematics as an Exercise of the Mind (p. 302)  
Harper & Brothers Publishers. New York, New York, USA. 1861

**Johnston, James Finlay Weir** 1796–1855  
Agricultural chemist

The common life of man is full of wonders, Chemical and Physiological. Most of us pass through this life without seeing or being sensible of them, though every day our existence and our comforts ought to recall them to our minds.

*The Chemistry of Common Life*

Author's Introduction (p. ix)

D. Appleton & Co. New York, New York, USA. 1880

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

There is plenty of wonder left in the universe even after we have examined all the clues nature has thrown our way. I really believe that our imaginations have not even begun to exhaust the possibilities of existence. To proclaim the slogan “The Truth IS Out There” is perhaps too trite. I prefer “You ain’t seen nothin’ yet!”

*Beyond Star Trek: Physics from Alien Invasions to the End of Time*

Epilogue (p. 175)

Basic Books, Inc. New York, New York, USA. 1997

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Novelty excited wonder in persons whose habits of thought are shaken and disarranged by what they see. But the element of wonder never lies in the phenomenon or event observed; its place is in the person observing. People of more vigorous mental type aim at once at an adaptation of thought that will conform to what they have observed. Thus does science eventually become the natural foe of the wonderful.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On Transformation and Adaptation of Scientific Thought (p. 224)

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Poe, Edgar Allan** 1809–49  
American short story writer

...wonders and wild fancies...strangely rife among mankind.

In H. Beaver (ed.)

*The Science Fiction of Edgar Allan Poe*

The Conversation of Eiros and Charmion (p. 67)

Penguin Books. Hammondsorth, England. 1976

**Pope, Alexander** 1688–1744  
English poet

Pretty! in amber to observe the forms  
Of hairs, of straws, or dirt, or grubs, or worms!  
The things, we know, are neither rich nor rare,  
But wonder how the devil they got there.

*The Complete Poetical Works*

Prologue to the Satires, l. 169

Houghton Mifflin Company. New York, New York, USA. 1903

**Sagan, Carl** 1934–96  
American astronomer and science writer

Claims that cannot be tested, assertions immune to disproof are veridically worthless, whatever value they may have in inspiring us or in exciting our sense of wonder.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 10 (p. 171)

Random House, Inc. New York, New York, USA. 1995

**Steeff, Duncan**  
No biographical data available

There is philosophy, and hope, in this great enterprise [of planetary exploration]. What a tribute to the human mind it is! We are replete with ambitions and egotisms, and with our love of the temporal – and yet we project our consciousness to the moons of Jupiter and light-years beyond, to the edges of the universe.

This fascination, which has endured in some form since our ancestors first contemplated the stars, has nothing to do with the material. It exists because we already possess the greatest treasure of all, wonder. wonder. For such a species, there is hope indeed.

In Nigel S. Hey

*Solar System*

Ices in the Solar System (p. 257)

Weidenfield & Nicolson. London, England. 2002

**Thompson, Sir J. Arthur** 1861–93  
Scottish biologist

In the heavens the navigator sails in a practically infinite ocean; for leagues and leagues beyond there is always more sea. There is room for wonder.

*The Bible of Nature*

Chapter I (pp. 10–11)

Charles Scribner's Sons. New York, New York, USA. 1908

**Trimmer, Joshua** 1795–1857  
English geologist

A contemplation of the variety of organization manifested in the world around us, cannot fail to excite our wonder; but if we extend our researches to the remains entombed in the earth's crust, our wonder is increased at the existing variety we find; and we are convinced that the increased system of nature is but a part of what has been, and that the whole visible creation, past and present, may be but an atom compared with the invisible.

*Practical Geology and Mineralogy*

INTRODUCTION (p. 38)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1842

**Verhoeven, Cornelis** 1928–2001  
Dutch philosopher and essayist



Wonder is a certainty which has only just been established and has not yet lost the expectation of seeing its opposite appear. This does not exclude the knowledge of that which is incited by wonder. On the contrary: the more we know about something the more we realize that this knowledge is never exhaustive. Knowledge may nourish wonder since it can postulate the possibility that things may be different than they are.... Wonder that a thing is so is motivated by the possibility that it might be different. This movement is endless since this “difference” remains completely undefined.

Translated by Mary Foran

*The Philosophy of Wonder*

Two (p. 27)

The Macmillan Company. New York, New York, USA. 1972

## WOODS

**Carson, Rachel** 1907–64

American marine biologist and writer

A rainy day is the perfect time for a walk in the woods.

*The Sense of Wonder* (p. 30)

Harper & Row, Publishers, New York 1984

**Foss, Sam Walter** 1858–1911

American librarian and poet

The woods were made for the hunters of dreams,

The brooks for the fishers of song ...

*Dreams in Homespun*

The Bloodless Sportsman (p. 177)

Lothrop, Lee & Shephard. Boston, Massachusetts, USA. 1903

**Howitt, William** 1792–1879

English author

Woods have in all ages vividly impressed the human mind; they possess a majesty and sublimity which strike and charm the eye. Their silence and obscurity affect the imagination with a meditative awe. They soothe the spirit by their grateful seclusion, and delight it by glimpses of their wild inhabitants, by their novel cries, and by odours and beautiful phenomena peculiar to themselves.

*The Book of the Seasons*

October (pp. 350–351)

Henry Colburn & Richad Bentley. London, England. 1831

... woods are to us anything but solitudes – they are populous and inexhaustible worlds, where creatures that mock the grasp but not the mind, a matchless phantasmagoria, flit before us; alternately make us merry with their pleasant follies, delight us with their romantic grandeur and beauty, and elevate our hearts with their sublime sentiments.

*The Book of the Seasons*

October (p. 353)

Henry Colburn & Richad Bentley. London, England. 1831

**Hudson, William Henry**

Argentinean/English ornithologist, naturalist, and author

Pine woods...are monotonous because the trees are nearly all pines and one tree is like another, and their tall, bare trunks wall you in, and their dark stiff foliage is like a roof above you.

*The Book of A Naturalist* (pp. 1–2)

George H. Doran Co. New York, New York, USA. 1919

**Meredith, George** 1828–1909

English novelist and poet

For him the woods were a home and gave him the key  
Of knowledge, thirst for their treasures in herbs and flowers.  
The secrets held by the creatures nearer than we  
To earth he sought, and the link of their life with ours ...

*The Works of George Meredith* (Volume 29)

Melampus

Archibald Constable & Co. Westminster, England. 1898

**Peattie, Donald Culross** 1898–1964

American botanist, naturalist, and author

What we love, when on a summer day we step into the coolness of a wood, is that its boughs close up behind us. We are escaped, into another room of life. The wood does not live as we live, restless and running, panting after flesh, and even in sleep tossing with fears. It is aloof from thoughts and instincts; it responds, but only to the sun and wind, the rock and the stream – never, though you shout yourself hoarse, to propaganda, temptation, reproach, or promises. You cannot mount a rock and preach to a tree how it shall attain the kingdom of heaven. It is already closer to it, up there, than you will grow to be. And you cannot make it see the light, since in the tree’s sense you are blind. You have nothing to bring it, for all the forest is self-sufficient; if you burn it, cut, hack through it with a blade, it angrily repairs the swathe with thorns and weeds and fierce suckers. Later there are good green leaves again, toiling, adjusting, breathing – forgetting you.

*Flowering Earth*

Chapter 3 (p. 22)

G.P. Putnam’s Sons. New York, New York, USA. 1939

## WORD

**Becker, Carl Lotus** 1873–1945

American historian

If we would discover the little backstairs door that for any age serves as the secret entranceway to knowledge, we will do well to look for certain unobtrusive words with uncertain meanings that are permitted to slip off the tongue or the pen without fear and without research; words which, having from constant repetition lost their metaphorical significance, are unconsciously mistaken for objective realities.



*The Heavenly City of the Eighteenth Century Philosophers*  
Chapter II (p. 47)  
Yale University Press. New Haven, Connecticut, USA. 1932

### Dewar, Redcote

No biographical data available

Words undoubtedly are words, but they are meaningless save when expressing intelligible ideas, or symbolising objects.

*From Matter to Man: A New Theory of the Universe*  
Chapter II (pp. 14–15)  
Chapman & Hall, Ltd. London, England. 1898

### Duke of Argyll (George Douglas Campbell)

1823–1900

English statesman and writer on science, religion, and politics

Words, which should be the servants of Thought, are too often its masters; and there are very few words which are used more ambiguously, and therefore more injuriously, than the word “Law.”

*The Reign of Law* (4th American edition)  
Chapter II (p. 63)  
George Routledge & Sons. New York, New York, USA. 1873

### Eddington, Sir Arthur Stanley

1882–1944

English astronomer, physicist, and mathematician

...in science and in most philosophies spoken and printed words are treated, not only as immediate sensory data of our own consciousness, but as communicating to us data existing in other consciousnesses.

*New Pathways in Science*  
Chapter I (p. 10)  
At the University Press. Cambridge, England. 1935

### Heisenberg, Werner Karl

1901–76

German physicist and philosopher

Words have no well-defined meaning. We can sometimes by axioms give a precise meaning to words, but still we never know how these precise words correspond to reality, whether they fit reality or not.

In Paul Buckley and F. David Peat (eds.)  
*Glimpsing Reality: Ideas in Physics and the Link to Biology*  
Werner Heisenberg (p. 7)  
University of Toronto Press. Toronto, Ontario, Canada. 1996

### Hobbes, Thomas

1588–1679

English philosopher and political theorist

...the light of human minds is perspicuous words, but by exact definitions first snuffed, and purged from ambiguity; “reason” is the “pace”; “increase of” science, the “way;” and the benefit of mankind, the “end.” And, on the contrary, metaphors, and senseless and ambiguous words, are like *ignes fatui*; and reasoning upon them is wandering amongst innumerable absurdities and their end, contention and sedition, or contempt.

*Leviathan, Or, The Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (2nd edition)

Chapter V (p. 30)  
George Routledge & Sons. London, England. 1886

### Horace (Quintus Horatius Flaccus)

65 BCE–8 BCE

Roman philosopher and dramatic critic

If so be there are abstruse things which absolutely require new terms to make them clear, it will be in your power to frame words which never sounded in the ears of a cinctured Cethegus, and free pardon will be granted if the license be used modestly.... Each generation has been allowed, and will be allowed still to issue words that bear the mint-mark of the day.

In James Boswell  
*Boswell's "Life of Samuel Johnson"*  
Ars Poetica 48 (Wickham) (fn p. 158, year 1750)  
Oxford University Press, Inc. Oxford, England. 1965

### Lewis, Gilbert Newton

1875–1946

American chemist

There is always the danger is scientific work that some word or phrase will be used by different authors to express so many ideas and surmises that, unless redefined, it loses all real significance.

Valence and Tautomerism  
*Journal of the American Chemical Society*, Volume 35, 191 (p. 144S)

### Locke, John

1632–1704

English philosopher and political theorist

...a loose use of their words serves them [men] well enough in their ordinary discourses or affairs. But this is not sufficient for philosophical inquiries. Knowledge and reasoning require precise determinate ideas.

*The Works of John Locke: In Three Volumes* (Volume 1)  
Book Three, Of the Abuse of Words, 22 (p. 292)  
Printed for John Churchill. London, England. 1714

Vague and insignificant forms of speech, and abuse of language, have so long passed for mysteries of science; and hard and misapplied words, with little or no meaning, have, by prescription, such a right to be mistaken for deep learning, and height of speculation, that it will not be easy to persuade, either those who speak, or those who hear them, that they are but the covers of ignorance, and hindrance of true knowledge.

*An Essay Concerning Human Understanding*  
Epistle to the Reader (p. viii)  
Printed for Thomas Tegg. London, England. 1841

### Lowell, Percival

1855–1916

American astronomer

Let us not cheat ourselves with words. Conservatism sounds finely, and covers any amount of ignorance and fear.

*Mars*  
Chapter VI (p. 210)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1895

### Mach, Ernst

1838–1916

Austrian physicist and philosopher

Without its associated thought a word remains a mere sound.

Translated by Thomas J. McCormack

*Popular Scientific Lectures* (2nd edition)

On Instruction in the Classics and the Mathematico-Physical (p. 343)  
Sciences

The Open Court Publishing Co. Chicago, Illinois, USA. 1897

**Maxwell, James Clerk** 1831–79

Scottish physicist

When a physical phenomenon can be completely described as a change in the configuration and motion of a material system, the dynamical explanation of that phenomenon is said to be complete. We cannot conceive any further explanation to be either necessary, desirable, or possible, for as soon as we know what is meant by the words configuration, mass and force, we see that the ideas which they represent are so elementary that they cannot be explained by means of anything else.

*Scientific Papers*

II, On the Dynamical Evidence of the Molecular Constitution of Bodies (p. 419)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Beware of words – they are dangerous things. They change color like the chameleon, and they return like a boomerang.

In W.S. Thayer

*Sir William Osler, Bart.: Brief Tributes to His Personality, Influence and Public Service*

Osler, The Teacher (p. 52)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Patri, Angelo** 1876–1965

Italian-American author and educator

We tell children things in the clearest words at our command. They say the words back to us and we are satisfied that they have learned something. We think that because they have the words they have the idea. A little investigation will show that very often the words are all they have, the sounds, and nothing whatever of the idea. So, whenever you teach a child something new, be sure to tie the stranger to an old familiar friend. If that does not seem possible, use pictures and drawings and illustrations until the child has a group of related ideas concerning this new idea. Then let him talk it back, making his meaning clear by word and gesture and drawing. Beware the empty word!

*The Problems of Childhood* (p. 188)

D. Appleton & Co. New York, New York, USA. 1926

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The relationship between a theory (or a statement) and the words used in its formulation is in several ways

analogous to that between written words and the letters used in writing them down.

In Paul Arthur Schlipp (ed.)

*The Philosophy of Karl Popper* (Volume 1)

Book I, Part I

Autobiography of Karl Popper

Section 7 (p. 15)

The Open Court Publishing Company. LaSalle, Illinois, USA. 1974

**Schuster, Sir Arthur** 1851–1934

English physicist

Scientific controversies constantly resolve themselves into differences about the meaning of words.

In C. K. Ogden and I. A. Richards

*The Meaning of Meaning*

Introductory Quotations (p. xxiv)

Harcourt, Brace & Company. New York, New York, USA. 1949

**Smith, George Otis** 1871–1944

American geologist

It seems that in our hunt for general principles we feel the need of tagging each observed fact with some word that may connect it with the language in which the great fundamental laws of the universe are proclaimed at the seats of learning.

Paper presented to the Society of Economic Geologists at the Amherst Meeting

December 28, 1921

The chief purpose of words is to convey thoughts, and unless the wavelengths of the words are right the receiving apparatus will utterly fail to pick up the thoughts.

Paper presented to the Society of Economic Geologists at the Amherst Meeting

December 28, 1921

**Whewell, William** 1794–1866

English philosopher and historian

I am always glad to hear of the progress of your researches, and never the less so because they require the fabrication of a new word or two. Such a coinage has always taken place at the great epochs of discovery; like the medals that are struck at the beginning of a new reign – or rather like the change of currency produced by the accession of a new sovereign; for their value and influence consists in their coming into common circulation.

In Silvanus P. Thompson

*Michael Faraday: His Life and Work*

Chapter IV

Letter from Whewell to Faraday

14 October, 1837 (p. 163)

Cassell & Company Ltd. London, England. 1901

**Wolfenden, John Frederick** 1906–85

English education leader

The everyday difficulty is to use words “pure and simple,” without getting entangled in their emotional lives.... [T]he scientist is to a large extent freed from

this temptation. He knows very well the danger of using words.

*The Gap – The Bridge*

Essay on institutional dichotomy

## WORK

**Darwin, Charles Robert** 1809–82

English naturalist

I forget whether I ever told you what the object of my present work is – it is to view all facts that I can master (ehou, ehau, how ignorant I find I am) in Natural History (as on geographical distribution, palaeontology, classification, hybridism, domestic animals and plants, &c., &c., &c.) to see how far they favor or are opposed to the notion that wild species are mutable or immutable: I mean with my utmost power to give all arguments and facts on both sides.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to Fox, March 27, 1855 (p. 409)

D. Appleton & Company. New York, New York, USA. 1896

**Davy, Sir Humphry** 1778–1829

English chemist

The most important part of the history of a man of science is necessarily recorded in his work.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter I (p. 1)

London, England. 1839–1840

## Editor

No man is truly equal to his work until he is superior to it.

Editor's Outlook

*Journal of Chemical Education*, Volume 10, Number 2, February, 1933 (p. 66)

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

Good work is not done by 'humble' men.

*A Mathematician's Apology*

Section 2 (p. 66)

Cambridge University Press. Cambridge, England. 1967

**Littlewood, John Edensor** 1885–1977

English mathematician

Most of the best work starts in hopeless muddle and floundering, sustained on the "smell" that something is there.

In Béla Bollabás (ed.)

*Littlewood's Miscellany*

Academic Life (p. 144)

Cambridge University Press. New York, New York, USA. 1986

**Lowell, Percival** 1855–1916

American astronomer

Gauge your work by its truth to nature, not by the plaudits it receives from man. In the end the truth will prevail and though you may never live to see it, your work will be recognized after you are gone.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 300)

University of Arizona Press. Tucson, Arizona, USA. 1976

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

A raised weight can produce work, but in doing so it must necessarily sink from its height, and, when it has fallen as deep as it can fall, its gravity remains as before, but it can no longer do work.

Translated by E. Atkinson

*Popular Lectures on Scientific Subjects*

First Series

On the Conservation of Force (p. 359)

D. Appleton & Co. New York, New York, USA. 1897

## WORLD

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

The world is the geologist's great puzzle-box; he stands before it like the child to whom the separate pieces of his puzzle remain a mystery till he detects their relation and sees where they fit, and then his fragments grow at once into a connected picture beneath his hand.

*Geological Sketches*

America the Old World (p. 11)

Houghton Mifflin Co. Boston, Massachusetts, USA. 1886

**Bennett, Arnold** 1867–1931

English novelist and playwright

Well, my deliberate opinion is – it's a jolly strange world.

In A.E. Trueman

*This Strange World*

Chapter I (p. 15)

The Scientific Book Club. London, England

**Bridgman, F. W.**

No biographical data available

The world is not a world of reason, understandable by the intellect of man.... It is probable that new methods of education will have to be painfully developed and applied to very young children in order to inculcate the instinctive and successful use of habits of thought so contrary to those which have been naturally acquired.

*Harper's Magazine*, March, 1919

**Bronk, William** 1918–99  
American poet and author

Whether what we sense of this world is the what of this world only, or the what of which of several possible worlds – which what?

*The World, the Worldless*

Metonymy as an Approach to a Real World  
New Directions. New York, New York, USA. 1964

**Bruno, Giordano** 1548–1600  
Italian philosopher and pantheist

God is infinite.... He is glorified not in one, but in countless suns; not in a single earth, a single world, but in a thousand thousand, I say in an infinity of worlds.

*On the Infinite Universe and Worlds*  
1584

**Buchner, Ludwig** 1824–99  
German physician and philosopher

That the world is not governed as is frequently expressed, but that the changes and motions of matter obey a necessity inherent in it, which admits of no exception, cannot be denied by any person who is but superficially acquainted with the natural sciences.

*Force and Matter*

Chapter I (p. 5)  
Trübner & Co. London, England. 1864

**Castaneda, Carlos** 1925–98  
Peruvian-born American author

The world doesn't yield to us directly, the description of the world stands in between.

*Tales of Power*

Appointment with Knowledge (p. 47)  
Washington Square Press. New York, New York, USA. 1974

**Davies, Sir John** 1569–1626  
English poet

Behold the world how it is whirled round,  
And for it is so whirl'd, is named so;  
In whose large volume many rules are found  
Of this new Art, which it doth fairly show:  
For your quick eyes in wandering too and fro  
From East to West, on no one thing can glance,  
But if you make it well, it seemes to daunce.

*Orchestra*

Stanza 34  
1596

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The world is an immense picture-book of every passage in human life.

*Letters and Social Aims*

Poetry and Imagination (pp. 8–9)  
James R. Osgood & Company, Boston, Massachusetts, USA. 1876

...the world is made of thickened light ...

*Complete Works*

The Scholar (p. 258)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1887

**Epicurus** ca. 55–135  
Greek philosopher

A world is a circumscribed portion of the universe, which contains stars and earth and all other visible things, cut off from the infinite, and terminating in an exterior which may either revolve or be at rest, and be round or triangular or of any other shape whatever.

Letter to Pythocles

**Goldsmith, Oliver** 1728–74  
Anglo-Irish writer, poet, and physician

The world may be considered as one vast mansion, where man has been admitted to enjoy, to admire, and to be grateful.

*A History of the Earth and Animated Nature* (Volume 1)

Chapter I (p. 9)  
Claxton, Remson & Haffelfinger. Philadelphia, Pennsylvania, USA. 1875

**Hazlitt, William Carew** 1834–1913  
English bibliographer

If the world were good for nothing else, it is a fine subject for speculation.

In W. Carew Hazlitt (ed.)

*The Round Table; Northcotes Conversations; Characteristics*

Characteristics, CCCII (p. 505)  
George Bell & Sons. London, England. 1884

**Hunt, Leigh** 1784–1859  
English author, poet, and editor

There are two worlds; the world that we can measure with line and rule, and the world that we feel with our hearts and imaginations.

*Men, Women, and Books* (Volume 1)

Fiction and Matter of Fact (p. 9)  
Harper & Brothers Publishers. New York, New York, USA. 1847

**Kant, Immanuel** 1724–1804  
German philosopher

The world around us opens before our view so magnificent a spectacle of order, variety, beauty, and conformity to ends, that whether we pursue our observations into the infinity of space in the one direction, or into its illimitable divisions on the other, whether we regard the world in its greatest or its least manifestations – even after we have attained to the highest summit of knowledge which our weak minds can reach, we find that language in the presence of wonders so inconceivable has lost its force, and number its power to reckon, nay, even thought fails to conceive adequately, and our conception of the whole dissolves into an astonishment without the power of expression – all the more eloquent that it is dumb.

*Critique of Pure Reason*  
Section Sixth (p. 463)  
American Dome Library Co. New York, New York, USA. 1902

### **Keller, David R.**

No biographical data available

### **Golley, Frank B.**

No biographical data available

Looking at the world scientifically is like looking at the world through sunglasses: the color of the lens, like the cultural filter through which each scientist sees the world, adds a quality to the world that is not inherent in the world.

*The Philosophy of Ecology: From Science to Synthesis*  
Introduction (p. 2)  
The University of Georgia Press. Athens, Georgia, USA. 2000

### **Lec, Stanislaw** 1909–66

Polish poet and aphorist

Who created the world? So far only God admits to it.

Translated by Jacek Galazka  
*More Unkempt Thoughts* (p. 52)  
Funk & Wagnalls. New York, New York, USA. 1968

How did they get a permit to create the world?

Translated by Jacek Galazka  
*More Unkempt Thoughts* (p. 57)  
Funk & Wagnalls. New York, New York, USA. 1968

### **Lubbock, John, First Baron Avebury** 1834–1919

English banker, politician, biologist, and archaeologist

The world we live in is a fairyland of exquisite beauty, our very existence is a miracle in itself, and yet few of us enjoy as we might, and none as yet appreciate fully, the beauties and wonders which surround us. The greatest traveler cannot hope even in a long life to visit more than a very small part of our earth, and even of that which is under our very eyes how little we see!

What we do see depends mainly on what we look for. When we turn our eyes to the sky, it is in most cases merely to see whether it is likely to rain. In the same field the farmer will notice the crop, geologists the fossils, botanists the flowers, artists the coloring, sportsmen the cover for game.

*The Beauties of Nature and the Wonders of the World We Live In*  
Chapter I (p. 3)  
Macmillan & Company Ltd. London, England. 1904

### **Lucretius** ca. 99 BCE–55

Roman poet

...lack of power to solve the question troubles the mind with doubts, whether there was ever a birth-time of the world, and whether likewise there is to be any end ...

Translated by H.A.J. Munro  
*T. Lucreti Cari De rerum natura libri sex*  
Book V (p. 145)  
George Bell & Sons. London, England. 1903

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

A competent view of the world can never be got as a gift; we must acquire it by hard work.

Translated by Thomas J. McCormack  
*The Science of Mechanics: A Critical and Historical Account of Its Development*  
Chapter IV (p. 465)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1893

Properly speaking the world is not composed of “things” as its elements, but colors, tones, pressures, spaces, times, in short what we ordinarily call individual sensations.

Translated by Thomas J. McCormack  
*The Science of Mechanics: A Critical and Historical Account of Its Development*  
Chapter IV, Part IV, Section 2 (p. 483)  
The Open Court Publishing Co. Chicago, Illinois, USA. 1893

### **Milne, John** 1850–1930

English geologist

In comparison with ourselves our world is large, its mountains and valleys are gigantic excrescences on its surface, whilst the elevations and depressions, representing continental elevations and ocean basins, form irregularities the magnitude of which we can only appreciate by the aid of figures.

*Seismology*  
Chapter I (p. 1)  
Kegan Paul, Trench, Trubner & Co. London, England. 1908

### **Mumford, David** 1937–

English-born mathematician

The world is a very complicated place, as babies know.

*International Congress of Mathematics 2002*  
Beijing, August 21, 2002

### **Pascal, Blaise** 1623–62

French mathematician and physicist

The whole visible world is only an imperceptible atom in the ample bosom of nature. No idea approaches it. We may enlarge our conceptions beyond all imaginable space; we only produce atoms in comparison with the reality of things.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section II, 72  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Nagel, Thomas** 1937–

American philosopher

...the world is a strange place, and nothing but radical speculation gives us a hope of coming up with any candidates for the truth.

*The View from Nowhere*  
Introduction (p. 10)  
Oxford University Press. Oxford, England. 1989



**Regnault, Noël** 1702–62  
Jesuit mathematician

We have not...Eyes piercing enough to penetrate so far as the Surface of the World; we don't see the external Figure of it: But if we judge it by the common Persuasion, and by what is offered to our Senses, when the Weather is serene, and the Heavens sparkle with Stars, the World is round: It is a Sphere.

*Philosophical Conversations* (Volume 1)  
Conversation XIII (p. 158)

Printed for W. Innys, C. Davis & N. Prevost. London, England. 1731

Till you have discovered to me the Mysteries of the Loadstone, I shall be no more at Quiet than a Loadstone itself, which is not in its natural Situation, and which is seeking out the Poles of the Earth.

*Philosophical Conversations* (Volume 1)  
Conversation XV (p. 196)

Printed for W. Innys, C. Davis & N. Prevost. London, England. 1731

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

The world is a poor affair if it does not contain matter for investigation for the whole world in every age. Nature does not reveal all her secrets at once. We imagine we are initiated in her mysteries: we are as yet, but hanging around her outer courts.

*De Aurmentis Scientiarum*  
De Cometis

**Shelley, Percy Bysshe** 1792–1822  
English poet

Worlds on worlds are rolling ever  
From creation to decay  
Like the bubbles on a river

Sparkling, bursting, borne away.  
*The Complete Poetical Works of Percy Bysshe Shelley*  
Worlds on Worlds

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

The world is so full of a number of things,  
I'm sure we should all be as happy as kings.

*A Child's Garden of Verses*  
Happy Thought  
Delacorte Press. New York, New York, USA. 1985

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Come, my friends,  
'T s not too late to seek a newer world.

...  
To sail beyond the sunset, and the baths  
Of all the western stars.

*Alfred Tennyson's Poetical Works*

Ulysses, l. 56–57, 60–61  
Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

This curious world which we inhabit is more wonderful than it is convenient, more beautiful than it is useful; it is more to be admired than to be used.

Commencement address  
Harvard University, 1837

**Toulmin, Stephen** 1922–  
English philosopher

**Goodfield, June**  
Science writer, screenwriter, and historian

The picture of the natural world we all take for granted today has one remarkable feature, which cannot be ignored in any study of the ancestry of science: it is a historical picture. Not content with achieving intellectual command over the world of their own times, men have been anxious to go further, and discover how the present state of things came to be as it is. Having mapped the existing topography of the heavens and grasped the principles now governing the world of matter, they have also reached back into the darkness of past time, to a period which earlier generations would have found inconceivably remote.

*The Discovery of Time*  
Introduction (p. 17)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

It takes a long time to prepare a world for man, and such a thing is not done in a day. Some of the great scientists, carefully ciphering the evidence furnished by geology, have arrived at the conviction that our world is prodigiously old, and they may be right, but Lord Kelvin is not of their opinion. He takes the cautious, conservative view, in order to be on the safe side, and feels sure it is not so old as they think. As Lord Kelvin is the highest authority in science now living, I think we must yield to him and accept his view. He does not concede that the world is more than a hundred million years old.

In Bernard Devoto (ed.)  
*Letters from the Earth*  
The Damned Human Race  
Chapter I (pp. 211–212)  
Harper & Row, Publishers. New York, New York, USA. 1959

**Weyl, Hermann** 1885–1955  
German mathematician

The world does not happen, it simply is.

*Symmetry*  
Bilateral Symmetry (p. 5)  
Princeton University Press. Princeton, New Jersey, USA. 1960



**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The world is the totality of facts, not of things.

Translated by C. K. Ogden

*Tractatus Logico-philosophicus*

1. 1 (p. 31)

Routledge. London, England. 2005

**Wordsworth, William** 1770–1850  
English poet

...worlds unthought of till the searching mind  
Of Science laid them open to mankind.

*The Complete Poetical Works of William Wordsworth*

To the Moon, Rydal, l. 40

Crowell. New York, New York, USA. 1888

## WORLD, CREATION OF

**Lyell, Sir Charles** 1797–1875  
English geologist

...it is not unreasonable, nor derogatory to the attributes of Omnipotence, to imagine that some general laws may be observed in the creation of new worlds; and if man could witness the birth of such worlds, he might reason by induction upon the origin of his own. But in the absence of such data, an attempt has been made to fancy some analogy between the agents now employed to destroy, renovate, and perpetually vary the earth's surface, and those whereby the first chaotic mass was formed, and brought by supposed nascent energy from the embryo to the habitable state.

*Principles of Geology*

Book I, Chapter II (p. 26)

James Kay, Jun, & Brother. Philadelphia, Pennsylvania, USA. 1837

**Rhind, William** 1797–1878  
Scottish scriptural geologist

The creation of the world, and the planetary system of which it forms a part, is an exercise of the Divine power so utterly beyond the conception of man, that, in speculating upon it, he is glad to throw around the whole the envelopment of infinitude, and filling his imagination with ideas of boundless space and indefinite duration, he endeavors to bring up his mind in some degree commensurate with the subject.

*The Age of the Earth Considered Geologically and Historically*

Section I (p. 11)

Fraser & Co. Edinburgh, Scotland 1838

## WORLD, END OF

**Byron, George Gordon, 6th Baron Byron** 1788–1824  
English Romantic poet and satirist

I had a dream which was not all a dream, The bright sun was extinguished, and the stars Did wander darkling in the external space, Rayless and pathless; and the icy earth Swung blind and blackening in the moonless air; Morn came and went – and came and brought no day...

*The Works of Lord Byron*

Darkness (p. 283)

John Murray. London, England. 1835

**Verne, Jules** 1828–1903  
French novelist

I have always fancied that the end of the world will be when some enormous boiler, heated to three thousand millions of atmospheric pressure, shall explode and blow up our Globe.

Translated by William Lackland

*Five Weeks in a Balloon*

Chapter Sixteenth (p. 123)

D. Appleton & Co. New York, New York, USA. 1869

## WORLD, PLURALITY OF

**Brewster, David** 1781–1868  
Scottish scientist, inventor, and writer

There is no subject within the whole range of knowledge so universally interesting as that of a Plurality of Worlds. It commands the sympathies, and appeals to the judgment of men of all nations, of all creeds, and of all times; and no sooner do we comprehend the few simple facts on which it rests, than the mind rushes instinctively to embrace it.

*More Worlds Than One: The Creed of the Philosopher and the Hope of the Christian*

Introduction (p. 1)

Chatto & Windus. London, England. 1876

## WORLD-EXPOSITION

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

A world-exposition will, therefore, as far as practicable, avoid placing in the forefront matters so abstruse as to be fit for the contemplation and understanding of none but specialists; it will, as a whole, and in all its principal parts, address itself to the general intelligence; for it aims at being, for the multitudes of men and women who avail themselves of its exhibitions and lessons, an exposition of humanity: an exposition, no doubt, of the activities and aspirations and prowess of individual men and women, but of men and women, not in their capacity, as individuals, but as representatives of humankind. Individual achievements are not the object, they are the means, of the exposition.

*The Human Worth of Rigorous Thinking: Essays and Addresses*  
Chapter II (pp. 26–27)  
Columbia University Press. New York, New York, USA. 1916

## WORLDS

**Flammarion, Camille** 1842–1925  
French astronomer and writer

Like a shower of stars the worlds whirl, borne along by the winds of heaven, and are carried down through immensity; suns, earths, satellites, comets, shooting stars, humanities, cradles, graves, atoms of the infinite, seconds of eternity, perpetually transform beings and things; all move on, all wing their flight under the breath divine...

Translated by John Ellard Gore  
*Popular Astronomy: A General Description of the Heavens*  
Book II, Chapter III (p. 109)  
Chatto & Windus. London, England. 1907

**Fort, Charles** 1874–1932  
American writer

But data we shall have of round worlds and spindle-shaped worlds, and worlds shaped like a wheel; worlds like titanic pruning hooks; world linked together by streaming filaments; solitary worlds, and worlds in hordes: tremendous worlds and tiny worlds: some of them made of material like the material of this earth; and worlds that are geometric super-constructions made of iron and steel.

*The Book of the Damned*  
Chapter XII (pp. 154–155)  
Boni & Liveright. New York, New York, USA. 1919

## WRITE

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

When I write for publication every word is misery, and my pen stumbles at every line, so anxious am I to find the ideally best expression, and so great is the number of possibilities which open before me at every step.

Translated by Humphry Ward  
*Amiel's Journal: The Journal Intime of Henri-Frédéric Amiel* (Volume 2)  
1 September, 1875 (p. 191)  
McGraw-Hill Book Co., Inc. New York, New York, USA. 1894

## WRITER

**Sharp, Dallas Lore** 1870–1929  
American author and university professor

For the nature-writer, while he may be more or less of a scientist, is never mere scientist – zoologist or botanist. Animals are not his theme; flowers are not his theme.

Nothing less than the universe is his theme, as it pivots on him, around the distant boundaries of his immediate neighborhood.

*The Face of the Fields*  
Chapter V (p. 116)  
Houghton Mifflin & Co. Boston, Massachusetts, USA. 1911

## WRITING

**Cohen, I. Bernard** 1914–2003  
American physicist and science historian

The writings of all great men stand as a perpetual challenge to each succeeding generation which attempts to make an interpretation suitable to its own age.

*Franklin and Newton*  
Chapter One (p. 3)  
Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Einstein, Albert** 1879–1955  
German-born physicist

Your exposition is of matchless clarity and perspicuity. You did not dodge any problems but took the bull by the horns, said all that is essential, and omitted all that is inessential.

*The Collected Papers of Albert Einstein* (Volume 8)  
Letter 297. Letter to Moritz Schlick, 6 February, 1917 (p. 284)

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

Man without writing cannot long retain his history in his head. His intelligence permits him to grasp some kind of succession of generations; but without writing, the tale of the past rapidly degenerates into fumbling myth and fable.

*The Star Thrower*  
The Long Loneliness (p. 41)  
Times Books. New York, New York, USA. 1978

**Emerson, William** 1701–82  
English mathematician

I am very sensible how difficult a thing it is to write well upon the science of Astronomy; by reason the subject is so comprehensive, and consists of so many parts, and is connected with so many other sciences, which it requires the perfect knowledge of; and besides, is a work of so much time, that a man had need have the life of Mathusalem, to go thro' the whole of it.

*A System of Astronomy: Containing the Investigation and Demonstration of the Elements of that Science*  
The Preface (p. iii)  
Printed for J. Nourse. London, England. 1769

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

...if I write for men of learning, for philosophers, who, one day, will try to some extent to unravel the tough

problem of instinct, I write also, I write above all things for the young. I want to make them love the natural history which you make them hate; and that is why, while keeping strictly to the domain of truth, I avoid your scientific prose, which too often, alas seems borrowed from some Iroquois idiom.

Translated by Alexander Teixeira de Mattos

*The Life of the Fly*

Chapter I (p. 15)

Dodd, Mead & Co. New York, New York, USA. 1925

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

I could not bear merely to write the shibboleths of the movement – or, even worse, to emote for show, catharsis, or accountability, but with nothing different to add to the hyperabundance of current expostulations.

*Eight Little Piggies: Reflections in Natural History*

A Reflective Prologue (p. 13)

W.W. Norton & Co. New York, New York, USA. 1993

**Kepler, Johannes** 1571–1630

German astronomer

...prolixity of phrases has its own obscurity, no less than terse brevity. The latter evades the mind's eye while the former distracts it; the one lacks the light while the other overwhelms with superfluous glitter; the latter does not arouse the sight while the former quite dazzles it.

*New Astronomy*

Author's introduction (p. 47)

At The University Press. Cambridge, England. 1992

**Locke, John** 1632–1704

English philosopher and political theorist

I have put into thy hands what has been the diversion of some of my idle and heavy hours. If it has the good luck to prove so of any of thine, and thou hast but half so much pleasure in reading as I had in writing it, thou wilt as little think thy money, as I do my pains, ill bestowed.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Epistle to the Reader (p. 87)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lowell, Percival** 1855–1916

American astronomer

I believe that all writing should be a collection of precious stones of truth which is beauty. Only the arrangement differs with the character of the book. You string them into a necklace for the world at large, pigeon hole them in drawers for the scientist. In the necklace you have the cutting of your thought, i.e., the expressing of it and the arrangement of the thoughts among themselves.

In Ferris Greenslet

*The Lowell's and Their Seven Worlds*

Book VII, Chapter I (p. 355)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1946

**Moog, Florence** 1915–87

American biologist

Good writing, after all, is just clear thinking. Anyone who can think well enough to make advances in any learned field ought to be able to write about his work. I am, of course, aware that many research papers submitted to scientific journals are, from a literary standpoint, putrid; but usually such essays are scientifically not very fragrant either.

Can Scientists Write for the General Public

*Science*, Volume 119, Number 3095, 23 April, 1954 (p. 567)

**Oersted, Hans Christian** 1777–1851

Danish physicist and chemist

So much is certain: that nothing is better adapted to form a mind which is capable of great development, than living and participating in great scientific revolutions. I would therefore counsel all those whom the period they live in has not naturally presented with this advantage, to procure it artificially for themselves, by reading the writings of those periods in which the sciences have suffered great changes. To pursue the writings of the most opposite systems, and to extract their hidden truth, to answer questions raised by these opposite systems, to transfer the chief theories of the one system into the other, is an exercise which cannot be sufficiently recommended to the student. He would certainly be rewarded for this labour, by becoming as independent as possible of the narrow opinions of his age.

*The Soul in Nature with Supplementary Contributions*

Observations on the History of Chemistry: A Lecture 1805–1807 (p. 322)  
Henry G. Bohn. London, England. 1852

**Rossi, Hugo** 1935–

American mathematician

It is extremely hard for mathematicians to do expository writing. It is not in our nature. In fact, the very nature of mathematical meaning and grammar militates against it. However, this puts us at a distinct disadvantage relative to other sciences.... Good exposition should be valued, not only for the success in communication but also as evidence of real mathematical insight. It is no accident that among our greatest mathematicians are our greatest teachers and expositors.

From the Editor

*Notices of the American Mathematical Society*, Volume 42, Number 1, January, 1995 (p. 4)

**von Braun, Werner** 1912–77

German-born rocket scientist

When a good scientific paper earns a student as much glory as we shower upon the halfback who scored the winning touchdown, we shall have restored the balance that is largely missing from our schools.

Text of Address by von Braun Before the Publishers' Group Meeting  
Here  
*New York Times*, 29 April, 1960, L 20, column 5

## WRONG

**Kingsley, Charles** 1819–75  
English clergyman and author

You must not say that this cannot be, or that that is contrary to nature. You do not know what Nature is, or what

she can do; and nobody knows, not even Sir Roderick Murchison, or Professor Owen, or Professor Sedgwick, or Professor Huxley, or Mr. Darwin, or Professor Faraday, or Mr. Grove.... They are very wise men; and you must listen respectfully to all they say: but even if they should say, which I am sure they never would, "That cannot exist. That is contrary to nature, you must wait a little and see; for perhaps even they may be wrong."

*The Water-Babies*

Chapter II (p. 58)

Dodd, Mead & Company. New York, New York, USA. 1910

## X

### X-RAY

#### Author Undetermined

The Roentgen Rays, The Roentgen Rays  
What is this craze,  
The town's ablaze,  
With the new phase  
of X-rays ways  
I'm full of daze,  
Shock and amaze,  
For nowadays,  
I hear they'll gaze,  
Thro' cloak and gown – and even stays,  
These naughty, naughty Roentgen Rays.

In John G. Taylor

*The New Physics*

Chapter 2 (p. 46)

Basic Books, Inc. New York, New York, USA. 1972

#### Bacon, Roger 1214–92

English philosopher, scientist, and friar

No substance is so dense as altogether to prevent rays from passing. Matter is common to all things, and thus there is no substance on which the action involved in the passage of a ray may not produce a change. Thus it is that rays of heat and sound penetrate through the walls of a vessel of gold or brass. It is said by Boethius that a lynx's eye will pierce through thick walls. In this case the wall would be permeable to visual rays. In any case there are many dense bodies which altogether interfere with the visual and other senses of man, so that rays cannot pass with such energy as to produce an effect on human sense, and yet nevertheless rays do really pass, though without our being aware of it.

In Victor Robinson

*The Story of Medicine*

Chapter VII (pp. 208–209)

The New York Home Library. New York, New York, USA. 1943

#### Charlie Chan (Fictional Character)

X-ray machine most useful for seeing where eye cannot reach.

*Charlie Chan in Egypt*

Film (1935)

#### Hildebrand, Joel Henry 1881–1983

American educator and pioneer chemist

...X-rays are like ordinary light in that they are electromagnetic waves, and unlike it merely on account of their vastly smaller wave length. Just as some substances are opaque, for example to blue light but transparent to red

light, so many substances opaque to ordinary light are transparent to X-rays.

*Principles of Chemistry*

The Constitution of the Atom (p. 274)

The Macmillan Co. New York, New York, USA. 1919

#### Jauncey, G. E. M. 1888–1947

Australian physicist

O Roentgen, then the news is true  
And not a trick of idle rumor  
That bids us each beware of you  
And of your grim and graveyard humor.

*Scientific American*, February 22, 1896

#### Lewis, Edwin Herbert 1866–1938

American rhetorician, novelist, and poet

...left alone with the X-ray man, Marvin plied him with questions. He so fascinated the radiographer that presently he was rewarded with a mystery even greater than that of the subtle unseen light. He was taken into a dark closet and permitted to peer into a small instrument containing salts of radium.

He saw a flight of stars, a sheaf of rays, a faint fierce sparkling! The heavy metallic radium atom was exploding! It was bombarding a small black screen with cannon flashes!

Instantly the boy inquired why somebody did not capture the power of that explosion and set it to work. He was told that any such achievement was impossible. The show was not affected by heat or cold, and would continue for a thousand years or more till the radium was all used up.

What were those flashes? How could he learn more about them? He must wait till he had enough physics to follow the writings of a man named Rutherford.

*White Lightning*

Chapter 2 (p. 8)

Covici-McGee. Chicago, Illinois, USA. 1923

#### Nichols, Ernest Fox 1869–1924

American physicist

In one sense the principal difference between X-rays and the yellow light from a sodium flame is analogous to the difference between the air disturbances caused by an irregular jumble of sharp thin reports of small percussion caps, and the droning of a heavy organ pipe. One is a tangle of single shocks, the other a steady wave motion.

*Physics*

Lecture (p. 20)

The Columbia University Press. New York, New York, USA. 1907

#### Polanyi, Michael 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

One of the greatest and most surprising discoveries of our own age, that of the diffraction of X-rays by crystals

(in 1912) was made by a mathematician, Max von Laue, by the sheer power of believing more concretely than anyone else in the accepted theory of crystals and X-rays.

*Personal Knowledge*

Chapter 9, Section 5 (p. 277)

Harper & Row, Publishers. New York, New York, USA. 1962

### **Röntgen, Wilhelm Conrad** 1845–1923

German physicist

For brevity's sake I shall use the expression "rays," and to distinguish them from others of this name I shall call them "X-rays."

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter IV (p. 42)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Everybody knows something about X-rays, because of their use in medicine. Everybody knows that they can take a photograph of the skeleton of a living person, and show the exact position of a bullet lodged in the brain. But not everybody knows why this is so. The reason is that the capacity of ordinary matter for stopping the rays varies approximately as the fourth power of the atomic number of the elements concerned....

*The ABC of Atoms* (p. 97)

E.P. Dutton & Company. New York, New York, USA. 1923

### **Russell, L. K.**

No biographical data available

She is so tall, so slender, and her bones –  
Those frail phosphates, those carbonates of lime –  
Are well produced by cathode rays sublime,  
By oscillations, amperes and by ohms.  
Her dorsal vertebrae are not concealed  
By epidermis, but are well revealed.

Line on an X-Ray Portrait of a Lady

*Life*, March 12, 1896

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

Come, come, and sit you down, you shall not budge;  
You go not till I set you up a glass

Where you may see the innermost part of you.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

*Hamlet, Prince of Denmark*

Act III, Scene iv, l. 18–20

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Sonneberg, Walter**

No biographical data available

The X-ray and radium were each to have created a revolution: the earth is still revolving.

*Social Eccentricities*

*Social Eccentricities* (p. 35)

Broadway Publishing Co. New York, New York, USA. 1906

## X-RAY ASTRONOMY

### **Keel, William C.**

Astronomer

X-ray astronomy began in serendipity and has remained in its friendly grip ever since.

*The Sky at Einstein's Feet*

Chapter 7 (p. 184)

Springer. New York, New York, USA. 2006

## X-RAY DIFFRACTION

### **Crick, Francis Harry Compton** 1916–2004

English molecular biologist, physicist, and neuroscientist

### **Kendrew, John** 1917–99

English biochemist

X-ray diffraction is not a difficult branch of physics: on the contrary, it is easy to the point of tediousness. The widespread view that it is unintelligible has arisen because a certain intellectual effort is needed to grasp its mathematical foundations, and because it is supposed, incorrectly, that some special type of "three-dimensional imagination" is a prerequisite of understanding its methods and results.

In C.B. Anfinsen and Mortimer Louis Anson

*Advances in Protein Chemistry*

X-Ray Analysis and Protein Structure (p. 135)

Academic Press, Inc. New York, New York, USA. 1957



## Y

### YEAST

**Berzelius, Jöns Jacob** 1779–1848  
Swedish chemist

If the coalescence of the globules of yeast can be ascribed to the presence of vegetable life, the same reason might well be assumed for the coalescence of globules of clay or calcium phosphate.

Quoted in Eduard Buchner  
*Nobel Lectures, Chemistry 1901–1921*

Cell-Free Fermentation  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

**von Liebig, Justus** 1803–73  
German organic chemist

**Wöhler, Friedrich** 1800–82  
German chemist

In a word, these infusoria gobble sugar, and discharge ethyl alcohol from the intestine and carbon dioxide from the urinary organs.

Quoted in Eduard Buchner  
*Nobel Lectures, Chemistry 1901–1921*  
Cell-Free Fermentation  
Elsevier Publishing Co. Amsterdam, The Netherlands. 1966

## Z

### ZEEMAN EFFECT

**Zeeman, Pieter** 1865–1943  
Dutch physicist

In consequence of my measurements of Kerr's magneto-optical phenomena, the thought occurred to me whether the period of the light emitted by a flame might be altered when the flame was acted upon by magnetic force. It has turned out that such an action really occurs.

The Effect of Magnetisation on the Nature of Light Emitted by a Substance  
*Nature*, Volume 55, Number 1424, 11 February, 1897 (p. 347)

### ZERO

**Berlinski, David** 1942–  
American mathematician

It required an act of profound intellectual audacity to assign a name and hence a symbol to all that nothingness. Nothing, *nada*, Zip, Zero, 0.

*A Tour of the Calculus*  
Chapter 2 (p. 13)  
Pantheon Books. New York, New York, USA. 1995

**Bôcher, Maxime** 1867–1918  
American mathematician

...there is what may perhaps be called the method of optimism which leads us either willfully or instinctively to shut our eyes to the possibility of evil. Thus the optimist who treats a problem in algebra or analytic geometry will say, if he stops to reflect on what he is doing: "I know that I have no right to divide by zero; but there are so many other values which the expression by which I am dividing might have that I will assume that the Evil One has not thrown a zero in my denominator this time."

The Fundamental Conceptions and Methods in Mathematics  
*Bulletin of the American Mathematical Society*, 2nd Series, Volume 11, 1904 (pp. 134–135)

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

"Take some more tea," the March Hare said to Alice, very earnestly.

"I've had nothing yet," Alice replied in an offended tone: "so I can't take more."

"You mean you can't take less," said the Hatter, "it's very easy to take more than nothing."

*Alice's Adventure in Wonderland*  
Chapter VII  
Lea & Shepard Publishers. Boston, Massachusetts, USA. 1869

**Carus, Paul** 1852–1919  
American philosopher

Infinity is the land of mathematical hocus pocus. There Zero the magician is king. When Zero divides any number he changes it without regard to its magnitude into the infinitely small; and inversely, when divided by any number he begets the infinitely great.

The Nature of Logical and Mathematical Thought  
*Monist*, Volume 20, Number 1, January, 1910 (p. 69)

**Dunham, William**  
American mathematician

Dividing by zero is the closest thing there is to arithmetic blasphemy.

*The Mathematical Universe: An Alphabetical Journey Through the Great Proofs, Problems, and Personalities*  
Quotient (p. 203)  
John Wiley & Sons, Inc. New York, New York, USA. 1994

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

One microscopic glittering point; then another; and another, and still another; they are scarcely perceptible, yet they are enormous. This light is a focus; this focus, a star; this star, a sun; this sun, a universe; this universe, nothing. Every number is zero in the presence of the infinite.

Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Second, Chapter V (p. 370)  
The Heritage Press. New York, New York, USA. 1961

**Humez, Alexander**  
No biographical data available

**Humez, Nicholas**  
No biographical data available

**Maguire, Joseph**  
No biographical data available

Zero is where it all begins, the clean slate.  
*Zero to Lazy Eight*  
Zero (p. 20)  
Simon & Schuster. New York, New York, USA. 1993

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

We can admire 0 [zero]; we can wonder at it; we could never love it, nor sin for its sake; neither would it regenerate us; it is lacking in heat and humanity.

*Prefaces*  
Preface to a Moral Book of Arithmetic (p. 194)  
D. Appleton & Co. New York, New York, USA. 1919

**Oken, Lorenz** 1779–1851  
German naturalist

The whole science of mathematics depends upon zero. Zero alone determines the value in mathematics. Zero is in itself nothing. Mathematics is based upon nothing, and, consequently, arises out of nothing.

*Elements of Physiophilosophy*

Part I (p. 5)

The Ray Society. London, England. 1847

**Pirsig, Robert M.** 1928–

American writer

He used the number zero as a starter. Zero, originally a Hindu number, was introduced to the West by the Arabs during the Middle Ages and was unknown to the ancient Greeks and Romans. How was that? he wondered. Had nature so subtly hidden zero that all the Greeks and all the Romans...millions of them...couldn't find it? One would normally think that zero is right out there in the open for everyone to see.

*Zen and the Art of Motorcycle Maintenance*

Chapter 19 (p. 298)

HarperCollins Publishers, Inc. New York, New York, USA. 2006

**Poincaré, Jules Henri** 1854–1912

French mathematician and theoretical astronomer

Zero is the number of objects that satisfy a condition that is never satisfied. But as never means *no case*, I do not see that any progress has been made.

In Morris Kline

*Mathematics: The Loss of Certainty* (p. 233)

Oxford University Press. Oxford, England. 1980

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The point about zero is that we do not need to use it in the operations of daily life. No one goes out to buy zero fish. It is in a way the most civilized of all the cardinals, and its use is only forced on us by the needs of cultivated modes of thought.

*An Introduction to Mathematics*

Chapter V (p. 63)

Henry Holt & Co. New York, New York, USA. 1911

**Zamyatin, Yevgeny** 1884–1937

Russian novelist, playwright, and satirist

The circles are at times golden, sometimes they are bloody, but all have 360 degrees. They go from 0 degrees to 10 degrees, 20 degrees, 200 degrees, 360 degrees – and then again 0 degrees. Yes we have returned to zero. But for a mathematically working mind it is obvious that this zero is different.

Translated by Gregory Zilboorg

*We*

Record Twenty (p. 110)

E.P. Dutton & Company. New York, New York, USA. 1952

## ZETA

**Conrey, B.**

No biographical data available

It's a whole beautiful subject and the Riemann zeta function is just the first one of these, but it's just the tip of the iceberg. They are just the most amazing objects, these L-functions – the fact that they exist, and have these incredible properties are tied up with all these arithmetical things – and it's just a beautiful subject. Discovering these things is like discovering a gemstone or something. You're amazed that this thing exists, has these properties and can do this.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 12 (p. 196)

Farrar, Straus & Giroux. New York, New York, USA. 2002

**Gutzwiller, M. C.**

Swiss-born American physicist

The zeta function is probably the most challenging and mysterious object of modern mathematics, in spite of its utter simplicity.... The main interest comes from trying to improve the Prime Number Theorem, i.e., getting better estimates for the distribution of the prime numbers. The secret to the success is assumed to lie in proving a conjecture which Riemann stated in 1859 without much fare, and whose proof has since then become the single most desirable achievement for a mathematician.

*Chaos in Classical and Quantum Mechanics*

Chapter 17.9 (p. 308)

Springer-Verlag. New York, New York, USA. 1990

**Sabbagh, K.**

Writer and television producer

In 1859, a German mathematician called Bernhard Riemann, a "timid diffident soul with a horror of attracting attention to himself," published a paper that drew more attention to him than to almost any other mathematician in the 19th century. In it he made an important statement: the non-trivial zeros of the Riemann zeta function all have real part equal to  $1/2$ . That is the Riemann Hypothesis: 15 words encapsulating a mystery at the heart of our number system.

In Ernst Peter Fischer

*Beautiful Mathematics*

Prospect, January, 2002

## ZETA FUNCTION

**Bombieri, Enrico** 1940–

Italian mathematician

I am firmly convinced that the most important unsolved problem in mathematics today is the truth or falsity of a conjecture about the zeros of the zeta function, which was first made by Riemann himself.... Even a single exception to Riemann's conjecture would have enormously strange consequences for the distribution of prime numbers.... If the Riemann hypothesis turns out to be false, there will be huge oscillations in the distribution of primes. In an orchestra, that would be like one loud instrument that drowns out the others – an aesthetically distasteful situation.

Prime Territory: Exploring the Infinite Landscape at the Base of the Number System

*The Sciences*, Sept/Oct 1992

**Borwein, J.** 1951–  
Scottish mathematician

**Bradley, D.**

No biographical data available

It is intriguing that any of the various new expansions and associated observations relevant to the critical zeros arise from the field of quantum theory, feeding back, as it were, into the study of the Riemann zeta function. But the feedback of which we speak can move in the other direction, as techniques attendant on the Riemann zeta function apply to quantum studies.

Computational Strategies for the Riemann Zeta Function

*Journal of Computational and Applied Mathematics*, Volume 121, 2000

**Sarnak, P.** 1953–  
South African-born American mathematician

[It has been] said that the zeros [of the Riemann zeta function] weren't real, nobody measured them. They are as real as anything you will measure in a laboratory – this has to be the way we look at the world.

1999 *Mathematical Science Research Institute lecture*

Random Matrix Theory and Zeroes of Zeta Functions – A Survey

## ZODIAC

**Porter, Jermain Gildersleeve** 1852–1933  
Astronomer

This zone or girdle, stretching around the celestial sphere, might be called the zoological garden of the sky, our title, zodiac, coming from the Greek and signifying “a circle of animals.”

*The Stars in Song and Legend*

The Starry Heavens (p. 25)

Ginn & Co. Boston, Massachusetts, USA. 1901

## ZOO

**Diolé, Philippe** 1908–77  
French author and undersea explorer

The world of animals in captivity offers us at once a prophetic glimpse and a caricature of the world in which modern man lives out his life. The animal suffers psychologically and his suffering is not unlike that of man himself, since its world is characterized by deterioration of its environment and by its own degradation. The causes are the same in both cases: the increase in the number of individual animals in a zoo – baboons, for example – suffer from, and are deformed by, lack of sufficient space for them to lead a harmonious social existence. When captivity has done its work and an animal has become truly dangerous, it then becomes necessary to isolate it in a cage of its own.

Translated by J.F. Bernard

*The Errant Ark: Man's Relationship with Animals*

The Cruelty of Paradise

Putnam. New York, New York, USA. 1974

**Hediger, Heini** 1908–92  
Swiss zoologist

One of the most frequent misconceptions which is constantly met in the zoo is the business of regarding the animals as prisoners. This is as false and old-fashioned as if in these days everybody still thought that radio and television sets contained little men who talked, sang and danced inside the sets.

Translated by Gwynne Vevers and Winwood Reade

*Man and Animal in the Zoo*

Chapter 3 (p. 99)

Delacorte Press. New York, New York, USA. 1969

**Queneau, Raymond** 1903–76  
French poet, novelist, and publisher

In the dog days while I was in a bird cage at feeding time I noticed a young puppy with a neck like a giraffe who, like the toad, ugly and venomous, wore yet a precious beaver upon his head. This queer fish obviously had a bee in his bonnet and was quite bats; he started yak-yakking at a wolf in sheep's clothing claiming that he was treading on his dogs with his beetle-crushers, but the sucker got a flea in his ear; that foxed him, and quiet as a mouse he ran like a hare for a perch.

I saw him again later in front of the Zoo with a young buck who was telling him to bear in mind a certain drill about his fevers.

*Exercises in Style*

Zoological (p. 179)

New Direction Publishing Corporation. New York, New York, USA. 1981

**Robinson, Phillip T.**  
No biographical data available

The zoo is like a living creature, demanding to be fed, bathed, and nurtured in a daily ritual of reincarnation.

*Life at the Zoo*

Intern at the Zoo (p. 13)

Columbia University Press. New York, New York, USA. 2004

**Wynne, Annette**

American poet

Excuse us, Animals in the Zoo,  
I'm sure we're very rude to you;  
Into your private house we stare  
And never ask you if you care;  
And never ask you if you mind.  
Perhaps we really are not kind:  
I think it must be hard to stay  
And have folks looking in all day,  
I wouldn't like my house that way.

*All Through the Year*

Excuse Us, Animals in the Zoo

Frederick A. Stokes. New York, New York, USA. 1932

**ZOO CHEMISTRY****Lehmann, Karl Gotthelf**

No biological data available

Zoo-chemistry should not only embrace, according to the principles of pure chemistry, all substances standing in a more or less intimate relation to the matters actually found in animal bodies, but it should likewise make the fullest and most extended application of the various propositions and theories by which general chemistry have at different times been embraced.

Translated by George E. Day

*Physiological Chemistry* (Volume 1)

The Organic Substrata of the Animal (pp. 35–36)

Blanchard &amp; Lea. Philadelphia, Pennsylvania, USA. 1855

**ZOOLOGIST****Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Lay aside all conceit. Learn to read the book of nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search.

In David Stair Jordan

*Popular Science Monthly*, Volume 40, 1891**Brooks, William Keith** 1848–1908

American zoologist

If I sometimes speak of things that are not commonly held to fall within the province of zoology – if I try now and then for soundings in waters which able pilots tell us are far out of the course of our ship – I hope they who follow me to the end of our voyage will admit that I have not wandered from our true course; although it may be well to show now, by way of introduction, how it is that zoologists find themselves face to face with many problems which other men of science have agreed to lay aside as insoluble or irrelevant.

*The Foundations of Zoology*

Lecture I (p. 14)

Macmillan &amp; Co Ltd. London, England. 1899

**Crampton, Henry Edward** 1875–1956

American paleontologist

Glorying in the great achievements of his science, reveling like the mathematician in the ordered assemblage of related and organized knowledge, the student of zoology joins his fellows yet again for a renewed attack upon the distant ramparts of the unknown, deriving courage and inspiration from the motto: *Ignoramus, in hoc signo laboremus* [We are ignorant; so let us work].

*Lectures on Science, Philosophy and Art, 1907–1908*

Zoology (p. 36)

The Columbia University Press. New York, New York, USA. 1908

**Hornaday, William Temple** 1854–1937

American naturalist

Trained zoologists are men and women of mental resources. They are accustomed to taking initiative, to creation, to organization and direction. A well trained zoologist is like a high-class business man; he knows how to attack any subject or cause and go to the bottom of it. More than that, he knows how to find out how to promote any cause.

*Proceedings of the American Association of Museums*

The Duty of American Zoologists to American Wild Life (p. 113)

Charleston, South Carolina, USA. 1912

**Huxley, Thomas Henry** 1825–95

English biologist

If the study of man is his object, he is called an anatomist, or a physiologist, or an ethnologist; but if he dissects animals, or examines into the mode in which their functions are performed, he is a comparative anatomist or comparative physiologist. If he turns his attention to fossil animals, he is a palaeontologist. If his mind is more particularly directed to the description specific, discrimination, classification, and distribution of animals, he is termed a zoologist.

*Lay Sermons, Addresses and Reviews*

Chapter VI (pp. 95–96)

D. Appleton &amp; Co. New York, New York, USA. 1903

**Wheeler, William Morton** 1865–1937

American entomologist

...I shall strenuously endeavor to be modern, I can only beg you, if I fail to come within hailing distance of the advance guard of present-day zoologists, to remember that the range of adaptability in all organisms, even zoologists, is very limited.

*Essays in Physiological Biology*

Essay I (p. 4)

Harvard University Press. Cambridge, Massachusetts, USA. 1939

**ZOOLOGY**

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

A man cannot be professor of zoology on one day and of chemistry on the next, and do good work in both. As in a concert all are musicians, one plays one instrument, and one another, but none all in perfection.

Quoted in David Starr Jordan

*Science Sketches*

Quoted in David Starr Jordan (p. 146)

A.C. McClurg & Co. Chicago, Illinois, USA. 1896

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

**HIPPOGRIF**, n. An animal (now extinct) which was half horse and half griffin. The griffin was a compound creature, half lion and half eagle. The hippogriff was, therefore, only one quarter eagle, which is \$2.50 in gold. Zoology is full of surprises.

*The Devil's Dictionary*

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**Bock, W. J.**

No biographical data available

Communication – information exchange – among zoologists is the core of zoological nomenclature; everything else pales in the light of the importance of communication.

History and Nomenclature of Avian Family Group Names

*Bulletin of the American Museum of Natural History*, Volume 221, 1994 (p. 8)

**Crampton, Henry Edward** 1875–1956

American paleontologist

Like the human and other sciences, zoology has arisen from that vague uncoordinated and unresolved mass of knowledge, the Natural Philosophy of not very remote times, which undertook to comprehend all there was of nature and thought.

*Lectures on Science, Philosophy and Art, 1907–1908*

Zoology (p. 5)

The Columbia University Press. New York, New York, USA. 1908

The many connected details of animal structure and development and function constitute the threads, as it were, which are interwoven by comparative treatment to form the warp and woof of the fabric of zoology.

*Lectures on Science, Philosophy and Art, 1907–1908*

Zoology (p. 8)

The Columbia University Press. New York, New York, USA. 1908

...the great questions of zoology are the *what* and the *how* of evolution.

*Lectures on Science, Philosophy and Art, 1907–1908*

Zoology (p. 8)

The Columbia University Press. New York, New York, USA. 1908

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Living, as I do, in an educated and scientific atmosphere, I could not have conceived that the first principles of zoology were so little known. Is it possible that you do not know the elementary fact in comparative anatomy, that the wing of a bird is really the forearm, while the wing of a bat consists of three elongated fingers with membranes between?

*The Lost World*

Chapter IV (p. 55)

The Colonial Press. Clinton, Massachusetts, USA. 1959

**Elton, Charles S.** 1900–91

English biologist

...the discoveries of Darwin, himself a magnificent field naturalist, had the remarkable effect of sending the whole zoological world flocking indoors, where they remained hard at work for fifty years or more, and whence they are now beginning to put forth cautious heads again into the open air.

*Animal Ecology*

Chapter I (p. 3)

Sidgwick & Jackson, Ltd. London, England. 1927

**Feynman, Richard P.** 1918–88

American theoretical physicist

I began to read the paper. It kept talking about extensors and flexors, the gastrocnemius muscle, and so on. This and that muscle were named, but I had not the foggiest idea of where they were located in relation to the nerves or to the cat. So I went to the librarian in the zoology section and asked her if she could find me a map of the cat. "A map of the cat, sir?" she asked horrified. "You mean a zoological chart!"

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

A Map of a Cat? (p. 72)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

**Hornaday, William Temple** 1854–1937

American naturalist

The love of wild life springs eternal in the human breast. It is as natural for every child to be interested in animals as it is for every child to love the sound of music. Sad to say, however, that natural love for zoology often is completely stifled, or warped out of shape, by lack of opportunity. Those who by force of circumstances are compelled to grow up and live out their lives without knowing the satisfaction that is derived from an intimate acquaintance with at least one section of animal life, lose much pleasure to which they legitimately are entitled,

*The Science-history of the Universe*

Introduction (p. ix)

The Current Literature Publishing Co. New York, New York, USA. 1909



Under favorable conditions, the study of animal life becomes not only profitable to mankind, but also as musical as Apollo's lute. To know the animal life of the world is to know the world. It is impossible for an intelligent mind to grasp the principal animal forms of a given country without at the same time acquiring a great store of knowledge of that country's topography, soil, climate and people.

In Francis Rolt-Wheeler

*The Science-history of the Universe* (Volume 6)

Introduction (p. ix)

The Current Literature Publishing Co. New York, New York, USA. 1909

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Zoology is as limitless as cosmography.

Translated by Isabel F. Haggood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 418)

The Heritage Press. New York, New York, USA. 1961

### **Kovalevskii, V. O.**

Russian paleontologist

And so, the task of modern zoology consists in this; it should acquaint us with the entire variety of animal forms which populate our world, not in terms of a disorganized multitude from which this or that form happens to catch our attention, but as a structured whole, in which each form occupies a designated place, so one can instantly note and critically analyze all the particularities of each separate member; it should show us the inner structure of these groups and of their individual members, and in what relationship they stand to members of other groups; it should present the history of each member, beginning with its [first] appearance...it should open the ancient tombs of the earth and demonstrate to us the endless series of ancestors and relatives which proceed those animals which we now see.

In William Coleman and Camille Limoges (eds.)

*Studies in History of Biology* (Volume 2)

Kovalevskii and Paleontology (pp. 112–113)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1977–84

### **Müller, Fritz** 1821–97

German biologist

Just as in Christian countries there is a catechism of morals, which everyone knows by heart, but which no one considers it his duty to follow, or expects to see followed by others – so zoology also has its dogmas, which are just as generally professed as they are denied in practice.

Quoted in Ernst Heinrich Philipp August Haeckel

*The History of Creation, Or, The Development of the Earth and Its Inhabitants by the Action of Natural Causes* (Volume 1) (4th edition) (p. 51)

D. Appleton & Co. New York, New York, USA. 1892

### **Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

The existence of animals was not discovered by zoologists, nor that of plants by botanists, and the scientific value of zoology and botany is but an extension of man's pre-scientific interests in animals and plants.

*Personal Knowledge*

Chapter 6, Section 2 (p. 139)

Harper & Row, Publishers. New York, New York, USA. 1962

### **Shipley, Arthur Everett** 1861–1927

Zoologist

### **MacBride, Ernest William**

No biographical data available

Before any progress can be made with the study of Zoology, it is necessary to get clear ideas on two points: firstly, as to what is meant by life and living things; and secondly, as to how an animal is to be distinguished from a plant.

*Zoology: An Elementary Text-book*

Chapter I (p. 1)

At the University Press. Cambridge, England. 1904

### **Wilson, Edmund Beecher** 1856–1939

American zoologist

The pioneer days of zoology are past. The naturalist of the future must be thoroughly trained in the methods and results of chemistry and physics. He must prepare himself for a life of intensive research, of high specialization; but in the future, even more than in the past, he will wander in vain amid the dry sands of special detail if the larger problems and general aims of his science be not held steadfastly in view. For these are the outstanding beacon lights of progress; and while science viewed at close range seems always to grow more complex, a wider vision shows that her signal discoveries are often singularly simple.

*Annual Report of the Board of Regents of the Smithsonian Institution* (1915)

Some Aspects of Progress in Modern Zoology (p. 408)

Government Printing Office. Washington, D.C. 1916

## ZOOLOGY, LEARNING

### **Hudson, C. T.**

No biographical data available

...the happier country lad wanders among fields and hedges, by moor and river, sea-washed cliff and shore, learning zoology as he learnt his native tongue, not in paradigms and rules, but from Mother Nature's own lips.

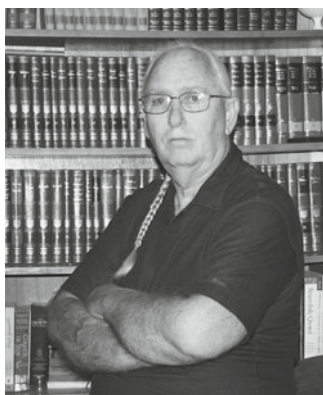
On Some Needless Difficulties in the Study of Natural History

*Nature*, Volume XLI, February 20, 1890 (p. 376)

# About the Editors



**Alma E. Cavazos-Gaither** was born on January 6, 1955, the sixth of eleven children, in the sleepy south Texas town of San Juan. Her parents were migrant farm workers and she grew up working long hours in the fields with her brothers and sisters. Upon graduating from high school she joined the US Navy. Alma has degrees from Central Texas College and the University of Mary Hardin-Baylor. She is in the Navy Reserves and has made two deployments in support of Iraqi Freedom. She enjoys traveling, scrap booking, photography, swimming, and writing.



**Carl C. Gaither** was born on June 3, 1944 in San Antonio, Texas. He was an only child, grew up in an Air Force family, and quit school while in the tenth grade to join the US Navy. Carl has degrees from the University of Hawaii, McNeese State University, Northeast Louisiana University, and the University of Southwest Louisiana and has completed the US Army Command and General Staff College. He enjoys writing, swimming, and music.

Carl and Alma were married in December 1995, and, together, they have compiled ten books on science quotations.

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